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Ferndale Stormwater Planning
Stormwater Management Action Plan

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This project is funded by the City of Ferndale Stormwater and Flood Control Utility Fund. The following people are instrumental to the success of this project:

- Paul Knippel — City of Ferndale, Project Manager
- Chad Drake — NHC, Water Resources Engineer
- Eli McMeen — NHC, Water Resources Engineer
- Derek Stuart — NHC, Principal
- Dale Buys — R&E, Principal

EXECUTIVE SUMMARY

As part of its NPDES Phase II Permit, the City of Ferndale (City) must perform stormwater planning to identify policies and strategies to improve water quality and protect the receiving waters to which the City's municipal separate storm sewer system (MS4) discharges. Specific requirements include performing a citywide watershed assessment to characterize receiving water conditions, prioritizing watersheds for retrofits and other stormwater management actions, and developing a Stormwater Management Action Plan (SMAP[1]) for a priority watershed. The first two steps are complete, as documented in the *Ferndale Watershed Planning: Receiving Water Assessment and Prioritization* report (NHC, 2022), which is available on the City's stormwater webpage. During these first two steps, the project team (City of Ferndale, Northwest Hydraulic Consultants, and Reichardt & Ebe Engineering) identified the Schell Creek basin as the City's highest priority and focus for the current SMAP.

Three types of stormwater actions are identified in the SMAP: stormwater facility retrofits, land management/development strategies, and enhanced stormwater management actions. Desktop GIS analysis, field reconnaissance, and site ranking criteria were used to identify 14 potential retrofit sites and select the following for conceptual design and development of planning level cost estimates:

- Thornton Terrace Pond Enhancements – existing detention pond repurposed as a constructed wetland – $2,513,000
- Hendrickson Ave Regional Facility – two new regional facilities – $4,161,000
- Main St Treatment and Schell Creek Realignment – two new media filter treatment cartridges along Main St and downstream creek realignment and culvert replacement – $1,135,000
- Ferndale Terrace Stormwater Improvement Project[2] – new media treatment filters – $1,505,000

Land management strategies and enhanced stormwater management actions target programmatic opportunities to improve flow and water quality problems in Schell Creek. Identified strategies and actions include potential property acquisition along Schell Creek for preservation and water quality protection, riparian restoration to remove invasive blackberries, removal of several in-stream stormwater facilities and fish passage improvements, low impact development code updates, evaluation of an urban forestry program, targeted source control inspections of septic systems and sanitary sewers to reduce bacteria counts, and additional education and outreach efforts related to pet waste management and disposal, trash and yard debris, fertilizer and pesticide use, and watershed stewardship.

The SMAP also includes a proposed implementation schedule for short (within six years) and long-term (within 7-20 years) stormwater actions, budget needs and potential funding sources, and a process to adaptively manage the plan. The Schell Creek SMAP establishes a path forward for the City to better steward the natural resources in this basin in the midst of ongoing development.

[1] Consistent with the NPDES Phase II Permit language (Ecology, 2019b), SMAP is used interchangeably in this report for both Stormwater Management Action Plan and Stormwater Management Action Planning.

[2] Project currently in design and pending Ecology grant funding for fiscal year 2024.

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1 INTRODUCTION

The deleterious influence of urbanization on small streams has been extensively documented over the past several decades and is of particular interest and concern in western Washington due to impacts on endangered salmonids (Booth, 1990; Booth and Jackson, 1997; May et al., 1997; Horner and May, 1998; Booth et al., 2002; Konrad and Booth, 2002; Rosburg et al., 2017). The transition of a watershed from its natural forested state to a predominantly urban condition encompasses removal of vegetation and canopy, compaction of soils, creation of impervious surfaces, introduction of pollutants, and alteration of natural drainage networks. Managing the impacts of runoff from urban areas (i.e., "stormwater") on natural systems has become a major focus of the Washington State Department of Ecology (Ecology), with regulations continually evolving to protect and restore stream hydrology, water quality, and ecological function.

The City of Ferndale (City) is performing stormwater planning for a 9.4 square mile area encompassing its city limits (7.1 square miles) and associated urban growth area (UGA; 2.3 square miles) which includes approximately 35 miles of streams. The City's municipal separate storm sewer system (MS4) includes 71 miles of pipes and ditches and 49 City-owned stormwater facilities (ponds, infiltration trenches, bioswales, bioretention, and permeable pavement). As a condition of its NPDES Phase II Municipal Stormwater Permit (Permit), the City is required to characterize receiving water conditions, prioritize watersheds for retrofits and other stormwater management actions, and develop a Stormwater Management Action Plan (SMAP) for a priority subbasin. This report describes the development of a SMAP for the selected subbasin, Schell Creek.

This plan summarizes the two prior SMAP planning steps and identifies actions along three parallel lines of effort – stormwater retrofits, land management strategies, and stormwater management actions – to address flow and water quality problems in Schell Creek. Conceptual designs and planning level cost estimates were developed for four priority stormwater retrofit projects. This plan also presents an implementation schedule, documents possible funding sources, and outlines an ongoing adaptive management plan for the selected actions.

2 BASIN CHARACTERIZATION AND SELECTION

The Ferndale stormwater planning project began with a review of receiving water conditions and systematic prioritization of subbasins for stormwater retrofits and other stormwater management actions. These first two steps are documented in the *Ferndale Watershed Planning: Receiving Water Assessment and Prioritization* report (NHC, 2022), which is available on the City's stormwater webpage[3]. The following sections summarize key steps and outcomes from the previous work.

[3] https://www.cityofferndale.org/ferndale-watershed-planning-receiving-water-assessment-and-prioritization/

2.1 Receiving Water Assessment

The Ferndale Receiving Water Assessment (RWA) used available geographic, monitoring, and modeling data to assess current conditions of the City's receiving waters. As part of the assessment, 19 planning level units (subbasins) covering the eight receiving water basins within the City were delineated. Information related to land cover and land use, stormwater infrastructure, water quality and hydrology, fish use and aquatic habitat, and overburdened communities was compiled to help assess overall basin conditions. Fifteen of the 19 subbasins were recommended for basin prioritization. The four subbasins that were excluded either met the Ecology criteria for low stormwater management influence or jurisdictional influence was expected to be low. A GIS-based screening process was used to characterize each subbasin in terms of its relative resource importance (for natural processes and aquatic species) and relative degradation (from existing development and other human impacts) based on 10 metrics. The relative rankings of resource importance and degradation for the Ferndale subbasins are shown in Figure 2.1.

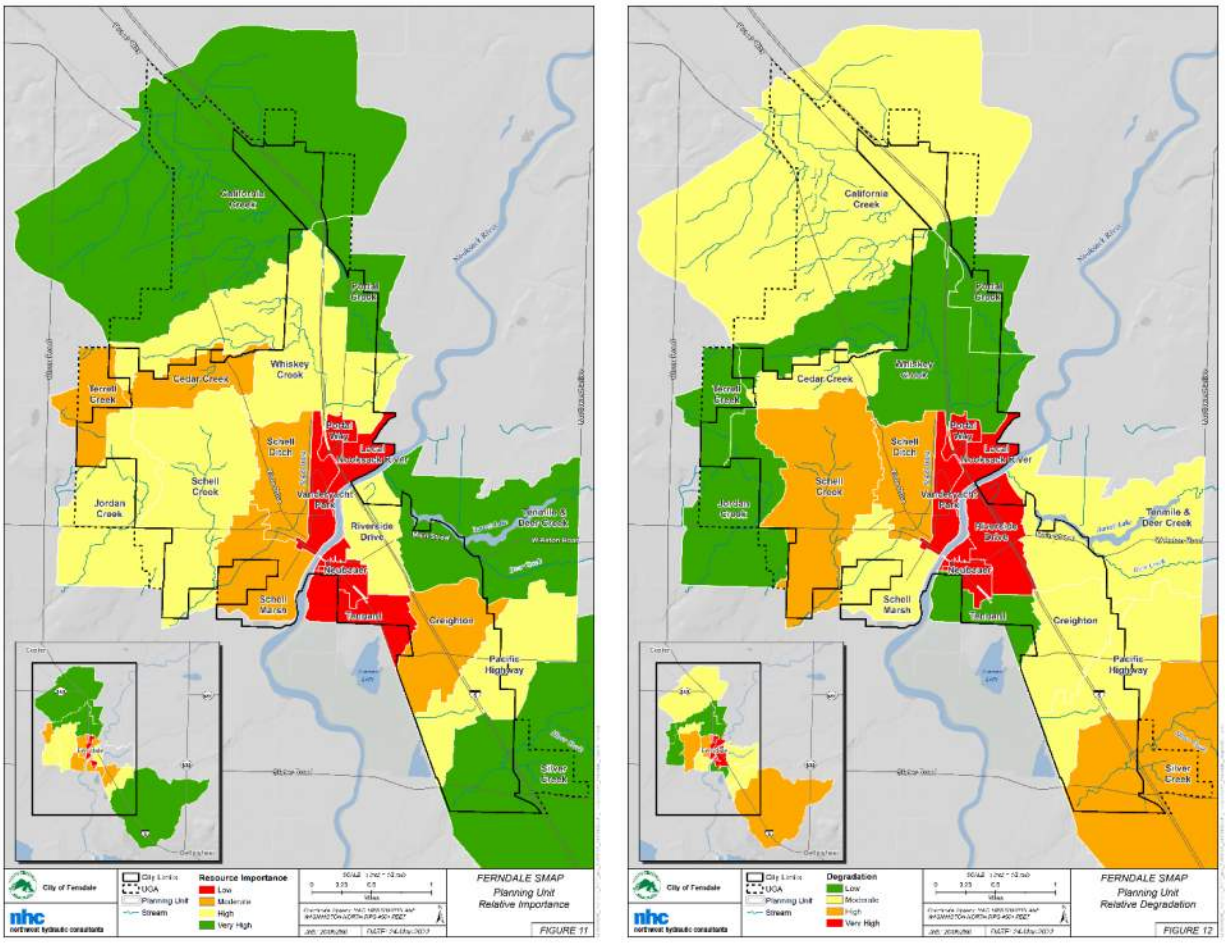

Figure 2.1 Relative rankings of resource importance (left) and degradation (right) for Ferndale subbasins.

The aggregated degradation and importance scores were used to identify a primary management objective – Protection, Restoration, Conservation, or Development – and related management goals for each subbasin to assist with basin prioritization. The subbasin importance and degradation scores are plotted on a management matrix in Figure 2.2. The basins falling into the "Restoration" quadrant will require a large effort to restore natural processes and achieve significant water quality benefits but also have a high ecosystem value. Basins in the "Protection" quadrant have a high ecological importance and low degradation. These basins have not been heavily impacted by development and may be target areas for programmatic actions or code revisions to protect existing resources. Basins in the "Conservation" quadrant have low ecological importance but also low degradation. These would require a much lower level of action, mainly to maintain existing conditions. The basins in the "Development" quadrant have relatively low ecological importance and significant existing human impact. Significant efforts to achieve water quality benefits may not be warranted by the lower resource value, and development should continue to be directed to these areas.

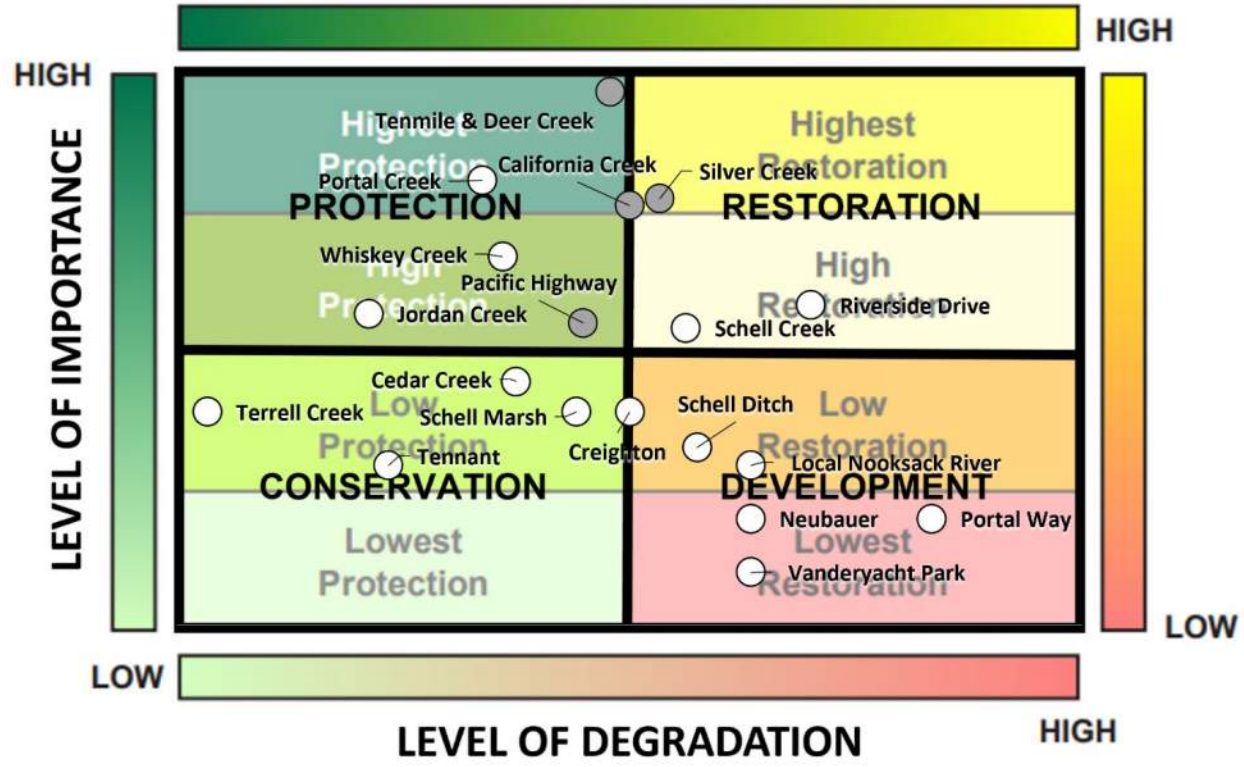

Figure 2.2 Subbasin management matrix.

Note: Gray dots on figure indicate subbasins with <50% area within the UGA.

2.2 Receiving Water Prioritization

The Ferndale Receiving Water Prioritization (RWP) documented the prioritization criteria used to score and rank the 15 candidate subbasins for SMAP. Five prioritization metrics related to existing degradation, resource importance, development pressure, jurisdictional influence, and other planning

efforts were used to score and rank the subbasins for stormwater action planning. Based on this prioritization scheme, the highest priority subbasins for SMAP were 1) Whiskey Creek, 2) Schell Creek, 3) Cedar Creek, 4) Creighton, and 5) Tennant. Basin characteristics related to stormwater planning and implementation potential were reviewed for these five subbasins to assist with subbasin selection. Whiskey Creek was classified as a protection basin, implying a greater focus on land management and programmatic actions, and is also included in the Nooksack River Watershed Bacteria TMDL study (City of Ferndale, 2020). For these reasons, Schell Creek was ultimately selected by the project team for development of a SMAP because of its greater restoration potential, location mostly in the city limits, other regional rehabilitation efforts, and good stormwater retrofit potential. Input received from interested parties and the public as part of a public process were reviewed prior to final subbasin selection. Several high priority catchment areas were identified in this subbasin for targeted stormwater retrofits, land management strategies, and stormwater actions to restore and protect healthy basin conditions. The subbasin SMAP rankings and high priority catchment areas in the selected Schell Creek subbasin are shown in Figure 2.3.

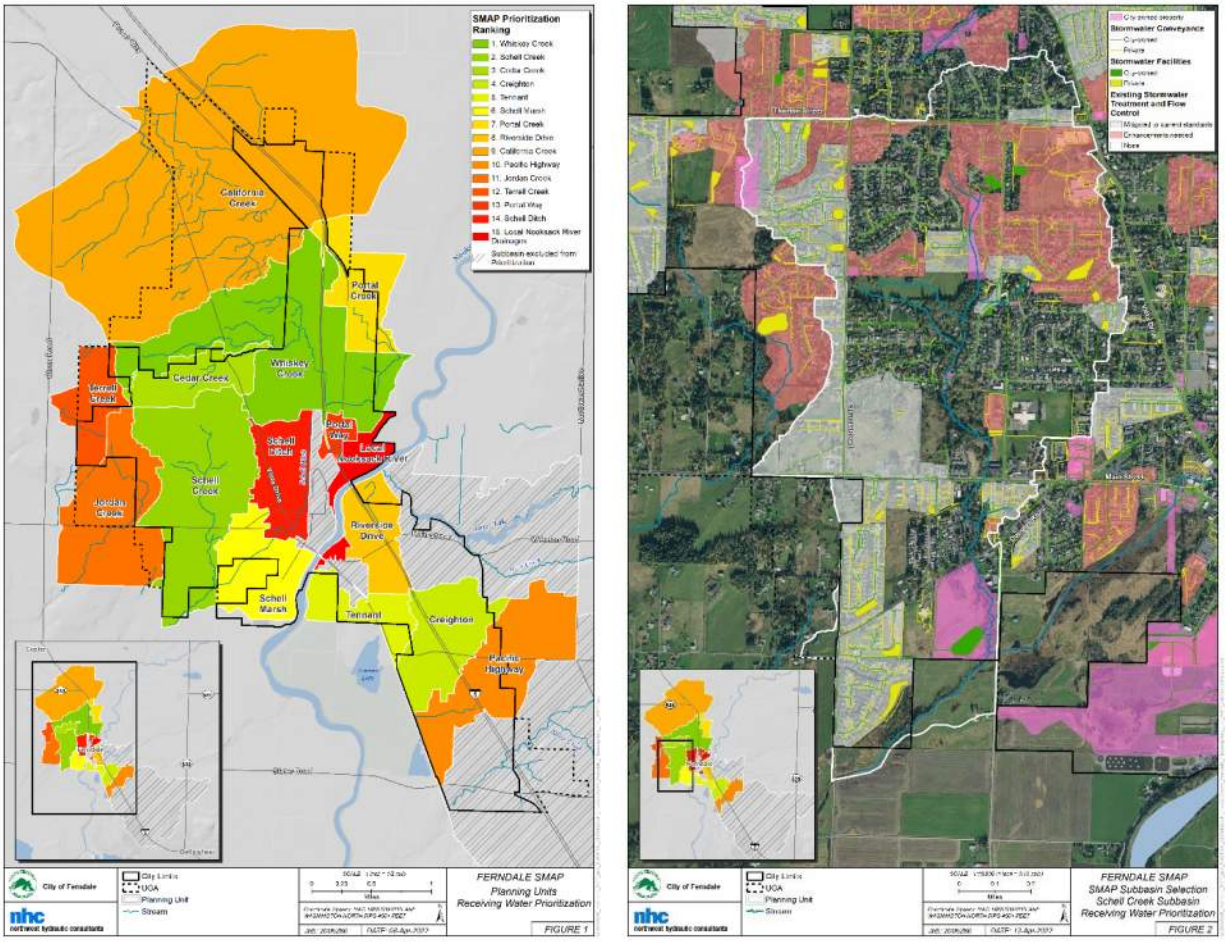

Figure 2.3 Ferndale subbasin SMAP rankings (left) and high priority catchment areas in the selected Schell Creek subbasin for SMAP (right).

3 STORMWATER RETROFITS

This section describes the selection and development of stormwater facility retrofits to improve flow control and water quality treatment in Schell Creek. Potential retrofits include modifications to existing stormwater facilities or construction of new facilities. Four stormwater retrofits were selected for conceptual design and development of planning level cost estimates. All stormwater retrofit figures and related information are included in Appendix A.

3.1 Selection Process

The stormwater retrofit selection process involved a desktop GIS analysis to identify and characterize potential sites, field reconnaissance and review to assess site feasibility, and ranking of potential sites based on multiple criteria to select four stormwater retrofits for conceptual design and planning level cost estimates.

As an initial step, a desktop GIS analysis was conducted to identify and characterize potential retrofit sites. Building off the map of high priority catchment areas developed for Schell Creek during the RWP (the right map in Figure 2.3 above), GIS mapping of the City's stormwater system and facilities, areas with existing conveyance, flow control, and water quality deficiencies, and parcel data describing property ownership were used to identify 14 potential retrofit sites and best management practices (BMPs) at existing stormwater facilities, vacant parcels, and in public right-of-way. The 14 potential retrofit sites are summarized in Table 3.1 and shown in Figure A-1.

Table 3.1 Schell Creek potential stormwater retrofit sites and BMPs identified through desktop GIS analysis.

ID	Name	Retrofit Type	Drainage Area Characteristics	Description	Possible BMPs or Other Actions
ST01	Skyline Elementary Pond	Existing facility improvements	• 135 acres • Mostly single family residential	• City-owned detention pond (1979) • Level 1 flow control • No treatment	• New outlet structure to provide Level 2 flow control • New wet pond for basic treatment
ST02	Thronton Terrace Pond	Existing facility improvements	• 13 acres • Mostly single family residential	• City-owned detention pond (1991) • Level 1 flow control • No treatment	• New inlet structure to improve runoff delivery to facility • New outlet structure to provide Level 2 flow control • Convert to constructed wetland to provide enhanced treatment • Expanded footprint could provide treatment for greater upstream area
ST03	Cedar Woods Pond	Existing facility improvements	• 12 acres • Mostly single family residential	• Two in-stream, City-owned detention ponds (1997) • Level 1 flow control • No treatment	• Remove berm to combine both ponds into a single facility • New outlet structure to provide Level 2 flow control • New wet pond for basic treatment
ST04	Emerald Terrace Pond A	Existing facility improvements	• 3.1 acres • Single family residential and Diamond Ln	• City-owned, in-stream detention pond (1993) • Level 1 flow control • No treatment	• Remove existing in-stream facility • Install media filters for treatment • Coordinate with Schell Creek-Heather Dr culvert replacement
ST05	Hendrickson Ave Regional Facility	New facility	• 82 acres • Single family residential and Hendrickson Ave	• No existing flow control and limited treatment in the Hendrickson Ave Basin	• Acquire private property for new regional stormwater facility meeting current flow control and treatment standards. Two facilities may be necessary.
ST06	Southwest Regional Pond	Existing facility improvements or new facility	• 77 acres • Mixed uses	• Existing constructed wetland (2014) meets current flow control and treatment standards • A large portion of the existing development between Douglas Rd and Main St lacks existing flow control and treatment	• Expand existing facility to accommodate future runoff from areas south of Main St • Build new regional facility on City property adjacent to existing facility to accommodate future runoff from areas south of Main St
ST07	Thornton St Flow Control and Treatment	New facility	• 1.5 acres • Thornton St	• Thornton St is a busy road and lacks existing flow control and treatment between Evergreen Way and Shannon Ave.	• Distributed treatment (tree box filters, media filters, bioretention) in City right of way • A new facility could also be built on a vacant City parcel on the southeast corner of Thornton St and Shannon Ave
ST08	Hendrickson Ave Flow Control and Treatment	New facility	• 1.7 acres • Hendrickson Ave	• Hendrickson Ave is a busy road and lacks existing flow control and treatment between Ferndale Terrace and Main St	• Distributed treatment (tree box filters, media filters, bioretention) in City right of way • Coordinate with recommended conveyance improvements to resolve known drainage issues
ST09	Main St Treatment and Schell Creek Realignment	New facility	• 12.2 acres • Main St and vicinity	• Main St is the busiest road in Ferndale and lacks existing flow control and treatment near the Schell Creek crossing	• Distributed treatment (tree box filters, media filters, bioretention) in City right of way • Realign Schell Creek and replace existing 48” CMP culvert with fish passable structure immediately south of Main St
ST10	Douglas Rd Regional Facility	New facility	• 40 acres • Area south of Main St, including Douglas Rd	• Much of the area south of Main St, including Douglas Rd, lacks existing flow control and treatment	• Distributed treatment (tree box filters, media filters, bioretention) in City right of way for Douglas Rd

ID	Name	Retrofit Type	Drainage Area Characteristics	Description	Possible BMPs or Other Actions
					• New regional facility south of Douglas Rd on City-owned parcel to accommodate future development runoff from areas south of Main St
ST11	Fieldview Dr/Shannon Ave Facility	New facility	• 7.5 acres • Single family residential	• City-owned, in-stream detention pond • Level 1 flow control • No treatment	• Remove existing in-stream facility • Acquire private property for new regional facility southeast of existing crossing • Coordinate with Schell Creek-Fieldview Dr culvert replacement
ST12	Pine Dr Outfall	New facility	• 15.3 acres • Single family residential	• No existing flow control or treatment prior to the Pine Dr outfall	• Media treatment filters or a below grade detention/treatment vault
ST13	Heather Dr Facility	New facility	• 37 acres • Single family residential	• No existing flow control or treatment in the Heather Dr Basin west of Schell Creek	• Media treatment filters or a below grade detention/treatment vault • Coordinate with Schell Creek-Heather Dr culvert replacement
ST14	Ferndale Terrace Stormwater Improvement Project	New facility	• 1.72 acres • Ferndale Terrace roadway	• Limited stormwater conveyance system and no existing flow control or treatment along Ferndale Terrace between Hendrickson Ave and Vista Dr.	• Street improvement project that includes stormwater, water, sanitary sewer, and sidewalk improvements • Stormwater filters will be installed to provided enhanced WQ treatment for 1.72 acres of previously untreated pollution generating surfaces from Ferndale Terrace between Hendrickson Ave and Vista Dr. This project is already in design.

Following the desktop GIS analysis, field reconnaissance of the 14 potential retrofit sites was conducted by the project team on March 2, 2023 to evaluate site feasibility, opportunities and constraints, and discuss preferred BMPs. Site visits were augmented with a review of all available materials for each site, including the City's stormwater GIS, record drawings, and other information developed for the project. Retrofit Reconnaissance Investigation (RRI) forms were filled out beforehand, summarizing the desktop GIS analysis for each site to support objective comparison between sites. The form includes a site description (location, property ownership, and infiltration potential), existing stormwater management, proposed stormwater retrofit characteristics (purpose, type, and drainage area characteristics), and site constraints (potential utility conflicts, access issues, permitting factors, critical areas, etc.). The forms were updated as necessary following field reconnaissance and project team discussion. The completed RRI forms are included in Appendix A.

Finally, the potential retrofits were ranked based on ten individual criteria related to site feasibility, environmental benefits, and opportunity/coordinated efforts to prioritize and select four retrofits for conceptual design and planning level cost estimates. The ranking criteria are summarized in Table 3.2.

Table 3.2 Ranking criteria used for retrofit site selection.

Category	Criteria	Scoring
Site Feasibility	Site Constraints (potential utility conflicts, access issues, permitting factors, critical areas, etc.)	5: no constraints 3: 1 constraint 1: ≥ 2 constraints
	Space	5: sufficient 3: neutral 1: limited
	Site Ownership	5: City/public 1: private
	Drainage Infrastructure Modification	5: easy 3: neutral 1: difficult
	Sufficient Head	5: yes 3: neutral 1: no
Environmental Benefits	Infiltration Potential	5: high 3: medium 2: deep 1: low
	Existing Level of Flow Control	5: none 3: Level 1 flow control (pre-1998) 1: Level 2 flow control (post 1998)

Category	Criteria	Scoring
Environmental Benefits (continued)	Pollutant Loading (accounting for any existing treatment)	5: high 3: medium 1: low
	Retrofit Drainage Area	5: >25 acres 4: 10-25 acres 3: 5-10 acres 2: 1-5 acres 1: <1 acre
Opportunity/ Coordinated Efforts	Coordinated Efforts (correct existing drainage issue, combine with another project, favorable for grant funding, ripeness to proceed, etc.)	5: ≥ 2 efforts 3: 1 effort 1: no efforts

Information from the RRI forms was used to assign scores to each site based on the guidance shown in Table 3.2. The initial retrofit rankings were distributed to the project team for input on site ranking. Concerns and/or opportunities were identified by team members and scores were adjusted to reflect consensus ratings. Final retrofit rankings are presented in Table 3.3.

Table 3.3 Retrofit site feasibility rankings.

Rank	Stormwater Retrofit	Feasibility Score
1	Thronton Terrace Pond (ST02)	4.1
2	Hendrickson Ave Regional Facility (ST05)	4.0
3	Main St Treatment and Schell Creek Realignment (ST09)	3.9
3	Ferndale Terrace Stormwater Improvement Project (ST14)	3.9
3	Douglas Rd Regional Facility (ST10)	3.9
6	Hendrickson Ave Flow Control and Treatment (ST08)	3.8
6	Pine Dr Outfall (ST12)	3.8
8	Heather Dr Facility (ST13)	3.7
8	Skyline Elementary Pond (ST01)	3.7
10	Thornton St Flow Control and Treatment (ST07)	3.6
10	Fieldview Dr/Shannon Ave Facility (ST11)	3.6
12	Southwest Regional Pond (ST06)	3.4
13	Emerald Terrace Pond A (ST04)	3.3
14	Cedar Woods Pond (ST03)	3.0

3.2 Priority Stormwater Retrofits

Based on the results from the selection process and project team discussion, four of the top ranked retrofits – Thorton Terrace Pond (ST02), Hendrickson Ave Regional Facility (ST05), Main St Treatment and Schell Creek Realignment (ST09), and Ferndale Terrace Stormwater Improvement Project (ST14) – were selected for conceptual design and development of planning level cost estimates. These four priority retrofits are shown in Figure A-2. This section summarizes each proposed retrofit. Facility designs (required detention volumes, water quality volumes, and outlet structure sizing) were determined using the Western Washington Hydrology Model (Clear Creek Solutions, Inc., 2021). Key project characteristics are summarized in Table 3.4. Project summary information, concept drawings, and itemized planning level cost estimates are included in Appendix A.

- **Thornton Terrace Pond (ST02).** An existing City-owned detention pond will be repurposed and redesigned as a constructed wetland to provide detention and enhanced water quality treatment, improved habitat, and greater aesthetic value. The existing detention pond was built in 1991, does not meet current standards for flow control or treatment, and has a drainage area of 13 acres consisting mostly of the Thornton Terrace residential development. Improvements will include a new inlet structure to improve runoff delivery to the proposed facility, a new outlet structure that meets current flow control standards, expanding the facility' footprint to increase storage for detention and treatment, and planting appropriate wetland vegetation. The existing conveyance system along Thornton St west of Shannon Ave may also be redirected to the facility, increasing the total treated area to 102.5 acres. Over detaining to the extent feasible at the Thornton Terrace facility could also facilitate the removal of the Emerald Terrace in-stream facility approximately 700 feet downstream, which is no longer functioning as designed and presents a barrier to fish passage. If space allows, a walking trail and educational signs and placards may also be integrated at the 0.7-acre site to promote inclusion and watershed stewardship by Ferndale residents.
- **Hendrickson Ave Regional Facility (ST05).** Full implementation of this project includes the construction of two ponds that can serves as constructed wetlands and provide detention for a total of 83 acres (18 acres of which drain to the west pond and 65 to the east pond) that currently lack any treatment. These would be partially constructed through excavation and partially with berms. Topographic limitations impose constraints on feasible sites, but at this level of design, it appears that the locations shown in Figure A-4 will work. This project, as currently depicted, could be completed in separate east and west phases if needed. There is also the potential for consolidation of both facilities into the eastern portion of the schoolyard, but additional investigation would be needed to assure the feasibility of this path, and further coordination with the school district and other nearby property owners would be required.
- **Main St Treatment and Schell Creek Realignment (ST09).** This project includes both water quality and stream improvements near the Schell Creek crossing on Main St. Main St is the busiest street in Ferndale and lacks water quality treatment in the vicinity of Schell Creek. Two new media filter cartridges (Filterra or equivalent systems) will be integrated into the existing stormwater conveyance systems on Main St to treat the runoff collected on the west (6.2 acres) and east (6.0 acres) sides of Schell Creek prior to their outfalls. It is assumed most of the runoff

conveyed by the Hendrickson Ave conveyance system will be redirected to a new regional facility (discussed above) or will bypass the media filters. Alternatively, the City may consider acquiring property immediately south of the Main St crossing and installing a modular wetland system for stormwater treatment. In addition to providing stormwater treatment for Main St in the vicinity of the Schell Creek crossing, Schell Creek immediately downstream (south) of Main St will be realigned to prevent potential flooding and erosion damage to a private apartment complex. The stream will be moved west of its current location approximately 60 feet and an existing 106-foot long, 48-inch diameter corrugated metal culvert that is a barrier to fish passage will be replaced with an appropriate fish passable structure.

- **Ferndale Terrace Stormwater Improvement Project (ST14).** This street improvement project is currently in design, and final design and construction are pending fiscal year 2024 grant funding from Ecology. Media filter cartridges integrated into a new stormwater conveyance system will provide water quality treatment for 1.72 acres of previously untreated pollution generating impervious surfaces from the Ferndale Terrace roadway prior to discharging to Schell Creek via conveyance to the Main St outfall. The treated area includes nearly 2,500 feet of Ferndale Terrace roadway between Hendrickson Ave and Vista Dr. The media filter cartridges will provide enhanced water quality treatment via filtration of 91% of the average annual runoff volume.

Table 3.4 Priority retrofit projects.

Project	Thornton Terrace Pond (ST02)	Hendrickson Ave Regional Facility (ST05)	Main St Treatment and Schell Creek Realignment (ST09)	Ferndale Terrace Stormwater Improvement Project (ST14)
Facility Type(s)	Constructed wetland with detention, new conveyance	Two constructed wetlands with detention, new conveyance	Two media filter cartridges, stream realignment, culvert replacement	Media filter cartridges, new conveyance
Treatment Type	Flow control and enhanced WQ	Flow control and basic WQ	Enhanced WQ and improve fish passage	Enhanced WQ
Drainage Area	12.9 acres (existing) 102.5 acres (future)	82.2 acres	12.2 acres	1.72 acres
Mitigated Acres (WQ/Flow Control)	12.9/12.9 (existing) 102.5/12.9 (future)	82.2/82.2	12.2/0	1.72/0
Anticipated Maintenance[1]	**Medium** Inspect outlet structure, walking trails, and educational materials every 6-12 months. Maintain wetland vegetation and replant as necessary.	**Medium** Inspect outlet structure every 6-12 months. Mow pond facilities quarterly.	**Low** Replace media filter cartridges every 1-2 years.	**Low** Replace media filter cartridges every 1-2 years.
Planning Level Cost Estimate[2]	$2,513,000	$4,161,000	$1,135,000	$1,505,000
Cost per Treated Acre[2]	$194,800 (existing) $24,500 (future)	$50,600	$93,000	$875,100

[1]Maintenance requirements approximated as relatively Low, Medium, or High based on complexity of installation (number of BMPs, accessibility), and requirements of individual BMP types.

[2]Dollars are reported in 2023 values and do not account for supply chain issues or changes in market conditions. Costs are rough order of magnitude that include construction, design and permitting (estimated as 30% of construction), and construction admin and inspection (estimated as 15% of construction) costs.

4 LAND MANAGEMENT STRATEGIES

To assist municipalities with the land management and development strategies assessment, Ecology issued an SMAP Guidance document (Ecology, 2019a) and incorporated it by reference into the Phase II Municipal Stormwater Permit (Ecology, 2019b). The stated intent of the requirement is to protect or conserve areas with high resource value. The Ecology guidance suggests that this could be done by purchasing property or implementing zoning changes. In areas that have already been built out, the guidance suggests that efforts to increase canopy cover should be implemented. The ideas below will be incorporated into the City's stormwater comprehensive plan (which is currently being updated and will be completed by June 2023) and future comprehensive planning efforts.

The City has identified several parcels for potential land acquisition along Schell Creek between Main St. and Fieldview Dr. for preservation, water quality protection, and creek daylighting. These parcels are located at or adjacent to 2330 Main St. and 5785 Hendrickson Rd. Together, they would protect approximately 2,000 feet of stream channel. Both land acquisition projects have been identified and included in the City's Storm and Flood Utility Capital Improvement Program Project List.

Additionally, the City will continue to evaluate opportunities to fully integrate low impact development policies into development codes to minimize impervious surfaces, native vegetation loss, and stormwater runoff. The City can evaluate urban forestry approaches to determine suitability for improvements at Ferndale's infrastructure-natural resource nexus in areas that are already developed.

Much of the Schell Creek riparian corridor is surrounded by thickets of invasive blackberries. Removal of these species will allow for planting of native plants and long-term maintenance and improvement of canopy cover. The City would like to identify opportunities to reduce invasive species through collaboration between the Public Works Department, the Parks and Recreation Department, nonprofit conservation groups, and the general public. Specific locations that provide opportunities for this include in-stream stormwater facilities at Fieldview Dr., the Emerald Terrace A facility at Heather Dr., the Cedar Woods Ponds west of Spruce Ave, as well as the Diamond Lane and Spruce Court Natural Resource Areas. The areas of opportunity for potential land acquisition or vegetation restoration are highlighted in Figure B-1 of Appendix B. Additionally, the City may seek opportunities to support voluntary riparian buffer restoration by private landowners adjacent to Schell Creek.

5 STORMWATER MANAGEMENT ACTIONS

Ecology has required "targeted, enhanced, or customized implementation of stormwater management actions" as part of this plan. This requirement is intended to provide a new focus for programs that are already mandatory. The list of recommended programs includes Illicit Discharge Detection and Elimination (IDDE) field screening, source control inspections, operations and maintenance inspections, enhanced maintenance, or public education and outreach behavior change programs. The City plans to continue IDDE field screening, make specific source control coordination and maintenance as needed, and implement focused outreach campaigns as discussed below.

Schell Creek currently is being monitored for fecal coliform alongside Nooksack River TMDL compliance monitoring (City of Ferndale, 2020). The City intends to continue this monitoring effort, which includes four sites in the Schell Creek basin (three culverts and the SW Regional Pond Outfall) as shown in Figure B-2 of Appendix B, with samples taken monthly as well as during four storm events each year.

As a targeted step to improve bacteria counts via source control, the City will coordinate with the Whatcom County Health Department for inspections of on-site septic systems in the Schell Creek basin, as well as internally with the Public Works department for inspection and necessary maintenance of sanitary sewers that run near Schell Creek. The priority for these inspections and any needed enforcement actions, as well as City maintenance efforts, will be determined based on assessment of the sample data in order to most effectively identify and reduce contributors to bacterial pollution in the basin. An initial examination of the bacteria monitoring data was performed for the RWA (NHC, 2022), and further examination for this phase of the SMAP process. The greatest mean concentrations of fecal coliforms in Schell Creek were observed at site SC5, followed by SC4, then SC3 (the three in-stream sites) followed by site SC6 (SW regional pond outfall). The frequency of exceedances above 100 CFU/100 mL[4] followed the same spatial pattern. Table 5.1 shows further details.

Table 5.1 Summary of Schell Creek bacteria monitoring, WY2010-2021 by season. Sample dates with no flow at a given site are excluded from calculations.

Sampling Site	Fall	Spring	Summer	Winter	Overall
Geometric Mean Concentration (CFU/100mL)					
SC5	627	1487	8070	248	1036
SC3	182	239	957	153	256
SC4	268	551	2541	177	478
SC6	22	17	14	10	15
Number of Samples with Total Coliform Concentration ≥ 100 CFU/100mL					
SC5	31	35	28	32	126
SC3	34	32	26	31	123
SC4	39	37	39	33	148
SC6	3	4	6	2	15
Percentage of Samples with Total Coliform Concentration ≥ 100 CFU/100mL					
SC5	89%	97%	100%	86%	93%
SC3	74%	73%	81%	67%	73%
SC4	85%	86%	100%	73%	86%
SC6	17%	21%	30%	11%	20%

[4] The current state freshwater quality standard for bacteria requires that E. coli levels must not exceed a geometric mean value of 100 CFU/100 mL, with not more than 10% of all samples (or any single sample when less than 10 sample points exist) exceeding 320 CFU/100 mL. Prior to December 31, 2020, fecal coliform levels were used to determine compliance. The same criteria were used for fecal coliforms except not more than 10% of all fecal coliform samples (or any single sample when less than 10 sample points exist) should exceed 200 CFU/100 mL.

While bacteria growth and decay can occur instream, and exact sample times and total loads are unavailable, these monitoring results suggest that the areas upstream of SC5 (the uppermost part of the basin, shaded purple in Figure B-2) should be the highest priority for source control, followed by the green shaded areas between SC3 and SC4, then the areas between SC5 and SC3 (shaded blue). The City will prioritize inspections of on-site septic systems and illicit connections and discharges accordingly, with additional consideration given to highly localized conditions, including an understanding that flows at the SC5 site are often intermittent, and that there are a greater number of septic systems in the incremental contributing area to SC4.

Additionally, the City will continue and refocus public education and outreach efforts. Currently, dumping of trash and yard debris into Schell Creek is a common issue, and there is a potential need for greater awareness of fertilizer and pesticide use issues (integrated pest management). It is hoped that general awareness education and outreach efforts can be used to address those issues, whether through posting of signs or mailers to residents. Enhanced connection to the watershed and stream can help shift attitudes around responsible stewardship of the creek.

Given the preponderance of single family homes in the upper Schell Creek basin, the focus for the City's education and outreach program is pet waste management and disposal in that area. To date, this has included signage at all Schell Creek crossings, mailers to educate pet owners on the impacts of pet waste including QR codes with pledge and survey information, and the planned installation of storm drain medallions on catch basins that drain to Schell Creek. The City intends to maintain these efforts, including periodic mailings and coordination with Whatcom County to ensure consistent branding and messaging on pet waste management and water quality issues.

6 IMPLEMENTATION PLAN

The SMAP includes a proposed implementation schedule and budget sources for short-term actions (within six years) and long-term actions (within 7-20 years), and an adaptive management plan to document progress towards meeting SMAP goals and improve the planning process.

6.1 Proposed Implementation Schedule

Table 6.1 shows the anticipated implementation schedule for short-term and long-term actions for the projects and programs described in the previous sections. Short-term actions will be accomplished within six years (2024-2029), while long-term actions will be accomplished within 7-20 years (2030-2043).

Table 6.1 Proposed implementation schedule for short-term (2024-2029) and long-term (2030-2043) SMAP actions.

Time Frame	Proposed Stormwater Management Action	Schedule	Funding Source/Budget	Assessment Frequency
Stormwater Retrofits				
Short-term	Ferndale Terrace Stormwater Improvement Project (ST14)	2023[1]-2026	Ecology grant and stormwater fund $1,505,000	Annually
	Douglas Rd Regional Facility (ST10)	2023[2]-2025	Stormwater fund	Annually
	Main St Treatment and Schell Creek Realignment (ST09)	2026-2029	TBD $1,135,000	Annually
	Thornton Terrace Pond (ST02)	2028-2031	TBD $2,513,000	Annually
Long-term	Hendrickson Ave Regional Facility (ST05)	2030-2035	TBD $4,161,000	Every 3 years
	Reevaluate other identified stormwater retrofits	2035-2043	TBD	Every 3 years
	Evaluate short-term actions for effectiveness and adjust as needed			Every 6 years
Land Management Strategies				
Short-term	Integrate current LID policies into land development codes	2024	Stormwater fund TBD	Annually
	Schell Creek relocation and riparian restoration	2024-2030	TBD	Annually
	Evaluate an urban forestry program	2027	Stormwater fund	Every 3 years
	Investigate removal of several in-stream stormwater facilities	2027-2037	Stormwater fund	Every 3 years
Long-term	Potential property acquisition along Schell Creek between Main St and Fieldview Dr.	2030-2040	TBD	Every 3 years
	Potential riparian restoration of Schell Creek corridor	2030-2040	TBD	Every 3 years
	Evaluate short-term actions for effectiveness and adjust as needed			Every 6 years
Stormwater Management Actions				
Short-	Prioritization of bacteria source control inspections	2024	Stormwater fund	Annually

Time Frame	Proposed Stormwater Management Action	Schedule	Funding Source/Budget	Assessment Frequency
	Public education and outreach efforts (trash and yard debris, fertilizer and pesticide use, watershed stewardship, etc.)	2024	Stormwater fund	Annually
Long-term	Evaluate short-term actions for effectiveness and adjust as needed			Every 6 years

[1]Project currently in design and pending Ecology grant funding for fiscal year 2024.

[1]Project to construct new municipal wells currently in design but stormwater improvements have not been evaluated.

6.2 Funding Sources

Potential grant funding sources for the SMAP actions are summarized in Table 6.2.

Table 6.2 Potential grant funding sources for stormwater actions.

Grant Fund	Description
Washington State Department of Ecology	
Coastal Protection Fund, Terry Husseman account grants	These grants support locally sponsored projects that restore or enhance the environment. Typical projects address water quality issues and fish and wildlife protection or enhancement
Floodplains by Design	This program supports projects that help communities live better in their floodplain. Project can include the following activities: • Improve flood protection for communities and people living and working in floodplains. • Conserve and restore habitat for salmon and other important aquatic species. • Preserve farmland to keep agriculture viable for future generations. • Improve water quality. • Enhance outdoor recreation.
Puget Sound National Estuary Program, Stormwater Strategic Initiative Grants	Funds from this initiative support projects that help prevent stormwater pollution and protect the Puget Sound estuary.
Stormwater Capacity Grants Program	Stormwater capacity grants are non-competitive and awarded to Phase I and Phase II NPDES municipal permittees for activities and equipment necessary for permit implementation.

Grant Fund	Description
Stormwater Grants of Regional or Statewide Significance Program	These competitive grants of regional or statewide significance assist permittees in completing projects that will benefit multiple permittees.
Streamflow Restoration, Competitive Grants	Streamflow restoration competitive grants help state and local agencies, Tribal governments, and non-profit organizations implement local watershed plans and projects to improve streamflow and aquatic resources.
Water Quality Combined Funding Program	This integrated funding program provides grants for projects that improve and protect water quality throughout the state.
Washington State Recreation and Conservation Office	
Aquatic Lands Enhancement Account	This account provides funding to buy, protect, and restore shorelines and tidelands and provide public access to the waterfront.
Brian Abbott Fish Barrier Removal Board	This grant program provides funding to identify and remove impediments to salmon and steelhead migration. A 15% match is generally required.
Community Forest Program	Funding from this program enables the purchase and restoration of working forests while creating recreational opportunities in subject forests.
Land and Water Conservation Fund	This fund enables communities to buy and improve parks, trails, wildlife lands, and other outdoor recreation resources.
Salmon Recovery and Puget Sound Acquisition and Restoration	This program provides funding to protect and restore salmon habitat.
Habitat Conservation Projects, Washington Wildlife and Recreation Program	This program provides funding to conserve wildlife habitat and restore sensitive state-owned lands.

6.3 Adaptive Management

The adaptive management plan is intended to document progress towards meeting SMAP goals, address the process used to develop the SMAP to improve program effectiveness, and include implementation tracking and an ongoing assessment of planned projects and activities. Adaptations to the SMAP are expected over time as the City implements the plan and reflects on lessons learned. Additionally, the City's stormwater comprehensive plan is currently being updated and will be completed by summer 2023. Outcomes from the current SMAP will influence the stormwater comprehensive plan update, and vice versa, and the prioritization of project and program timelines may be adjusted. Both plans provide

an opportunity to review projects and progress, evaluate additional retrofits, and identify additional funding and budget sources for the City's surface water program as a whole.

To document progress towards meeting SMAP goals, it is important to review Schell Creek's designated uses, current water quality conditions, and restoration goals developed during the RWA. Schell Creek's designated uses consist of core summer salmonid habitat, primary contact recreation, water supply, and various miscellaneous uses (Ecology, 2021), and Ecology has established water quality standards to assess the level of impairment (Ecology, 2020). A review of available water quality monitoring data from 2010-2021 performed during the RWA revealed that several locations along Schell Creek did not consistently meet the state standards for pH, DO, bacteria, and water temperature. The following restoration management goals were developed for Schell Creek during the RWA: implement stormwater retrofits to improve flow control and water quality treatment, riparian restoration, increase septic inspections and O&M, and improve fish passage (NHC, 2022).

Keeping in mind the Schell Creek designated uses and restoration goals, the City will track the progress of the SMAP, reflect on the planning process, and make modifications as required to improve program efficiency. The City's adaptive management plan may include documentation of the following:

- Summary of progress and implementation of stormwater retrofit projects, including updates to the City's stormwater GIS data and subbasin mapping to track how much of the Schell Creek basin has been mitigated.
- Summary of progress on identified land management strategies: potential property acquisition, integration of LID policies, evaluation of an urban forestry program, Schell Creek riparian restoration, and potential removal of several in-stream stormwater facilities.
- Summary of progress on identified stormwater management actions: bacteria monitoring, source control inspections of targeted on-site septic systems and sanitary sewers to reduce bacteria counts, and education and outreach efforts (trash and yard debris, appropriate fertilizer and pesticide use, watershed stewardship, and pet waste management).
- Continued water quality monitoring in Schell Creek to quantify actual water quality conditions. Bacteria monitoring is prioritized and grab samples are currently being collected at four locations. Monitoring of other water quality constituents (pH, DO, water temperature, nutrients, etc.) will also be conducted where feasible.
- Land cover assessment (specifically changes in impervious area and forest coverage) based on updated imagery or other publicly available land cover datasets to understand changes in basin conditions.
- A review of the SMAP process, including the feasibility and effectiveness of SMAP actions, changes to proposed implementation schedule and prioritization of actions, changes to budget needs and funding sources, and identification of new strategic opportunities that may provide a greater basin impact.

7 SUMMARY AND CONCLUSIONS

As a condition of its NPDES Phase II Permit, the City of Ferndale has characterized receiving water conditions, prioritized watersheds for retrofits and other stormwater management actions, and developed this SMAP for the Schell Creek basin. The SMAP identifies a broad range of actions to address flow and water quality problems in Schell Creek and presents an implementation plan for the selected actions.

Thirteen potential stormwater retrofit sites in the Schell Creek basin were identified and ranked based on desktop and field analyses. Conceptual designs and planning level cost estimates were developed for four of the top ranked retrofits: Thornton Terrace Pond, Hendrickson Ave Regional Facility, Main St Treatment and Schell Creek Realignment, and the Ferndale Terrace Stormwater Improvement Project (already in design). Planning level cost estimates (in 2023 dollars) for the four priority retrofits range from $1,135,000 to $4,161,000.

Several land management strategies to improve hydrologic and water quality conditions in Schell Creek through non-structural measures were also identified. These include potential property acquisitions along Schell Creek for preservation, water quality protection, and creek daylighting, full integration of LID policies into current and future development codes, evaluating an urban forestry program, and riparian restoration to remove invasive blackberries and improve fish passage.

Several enhanced stormwater management actions to improve overall basin conditions in Schell Creek through programmatic opportunities were also identified. As a targeted step to improve bacteria counts via source control, the City will coordinate with the Whatcom County Health Department and internally with the Public Works department for focused inspections of on-site septic systems and sanitary sewers near Schell Creek. The City will also continue and refocus public education and outreach efforts related to trash and yard debris impacts on stream health, appropriate fertilizer and pesticide use, watershed stewardship, and its ongoing pet waste management campaign.

A proposed implementation schedule, budget needs and grant funding sources, and an adaptive management plan were developed for the SMAP projects and activities. Short-term actions intended to be accomplished within six years (2024-2029) include four stormwater retrofits, Schell Creek riparian restoration and potential removal of several in-stream stormwater facilities, and prioritization of source control inspections to reduce bacteria counts. Long-term actions intended to be accomplished (within 7-20 years (2030-2043) include further evaluation of the Hendrickson Ave Regional Facility retrofit and other identified retrofit sites and potential property acquisition to restore and protect the Schell Creek riparian corridor. The City will track, document, and modify the SMAP as part of an adaptive management plan. Water quality conditions will also be summarized based on the City's existing monitoring program, and basin land cover conditions will be assessed when updated imagery is available.

This plan establishes a path forward for the City to better steward the natural resources in the Schell Creek basin in the midst of ongoing development. It identifies a number of specific and achievable steps while allowing flexibility to respond to opportunities as they arise. As Ferndale implements this plan, it

sets a course towards a Schell Creek that is healthier for people, plants, and fish, enhancing the natural environment and the Ferndale community

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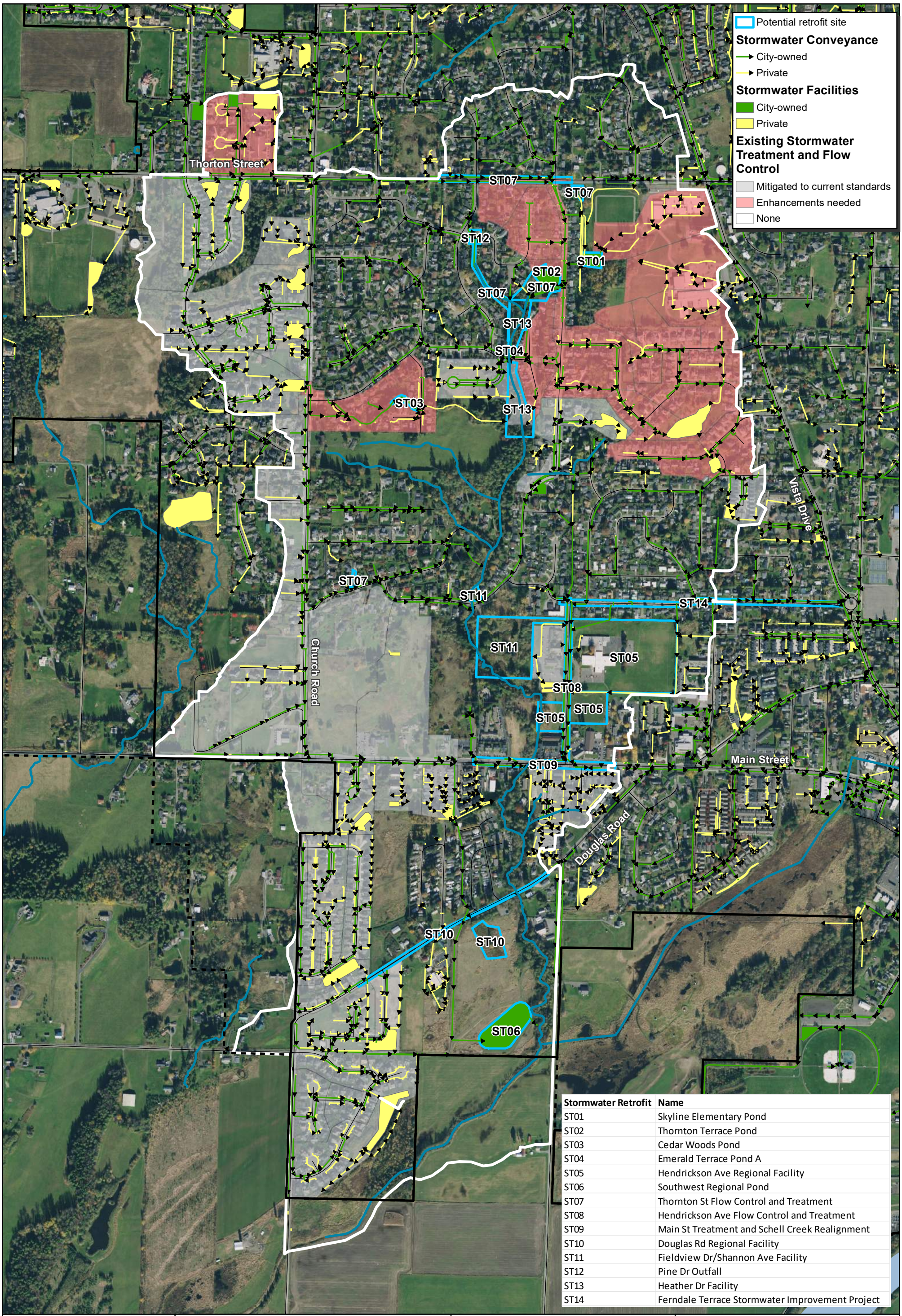
APPENDIX A

STORMWATER RETROFITS



Stormwater Retrofit	Name
ST01	Skyline Elementary Pond
ST02	Thornton Terrace Pond
ST03	Cedar Woods Pond
ST04	Emerald Terrace Pond A
ST05	Hendrickson Ave Regional Facility
ST06	Southwest Regional Pond
ST07	Thornton St Flow Control and Treatment
ST08	Hendrickson Ave Flow Control and Treatment
ST09	Main St Treatment and Schell Creek Realignment
ST10	Douglas Rd Regional Facility
ST11	Fieldview Dr/Shannon Ave Facility
ST12	Pine Dr Outfall
ST13	Heather Dr Facility
ST14	Ferndale Terrace Stormwater Improvement Project

City of Ferndale

nhc northwest hydraulic consultants

City Limits
UGA
Planning Unit
Stream

SCALE - 1:10,000 (1 inch = 0.16 mile)

0 0.1 0.2

Miles

Coordinate System: NAD 1983 STATEPLANE WASHINGTON NORTH FIPS 4601 FEET

N

Job: 2006286 | DATE: 28-Mar-2023

FERNDALE SMAP
Schell Creek
Potential Stormwater Retrofit SIte

FIGURE A-1

Q:\2006286_Ferndale_SCP_and_SMAP\95_GIS\MXDs\Figures\2006286_Ferndale_SMAP_Retrofits.mxd

Retrofit Reconnaissance Investigation (Modified by NHC) **RRI**

DATE/TIME: 3/2/23	**WATERSHED:** Schell Creek	**SITE ID:** ST01

Name(s) of Investigators: Chad Drake (NHC), Derek Stuart (NHC), Paul Knippel (COF), Dale Buys (R&E)

SITE DESCRIPTION

Location Notes: Skyline Elementary Pond. Near Shannon Ave and Pine Dr in Ferndale city limits.

Ownership: ☒ Public ☐ Private ☐ Unknown
If Public, Government Jurisdiction: ☒ Local ☐ State ☐ DOT ☐ Other:

Soils:
☐ Clay ☐ Sand ☐ Loam ☒ Till ☐ Outwash ☐ Saturated
☐ HSG A ☐ HSG B ☐ HSG C ☐ HSG D ☐ Other:
Infiltration Potential:
☒ Low ☐ Moderate ☐ High ☒ Other: deep infiltration potential

EXISTING STORMWATER MANAGEMENT

Existing Stormwater System: ☒ Yes ☐ No ☐ Unknown
Existing Treatment: ☒ Detention ☐ Infiltration ☐ Water Quality ☐ None ☐ Unknown
Year of Construction: 1979
Existing head available:
Description of existing site conditions:
No water quality treatment provided. As-builts indicate outlet structure consists of a 12" orifice, 21" orifice, and a 36" diameter overflow structure. 2.2 acre-feet of detention storage. A significant amount of runoff from the north and west is routed through the control structure. Verify if this bypasses the pond.

PROPOSED STORMWATER RETROFIT

Purpose of Proposed Retrofit
☒ Flow Control ☒ Water Quality ☐ Infiltration ☐ Other:

Location of Proposed Retrofit
☒ Existing Stormwater Facility:
☒ Detention Pond ☐ Wet Pond ☐ Infiltration Pond ☐ Conveyance System ☐ Outfall ☐ Vault
☐ Other:
☐ New Facility:
☐ Vacant Parcel ☐ ROW ☐ Other:

Type of Proposed Retrofit
☒ Expanded detention ☒ Wet Pond ☐ Constructed Wetland ☐ Bioretention
☐ Proprietary Media Filter ☐ Infiltration ☐ Swale ☐ Other:

Description of proposed retrofit:
New outlet structure to provide Level 2 flow control. Construct wet pond for water quality treatment.

Drainage Area to Proposed Retrofit
Drainage Area: 135 acres
Impervious Area: ~30%
Notes:
TIA estimated based on EIA Table #2 for SFR-Med

Drainage Area Land Use
☒ Residential ☐ Commercial/Industrial
☒ SFH (<1 ac lots) ☐ Transportation
☐ SFH (>1 ac lots) ☐ Undeveloped
☐ Multifamily
☐ Other:

SITE CONSTRAINTS

- ☐ Adjacent Land Use:
- ☐ Access (slope, utilities, structures, space, tree impacts, property ownership, etc.):
- ☐ Existing Utilities:
- ☒ Permitting (dam safety, wetlands, stream, floodplain, forest, etc.): wetlands
- ☐ Other:

SKETCH AND/OR OTHER NOTES

Retrofit Reconnaissance Investigation (Modified by NHC) **RRI**

DATE/TIME: 3/2/23	**WATERSHED:** Schell Creek	**SITE ID:** ST02

Name(s) of Investigators: Chad Drake (NHC), Derek Stuart (NHC), Paul Knippel (COF), Dale Buys (R&E)

SITE DESCRIPTION

Location Notes: Thorton Terrace Pond. Near Shannon Ave and Pine Dr in Ferndale city limits.

Ownership: ☒ Public ☐ Private ☐ Unknown
If Public, Government Jurisdiction: ☒ Local ☐ State ☐ DOT ☐ Other:

Soils:
☐ Clay ☐ Sand ☐ Loam ☒ Till ☐ Outwash ☐ Saturated
☐ HSG A ☐ HSG B ☐ HSG C ☐ HSG D ☐ Other:
Infiltration Potential:
☒ Low ☐ Moderate ☐ High ☒ Other: deep infiltration potential

EXISTING STORMWATER MANAGEMENT

Existing Stormwater System: ☒ Yes ☐ No ☐ Unknown
Existing Treatment: ☒ Detention ☐ Infiltration ☐ Water Quality ☐ None ☐ Unknown
Year of Construction: 1991
Existing head available:
Description of existing site conditions:
No water quality treatment provided. As-builts indicate the control structure consists of a 3.5" orifice and two 7.5" orifice that cause runoff to backwater into the pond. 3.3 acre-feet of detention storage. Verify control structure.

PROPOSED STORMWATER RETROFIT

Purpose of Proposed Retrofit
☒ Flow Control ☒ Water Quality ☐ Infiltration ☐ Other:

Location of Proposed Retrofit
☒ Existing Stormwater Facility:
☒ Detention Pond ☐ Wet Pond ☐ Infiltration Pond ☐ Conveyance System ☐ Outfall ☐ Vault
☐ Other:
☐ New Facility:
☐ Vacant Parcel ☐ ROW ☐ Other:

Type of Proposed Retrofit
☒ Expanded detention ☐ Wet Pond ☒ Constructed Wetland ☐ Bioretention
☐ Proprietary Media Filter ☐ Infiltration ☐ Swale ☐ Other:

Description of proposed retrofit:
New inlet structure to improve runoff delivery to existing pond. New outlet structure to provide Level 2 flow control. Convert existing detention pond to constructed wetland to provide enhanced water quality treatment and improve aesthetics for City residents. Over detain and provide WQ treatment for greater upstream drainage area in conjunction with the removal of several downstream in-stream facilities.

Drainage Area to Proposed Retrofit
Drainage Area: 13 acres (ex.)/148 acres (pot.)
Impervious Area: ~30%
Notes:
TIA estimated based on EIA Table #2 for SFR-Med

Drainage Area Land Use
☒ Residential ☐ Commercial/Industrial
☒ SFH (<1 ac lots) ☐ Transportation
☐ SFH (>1 ac lots) ☐ Undeveloped
☐ Multifamily
☐ Other:

SITE CONSTRAINTS

- ☐ Adjacent Land Use:
- ☐ Access (slope, utilities, structures, space, tree impacts, property ownership, etc.):
- ☐ Existing Utilities:
- ☒ Permitting (dam safety, wetlands, stream, floodplain, forest, etc.): wetlands
- ☐ Other:

SKETCH AND/OR OTHER NOTES

Retrofit Reconnaissance Investigation (Modified by NHC) **RRI**

DATE/TIME: 3/2/23	**WATERSHED:** Schell Creek	**SITE ID:** ST03

Name(s) of Investigators: Chad Drake (NHC), Derek Stuart (NHC), Paul Knippel (COF), Dale Buys (R&E)

SITE DESCRIPTION

Location Notes: Cedar Woods Pond. Near Spruce Ave and Spruce Ct in Ferndale city limits.

Ownership: ☒ Public ☐ Private ☐ Unknown
If Public, Government Jurisdiction: ☒ Local ☐ State ☐ DOT ☐ Other:

Soils:
☐ Clay ☐ Sand ☐ Loam ☒ Till ☐ Outwash ☐ Saturated
☐ HSG A ☐ HSG B ☐ HSG C ☐ HSG D ☐ Other:
Infiltration Potential:
☒ Low ☐ Moderate ☐ High ☒ Other: deep infiltration potential

EXISTING STORMWATER MANAGEMENT

Existing Stormwater System: ☒ Yes ☐ No ☐ Unknown
Existing Treatment: ☒ Detention ☐ Infiltration ☐ Water Quality ☐ None ☐ Unknown
Year of Construction: 1997
Existing head available:
Description of existing site conditions:
Two ponds (Cedar Woods Pond A and B). No water quality treatment provided. As-builts indicate the ponds are connected by a 10" pipe and control structure from Cedar Woods Pond A consists of 8" orifice, 2.5' orifice, and 1.5' orifice. Detention storage: Cedar Woods Pond B 0.3 acre-feet of storage, Cedar Woods Pond A has 0.6 acre-feet. Verify control structure.

PROPOSED STORMWATER RETROFIT

Purpose of Proposed Retrofit
☒ Flow Control ☒ Water Quality ☐ Infiltration ☐ Other:

Location of Proposed Retrofit
☒ Existing Stormwater Facility:
☒ Detention Pond ☐ Wet Pond ☐ Infiltration Pond ☐ Conveyance System ☐ Outfall ☐ Vault
☐ Other:
☐ New Facility:
☐ Vacant Parcel ☐ ROW ☐ Other:

Type of Proposed Retrofit
☐ Expanded detention ☒ Wet Pond ☐ Constructed Wetland ☐ Bioretention
☐ Proprietary Media Filter ☐ Infiltration ☐ Swale ☐ Other:

Description of proposed retrofit:
New outlet control structure to provide Level 2 flow control. Construct wet pond for water quality treatment. Remove berm separating two existing ponds to create a single facility and reduce maintenance access issues.

Drainage Area to Proposed Retrofit
Drainage Area: 12 acres
Impervious Area: ~30%
Notes:
TIA estimated based on EIA Table #2 for SFR-Med

Drainage Area Land Use
☒ Residential ☐ Commercial/Industrial
☒ SFH (<1 ac lots) ☐ Transportation
☐ SFH (>1 ac lots) ☐ Undeveloped
☐ Multifamily
☐ Other:

SITE CONSTRAINTS

- ☐ Adjacent Land Use:
- ☐ Access (slope, utilities, structures, space, tree impacts, property ownership, etc.):
- ☐ Existing Utilities:
- ☒ Permitting (dam safety, wetlands, stream, floodplain, forest, etc.): wetlands
- ☐ Other:

SKETCH AND/OR OTHER NOTES

Retrofit Reconnaissance Investigation (Modified by NHC) **RRI**

DATE/TIME: 3/2/23	**WATERSHED:** Schell Creek	**SITE ID:** ST04

Name(s) of Investigators: Chad Drake (NHC), Derek Stuart (NHC), Paul Knippel (COF), Dale Buys (R&E)

SITE DESCRIPTION

Location Notes: Emerald Terrace Pond A. North side of Heather Dr at Schell Creek crossing.

Ownership: ☐ Public ☒ Private ☐ Unknown
If Public, Government Jurisdiction: ☐ Local ☐ State ☐ DOT ☐ Other:

Soils:
☐ Clay ☐ Sand ☐ Loam ☒ Till ☐ Outwash ☐ Saturated
☐ HSG A ☐ HSG B ☐ HSG C ☐ HSG D ☐ Other:
Infiltration Potential:
☒ Low ☐ Moderate ☐ High ☒ Other: deep infiltration potential

EXISTING STORMWATER MANAGEMENT

Existing Stormwater System: ☒ Yes ☐ No ☐ Unknown
Existing Treatment: ☒ Detention ☐ Infiltration ☐ Water Quality ☐ None ☐ Unknown
Year of Construction: 1993
Existing head available:
Description of existing site conditions:
In-stream facility constructed on City property. Control structure consists of 12" weir, 21" weir, and 11" orifice.

PROPOSED STORMWATER RETROFIT

Purpose of Proposed Retrofit
☐ Flow Control ☒ Water Quality ☐ Infiltration ☒ Other: removal of in-stream facility

Location of Proposed Retrofit
☒ Existing Stormwater Facility:
☒ Detention Pond ☐ Wet Pond ☐ Infiltration Pond ☐ Conveyance System ☐ Outfall ☐ Vault
☐ Other:
☐ New Facility:
☐ Vacant Parcel ☐ ROW ☐ Other:

Type of Proposed Retrofit
☐ Expanded detention ☐ Wet Pond ☐ Constructed Wetland ☐ Bioretention
☒ Proprietary Media Filter ☐ Infiltration ☐ Swale ☐ Other:

Description of proposed retrofit:
Remove existing in-stream facility as it is not functioning as designed. Install media filters in existing catch basins to treat Diamond and Pearl Lanes east of Schell Creek crossing. Could be coordinated with Schell Creek – Heather Drive culvert replacement.

Drainage Area to Proposed Retrofit
Drainage Area: 3.1 acres
Impervious Area: ~30%
Notes:
TIA estimated based on EIA Table #2 for SFR-Med

Drainage Area Land Use
☒ Residential ☐ Commercial/Industrial
☒ SFH (<1 ac lots) ☐ Transportation
☐ SFH (>1 ac lots) ☐ Undeveloped
☐ Multifamily
☐ Other:

SITE CONSTRAINTS

- ☐ Adjacent Land Use:
- ☒ Access (slope, utilities, structures, space, tree impacts, property ownership, etc.): space
- ☐ Existing Utilities:
- ☐ Permitting (dam safety, wetlands, stream, floodplain, forest, etc.):
- ☐ Other:

SKETCH AND/OR OTHER NOTES

Retrofit Reconnaissance Investigation (Modified by NHC) **RRI**

DATE/TIME: 3/2/23	**WATERSHED:** Schell Creek	**SITE ID:** ST05

Name(s) of Investigators: Chad Drake (NHC), Derek Stuart (NHC), Paul Knippel (COF), Dale Buys (R&E)

SITE DESCRIPTION

Location Notes: Hendrickson Ave Regional Facility. Hendrickson Ave north of Main St in Ferndale city limits.

Ownership: ☐ Public ☒ Private ☐ Unknown
If Public, Government Jurisdiction: ☐ Local ☐ State ☐ DOT ☐ Other:

Soils:
☐ Clay ☐ Sand ☐ Loam ☒ Till ☐ Outwash ☐ Saturated
☐ HSG A ☐ HSG B ☐ HSG C ☐ HSG D ☐ Other:
Infiltration Potential:
☒ Low ☐ Moderate ☐ High ☐ Other:

EXISTING STORMWATER MANAGEMENT

Existing Stormwater System: ☒ Yes ☐ No ☐ Unknown
Existing Treatment: ☐ Detention ☐ Infiltration ☐ Water Quality ☒ None ☐ Unknown
Year of Construction:
Existing head available:
Description of existing site conditions:
Stormwater conveyance system running south along Hendrickson Ave. No flow control or treatment before the Schell Creek outfall on Main St.

PROPOSED STORMWATER RETROFIT

Purpose of Proposed Retrofit
☒ Flow Control ☒ Water Quality ☐ Infiltration ☐ Other:

Location of Proposed Retrofit
☐ Existing Stormwater Facility:
☐ Detention Pond ☐ Wet Pond ☐ Infiltration Pond ☐ Conveyance System ☐ Outfall ☐ Vault
☐ Other:
☒ New Facility:
☒ Vacant Parcel ☐ ROW ☐ Other:

Type of Proposed Retrofit
☒ Expanded detention ☒ Wet Pond ☐ Constructed Wetland ☐ Bioretention
☐ Proprietary Media Filter ☐ Infiltration ☐ Swale ☐ Other:

Description of proposed retrofit:
Property acquisition along Hendrickson Ave for new regional stormwater facility (combined detention/wetpond). Three private vacant parcels to be considered. Coordinate with recommended conveyance improvements along Hendrickson Ave to resolve observed drainage issues.

Drainage Area to Proposed Retrofit
Drainage Area: 82 acres
Impervious Area: ~30%
Notes:
TIA estimated based on EIA Table #2 for SFR-Med

Drainage Area Land Use
☒ Residential ☐ Commercial/Industrial
☒ SFH (<1 ac lots) ☐ Transportation
☐ SFH (>1 ac lots) ☒ Undeveloped
☐ Multifamily
☐ Other:

SITE CONSTRAINTS

☐ Adjacent Land Use:
☒ Access (slope, utilities, structures, space, tree impacts, property ownership, etc.): property ownership
☐ Existing Utilities:
☒ Permitting (dam safety, wetlands, stream, floodplain, forest, etc.): wetlands (west of Hendrickson Ave)
☐ Other:

SKETCH AND/OR OTHER NOTES

Retrofit Reconnaissance Investigation (Modified by NHC) **RRI**

DATE/TIME: 3/2/23	**WATERSHED:** Schell Creek	**SITE ID:** ST06

Name(s) of Investigators: Chad Drake (NHC), Derek Stuart (NHC), Paul Knippel (COF), Dale Buys (R&E)

SITE DESCRIPTION

Location Notes: Southwest Regional Pond. 0.2 miles south of Douglas Road in Ferndale city limits.

Ownership: ☒ Public ☐ Private ☐ Unknown
If Public, Government Jurisdiction: ☒ Local ☐ State ☐ DOT ☐ Other:

Soils:
☐ Clay ☐ Sand ☐ Loam ☐ Till ☒ Outwash ☐ Saturated
☐ HSG A ☐ HSG B ☐ HSG C ☐ HSG D ☐ Other:
Infiltration Potential:
☐ Low ☒ Moderate ☐ High ☐ Other:

EXISTING STORMWATER MANAGEMENT

Existing Stormwater System: ☒ Yes ☐ No ☐ Unknown
Existing Treatment: ☒ Detention ☐ Infiltration ☒ Water Quality ☐ None ☐ Unknown
Year of Construction: 2014
Existing head available:
Description of existing site conditions:
Southwest Regional Pond provides detention for the 100-year design storm and enhanced WQ treatment.

PROPOSED STORMWATER RETROFIT

Purpose of Proposed Retrofit
☒ Flow Control ☒ Water Quality ☐ Infiltration ☐ Other:

Location of Proposed Retrofit
☒ Existing Stormwater Facility:
☒ Detention Pond ☒ Wet Pond ☐ Infiltration Pond ☐ Conveyance System ☐ Outfall ☐ Vault
☐ Other:
☐ New Facility:
☐ Vacant Parcel ☐ ROW ☐ Other:

Type of Proposed Retrofit
☒ Expanded detention ☐ Wet Pond ☒ Constructed Wetland ☐ Bioretention
☐ Proprietary Media Filter ☐ Infiltration ☐ Swale ☐ Other:

Description of proposed retrofit:
Expand footprint of existing pond or construct a new regional facility (combined detention and constructed wetland) on adjacent City property to treat and detain additional runoff collected between Main St and Douglas Rd. New conveyance would be required to direct runoff from Main St, Hendrickson Ave, or area between Douglas Rd and Main St to expanded or new facility.

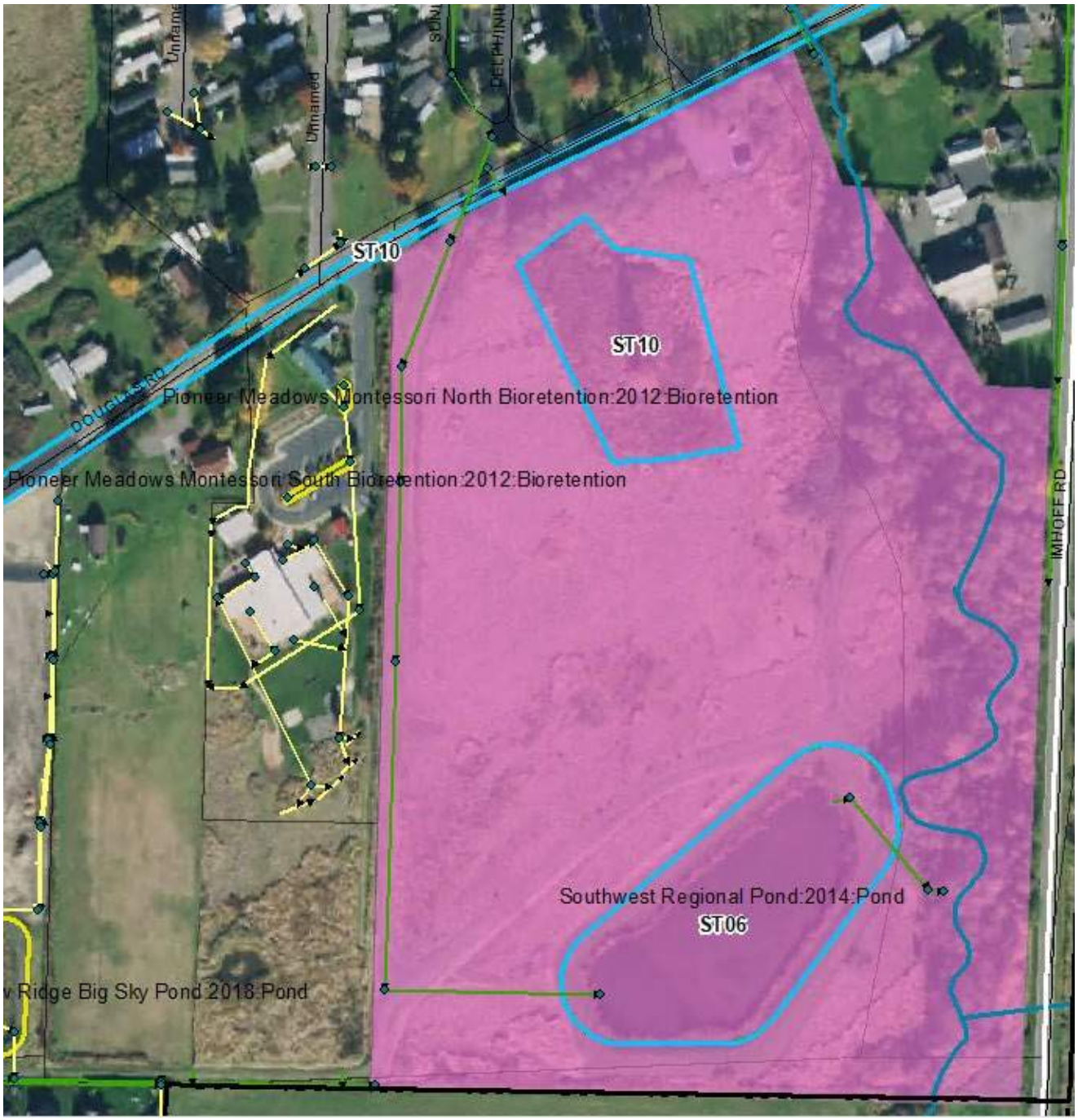
Drainage Area to Proposed Retrofit
Drainage Area: 77 acres
Impervious Area: 50~60%
Notes:
TIA estimated from SW Regional Pond design report

Drainage Area Land Use
☒ Residential ☐ Commercial/Industrial
☒ SFH (<1 ac lots) ☐ Transportation
☐ SFH (>1 ac lots) ☐ Undeveloped
☒ Multifamily
☐ Other:

SITE CONSTRAINTS

- ☐ Adjacent Land Use:
- ☐ Access (slope, utilities, structures, space, tree impacts, property ownership, etc.):
- ☐ Existing Utilities:
- ☒ Permitting (dam safety, wetlands, stream, floodplain, forest, etc.): wetlands
- ☐ Other:

SKETCH AND/OR OTHER NOTES



Retrofit Reconnaissance Investigation (Modified by NHC) **RRI**

DATE/TIME: 3/2/23	**WATERSHED:** Schell Creek	**SITE ID:** ST07

Name(s) of Investigators: Chad Drake (NHC), Derek Stuart (NHC), Paul Knippel (COF), Dale Buys (R&E)

SITE DESCRIPTION

Location Notes: Thornton St between Evergreen Way and Shannon Ave in Ferndale city limits.

Ownership: ☒ Public ☐ Private ☐ Unknown
If Public, Government Jurisdiction: ☒ Local ☐ State ☐ DOT ☐ Other:

Soils:
☐ Clay ☐ Sand ☐ Loam ☒ Till ☐ Outwash ☐ Saturated
☐ HSG A ☐ HSG B ☐ HSG C ☐ HSG D ☐ Other:
Infiltration Potential:
☐ Low ☐ Moderate ☐ High ☒ Other: deep infiltration potential

EXISTING STORMWATER MANAGEMENT

Existing Stormwater System: ☒ Yes ☐ No ☐ Unknown
Existing Treatment: ☐ Detention ☐ Infiltration ☐ Water Quality ☒ None ☐ Unknown
Year of Construction:
Existing head available:
Description of existing site conditions:
Thornton St is one of the heavier use roads in the Schell Creek Basin and lacks existing treatment and flow control west of Shannon Ave.

PROPOSED STORMWATER RETROFIT

Purpose of Proposed Retrofit
☒ Flow Control ☒ Water Quality ☒ Infiltration ☐ Other:

Location of Proposed Retrofit
☐ Existing Stormwater Facility:
☐ Detention Pond ☒ Wet Pond ☐ Infiltration Pond ☐ Conveyance System ☐ Outfall ☐ Vault
☐ Other:
☒ New Facility:
☐ Vacant Parcel ☒ ROW ☐ Other:

Type of Proposed Retrofit
☐ Expanded detention ☐ Wet Pond ☐ Constructed Wetland ☒ Bioretention
☒ Proprietary Media Filter ☒ Infiltration ☐ Swale ☒ Other: vault

Description of proposed retrofit:
Install distributed treebox filters, detention or infiltration vaults, bioretention, or StormFilter catch basins for roadway treatment. A vacant parcel owned by the City south of Thornton St and east of Shannon Ave could also be used for a facility.

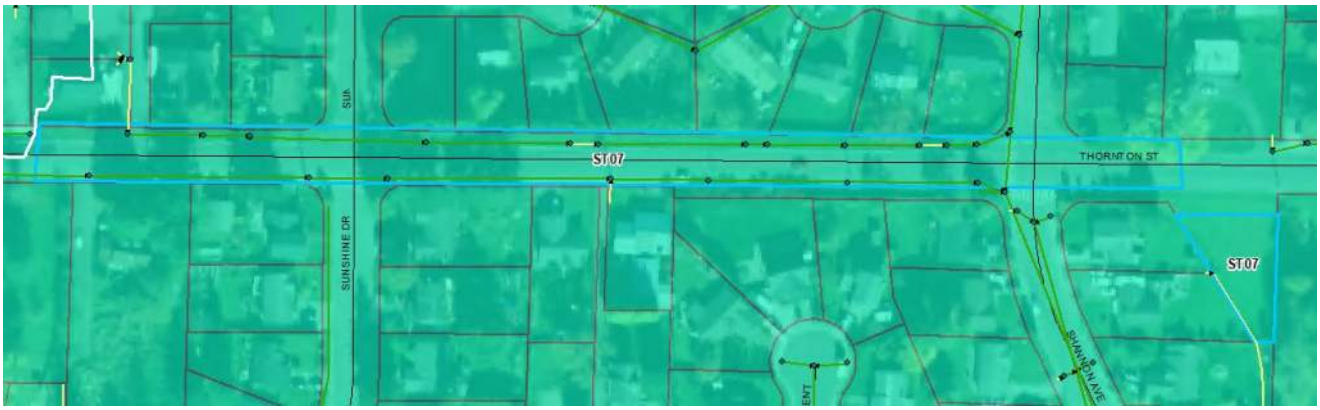
Drainage Area to Proposed Retrofit
Drainage Area: 1.5 acres
Impervious Area: 90%
Notes:
TIA estimated from EIA Table #2 for Roads.

Drainage Area Land Use
☐ Residential ☐ Commercial/Industrial
☐ SFH (<1 ac lots) ☒ Transportation
☐ SFH (>1 ac lots) ☐ Undeveloped
☐ Multifamily
☐ Other:

SITE CONSTRAINTS

☐ Adjacent Land Use:
☒ Access (slope, utilities, structures, space, tree impacts, property ownership, etc.): space
☒ Existing Utilities:
☐ Permitting (dam safety, wetlands, stream, floodplain, forest, etc.):
☐ Other:

SKETCH AND/OR OTHER NOTES



Retrofit Reconnaissance Investigation (Modified by NHC) **RRI**

DATE/TIME: 3/2/23	**WATERSHED:** Schell Creek	**SITE ID:** ST08

Name(s) of Investigators: Chad Drake (NHC), Derek Stuart (NHC), Paul Knippel (COF), Dale Buys (R&E)

SITE DESCRIPTION

Location Notes: Hendrickson Ave between Ferndale Terrace and Main St in Ferndale city limits.

Ownership: ☒ Public ☐ Private ☐ Unknown
If Public, Government Jurisdiction: ☒ Local ☐ State ☐ DOT ☐ Other:

Soils:
☐ Clay ☐ Sand ☐ Loam ☒ Till ☐ Outwash ☐ Saturated
☐ HSG A ☐ HSG B ☐ HSG C ☐ HSG D ☐ Other:
Infiltration Potential:
☒ Low ☐ Moderate ☐ High ☐ Other:

EXISTING STORMWATER MANAGEMENT

Existing Stormwater System: ☒ Yes ☐ No ☐ Unknown
Existing Treatment: ☐ Detention ☐ Infiltration ☐ Water Quality ☒ None ☐ Unknown
Year of Construction:
Existing head available:
Description of existing site conditions:
Hendrickson Ave is one of the heavier use roads in the Schell Creek Basin and lacks existing treatment and flow control. There are several observed drainage issues along the road and there is an existing conveyance system.

PROPOSED STORMWATER RETROFIT

Purpose of Proposed Retrofit
☒ Flow Control ☒ Water Quality ☒ Infiltration ☐ Other:

Location of Proposed Retrofit
☐ Existing Stormwater Facility:
☐ Detention Pond ☐ Wet Pond ☐ Infiltration Pond ☐ Conveyance System ☐ Outfall ☐ Vault
☐ Other:
☒ New Facility:
☐ Vacant Parcel ☒ ROW ☐ Other:

Type of Proposed Retrofit
☐ Expanded detention ☐ Wet Pond ☐ Constructed Wetland ☒ Bioretention
☒ Proprietary Media Filter ☒ Infiltration ☐ Swale ☒ Other: vault

Description of proposed retrofit:
Install treebox filters, detention or infiltration vaults, bioretention, or StormFilter catch basins to provide treatment and flow control for the road runoff from Hendrickson Ave between Ferndale Terrace and Main St (0.27 miles).

Drainage Area to Proposed Retrofit
Drainage Area: 1.7 acres
Impervious Area: 90%
Notes:
TIA estimated from EIA Table #2 for Roads.

Drainage Area Land Use
☐ Residential ☐ Commercial/Industrial
☐ SFH (<1 ac lots) ☒ Transportation
☐ SFH (>1 ac lots) ☐ Undeveloped
☐ Multifamily
☐ Other:

SITE CONSTRAINTS

☐ Adjacent Land Use:
☒ Access (slope, utilities, structures, space, tree impacts, property ownership, etc.): space
☒ Existing Utilities:
☐ Permitting (dam safety, wetlands, stream, floodplain, forest, etc.):
☐ Other:

SKETCH AND/OR OTHER NOTES

Retrofit Reconnaissance Investigation (Modified by NHC) **RRI**

DATE/TIME: 3/2/23	**WATERSHED:** Schell Creek	**SITE ID:** ST09

Name(s) of Investigators: Chad Drake (NHC), Derek Stuart (NHC), Paul Knippel (COF), Dale Buys (R&E)

SITE DESCRIPTION

Location Notes: Main St between Shannon Ave and east basin boundary ~450 feet east of Hendrickson Ave in Ferndale city limits. Encompasses Schell Creek stream crossing.

Ownership: ☒ Public ☐ Private ☐ Unknown
If Public, Government Jurisdiction: ☒ Local ☐ State ☐ DOT ☐ Other:

Soils:
☐ Clay ☐ Sand ☐ Loam ☒ Till ☒ Outwash ☐ Saturated
☐ HSG A ☐ HSG B ☐ HSG C ☐ HSG D ☐ Other:
Infiltration Potential:
☐ Low ☒ Moderate ☐ High ☐ Other:

EXISTING STORMWATER MANAGEMENT

Existing Stormwater System: ☒ Yes ☐ No ☐ Unknown
Existing Treatment: ☐ Detention ☐ Infiltration ☐ Water Quality ☒ None ☐ Unknown
Year of Construction:
Existing head available:
Description of existing site conditions:
Main St is one of the heavier use roads in the Schell Creek Basin and lacks existing treatment and flow control along this corridor. There is an existing stormwater conveyance system.

PROPOSED STORMWATER RETROFIT

Purpose of Proposed Retrofit
☒ Flow Control ☒ Water Quality ☒ Infiltration ☐ Other:

Location of Proposed Retrofit
☐ Existing Stormwater Facility:
☐ Detention Pond ☐ Wet Pond ☐ Infiltration Pond ☐ Conveyance System ☐ Outfall ☐ Vault
☐ Other:
☒ New Facility:
☐ Vacant Parcel ☒ ROW ☐ Other:

Type of Proposed Retrofit
☐ Expanded detention ☐ Wet Pond ☐ Constructed Wetland ☐ Bioretention
☒ Proprietary Media Filter ☐ Infiltration ☐ Swale ☐ Other:

Description of proposed retrofit:
Install Filterra treatment cartridges in the existing conveyance system on Main St on each side of Schell Creek crossing. Realign Schell Creek immediately downstream of the Main St crossing to move away from private property owner and replace existing 48" CMP culvert with a fish passable structure.

Drainage Area to Proposed Retrofit
Drainage Area: 12.2 acres
Impervious Area: 90%
Notes:
TIA estimated from EIA Table #2 for Roads.

Drainage Area Land Use
☐ Residential ☐ Commercial/Industrial
☐ SFH (<1 ac lots) ☒ Transportation
☐ SFH (>1 ac lots) ☐ Undeveloped
☐ Multifamily
☐ Other:

SITE CONSTRAINTS

☐ Adjacent Land Use:
☒ Access (slope, utilities, structures, space, tree impacts, property ownership, etc.): space, private property
☒ Existing Utilities:
☐ Permitting (dam safety, wetlands, stream, floodplain, forest, etc.):
☐ Other:

SKETCH AND/OR OTHER NOTES

DATE/TIME: 3/2/23	**WATERSHED:** Schell Creek	**SITE ID:** ST10

Name(s) of Investigators: Chad Drake (NHC), Derek Stuart (NHC), Paul Knippel (COF), Dale Buys (R&E)

SITE DESCRIPTION

Location Notes: Douglas Road between Angelina St and Imhoff Rd. Encompasses Schell Creek stream crossing.

Ownership: ☒ Public ☐ Private ☐ Unknown
If Public, Government Jurisdiction: ☒ Local ☐ State ☐ DOT ☐ Other:

Soils:
☐ Clay ☐ Sand ☐ Loam ☐ Till ☒ Outwash ☐ Saturated
☐ HSG A ☐ HSG B ☐ HSG C ☐ HSG D ☐ Other:
Infiltration Potential:
☐ Low ☒ Moderate ☒ High ☐ Other:

EXISTING STORMWATER MANAGEMENT

Existing Stormwater System: ☐ Yes ☐ No ☐ Unknown
Existing Treatment: ☐ Detention ☐ Infiltration ☐ Water Quality ☒ None ☐ Unknown
Year of Construction:
Existing head available:
Description of existing site conditions:
Douglas Rd is one of the heavier use roads in the Schell Creek Basin and lacks existing treatment and flow control along this corridor.

PROPOSED STORMWATER RETROFIT

Purpose of Proposed Retrofit
☒ Flow Control ☒ Water Quality ☒ Infiltration ☐ Other:

Location of Proposed Retrofit
☐ Existing Stormwater Facility:
☐ Detention Pond ☐ Wet Pond ☐ Infiltration Pond ☐ Conveyance System ☐ Outfall ☐ Vault
☐ Other:
☒ New Facility:
☒ Vacant Parcel ☒ ROW ☐ Other:

Type of Proposed Retrofit
☒ Expanded detention ☒ Wet Pond ☒ Constructed Wetland ☒ Bioretention
☒ Proprietary Media Filter ☒ Infiltration ☐ Swale ☒ Other: vault

Description of proposed retrofit:
This retrofit could include roadway treatment and a potential regional facility. Install distributed treatment filters, bioretention, or StormFilter catch basins to treat roadway runoff from Douglas Rd between Angelina St and Imhoff Rd (0.38 miles). Alternatively, a new regional facility (combined detention and wetpond or constructed wetland) could be built on an elevated piece of City ground south of Douglas Rd. The facility would be sized to provide treatment and flow control for both Douglas Rd and the upstream drainage area between Main St and Douglas Rd under future build out conditions. Coordinate with road improvement projects and Schell Creek culvert replacement.

Drainage Area to Proposed Retrofit	**Drainage Area Land Use**
Drainage Area: 1.1 acres (road)/40 acres (regional facility) Impervious Area: ~75% Notes: TIA estimated based on EIA Table #2 for Roads and MFR.	☒ Residential ☐ SFH (<1 ac lots) ☐ SFH (>1 ac lots) ☒ Multifamily ☐ Other: ☐ Commercial/Industrial ☒ Transportation ☐ Undeveloped

SITE CONSTRAINTS

☐ Adjacent Land Use:
☒ Access (slope, utilities, structures, space, tree impacts, property ownership, etc.): space
☒ Existing Utilities:
☐ Permitting (dam safety, wetlands, stream, floodplain, forest, etc.):
☐ Other:

SKETCH AND/OR OTHER NOTES

Retrofit Reconnaissance Investigation (Modified by NHC) **RRI**

DATE/TIME: 3/2/23	**WATERSHED:** Schell Creek	**SITE ID:** ST11

Name(s) of Investigators: Chad Drake (NHC), Derek Stuart (NHC), Paul Knippel (COF), Dale Buys (R&E)

SITE DESCRIPTION

Location Notes: Fieldview Dr/Shannon Ave Facility

Ownership: ☒ Public ☐ Private ☐ Unknown
If Public, Government Jurisdiction: ☒ Local ☐ State ☐ DOT ☐ Other:

Soils:
☐ Clay ☐ Sand ☐ Loam ☒ Till ☐ Outwash ☐ Saturated
☐ HSG A ☐ HSG B ☐ HSG C ☐ HSG D ☐ Other:
Infiltration Potential:
☒ Low ☐ Moderate ☐ High ☐ Other:

EXISTING STORMWATER MANAGEMENT

Existing Stormwater System: ☒ Yes ☐ No ☐ Unknown
Existing Treatment: ☐ Detention ☐ Infiltration ☐ Water Quality ☒ None ☐ Unknown
Year of Construction:
Existing head available:
Description of existing site conditions:
The existing stormwater conveyance system along Fieldview Dr (west of Schell Creek crossing) and Shannon Ave (east of Schell Creek crossing) lacks flow control or treatment prior to discharging to Schell Creek.

PROPOSED STORMWATER RETROFIT

Purpose of Proposed Retrofit
☒ Flow Control ☒ Water Quality ☐ Infiltration ☒ Other: Remove in-stream facility

Location of Proposed Retrofit
☐ Existing Stormwater Facility:
☐ Detention Pond ☐ Wet Pond ☐ Infiltration Pond ☐ Conveyance System ☐ Outfall ☐ Vault
☐ Other:
☒ New Facility:
☒ Vacant Parcel ☐ ROW ☐ Other:

Type of Proposed Retrofit
☒ Expanded detention ☒ Wet Pond ☐ Constructed Wetland ☐ Bioretention
☐ Proprietary Media Filter ☐ Infiltration ☐ Swale ☐ Other:

Description of proposed retrofit:
Remove existing in-stream facility and replace existing culvert crossing with fish passable structure. Acquire private property owned by Catholic Church southeast of existing crossing for new regional detention and water quality facility. Riparian restoration opportunities also possible.

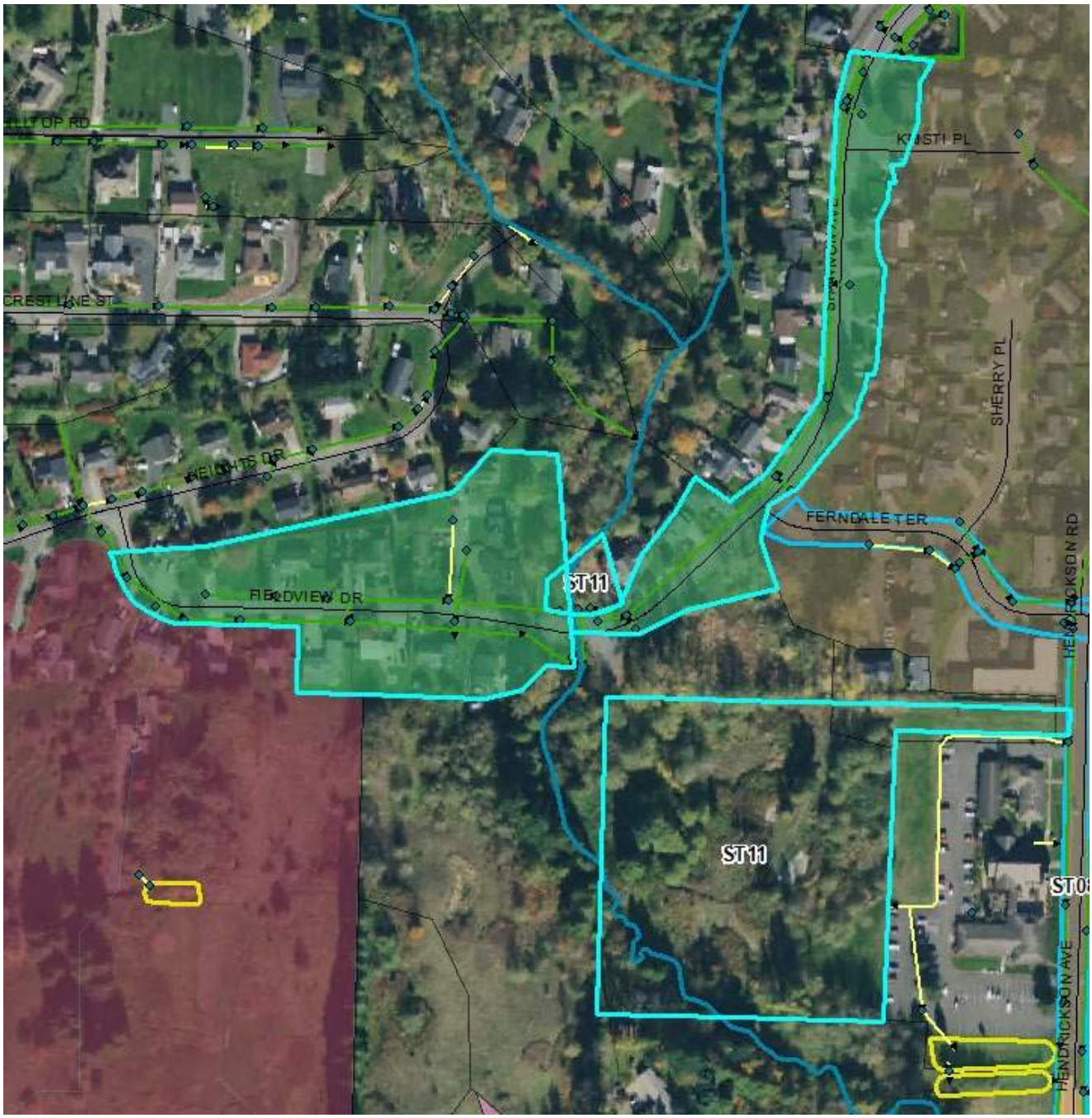
Drainage Area to Proposed Retrofit
Drainage Area: 7.5 acres
Impervious Area: ~30%
Notes:
TIA estimated from EIA Table #2 for SFR-Med.

Drainage Area Land Use
☒ Residential
☒ SFH (<1 ac lots)
☐ SFH (>1 ac lots)
☐ Multifamily
☐ Commercial/Industrial
☐ Transportation
☐ Undeveloped
☐ Other:

SITE CONSTRAINTS

☐ Adjacent Land Use:
☒ Access (slope, utilities, structures, space, tree impacts, property ownership, etc.): space, property ownership
☐ Existing Utilities:
☒ Permitting (dam safety, wetlands, stream, floodplain, forest, etc.): wetlands
☐ Other:

SKETCH AND/OR OTHER NOTES



Retrofit Reconnaissance Investigation (Modified by NHC) **RRI**

DATE/TIME: 3/2/23	**WATERSHED:** Schell Creek	**SITE ID:** ST12

Name(s) of Investigators: Chad Drake (NHC), Derek Stuart (NHC), Paul Knippel (COF), Dale Buys (R&E)

SITE DESCRIPTION

Location Notes: Pine Dr Outfall. Near Pine Dr and Sunshine Dr in Ferndale city limits.

Ownership: ☐ Public ☒ Private ☐ Unknown
If Public, Government Jurisdiction: ☐ Local ☐ State ☐ DOT ☐ Other:

Soils:
☐ Clay ☐ Sand ☐ Loam ☒ Till ☐ Outwash ☐ Saturated
☐ HSG A ☐ HSG B ☐ HSG C ☐ HSG D ☐ Other:
Infiltration Potential:
☒ Low ☐ Moderate ☐ High ☒ Other: deep infiltration potential

EXISTING STORMWATER MANAGEMENT

Existing Stormwater System: ☒ Yes ☐ No ☐ Unknown
Existing Treatment: ☐ Detention ☐ Infiltration ☐ Water Quality ☒ None ☐ Unknown
Year of Construction:
Existing head available:
Description of existing site conditions:
The existing stormwater conveyance system along Pine Dr and Sunshine Dr lacks flow control or treatment prior to discharging to Schell Creek.

PROPOSED STORMWATER RETROFIT

Purpose of Proposed Retrofit
☒ Flow Control ☒ Water Quality ☐ Infiltration ☐ Other:

Location of Proposed Retrofit
☒ Existing Stormwater Facility:
☐ Detention Pond ☐ Wet Pond ☐ Infiltration Pond ☐ Conveyance System ☒ Outfall ☐ Vault
☐ Other:
☐ New Facility:
☐ Vacant Parcel ☐ ROW ☐ Other:

Type of Proposed Retrofit
☐ Expanded detention ☐ Wet Pond ☐ Constructed Wetland ☐ Bioretention
☒ Proprietary Media Filter ☐ Infiltration ☐ Swale ☒ Other: vault

Description of proposed retrofit:
Install treatment media filters or a detention vault for treatment of Pine Dr Basin prior to discharging to Schell Creek.

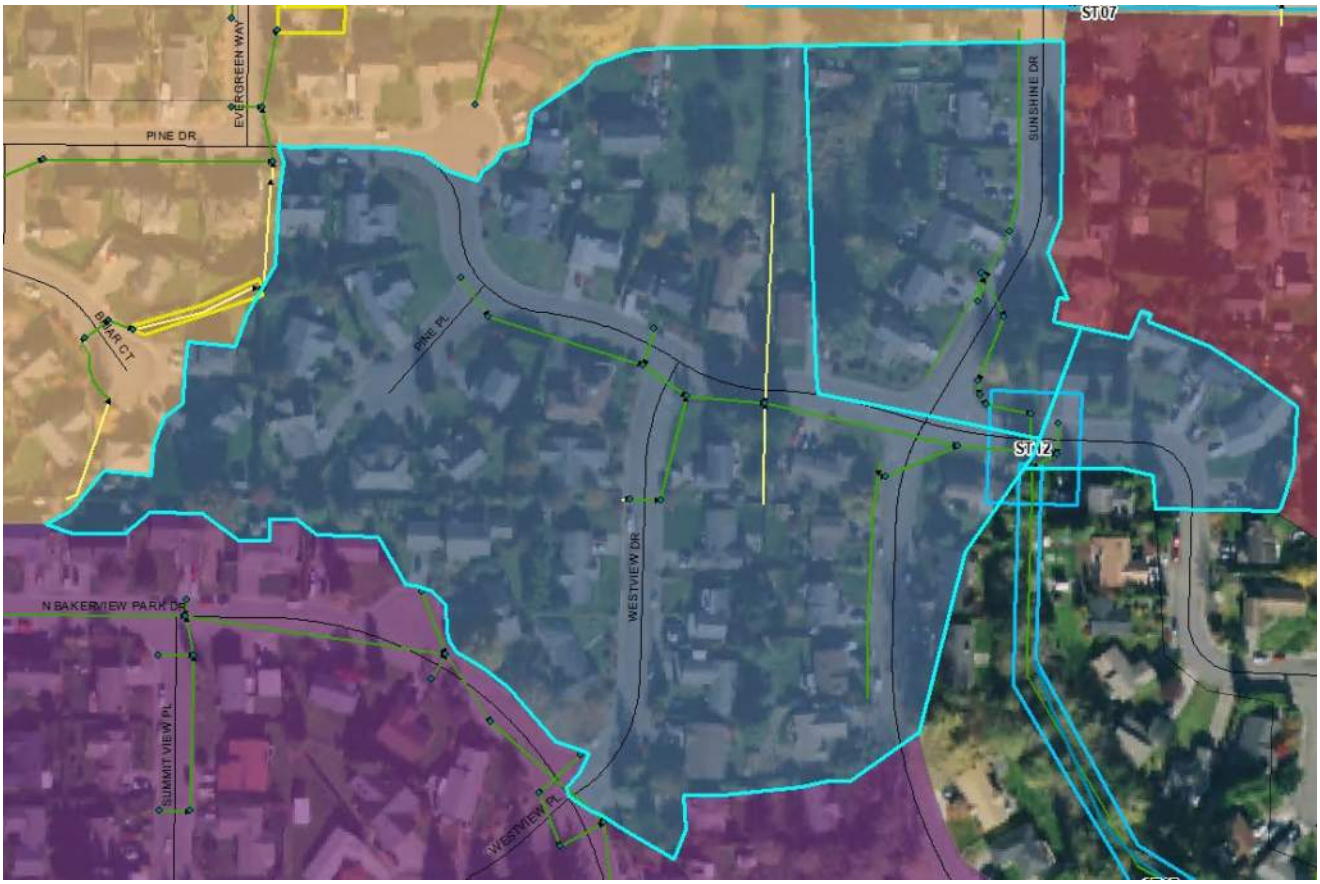
Drainage Area to Proposed Retrofit
Drainage Area: 15.3 acres
Impervious Area: ~30%
Notes:
TIA estimated from EIA Table #2 for SFR-Med.

Drainage Area Land Use
☒ Residential ☐ Commercial/Industrial
☒ SFH (<1 ac lots) ☐ Transportation
☐ SFH (>1 ac lots) ☐ Undeveloped
☐ Multifamily
☐ Other:

SITE CONSTRAINTS

- ☐ Adjacent Land Use:
- ☒ Access (slope, utilities, structures, space, tree impacts, property ownership, etc.): space, property ownership
- ☐ Existing Utilities:
- ☐ Permitting (dam safety, wetlands, stream, floodplain, forest, etc.): wetlands
- ☐ Other:

SKETCH AND/OR OTHER NOTES



Retrofit Reconnaissance Investigation (Modified by NHC) **RRI**

DATE/TIME: 3/2/23	**WATERSHED:** Schell Creek	**SITE ID:** ST13

Name(s) of Investigators: Chad Drake (NHC), Derek Stuart (NHC), Paul Knippel (COF), Dale Buys (R&E)

SITE DESCRIPTION

Location Notes: Heather Dr Facility. Near Heather Dr and Sunshine Dr in Ferndale city limits. South of Heather Dr at Schell Creek crossing. Directly downstream of Emerald Terrace Pond A.

Ownership: ☒ Public ☐ Private ☐ Unknown
If Public, Government Jurisdiction: ☒ Local ☐ State ☐ DOT ☐ Other:

Soils:
☐ Clay ☐ Sand ☐ Loam ☒ Till ☐ Outwash ☐ Saturated
☐ HSG A ☐ HSG B ☐ HSG C ☐ HSG D ☐ Other:
Infiltration Potential:
☒ Low ☐ Moderate ☐ High ☒ Other: deep infiltration potential

EXISTING STORMWATER MANAGEMENT

Existing Stormwater System: ☒ Yes ☐ No ☐ Unknown
Existing Treatment: ☐ Detention ☐ Infiltration ☐ Water Quality ☒ None ☐ Unknown
Year of Construction:
Existing head available:
Description of existing site conditions:
The existing stormwater conveyance system along Heather Dr (west of the Schell Creek crossing) lacks flow control or treatment prior to discharging to Schell Creek on the south side of Heather Dr.

PROPOSED STORMWATER RETROFIT

Purpose of Proposed Retrofit
☒ Flow Control ☒ Water Quality ☐ Infiltration ☐ Other:

Location of Proposed Retrofit
☐ Existing Stormwater Facility:
☐ Detention Pond ☐ Wet Pond ☐ Infiltration Pond ☐ Conveyance System ☐ Outfall ☐ Vault
☐ Other:
☒ New Facility:
☐ Vacant Parcel ☒ ROW ☐ Other:

Type of Proposed Retrofit
☐ Expanded detention ☐ Wet Pond ☐ Constructed Wetland ☐ Bioretention
☒ Proprietary Media Filter ☐ Infiltration ☐ Swale ☒ Other: vault

Description of proposed retrofit:
Install a new below grade detention vault on Heather Dr that also provides water quality treatment for the runoff from the Heather Dr Basin prior to discharging to Schell Creek on the south side of Heather Dr. Combine with Schell Creek-Heather Dr culvert replacement project.

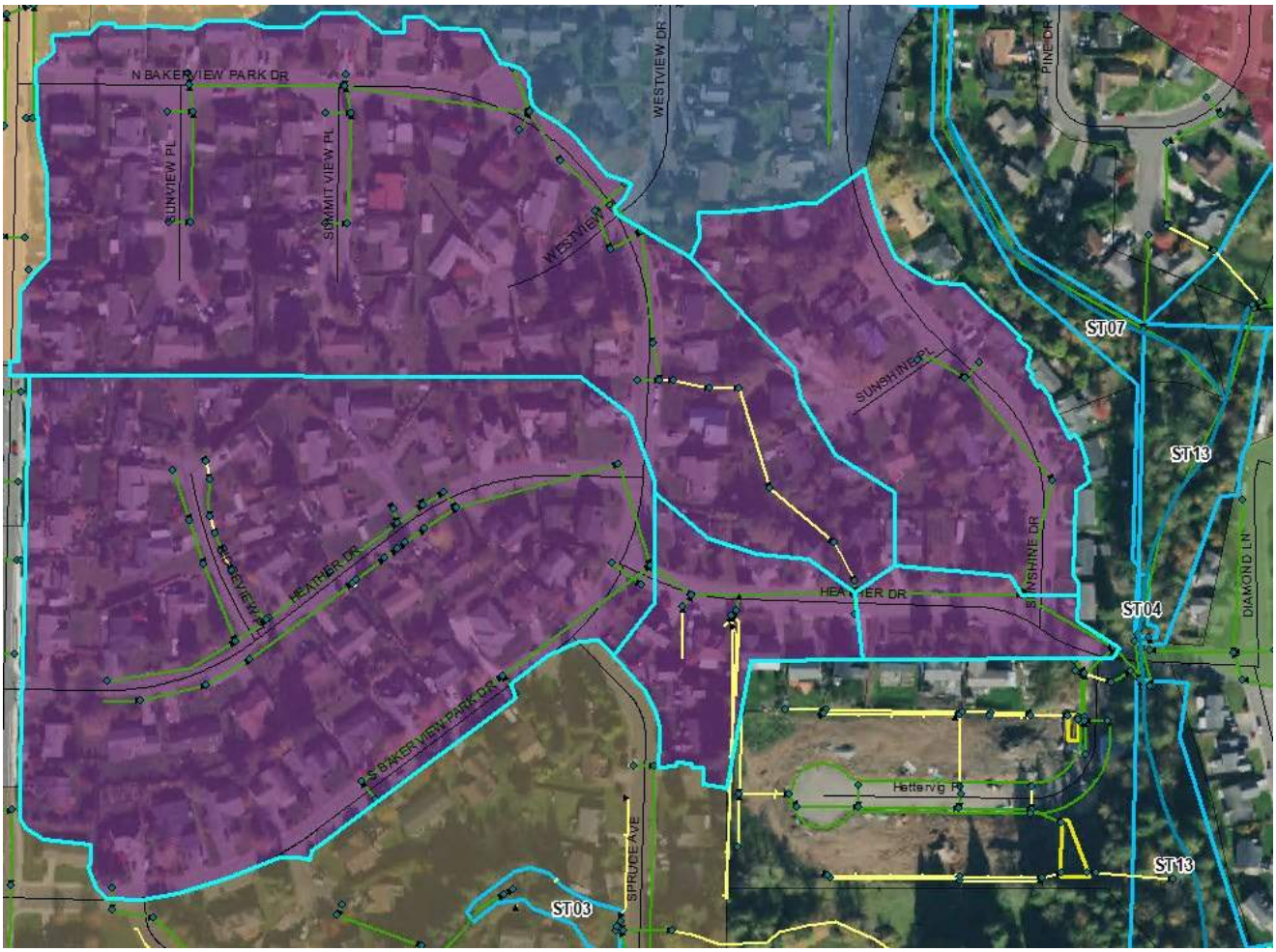
Drainage Area to Proposed Retrofit
Drainage Area: 37 acres
Impervious Area: ~30%
Notes:
TIA estimated from EIA Table #2 for SFR-Med.

Drainage Area Land Use
☒ Residential ☐ Commercial/Industrial
☒ SFH (<1 ac lots) ☐ Transportation
☐ SFH (>1 ac lots) ☐ Undeveloped
☐ Multifamily
☐ Other:

SITE CONSTRAINTS

☐ Adjacent Land Use:
☒ Access (slope, utilities, structures, space, tree impacts, property ownership, etc.): space
☐ Existing Utilities:
☒ Permitting (dam safety, wetlands, stream, floodplain, forest, etc.): wetlands
☐ Other:

SKETCH AND/OR OTHER NOTES



Priority Retrofit

Stormwater Conveyance

City-owned

Private

Stormwater Facilities

City-owned

Private

Retrofit Drainage Area

Thornton Terrace Pond (Existing)

Thornton Terrace Pond (Future)

Hendrickson Ave Regional Facility (East)

Hendrickson Ave Regional Facility (West)

Main St Treatment (East)

Main St Treatment (West)

Thorton Street

Thornton Terrace Pond (ST02)

Ferndale Terrace Stormwater Improvement Project (ST14)

Church Road

Hendrickson Ave Regional Facility (West) (ST05)

Main St Treatment (West) (ST09)

Schell Creek Realignment and Culvert Replacement (ST09)

Hendrickson Ave Regional Facility (East) (ST05)

Main St Treatment (East) (ST09)

Main Stre

Douglas

City of Ferndale

nhc northwest hydraulic consultants

City Limits

UGA

Planning Unit

Stream

SCALE - 1:10,000 (1 inch = 0.16 mile)

0 400 800

Feet

Coordinate System: NAD 1983 STATEPLANE WASHINGTON NORTH FIPS 4601 FEET

N

Job: 2006286

DATE: 28-Mar-2023

FERNDALE SMAP
Schell Creek Priority Stormwater Retrofits

FIGURE A-2

Q:\2006286_Ferndale_SCP_and_SMAP\95_GIS\MXDs\Figures\2006286_Ferndale_SMAP_Retrofits_Priority.mxd

Project Summary Sheet

Stormwater Retrofit: Thornton Terrace Pond Enhancements

Project Description: An existing City-owned detention pond will be repurposed and redesigned as a constructed wetland to provide detention and enhanced water quality treatment, improved habitat, and greater aesthetic value. The existing detention pond was built in 1991, does not meet current standards for flow control or treatment, and has a drainage area of 13 acres consisting mostly of the Thornton Terrace residential development. Improvements will include a new inlet structure to improve runoff delivery to the proposed facility, a new outlet structure that meets current flow control standards, expanding the facility' footprint to increase storage for detention and treatment, and planting appropriate wetland vegetation. The existing conveyance system along Thornton St west of Shannon Ave may also be redirected to the facility, increasing the total treated area to 102.5 acres. Over detaining to the extent feasible at the Thornton Terrace facility will also facilitate the removal of the Emerald Terrace in-stream facility approximately 700 feet downstream, which is no longer functioning as designed and presents a barrier to fish passage. If space allows, a walking trail and educational signs and placards may also be integrated at the 0.7-acre site to promote inclusion and watershed stewardship by Ferndale residents.

Existing Condition Photos:

Planning Level Cost Estimate: $2,513,000

Design Methodology: WWHM4 (Version 4.2.18; 2021), assume full buildout conditions

Design Quantities:

Parameter	Quantity	Units
Drainage Area	102.5	acres
Impervious Area	34.1	acres
Pervious Area	68.4	acres
WQ Design Volume	6.6	acre-feet
WQ Design Flow Rate	6.7	cfs
Detention Volume Required for Flow Control	25.2	acre-feet
Width	407.2	feet
Length	407.2	feet
Depth	7	feet
Side slopes	3:1	H:V
Outlet Structure	1 orifice & rectangular notch	
Riser Height	6	feet
Riser Diameter	54	inches
Notch Depth	2.0	feet
Notch Width	0.4	feet
Orifice Height	0	feet
Orifice Diameter	0.44	inches
Stormwater Conveyance	700 ft. 24-inch pipe	

City of Ferndale

nhc
northwest hydraulic consultants

10' Contours
Proposed Conveyance
Proposed Retrofit Footprint
Existing Conveyance
City-owned
Private
Stormwater Catch Basin
Existing Facilities
City-owned
Private

SCALE - 1:2,500
0 100 200
Feet

Coordinate System: NAD 1983 STATEPLANE WASHINGTON NORTH FIPS 4601 FEET

N

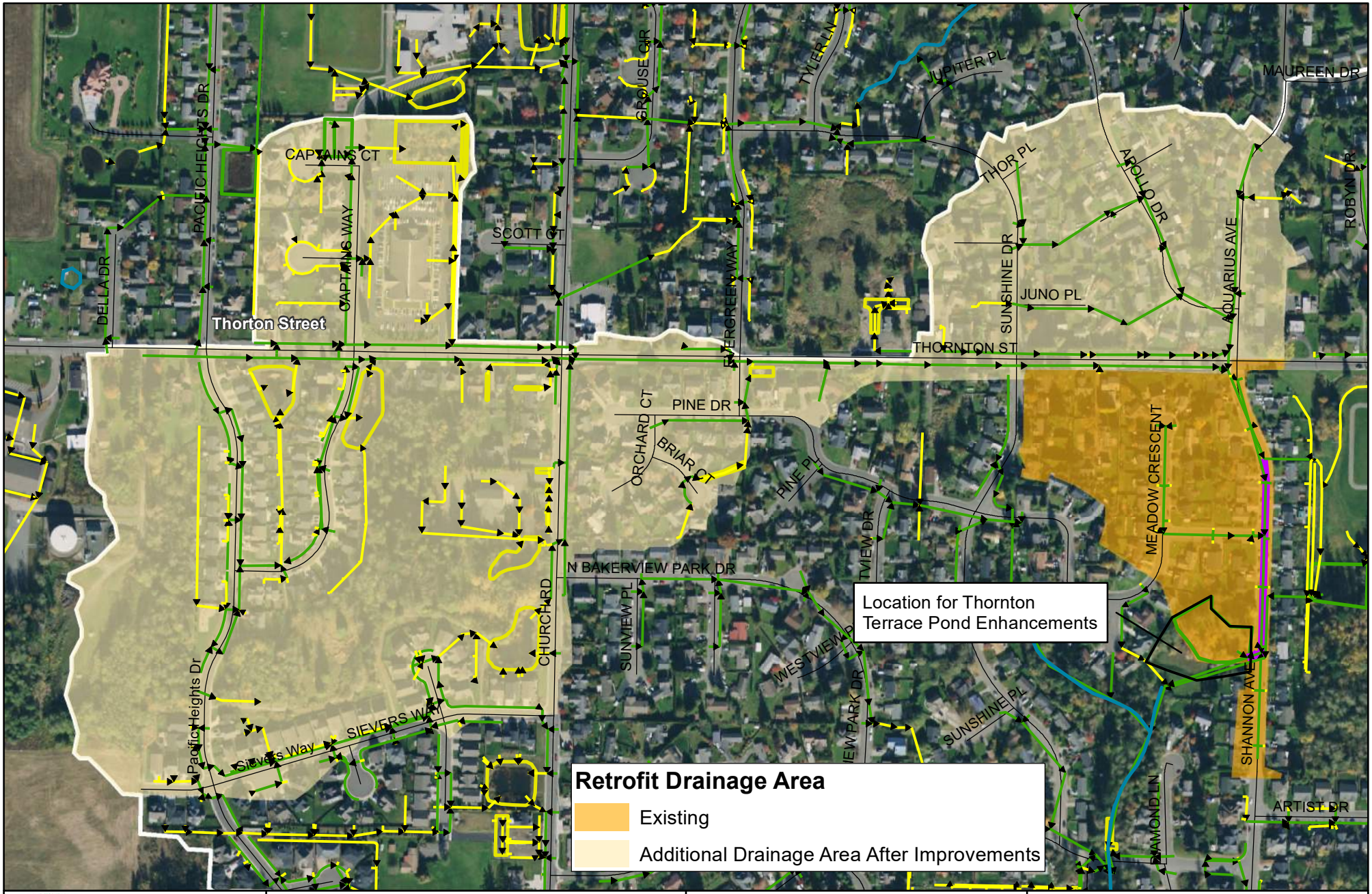
Job: 2006286

Date: 28-MAR-2023

FERNDALE SMAP
Schell Creek Stormwater Retrofits - Thornton Terrace Pond Enhancements

FIGURE A-3

Q:\2006286_Ferndale_SCP_and_SMAP\95_GIS\MXDs\Figures\2006286_Ferndale_SMAP_Retrofits_ThorntonTerracePond.mxd



City of Ferndale

nhc northwest hydraulic consultants

Proposed Conveyance
Proposed Retrofit Footprint
Existing Conveyance
City-owned
Private

Existing Facilities
City-owned
Private
Schell Creek Basin

SCALE - 1:2,500

0 500 1,000

Feet

Coordinate System: NAD 1983 STATEPLANE WASHINGTON NORTH FIPS 4601 FEET

N

Job: 2006286

Date: 30-MAR-2023

FERNDALE SMAP

Schell Creek Stormwater Retrofits - Thornton Terrace Pond Enhancements - Drainage Area

FIGURE A-4

Q:\2006286_Ferndale_SCP_and_SMAP\95_GIS\MXDs\Figures\2006286_Ferndale_SMAP_Retrofits_ThorntonTerracePond_DrainageArea.mxd

R&E Reichhardt & Ebe
ENGINEERING INC
423 Front Street
Lynden, WA 98264
Phone: (360) 354-3687

Called By:	City of Ferndale
For:	**Thornton Terrace Pond Enhancements** PO Box 936 / 2095 Main St Ferndale, WA 98248
	PRELIMINARY ENGINEER'S ESTIMATE
By:	Dale Buys, P.E.
Date:	March 28, 2023

Item No.	Item Description	Quantity	Unit	Unit Price	Amount
1	Mobilization	1	LS	$ 140,000.00	$ 140,000.00
2	Record Drawings	1	LS	$ 1,000.00	$ 1,000.00
3	SPCC Plan	1	LS	$ 1,000.00	$ 1,000.00
4	Project Temporary Traffic Control	1	LS	$ 5,000.00	$ 5,000.00
5	Flaggers	600	HR	$ 70.00	$ 42,000.00
6	Other Traffic Control Labor	120	HR	$ 70.00	$ 8,400.00
7	Clearing and Grubbing	1	LS	$ 10,000.00	$ 10,000.00
8	Removal of Structures and Obstructions	1	LS	$ 15,000.00	$ 15,000.00
9	Sawcut ACP	8,000	LF-IN	$ 3.00	$ 24,000.00
10	Sawcut PCC	75	LF-IN	$ 5.00	$ 375.00
11	Pond Excavation Incl. Haul	5,500	CY	$ 25.00	$ 137,500.00
12	Pond Embankment Compaction	5,000	CY	$ 15.00	$ 75,000.00
13	Clay Liner	7,000	CY	$ 25.00	$ 175,000.00
14	Water	5	M GAL.	$ 100.00	$ 500.00
15	Shoring or Extra Excavation Class B	4,000	SF	$ 2.00	$ 8,000.00
16	Dewatering	1	LS	$ 5,000.00	$ 5,000.00
17	Construction Geotextile for Separation	600	SY	$ 4.00	$ 2,400.00
18	Gravel Base	350	TON	$ 20.00	$ 7,000.00
19	Crushed Surfacing Top Course	75	TON	$ 40.00	$ 3,000.00
20	HMA Cl. 1/2" PG 64-22	275	TON	$ 150.00	$ 41,250.00
21	Planing Bituminous Pavement	750	SY	$ 50.00	$ 37,500.00
22	Compaction Price Adjustment	1	CALC		$ -
23	Job Mix Compliance Price Adjustment	1	CALC		$ -
24	Deficient Strength Conc. Price Adjustment	1	CALC		$ -
25	Corrugated Polyethylene Storm Sewer Pipe 24 In. Diam.	700	LF	$ 175.00	$ 122,500.00
26	Catch Basin Type 2 48 In. Diam.	5	EA	$ 4,750.00	$ 23,750.00
27	Pond Outlet Control Structure Catchbasin	1	EA	$ 9,000.00	$ 9,000.00
28	Adjustments to Finished Grade	1	LS	$ 5,000.00	$ 5,000.00
29	Erosion/Water Pollution Control	1	EST	$ 10,000.00	$ 10,000.00
30	ESC Lead	80	DAY	$ 50.00	$ 4,000.00
31	Street Cleaning	80	HR	$ 185.00	$ 14,800.00
32	Silt Fence	150	LF	$ 10.00	$ 1,500.00
33	Inlet Protection	10	EA	$ 100.00	$ 1,000.00
34	Landscape Restoration	1	EST	$ 10,000.00	$ 10,000.00
34	Topsoil Type A	22,000	SY	$ 20.00	$ 440,000.00
35	Seeded Lawn Installation	3,000	SY	$ 15.00	$ 45,000.00
36	Wetland Planting	1	AC	$ 350,000.00	$ 350,000.00
37	Cement Conc. Traffic Curb and Gutter	250	LF	$ 60.00	$ 15,000.00
38	Cement Conc. Sidewalk	140	SY	$ 100.00	$ 14,000.00
39	Quarry Spalls	20	TON	$ 75.00	$ 1,500.00
40	Pothole Existing Underground Utility	10	EA	$ 550.00	$ 5,500.00
41	Repair Existing Public and Private Facilities	1	EST	$ 50,000.00	$ 50,000.00
	Subtotal				$ 1,861,475.00
	Design and Permitting (20%)				$ 372,295.00
	Construction Admin and Inspection (15%)				$ 279,221.25
	TOTAL				**$ 2,512,991.25**

WWHM2012

PROJECT REPORT

General Model Information

Project Name:	TotalBasin
Site Name:	Ferndale SMAP
Site Address:	
City:	
Report Date:	3/24/2023
Gage:	Blaine
Data Start:	1948/10/01
Data End:	2009/09/30
Timestep:	15 Minute
Precip Scale:	0.857
Version Date:	2021/08/18
Version:	4.2.18

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, Flat	123.98
C, Forest, Mod	16.04
SAT, Forest, Flat	7.69
Pervious Total	147.71
Impervious Land Use	acre
Impervious Total	0
Basin Total	147.71

Element Flows To:

Surface	Interflow	Groundwater

Mitigated Land Use

Basin 1

Bypass:	No
GroundWater:	No

Pervious Land Use	acre
C, Forest, Flat	25.3
C, Lawn, Flat	57.38
C, Lawn, Mod	7.01
C, Forest, Mod	3.69
SAT, Forest, Flat	5.13
Pervious Total	98.51

Impervious Land Use	acre
ROADS MOD	49.21
Impervious Total	49.21
Basin Total	147.72

Element Flows To:

Surface	Interflow	Groundwater
Trapezoidal Pond 1	Trapezoidal Pond 1	Trapezoidal Pond 1

Routing Elements
Predeveloped Routing

Mitigated Routing

Trapezoidal Pond 1

Bottom Length: 407.16 ft.
Bottom Width: 407.16 ft.
Depth: 7 ft.
Volume at riser head: 25.2138 acre-feet.
Side slope 1: 3 To 1
Side slope 2: 3 To 1
Side slope 3: 3 To 1
Side slope 4: 3 To 1
Discharge Structure
Riser Height: 6 ft.
Riser Diameter: 54 in.
Notch Type: Rectangular
Notch Width: 0.439 ft.
Notch Height: 2.037 ft.
Orifice 1 Diameter: 5.036 in. Elevation:0 ft.
Element Flows To:
Outlet 1 Outlet 2

Pond Hydraulic Table

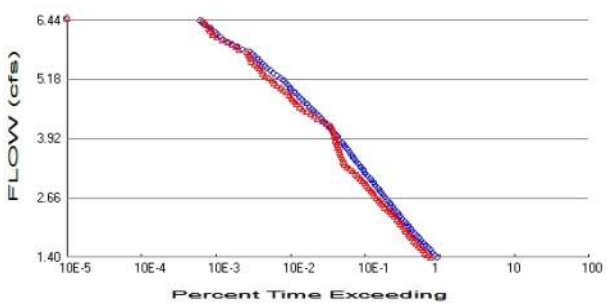
Stage(feet)	Area(ac.)	Volume(ac-ft.)	Discharge(cfs)	Infilt(cfs)
0.0000	3.805	0.000	0.000	0.000
0.0778	3.814	0.296	0.191	0.000
0.1556	3.823	0.593	0.271	0.000
0.2333	3.832	0.891	0.332	0.000
0.3111	3.840	1.189	0.383	0.000
0.3889	3.849	1.488	0.429	0.000
0.4667	3.858	1.788	0.470	0.000
0.5444	3.867	2.088	0.507	0.000
0.6222	3.875	2.389	0.542	0.000
0.7000	3.884	2.691	0.575	0.000
0.7778	3.893	2.994	0.607	0.000
0.8556	3.902	3.297	0.636	0.000
0.9333	3.911	3.601	0.664	0.000
1.0111	3.920	3.905	0.692	0.000
1.0889	3.928	4.210	0.718	0.000
1.1667	3.937	4.516	0.743	0.000
1.2444	3.946	4.823	0.767	0.000
1.3222	3.955	5.130	0.791	0.000
1.4000	3.964	5.438	0.814	0.000
1.4778	3.973	5.747	0.836	0.000
1.5556	3.982	6.056	0.858	0.000
1.6333	3.991	6.366	0.879	0.000
1.7111	4.000	6.677	0.900	0.000
1.7889	4.009	6.989	0.920	0.000
1.8667	4.018	7.301	0.940	0.000
1.9444	4.027	7.614	0.959	0.000
2.0222	4.035	7.927	0.978	0.000
2.1000	4.044	8.241	0.997	0.000
2.1778	4.053	8.556	1.015	0.000
2.2556	4.062	8.872	1.033	0.000
2.3333	4.072	9.188	1.051	0.000
2.4111	4.081	9.506	1.068	0.000

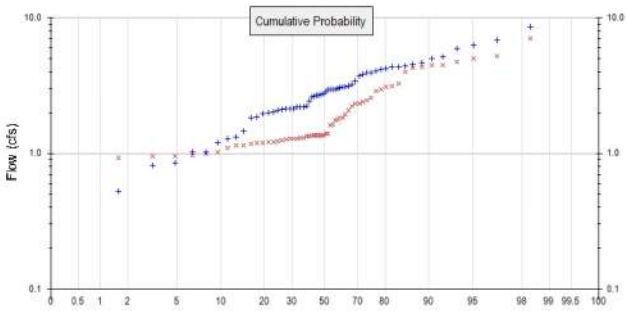
2.4889	4.090	9.823	1.085	0.000
2.5667	4.099	10.14	1.102	0.000
2.6444	4.108	10.46	1.119	0.000
2.7222	4.117	10.78	1.135	0.000
2.8000	4.126	11.10	1.151	0.000
2.8778	4.135	11.42	1.167	0.000
2.9556	4.144	11.74	1.183	0.000
3.0333	4.153	12.06	1.198	0.000
3.1111	4.162	12.39	1.213	0.000
3.1889	4.171	12.71	1.229	0.000
3.2667	4.181	13.04	1.243	0.000
3.3444	4.190	13.36	1.258	0.000
3.4222	4.199	13.69	1.273	0.000
3.5000	4.208	14.01	1.287	0.000
3.5778	4.217	14.34	1.301	0.000
3.6556	4.226	14.67	1.315	0.000
3.7333	4.236	15.00	1.329	0.000
3.8111	4.245	15.33	1.343	0.000
3.8889	4.254	15.66	1.357	0.000
3.9667	4.263	15.99	1.371	0.000
4.0444	4.272	16.32	1.417	0.000
4.1222	4.282	16.66	1.487	0.000
4.2000	4.291	16.99	1.571	0.000
4.2778	4.300	17.32	1.665	0.000
4.3556	4.310	17.66	1.767	0.000
4.4333	4.319	17.99	1.876	0.000
4.5111	4.328	18.33	1.990	0.000
4.5889	4.337	18.67	2.107	0.000
4.6667	4.347	19.00	2.228	0.000
4.7444	4.356	19.34	2.351	0.000
4.8222	4.365	19.68	2.475	0.000
4.9000	4.375	20.02	2.600	0.000
4.9778	4.384	20.36	2.730	0.000
5.0556	4.393	20.70	2.882	0.000
5.1333	4.403	21.05	3.039	0.000
5.2111	4.412	21.39	3.201	0.000
5.2889	4.422	21.73	3.367	0.000
5.3667	4.431	22.08	4.161	0.000
5.4444	4.440	22.42	4.389	0.000
5.5222	4.450	22.77	4.622	0.000
5.6000	4.459	23.11	4.861	0.000
5.6778	4.469	23.46	5.105	0.000
5.7556	4.478	23.81	5.355	0.000
5.8333	4.488	24.16	5.610	0.000
5.9111	4.497	24.51	5.870	0.000
5.9889	4.507	24.86	6.134	0.000
6.0667	4.516	25.21	7.004	0.000
6.1444	4.526	25.56	8.813	0.000
6.2222	4.535	25.91	11.20	0.000
6.3000	4.545	26.27	14.04	0.000
6.3778	4.554	26.62	17.27	0.000
6.4556	4.564	26.98	20.82	0.000
6.5333	4.573	27.33	24.66	0.000
6.6111	4.583	27.69	28.74	0.000
6.6889	4.593	28.04	33.02	0.000
6.7667	4.602	28.40	37.45	0.000
6.8444	4.612	28.76	41.99	0.000
6.9222	4.621	29.12	46.60	0.000

7.0000	4.631	29.48	51.24	0.000
7.0778	4.641	29.84	55.85	0.000

Analysis Results

POC 1





+ Predeveloped x Mitigated

Predeveloped Landuse Totals for POC #1
Total Pervious Area: 147.71
Total Impervious Area: 0

Mitigated Landuse Totals for POC #1
Total Pervious Area: 98.51
Total Impervious Area: 49.21

Flow Frequency Method: Log Pearson Type III 17B

Flow Frequency Return Periods for Predeveloped. POC #1

Return Period	Flow(cfs)
2 year	2.806433
5 year	4.264928
10 year	5.07326
25 year	5.918692
50 year	6.437034
100 year	6.875325

Flow Frequency Return Periods for Mitigated. POC #1

Return Period	Flow(cfs)
2 year	1.707338
5 year	2.75004
10 year	3.621668
25 year	4.957673
50 year	6.142252
100 year	7.505831

Annual Peaks

Annual Peaks for Predeveloped and Mitigated. POC #1

Year	Predeveloped	Mitigated
1949	3.072	1.336
1950	3.213	1.342
1951	4.542	4.711
1952	1.016	1.023
1953	1.322	1.229
1954	2.608	1.353
1955	1.864	2.393
1956	2.072	2.876
1957	4.632	1.388
1958	1.463	1.180

1959	1.985	1.351
1960	2.947	1.307
1961	2.207	1.752
1962	1.966	1.198
1963	2.131	1.269
1964	4.151	4.317
1965	5.151	4.308
1966	4.373	1.100
1967	4.023	3.277
1968	3.911	3.134
1969	2.212	1.358
1970	0.814	0.928
1971	3.844	1.840
1972	2.963	1.766
1973	2.218	2.329
1974	2.718	1.350
1975	2.143	1.282
1976	3.925	4.491
1977	2.212	1.210
1978	2.950	1.642
1979	2.029	1.188
1980	4.209	4.472
1981	1.827	1.215
1982	5.030	4.004
1983	2.096	1.350
1984	8.589	4.970
1985	4.334	1.276
1986	6.797	2.981
1987	3.121	1.610
1988	2.428	1.247
1989	2.775	1.150
1990	3.704	2.321
1991	2.693	3.085
1992	3.041	2.476
1993	2.629	1.278
1994	1.193	0.951
1995	2.967	1.829
1996	4.387	1.397
1997	5.914	7.046
1998	0.848	0.961
1999	6.292	5.258
2000	1.028	1.151
2001	0.377	0.715
2002	2.692	1.349
2003	0.521	0.952
2004	2.139	1.931
2005	3.432	2.220
2006	2.840	2.091
2007	3.095	1.304
2008	1.285	0.993
2009	3.009	2.573

Ranked Annual Peaks

Ranked Annual Peaks for Predeveloped and Mitigated. POC #1

Rank	Predeveloped	Mitigated
1	8.5894	7.0462
2	6.7968	5.2578
3	6.2919	4.9701

4	5.9143	4.7106
5	5.1506	4.4905
6	5.0296	4.4725
7	4.6324	4.3173
8	4.5420	4.3084
9	4.3873	4.0039
10	4.3732	3.2770
11	4.3340	3.1343
12	4.2094	3.0847
13	4.1514	2.9812
14	4.0228	2.8765
15	3.9253	2.5732
16	3.9114	2.4756
17	3.8435	2.3932
18	3.7045	2.3293
19	3.4325	2.3211
20	3.2127	2.2196
21	3.1209	2.0908
22	3.0948	1.9314
23	3.0724	1.8405
24	3.0412	1.8294
25	3.0087	1.7665
26	2.9671	1.7516
27	2.9628	1.6425
28	2.9499	1.6102
29	2.9470	1.3972
30	2.8404	1.3881
31	2.7751	1.3584
32	2.7177	1.3533
33	2.6925	1.3510
34	2.6915	1.3501
35	2.6288	1.3499
36	2.6080	1.3491
37	2.4283	1.3416
38	2.2182	1.3355
39	2.2123	1.3075
40	2.2117	1.3040
41	2.2075	1.2820
42	2.1431	1.2783
43	2.1390	1.2760
44	2.1310	1.2687
45	2.0956	1.2474
46	2.0724	1.2293
47	2.0289	1.2153
48	1.9852	1.2096
49	1.9656	1.1985
50	1.8641	1.1881
51	1.8271	1.1797
52	1.4635	1.1510
53	1.3222	1.1500
54	1.2851	1.0996
55	1.1934	1.0233
56	1.0281	0.9930
57	1.0156	0.9608
58	0.8476	0.9521
59	0.8135	0.9511
60	0.5213	0.9281
61	0.3771	0.7153

Duration Flows

The Facility PASSED

Flow(cfs)	Predev	Mit	Percentage	Pass/Fail
1.4032	19817	15990	80	Pass
1.4541	18392	14686	79	Pass
1.5049	17049	13554	79	Pass
1.5558	15866	12637	79	Pass
1.6066	14780	11800	79	Pass
1.6574	13727	11043	80	Pass
1.7083	12835	10211	79	Pass
1.7591	11967	9561	79	Pass
1.8100	11212	8983	80	Pass
1.8608	10525	8397	79	Pass
1.9117	9871	7995	80	Pass
1.9625	9268	7548	81	Pass
2.0134	8682	7142	82	Pass
2.0642	8153	6752	82	Pass
2.1151	7627	6382	83	Pass
2.1659	7125	6036	84	Pass
2.2168	6684	5642	84	Pass
2.2676	6305	5242	83	Pass
2.3185	5944	4898	82	Pass
2.3693	5623	4575	81	Pass
2.4201	5287	4244	80	Pass
2.4710	4988	3921	78	Pass
2.5218	4695	3651	77	Pass
2.5727	4406	3420	77	Pass
2.6235	4164	3221	77	Pass
2.6744	3946	3020	76	Pass
2.7252	3720	2849	76	Pass
2.7761	3518	2699	76	Pass
2.8269	3311	2554	77	Pass
2.8778	3129	2381	76	Pass
2.9286	2947	2229	75	Pass
2.9795	2785	2084	74	Pass
3.0303	2614	1952	74	Pass
3.0812	2462	1831	74	Pass
3.1320	2308	1702	73	Pass
3.1828	2171	1566	72	Pass
3.2337	2053	1436	69	Pass
3.2845	1943	1317	67	Pass
3.3354	1833	1200	65	Pass
3.3862	1718	1128	65	Pass
3.4371	1620	1098	67	Pass
3.4879	1530	1071	70	Pass
3.5388	1452	1033	71	Pass
3.5896	1376	999	72	Pass
3.6405	1305	974	74	Pass
3.6913	1230	947	76	Pass
3.7422	1161	928	79	Pass
3.7930	1098	907	82	Pass
3.8439	1031	886	85	Pass
3.8947	971	861	88	Pass
3.9455	922	849	92	Pass
3.9964	880	833	94	Pass
4.0472	820	813	99	Pass

4.0981	763	797	104	Pass
4.1489	709	778	109	Pass
4.1998	661	722	109	Pass
4.2506	617	656	106	Pass
4.3015	583	575	98	Pass
4.3523	547	498	91	Pass
4.4032	506	448	88	Pass
4.4540	471	395	83	Pass
4.5049	432	349	80	Pass
4.5557	406	308	75	Pass
4.6066	380	284	74	Pass
4.6574	351	258	73	Pass
4.7082	324	242	74	Pass
4.7591	303	227	74	Pass
4.8099	277	219	79	Pass
4.8608	262	204	77	Pass
4.9116	239	188	78	Pass
4.9625	222	170	76	Pass
5.0133	209	157	75	Pass
5.0642	194	140	72	Pass
5.1150	184	128	69	Pass
5.1659	169	120	71	Pass
5.2167	155	110	70	Pass
5.2676	141	97	68	Pass
5.3184	125	91	72	Pass
5.3693	115	87	75	Pass
5.4201	103	81	78	Pass
5.4709	97	76	78	Pass
5.5218	89	71	79	Pass
5.5726	84	64	76	Pass
5.6235	77	62	80	Pass
5.6743	71	60	84	Pass
5.7252	65	58	89	Pass
5.7760	60	55	91	Pass
5.8269	48	43	89	Pass
5.8777	41	40	97	Pass
5.9286	34	36	105	Pass
5.9794	31	31	100	Pass
6.0303	27	26	96	Pass
6.0811	24	22	91	Pass
6.1320	22	19	86	Pass
6.1828	21	19	90	Pass
6.2336	19	18	94	Pass
6.2845	18	17	94	Pass
6.3353	15	16	106	Pass
6.3862	14	15	107	Pass
6.4370	13	14	107	Pass

Water Quality

Water Quality BMP Flow and Volume for POC #1

On-line facility volume:	6.6486 acre-feet
On-line facility target flow:	6.6527 cfs.
Adjusted for 15 min:	6.6527 cfs.
Off-line facility target flow:	3.7105 cfs.
Adjusted for 15 min:	3.7105 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
Trapezoidal Pond 1 POC	☐	12893.89			☐	0.00			
Total Volume Infiltrated		12893.89	0.00	0.00		0.00	0.00	0%	No Treat. Credit
Compliance with LID Standard 8% of 2-yr to 50% of 2-yr									Duration Analysis Result = Failed

POC 2

POC #2 was not reported because POC must exist in both scenarios and both scenarios must have been run.

POC 3

POC #3 was not reported because POC must exist in both scenarios and both scenarios must have been run.

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   TotalBasin.wdm
MESSU       25   PreTotalBasin.MES
            27   PreTotalBasin.L61
            28   PreTotalBasin.L62
            30   POCTotalBasin1.dat
END FILES

OPN SEQUENCE
    INGRP               INDELT 00:15
      PERLND      10
      PERLND      11
      PERLND      19
      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           ***
   10     C, Forest, Flat         1    1    1    1   27    0
   11     C, Forest, Mod          1    1    1    1   27    0
   19     SAT, Forest, Flat       1    1    1    1   27    0
  END GEN-INFO
  *** Section PWATER***

  ACTIVITY
    <PLS > ************ Active Sections ******************************
    # -  # ATMP SNOW PWAT  SED  PST  PWG PQAL MSTL PEST NITR PHOS TRAC ***
   10         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
   19         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  *********
   10         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
   19         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 ***
   10         0    0    0    0    0    0    0    0    0    0    0
   11         0    0    0    0    0    0    0    0    0    0    0
   19         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
   10              0       4.5      0.08       400      0.05       0.5     0.996
   11              0       4.5      0.08       400       0.1       0.5     0.996
   19              0         4         2       100     0.001       0.5     0.996
  END PWAT-PARM2

  PWAT-PARM3
    <PLS >      PWATER input info: Part 3         ***
    # -  # ***PETMAX    PETMIN    INFEXP    INFILD    DEEPFR    BASETP    AGWETP
   10              0         0         2         2         0         0         0
   11              0         0         2         2         0         0         0
   19              0         0        10         2         0         0       0.7
  END PWAT-PARM3
  PWAT-PARM4
    <PLS >     PWATER input info: Part 4                              ***
    # -  #     CEPSC      UZSN      NSUR     INTFW       IRC     LZETP ***
   10            0.2       0.5      0.35         6       0.5       0.7
   11            0.2       0.5      0.35         6       0.5       0.7
   19            0.2         3       0.5         1       0.7       0.8
  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
   10              0         0         0         0       2.5          1         0
   11              0         0         0         0       2.5          1         0
   19              0         0         0         0       4.2          1         0
  END PWAT-STATE1

END PERLND

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

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

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

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

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

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

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

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

END IMPLND

SCHEMATIC
<-Source->                 <--Area-->     <-Target->   MBLK    ***
<Name>   #                 <-factor->     <Name>   #   Tbl#    ***
Basin  1***
PERLND  10                     123.98     COPY   501     12
PERLND  10                     123.98     COPY   501     13
PERLND  11                      16.04     COPY   501     12
PERLND  11                      16.04     COPY   501     13
PERLND  19                       7.69     COPY   501     12
PERLND  19                       7.69     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    0.857          PERLND   1 999 EXTNL  PREC
WDM      2 PREC     ENGL    0.857          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   TotalBasin.wdm
MESSU       25   MitTotalBasin.MES
            27   MitTotalBasin.L61
            28   MitTotalBasin.L62
            30   POCTotalBasin1.dat
END FILES

OPN SEQUENCE
    INGRP               INDELT 00:15
      PERLND      10
      PERLND      16
      PERLND      17
      PERLND      11
      PERLND      19
      IMPLND       2
      RCHRES       1
      COPY         1
      COPY       501
      DISPLY       1
    END INGRP
END OPN SEQUENCE
DISPLY
  DISPLY-INFO1
    # -  #<----------Title---------->***TRAN PIVL DIG1 FIL1  PYR DIG2 FIL2 YRND
    1        Trapezoidal Pond  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             ***
   10     C, Forest, Flat         1    1    1    1   27    0
   16     C, Lawn, Flat           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
   19     SAT, Forest, Flat       1    1    1    1   27    0
  END GEN-INFO
  *** Section PWATER***

  ACTIVITY
```

```
  <PLS > ************ Active Sections ****************************
  # -  # ATMP SNOW PWAT  SED  PST  PWG PQAL MSTL PEST NITR PHOS TRAC ***
 10         0    0    1    0    0    0    0    0    0    0    0    0
 16         0    0    1    0    0    0    0    0    0    0    0    0
 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
 19         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  *********
 10         0    0    4    0    0    0    0    0    0    0    0    0    1    9
 16         0    0    4    0    0    0    0    0    0    0    0    0    1    9
 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
 19         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 ***
 10         0    0    0    0    0    0    0    0    0    0    0
 16         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
 19         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
 10              0       4.5     0.08       400      0.05        0.5      0.996
 16              0       4.5     0.03       400      0.05        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
 19              0         4        2       100     0.001        0.5      0.996
END PWAT-PARM2

PWAT-PARM3
  <PLS >      PWATER input info: Part 3         ***
  # -  # ***PETMAX    PETMIN    INFEXP    INFILD    DEEPFR    BASETP    AGWETP
 10              0         0         2         2         0         0         0
 16              0         0         2         2         0         0         0
 17              0         0         2         2         0         0         0
 11              0         0         2         2         0         0         0
 19              0         0        10         2         0         0       0.7
END PWAT-PARM3
PWAT-PARM4
  <PLS >     PWATER input info: Part 4                              ***
  # -  #     CEPSC      UZSN      NSUR     INTFW       IRC     LZETP ***
 10            0.2       0.5      0.35         6       0.5       0.7
 16            0.1      0.25      0.25         6       0.5      0.25
 17            0.1      0.25      0.25         6       0.5      0.25
 11            0.2       0.5      0.35         6       0.5       0.7
 19            0.2         3       0.5         1       0.7       0.8
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
 10              0         0         0         0       2.5          1         0
 16              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
 19              0         0         0         0       4.2          1         0
END PWAT-STATE1

END PERLND
```

```
IMPLND
  GEN-INFO
    <PLS ><-------Name------->   Unit-systems   Printer ***
    # -  #                     User  t-series Engl Metr ***
                                    in  out           ***
    2      ROADS/MOD              1    1    1   27    0
  END GEN-INFO
  *** Section IWATER***

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

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

  IWAT-PARM1
    <PLS >  IWATER variable monthly parameter value flags  ***
    # -  # CSNO RTOP  VRS  VNN RTLI     ***
    2         0    0    0    0    0
  END IWAT-PARM1

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

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

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

END IMPLND

SCHEMATIC
<-Source->                 <--Area-->     <-Target->   MBLK   ***
<Name>   #                 <-factor->     <Name>   #   Tbl#   ***
Basin  1***
PERLND  10                      25.3      RCHRES   1      2
PERLND  10                      25.3      RCHRES   1      3
PERLND  10                      25.3      RCHRES   1      4
PERLND  16                     57.38      RCHRES   1      2
PERLND  16                     57.38      RCHRES   1      3
PERLND  16                     57.38      RCHRES   1      4
PERLND  17                      7.01      RCHRES   1      2
PERLND  17                      7.01      RCHRES   1      3
PERLND  17                      7.01      RCHRES   1      4
PERLND  11                      3.69      RCHRES   1      2
PERLND  11                      3.69      RCHRES   1      3
PERLND  11                      3.69      RCHRES   1      4
PERLND  19                      5.13      RCHRES   1      2
PERLND  19                      5.13      RCHRES   1      3
PERLND  19                      5.13      RCHRES   1      4
IMPLND   2                     49.21      RCHRES   1      5

******Routing******
```

```
PERLND  10                      25.3     COPY     1     12
PERLND  16                     57.38     COPY     1     12
PERLND  17                      7.01     COPY     1     12
PERLND  11                      3.69     COPY     1     12
PERLND  19                      5.13     COPY     1     12
IMPLND   2                     49.21     COPY     1     15
PERLND  10                      25.3     COPY     1     13
PERLND  16                     57.38     COPY     1     13
PERLND  17                      7.01     COPY     1     13
PERLND  11                      3.69     COPY     1     13
PERLND  19                      5.13     COPY     1     13
PERLND  10                      25.3     COPY     1     14
PERLND  16                     57.38     COPY     1     14
PERLND  17                      7.01     COPY     1     14
PERLND  11                      3.69     COPY     1     14
PERLND  19                      5.13     COPY     1     14
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     Trapezoidal Pond-011    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      0.08       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
   91    4
     Depth      Area    Volume  Outflow1 Velocity  Travel Time***
      (ft)   (acres) (acre-ft)   (cfs)   (ft/sec)    (Minutes)***
  0.000000  3.805744  0.000000  0.000000
  0.077778  3.814473  0.296342  0.191937
  0.155556  3.823212  0.593363  0.271439
  0.233333  3.831961  0.891064  0.332444
  0.311111  3.840720  1.189446  0.383873
  0.388889  3.849489  1.488510  0.429183
  0.466667  3.858268  1.788256  0.470147
  0.544444  3.867057  2.088685  0.507817
  0.622222  3.875855  2.389798  0.542879
  0.700000  3.884664  2.691596  0.575810
  0.777778  3.893483  2.994080  0.606957
  0.855556  3.902312  3.297250  0.636582
  0.933333  3.911151  3.601107  0.664888
  1.011111  3.920000  3.905651  0.692037
  1.088889  3.928859  4.210885  0.718161
  1.166667  3.937728  4.516808  0.743367
  1.244444  3.946607  4.823421  0.767747
  1.322222  3.955496  5.130725  0.791375
  1.400000  3.964395  5.438720  0.814318
  1.477778  3.973304  5.747409  0.836633
  1.555556  3.982223  6.056790  0.858367
  1.633333  3.991151  6.366866  0.879564
  1.711111  4.000090  6.677636  0.900263
  1.788889  4.009039  6.989102  0.920496
  1.866667  4.017998  7.301265  0.940294
  1.944444  4.026967  7.614125  0.959683
  2.022222  4.035946  7.927682  0.978689
  2.100000  4.044935  8.241939  0.997332
  2.177778  4.053934  8.556895  1.015633
  2.255556  4.062943  8.872551  1.033611
  2.333333  4.071962  9.188909  1.051280
  2.411111  4.080991  9.505968  1.068658
  2.488889  4.090029  9.823730  1.085758
  2.566667  4.099078  10.14220  1.102592
  2.644444  4.108137  10.46136  1.119173
  2.722222  4.117206  10.78124  1.135513
  2.800000  4.126285  11.10182  1.151620
  2.877778  4.135374  11.42311  1.167505
  2.955556  4.144473  11.74510  1.183177
  3.033333  4.153582  12.06780  1.198644
  3.111111  4.162701  12.39121  1.213914
  3.188889  4.171830  12.71533  1.228994
  3.266667  4.180969  13.04016  1.243892
  3.344444  4.190117  13.36571  1.258613
  3.422222  4.199276  13.69196  1.273164
  3.500000  4.208445  14.01893  1.287550
  3.577778  4.217624  14.34661  1.301778
  3.655556  4.226813  14.67500  1.315851
  3.733333  4.236012  15.00411  1.329776
  3.811111  4.245221  15.33394  1.343557
  3.888889  4.254440  15.66448  1.357197
  3.966667  4.263669  15.99574  1.371059
  4.044444  4.272907  16.32772  1.417629
  4.122222  4.282156  16.66042  1.487392
  4.200000  4.291415  16.99383  1.571263
  4.277778  4.300684  17.32797  1.665495
  4.355556  4.309963  17.66283  1.767751
  4.433333  4.319252  17.99841  1.876343
  4.511111  4.328551  18.33471  1.989960
  4.588889  4.337860  18.67174  2.107524
```

```
  4.666667  4.347178  19.00949  2.228124
  4.744444  4.356507  19.34797  2.350968
  4.822222  4.365846  19.68717  2.475354
  4.900000  4.375195  20.02710  2.600651
  4.977778  4.384554  20.36776  2.730775
  5.055556  4.393923  20.70914  2.882709
  5.133333  4.403302  21.05126  3.039627
  5.211111  4.412691  21.39410  3.201358
  5.288889  4.422089  21.73768  3.367749
  5.366667  4.431498  22.08198  4.161293
  5.444444  4.440917  22.42702  4.389050
  5.522222  4.450346  22.77279  4.622476
  5.600000  4.459785  23.11930  4.861431
  5.677778  4.469234  23.46654  5.105779
  5.755556  4.478693  23.81451  5.355397
  5.833333  4.488162  24.16322  5.610169
  5.911111  4.497640  24.51267  5.869987
  5.988889  4.507129  24.86285  6.134749
  6.066667  4.516628  25.21378  7.004398
  6.144444  4.526137  25.56544  8.813106
  6.222222  4.535656  25.91784  11.19974
  6.300000  4.545185  26.27099  14.04278
  6.377778  4.554724  26.62487  17.26961
  6.455556  4.564272  26.97950  20.82593
  6.533333  4.573831  27.33487  24.66530
  6.611111  4.583400  27.69099  28.74450
  6.688889  4.592979  28.04785  33.02121
  6.766667  4.602568  28.40545  37.45291
  6.844444  4.612167  28.76380  41.99638
  6.922222  4.621775  29.12290  46.60762
  7.000000  4.631394  29.48274  51.24207
  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    0.857          PERLND   1 999 EXTNL  PREC
WDM      2 PREC     ENGL    0.857          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
WDM      1 EVAP     ENGL    0.76           RCHRES   1     EXTNL  POTEV

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
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        4
PERLND     PWATER AGWO       0.083333      RCHRES         INFLOW IVOL
  END MASS-LINK    4

  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       14
PERLND     PWATER AGWO       0.083333      COPY           INPUT  MEAN
  END MASS-LINK   14

  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

Legal Notice

Clear Creek Solutions, Inc.
6200 Capitol Blvd. Ste F
Olympia, WA. 98501
Toll Free 1(866)943-0304
Local (360)943-0304

www.clearcreeksolutions.com

Project Summary Sheet

Stormwater Retrofit: Hendrickson Ave Regional Facility

Project Description: Full implementation of this project includes the construction of two ponds that can serves as constructed wetlands and provide detention for a total of 83 acres (18 acres of which drain to the west pond and 65 to the east pond) that currently lack any treatment. These would be partially constructed through excavation and partially with berms. Topographic limitations impose constraints on feasible sites, but at this level of design, it appears that the locations shown in Figure A-4 will work. This project, as currently depicted, could be completed in separate east and west phases if needed. There is also the potential for consolidation of both facilities into the eastern portion of the schoolyard, but additional investigation would be needed to assure the feasibility of this path, and further coordination with the school district and other nearby property owners would be required.

Existing Condition Photos:

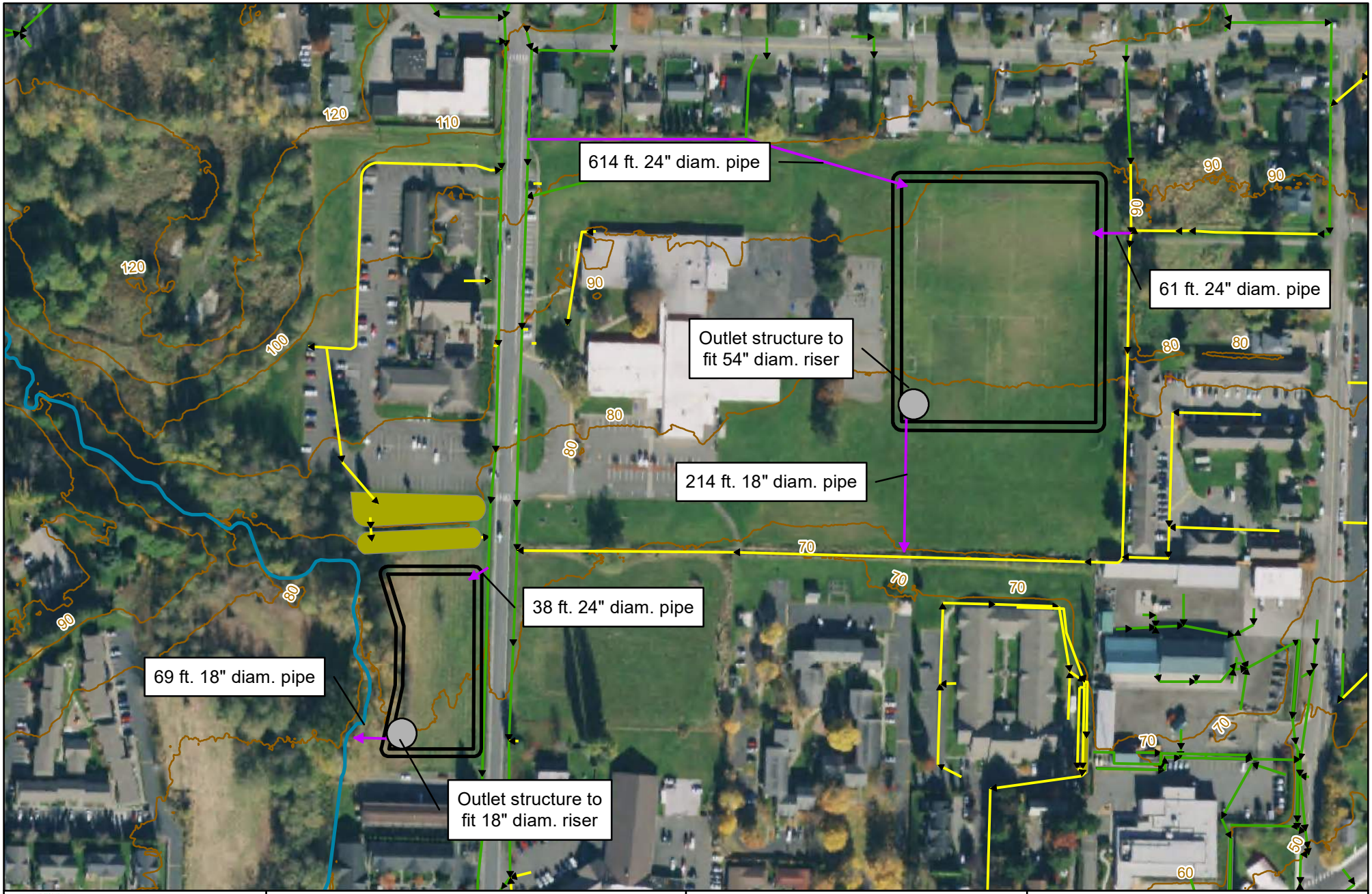
Planning Level Cost Estimate: $4,161,000

Design Methodology: WWHM4 (Version 4.2.18; 2021), assume full buildout conditions

Design Quantities:

Parameter	Quantity	Units
West Hendrickson Ave Regional Facility		
Drainage Area	18.2	acres
Impervious Area	6.7	acres
Pervious Area	11.5	acres
WQ Design Volume	0.5	acre-feet
WQ Design Flow Rate	0.8	cfs
Detention Volume Required for Flow Control	4.8	acre-feet
Width	272.9	feet
Length	136.5	feet
Depth	6	feet
Side slopes	2:1	H:V
Outlet Structure	1 orifice & rectangular notch	
Riser Height	5	feet
Riser Diameter	18	inches
Notch Depth	1	feet
Notch Width	0.2	feet
Orifice Height	0	feet
Orifice Diameter	1.8	inches
Stormwater Conveyance	70 ft. 18-inch pipe 40 ft. 24-inch pipe	
East Hendrickson Ave Regional Facility		
Drainage Area	64.9	acres
Impervious Area	23.3	acres
Pervious Area	41.6	acres
WQ Design Volume	2.0	acre-feet
WQ Design Flow Rate	2.8	cfs
Detention Volume Required for Flow Control	17.6	acre-feet
Width	383.8	feet
Length	307.0	feet
Depth	7	feet

Parameter	Quantity	Units
Side slopes	2:1	H:V
Outlet Structure	1 orifice & rectangular notch	
Riser Height	6	feet
Riser Diameter	54	inches
Notch Depth	1.2	feet
Notch Width	0.4	feet
Orifice Height	0	feet
Orifice Diameter	3.2	inches
Stormwater Conveyance	215 ft. 18-inch pipe 675 ft. 24-inch pipe	



City of Ferndale

nhc northwest hydraulic consultants

10' Contours
Proposed Conveyance
Proposed Retrofit Pond

Existing Conveyance
City-owned
Private

Existing Facilities
City-owned
Private

SCALE - 1:2,500

0 100 200 400
Feet

Coordinate System: NAD 1983 STATEPLANE WASHINGTON NORTH FIPS 4601 FEET

N

Job: 2006286

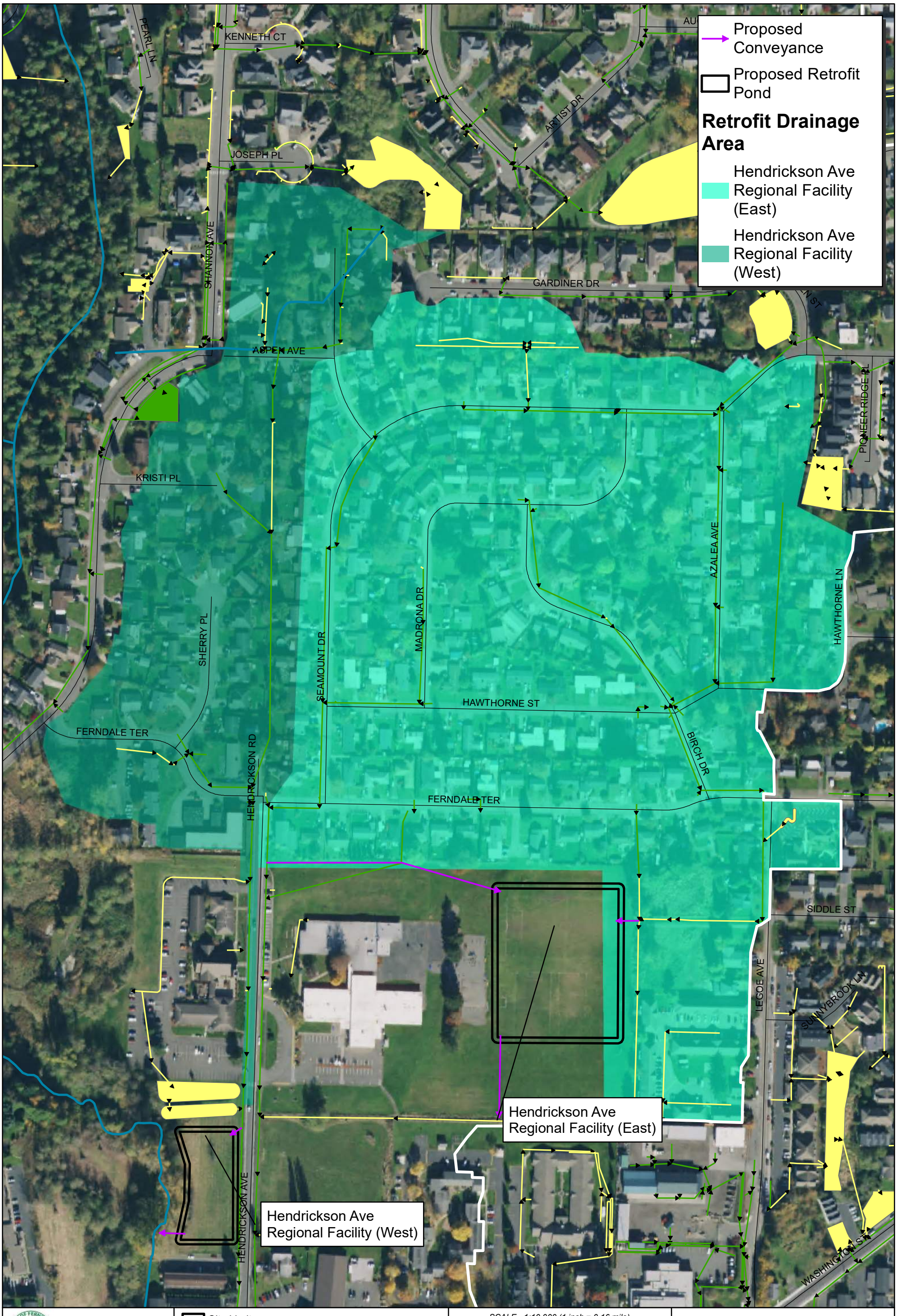
Date: 30-MAR-2023

FERNDALE SMAP

Schell Creek Stormwater Retrofits - Hendrickson Ave

FIGURE A-5

Q:\2006286_Ferndale_SCP_and_SMAP\95_GIS\MXDs\Figures\2006286_Ferndale_SMAP_Retrofit_Hendrickson.mxd



City of Ferndale

nhc northwest hydraulic consultants

City Limits
UGA
Planning Unit
Stream

Stormwater Conveyance
City-owned
Private

Stormwater Facilities
City-owned
Private

SCALE - 1:10,000 (1 inch = 0.16 mile)

0 250 500
Feet

Coordinate System: NAD 1983 STATEPLANE WASHINGTON NORTH FIPS 4601 FEET

N

Job: 2006286

DATE: 28-Mar-2023

FERNDALE SMAP
Schell Creek Stormwater Retrofits - Hendrickson Ave - Drainage Area

FIGURE A-6

Q:\2006286_Ferndale_SCP_and_SMAP\95_GIS\MXDs\Figures\2006286_Ferndale_SMAP_Retrofit_Hendrickson_DrainageArea.mxd

Reichhardt & Ebe
ENGINEERING INC
423 Front Street
Lynden, WA 98264
Phone: (360) 354-3687

Called By:	City of Ferndale
For:	**Hendrickson Ave Regional Facilities** PO Box 936 / 2095 Main St Ferndale, WA 98248
	PRELIMINARY ENGINEER'S ESTIMATE
By:	Dale Buys, P.E.
Date:	March 28, 2023

Item No.	Item Description	Quantity	Unit	Unit Price	Amount
1	Mobilization	1	LS	$ 250,000.00	$ 250,000.00
2	Record Drawings	1	LS	$ 1,000.00	$ 1,000.00
3	SPCC Plan	1	LS	$ 1,000.00	$ 1,000.00
4	Project Temporary Traffic Control	1	LS	$ 5,000.00	$ 5,000.00
5	Flaggers	100	HR	$ 75.00	$ 7,500.00
6	Other Traffic Control Labor	20	HR	$ 75.00	$ 1,500.00
7	Clearing and Grubbing	1	LS	$ 30,000.00	$ 30,000.00
8	Removal of Structures and Obstructions	1	LS	$ 5,000.00	$ 5,000.00
9	Sawcut ACP	300	LF-IN	$ 3.00	$ 900.00
10	Pond Excavation Incl. Haul	30,000	CY	$ 25.00	$ 750,000.00
11	Pond Embankment Compaction	7,000	CY	$ 15.00	$ 105,000.00
12	Clay Liner	6,500	CY	$ 25.00	$ 162,500.00
13	Water	5	M GAL.	$ 100.00	$ 500.00
14	Shoring or Extra Excavation Class B	3,800	SF	$ 2.00	$ 7,600.00
15	Dewatering	1	LS	$ 10,000.00	$ 10,000.00
16	Gravel Base	100	TON	$ 20.00	$ 2,000.00
17	Crushed Surfacing Top Course	5	TON	$ 40.00	$ 200.00
18	HMA Cl. 1/2" PG 64-22	10	TON	$ 150.00	$ 1,500.00
19	Planing Bituminous Pavement	50	SY	$ 60.00	$ 3,000.00
20	Compaction Price Adjustment	-	CALC		$ -
21	Job Mix Compliance Price Adjustment	-	CALC		$ -
22	Deficient Strength Conc. Price Adjustment	-	CALC		$ -
23	Corrugated Polyethylene Storm Sewer Pipe 18 In. Diam.	300	LF	$ 90.00	$ 27,000.00
24	Corrugated Polyethylene Storm Sewer Pipe 24 In. Diam.	750	LF	$ 175.00	$ 131,250.00
25	Catch Basin Type 2 48 In. Diam.	5	EA	$ 4,750.00	$ 23,750.00
26	Pond Outlet Control Structure Catch Basin	2	EA	$ 9,000.00	$ 18,000.00
27	Adjustments to Finished Grade	1	LS	$ 2,500.00	$ 2,500.00
28	Erosion/Water Pollution Control	1	EST	$ 20,000.00	$ 20,000.00
29	ESC Lead	120	DAY	$ 50.00	$ 6,000.00
30	Street Cleaning	120	HR	$ 185.00	$ 22,200.00
31	Silt Fence	750	LF	$ 10.00	$ 7,500.00
32	Inlet Protection	15	EA	$ 100.00	$ 1,500.00
33	Landscape Restoration	1	EST	$ 20,000.00	$ 20,000.00
34	Topsoil Type A	25,000	SY	$ 20.00	$ 500,000.00
35	Seeded Lawn Installation	5,000	SY	$ 15.00	$ 75,000.00
36	Wetland Planting	1	AC	$ 350,000.00	$ 350,000.00
37	Quarry Spalls	60	TON	$ 75.00	$ 4,500.00
38	Paint Line	50	LF	$ 1.50	$ 75.00
39	Pothole Existing Underground Utility	10	EA	$ 550.00	$ 5,500.00
40	Repair Existing Public and Private Facilities	1	EST	$ 20,000.00	$ 20,000.00
41	Wetland Mitigation	1.5	AC	$ 500,000.00	$ 750,000.00
	Subtotal				$ 3,328,975.00
	Design and Permitting (15%)				$ 499,346.25
	Construction Admin and Inspection (10%)				$ 332,897.50
	TOTAL				**$ 4,161,218.75**

WWHM2012

PROJECT REPORT

General Model Information

Project Name:	WestBasin
Site Name:	Ferndale SMAP
Site Address:	
City:	
Report Date:	3/24/2023
Gage:	Blaine
Data Start:	1948/10/01
Data End:	2009/09/30
Timestep:	15 Minute
Precip Scale:	0.857
Version Date:	2019/09/13
Version:	4.2.17

POC Thresholds

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

Landuse Basin Data

Predeveloped Land Use

Basin 1

Bypass:	No
GroundWater:	No

Pervious Land Use	acre
A B, Forest, Flat	0.087
C, Forest, Flat	12.885
C, Forest, Mod	4.932
SAT, Forest, Flat	0.255
Pervious Total	18.159

Impervious Land Use	acre
Impervious Total	0
Basin Total	18.159

Element Flows To:

Surface	Interflow	Groundwater

Mitigated Land Use

Basin 1

Bypass:	No
GroundWater:	No

Pervious Land Use	acre
C, Forest, Flat	2.164
C, Forest, Mod	1.234
C, Lawn, Flat	5.989
C, Lawn, Mod	1.886
A B, Lawn, Flat	0.055
SAT, Forest, Flat	0.162
Pervious Total	11.49

Impervious Land Use	acre
ROADS FLAT	6.669
Impervious Total	6.669
Basin Total	18.159

Element Flows To:

Surface	Interflow	Groundwater
Trapezoidal Pond 1	Trapezoidal Pond 1	Trapezoidal Pond 1

Routing Elements
Predeveloped Routing

Mitigated Routing

Trapezoidal Pond 1

Bottom Length: 272.90 ft.
Bottom Width: 136.45 ft.
Depth: 6 ft.
Volume at riser head: 4.7594 acre-feet.
Side slope 1: 2 To 1
Side slope 2: 2 To 1
Side slope 3: 2 To 1
Side slope 4: 2 To 1
Discharge Structure
Riser Height: 5 ft.
Riser Diameter: 18 in.
Notch Type: Rectangular
Notch Width: 0.160 ft.
Notch Height: 1.003 ft.
Orifice 1 Diameter: 1.8 in. Elevation:0 ft.
Element Flows To:
Outlet 1 Outlet 2

Pond Hydraulic Table

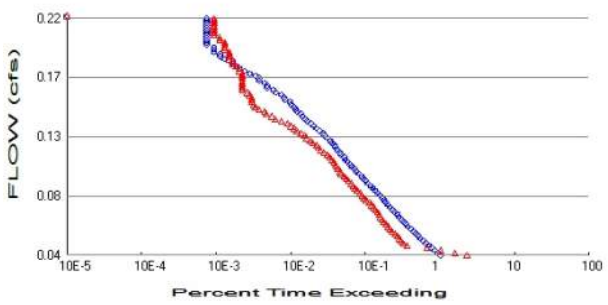
Stage(feet)	Area(ac.)	Volume(ac-ft.)	Discharge(cfs)	Infilt(cfs)
0.0000	0.854	0.000	0.000	0.000
0.0667	0.857	0.057	0.022	0.000
0.1333	0.859	0.114	0.032	0.000
0.2000	0.862	0.171	0.039	0.000
0.2667	0.864	0.229	0.045	0.000
0.3333	0.867	0.287	0.050	0.000
0.4000	0.869	0.345	0.055	0.000
0.4667	0.872	0.403	0.060	0.000
0.5333	0.875	0.461	0.064	0.000
0.6000	0.877	0.519	0.068	0.000
0.6667	0.880	0.578	0.071	0.000
0.7333	0.882	0.637	0.075	0.000
0.8000	0.885	0.696	0.078	0.000
0.8667	0.887	0.755	0.081	0.000
0.9333	0.890	0.814	0.084	0.000
1.0000	0.892	0.873	0.087	0.000
1.0667	0.895	0.933	0.090	0.000
1.1333	0.897	0.993	0.093	0.000
1.2000	0.900	1.053	0.096	0.000
1.2667	0.903	1.113	0.099	0.000
1.3333	0.905	1.173	0.101	0.000
1.4000	0.908	1.234	0.104	0.000
1.4667	0.910	1.294	0.106	0.000
1.5333	0.913	1.355	0.108	0.000
1.6000	0.915	1.416	0.111	0.000
1.6667	0.918	1.477	0.113	0.000
1.7333	0.921	1.538	0.115	0.000
1.8000	0.923	1.600	0.118	0.000
1.8667	0.926	1.662	0.120	0.000
1.9333	0.928	1.723	0.122	0.000
2.0000	0.931	1.785	0.124	0.000
2.0667	0.934	1.848	0.126	0.000

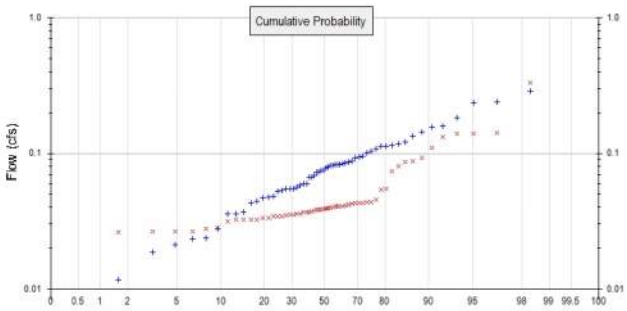
2.1333	0.936	1.910	0.128	0.000
2.2000	0.939	1.972	0.130	0.000
2.2667	0.941	2.035	0.132	0.000
2.3333	0.944	2.098	0.134	0.000
2.4000	0.947	2.161	0.136	0.000
2.4667	0.949	2.224	0.138	0.000
2.5333	0.952	2.288	0.139	0.000
2.6000	0.955	2.351	0.141	0.000
2.6667	0.957	2.415	0.143	0.000
2.7333	0.960	2.479	0.145	0.000
2.8000	0.963	2.543	0.147	0.000
2.8667	0.965	2.607	0.148	0.000
2.9333	0.968	2.672	0.150	0.000
3.0000	0.970	2.737	0.152	0.000
3.0667	0.973	2.801	0.154	0.000
3.1333	0.976	2.866	0.155	0.000
3.2000	0.978	2.932	0.157	0.000
3.2667	0.981	2.997	0.158	0.000
3.3333	0.984	3.062	0.160	0.000
3.4000	0.986	3.128	0.162	0.000
3.4667	0.989	3.194	0.163	0.000
3.5333	0.992	3.260	0.165	0.000
3.6000	0.994	3.326	0.166	0.000
3.6667	0.997	3.393	0.168	0.000
3.7333	1.000	3.459	0.169	0.000
3.8000	1.003	3.526	0.171	0.000
3.8667	1.005	3.593	0.172	0.000
3.9333	1.008	3.660	0.174	0.000
4.0000	1.011	3.728	0.175	0.000
4.0667	1.013	3.795	0.186	0.000
4.1333	1.016	3.863	0.204	0.000
4.2000	1.019	3.931	0.226	0.000
4.2667	1.021	3.999	0.252	0.000
4.3333	1.024	4.067	0.279	0.000
4.4000	1.027	4.135	0.309	0.000
4.4667	1.030	4.204	0.341	0.000
4.5333	1.032	4.273	0.373	0.000
4.6000	1.035	4.341	0.407	0.000
4.6667	1.038	4.411	0.442	0.000
4.7333	1.041	4.480	0.478	0.000
4.8000	1.043	4.549	0.514	0.000
4.8667	1.046	4.619	0.550	0.000
4.9333	1.049	4.689	0.587	0.000
5.0000	1.052	4.759	0.624	0.000
5.0667	1.054	4.829	0.899	0.000
5.1333	1.057	4.900	1.398	0.000
5.2000	1.060	4.970	2.032	0.000
5.2667	1.063	5.041	2.753	0.000
5.3333	1.065	5.112	3.513	0.000
5.4000	1.068	5.183	4.264	0.000
5.4667	1.071	5.254	4.959	0.000
5.5333	1.074	5.326	5.559	0.000
5.6000	1.076	5.398	6.037	0.000
5.6667	1.079	5.470	6.391	0.000
5.7333	1.082	5.542	6.652	0.000
5.8000	1.085	5.614	6.978	0.000
5.8667	1.088	5.686	7.238	0.000
5.9333	1.090	5.759	7.488	0.000

6.0000	1.093	5.832	7.730	0.000
6.0667	1.096	5.905	7.963	0.000

Analysis Results

POC 1





\+ Predeveloped x Mitigated

Predeveloped Landuse Totals for POC #1
Total Pervious Area: 18.159
Total Impervious Area: 0

Mitigated Landuse Totals for POC #1
Total Pervious Area: 11.49
Total Impervious Area: 6.669

Flow Frequency Method: Log Pearson Type III 17B

Flow Frequency Return Periods for Predeveloped. POC #1

Return Period	**Flow(cfs)**
2 year	0.073211
5 year	0.12227
10 year	0.154234
25 year	0.192577
50 year	0.219308
100 year	0.244386

Flow Frequency Return Periods for Mitigated. POC #1

Return Period	**Flow(cfs)**
2 year	0.041853
5 year	0.066849
10 year	0.088965
25 year	0.124648
50 year	0.157852
100 year	0.197671

Annual Peaks

Annual Peaks for Predeveloped and Mitigated. POC #1

Year	**Predeveloped**	**Mitigated**
1949	0.094	0.038
1950	0.095	0.039
1951	0.134	0.140
1952	0.023	0.028
1953	0.036	0.037
1954	0.075	0.039
1955	0.048	0.043
1956	0.044	0.043
1957	0.082	0.039
1958	0.037	0.032

1959	0.052	0.038
1960	0.082	0.035
1961	0.057	0.041
1962	0.055	0.036
1963	0.055	0.034
1964	0.121	0.093
1965	0.157	0.087
1966	0.060	0.032
1967	0.092	0.074
1968	0.113	0.055
1969	0.058	0.039
1970	0.021	0.026
1971	0.114	0.041
1972	0.078	0.041
1973	0.043	0.042
1974	0.067	0.037
1975	0.059	0.037
1976	0.112	0.141
1977	0.053	0.032
1978	0.073	0.042
1979	0.082	0.032
1980	0.118	0.080
1981	0.047	0.033
1982	0.144	0.110
1983	0.048	0.037
1984	0.288	0.141
1985	0.159	0.035
1986	0.238	0.046
1987	0.086	0.038
1988	0.067	0.034
1989	0.086	0.032
1990	0.109	0.054
1991	0.075	0.086
1992	0.084	0.044
1993	0.073	0.034
1994	0.028	0.027
1995	0.087	0.039
1996	0.103	0.041
1997	0.184	0.331
1998	0.019	0.028
1999	0.240	0.132
2000	0.024	0.033
2001	0.008	0.020
2002	0.069	0.036
2003	0.012	0.027
2004	0.055	0.041
2005	0.101	0.040
2006	0.083	0.043
2007	0.083	0.035
2008	0.036	0.027
2009	0.079	0.043

Ranked Annual Peaks

Ranked Annual Peaks for Predeveloped and Mitigated. POC #1

Rank	Predeveloped	Mitigated
1	0.2885	0.3309
2	0.2396	0.1412
3	0.2375	0.1406

4	0.1840	0.1398
5	0.1586	0.1323
6	0.1569	0.1105
7	0.1443	0.0931
8	0.1344	0.0872
9	0.1207	0.0858
10	0.1178	0.0803
11	0.1138	0.0740
12	0.1131	0.0546
13	0.1125	0.0543
14	0.1085	0.0457
15	0.1031	0.0437
16	0.1008	0.0434
17	0.0952	0.0432
18	0.0937	0.0431
19	0.0925	0.0428
20	0.0870	0.0425
21	0.0864	0.0417
22	0.0855	0.0410
23	0.0840	0.0409
24	0.0827	0.0409
25	0.0826	0.0406
26	0.0823	0.0405
27	0.0818	0.0399
28	0.0818	0.0394
29	0.0787	0.0394
30	0.0776	0.0390
31	0.0751	0.0387
32	0.0746	0.0385
33	0.0726	0.0384
34	0.0726	0.0383
35	0.0686	0.0377
36	0.0666	0.0375
37	0.0666	0.0368
38	0.0599	0.0367
39	0.0592	0.0366
40	0.0578	0.0356
41	0.0565	0.0356
42	0.0549	0.0351
43	0.0546	0.0350
44	0.0545	0.0347
45	0.0531	0.0343
46	0.0524	0.0342
47	0.0484	0.0342
48	0.0477	0.0332
49	0.0468	0.0331
50	0.0442	0.0325
51	0.0431	0.0324
52	0.0366	0.0323
53	0.0360	0.0323
54	0.0358	0.0316
55	0.0276	0.0280
56	0.0236	0.0275
57	0.0233	0.0267
58	0.0211	0.0266
59	0.0187	0.0265
60	0.0117	0.0261
61	0.0081	0.0200

Duration Flows

Flow(cfs)	Predev	Mit	Percentage	Pass/Fail
0.0366	21795	48766	223	Fail
0.0385	19860	34030	171	Fail
0.0403	18228	21988	120	Fail
0.0421	16688	14228	85	Pass
0.0440	15225	7773	51	Pass
0.0458	13877	6945	50	Pass
0.0477	12761	6481	50	Pass
0.0495	11792	6113	51	Pass
0.0514	10936	5692	52	Pass
0.0532	10123	5332	52	Pass
0.0551	9396	4892	52	Pass
0.0569	8701	4596	52	Pass
0.0588	8068	4331	53	Pass
0.0606	7465	4017	53	Pass
0.0624	6983	3764	53	Pass
0.0643	6519	3585	54	Pass
0.0661	6096	3444	56	Pass
0.0680	5724	3277	57	Pass
0.0698	5328	3112	58	Pass
0.0717	4969	2932	59	Pass
0.0735	4579	2785	60	Pass
0.0754	4316	2612	60	Pass
0.0772	4051	2440	60	Pass
0.0791	3805	2184	57	Pass
0.0809	3572	2044	57	Pass
0.0827	3337	1936	58	Pass
0.0846	3121	1812	58	Pass
0.0864	2900	1652	56	Pass
0.0883	2699	1548	57	Pass
0.0901	2505	1468	58	Pass
0.0920	2308	1380	59	Pass
0.0938	2143	1272	59	Pass
0.0957	2024	1188	58	Pass
0.0975	1896	1116	58	Pass
0.0994	1768	1028	58	Pass
0.1012	1612	976	60	Pass
0.1030	1508	928	61	Pass
0.1049	1404	880	62	Pass
0.1067	1324	852	64	Pass
0.1086	1236	812	65	Pass
0.1104	1164	756	64	Pass
0.1123	1104	708	64	Pass
0.1141	1004	664	66	Pass
0.1160	964	596	61	Pass
0.1178	892	536	60	Pass
0.1197	852	504	59	Pass
0.1215	816	472	57	Pass
0.1233	768	424	55	Pass
0.1252	724	388	53	Pass
0.1270	672	352	52	Pass
0.1289	600	328	54	Pass
0.1307	580	296	51	Pass
0.1326	520	256	49	Pass
0.1344	472	236	50	Pass

0.1363	440	216	49	Pass
0.1381	400	192	48	Pass
0.1400	360	160	44	Pass
0.1418	336	132	39	Pass
0.1436	304	120	39	Pass
0.1455	292	100	34	Pass
0.1473	260	96	36	Pass
0.1492	248	80	32	Pass
0.1510	236	72	30	Pass
0.1529	216	68	31	Pass
0.1547	208	64	30	Pass
0.1566	180	64	35	Pass
0.1584	172	64	37	Pass
0.1603	160	60	37	Pass
0.1621	136	56	41	Pass
0.1639	124	48	38	Pass
0.1658	104	48	46	Pass
0.1676	104	48	46	Pass
0.1695	96	48	50	Pass
0.1713	80	48	60	Pass
0.1732	80	48	60	Pass
0.1750	72	48	66	Pass
0.1769	60	48	80	Pass
0.1787	52	44	84	Pass
0.1806	44	44	100	Pass
0.1824	40	40	100	Pass
0.1842	36	36	100	Pass
0.1861	36	36	100	Pass
0.1879	28	32	114	Fail
0.1898	24	32	133	Fail
0.1916	24	32	133	Fail
0.1935	20	32	160	Fail
0.1953	20	28	140	Fail
0.1972	20	28	140	Fail
0.1990	16	28	175	Fail
0.2009	16	28	175	Fail
0.2027	16	24	150	Fail
0.2045	16	24	150	Fail
0.2064	16	20	125	Fail
0.2082	16	20	125	Fail
0.2101	16	20	125	Fail
0.2119	16	20	125	Fail
0.2138	16	20	125	Fail
0.2156	16	20	125	Fail
0.2175	16	20	125	Fail
0.2193	16	20	125	Fail

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

Water Quality

Water Quality BMP Flow and Volume for POC #1

On-line facility volume:	0.5413 acre-feet
On-line facility target flow:	0.7841 cfs.
Adjusted for 15 min:	0.7841 cfs.
Off-line facility target flow:	0.4344 cfs.
Adjusted for 15 min:	0.4344 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
Trapezoidal Pond 1 POC	☐	1710.87			☐	0.00			
Total Volume Infiltrated		1710.87	0.00	0.00		0.00	0.00	0%	No Treat. Credit
Compliance with LID Standard 8% of 2-yr to 50% of 2-yr									Duration Analysis Result = Failed

POC 2

POC #2 was not reported because POC must exist in both scenarios and both scenarios must have been run.

Model Default Modifications

Total of 0 changes have been made.

PERLND Changes

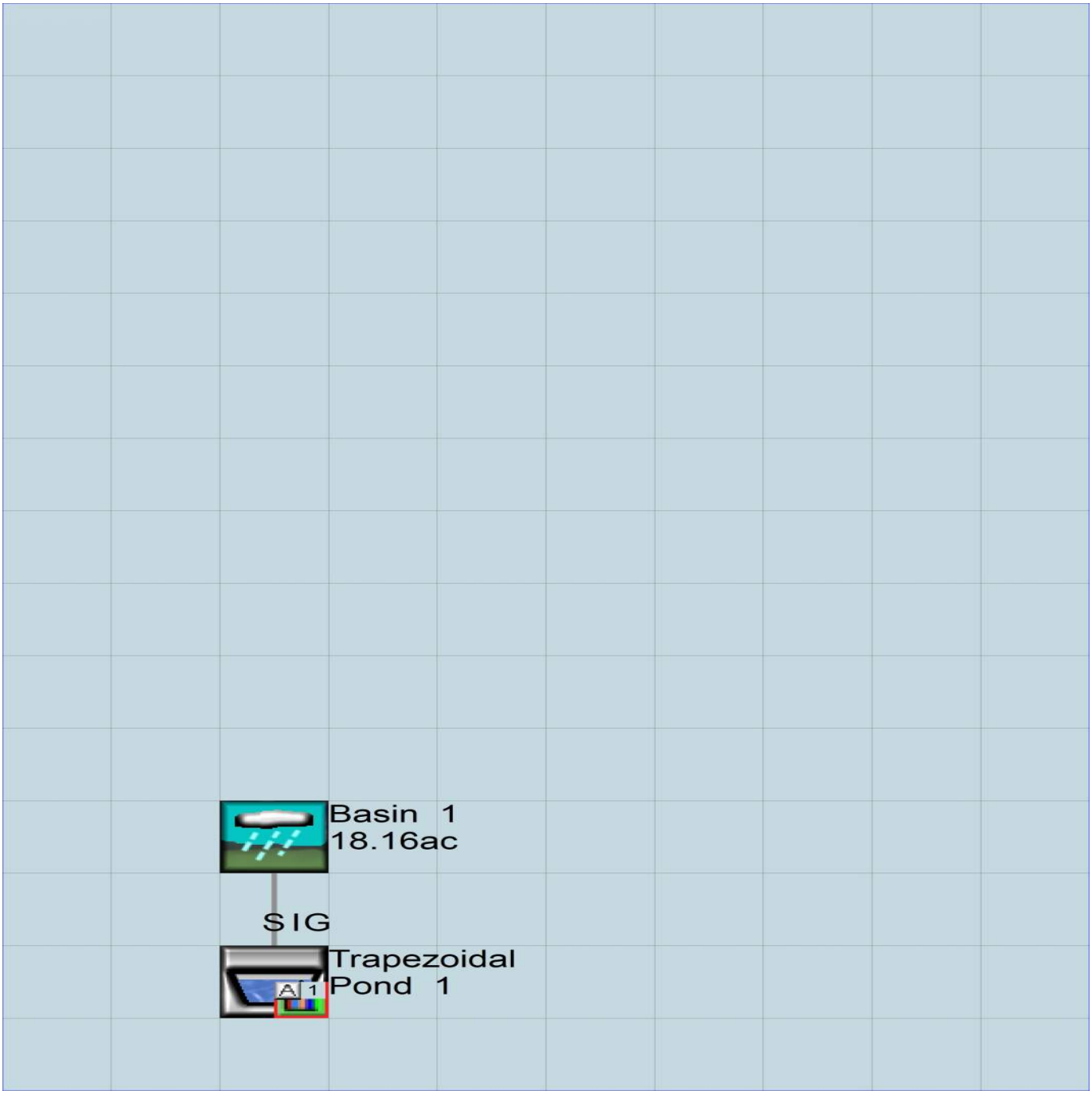
No PERLND changes have been made.

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   WestBasin.wdm
MESSU       25   PreWestBasin.MES
            27   PreWestBasin.L61
            28   PreWestBasin.L62
            30   POCWestBasin1.dat
END FILES

OPN SEQUENCE
    INGRP              INDELT 00:60
      PERLND       1
      PERLND      10
      PERLND      11
      PERLND      19
      COPY       501
      DISPLY       1
    END INGRP
END OPN SEQUENCE
DISPLY
  DISPLY-INFO1
    # -  #<----------Title----------->***TRAN PIVL DIG1 FIL1  PYR DIG2 FIL2 YRND
    1        Basin  1                   MAX                     1    2   30    9
  END DISPLY-INFO1
END DISPLY
COPY
  TIMESERIES
    # -  #  NPT  NMN ***
    1         1    1
  501         1    1
  END TIMESERIES
END COPY
GENER
  OPCODE
    #    # OPCD ***
  END OPCODE
  PARM
    #    #         K ***
  END PARM
END GENER
PERLND
  GEN-INFO
    <PLS ><-------Name------->NBLKS   Unit-systems   Printer ***
    # -  #                          User  t-series Engl Metr ***
                                      in  out           ***
    1     A/B, Forest, Flat       1    1    1    1   27    0
   10     C, Forest, Flat         1    1    1    1   27    0
   11     C, Forest, Mod          1    1    1    1   27    0
   19     SAT, Forest, Flat       1    1    1    1   27    0
  END GEN-INFO
  *** Section PWATER***

  ACTIVITY
    <PLS > ************ Active Sections ******************************
    # -  # ATMP SNOW PWAT  SED  PST  PWG PQAL MSTL PEST NITR PHOS TRAC ***
    1         0    0    1    0    0    0    0    0    0    0    0    0
   10         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
```

```
   19         0    0    1    0    0    0    0    0    0    0    0    0
  END ACTIVITY

  PRINT-INFO
    <PLS > ***************** Print-flags **************************** PIVL  PYR
    # -  # ATMP SNOW PWAT  SED  PST  PWG PQAL MSTL PEST NITR PHOS TRAC  *********
    1         0    0    4    0    0    0    0    0    0    0    0    0    1    9
   10         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
   19         0    0    4    0    0    0    0    0    0    0    0    0    1    9
  END PRINT-INFO

  PWAT-PARM1
    <PLS >  PWATER variable monthly parameter value flags  ***
    # -  # CSNO RTOP UZFG  VCS  VUZ  VNN VIFW VIRC  VLE INFC  HWT ***
    1         0    0    0    0    0    0    0    0    0    0    0
   10         0    0    0    0    0    0    0    0    0    0    0
   11         0    0    0    0    0    0    0    0    0    0    0
   19         0    0    0    0    0    0    0    0    0    0    0
  END PWAT-PARM1

  PWAT-PARM2
    <PLS >      PWATER input info: Part 2         ***
    # -  # ***FOREST      LZSN    INFILT      LSUR     SLSUR      KVARY      AGWRC
    1              0         5         2       400      0.05        0.3      0.996
   10              0       4.5      0.08       400      0.05        0.5      0.996
   11              0       4.5      0.08       400       0.1        0.5      0.996
   19              0         4         2       100     0.001        0.5      0.996
  END PWAT-PARM2

  PWAT-PARM3
    <PLS >      PWATER input info: Part 3         ***
    # -  # ***PETMAX    PETMIN    INFEXP    INFILD    DEEPFR    BASETP    AGWETP
    1              0         0         2         2         0         0         0
   10              0         0         2         2         0         0         0
   11              0         0         2         2         0         0         0
   19              0         0        10         2         0         0       0.7
  END PWAT-PARM3
  PWAT-PARM4
    <PLS >     PWATER input info: Part 4                                  ***
    # -  #     CEPSC      UZSN      NSUR     INTFW       IRC     LZETP ***
    1          0.2       0.5      0.35         0       0.7       0.7
   10          0.2       0.5      0.35         6       0.5       0.7
   11          0.2       0.5      0.35         6       0.5       0.7
   19          0.2         3       0.5         1       0.7       0.8
  END PWAT-PARM4

  PWAT-STATE1
    <PLS > *** Initial conditions at start of simulation
             ran from 1990 to end of 1992 (pat 1-11-95) RUN 21 ***
    # -  # ***  CEPS      SURS       UZS      IFWS       LZS      AGWS      GWVS
    1              0         0         0         0         3         1         0
   10              0         0         0         0       2.5         1         0
   11              0         0         0         0       2.5         1         0
   19              0         0         0         0       4.2         1         0
  END PWAT-STATE1

END PERLND

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

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

```
  END ACTIVITY

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

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

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

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

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

END IMPLND

SCHEMATIC
<-Source->                  <--Area-->     <-Target->   MBLK   ***
<Name>   #                  <-factor->     <Name>   #   Tbl#   ***
Basin  1***
PERLND   1                       0.087     COPY   501     12
PERLND   1                       0.087     COPY   501     13
PERLND  10                      12.885     COPY   501     12
PERLND  10                      12.885     COPY   501     13
PERLND  11                       4.932     COPY   501     12
PERLND  11                       4.932     COPY   501     13
PERLND  19                       0.255     COPY   501     12
PERLND  19                       0.255     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   12.1        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    0.857     SUM  PERLND   1 999 EXTNL  PREC
WDM      2 PREC     ENGL    0.857     SUM  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     12.1      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   WestBasin.wdm
MESSU       25   MitWestBasin.MES
            27   MitWestBasin.L61
            28   MitWestBasin.L62
            30   POCWestBasin1.dat
END FILES

OPN SEQUENCE
    INGRP               INDELT 00:60
      PERLND      10
      PERLND      11
      PERLND      16
      PERLND      17
      PERLND       7
      PERLND      19
      IMPLND       1
      RCHRES       1
      COPY         1
      COPY       501
      DISPLY       1
    END INGRP
END OPN SEQUENCE
DISPLY
  DISPLY-INFO1
    # -  #<----------Title----------->***TRAN PIVL DIG1 FIL1  PYR DIG2 FIL2 YRND
    1        Trapezoidal Pond  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             ***
   10     C, Forest, Flat         1    1    1    1   27    0
   11     C, Forest, Mod          1    1    1    1   27    0
   16     C, Lawn, Flat           1    1    1    1   27    0
   17     C, Lawn, Mod            1    1    1    1   27    0
    7     A/B, Lawn, Flat         1    1    1    1   27    0
   19     SAT, Forest, Flat       1    1    1    1   27    0
  END GEN-INFO
  *** Section PWATER***
```

```
ACTIVITY
  <PLS > ************ Active Sections ****************************
  # -  # ATMP SNOW PWAT  SED  PST  PWG PQAL MSTL PEST NITR PHOS TRAC ***
 10         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
 16         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
  7         0    0    1    0    0    0    0    0    0    0    0    0
 19         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  *********
 10         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
 16         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
  7         0    0    4    0    0    0    0    0    0    0    0    0    1    9
 19         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 ***
 10         0    0    0    0    0    0    0    0    0    0    0
 11         0    0    0    0    0    0    0    0    0    0    0
 16         0    0    0    0    0    0    0    0    0    0    0
 17         0    0    0    0    0    0    0    0    0    0    0
  7         0    0    0    0    0    0    0    0    0    0    0
 19         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
 10              0       4.5      0.08       400      0.05       0.5     0.996
 11              0       4.5      0.08       400       0.1       0.5     0.996
 16              0       4.5      0.03       400      0.05       0.5     0.996
 17              0       4.5      0.03       400       0.1       0.5     0.996
  7              0         5       0.8       400      0.05       0.3     0.996
 19              0         4         2       100     0.001       0.5     0.996
END PWAT-PARM2

PWAT-PARM3
  <PLS >      PWATER input info: Part 3          ***
  # -  # ***PETMAX    PETMIN    INFEXP    INFILD    DEEPFR    BASETP    AGWETP
 10              0         0         2         2         0         0         0
 11              0         0         2         2         0         0         0
 16              0         0         2         2         0         0         0
 17              0         0         2         2         0         0         0
  7              0         0         2         2         0         0         0
 19              0         0        10         2         0         0       0.7
END PWAT-PARM3
PWAT-PARM4
  <PLS >     PWATER input info: Part 4                                  ***
  # -  #     CEPSC      UZSN      NSUR     INTFW       IRC     LZETP ***
 10            0.2       0.5      0.35         6       0.5       0.7
 11            0.2       0.5      0.35         6       0.5       0.7
 16            0.1      0.25      0.25         6       0.5      0.25
 17            0.1      0.25      0.25         6       0.5      0.25
  7            0.1       0.5      0.25         0       0.7      0.25
 19            0.2         3       0.5         1       0.7       0.8
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
```

```
   10             0         0         0         0       2.5         1         0
   11             0         0         0         0       2.5         1         0
   16             0         0         0         0       2.5         1         0
   17             0         0         0         0       2.5         1         0
    7             0         0         0         0         3         1         0
   19             0         0         0         0       4.2         1         0
  END PWAT-STATE1

END PERLND

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

  PRINT-INFO
    <ILS > ******** Print-flags ******** PIVL  PYR
    # -  # ATMP SNOW IWAT  SLD  IWG IQAL    *********
    1         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
  END IWAT-PARM1

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

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

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

END IMPLND

SCHEMATIC
<-Source->                 <--Area-->     <-Target->   MBLK   ***
<Name>   #                 <-factor->     <Name>   #   Tbl#   ***
Basin  1***
PERLND  10                      2.164     RCHRES   1      2
PERLND  10                      2.164     RCHRES   1      3
PERLND  10                      2.164     RCHRES   1      4
PERLND  11                      1.234     RCHRES   1      2
PERLND  11                      1.234     RCHRES   1      3
PERLND  11                      1.234     RCHRES   1      4
PERLND  16                      5.989     RCHRES   1      2
PERLND  16                      5.989     RCHRES   1      3
PERLND  16                      5.989     RCHRES   1      4
```

```
PERLND  17                      1.886     RCHRES   1      2
PERLND  17                      1.886     RCHRES   1      3
PERLND  17                      1.886     RCHRES   1      4
PERLND   7                      0.055     RCHRES   1      2
PERLND   7                      0.055     RCHRES   1      3
PERLND   7                      0.055     RCHRES   1      4
PERLND  19                      0.162     RCHRES   1      2
PERLND  19                      0.162     RCHRES   1      3
PERLND  19                      0.162     RCHRES   1      4
IMPLND   1                      6.669     RCHRES   1      5

******Routing******
PERLND  10                      2.164     COPY     1     12
PERLND  11                      1.234     COPY     1     12
PERLND  16                      5.989     COPY     1     12
PERLND  17                      1.886     COPY     1     12
PERLND   7                      0.055     COPY     1     12
PERLND  19                      0.162     COPY     1     12
IMPLND   1                      6.669     COPY     1     15
PERLND  10                      2.164     COPY     1     13
PERLND  11                      1.234     COPY     1     13
PERLND  16                      5.989     COPY     1     13
PERLND  17                      1.886     COPY     1     13
PERLND   7                      0.055     COPY     1     13
PERLND  19                      0.162     COPY     1     13
PERLND  10                      2.164     COPY     1     14
PERLND  11                      1.234     COPY     1     14
PERLND  16                      5.989     COPY     1     14
PERLND  17                      1.886     COPY     1     14
PERLND   7                      0.055     COPY     1     14
PERLND  19                      0.162     COPY     1     14
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   12.1        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     Trapezoidal Pond-011    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      0.05       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
   91    4
     Depth      Area    Volume  Outflow1 Velocity  Travel Time***
      (ft)   (acres) (acre-ft)   (cfs)   (ft/sec)    (Minutes)***
  0.000000  0.854851  0.000000  0.000000
  0.066667  0.857358  0.057074  0.022702
  0.133333  0.859869  0.114315  0.032105
  0.200000  0.862383  0.171723  0.039320
  0.266667  0.864901  0.229299  0.045403
  0.333333  0.867421  0.287043  0.050763
  0.400000  0.869945  0.344955  0.055608
  0.466667  0.872472  0.403036  0.060063
  0.533333  0.875003  0.461285  0.064210
  0.600000  0.877536  0.519703  0.068105
  0.666667  0.880073  0.578290  0.071789
  0.733333  0.882614  0.637046  0.075293
  0.800000  0.885157  0.695972  0.078641
  0.866667  0.887704  0.755067  0.081852
  0.933333  0.890254  0.814333  0.084942
  1.000000  0.892807  0.873768  0.087923
  1.066667  0.895364  0.933374  0.090807
  1.133333  0.897924  0.993150  0.093601
  1.200000  0.900487  1.053097  0.096315
  1.266667  0.903053  1.113215  0.098954
  1.333333  0.905623  1.173504  0.101525
  1.400000  0.908196  1.233965  0.104032
  1.466667  0.910772  1.294597  0.106480
  1.533333  0.913351  1.355401  0.108873
  1.600000  0.915934  1.416377  0.111215
  1.666667  0.918520  1.477526  0.113508
  1.733333  0.921109  1.538847  0.115756
  1.800000  0.923702  1.600341  0.117961
  1.866667  0.926298  1.662007  0.120126
  1.933333  0.928897  1.723847  0.122252
  2.000000  0.931499  1.785860  0.124342
  2.066667  0.934104  1.848047  0.126398
  2.133333  0.936713  1.910408  0.128420
  2.200000  0.939325  1.972942  0.130411
  2.266667  0.941941  2.035651  0.132372
  2.333333  0.944559  2.098534  0.134305
  2.400000  0.947181  2.161592  0.136210
  2.466667  0.949806  2.224825  0.138089
  2.533333  0.952435  2.288233  0.139943
  2.600000  0.955066  2.351817  0.141772
  2.666667  0.957701  2.415576  0.143578
  2.733333  0.960340  2.479510  0.145362
  2.800000  0.962981  2.543621  0.147124
  2.866667  0.965626  2.607908  0.148865
  2.933333  0.968274  2.672371  0.150586
```

```
  3.000000  0.970925  2.737011  0.152288
  3.066667  0.973580  2.801828  0.153970
  3.133333  0.976237  2.866822  0.155635
  3.200000  0.978898  2.931993  0.157282
  3.266667  0.981563  2.997342  0.158912
  3.333333  0.984230  3.062868  0.160525
  3.400000  0.986901  3.128573  0.162122
  3.466667  0.989575  3.194455  0.163704
  3.533333  0.992253  3.260516  0.165271
  3.600000  0.994933  3.326756  0.166823
  3.666667  0.997617  3.393174  0.168360
  3.733333  1.000304  3.459771  0.169884
  3.800000  1.002995  3.526548  0.171394
  3.866667  1.005689  3.593504  0.172891
  3.933333  1.008386  3.660640  0.174375
  4.000000  1.011086  3.727956  0.175922
  4.066667  1.013789  3.795451  0.186909
  4.133333  1.016496  3.863128  0.204764
  4.200000  1.019206  3.930984  0.226848
  4.266667  1.021919  3.999022  0.252096
  4.333333  1.024636  4.067240  0.279846
  4.400000  1.027356  4.135640  0.309629
  4.466667  1.030079  4.204221  0.341077
  4.533333  1.032805  4.272984  0.373895
  4.600000  1.035535  4.341929  0.407831
  4.666667  1.038268  4.411056  0.442668
  4.733333  1.041004  4.480365  0.478214
  4.800000  1.043743  4.549856  0.514299
  4.866667  1.046486  4.619530  0.550767
  4.933333  1.049232  4.689388  0.587475
  5.000000  1.051981  4.759428  0.624583
  5.066667  1.054734  4.829652  0.899585
  5.133333  1.057489  4.900059  1.398652
  5.200000  1.060248  4.970651  2.032941
  5.266667  1.063011  5.041426  2.753581
  5.333333  1.065776  5.112386  3.513550
  5.400000  1.068545  5.183530  4.264497
  5.466667  1.071317  5.254858  4.959580
  5.533333  1.074092  5.326372  5.559000
  5.600000  1.076871  5.398071  6.037266
  5.666667  1.079653  5.469955  6.391775
  5.733333  1.082438  5.542025  6.652497
  5.800000  1.085226  5.614280  6.978236
  5.866667  1.088018  5.686721  7.238270
  5.933333  1.090813  5.759349  7.488520
  6.000000  1.093611  5.832163  7.730016
  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    0.857     SUM  PERLND   1 999 EXTNL  PREC
WDM      2 PREC     ENGL    0.857     SUM  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
WDM      2 PREC     ENGL    0.857     SUM  RCHRES   1     EXTNL  PREC
WDM      1 EVAP     ENGL    0.76           RCHRES   1     EXTNL  POTEV

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     12.1      WDM    701 FLOW     ENGL      REPL
COPY   501 OUTPUT MEAN   1 1     12.1      WDM    801 FLOW     ENGL      REPL
END EXT TARGETS
```

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

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

  MASS-LINK         4
PERLND     PWATER AGWO       0.083333      RCHRES         INFLOW IVOL
  END MASS-LINK     4

  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        14
PERLND     PWATER AGWO       0.083333      COPY           INPUT  MEAN
  END MASS-LINK    14

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

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


END MASS-LINK

END RUN
```

Predeveloped HSPF Message File

Mitigated HSPF Message File

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WWHM2012

PROJECT REPORT

General Model Information

Project Name:	EastBasin
Site Name:	Ferndale SMAP
Site Address:	
City:	
Report Date:	3/24/2023
Gage:	Blaine
Data Start:	1948/10/01
Data End:	2009/09/30
Timestep:	15 Minute
Precip Scale:	0.857
Version Date:	2019/09/13
Version:	4.2.17

POC Thresholds

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

Landuse Basin Data

Predeveloped Land Use

Basin 1

Bypass:	No
GroundWater:	No
Pervious Land Use	acre
A B, Forest, Flat	2.358
C, Forest, Flat	53.278
C, Forest, Mod	9.267
Pervious Total	64.903
Impervious Land Use	acre
Impervious Total	0
Basin Total	64.903

Element Flows To:

Surface	Interflow	Groundwater

Mitigated Land Use

Basin 1

Bypass:	No
GroundWater:	No

Pervious Land Use	acre
C, Forest, Flat	4.875
C, Forest, Mod	1.15
C, Lawn, Flat	29.253
C, Lawn, Mod	4.785
A B, Lawn, Flat	1.394
A B, Forest, Flat	0.117
Pervious Total	41.574

Impervious Land Use	acre
ROADS FLAT	23.329
Impervious Total	23.329
Basin Total	64.903

Element Flows To:

Surface	Interflow	Groundwater
Trapezoidal Pond 1	Trapezoidal Pond 1	Trapezoidal Pond 1

Routing Elements
Predeveloped Routing

Mitigated Routing

Trapezoidal Pond 1

Bottom Length: 383.78 ft.
Bottom Width: 307.02 ft.
Depth: 7 ft.
Volume at riser head: 17.6048 acre-feet.
Side slope 1: 2 To 1
Side slope 2: 2 To 1
Side slope 3: 2 To 1
Side slope 4: 2 To 1
Discharge Structure
Riser Height: 6 ft.
Riser Diameter: 54 in.
Notch Type: Rectangular
Notch Width: 0.390 ft.
Notch Height: 1.225 ft.
Orifice 1 Diameter: 3.208 in. Elevation:0 ft.
Element Flows To:
Outlet 1 Outlet 2

Pond Hydraulic Table

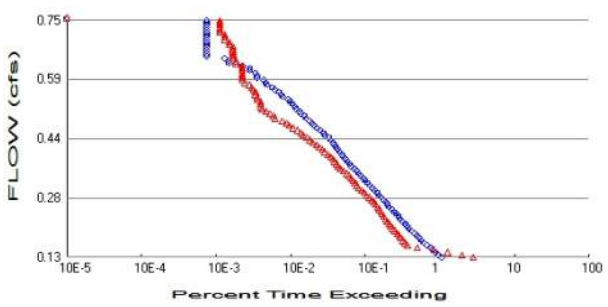
Stage(feet)	Area(ac.)	Volume(ac-ft.)	Discharge(cfs)	Infilt(cfs)
0.0000	2.705	0.000	0.000	0.000
0.0778	2.709	0.210	0.077	0.000
0.1556	2.714	0.421	0.110	0.000
0.2333	2.719	0.632	0.134	0.000
0.3111	2.724	0.844	0.155	0.000
0.3889	2.729	1.056	0.174	0.000
0.4667	2.734	1.269	0.190	0.000
0.5444	2.739	1.482	0.206	0.000
0.6222	2.744	1.695	0.220	0.000
0.7000	2.749	1.909	0.233	0.000
0.7778	2.754	2.123	0.246	0.000
0.8556	2.759	2.337	0.258	0.000
0.9333	2.764	2.552	0.269	0.000
1.0111	2.769	2.767	0.280	0.000
1.0889	2.774	2.983	0.291	0.000
1.1667	2.779	3.199	0.301	0.000
1.2444	2.784	3.415	0.311	0.000
1.3222	2.789	3.632	0.321	0.000
1.4000	2.794	3.849	0.330	0.000
1.4778	2.799	4.067	0.339	0.000
1.5556	2.804	4.284	0.348	0.000
1.6333	2.809	4.503	0.356	0.000
1.7111	2.814	4.722	0.365	0.000
1.7889	2.819	4.941	0.373	0.000
1.8667	2.824	5.160	0.381	0.000
1.9444	2.829	5.380	0.389	0.000
2.0222	2.834	5.600	0.397	0.000
2.1000	2.839	5.821	0.404	0.000
2.1778	2.844	6.042	0.412	0.000
2.2556	2.849	6.264	0.419	0.000
2.3333	2.855	6.485	0.426	0.000
2.4111	2.860	6.708	0.433	0.000

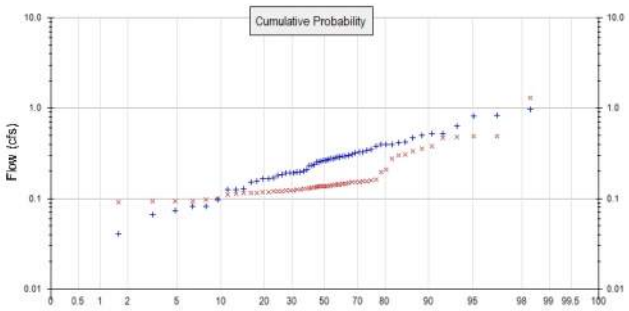
2.4889	2.865	6.930	0.440	0.000
2.5667	2.870	7.153	0.447	0.000
2.6444	2.875	7.377	0.454	0.000
2.7222	2.880	7.601	0.460	0.000
2.8000	2.885	7.825	0.467	0.000
2.8778	2.890	8.049	0.473	0.000
2.9556	2.895	8.274	0.480	0.000
3.0333	2.900	8.500	0.486	0.000
3.1111	2.905	8.726	0.492	0.000
3.1889	2.911	8.952	0.498	0.000
3.2667	2.916	9.179	0.504	0.000
3.3444	2.921	9.406	0.510	0.000
3.4222	2.926	9.633	0.516	0.000
3.5000	2.931	9.861	0.522	0.000
3.5778	2.936	10.08	0.528	0.000
3.6556	2.941	10.31	0.534	0.000
3.7333	2.946	10.54	0.539	0.000
3.8111	2.952	10.77	0.545	0.000
3.8889	2.957	11.00	0.550	0.000
3.9667	2.962	11.23	0.556	0.000
4.0444	2.967	11.46	0.561	0.000
4.1222	2.972	11.69	0.567	0.000
4.2000	2.977	11.92	0.572	0.000
4.2778	2.983	12.16	0.577	0.000
4.3556	2.988	12.39	0.582	0.000
4.4333	2.993	12.62	0.588	0.000
4.5111	2.998	12.85	0.593	0.000
4.5889	3.003	13.09	0.598	0.000
4.6667	3.009	13.32	0.603	0.000
4.7444	3.014	13.56	0.608	0.000
4.8222	3.019	13.79	0.626	0.000
4.9000	3.024	14.03	0.674	0.000
4.9778	3.029	14.26	0.736	0.000
5.0556	3.035	14.50	0.809	0.000
5.1333	3.040	14.73	0.891	0.000
5.2111	3.045	14.97	0.978	0.000
5.2889	3.050	15.21	1.071	0.000
5.3667	3.056	15.44	1.167	0.000
5.4444	3.061	15.68	1.267	0.000
5.5222	3.066	15.92	1.369	0.000
5.6000	3.071	16.16	1.473	0.000
5.6778	3.077	16.40	1.578	0.000
5.7556	3.082	16.64	1.683	0.000
5.8333	3.087	16.88	1.805	0.000
5.9111	3.092	17.12	1.936	0.000
5.9889	3.098	17.36	2.072	0.000
6.0667	3.103	17.60	2.918	0.000
6.1444	3.108	17.84	4.720	0.000
6.2222	3.113	18.08	7.100	0.000
6.3000	3.119	18.33	9.937	0.000
6.3778	3.124	18.57	13.15	0.000
6.4556	3.129	18.81	16.70	0.000
6.5333	3.135	19.06	20.54	0.000
6.6111	3.140	19.30	24.61	0.000
6.6889	3.145	19.54	28.88	0.000
6.7667	3.151	19.79	33.31	0.000
6.8444	3.156	20.03	37.84	0.000
6.9222	3.161	20.28	42.45	0.000

7.0000	3.167	20.53	47.08	0.000
7.0778	3.172	20.77	51.68	0.000

Analysis Results

POC 1





\+ Predeveloped x Mitigated

Predeveloped Landuse Totals for POC #1
Total Pervious Area: 64.903
Total Impervious Area: 0

Mitigated Landuse Totals for POC #1
Total Pervious Area: 41.574
Total Impervious Area: 23.329

Flow Frequency Method: Log Pearson Type III 17B

Flow Frequency Return Periods for Predeveloped. POC #1

Return Period	**Flow(cfs)**
2 year	0.253365
5 year	0.420991
10 year	0.529819
25 year	0.660074
50 year	0.750724
100 year	0.835669

Flow Frequency Return Periods for Mitigated. POC #1

Return Period	**Flow(cfs)**
2 year	0.148235
5 year	0.239462
10 year	0.320896
25 year	0.453285
50 year	0.577319
100 year	0.726896

Annual Peaks

Annual Peaks for Predeveloped and Mitigated. POC #1

Year	**Predeveloped**	**Mitigated**
1949	0.326	0.135
1950	0.328	0.137
1951	0.465	0.493
1952	0.082	0.098
1953	0.126	0.131
1954	0.262	0.139
1955	0.167	0.161
1956	0.155	0.154
1957	0.286	0.138
1958	0.128	0.114

1959	0.184	0.132
1960	0.278	0.122
1961	0.194	0.142
1962	0.192	0.126
1963	0.191	0.120
1964	0.419	0.354
1965	0.522	0.304
1966	0.198	0.111
1967	0.321	0.279
1968	0.392	0.197
1969	0.199	0.136
1970	0.074	0.092
1971	0.399	0.144
1972	0.259	0.145
1973	0.150	0.151
1974	0.233	0.129
1975	0.207	0.133
1976	0.393	0.480
1977	0.180	0.113
1978	0.255	0.148
1979	0.273	0.114
1980	0.413	0.300
1981	0.164	0.117
1982	0.498	0.377
1983	0.170	0.129
1984	0.958	0.487
1985	0.524	0.123
1986	0.823	0.158
1987	0.302	0.136
1988	0.234	0.119
1989	0.295	0.114
1990	0.380	0.210
1991	0.263	0.332
1992	0.294	0.156
1993	0.255	0.119
1994	0.097	0.094
1995	0.305	0.134
1996	0.340	0.145
1997	0.631	1.298
1998	0.066	0.099
1999	0.828	0.465
2000	0.082	0.119
2001	0.028	0.068
2002	0.236	0.126
2003	0.041	0.092
2004	0.191	0.144
2005	0.350	0.138
2006	0.285	0.151
2007	0.280	0.122
2008	0.126	0.093
2009	0.276	0.153

Ranked Annual Peaks

Ranked Annual Peaks for Predeveloped and Mitigated. POC #1

Rank	Predeveloped	Mitigated
1	0.9577	1.2977
2	0.8281	0.4927
3	0.8225	0.4870

4	0.6312	0.4804
5	0.5240	0.4654
6	0.5218	0.3771
7	0.4982	0.3540
8	0.4651	0.3324
9	0.4188	0.3039
10	0.4135	0.3000
11	0.3991	0.2787
12	0.3933	0.2101
13	0.3924	0.1975
14	0.3805	0.1613
15	0.3500	0.1583
16	0.3400	0.1561
17	0.3284	0.1539
18	0.3262	0.1527
19	0.3211	0.1508
20	0.3050	0.1507
21	0.3025	0.1479
22	0.2955	0.1454
23	0.2944	0.1452
24	0.2864	0.1437
25	0.2852	0.1436
26	0.2804	0.1420
27	0.2776	0.1395
28	0.2762	0.1382
29	0.2727	0.1376
30	0.2635	0.1368
31	0.2617	0.1361
32	0.2588	0.1357
33	0.2547	0.1353
34	0.2546	0.1339
35	0.2362	0.1326
36	0.2337	0.1319
37	0.2333	0.1309
38	0.2072	0.1291
39	0.1987	0.1287
40	0.1980	0.1264
41	0.1939	0.1259
42	0.1916	0.1229
43	0.1914	0.1223
44	0.1914	0.1216
45	0.1840	0.1198
46	0.1805	0.1192
47	0.1695	0.1190
48	0.1669	0.1187
49	0.1636	0.1168
50	0.1549	0.1145
51	0.1504	0.1139
52	0.1282	0.1139
53	0.1263	0.1135
54	0.1256	0.1114
55	0.0967	0.0990
56	0.0823	0.0981
57	0.0817	0.0939
58	0.0738	0.0930
59	0.0657	0.0925
60	0.0409	0.0917
61	0.0282	0.0683

Duration Flows

Flow(cfs)	Predev	Mit	Percentage	Pass/Fail
0.1267	22351	59418	265	Fail
0.1330	20488	42221	206	Fail
0.1393	18640	27313	146	Fail
0.1456	17160	17851	104	Fail
0.1519	15785	10615	67	Pass
0.1582	14251	7901	55	Pass
0.1645	13111	7212	55	Pass
0.1708	12183	6817	55	Pass
0.1771	11285	6417	56	Pass
0.1834	10468	6087	58	Pass
0.1897	9751	5741	58	Pass
0.1960	8947	5360	59	Pass
0.2023	8357	4975	59	Pass
0.2086	7800	4688	60	Pass
0.2149	7313	4449	60	Pass
0.2212	6740	4235	62	Pass
0.2275	6320	3989	63	Pass
0.2338	5961	3764	63	Pass
0.2401	5535	3572	64	Pass
0.2464	5208	3452	66	Pass
0.2528	4860	3296	67	Pass
0.2591	4451	3127	70	Pass
0.2654	4207	2964	70	Pass
0.2717	3980	2791	70	Pass
0.2780	3756	2601	69	Pass
0.2843	3508	2391	68	Pass
0.2906	3277	2207	67	Pass
0.2969	3080	2076	67	Pass
0.3032	2828	1884	66	Pass
0.3095	2661	1740	65	Pass
0.3158	2464	1652	67	Pass
0.3221	2267	1548	68	Pass
0.3284	2124	1464	68	Pass
0.3347	2000	1380	69	Pass
0.3410	1848	1292	69	Pass
0.3473	1764	1200	68	Pass
0.3536	1620	1088	67	Pass
0.3599	1508	992	65	Pass
0.3662	1384	924	66	Pass
0.3725	1320	884	66	Pass
0.3788	1248	836	66	Pass
0.3851	1152	788	68	Pass
0.3914	1088	736	67	Pass
0.3977	1036	668	64	Pass
0.4040	976	608	62	Pass
0.4103	900	560	62	Pass
0.4166	864	512	59	Pass
0.4229	816	472	57	Pass
0.4292	784	424	54	Pass
0.4356	732	384	52	Pass
0.4419	704	352	50	Pass
0.4482	608	312	51	Pass
0.4545	588	292	49	Pass
0.4608	532	264	49	Pass

0.4671	480	228	47	Pass
0.4734	444	204	45	Pass
0.4797	412	188	45	Pass
0.4860	384	164	42	Pass
0.4923	344	132	38	Pass
0.4986	328	124	37	Pass
0.5049	292	112	38	Pass
0.5112	280	100	35	Pass
0.5175	252	88	34	Pass
0.5238	244	84	34	Pass
0.5301	224	84	37	Pass
0.5364	208	84	40	Pass
0.5427	200	76	38	Pass
0.5490	168	76	45	Pass
0.5553	160	72	45	Pass
0.5616	148	72	48	Pass
0.5679	132	68	51	Pass
0.5742	120	64	53	Pass
0.5805	104	60	57	Pass
0.5868	100	52	52	Pass
0.5931	92	48	52	Pass
0.5994	76	48	63	Pass
0.6057	76	48	63	Pass
0.6120	72	48	66	Pass
0.6184	60	48	80	Pass
0.6247	60	48	80	Pass
0.6310	48	48	100	Pass
0.6373	32	40	125	Fail
0.6436	32	40	125	Fail
0.6499	28	36	128	Fail
0.6562	16	36	225	Fail
0.6625	16	36	225	Fail
0.6688	16	36	225	Fail
0.6751	16	36	225	Fail
0.6814	16	36	225	Fail
0.6877	16	32	200	Fail
0.6940	16	32	200	Fail
0.7003	16	28	175	Fail
0.7066	16	28	175	Fail
0.7129	16	28	175	Fail
0.7192	16	24	150	Fail
0.7255	16	24	150	Fail
0.7318	16	24	150	Fail
0.7381	16	24	150	Fail
0.7444	16	24	150	Fail
0.7507	16	24	150	Fail

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

Water Quality

Water Quality BMP Flow and Volume for POC #1

On-line facility volume:	1.9664 acre-feet
On-line facility target flow:	2.7666 cfs.
Adjusted for 15 min:	2.7666 cfs.
Off-line facility target flow:	1.5307 cfs.
Adjusted for 15 min:	1.5307 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
Trapezoidal Pond 1 POC	☐	6204.26			☐	0.00			
Total Volume Infiltrated		6204.26	0.00	0.00		0.00	0.00	0%	No Treat. Credit
Compliance with LID Standard 8% of 2-yr to 50% of 2-yr									Duration Analysis Result = Failed

POC 2

POC #2 was not reported because POC must exist in both scenarios and both scenarios must have been run.

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   EastBasin.wdm
MESSU       25   PreEastBasin.MES
            27   PreEastBasin.L61
            28   PreEastBasin.L62
            30   POCEastBasin1.dat
END FILES

OPN SEQUENCE
    INGRP              INDELT 00:60
      PERLND       1
      PERLND      10
      PERLND      11
      COPY       501
      DISPLY       1
    END INGRP
END OPN SEQUENCE
DISPLY
  DISPLY-INFO1
    # -  #<----------Title----------->***TRAN PIVL DIG1 FIL1  PYR DIG2 FIL2 YRND
    1        Basin  1                   MAX                     1    2   30    9
  END DISPLY-INFO1
END DISPLY
COPY
  TIMESERIES
    # -  #  NPT  NMN ***
    1         1    1
  501         1    1
  END TIMESERIES
END COPY
GENER
  OPCODE
    #    # OPCD ***
  END OPCODE
  PARM
    #    #         K ***
  END PARM
END GENER
PERLND
  GEN-INFO
    <PLS ><-------Name------->NBLKS   Unit-systems   Printer ***
    # -  #                          User  t-series Engl Metr ***
                                        in  out           ***
    1     A/B, Forest, Flat       1    1    1    1   27    0
   10     C, Forest, Flat         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 ***
    1         0    0    1    0    0    0    0    0    0    0    0    0
   10         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  *********
    1         0    0    4    0    0    0    0    0    0    0    0    0    1    9
   10         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 ***
    1         0    0    0    0    0    0    0    0    0    0    0
   10         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
    1              0         5         2       400      0.05       0.3     0.996
   10              0       4.5      0.08       400      0.05       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
    1              0         0         2         2         0         0         0
   10              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 ***
    1          0.2       0.5      0.35         0       0.7       0.7
   10          0.2       0.5      0.35         6       0.5       0.7
   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
    1              0         0         0         0         3          1         0
   10              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           ***
  END GEN-INFO
  *** Section IWATER***

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

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

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

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

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

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

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

END IMPLND

SCHEMATIC
<-Source->                 <--Area-->     <-Target->   MBLK   ***
<Name>   #                 <-factor->     <Name>   #   Tbl#   ***
Basin  1***
PERLND   1                      2.358     COPY   501     12
PERLND   1                      2.358     COPY   501     13
PERLND  10                     53.278     COPY   501     12
PERLND  10                     53.278     COPY   501     13
PERLND  11                      9.267     COPY   501     12
PERLND  11                      9.267     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   12.1        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    0.857     SUM  PERLND   1 999 EXTNL  PREC
WDM      2 PREC     ENGL    0.857     SUM  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     12.1      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   EastBasin.wdm
MESSU       25   MitEastBasin.MES
            27   MitEastBasin.L61
            28   MitEastBasin.L62
            30   POCEastBasin1.dat
END FILES

OPN SEQUENCE
    INGRP               INDELT 00:60
      PERLND      10
      PERLND      11
      PERLND      16
      PERLND      17
      PERLND       7
      PERLND       1
      IMPLND       1
      RCHRES       1
      COPY         1
      COPY       501
      DISPLY       1
    END INGRP
END OPN SEQUENCE
DISPLY
  DISPLY-INFO1
    # -  #<----------Title----------->***TRAN PIVL DIG1 FIL1  PYR DIG2 FIL2 YRND
    1        Trapezoidal Pond  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            ***
   10     C, Forest, Flat         1    1    1    1   27    0
   11     C, Forest, Mod          1    1    1    1   27    0
   16     C, Lawn, Flat           1    1    1    1   27    0
   17     C, Lawn, Mod            1    1    1    1   27    0
    7     A/B, Lawn, Flat         1    1    1    1   27    0
    1     A/B, Forest, Flat       1    1    1    1   27    0
  END GEN-INFO
  *** Section PWATER***
```

```
ACTIVITY
  <PLS > ************ Active Sections ****************************
  # -  # ATMP SNOW PWAT  SED  PST  PWG PQAL MSTL PEST NITR PHOS TRAC ***
 10         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
 16         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
  7         0    0    1    0    0    0    0    0    0    0    0    0
  1         0    0    1    0    0    0    0    0    0    0    0    0
END ACTIVITY

PRINT-INFO
  <PLS > ***************** Print-flags **************************** PIVL  PYR
  # -  # ATMP SNOW PWAT  SED  PST  PWG PQAL MSTL PEST NITR PHOS TRAC  *********
 10         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
 16         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
  7         0    0    4    0    0    0    0    0    0    0    0    0    1    9
  1         0    0    4    0    0    0    0    0    0    0    0    0    1    9
END PRINT-INFO

PWAT-PARM1
  <PLS >  PWATER variable monthly parameter value flags  ***
  # -  # CSNO RTOP UZFG  VCS  VUZ  VNN VIFW VIRC  VLE INFC  HWT ***
 10         0    0    0    0    0    0    0    0    0    0    0
 11         0    0    0    0    0    0    0    0    0    0    0
 16         0    0    0    0    0    0    0    0    0    0    0
 17         0    0    0    0    0    0    0    0    0    0    0
  7         0    0    0    0    0    0    0    0    0    0    0
  1         0    0    0    0    0    0    0    0    0    0    0
END PWAT-PARM1

PWAT-PARM2
  <PLS >      PWATER input info: Part 2          ***
  # -  # ***FOREST      LZSN    INFILT      LSUR     SLSUR     KVARY     AGWRC
 10              0       4.5      0.08       400      0.05       0.5     0.996
 11              0       4.5      0.08       400       0.1       0.5     0.996
 16              0       4.5      0.03       400      0.05       0.5     0.996
 17              0       4.5      0.03       400       0.1       0.5     0.996
  7              0         5       0.8       400      0.05       0.3     0.996
  1              0         5         2       400      0.05       0.3     0.996
END PWAT-PARM2

PWAT-PARM3
  <PLS >      PWATER input info: Part 3          ***
  # -  # ***PETMAX    PETMIN    INFEXP    INFILD    DEEPFR    BASETP    AGWETP
 10              0         0         2         2         0         0         0
 11              0         0         2         2         0         0         0
 16              0         0         2         2         0         0         0
 17              0         0         2         2         0         0         0
  7              0         0         2         2         0         0         0
  1              0         0         2         2         0         0         0
END PWAT-PARM3
PWAT-PARM4
  <PLS >     PWATER input info: Part 4                              ***
  # -  #     CEPSC      UZSN      NSUR     INTFW       IRC     LZETP ***
 10            0.2       0.5      0.35         6       0.5       0.7
 11            0.2       0.5      0.35         6       0.5       0.7
 16            0.1      0.25      0.25         6       0.5      0.25
 17            0.1      0.25      0.25         6       0.5      0.25
  7            0.1       0.5      0.25         0       0.7      0.25
  1            0.2       0.5      0.35         0       0.7       0.7
END PWAT-PARM4

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

```
   10             0         0         0         0       2.5         1         0
   11             0         0         0         0       2.5         1         0
   16             0         0         0         0       2.5         1         0
   17             0         0         0         0       2.5         1         0
    7             0         0         0         0         3         1         0
    1             0         0         0         0         3         1         0
  END PWAT-STATE1

END PERLND

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

  PRINT-INFO
    <ILS > ******** Print-flags ******** PIVL  PYR
    # -  # ATMP SNOW IWAT  SLD  IWG IQAL     *********
    1         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
  END IWAT-PARM1

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

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

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

END IMPLND

SCHEMATIC
<-Source->                 <--Area-->     <-Target->   MBLK   ***
<Name>   #                 <-factor->     <Name>   #   Tbl#   ***
Basin  1***
PERLND  10                      4.875     RCHRES   1      2
PERLND  10                      4.875     RCHRES   1      3
PERLND  10                      4.875     RCHRES   1      4
PERLND  11                       1.15     RCHRES   1      2
PERLND  11                       1.15     RCHRES   1      3
PERLND  11                       1.15     RCHRES   1      4
PERLND  16                     29.253     RCHRES   1      2
PERLND  16                     29.253     RCHRES   1      3
PERLND  16                     29.253     RCHRES   1      4
```

```
PERLND  17                        4.785     RCHRES   1      2
PERLND  17                        4.785     RCHRES   1      3
PERLND  17                        4.785     RCHRES   1      4
PERLND   7                        1.394     RCHRES   1      2
PERLND   7                        1.394     RCHRES   1      3
PERLND   7                        1.394     RCHRES   1      4
PERLND   1                        0.117     RCHRES   1      2
PERLND   1                        0.117     RCHRES   1      3
PERLND   1                        0.117     RCHRES   1      4
IMPLND   1                       23.329     RCHRES   1      5

******Routing******
PERLND  10                        4.875     COPY     1     12
PERLND  11                         1.15     COPY     1     12
PERLND  16                       29.253     COPY     1     12
PERLND  17                        4.785     COPY     1     12
PERLND   7                        1.394     COPY     1     12
PERLND   1                        0.117     COPY     1     12
IMPLND   1                       23.329     COPY     1     15
PERLND  10                        4.875     COPY     1     13
PERLND  11                         1.15     COPY     1     13
PERLND  16                       29.253     COPY     1     13
PERLND  17                        4.785     COPY     1     13
PERLND   7                        1.394     COPY     1     13
PERLND   1                        0.117     COPY     1     13
PERLND  10                        4.875     COPY     1     14
PERLND  11                         1.15     COPY     1     14
PERLND  16                       29.253     COPY     1     14
PERLND  17                        4.785     COPY     1     14
PERLND   7                        1.394     COPY     1     14
PERLND   1                        0.117     COPY     1     14
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   12.1        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     Trapezoidal Pond-011    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      0.07       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
   91    4
     Depth      Area    Volume  Outflow1 Velocity  Travel Time***
      (ft)   (acres) (acre-ft)   (cfs)   (ft/sec)    (Minutes)***
  0.000000  2.704973  0.000000  0.000000
  0.077778  2.709909  0.210579  0.077885
  0.155556  2.714849  0.421542  0.110146
  0.233333  2.719794  0.632889  0.134901
  0.311111  2.724744  0.844621  0.155770
  0.388889  2.729697  1.056738  0.174157
  0.466667  2.734656  1.269241  0.190779
  0.544444  2.739618  1.482129  0.206065
  0.622222  2.744585  1.695404  0.220293
  0.700000  2.749557  1.909065  0.233656
  0.777778  2.754533  2.123113  0.246295
  0.855556  2.759513  2.337548  0.258316
  0.933333  2.764498  2.552370  0.269802
  1.011111  2.769488  2.767581  0.280819
  1.088889  2.774481  2.983180  0.291420
  1.166667  2.779480  3.199167  0.301648
  1.244444  2.784482  3.415544  0.311541
  1.322222  2.789489  3.632309  0.321129
  1.400000  2.794501  3.849464  0.330439
  1.477778  2.799517  4.067009  0.339494
  1.555556  2.804537  4.284945  0.348313
  1.633333  2.809562  4.503271  0.356915
  1.711111  2.814592  4.721988  0.365314
  1.788889  2.819625  4.941097  0.373525
  1.866667  2.824664  5.160597  0.381558
  1.944444  2.829706  5.380489  0.389426
  2.022222  2.834753  5.600773  0.397138
  2.100000  2.839805  5.821451  0.404704
  2.177778  2.844861  6.042521  0.412130
  2.255556  2.849921  6.263985  0.419425
  2.333333  2.854986  6.485842  0.426595
  2.411111  2.860056  6.708094  0.433647
  2.488889  2.865129  6.930740  0.440585
  2.566667  2.870208  7.153781  0.447417
  2.644444  2.875290  7.377217  0.454145
  2.722222  2.880377  7.601049  0.460775
  2.800000  2.885469  7.825276  0.467311
  2.877778  2.890565  8.049899  0.473757
  2.955556  2.895665  8.274919  0.480117
  3.033333  2.900770  8.500336  0.486393
  3.111111  2.905880  8.726151  0.492590
  3.188889  2.910993  8.952362  0.498709
  3.266667  2.916112  9.178972  0.504754
  3.344444  2.921234  9.405980  0.510728
  3.422222  2.926361  9.633386  0.516632
```

```
  3.500000  2.931493  9.861192  0.522470
  3.577778  2.936629  10.08940  0.528243
  3.655556  2.941769  10.31800  0.533954
  3.733333  2.946914  10.54701  0.539605
  3.811111  2.952064  10.77641  0.545197
  3.888889  2.957217  11.00622  0.550732
  3.966667  2.962376  11.23642  0.556212
  4.044444  2.967538  11.46703  0.561639
  4.122222  2.972705  11.69804  0.567013
  4.200000  2.977877  11.92945  0.572337
  4.277778  2.983053  12.16126  0.577612
  4.355556  2.988233  12.39348  0.582840
  4.433333  2.993418  12.62610  0.588021
  4.511111  2.998607  12.85912  0.593156
  4.588889  3.003801  13.09255  0.598248
  4.666667  3.008999  13.32638  0.603297
  4.744444  3.014202  13.56062  0.608303
  4.822222  3.019409  13.79526  0.626395
  4.900000  3.024621  14.03030  0.674036
  4.977778  3.029837  14.26576  0.736713
  5.055556  3.035057  14.50161  0.809924
  5.133333  3.040282  14.73788  0.891166
  5.211111  3.045511  14.97454  0.978725
  5.288889  3.050745  15.21162  1.071302
  5.366667  3.055983  15.44911  1.167856
  5.444444  3.061226  15.68700  1.267516
  5.522222  3.066473  15.92530  1.369532
  5.600000  3.071725  16.16400  1.473246
  5.677778  3.076981  16.40312  1.578069
  5.755556  3.082241  16.64265  1.683469
  5.833333  3.087506  16.88258  1.805399
  5.911111  3.092775  17.12292  1.936831
  5.988889  3.098049  17.36368  2.072658
  6.066667  3.103327  17.60484  2.918290
  6.144444  3.108610  17.84642  4.720562
  6.222222  3.113897  18.08841  7.100801
  6.300000  3.119188  18.33080  9.937486
  6.377778  3.124484  18.57361  13.15800
  6.455556  3.129785  18.81683  16.70804
  6.533333  3.135090  19.06047  20.54117
  6.611111  3.140399  19.30451  24.61417
  6.688889  3.145713  19.54897  28.88471
  6.766667  3.151031  19.79385  33.31028
  6.844444  3.156353  20.03914  37.84765
  6.922222  3.161681  20.28484  42.45283
  7.000000  3.167012  20.53095  47.08125
  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    0.857     SUM  PERLND   1 999 EXTNL  PREC
WDM      2 PREC     ENGL    0.857     SUM  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
WDM      2 PREC     ENGL    0.857     SUM  RCHRES   1     EXTNL  PREC
WDM      1 EVAP     ENGL    0.76           RCHRES   1     EXTNL  POTEV

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     12.1      WDM    701 FLOW     ENGL      REPL
COPY   501 OUTPUT MEAN   1 1     12.1      WDM    801 FLOW     ENGL      REPL
END EXT TARGETS
```

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

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

  MASS-LINK         4
PERLND     PWATER AGWO       0.083333      RCHRES         INFLOW IVOL
  END MASS-LINK     4

  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        14
PERLND     PWATER AGWO       0.083333      COPY           INPUT  MEAN
  END MASS-LINK    14

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

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


END MASS-LINK

END RUN
```

Predeveloped HSPF Message File

Mitigated HSPF Message File

Disclaimer

Legal Notice

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Clear Creek Solutions, Inc.
6200 Capitol Blvd. Ste F
Olympia, WA. 98501
Toll Free 1(866)943-0304
Local (360)943-0304

www.clearcreeksolutions.com

Project Summary Sheet

Stormwater Retrofit: Main St Treatment and Schell Creek Realignment

Project Description: This project includes both water quality and stream improvements near the Schell Creek crossing on Main St. Main St is the busiest street in Ferndale and lacks water quality treatment in the vicinity of Schell Creek. Two new media filter cartridges (Filterra or equivalent systems) will be integrated into the existing stormwater conveyance systems on Main St to treat the runoff collected on the west (6.2 acres) and east (6.0 acres) sides of Schell Creek prior to their outfalls. It is assumed most of the runoff conveyed by the Hendrickson Ave conveyance system will be redirected to a new regional facility (discussed above) or will bypass the media filters. Alternatively, the City may consider acquiring property immediately south of the Main St crossing and installing a modular wetland system for stormwater treatment. In addition to providing stormwater treatment for Main St in the vicinity of the Schell Creek crossing, Schell Creek immediately downstream (south) of Main St will be realigned to prevent potential flooding and erosion damage to a private apartment complex. The stream will be moved west of its current location approximately 60 feet and an existing 106-foot long, 48-inch diameter corrugated metal culvert that is a barrier to fish passage will be replaced with an appropriate fish passable structure.

Existing Condition Photos:

Planning Level Cost Estimate: $1,135,000

Design Methodology: WWHM4 (Version 4.2.18; 2021), assume full buildout conditions

Design Quantities:

Parameter	Quantity	Units
Main St Treatment West of Schell Creek		
Drainage Area	6.2	acres
Impervious Area	3.6	acres
Pervious Area	2.6	acres
WQ Design Volume	0.4	acre-feet
WQ Design Flow Rate	0.6	cfs
100-Year Peak Flow	4.1	cfs
Stormwater Treatment Cartridges (Filterra or equivalent systems)	1	
Main St Treatment East of Schell Creek		
Drainage Area	6.0	acres
Impervious Area	3.9	acres
Pervious Area	2.1	acres
WQ Design Volume	0.4	acre-feet
WQ Design Flow Rate	0.6	cfs
100-Year Peak Flow	4.1	cfs
Stormwater Treatment Cartridges (Filterra or equivalent systems)	1	
Schell Creek Realignment and Culvert Replacement		
Stream culvert designed for fish passage	1	

City of Ferndale

nhc northwest hydraulic consultants

Proposed Conveyance
Proposed Retrofit Footprint
Existing Conveyance
City-owned
Private
Stormwater Catch Basin
Existing Facilities
City-owned
Private

SCALE - 1:2,500

0 100 200

Feet

Coordinate System: NAD 1983 STATEPLANE WASHINGTON NORTH FIPS 4601 FEET

N

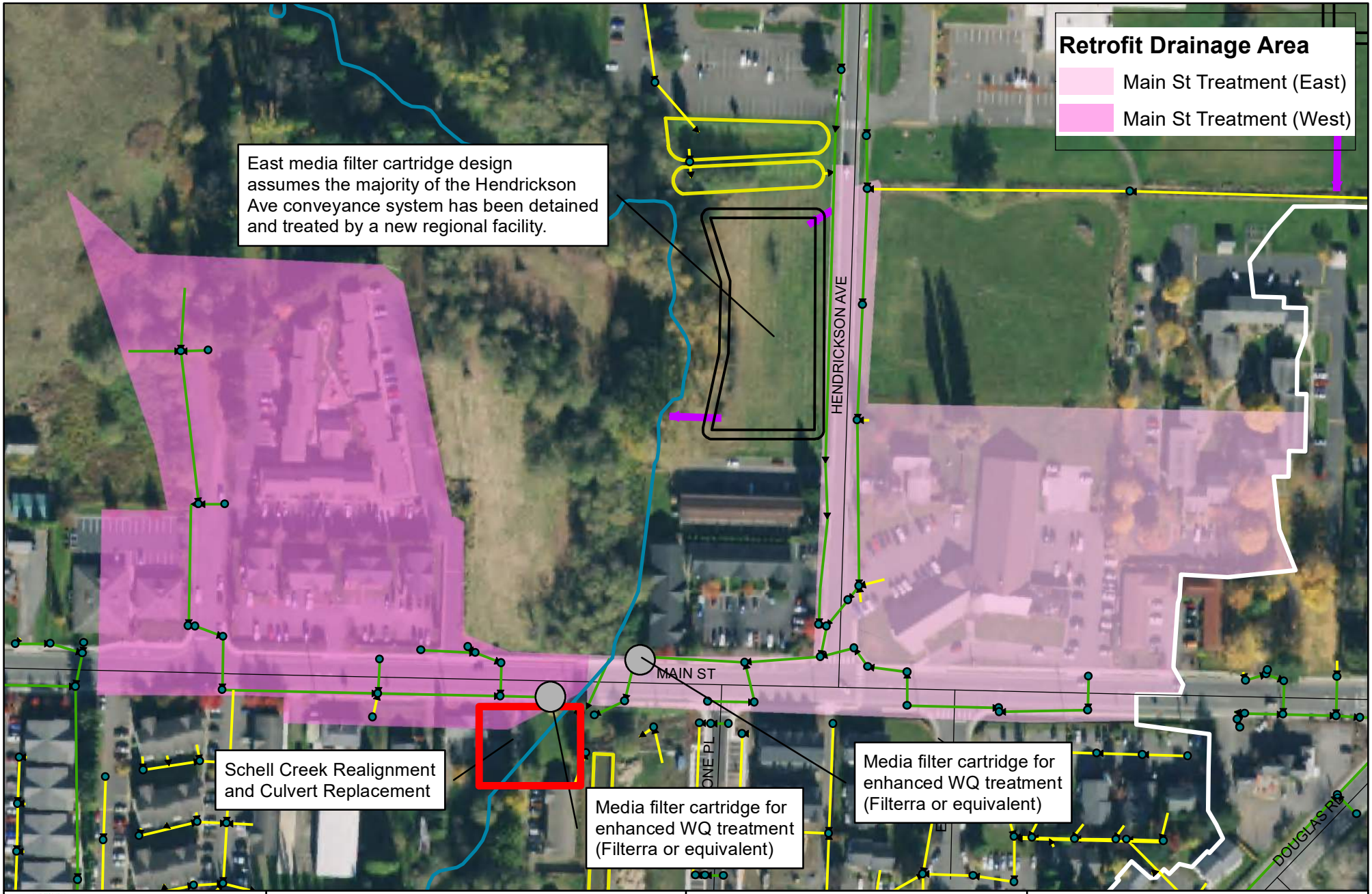
Job: 2006286

Date: 30-MAR-2023

FERNDALE SMAP
Schell Creek Stormwater Retrofits - Main St Treatment and Schell Creek Realignment

FIGURE A-7

Q:\2006286_Ferndale_SCP_and_SMAP\95_GIS\MXDs\Figures\2006286_Ferndale_SMAP_Retrofits_MainStreet.mxd



City of Ferndale

northwest hydraulic consultants

Proposed Conveyance
Proposed Retrofit Footprint
Existing Conveyance
City-owned
Private
Stormwater Catch Basin
Existing Facilities
City-owned
Private
Planning Unit

SCALE - 1:2,500

0 100 200

Feet

Coordinate System: NAD 1983 STATEPLANE WASHINGTON NORTH FIPS 4601 FEET

N

Job: 2006286

Date: 30-MAR-2023

FERNDALE SMAP

Schell Creek Stormwater Retrofits - Main St Treatment and Schell Creek Realignment - Drainage Area

FIGURE A-8

Q:\2006286_Ferndale_SCP_and_SMAP\95_GIS\MXDs\Figures\2006286_Ferndale_SMAP_Retrofits_MainStreet_DrainageArea.mxd

Reichhardt & Ebe
ENGINEERING INC
423 Front Street
Lynden, WA 98264
Phone: (360) 354-3687

Called By:	City of Ferndale
For:	**Main St Treatment** PO Box 936 / 2095 Main St Ferndale, WA 98248
	PRELIMINARY ENGINEER'S ESTIMATE
By:	Dale Buys, P.E.
Date:	March 31, 2023

Item No.	Item Description	Quantity	Unit	Unit Price	Amount
1	Mobilization	1	LS	$ 60,000.00	$ 60,000.00
2	Record Drawings	1	LS	$ 1,000.00	$ 1,000.00
3	SPCC Plan	1	LS	$ 1,000.00	$ 1,000.00
4	Project Temporary Traffic Control	1	LS	$ 5,000.00	$ 5,000.00
5	Flaggers	600	HR	$ 70.00	$ 42,000.00
6	Other Traffic Control Labor	120	HR	$ 70.00	$ 8,400.00
7	Clearing and Grubbing	1	LS	$ 2,000.00	$ 2,000.00
8	Removal of Structures and Obstructions	1	LS	$ 3,000.00	$ 3,000.00
9	Sawcut ACP	250	LF-IN	$ 3.00	$ 750.00
10	Streambed Excavation	500	CY	$ 25.00	$ 12,500.00
11	Water	5	M GAL.	$ 100.00	$ 500.00
12	Construction Geotextile for Separation	250	SY	$ 5.00	$ 1,250.00
13	Gravel Base	200	TON	$ 20.00	$ 4,000.00
14	Streambed Aggregate	200	TONS	$ 30.00	$ 6,000.00
15	Crushed Surfacing Top Course	50	TON	$ 40.00	$ 2,000.00
16	HMA Cl. 1/2" PG 64-22	50	TON	$ 150.00	$ 7,500.00
17	Planing Bituminous Pavement	150	SY	$ 55.00	$ 8,250.00
18	Compaction Price Adjustment	-	CALC		$ -
19	Job Mix Compliance Price Adjustment	-	CALC		$ -
20	Deficient Strength Conc. Price Adjustment	-	CALC		$ -
20	Stream Culvert	1	LS	$ 150,000.00	$ 150,000.00
21	Abandon Existing Culvert	1	LS	$ 20,000.00	$ 20,000.00
22	Corrugated Polyethylene Storm Sewer Pipe 18 In. Diam.	50	LF	$ 150.00	$ 7,500.00
23	Corrugated Polyethylene Storm Sewer Pipe 36 In. Diam.	50	LF	$ 250.00	$ 12,500.00
24	Stormwater Treatment Cartridge	2	EA	$ 150,000.00	$ 300,000.00
25	Adjustments to Finished Grade	1	LS	$ 2,000.00	$ 2,000.00
26	Erosion/Water Pollution Control	1	EST	$ 5,000.00	$ 5,000.00
27	ESC Lead	50	DAY	$ 50.00	$ 2,500.00
28	Street Cleaning	50	HR	$ 185.00	$ 9,250.00
29	Silt Fence	200	LF	$ 10.00	$ 2,000.00
30	Inlet Protection	15	EA	$ 100.00	$ 1,500.00
31	Landscape Restoration	1	EST	$ 10,000.00	$ 10,000.00
31	Seeded Lawn Installation	200	SY	$ 20.00	$ 4,000.00
32	Stream Planting	1	LS	$ 30,000.00	$ 30,000.00
32	Quarry Spalls	40	TON	$ 75.00	$ 3,000.00
33	Paint Line	100	LF	$ 1.50	$ 150.00
34	Pothole Existing Underground Utility	20	EA	$ 550.00	$ 11,000.00
35	Repair Existing Public and Private Facilities	1	EST	$ 15,000.00	$ 15,000.00
36	Right of Way Acquisition	2,000	SF	$ 16.00	$ 32,000.00
	Subtotal				$ 782,550.00
	Design and Permitting (30%)				$ 234,765.00
	Construction Admin and Inspection (15%)				$ 117,382.50
	TOTAL				**$ 1,134,697.50**

WWHM2012

PROJECT REPORT

General Model Information

Project Name:	WestBasin
Site Name:	Ferndale SMAP
Site Address:	
City:	
Report Date:	3/24/2023
Gage:	Blaine
Data Start:	1948/10/01
Data End:	2009/09/30
Timestep:	15 Minute
Precip Scale:	0.857
Version Date:	2021/08/18
Version:	4.2.18

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, Flat	2.47
C, Forest, Mod	3.7
Pervious Total	6.17
Impervious Land Use	acre
Impervious Total	0
Basin Total	6.17

Element Flows To:

Surface	Interflow	Groundwater

Mitigated Land Use

Basin 1

Bypass:	No
GroundWater:	No

Pervious Land Use	acre
C, Forest, Flat	0.07
C, Forest, Mod	0.73
C, Lawn, Flat	0.95
C, Lawn, Mod	0.8
Pervious Total	2.55

Impervious Land Use	acre
ROADS MOD	3.61
Impervious Total	3.61
Basin Total	6.16

Element Flows To:

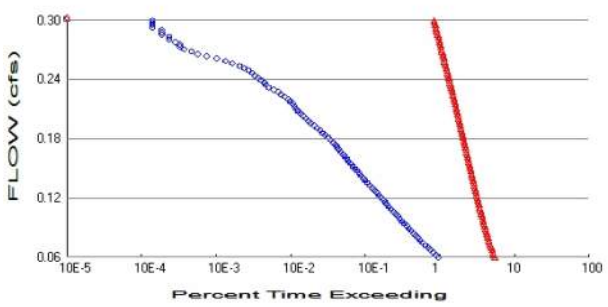
Surface	Interflow	Groundwater

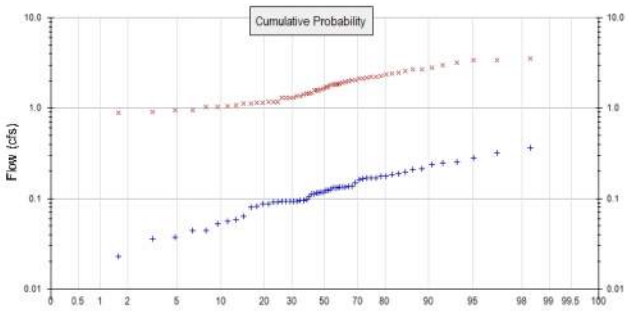
Routing Elements
Predeveloped Routing

Mitigated Routing

Analysis Results

POC 1





\+ Predeveloped x Mitigated

Predeveloped Landuse Totals for POC #1
Total Pervious Area: 6.17
Total Impervious Area: 0

Mitigated Landuse Totals for POC #1
Total Pervious Area: 2.55
Total Impervious Area: 3.61

Flow Frequency Method: Log Pearson Type III 17B

Flow Frequency Return Periods for Predeveloped. POC #1

Return Period	Flow(cfs)
2 year	0.120008
5 year	0.186824
10 year	0.227032
25 year	0.272392
50 year	0.302347
100 year	0.32929

Flow Frequency Return Periods for Mitigated. POC #1

Return Period	Flow(cfs)
2 year	1.651392
5 year	2.276568
10 year	2.702199
25 year	3.252936
50 year	3.672535
100 year	4.100152

Annual Peaks

Annual Peaks for Predeveloped and Mitigated. POC #1

Year	Predeveloped	Mitigated
1949	0.135	1.152
1950	0.138	2.450
1951	0.197	1.033
1952	0.045	1.164
1953	0.058	1.120
1954	0.115	2.240
1955	0.081	1.589
1956	0.091	2.185
1957	0.237	2.407
1958	0.064	1.732

1959	0.087	1.033
1960	0.125	1.944
1961	0.094	0.946
1962	0.086	2.377
1963	0.092	2.139
1964	0.177	3.198
1965	0.250	3.389
1966	0.215	2.777
1967	0.170	1.580
1968	0.168	1.426
1969	0.092	1.461
1970	0.035	1.298
1971	0.169	0.893
1972	0.113	2.136
1973	0.096	0.952
1974	0.118	1.301
1975	0.093	1.317
1976	0.175	2.048
1977	0.092	3.408
1978	0.132	1.976
1979	0.092	1.892
1980	0.185	1.827
1981	0.080	2.971
1982	0.208	1.820
1983	0.092	1.079
1984	0.364	2.693
1985	0.165	1.651
1986	0.318	2.678
1987	0.134	2.212
1988	0.107	1.367
1989	0.121	3.548
1990	0.162	1.619
1991	0.118	1.184
1992	0.133	1.134
1993	0.116	1.309
1994	0.052	1.048
1995	0.130	1.170
1996	0.188	1.888
1997	0.252	1.786
1998	0.037	0.782
1999	0.279	1.716
2000	0.044	1.354
2001	0.016	2.570
2002	0.113	1.458
2003	0.023	1.489
2004	0.094	2.282
2005	0.148	1.564
2006	0.122	2.058
2007	0.130	1.830
2008	0.056	0.910
2009	0.132	1.154

Ranked Annual Peaks

Ranked Annual Peaks for Predeveloped and Mitigated. POC #1

Rank	Predeveloped	Mitigated
1	0.3639	3.5482
2	0.3184	3.4084
3	0.2789	3.3894

4	0.2522	3.1982
5	0.2497	2.9707
6	0.2369	2.7773
7	0.2153	2.6932
8	0.2082	2.6780
9	0.1969	2.5696
10	0.1877	2.4503
11	0.1853	2.4067
12	0.1771	2.3767
13	0.1752	2.2823
14	0.1703	2.2401
15	0.1686	2.2115
16	0.1678	2.1854
17	0.1648	2.1387
18	0.1619	2.1357
19	0.1484	2.0581
20	0.1376	2.0477
21	0.1351	1.9764
22	0.1343	1.9436
23	0.1330	1.8920
24	0.1323	1.8883
25	0.1319	1.8298
26	0.1302	1.8269
27	0.1301	1.8201
28	0.1247	1.7857
29	0.1223	1.7319
30	0.1214	1.7160
31	0.1185	1.6506
32	0.1180	1.6187
33	0.1157	1.5893
34	0.1148	1.5798
35	0.1131	1.5637
36	0.1130	1.4890
37	0.1066	1.4606
38	0.0962	1.4579
39	0.0942	1.4260
40	0.0942	1.3672
41	0.0933	1.3539
42	0.0924	1.3168
43	0.0923	1.3087
44	0.0923	1.3008
45	0.0922	1.2980
46	0.0920	1.1840
47	0.0912	1.1698
48	0.0866	1.1643
49	0.0864	1.1542
50	0.0812	1.1525
51	0.0798	1.1345
52	0.0641	1.1200
53	0.0582	1.0790
54	0.0560	1.0481
55	0.0525	1.0335
56	0.0447	1.0333
57	0.0444	0.9523
58	0.0369	0.9459
59	0.0354	0.9098
60	0.0229	0.8927
61	0.0162	0.7820

Duration Flows

Flow(cfs)	Predev	Mit	Percentage	Pass/Fail
0.0600	20514	115564	563	Fail
0.0625	18882	112420	595	Fail
0.0649	17342	109532	631	Fail
0.0673	15986	106880	668	Fail
0.0698	14788	104270	705	Fail
0.0722	13665	101768	744	Fail
0.0747	12660	99372	784	Fail
0.0771	11717	97084	828	Fail
0.0796	10936	94902	867	Fail
0.0820	10190	92806	910	Fail
0.0845	9507	90753	954	Fail
0.0869	8853	88742	1002	Fail
0.0894	8258	86817	1051	Fail
0.0918	7687	85020	1106	Fail
0.0943	7103	83288	1172	Fail
0.0967	6620	81662	1233	Fail
0.0992	6179	80037	1295	Fail
0.1016	5803	78497	1352	Fail
0.1041	5467	77042	1409	Fail
0.1065	5114	75567	1477	Fail
0.1090	4778	74112	1551	Fail
0.1114	4455	72679	1631	Fail
0.1139	4173	71374	1710	Fail
0.1163	3923	70048	1785	Fail
0.1188	3698	68765	1859	Fail
0.1212	3446	67503	1958	Fail
0.1236	3240	66305	2046	Fail
0.1261	3039	65172	2144	Fail
0.1285	2834	63974	2257	Fail
0.1310	2629	62862	2391	Fail
0.1334	2443	61749	2527	Fail
0.1359	2278	60723	2665	Fail
0.1383	2111	59718	2828	Fail
0.1408	2000	58691	2934	Fail
0.1432	1883	57643	3061	Fail
0.1457	1775	56680	3193	Fail
0.1481	1659	55696	3357	Fail
0.1506	1546	54777	3543	Fail
0.1530	1451	53793	3707	Fail
0.1555	1362	52895	3883	Fail
0.1579	1276	51975	4073	Fail
0.1604	1210	51141	4226	Fail
0.1628	1140	50221	4405	Fail
0.1653	1071	49344	4607	Fail
0.1677	997	48488	4863	Fail
0.1702	935	47676	5099	Fail
0.1726	889	46906	5276	Fail
0.1751	843	46178	5477	Fail
0.1775	786	45344	5768	Fail
0.1800	736	44617	6062	Fail
0.1824	677	43890	6483	Fail
0.1848	619	43098	6962	Fail
0.1873	571	42393	7424	Fail
0.1897	532	41665	7831	Fail

0.1922	490	40981	8363	Fail
0.1946	444	40296	9075	Fail
0.1971	399	39591	9922	Fail
0.1995	373	38906	10430	Fail
0.2020	343	38243	11149	Fail
0.2044	311	37516	12063	Fail
0.2069	290	36896	12722	Fail
0.2093	266	36275	13637	Fail
0.2118	250	35655	14262	Fail
0.2142	241	35056	14546	Fail
0.2167	226	34436	15237	Fail
0.2191	210	33816	16102	Fail
0.2216	197	33195	16850	Fail
0.2240	177	32597	18416	Fail
0.2265	159	32062	20164	Fail
0.2289	144	31484	21863	Fail
0.2314	128	30907	24146	Fail
0.2338	109	30287	27786	Fail
0.2363	100	29773	29773	Fail
0.2387	95	29196	30732	Fail
0.2411	85	28682	33743	Fail
0.2436	78	28190	36141	Fail
0.2460	71	27656	38952	Fail
0.2485	65	27185	41823	Fail
0.2509	58	26650	45948	Fail
0.2534	51	26159	51292	Fail
0.2558	44	25602	58186	Fail
0.2583	35	25110	71742	Fail
0.2607	29	24640	84965	Fail
0.2632	22	24191	109959	Fail
0.2656	16	23742	148387	Fail
0.2681	12	23335	194458	Fail
0.2705	10	22865	228650	Fail
0.2730	8	22437	280462	Fail
0.2754	7	21966	313800	Fail
0.2779	7	21581	308300	Fail
0.2803	6	21183	353050	Fail
0.2828	5	20790	415800	Fail
0.2852	5	20386	407720	Fail
0.2877	4	19999	499975	Fail
0.2901	4	19592	489800	Fail
0.2926	4	19237	480925	Fail
0.2950	3	18884	629466	Fail
0.2975	3	18555	618500	Fail
0.2999	3	18204	606800	Fail
0.3023	3	17853	595100	Fail

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

Water Quality

Water Quality BMP Flow and Volume for POC #1

On-line facility volume:	0.4293 acre-feet
On-line facility target flow:	0.5561 cfs.
Adjusted for 15 min:	0.5561 cfs.
Off-line facility target flow:	0.3117 cfs.
Adjusted for 15 min:	0.3117 cfs.

LID Report

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

POC 2

POC #2 was not reported because POC must exist in both scenarios and both scenarios must have been run.

POC 3

POC #3 was not reported because POC must exist in both scenarios and both scenarios must have been run.

POC 4

POC #4 was not reported because POC must exist in both scenarios and both scenarios must have been run.

Model Default Modifications

Total of 0 changes have been made.

PERLND Changes

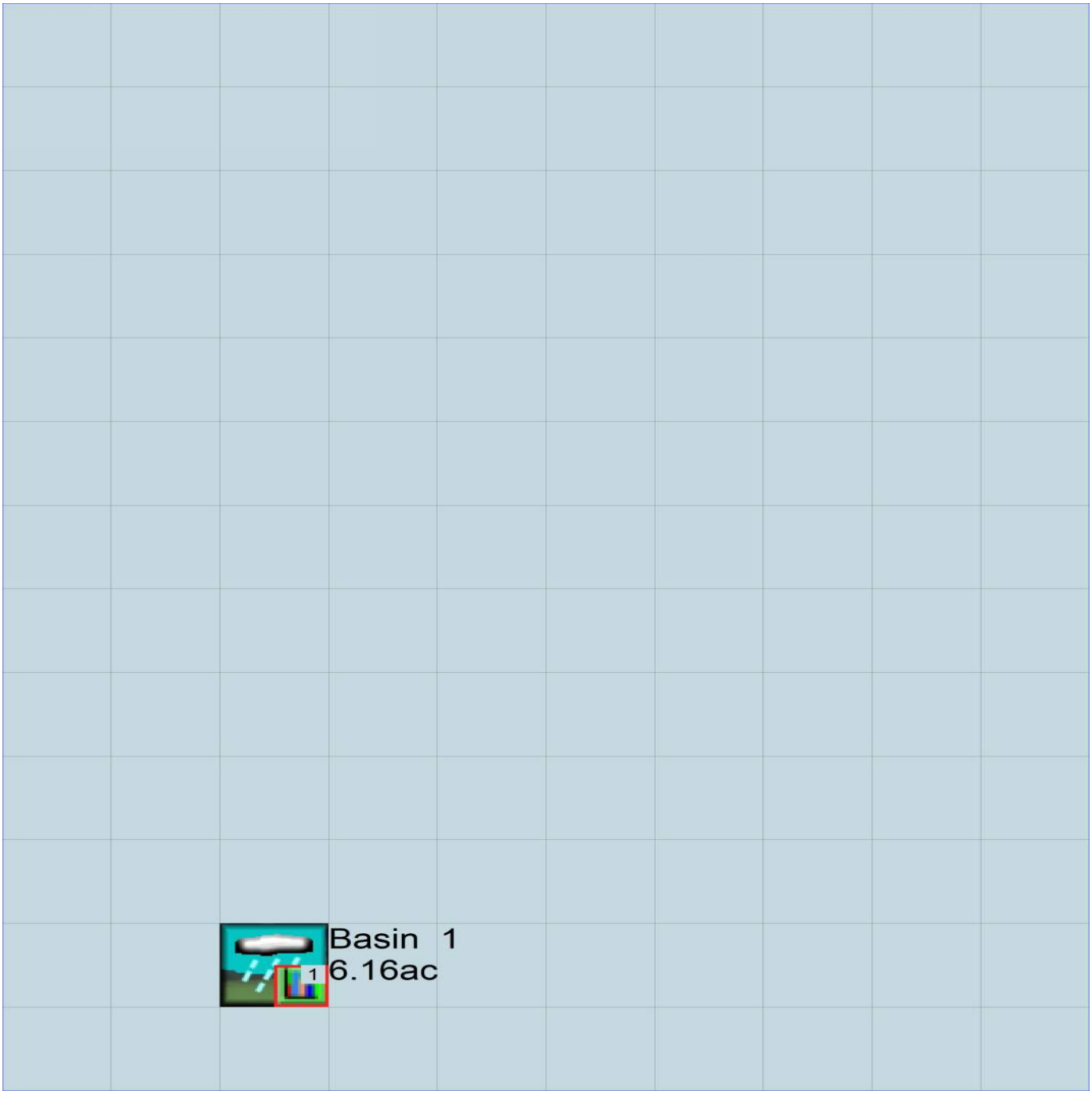
No PERLND changes have been made.

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   WestBasin.wdm
MESSU       25   PreWestBasin.MES
            27   PreWestBasin.L61
            28   PreWestBasin.L62
            30   POCWestBasin1.dat
END FILES

OPN SEQUENCE
    INGRP               INDELT 00:15
      PERLND      10
      PERLND      11
      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           ***
   10     C, Forest, Flat         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 ***
   10         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  *********
```

```
   10         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 ***
   10         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
   10              0       4.5      0.08       400      0.05       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
   10              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 ***
   10            0.2       0.5      0.35         6       0.5       0.7
   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
   10              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           ***
  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  10                        2.47     COPY   501     12
PERLND  10                        2.47     COPY   501     13
PERLND  11                         3.7     COPY   501     12
PERLND  11                         3.7     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    0.857          PERLND   1 999 EXTNL  PREC
WDM      2 PREC     ENGL    0.857          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   WestBasin.wdm
MESSU       25   MitWestBasin.MES
            27   MitWestBasin.L61
            28   MitWestBasin.L62
            30   POCWestBasin1.dat
END FILES

OPN SEQUENCE
    INGRP               INDELT 00:15
      PERLND      10
      PERLND      11
      PERLND      16
      PERLND      17
      IMPLND       2
      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            ***
   10     C, Forest, Flat         1    1    1    1   27    0
   11     C, Forest, Mod          1    1    1    1   27    0
   16     C, Lawn, Flat           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 ***
   10         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
```

```
   16         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  *********
   10         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
   16         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 ***
   10         0    0    0    0    0    0    0    0    0    0    0
   11         0    0    0    0    0    0    0    0    0    0    0
   16         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
   10              0       4.5      0.08       400      0.05        0.5      0.996
   11              0       4.5      0.08       400       0.1        0.5      0.996
   16              0       4.5      0.03       400      0.05        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
   10              0         0         2         2         0         0         0
   11              0         0         2         2         0         0         0
   16              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 ***
   10            0.2       0.5      0.35         6       0.5       0.7
   11            0.2       0.5      0.35         6       0.5       0.7
   16            0.1      0.25      0.25         6       0.5      0.25
   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
   10              0         0         0         0       2.5          1         0
   11              0         0         0         0       2.5          1         0
   16              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           ***
    2      ROADS/MOD              1    1    1   27    0
  END GEN-INFO
  *** Section IWATER***

  ACTIVITY
```

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

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

  IWAT-PARM1
    <PLS >  IWATER variable monthly parameter value flags  ***
    # -  # CSNO RTOP  VRS  VNN RTLI     ***
    2         0    0    0    0    0
  END IWAT-PARM1

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

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

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

END IMPLND

SCHEMATIC
<-Source->                <--Area-->     <-Target->   MBLK   ***
<Name>   #                <-factor->     <Name>   #   Tbl#   ***
Basin  1***
PERLND  10                      0.07     COPY   501     12
PERLND  10                      0.07     COPY   501     13
PERLND  11                      0.73     COPY   501     12
PERLND  11                      0.73     COPY   501     13
PERLND  16                      0.95     COPY   501     12
PERLND  16                      0.95     COPY   501     13
PERLND  17                       0.8     COPY   501     12
PERLND  17                       0.8     COPY   501     13
IMPLND   2                      3.61     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

SPECIAL-ACTIONS
END SPECIAL-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    0.857          PERLND   1 999 EXTNL  PREC
WDM      2 PREC     ENGL    0.857          IMPLND   1 999 EXTNL  PREC
WDM      1 EVAP     ENGL    0.76           PERLND   1 999 EXTNL  PETINP
WDM      1 EVAP     ENGL    0.76           IMPLND   1 999 EXTNL  PETINP

END EXT SOURCES

EXT TARGETS
<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Volume-> <Member> Tsys Tgap Amd ***
<Name>   #        <Name> # #<-factor->strg <Name>   # <Name>    tem strg strg***
COPY     1 OUTPUT MEAN   1 1     48.4      WDM    701 FLOW     ENGL      REPL
COPY   501 OUTPUT MEAN   1 1     48.4      WDM    801 FLOW     ENGL      REPL
END EXT TARGETS

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

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

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

```
END MASS-LINK

END RUN
```

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WWHM2012

PROJECT REPORT

General Model Information

Project Name:	EastBasin
Site Name:	Ferndale SMAP
Site Address:	
City:	
Report Date:	3/24/2023
Gage:	Blaine
Data Start:	1948/10/01
Data End:	2009/09/30
Timestep:	15 Minute
Precip Scale:	0.857
Version Date:	2021/08/18
Version:	4.2.18

POC Thresholds

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

Landuse Basin Data

Predeveloped Land Use

Basin 1

Bypass:	No
GroundWater:	No

Pervious Land Use	acre
A B, Forest, Mod	5.05
C, Forest, Flat	0.96
SAT, Forest, Flat	0.03
Pervious Total	6.04

Impervious Land Use	acre
Impervious Total	0
Basin Total	6.04

Element Flows To:

Surface	Interflow	Groundwater

Mitigated Land Use

Basin 1

Bypass:	No
GroundWater:	No

Pervious Land Use	acre
C, Forest, Flat	0.03
C, Lawn, Flat	0.3
A B, Forest, Mod	0.35
A B, Lawn, Mod	1.41
SAT, Forest, Flat	0.01
Pervious Total	2.1

Impervious Land Use	acre
ROADS MOD	3.93
Impervious Total	3.93
Basin Total	6.03

Element Flows To:

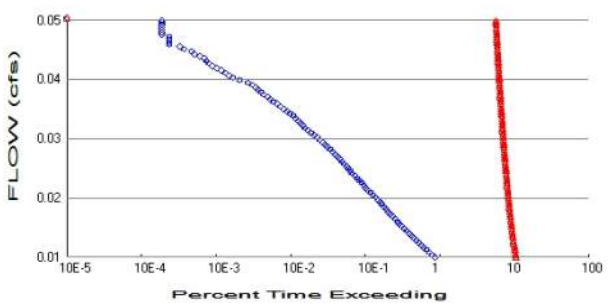
Surface	Interflow	Groundwater

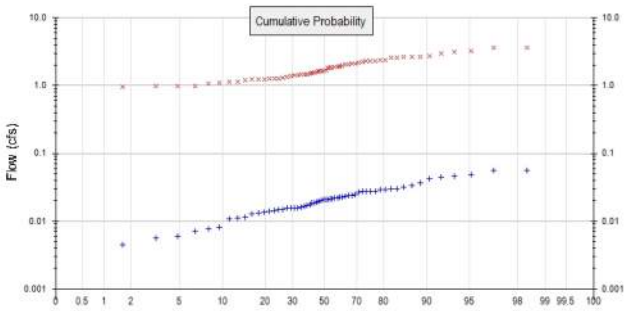
Routing Elements
Predeveloped Routing

Mitigated Routing

Analysis Results

POC 1





\+ Predeveloped x Mitigated

Predeveloped Landuse Totals for POC #1
Total Pervious Area: 6.04
Total Impervious Area: 0

Mitigated Landuse Totals for POC #1
Total Pervious Area: 2.1
Total Impervious Area: 3.93

Flow Frequency Method: Log Pearson Type III 17B

Flow Frequency Return Periods for Predeveloped. POC #1

Return Period	Flow(cfs)
2 year	0.020148
5 year	0.031308
10 year	0.038016
25 year	0.045577
50 year	0.050568
100 year	0.055055

Flow Frequency Return Periods for Mitigated. POC #1

Return Period	Flow(cfs)
2 year	1.706153
5 year	2.31911
10 year	2.73204
25 year	3.262159
50 year	3.663364
100 year	4.070166

Annual Peaks

Annual Peaks for Predeveloped and Mitigated. POC #1

Year	Predeveloped	Mitigated
1949	0.021	1.196
1950	0.024	2.621
1951	0.032	1.097
1952	0.007	1.267
1953	0.011	1.218
1954	0.020	2.281
1955	0.013	1.579
1956	0.015	2.373
1957	0.030	2.348
1958	0.012	1.815

1959	0.014	1.082
1960	0.021	2.115
1961	0.015	0.976
1962	0.014	2.580
1963	0.017	2.328
1964	0.029	3.124
1965	0.034	3.200
1966	0.029	2.714
1967	0.026	1.563
1968	0.028	1.479
1969	0.015	1.481
1970	0.006	1.362
1971	0.027	0.948
1972	0.020	2.103
1973	0.016	0.982
1974	0.019	1.294
1975	0.015	1.420
1976	0.056	2.150
1977	0.016	3.647
1978	0.024	2.032
1979	0.014	1.878
1980	0.030	1.941
1981	0.013	2.936
1982	0.048	1.871
1983	0.016	1.118
1984	0.056	2.660
1985	0.028	1.643
1986	0.046	2.546
1987	0.023	2.213
1988	0.017	1.488
1989	0.022	3.608
1990	0.028	1.649
1991	0.019	1.231
1992	0.022	1.234
1993	0.019	1.342
1994	0.008	1.142
1995	0.021	1.273
1996	0.036	1.928
1997	0.042	1.848
1998	0.006	0.818
1999	0.044	1.669
2000	0.008	1.414
2001	0.003	2.675
2002	0.021	1.477
2003	0.004	1.556
2004	0.017	2.276
2005	0.024	1.655
2006	0.022	2.078
2007	0.020	1.842
2008	0.011	0.988
2009	0.022	1.251

Ranked Annual Peaks

Ranked Annual Peaks for Predeveloped and Mitigated. POC #1

Rank	Predeveloped	Mitigated
1	0.0563	3.6467
2	0.0559	3.6084
3	0.0479	3.2004

4	0.0457	3.1243
5	0.0441	2.9356
6	0.0422	2.7138
7	0.0364	2.6750
8	0.0336	2.6601
9	0.0316	2.6214
10	0.0302	2.5803
11	0.0299	2.5465
12	0.0294	2.3729
13	0.0288	2.3482
14	0.0279	2.3276
15	0.0277	2.2810
16	0.0277	2.2759
17	0.0275	2.2134
18	0.0265	2.1498
19	0.0243	2.1153
20	0.0237	2.1033
21	0.0236	2.0779
22	0.0229	2.0321
23	0.0225	1.9409
24	0.0224	1.9277
25	0.0222	1.8780
26	0.0218	1.8710
27	0.0213	1.8482
28	0.0212	1.8417
29	0.0206	1.8147
30	0.0206	1.6690
31	0.0205	1.6550
32	0.0203	1.6493
33	0.0197	1.6432
34	0.0190	1.5786
35	0.0187	1.5626
36	0.0186	1.5565
37	0.0174	1.4882
38	0.0171	1.4815
39	0.0167	1.4789
40	0.0162	1.4765
41	0.0156	1.4197
42	0.0155	1.4140
43	0.0155	1.3622
44	0.0154	1.3420
45	0.0148	1.2938
46	0.0148	1.2731
47	0.0145	1.2665
48	0.0140	1.2512
49	0.0137	1.2344
50	0.0133	1.2315
51	0.0128	1.2176
52	0.0116	1.1959
53	0.0110	1.1420
54	0.0109	1.1177
55	0.0082	1.0968
56	0.0076	1.0824
57	0.0070	0.9879
58	0.0060	0.9820
59	0.0056	0.9756
60	0.0044	0.9478
61	0.0027	0.8184

Duration Flows

Flow(cfs)	Predev	Mit	Percentage	Pass/Fail
0.0101	18219	223513	1226	Fail
0.0105	16709	220732	1321	Fail
0.0109	15353	217952	1419	Fail
0.0113	14112	215385	1526	Fail
0.0117	13013	212840	1635	Fail
0.0121	12012	210487	1752	Fail
0.0125	11152	208220	1867	Fail
0.0129	10339	205996	1992	Fail
0.0133	9591	203921	2126	Fail
0.0138	8921	201867	2262	Fail
0.0142	8277	199964	2415	Fail
0.0146	7657	198103	2587	Fail
0.0150	7071	196242	2775	Fail
0.0154	6571	194467	2959	Fail
0.0158	6119	192777	3150	Fail
0.0162	5730	191152	3335	Fail
0.0166	5345	189590	3547	Fail
0.0170	4984	188050	3773	Fail
0.0174	4646	186532	4014	Fail
0.0178	4331	185035	4272	Fail
0.0183	4057	183559	4524	Fail
0.0187	3805	182126	4786	Fail
0.0191	3561	180757	5076	Fail
0.0195	3332	179452	5385	Fail
0.0199	3110	178147	5728	Fail
0.0203	2911	176928	6077	Fail
0.0207	2701	175688	6504	Fail
0.0211	2520	174426	6921	Fail
0.0215	2331	173228	7431	Fail
0.0219	2175	172009	7908	Fail
0.0223	2043	170811	8360	Fail
0.0228	1916	169656	8854	Fail
0.0232	1771	168565	9518	Fail
0.0236	1657	167453	10105	Fail
0.0240	1545	166383	10769	Fail
0.0244	1437	165335	11505	Fail
0.0248	1345	164287	12214	Fail
0.0252	1265	163282	12907	Fail
0.0256	1188	162320	13663	Fail
0.0260	1109	161272	14542	Fail
0.0264	1034	160266	15499	Fail
0.0268	963	159282	16540	Fail
0.0273	917	158341	17267	Fail
0.0277	850	157400	18517	Fail
0.0281	780	156545	20069	Fail
0.0285	726	155604	21433	Fail
0.0289	668	154684	23156	Fail
0.0293	620	153828	24810	Fail
0.0297	573	152994	26700	Fail
0.0301	524	152096	29025	Fail
0.0305	483	151197	31303	Fail
0.0309	442	150385	34023	Fail
0.0313	405	149529	36920	Fail
0.0318	365	148695	40738	Fail

0.0322	336	147904	44019	Fail
0.0326	309	147048	47588	Fail
0.0330	291	146278	50267	Fail
0.0334	268	145508	54294	Fail
0.0338	248	144781	58379	Fail
0.0342	233	144032	61816	Fail
0.0346	209	143262	68546	Fail
0.0350	193	142578	73874	Fail
0.0354	174	141872	81535	Fail
0.0358	155	141166	91074	Fail
0.0363	141	140460	99617	Fail
0.0367	124	139754	112704	Fail
0.0371	113	139070	123070	Fail
0.0375	105	138364	131775	Fail
0.0379	93	137701	148065	Fail
0.0383	85	137059	161245	Fail
0.0387	78	136375	174839	Fail
0.0391	73	135669	185847	Fail
0.0395	66	135049	204619	Fail
0.0399	57	134450	235877	Fail
0.0403	44	133808	304109	Fail
0.0408	36	133209	370025	Fail
0.0412	32	132611	414409	Fail
0.0416	29	132033	455286	Fail
0.0420	25	131434	525736	Fail
0.0424	22	130835	594704	Fail
0.0428	19	130236	685452	Fail
0.0432	17	129659	762700	Fail
0.0436	16	129060	806625	Fail
0.0440	15	128504	856693	Fail
0.0444	13	127948	984215	Fail
0.0448	11	127370	1157909	Fail
0.0453	10	126836	1268360	Fail
0.0457	8	126301	1578762	Fail
0.0461	7	125745	1796357	Fail
0.0465	5	125231	2504620	Fail
0.0469	5	124675	2493500	Fail
0.0473	5	124119	2482380	Fail
0.0477	5	123584	2471680	Fail
0.0481	4	123071	3076775	Fail
0.0485	4	122536	3063400	Fail
0.0489	4	122044	3051100	Fail
0.0493	4	121553	3038825	Fail
0.0497	4	121018	3025450	Fail
0.0502	4	120526	3013150	Fail
0.0506	4	120013	3000325	Fail

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

Water Quality

Water Quality BMP Flow and Volume for POC #1

On-line facility volume:	0.4122 acre-feet
On-line facility target flow:	0.6258 cfs.
Adjusted for 15 min:	0.6258 cfs.
Off-line facility target flow:	0.3516 cfs.
Adjusted for 15 min:	0.3516 cfs.

LID Report

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

POC 2

POC #2 was not reported because POC must exist in both scenarios and both scenarios must have been run.

POC 3

POC #3 was not reported because POC must exist in both scenarios and both scenarios must have been run.

POC 4

POC #4 was not reported because POC must exist in both scenarios and both scenarios must have been run.

Model Default Modifications

Total of 0 changes have been made.

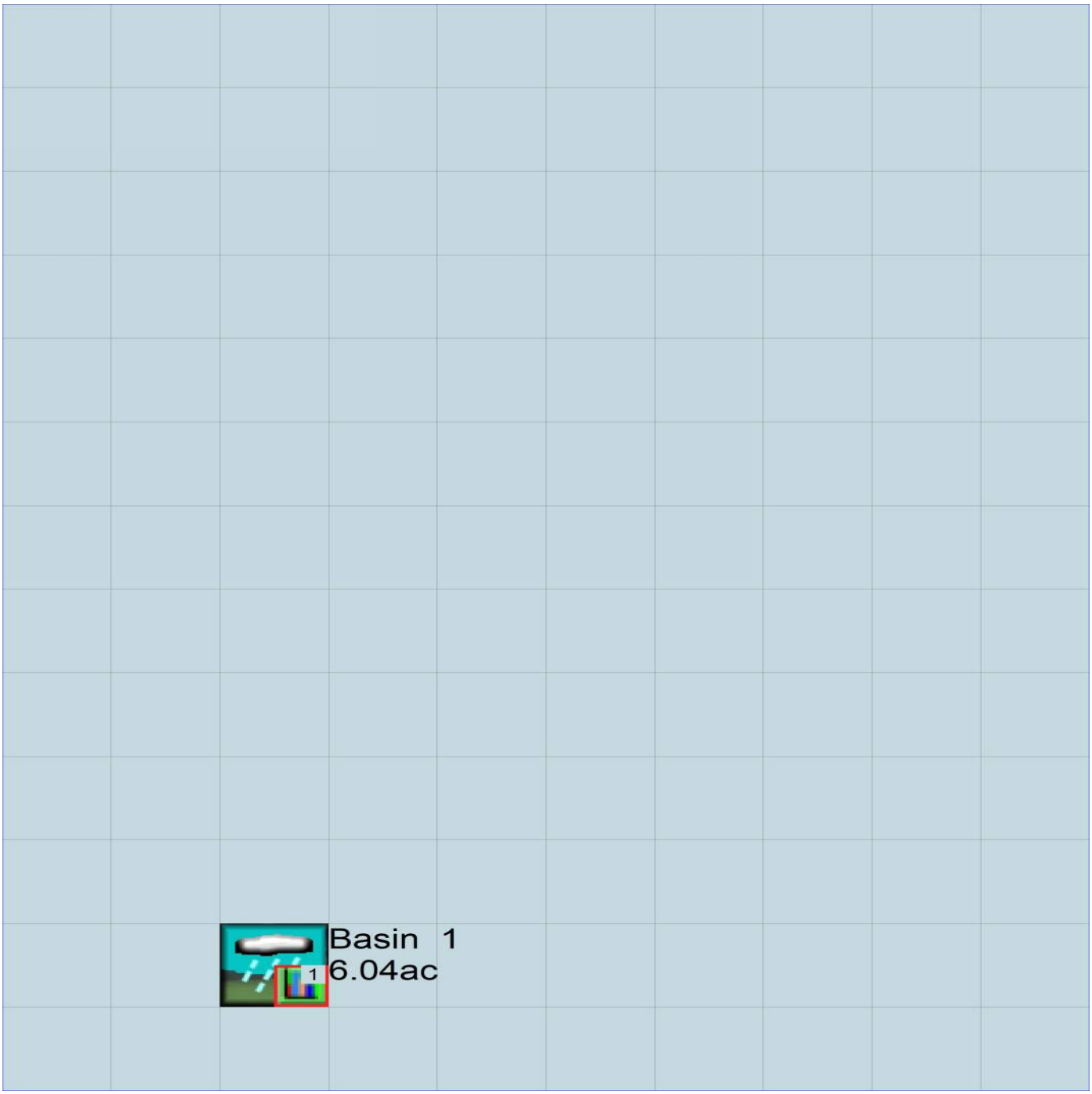
PERLND Changes

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   EastBasin.wdm
MESSU       25   PreEastBasin.MES
            27   PreEastBasin.L61
            28   PreEastBasin.L62
            30   POCEastBasin1.dat
END FILES

OPN SEQUENCE
    INGRP               INDELT 00:15
      PERLND       2
      PERLND      10
      PERLND      19
      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           ***
    2     A/B, Forest, Mod        1    1    1    1   27    0
   10     C, Forest, Flat         1    1    1    1   27    0
   19     SAT, Forest, Flat       1    1    1    1   27    0
  END GEN-INFO
  *** Section PWATER***

  ACTIVITY
    <PLS > ************ Active Sections ******************************
    # -  # ATMP SNOW PWAT  SED  PST  PWG PQAL MSTL PEST NITR PHOS TRAC ***
    2         0    0    1    0    0    0    0    0    0    0    0    0
   10         0    0    1    0    0    0    0    0    0    0    0    0
   19         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  *********
    2         0    0    4    0    0    0    0    0    0    0    0    0    1    9
   10         0    0    4    0    0    0    0    0    0    0    0    0    1    9
   19         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 ***
    2         0    0    0    0    0    0    0    0    0    0    0
   10         0    0    0    0    0    0    0    0    0    0    0
   19         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
    2              0         5         2       400       0.1       0.3     0.996
   10              0       4.5      0.08       400      0.05       0.5     0.996
   19              0         4         2       100     0.001       0.5     0.996
  END PWAT-PARM2

  PWAT-PARM3
    <PLS >      PWATER input info: Part 3         ***
    # -  # ***PETMAX    PETMIN    INFEXP    INFILD    DEEPFR    BASETP    AGWETP
    2              0         0         2         2         0         0         0
   10              0         0         2         2         0         0         0
   19              0         0        10         2         0         0       0.7
  END PWAT-PARM3
  PWAT-PARM4
    <PLS >     PWATER input info: Part 4                              ***
    # -  #     CEPSC      UZSN      NSUR     INTFW       IRC     LZETP ***
    2          0.2       0.5      0.35         0       0.7       0.7
   10          0.2       0.5      0.35         6       0.5       0.7
   19          0.2         3       0.5         1       0.7       0.8
  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
    2             0         0         0         0         3          1         0
   10             0         0         0         0       2.5          1         0
   19             0         0         0         0       4.2          1         0
  END PWAT-STATE1

END PERLND

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

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

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

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

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

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

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

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

END IMPLND

SCHEMATIC
<-Source->                 <--Area-->     <-Target->   MBLK    ***
<Name>   #                 <-factor->     <Name>   #   Tbl#    ***
Basin  1***
PERLND   2                      5.05      COPY   501     12
PERLND   2                      5.05      COPY   501     13
PERLND  10                      0.96      COPY   501     12
PERLND  10                      0.96      COPY   501     13
PERLND  19                      0.03      COPY   501     12
PERLND  19                      0.03      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    0.857          PERLND   1 999 EXTNL  PREC
WDM      2 PREC     ENGL    0.857          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   EastBasin.wdm
MESSU       25   MitEastBasin.MES
            27   MitEastBasin.L61
            28   MitEastBasin.L62
            30   POCEastBasin1.dat
END FILES

OPN SEQUENCE
    INGRP               INDELT 00:15
      PERLND      10
      PERLND      16
      PERLND       2
      PERLND       8
      PERLND      19
      IMPLND       2
      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           ***
   10     C, Forest, Flat         1    1    1    1   27    0
   16     C, Lawn, Flat           1    1    1    1   27    0
    2     A/B, Forest, Mod        1    1    1    1   27    0
    8     A/B, Lawn, Mod          1    1    1    1   27    0
   19     SAT, Forest, Flat       1    1    1    1   27    0
  END GEN-INFO
  *** Section PWATER***

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

```
 10         0    0    1    0    0    0    0    0    0    0    0    0
 16         0    0    1    0    0    0    0    0    0    0    0    0
  2         0    0    1    0    0    0    0    0    0    0    0    0
  8         0    0    1    0    0    0    0    0    0    0    0    0
 19         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  *********
 10         0    0    4    0    0    0    0    0    0    0    0    0    1    9
 16         0    0    4    0    0    0    0    0    0    0    0    0    1    9
  2         0    0    4    0    0    0    0    0    0    0    0    0    1    9
  8         0    0    4    0    0    0    0    0    0    0    0    0    1    9
 19         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 ***
 10         0    0    0    0    0    0    0    0    0    0    0
 16         0    0    0    0    0    0    0    0    0    0    0
  2         0    0    0    0    0    0    0    0    0    0    0
  8         0    0    0    0    0    0    0    0    0    0    0
 19         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
 10              0       4.5      0.08       400      0.05        0.5      0.996
 16              0       4.5      0.03       400      0.05        0.5      0.996
  2              0         5         2       400       0.1        0.3      0.996
  8              0         5       0.8       400       0.1        0.3      0.996
 19              0         4         2       100     0.001        0.5      0.996
END PWAT-PARM2

PWAT-PARM3
  <PLS >      PWATER input info: Part 3          ***
  # -  # ***PETMAX    PETMIN    INFEXP    INFILD    DEEPFR    BASETP    AGWETP
 10              0         0         2         2         0         0         0
 16              0         0         2         2         0         0         0
  2              0         0         2         2         0         0         0
  8              0         0         2         2         0         0         0
 19              0         0        10         2         0         0       0.7
END PWAT-PARM3
PWAT-PARM4
  <PLS >     PWATER input info: Part 4                                  ***
  # -  #     CEPSC      UZSN      NSUR     INTFW       IRC     LZETP ***
 10            0.2       0.5      0.35         6       0.5       0.7
 16            0.1      0.25      0.25         6       0.5      0.25
  2            0.2       0.5      0.35         0       0.7       0.7
  8            0.1       0.5      0.25         0       0.7      0.25
 19            0.2         3       0.5         1       0.7       0.8
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
 10              0         0         0         0       2.5          1         0
 16              0         0         0         0       2.5          1         0
  2              0         0         0         0         3          1         0
  8              0         0         0         0         3          1         0
 19              0         0         0         0       4.2          1         0
END PWAT-STATE1

END PERLND

IMPLND
```

```
  GEN-INFO
    <PLS ><-------Name------->   Unit-systems   Printer ***
    # -  #                     User  t-series Engl Metr ***
                                    in  out           ***
    2      ROADS/MOD              1    1    1   27    0
  END GEN-INFO
  *** Section IWATER***

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

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

  IWAT-PARM1
    <PLS >  IWATER variable monthly parameter value flags  ***
    # -  # CSNO RTOP  VRS  VNN RTLI     ***
    2         0    0    0    0    0
  END IWAT-PARM1

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

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

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

END IMPLND

SCHEMATIC
<-Source->                 <--Area-->     <-Target->   MBLK   ***
<Name>   #                 <-factor->     <Name>   #   Tbl#   ***
Basin  1***
PERLND  10                      0.03     COPY   501     12
PERLND  10                      0.03     COPY   501     13
PERLND  16                       0.3     COPY   501     12
PERLND  16                       0.3     COPY   501     13
PERLND   2                      0.35     COPY   501     12
PERLND   2                      0.35     COPY   501     13
PERLND   8                      1.41     COPY   501     12
PERLND   8                      1.41     COPY   501     13
PERLND  19                      0.01     COPY   501     12
PERLND  19                      0.01     COPY   501     13
IMPLND   2                      3.93     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    0.857          PERLND   1 999 EXTNL  PREC
WDM      2 PREC     ENGL    0.857          IMPLND   1 999 EXTNL  PREC
WDM      1 EVAP     ENGL    0.76           PERLND   1 999 EXTNL  PETINP
WDM      1 EVAP     ENGL    0.76           IMPLND   1 999 EXTNL  PETINP

END EXT SOURCES

EXT TARGETS
<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Volume-> <Member> Tsys Tgap Amd ***
<Name>   #        <Name> # #<-factor->strg <Name>   # <Name>    tem strg strg***
COPY     1 OUTPUT MEAN   1 1     48.4      WDM    701 FLOW     ENGL      REPL
COPY   501 OUTPUT MEAN   1 1     48.4      WDM    801 FLOW     ENGL      REPL
END EXT TARGETS

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

```
  END MASS-LINK   12

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

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


END MASS-LINK

END RUN
```

Disclaimer

Legal Notice

Clear Creek Solutions, Inc.
6200 Capitol Blvd. Ste F
Olympia, WA. 98501
Toll Free 1(866)943-0304
Local (360)943-0304

www.clearcreeksolutions.com

General Information

Project Title

Ferndale Terrace Stormwater Improvements Construction

Project Short Description

This project will improve water quality in Schell Creek by installing stormwater filters in Ferndale Terrace in the City of Ferndale to provide treatment for total suspended solids (TSS) and dissolved metals. Flows to Schell Creek will also be reduced by providing limited stormwater infiltration.

Project Long Description

This project will improve water quality in Schell Creek by providing stormwater treatment for approximately 1.72 acres of previously untreated pollution generating surfaces from Ferndale Terrace between Hendrickson Avenue and Vista Drive in the City of Ferndale. Treatment for total suspended solids (TSS), dissolved zinc, and dissolved copper is provided by routing stormwater through stormwater filters. Flows to Schell Creek will also be reduced through limited stormwater infiltration. Stormwater from the Ferndale Terrace project area discharges to Schell Ditch and Schell Creek, which flow to the Lummi (Red) River and Lummi Bay on the Salish Sea. Listed fish species in Schell Creek include Winter Steelhead, Coho Salmon, Fall Chum Salmon, Cutthroat Trout, and Bull Trout. Lummi Bay is also the location of the Lummi Nation Hatchery facility.

Ferndale Terrace is a road in the Seamount neighborhood of Ferndale, which was constructed in the 1950s to house the growing number of refinery workers in Ferndale. There are few stormwater inlets, and the limited stormwater system was constructed for the purpose of conveying stormwater from roads to Schell Creek, with no treatment or flow control facilities required or constructed. Ferndale Terrace was chosen for this stormwater retrofit because it is classified as an urban major collector serving Seamount and adjacent neighborhoods, with a higher level of benefit associated with treating roads with higher traffic counts. Schell Creek has recently been selected as the high priority basin for the City of Ferndale Stormwater Management Action Plan.

Ferndale Terrace lacks curb and gutter, making construction of stormwater collection and conveyance necessary to route flows to treatment and infiltration for this stormwater retrofit project. The lack of sidewalk, condition of the pavement and subgrade, and age of the underlying utilities, also makes construction of the stormwater improvements an ideal time to address replacement of the water and sanitary sewer lines under the road, and the addition of sidewalks for pedestrian safety. This grant application seeks funding for treating stormwater from existing surfaces, with grant eligible costs determined in the estimates for the application.

General Information

This application includes a revised design report and 90 percent design package. After close-out of the design grant (WQSWPC-2016-Fernda-00040), additional groundwater monitoring and assessment has resulted in revisions to the design report and 90 percent design, reducing the depth of infiltration trenches to meet separation to groundwater requirements. This also made treatment through native soils infeasible, so revised design has routed stormwater to filters for treatment, with no decrease in retrofit treatment area. The fundamentals of the design report concept and methods remain the same, including the BMP design criteria, water quality benefit calculation methodology, and eligible cost ratio calculation

Total Cost $6,631,534.13

Total Eligible Cost $1,505,253.84

Effective Date 7/1/2023

Expiration Date 7/1/2026

Project Category

Nonpoint Source Activity
Onsite Sewage System
Stormwater Activity
✔ Stormwater Facility
Wastewater Facility

Will Environmental Monitoring Data be collected? No

Ecology Program Water Quality

Overall Goal This project will protect and restore water quality in Schell Creek in the City of Ferndale by reducing stormwater impacts from existing development.

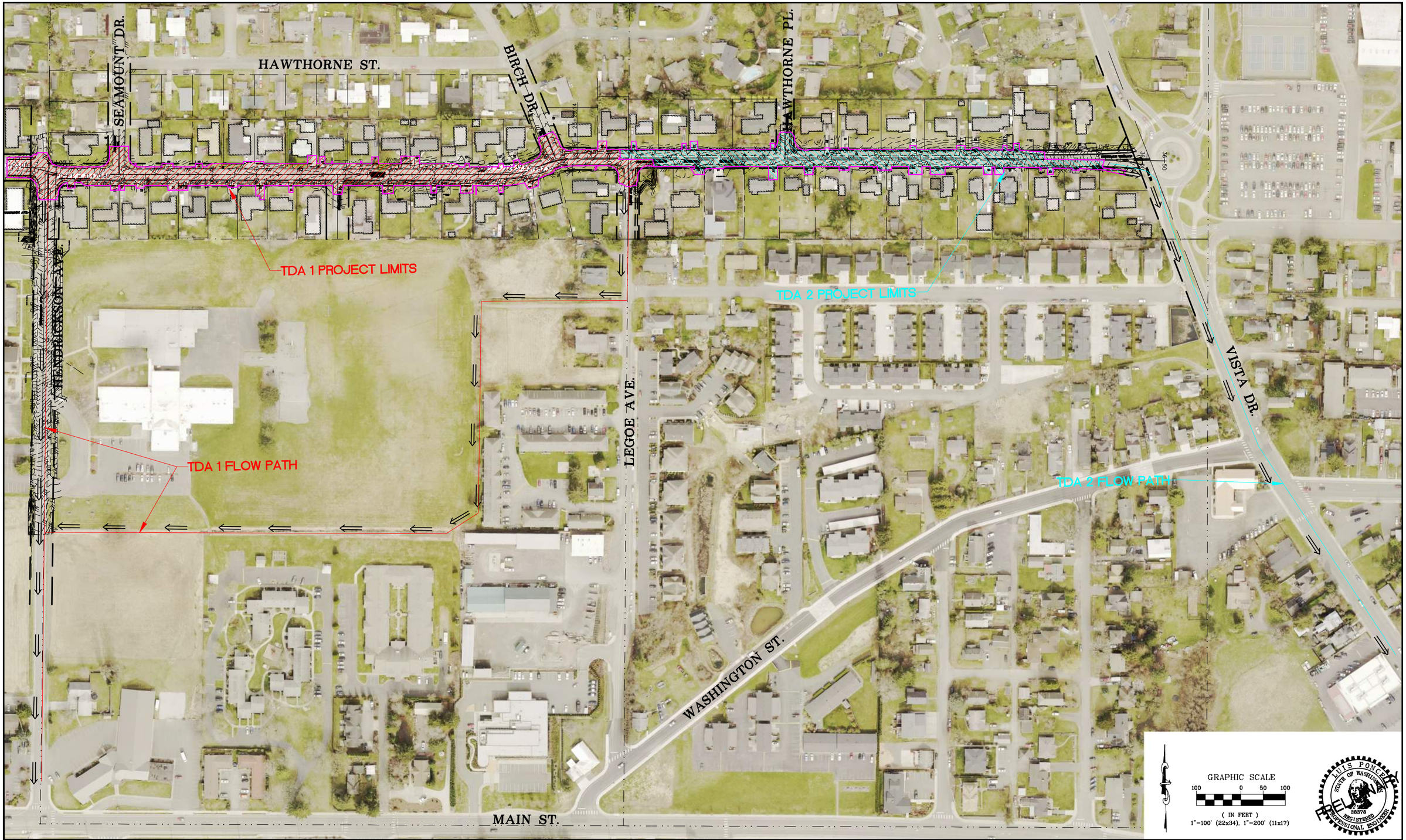


FIGURE 4

DESIGNED BY	JAM/GTS
DRAWN BY	JAM/GTS
CHECKED BY	GTS/LP

R&E Reichhardt & Ebe ENGINEERING INC
P.O. Box 978 | 423 Front Street
Lynden, WA 98264 (360) 354-3687

NO.	DATE	DESCRIPTION	BY

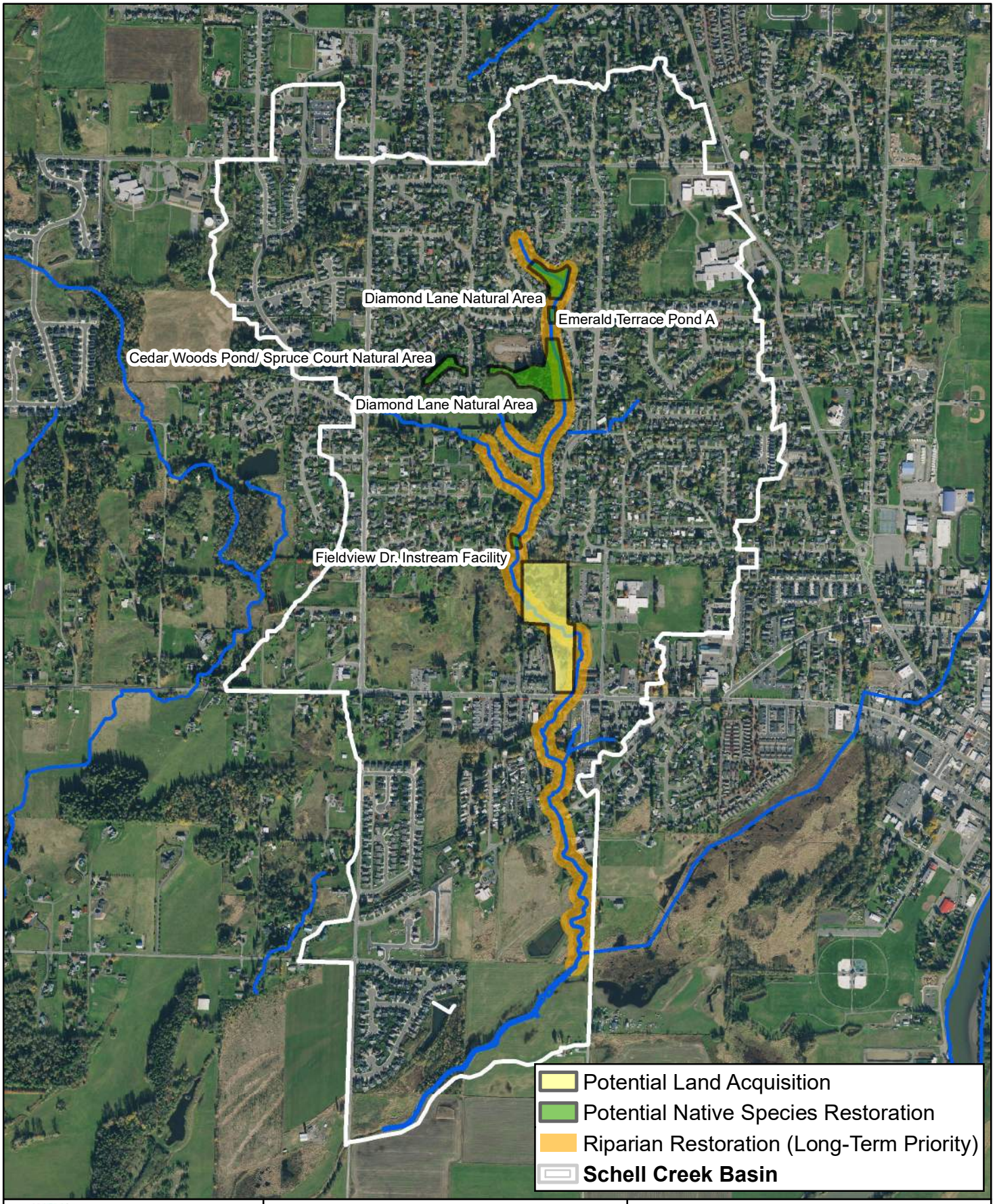
CITY OF FERNDALE
2095 MAIN ST
FERNDALE, WA 98248

FERNDALE TERRACE PROJECT
VISTA DRIVE TO HENDRICKSON AVENUE
TDA FLOW PATHS

DWG 18023 SSP EXHIBITS		DATE 10/7/22
JOB# 18023	SCALE H: 1" = 100' V: N/A	SHEET 1 of 16

APPENDIX B

LAND MANAGEMENT STRATEGIES AND STORMWATER MANAGEMENT ACTIONS



City of Ferndale

SCALE - 1:15,417

0 650 1,300 2,600 Feet

N

nhc northwest hydraulic consultants

Coordinate System: NAD 1983 STATEPLANE WASHINGTON NORTH FIPS 4601 FEET

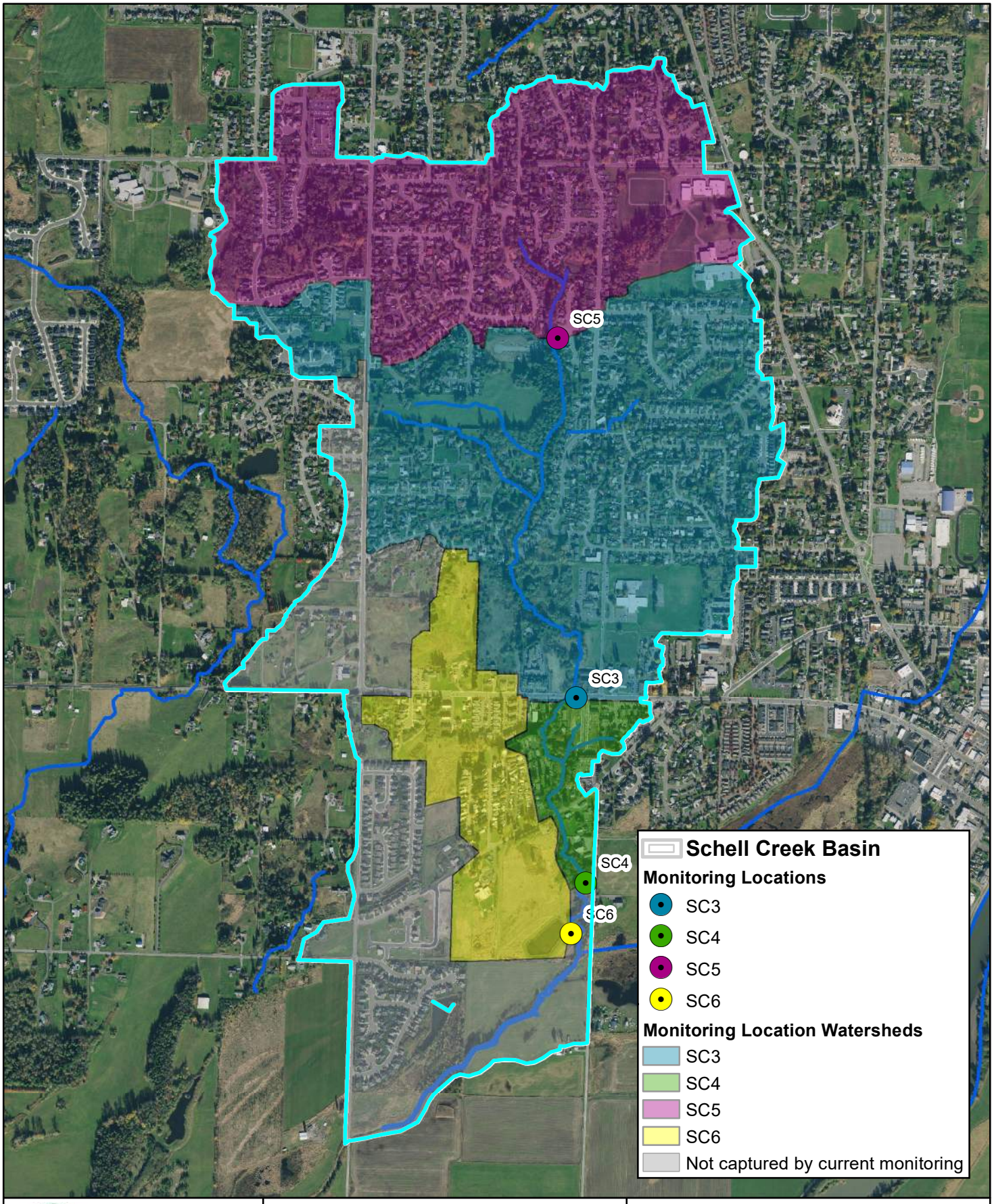
Job: 2006286 | Date: 09-MAR-2023

FERNDALE SMAP

Land Management Strategies Sites of Opportunity

FIGURE B-1

Q:\2006286_Ferndale_SCP_and_SMAP\95_GIS\MXDs\Figures\2006286_Ferndale_SMAP_LandManagementStrategies.mxd



City of Ferndale

SCALE - 1:15,414

0 650 1,300 2,600 Feet

N

nhc northwest hydraulic consultants

Coordinate System: NAD 1983 STATEPLANE WASHINGTON NORTH FIPS 4601 FEET

Job: 2006286 | Date: 08-MAR-2023

FERNDALE SMAP

Water Quality Monitoring Sites and Drainage Basins

FIGURE B-2

Q:\2006286_Ferndale_SCP_and_SMAP\95_GIS\MXDs\Figures\2006286_Ferndale_SMAP_WQMonitoring.mxd