

SAN JUAN COUNTY STORMWATER BASIN PLANNING

VOLUME 2: PRIORITY WATERSHED PLANNING, SAN JUAN COUNTY, WASHINGTON

Prepared for
San Juan County Public Works

Prepared by
Herrera Environmental Consultants, Inc.

AESI

ESA

Hart Pacific Engineering

Stillwater Sciences



associated
earth sciences
incorporated

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EXECUTIVE SUMMARY

This report summarizes results from an evaluation performed to identify programmatic stormwater management recommendations and capital improvement project alternatives for five priority watersheds in San Juan County (County), which include East Sound, False Bay, Fisherman Bay, Mud Bay, and Westcott/Garrison Bay. The five priority watersheds were prioritized for this evaluation by the County and the San Juan County Citizen Stormwater Advisory Committee (CSWAC) based on current development patterns, expected development trends, and presence of natural resources.

In addition to these watersheds, this evaluation also encompasses two Urban Growth Areas (UGAs) in the County. One of these UGAs is the village of Eastsound in the East Sound watershed and the North Shore watershed (Figure 1). The other UGA is Lopez Village in the Fisherman Bay watershed. This report incorporates and updates recommendations and capital improvement projects from long-range drainage plans developed previously for these UGAs (Rasmussen et al. 2005; SJC DPW and Hart Pacific Inc. 2004). This report represents Volume 2 of the County's stormwater management plan.

Volume 1 of the County's stormwater management plan (Herrera et al. 2014) was completed in June 2014 and provided a countywide inventory and high-level evaluation of watershed conditions that covers existing and future land use, existing stormwater infrastructure, documented presence of Washington Department of Fish and Wildlife Priority Habitats and Species (PHS), and detailed information on water quality where data are available. Based on this information, the Volume 1 report identified a suite of countywide recommendations for effective and protective stormwater management.

This Volume 2 report is organized to include the following information for each of the priority watersheds:

- A detailed description of existing conditions including land uses, water quality, and PHS
- Reported stormwater problems (if applicable) and capital improvement projects that have been prioritized to address these problems
- Summary of results from hydrologic modeling that was performed to evaluate the capacity of the existing and future proposed stormwater conveyance system (Eastsound Village UGA only)

Separate programmatic stormwater management recommendations are presented for implementation within the individual UGAs and countywide, respectively. Finally, recommendations to guide the County's implementation of stormwater management strategies described in this report are presented.

The evaluation performed for the Volume 2 report involved the following steps to identify and prioritize stormwater capital improvement projects in the priority watersheds and UGAs:

1. Identify discrete stormwater problems based on citizen reports, a review of the existing long-range drainage plans for Eastsound and Lopez Villages, and interviews with County Public Works staff.
2. Consolidate multiple citizen complaints into a single problem where the same issue was described and cross-referenced against County Public Works staff knowledge and against the existing long-range drainage plans.
3. Develop conceptual solutions to address new problems and improvements, and update projects already identified in the existing long-range drainage plans.
4. Rank stormwater problems and their solutions using the following seven criteria:
 - The problem poses a risk to human health and safety.
 - The solution was proposed in a previous UGA drainage plan and was not yet addressed.
 - The solution provides a water quality treatment retrofit.
 - The solution provides conveyance capacity for future development.
 - The solution protects PHS.
 - The problem poses an obstacle for completing other needed stormwater management projects.
 - The solution has favorable funding potential (e.g., low cost or high grant potential).
5. Prepare capital improvement projects concept-level designs and cost estimates for top ranked solutions.
6. Present top ranked capital improvement projects concept-level designs at four public workshops to garner feedback for further prioritization.
7. Present top ranked capital improvement projects concept-level designs to the San Juan County Citizen Stormwater Advisory Committee (CSWAC) and County Public Works staff for review and identification of the top five solutions for development of predesign reports.
8. Conduct hydrologic and hydraulic modeling to further evaluate problem areas and refine proposed solutions.
9. Prepare predesign reports for the top five solutions that are specifically tailored to address application requirements for grants to fund full design and/or construction.

Based on the results of this evaluation, 24 capital improvement projects were identified for the Eastsound Village UGA and East Sound watershed. Predesign reports were prepared for two of these projects. In general, the majority of these projects are conveyance capacity improvements coupled with water quality treatment where possible. Much of the existing conveyance network in the Eastsound Village UGA and East Sound watershed is a patchwork of private and publically installed pipes and ditches. Many problems have occurred due to the lack of a systematically designed drainage system, resulting in inadequate conveyance capacity. These projects aim to rectify these problems by allowing San Juan County Public Works to retrofit conveyance problems where a drainage easement exists or can be acquired. Estimated costs to complete these projects range from \$38,000 to \$4,500,000.

Two capital improvement projects were identified for the False Bay watershed; a predesign report was prepared for one of these projects. These projects are intended to address flooding issues within the watershed and have estimated costs ranging from \$35,000 to \$237,000.

Finally, four capital improvement projects were identified for the Fisherman Bay watershed; predesign reports were prepared for two of these projects. These projects provide additional conveyance capacity to address existing problems and accommodate future growth, as well as water quality treatment. Estimated costs to complete these projects range from \$57,000 to \$940,000.

In addition to these capital improvement projects, the following programmatic stormwater management strategies are recommended for implementation within the individual UGAs:

Incentivize Rain Gardens and Stormwater Planters: Development and growth in the County has altered the watershed hydrology in several ways including increasing stormwater flows and volumes. Sediment, nutrients, trace metals, petroleum hydrocarbons, bacteria, and organic chemicals are common pollutants found in stormwater runoff and these are expected to be found in higher concentrations in the County as this growth continues. Rain gardens and stormwater planters can provide water quality treatment, detention, and onsite management of stormwater flows; however, private developers and landowners are not likely to opt for these facilities when they are not required to under current County code. Several Puget Sound jurisdictions have implemented incentive programs to encourage commercial and residential property owners to manage stormwater on site using rain gardens and stormwater planters. In general, the incentive programs have provided construction cost assistance and technical assistance. San Juan County should consider offering similar incentives to promote rain garden and stormwater planter retrofit projects on private properties. Based on successful programs being implemented by other Puget Sound jurisdictions, the County could begin by offering as little as \$200 for plants and/or compost for a limited number of applicants. Administering the program for a limited number of applicants is estimated to take about 40 hours annually.

Incentivize Rainwater Harvesting: Potable rainwater harvesting systems provide several benefits including reduction of stormwater runoff volumes and flows, restoration of natural hydrology, and reduced demand on groundwater for water supply. However, there are several barriers to adoption of rainwater harvesting in cisterns for potable water use on a household

level. A major obstacle is ensuring compliance with federal and local standards for drinking water, which can be complex and difficult for homeowners to navigate. Rainwater harvesting systems can also have a high capital cost which may discourage adoption despite long-term cost savings. Potable rainwater harvesting incentive programs can address these barriers. Because the County has generally lower rainfall all year round than most of Western Washington, an incentive program here could provide significant benefits for protection of groundwater supply. Based on other models from around the country, the County could begin by offering 50 percent of the cost up to \$500 for a minimum of 2,500 gallons. This could be offered for a limited number of applicants each year or every other year. Administering the program for a limited number of applicants is estimated to take about 40 hours annually.

The following programmatic stormwater management strategies are recommended for implementation countywide:

Retrofit Ditches: Roadside ditches are the primary stormwater conveyance in San Juan County. In general, roadside ditches have the potential to provide flow attenuation and water quality treatment of stormwater runoff; however, many existing ditches in the County are not designed to provide these additional benefits. Furthermore, steep and narrow ditches can actually increase stormwater flow velocity causing scour. Erosion and sedimentation can clog ditches, deposit soil on roadways, cause localized flooding, and adversely affect downstream water bodies. Implementing a ditch retrofit program will enable the County to reconfigure, construct, and maintain appropriate and effective drainage ditches. The estimated annual cost for implementing this program is approximately \$110,500, assuming retrofit of 2,000 linear feet of ditch each year.

Maximize Use of Existing Ecological Systems through Watershed Planning: In some areas of the County, development and growth has increased runoff volumes leading to downstream flooding problems or more frequent standing water. As additional land is developed, we can reasonably expect property owners along these drainages to be further impacted by flooding and loss of developable property. In contrast, other nearby wetlands and drainages may have capacity and could benefit from more stormwater flow. The County could use watershed scale planning to define the watershed landscape's natural capacity and limitations in order to develop more watershed specific stormwater requirements for development or capital projects that manage excess stormwater in ways that maintain and maximize use of existing resources. This would require the development of hydrologic models to facilitate an understanding of each watershed studied. Such watershed-specific studies would guide the selection of solutions within watersheds and identify projects that should be constructed, and property or drainage easements that should be acquired for flow and treatment benefits. Using the Eastsound Village UGA as an example, the estimated cost to complete a study of how to maximize use of existing ecological systems for stormwater management through watershed planning including project construction is \$938,000.

Retrofit Problem Ponds: In San Juan County, there are hundreds of private ponds that collectively receive a large portion of runoff from agricultural lands, developed areas, and roadways. Ponds have many beneficial uses but they also allow for high rates of evaporation during the dry season, which can reduce available groundwater. Ponds generally have far lower plant diversity than natural wetlands, which substantially reduces their water quality

treatment effectiveness. Moreover, many ponds in our County have significantly affected both the timing and volume of instream flows in County streams. This is because some ponds are designed such that they operate like bathtubs within a stream system, requiring they be filled before water passes downstream. These issues could be improved through a County program that identifies problem ponds affecting fish species, and permits strategic purchases of land or drainage easements that would allow the County to retrofit these ponds in manner that would improve degraded instream flows, thus benefiting aquatic habitats and species. For example, these retrofits could allow some water to pass through an instream pond to allow more downstream flow during the drier summer months, and especially during early fall. The estimated cost for implementing a public outreach campaign for the program ranges from \$4,500 to \$9,500 annually. The estimated annual cost for retrofitting two ponds annually is approximately \$49,500.

Support Neighborhood-Based Stormwater Management Solutions: There are a number of neighborhoods within the County with a high percentage of private roads that were constructed without an integrated stormwater management plan and with infrastructure that is inadequate to meet County standards. This is particularly problematic when County roads meet private developments with inadequate infrastructure. This can result in flooding of down gradient property owners. In addition, water quality treatment is rarely provided in private residential developments, roads tend to be gravel, and consequently sediment pollution can be high. Measures that encourage stormwater projects sponsored by neighborhood groups and the community could provide innovative implementation of stormwater management solutions for private developments. The County would offer technical assistance and potentially some funding to assist neighborhoods in solving local stormwater management problems in ways that are cost effective and meet local needs. Costs for this program will vary dependent on the scope of the problem, the number and financial commitment of partners, and the resources the County is able to commit. Using an example from the Rosario Neighborhood, design and construction costs for the County to implement conveyance improvements and roadway repairs on private property are estimated to be \$200,000 assuming a cost share with the property owners. The total cost of the project is estimated to be \$440,000.

Coordinate Stormwater Planning with Transportation Planning: County transportation projects such as road improvements or new roadways are an opportunity to improve stormwater treatment and flow control in existing and typically inadequate stormwater management systems. To ensure consideration of stormwater issues occurs as a routine part of project design, implementation, and maintenance programs, the following activities are suggested:

- Schedule project kick-off meetings with Stormwater Utility staff to allow opportunities to collaborate on stormwater issues and resources pertinent to the project.
- Use a project checklist to indicate that Engineering, Roads, and Facilities Maintenance are coordinating with the Stormwater Utility.

This program can be implemented as part of ongoing Public Works operations and is not expected to add to existing program costs.

INTRODUCTION

San Juan County Public Works (County) is committed to effective stormwater management that cost effectively addresses flooding and water quality problems that may adversely affect property and the natural environment. The County seeks to address these potential issues proactively at two primary levels:

- Completion of an inventory and high-level evaluation of County watershed conditions that provides a resource for identifying problem areas and recommends countywide stormwater management strategies (Phase 1)
- A second-level evaluation that provides a more detailed review of conditions in five priority watersheds and identifies programmatic stormwater management recommendations and capital improvement project alternatives to address specific stormwater issues in these areas (Phase 2)

The Phase 1 high-level evaluation was completed in June 2014 and the results were summarized in a report titled *San Juan County Stormwater Basin Planning: Volume 1 County Overview* (Herrera et al. 2014). This report describes regulatory drivers in the County for stormwater management and provides a discussion of how other plans and initiatives affecting San Juan County relate to stormwater management. The report then describes general characteristics of the County such as climate, geology, soil types, groundwater, and aquifers; and provides an infiltration assessment based on factors such as surficial geology and soil characteristics. This high-level summary is followed by a detailed inventory of watershed characteristics for 37 watersheds identified for this study (Figure 1). The inventory includes land use, existing stormwater infrastructure, documented presence of Priority Habitats and Species (PHS), and detailed information on water quality where data is available.¹ Finally, a suite of countywide recommendations for effective and protective stormwater management is provided.

This report summarizes the Phase 2 second-level evaluation that was conducted for the five priority watersheds, which include East Sound, False Bay, Fisherman Bay, Mud Bay, and Westcott/Garrison Bay. These watersheds were prioritized for this evaluation by the County and the San Juan County Citizen Stormwater Advisory Committee (CSWAC) based on current development patterns, expected development trends, and presence of natural resources. In addition to these watersheds, this evaluation also encompasses two Urban Growth Areas (UGAs) in San Juan County. One of these UGAs is the village of Eastsound located in the East Sound watershed and the North Shore watershed (Figure 1). The other UGA is Lopez Village located in the Fisherman Bay watershed. Much of the predicted growth is expected to be

¹ Priority Habitats and Species (PHS) are habitats and species considered priorities for conservation and management by Washington Department of Fish and Wildlife. Priority species require protective measures for their survival due to their population status, sensitivity to habitat alteration, and/or recreational, commercial, or tribal importance.

concentrated in the UGAs; therefore, they are an added focus of this stormwater planning study. This report incorporates and updates recommendations and capital improvement projects from the following long-range drainage plans that were developed previously for these UGAs:

- Long Range Drainage Plan Proposal for Eastsound Village Urban Growth Area (Rasmussen et al. 2005)
- Long Range Drainage Plan Proposal for Lopez Village Urban Growth Areas (SJC DPW and Hart Pacific Inc. 2004)

The specific goal of this Phase 2 level evaluation is to identify tailored stormwater management strategies for each of the priority watersheds and UGAs to address existing problems and prevent future problems that could occur with increased development. This summary report begins with a description of the methods that were used for this evaluation. It is then organized to include separate sections for each of the priority watersheds that provide the following information:

- A detailed description of existing conditions including land uses, water quality, and PHS present
- Reported stormwater problems (if applicable) and capital improvement projects that have been prioritized to address these problems
- Summary of results from hydrologic modeling that was performed to evaluate the capacity of the existing and future proposed stormwater conveyance system (Eastsound Village UGA only)

Separate programmatic stormwater management recommendations are then presented for implementation within the individual UGAs and countywide, respectively. Finally, recommendations to guide the County's implementation of stormwater management strategies described in this report are presented.

Methods








This section summarizes the methods used in connection with this Phase 2 level evaluation of the priority watersheds including:

- Process for identifying problems and prioritizing capital improvement project alternatives to address them
- Approach for develop capital improvement project conceptual designs and cost estimates
- Methods used to develop a hydrologic model for the Eastsound Village UGA

Problem Identification and Prioritization Process

Stormwater problems in San Juan County were compiled, consolidated, and analyzed. Preliminary projects were then developed to address identified stormwater problems.



 UGA Boundaries
 Watersheds (SJC)
Priority Watersheds
 East Sound
 False Bay
 Fisherman Bay
 Garrison Bay and Westcott Bay
 Mud Bay



This map is derived from San Juan County's Geographic Information System (GIS). It is intended for reference only and is not guaranteed to survey accuracy. The information represented on this map is subject to change without

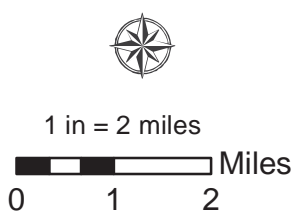


Figure 1:
Study Area for San Juan County
Stormwater Basin Planning Project

Problems and potential solutions were evaluated and prioritized through a consensus between the County and the CSWAC following outreach efforts to the public. Figure 2 depicts the specific steps that were implemented in this process.

The following sources were reviewed to evaluate discrete stormwater problems in San Juan County:

- Citizen reported stormwater problems via the San Juan County Stormwater Issue Reporting Website
- Long Range Drainage Plan Proposals for Eastsound Village Urban Growth Area (Rasmussen et al. 2005)
- Long Range Drainage Plan Proposals for Lopez Village Urban Growth Areas (SJC DPW and Hart Pacific Inc. 2004)
- County Public Works institutional knowledge of stormwater problems

San Juan County prepared a website for citizens to report stormwater problems found at <http://sjcgis.maps.arcgis.com/home/item.html?id=cd645b044c5445e3a3799ce94e1d0524>. Fifty-three stormwater complaints were submitted within the five priority watersheds in categories including erosion, flooding, private property damage, water quality, and environmental damage (see Appendix A). Figure 3 shows the locations of all reported stormwater problems.

Multiple complaints were consolidated into a single problem where the same issue was described. Drainage complaints and problems were cross-referenced against County staff knowledge and against the long-range drainage plans for Eastsound and Lopez Villages.

After consolidating projects, capital improvement concepts were developed to address new problems and improvements, and updates were made to projects already identified in the long-range drainage plans for Eastsound and Lopez Villages. Stormwater problems and their conceptual solutions were ranked using the following seven criteria:

- The problem poses a risk to human health and safety
- The solution was proposed in a previous UGA drainage plan
- The solution provides a water quality treatment retrofit
- The solution provides conveyance capacity for future development
- The solution protects PHS
- The problem poses an obstacle for completing other projects
- The solution has favorable funding potential (e.g., low cost or high grant potential)

The top ranked capital improvement concepts were then presented to the public to garner feedback for further prioritization. Members of the public provided their review of projects at

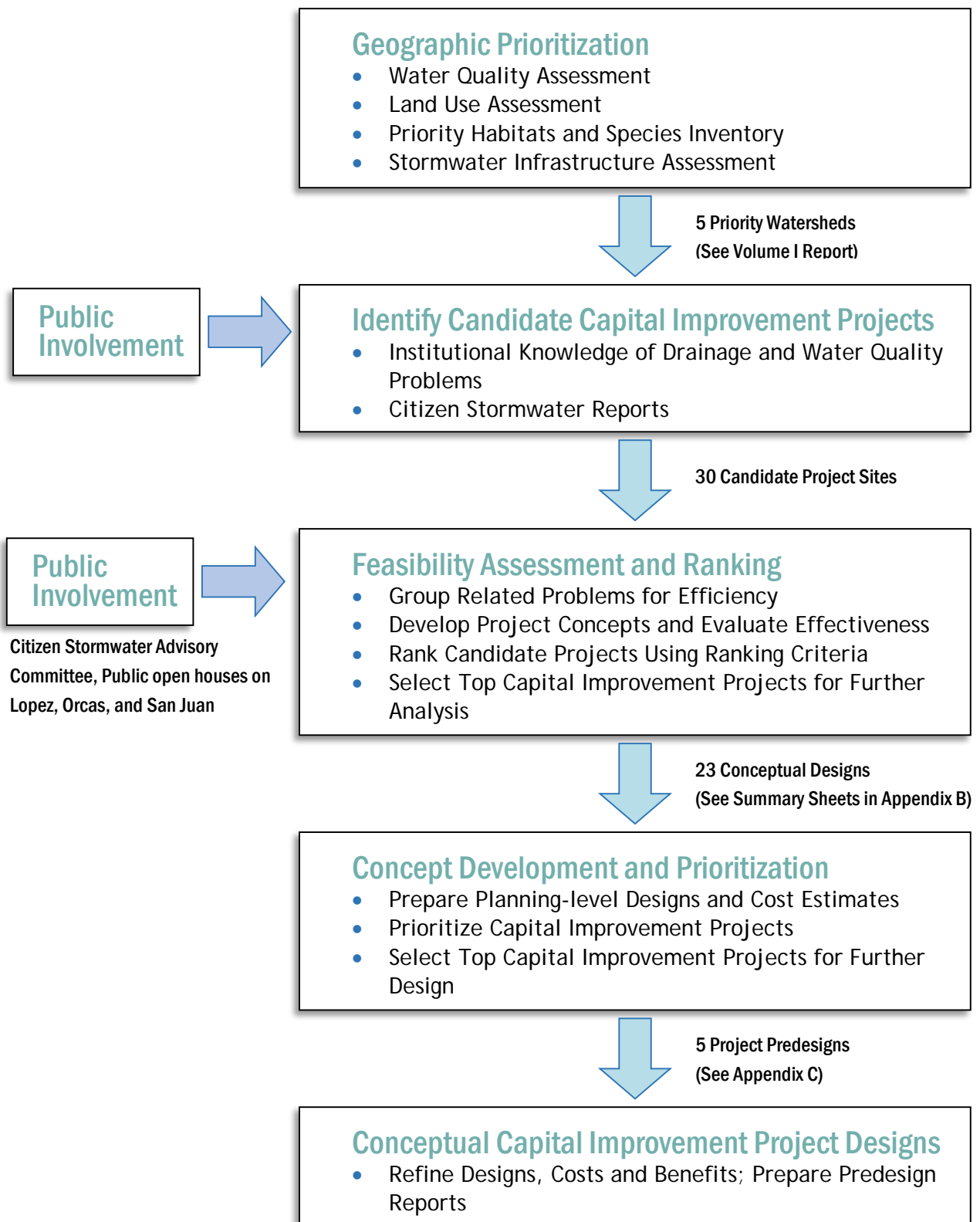





Figure 2. Process for Identifying and Prioritizing Stormwater Capital Improvement Projects.



Reported Issues

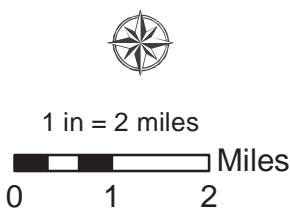
Type of Issue

- Erosion
- Flooding
- Ponding
- Property Damage
- Other

 Watershed Boundaries
 UGA Boundaries
 Possible Wetland



This map is derived from San Juan County's Geographic Information System (GIS). It is intended for reference only and is not guaranteed to survey accuracy. The information represented on this map is subject to change without notice



**Figure 3:
San Juan County Stormwater Issues
Reported by Citizens**

four public workshops; two held on Orcas, and one each on Lopez and San Juan Islands. The CSWAC and County Public Works staff reviewed and provided a final ranking of the top five capital improvement concepts. More detailed preliminary design (predesign) reports were subsequently developed for these five projects as described below.

Conceptual Design and Cost Estimating

Conceptual designs and cost estimates for capital improvement projects were developed, using the methods presented in the following subsections for the prioritized stormwater problems.

Conceptual Designs

Sites associated with stormwater problems that were identified using the process described above were visited in the field to determine the potential cause(s) of the problem. Engineering judgment was then used to identify appropriate capital improvement projects to address each stormwater problem factoring in constraints and opportunities at the site. For some capital improvement projects, multiple alternatives were considered. In general, the following broad types of capital improvement projects were identified through this process:

- Conveyance projects to address flooding and erosion problems in the public stormwater system including installation of new or replacement storm drain pipes in Eastsound Village and new shoreline outfall pipes
- Conveyance projects to address flooding and erosion on private property
- Water quality treatment facilities to address existing problems or to prevent future problems stemming from anticipated development

Conceptual designs for each capital improvement project were subsequently developed and are provided in the project summary sheets in Appendix B. The conceptual designs include a plan view sketch of the stormwater facilities, a narrative description of the solution, a list of the primary project components that were included in the cost estimate, and in some cases considerations for future project development. For conveyance projects, nominal pipe sizes were selected based on engineering judgment and consideration of the pipe and ditch sizes of the existing storm drain system. Water quality treatment components were included for conveyance projects, except in cases where stormwater treatment was provided in existing downstream facilities or where the water being conveyed was considered low in pollutants (i.e., high base flow relative to the flow off impervious surfaces). Hydrologic and hydraulic analysis was conducted to confirm pipe sizing for a subset of the capital improvement projects proposed for the Eastsound Village UGA.

One project was developed purely for water quality treatment improvements in Lopez Village (FMB6) that would add a stormwater treatment wetland where there is currently no treatment or very limited water quality treatment. This project was identified based on input from members of the CSWAC and members of the Lopez Village Planning Review Committee. The project was evaluated in the field and through a desktop analysis, and selected for inclusion in this plan based on multiple factors that include feasibility (e.g., available space, appropriate topography), anticipated water quality benefits (e.g., size and level of

development in tributary drainage area), project efficiency (e.g., ability to combine with other planned projects), and ancillary project benefits (e.g., public visibility, educational value, and ability to provide amenity).

More detailed predesign reports, including cost estimates and a refined conceptual design, were developed for five projects that were ranked highest in priority by the CSWAC and Public Works as described above. The predesign reports for water quality treatment projects in the Eastsound Village and Lopez Village are specifically tailored to address application requirements for grants provided by Washington State Department of Ecology (Ecology) to fund full design and/or construction of stormwater treatment retrofit projects. The predesign report for San Juan Valley Creek (FB1) was specifically tailored to address application requirements for watershed restoration grants. These predesign reports can be found in Appendix C.

Conceptual Cost Estimates

The cost estimates for capital improvement projects were derived differently depending on whether the associated design was adopted with or without major modification from what was presented in the long-range drainage plans for Eastsound and Lopez Villages (Rasmussen et al. 2005; SJC DPW 2014), or whether the project was newly identified in this evaluation. As summarized in Appendix D, the designs for nine projects previously identified in the long-range drainage plan for Eastsound Village UGA were adopted without major modification in this report (these projects are identified as ES10, ES29, ES30, ES31, ES33, ES35, ES36, ES37, and ES39 herein). Therefore, the original cost estimates for these projects were simply escalated to reflect current costs based on a scalar developed from historical and current construction cost indexes (ENR 2014) and a more conservative contingency was added. For two capital improvement projects in the Eastsound Village UGA (ES32 and ES42), costs were not included because the projects are underway.

Cost estimates for capital improvement projects that were new or required significant design modifications relative to previous designs from the long-range drainage plans for Eastsound and Lopez villages were prepared based upon the collective experience of Herrera with projects of a similar scale and site settings. Unless otherwise noted in the cost estimates the following assumptions apply to these projects:

- Construction bid items were based on Washington State Department of Transportation (WSDOT) standard specifications where applicable, including material, construction requirements, measurement, and payment.
- Line item unit prices used in the construction cost estimate were developed with sound engineering judgment and were derived from a combination of applicable sources, including contractor bid tabs from similar past projects, prices compiled by WSDOT and Seattle Public Utilities, quotes from vendors, cost estimating guides (The Guide 2014), site-specific understanding of probable contractor staging, access, and other project specific requirements and constraints that would affect contractor bids for the project.
- County sales tax of 8.1 percent was applied to the construction cost.

- Allied costs (project management, survey, geotechnical analyses, design, permitting, property acquisition, construction management) were included for each project, as appropriate.
- The County would hire a consultant to perform the survey, geotechnical analysis, design, and permitting.
- The County would manage the project for a cost equal to 10 percent of the construction cost and perform construction management for a cost equal to 20 percent of the construction cost.
- Costs for survey, geotechnical analyses, design, and permitting are based on experience with design and permitting similar projects and knowledge of site-specific job complexities and challenges. In some cases, professional judgment was used to estimate allied costs as a percentage of construction costs.
- Property acquisition costs were listed as a minimum cost to document an easement when required and do not include costs for acquiring real estate.
- A 50 percent contingency was applied to the total cost of each project (except projects advanced to the predesign level) to account for uncertainties related to the lack of project definition in accordance with recommendations by the Association for the Advancement of Cost Engineering (AACE 2005; Rothwell 2005).

The cost estimates for all prioritized capital improvement projects are included in Appendix E. Appendix E also includes the cost estimates for all projects that were advanced to the predesign level (i.e. ES8/ES9, ES7/ES44, FB1, FMB4, and FMB6). A more detailed description of the cost estimating methodology for each predesign report can be found in Appendix C.

Hydrologic and Hydraulic Analysis

A hydraulic/hydrologic (H/H) model was developed for some portions of the East Sound watershed as part of this stormwater basin planning effort. The modeled areas include Eastsound Village, Ship Bay basin to the east of Eastsound, and areas tributary to the stormwater system in the urban growth area along the North Shore of Orcas Island. All H/H modeling was conducted in the US Environmental Protection Agency (USEPA) Storm Water Management Model version 5.0.022 (SWMM5). Best available data was utilized in the model development including GIS data, field surveys, prior work conducted in these basins, field assessment, and best engineering judgment.

The objective of model development was to construct the SWMM5 H/H model for the aforementioned areas and conduct a 25-year design storm analysis of the existing system and proposed alternatives. The long-term goal of establishing this model is to determine capacities of primary pipe and channel networks in the basins, to continue to assist with capital improvement project development, and to create a tool that can be used in the future to consider the impacts of future development and capital improvement projects on natural wetland systems.

The model was developed using County provided GIS data that was analyzed to develop basin characteristics. The following GIS layers were used: land use, soils, parcels/buildings, roadways, and aerial photography. The County GIS soil layer was used to characterize the subcatchments in the model by superimposing the soil layer on top of the model subcatchments. The predominant soil type for each subcatchment was used to determine the soil infiltration characteristics to be used in the model.

A review of the GIS layers provided showed large amounts of missing data and gaps in the stormwater structures inventory primarily in the Eastsound Village basin. Almost no infrastructure information existed for the Ship Bay basin so ditch cross-sections there were developed based on field observations. An Airport Ditch Survey (Port of Orcas 2002) was used to fill data gaps for stormwater infrastructure at the airport. Other data gaps were filled using generally accepted fundamentals for a stormwater conveyance system. Below is a list of examples of missing data and assumptions used.

- Pipe invert missing: Used invert of adjacent MH invert that fits with the profile
- Pipe and manhole invert missing: Interpolated between the next upstream and downstream known points.
- All inverts missing: Used the ground slope for pipe slope.
- Manhole rim elevation missing: Inferred from surface elevation interpolating between contour lines.
- Missing diameter: Assumed logical size inferred from adjacent pipes.
- Manning's coefficient (n) assumptions: Reinforced Concrete Pipe (RCP) = 0.013, Corrugated Metal Pipe (CMP) = 0.024, Dual Wall Pipe (DWP) = 0.011, Single Wall Pipe (SWP) = 0.015, Unknown Pipe Type (UNK) = 0.013.
- Missing natural channel: Assumed trapezoidal channels with standard side slopes, widths, and depths. Typical residential ditches were assumed to have 1-ft bottom width, 1.5-ft deep, with side slopes of 1:1. In cases where aerial photographs showed wider swales and open channels or field observations were made, widths were estimated to scale. Airport swales and the ditches along Olga Road are a good example of this case.

All modeling was performed using the 25-year, 24-hour recurrence interval storm. The design rainfall hyetograph was generated using the SCS Type 1A rainfall distribution. Rainfall amount of 3.0 inches was inferred from National Oceanic and Atmospheric Association (NOAA) published data. Considering the northwest climate and antecedent conditions, and to build some conservatism into the uncalibrated model, the design storm was preceded by a 6-month, 24-hour storm (1.05 inches).

Given the data limitations, the model is not intended to be used to determine exact flows or hydraulic grade line elevations, but rather is a tool to compare existing conditions to proposed alternatives. The modeling process used for this project relied on a number of assumptions, and as such, inferred model parameters may not always best represent actual

field conditions. Model results may not be completely reflective of basin and conveyance system flow magnitudes due to the absence of flow monitoring data to conduct model calibration and/or validation. However, the current version of the model is a good tool for relative comparison between existing conditions to proposed alternatives.

The model was used for this study with its limitations in mind. These limitations may be resolved through future model development if warranted for design of capital improvement projects or evaluation of natural resources impacts. The final Model Development and Alternatives Analysis report detailing modeling assumptions and results for each basin is provided in Appendix F. Capital improvement project summary sheets in Appendix B identify problems and solutions that were evaluated with the model along with model results.

PRIORITY WATERSHED ANALYSIS

East Sound

The East Sound watershed is approximately 13,562 acres and is the largest watershed on Orcas Island. It comprises 11 main drainage basins with defined outlets into East Sound (Figure 4). The watershed is characterized by steep slopes in the upper elevations, gentle slopes up to about 5 percent in the middle portions, and it flattens to about 1 percent nearer the shore. There is a total elevation drop of about 2,400 feet across the watershed. The watershed flow crosses several County roads in culverts including Dolphin Bay Road, Orcas Road, Crescent Beach Road, Olga Road, Palisades Drive, and Point Lawrence Road. The depths of East Sound are relatively uniform at about 90 feet throughout its 6 to 7 mile length.

The watershed has a varied mix of land uses including parks and other protected lands, residential housing, forestry, and agriculture. The watershed has 28.4 miles of streams of which 7.7 miles are fish bearing. Freshwater wetlands comprise 6 percent of the watershed. There are three lakes over 20 acres and numerous small lakes and ponds.

Existing impervious surface in the East Sound watershed is 2.4 percent and is estimated to increase to 7.8 percent at buildout; however, that estimate covers the entire watershed. Increased impervious area within Eastsound Village could be higher as the UGA allows for higher density and greater lot coverage.

The village of Eastsound resides in the East Sound watershed and the North Shore watershed and is one of two UGAs in San Juan County. Much of the predicted growth is expected to be concentrated in the UGAs; therefore, they are an added focus of this stormwater planning study. UGA's typically will produce stormwater runoff that will increasingly degrade water quality and exceed conveyance capacity unless adequate system capacity is provided for expected future conditions. Eastsound Village is at that crossroads. Flooding is increasingly a concern in the village and although water quality is better than typical urban areas in Puget Sound, there are some ongoing concerns including elevated bacteria, low dissolved oxygen, and high nutrient concentrations.

Hydrologic and Hydraulic analysis was completed for several basins within the East Sound watershed. Methods and results are described in Appendix F, Hydraulic/Hydrologic Model Development and Alternatives Analysis.

Water Quality Conditions

East Sound is identified on Ecology's 303(d) list as an impaired waterbody (Category 5) due to low dissolved oxygen concentrations (Listing 10101) and a water body of concern (Category 2) due to pH excursions (Listing 10102). Results of 2012–2013 SJC pilot stormwater monitoring for Eastsound are reported in Stillwater Sciences (2014a) and summarized in the companion Volume 1 of this study (Herrera et al. 2014). 2013-2014 results are reported in Stillwater Sciences (2014b). When compared to the five other San Juan County watersheds included in

the pilot program, the East Sound watershed monitoring sites exhibit moderate to high fecal coliform and *E. coli* levels, with frequent exceedances of the Ecology freshwater maximum criterion of 100 CFU/100 mL driven by contaminated stormwater discharges from Eastsound Village. Monitoring of the Eastsound Village main stormwater outfall indicates that this runoff can also have low concentrations of dissolved oxygen (< 5 mg/L). Compared to national databases for stormwater concentrations, measurements across the first two years of the pilot study for nitrate+nitrite (0.07-1.8 mg/L), ammonium (0.02-0.4 mg/L), total nitrogen (0.5-2.7 mg/L), ortho-phosphorus (1.5-980 ug/L), and total phosphorus (3-1,100 ug/L) at East Sound monitoring sites were moderate to high and highly variable (Stillwater 2014a,b).

Although pilot monitoring results to date show dissolved metal (arsenic, cadmium, copper, lead, zinc) concentrations are below applicable criteria in Washington State for preventing acute and chronic toxicity in aquatic life, concentrations of these pollutants are expected to increase with further development and increased traffic in the UGA based on regional studies of Puget Sound watersheds (Herrera 2007, 2011; Ecology and King County 2011). For example, a study by Ecology and King County found that concentrations of 21 priority pollutants in stormwater runoff varied as a function of land use (Ecology and King County 2011). The analysis indicated that forested land uses had lower concentrations of nitrate+nitrite nitrogen, total phosphorus, total mercury, total arsenic, total copper, and total suspended solids. Commercial land uses had comparatively high concentrations of toxic organic chemicals including polychlorinated biphenyl (PCBs) and polybrominated diphenyl ethers (PBDEs), total zinc, and total lead. Residential and agricultural basins had similar chemical signatures and generally exhibited higher concentrations than forested basins and lower concentrations than commercial basins. A similar study of water quality in the Green-Duwamish watershed indicated that roads and effective impervious area were highly correlated with high concentrations of fecal coliform bacteria and total zinc (Herrera 2007).

Ecological Conditions

In terms of watershed value, East Sound watershed was ranked first for protection by the San Juan County Watershed Ranking Committee in its 1988 watershed ranking report. This rank was based on its large wetland systems, streams, lakes, and abundant diverse habitats (SJC 2000). East Sound contains habitat for river otter and harbor seal. Pacific herring spawning sites are present in Ship Bay and Judd Cove (FOSF 2004a; WDFW 2014). Suitable habitat for a variety of clam and crab species is present (WDFW 2014a). Hard-shell clams are on the northwest and southeast portions of the sound. Areas at the mouth and at the head of the sound on the eastern side are used for crabbing. There are bull kelp beds along the rocky shores and rockfish frequent the rocky headlands. Eelgrass is found in most of the shallower pocket estuaries. Documented forage fish spawning areas are near the town of Olga and Crescent Beach (WDFW 2014a; FOSF 2004b).

Juvenile Chinook salmon use portions of East Sound for rearing and East Sound was identified as a Priority Fish Use Region based on the presence and distribution of shoreforms that are attractive to a range of fish species (WDFW 2014b; Whitman et al. 2012).



San Juan County GIS



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1 in = 6,000 feet
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Figure 4:
Overview of East Sound Watershed
Showing Drainage Basins and Aquatic Resources

The coastal portions of the watershed provide extensive areas of eagle habitat and many nests of bald eagle, osprey, great blue heron, and turkey vulture (WDFW 2014a). State certified oyster growing areas are active along Crescent Beach off Ship Bay and the Buck Bay area has an active commercial shellfish operation. A small private fish hatchery for Chinook salmon is operated inland about mid-way on the eastern side of the watershed.

Given the valuable and diverse ecosystem resources of East Sound, the expected development pressures, the ongoing water quality concerns, and the significant flooding problems within this watershed, stormwater management in the East Sound watershed is a high priority.

Reported Stormwater Issues

As the Eastsound Village UGA and East Sound watershed continue to develop it is important to plan for adequate stormwater conveyance and treatment in order to protect health and safety, and East Sound's abundant natural resources.

This discussion focuses on basins within the East Sound watershed and areas within the Eastsound Village UGA where there are reported conveyance or water quality problems.

The following sources were reviewed to evaluate discrete stormwater problems in the East Sound watershed:

- Citizen reported stormwater problems via the San Juan County Stormwater Issue Reporting Website
- Long Range Drainage Plan Proposal for Eastsound Village Urban Growth Area (Rasmussen et al. 2005)
- County Public Works institutional knowledge of stormwater problems

The Eastsound Village UGA, which includes the Eastsound Village, Crescent Beach, and Ship Bay basins, contains the majority of reported problems in the watershed. Although not included as a priority basin, the North Shore watershed largely lies within the Eastsound Village UGA and problems reported in North Shore basin are included in this discussion. The second most reported problematic area within the East Sound watershed was the Rosario neighborhood where flows are generally overland and direct to East Sound (see Figure 4).

The East Sound watershed had the highest number of stormwater problems with 33 percent of the total reported on the San Juan County Stormwater Issue Reporting Website. Eastsound Village accounts for close to 41 percent of the 127 stormwater complaints submitted. The North Shore watershed of Orcas had 8 percent of reported problems. The majority of complaints reported flooding, ponding, erosion, and private property damage. The number of complaints by category for East Sound watershed can be found in Appendix A.

The Long Range Drainage Plan Proposal for Eastsound Village Urban Growth Area describes drainage issues in ten subbasins within the Eastsound Village UGA (Rasmussen et al. 2005). Problems mainly include flooding, erosion, lack of treatment and detention, and inadequate drainage easements. Eight of the 38 projects presented in the plan have been implemented since 2005 by San Juan County Public Works. The remaining projects identified in the long-range drainage plan were considered in this analysis. The projects proposed in the long-range drainage plan and their implementation status is presented in Appendix D. The 2005 Eastsound Village Drainage Plan does not address stormwater issues outside the UGA.

In the East Sound watershed and the Eastsound Village UGA, 82 stormwater issues were compiled and evaluated in this analysis. Related problems were combined in order to maximize the efficiency of recommended solutions. Certain private property drainage problems were removed from the list if there did not appear to be a practical solution available through a Stormwater Utility funded project or program.

Stormwater problems on record or reported for East Sound watershed and the Eastsound Village UGA were generally in two categories:

- Where County stormwater infrastructure had not kept pace with ongoing development causing flooding and concerns about deteriorating water quality. These issues are frequently exacerbated by the presence of old disconnected drainage systems, inadequate road grades, deteriorated rolled curbs, and under capacity storm drain inlets.
- Where private developments had installed infrastructure that did not meet County stormwater standards, with resultant effects on down gradient properties as development has continued. In some areas, flooding and erosion on gravel roads has led to sediment and surface water flow across County roadways.

Capital Improvement Projects

Conceptual solutions were developed to address one or more stormwater complaints or by updating existing projects or costs defined in the 2005 Eastsound Village Drainage Plan. The goal of these solutions was to address an existing health and safety problem or water quality problem and to realize additional benefits such as adding water quality treatment where it currently does not exist or providing conveyance capacity for future development.

Twenty-four capital improvement projects in the East Sound and North Shore watersheds are presented in priority order in Table 1. The 24 projects include 17 of the top ranked projects selected through the prioritization process as well as seven additional projects from the 2005 Eastsound Village Drainage Plan that were carried forward by updating the costs to reflect current construction costs and include a more conservative contingency. Of the 17 top ranked projects, predesign reports were developed for four (ES8/ES9, ES7/ES44), new conceptual designs were developed for nine (ES1, ES3, ES13, ES18, ES19, ES26, ES27, ES28, ES34), and summary sheets were developed and 2005 cost estimates were escalated to reflect current construction costs and include a more conservative contingency for the remaining four (ES29, ES31, ES33, ES35) (Figure 5). For the seven projects that were carried forward from 2005 (ES10, ES30, ES32, ES36, ES37, ES39, ES42), summary sheets were not developed, but the cost estimates were escalated to reflect current construction costs and include a more conservative contingency.

The majority of these projects are conveyance capacity improvements coupled with water quality treatment where possible. Much of the conveyance network in the Eastsound Village UGA and East Sound watershed is a patchwork of private and publically installed pipes and ditches. Many problems have occurred due to the lack of a systematically designed drainage system, resulting in inadequate conveyance capacity. These projects aim to rectify these problems by allowing San Juan County Public Works to retrofit conveyance problems where a drainage easement exists or can be acquired.

Table 1. East Sound Watershed Stormwater Capital Improvement Projects.

ID	Improvement Name	Description of Problem	Recommended Solutions	Estimated Cost^a	Design Level^b
ES44	Market Street Drainage System Upgrade	The private drainage system on Market Street has been problematic and was not designed to accommodate future development in the area tributary to the system; however, modeling indicates the existing storm drainpipes have adequate capacity. The existing water quality swale is much too small. The swale is only large enough to provide water quality treatment for 5 percent of the tributary drainage area.	Replace (as needed) and reconfigure the existing private storm drain on Market Street to route surface flow to two Modular Wetland Systems (MWS). The proposed MWS will replace the existing swale located in the planter strip at the west boundary of the parking lot and provide treatment for 5.2 acres.	\$420,000	Predesign
ES7	Market Street and Madrona Street Conveyance Improvements	Surface flow path across private property between Madrona Street and Crescent Beach wetland causes flooding.	Redirect runoff from the south end of Madrona Street into the public storm drain on Market Street (requires implementation of ES44).	See ES44 ^c	Predesign
ES8	Prune Alley Drainage and Water Quality Improvements	Poor road grades, deteriorated rolled curbs, and ineffective storm drain inlet locations are causing flooding of Prune Alley and surrounding private properties. Modeling indicates the existing main storm drain on Prune Alley has adequate capacity.	Install water quality treatment BMPs, new storm drainpipe, and new inlets along Prune Alley to alleviate drainage problems and provide water quality treatment.	\$340,000	Predesign
ES9	Fern Street Conveyance and Water Quality Improvements	Deteriorating drainage system and groundwater seepage is causing ponding, icing, and pavement cracking along Fern Street. Modeling indicates that the existing storm drainpipes are adequately sized, though anecdotal evidence indicates there are issues with surface and groundwater sheet flowing across the street.	Reconfigure the existing public storm drain on Fern Street to route surface flow to two Modular Wetland Systems (MWS) and two Filterrass. The proposed MWS and Filterrass will provide treatment for 2.4 acres. Diversion of groundwater seepage to drainage system.	See ES8	Predesign
ES1	Olga Road Conveyance and Outfall Replacement	A surface water outfall and wave action is contributing to rapid bluff erosion at the abandoned County road behind Inn at Ship Bay. Further south on Olga Road an outfall pipe is rusted and deteriorated causing erosion of the steep sandy soils between the road and the shoreline. Model results indicate that the existing 18-inch diameter outfall pipe and ditch are undersized.	Plug the culvert under Olga Road at the Inn at Ship Bay to divert flow away from the sand bluff towards the more stable rocky shoreline at the next outfall to the south. Widen and armor the existing ditch along the east side of Olga Road and replace the deteriorated outfall to accommodate the combined flow under future conditions. Model results indicate that a 54-inch diameter outfall pipe will be adequate.	\$720,000	Conceptual

Table 1 (continued). East Sound Watershed Stormwater Capital Improvement Projects.

ID	Improvement Name	Description of Problem	Recommended Solutions	Estimated Cost ^a	Design Level ^b
ES26	North Beach Road Outfall	Outfall on the beach is buried and clogged with sediment due to wave action. Modeling confirmed the existing conveyance system has adequate capacity if free of sediment and not affected by tidal backwater.	Replacement of buried outfall pipe with a new shoreline outfall to President Channel or an outfall to Brandt's Marina.	\$260,000 to \$300,000 ^d	Conceptual
ES29	School Road Conveyance Improvements	The main storm drain for School Road crosses private property and cannot be maintained easily by Public Works. Ditch along School Road is clogged with sediment.	Install a new drainage system on School Road connecting to Prune Alley main storm drain. Model results indicate that installation of a 12-inch diameter storm drain should provide sufficient conveyance capacity.	\$140,000	Conceptual (2005)
ES3	Montgomery Lane to Crescent Beach Wetland	Ponding in ditches overflows to private property and contributes to bluff erosion. Capacity and erosion problems along Crescent Beach Road west of Montgomery Lane contribute to bluff erosion.	Construct a ditch along the northeast side of Montgomery Lane, culverts under driveways, and a culvert across Crescent Beach Drive. Construct a small stormwater treatment BMP before discharging to the Crescent Beach Wetland on north side of Crescent Beach Drive.	\$670,000	Conceptual
ES28	Crescent Beach Wetland Outfall	Outfall becomes clogged with sediment due to wave action and may contribute to flooding of a property on Crescent Beach Dr. Model results indicate that the current 12-inch outfall has sufficient capacity if free of sediment and not affected by tidal backwater.	Replacement of Crescent Beach Wetland outfall to Ship Bay.	\$300,000 ^e	Conceptual
ES18	Rosario Road Drainage Improvements	Under capacity ditch and culvert conveyance system along Rosario Road is resulting in surface water and sediment from ditches and roadways flowing across the roadway. The intensity of development within the basin is contributing to the problem.	Improvement of drainage system along Rosario Road including addressing sediment from Firehouse Lane gravel road.	\$75,000	Conceptual
ES19	Rosario Neighborhood Drainage Improvements	Poor road maintenance, under capacity drainage system, steep grades, and upland development is contributing to road flooding, potholes, erosion, and flooding on private property throughout the Rosario neighborhood. Upstream development is likely contributing increased flow relative to historic conditions.	Conceptual plan for conveyance improvements and roadway repairs on private property around Grove Street and Cascade Way from Rosario Road to Ocean Mist Way for residents to execute, potentially with County support.	\$440,000	Conceptual

Table 1 (continued). East Sound Watershed Stormwater Capital Improvement Projects.

ID	Improvement Name	Description of Problem	Recommended Solutions	Estimated Cost ^a	Design Level ^b
ES13	Myer Street and Langell Lane Conveyance to Outfall	Runoff and sediment from the hillside, along with limited ditch capacity, is causing flooding on private property.	Obtain easement and pipe or ditch flow across private property to shoreline to alleviate problems on Myer Street. Increase frequency of ditch maintenance at intersection of Myer Street and Langell Lane. Consider deepening ditch or raising road elevation.	\$180,000	Conceptual
ES27	Bracken Fern Lane Drainage Improvements	Lack of a drainage system is causing ponding and flooding on private properties along Bracken Fern Street and Candlewood Lane.	Installation of new conveyance to connect with ditch drainage system on Maidenhair Lane.	\$90,000	Conceptual
ES33	West Airport Drainage	Increased flow from recent development is causing flooding of the existing Airport storm drainage system and also may be affecting the Airport Wetland. Future development may exacerbate existing problems. Modeling results indicate that airport flooding may be due to an existing 6 inch culvert along the west side of the runway.	The current solution and cost estimate is based on Project 5.1 from the 2005 Eastsound Drainage Plan and includes a large conveyance system along the west side of the airport with potential to divert controlled amounts of flow to the Airport Wetland. This solution is viewed as conservative because updated modeling indicates the existing system is adequate, except for one 6-inch diameter culvert. Modeling indicates upsizing the 6-inch culvert to 18-inches would provide adequate capacity.	\$780,000	Conceptual (2005)
ES34	Blanchard Road and Nina Lane Conveyance & Outfall	The area around Nina Lane is flat and does not drain resulting in flooding of the roadways. Increased flows are stressing the existing conveyance and neighboring Airport Wetland. Modeling indicates the existing 8" outfall is undersized.	Upsize the existing outfall to 18 inches, improve ditching along Donahue Lane, and add culverts.	\$150,000	Conceptual

Table 1 (continued). East Sound Watershed Stormwater Capital Improvement Projects.

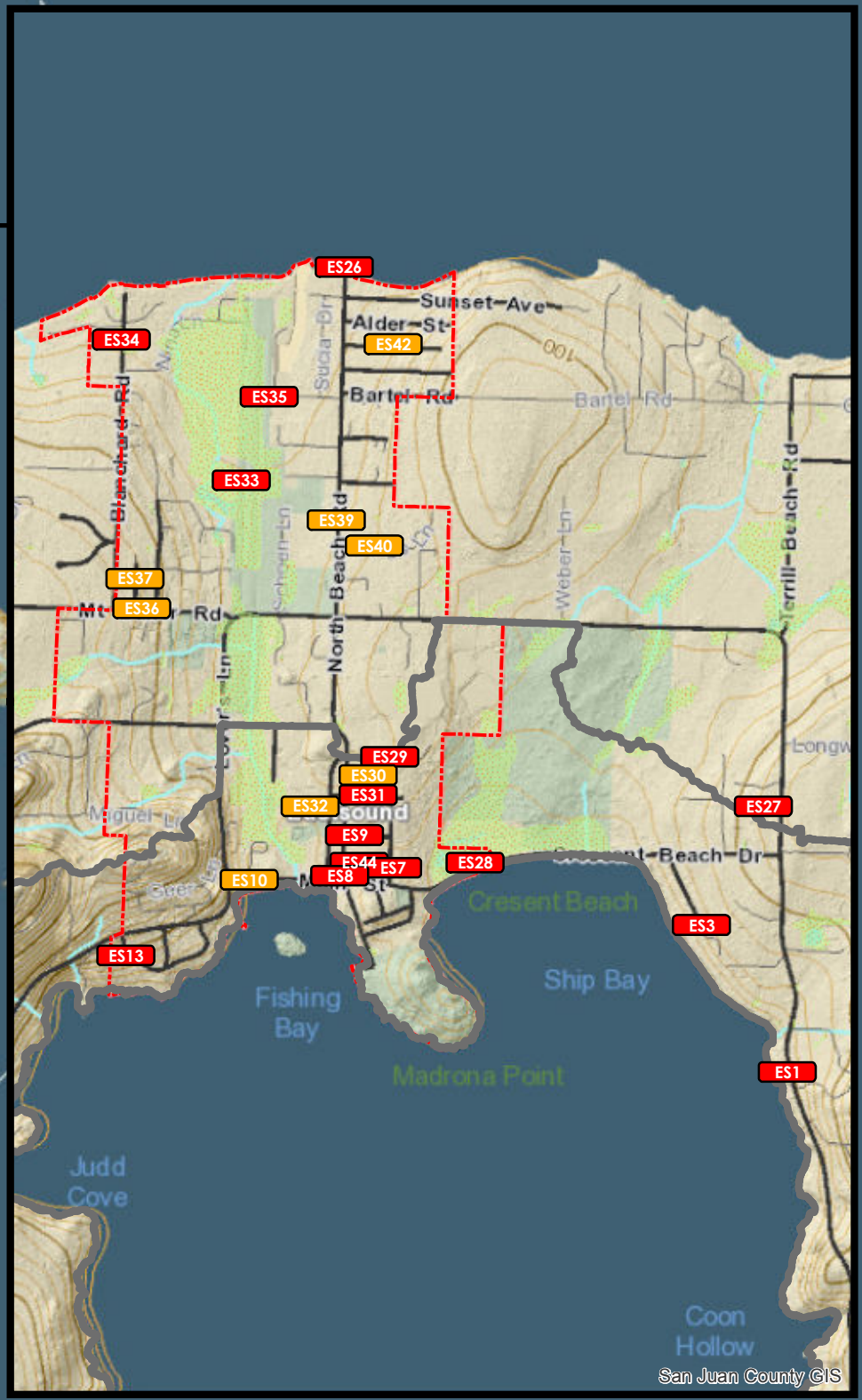
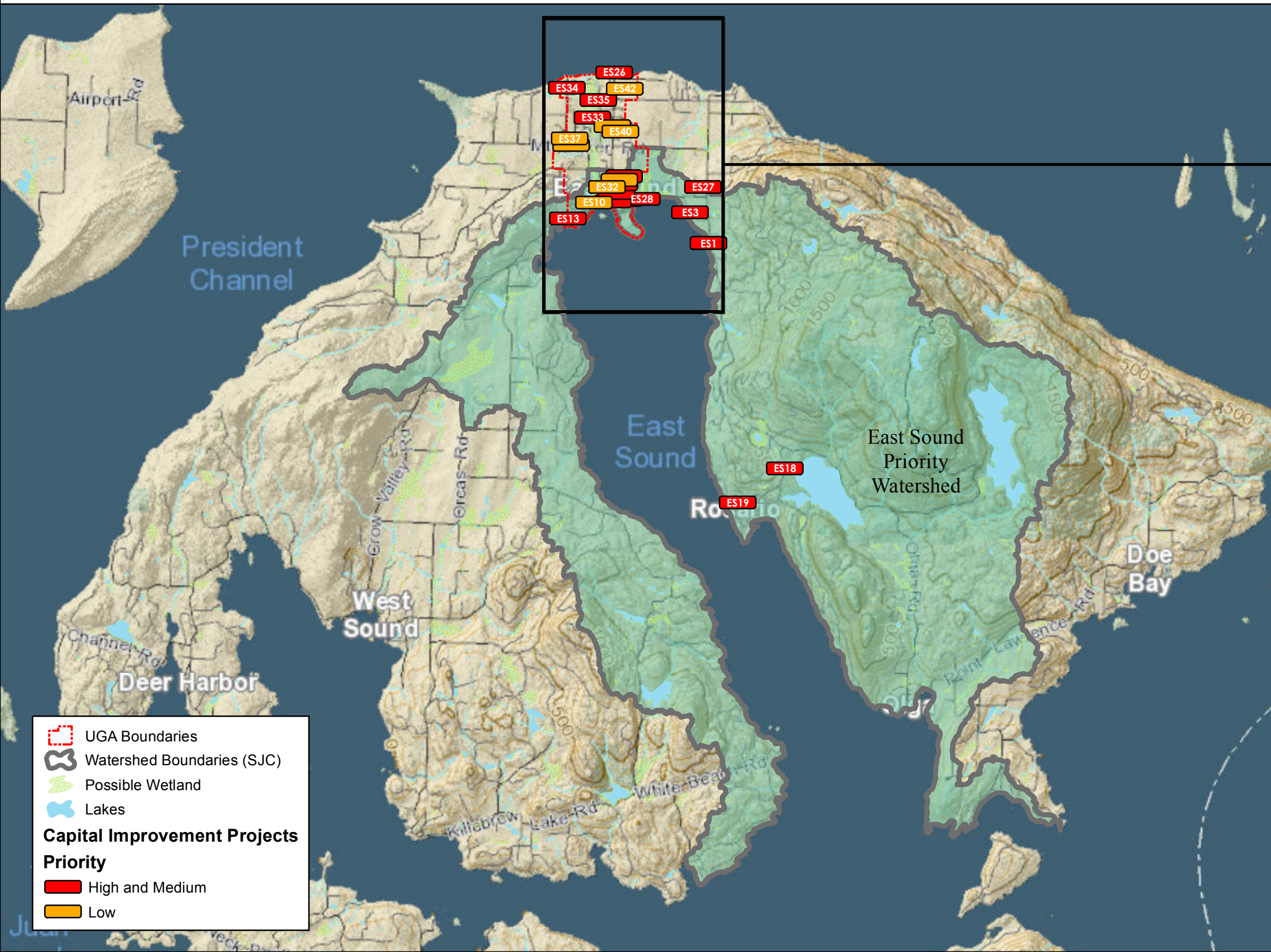
ID	Improvement Name	Description of Problem	Recommended Solutions	Estimated Cost ^a	Design Level ^b
ES31	Rose Street Conveyance Improvements	Drainage system is under capacity which may be exacerbated by Poplar roots along Rose Street	Installation of new drainage system on Rose Street including addressing Poplar roots in nearby catch basins. Project will improve conveyance of stormwater to the existing Eastsound Constructed Wetland. Model results indicate that the addition of 12 inch Storm Drain Pipe will provide sufficient capacity along Rose Street.	\$210,000	Conceptual (2005)
ES35	East Airport Drainage Improvements	Increased flows are stressing the conveyance along North Beach Road and Cessna Road to the marina outfall. No easement exists for County to perform maintenance. Model results indicate that the current 16-inch outfall pipe is undersized.	Solution includes improvement of ditches, culverts, and outfall as well as acquisition of a new County easement to conduct maintenance. The existing solution and cost are based on Project 5.3 in Eastsound drainage plan, and should be refined prior to final design in order to ensure that the wetland is protected. Modeling indicates upsizing the existing outfall from 16-inch diameter to 24-inch diameter may solve the flooding problem along the east side of the airport runway (but tidal affects were not accounted for).	\$855,000	Conceptual (2005)
ES30	Pine Street Conveyance Improvements	Conveyance system on Pine Street is under capacity causing flooding.	Installation of new storm drain and catch basins along Pine Street.	\$116,000	Carried Forward
ES10	Lover's Lane Conveyance to Outfall	Flooding and ponding on private property below grade of Lover's Lane. Inlet and conveyance on private property may be undersized.	Installation of piped conveyance to bypass private property to shoreline outfall.	\$80,000	Carried Forward
ES32	A Street Conveyance Improvements	Ponding on private property (Post Office) on A Street.	Installation of new inlets on A street to tie private property drainage into Eastsound Swale.	N/A Partially Complete	Carried Forward
ES36	Mt Baker Road Ditch Improvement	Increased flows are stressing ditch drainage system and flooding properties adjacent to Mt Baker Road west of Lover's Lane.	Improvement of ditch capacity and replacement of culverts.	\$180,000	Carried Forward

Table 1 (continued). East Sound Watershed Stormwater Capital Improvement Projects.

ID	Improvement Name	Description of Problem	Recommended Solutions	Estimated Cost ^a	Design Level ^b
ES37	Mountain View Street Drainage to Wetland	Private property flooding along Mountain View Road.	Improve ditch capacity along Mountain View Road and direct flow to Seaview Street.	\$38,000	Carried Forward
ES42	North Beach Road Neighborhood Rain Gardens	Roadside erosion and flooding occurring adjacent to private property.	Installation of rain gardens and tie into recently installed conveyance system.	N/A Partially Complete	Carried Forward
ES39	North Beach Road Ditch Improvement	Conveyance problems along North Beach Road.	Improve ditch capacity.	\$86,000	Carried Forward

Notes:

- ^a Project cost estimates are in Appendix E.
- ^b Definitions: Predesign = more refined conceptual design was developed and is described in a predesign report; Conceptual = conceptual solution was developed; Conceptual (2005) = conceptual solution developed in Long Range Drainage Plan Proposal for Eastsound Village Urban Growth Area (Rasmussen et al. 2005) was not developed further; Carried Forward = outside of the top 24 projects, but carried forward into this plan.
- ^c ES7 Option 1 is included in the cost estimate for ES44. Initial cost estimates for ES7 Options 2 and 3 range from \$53,000 to \$740,000.
- ^d Cost range and solution descriptions reflect ES26 Options 1 and 2. Option 3 is a 1,400 linear foot directionally-drilled outfall that is estimated to cost up to \$4.5 Million.
- ^e Cost and solution description reflects ES28 Options 1. Option 2 is a 1,650 linear foot directionally-drilled outfall that is estimated to cost up to \$3.6 Million.



- UGA Boundaries
 - Watershed Boundaries (SJC)
 - Possible Wetland
 - Lakes
- Capital Improvement Projects**
- Priority**
- High and Medium
 - Low



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1 in = 6,000 feet

0 3,000 6,000 Feet

Figure 5:
Capital Improvement Projects Identified for East Sound Watershed

Pre-design Projects

Projects were ranked using the seven criteria listed in the *Problem Identification and Prioritization Process* section and by taking into account feedback from San Juan County Public Works Staff and the CSWAC. Of the seventeen potential projects identified in the East Sound and North Shore watersheds, four were selected as good candidates for pre-design reports. The four projects (ES7, ES8, ES9, and ES44) are described in Table 1. ES8 and ES9 were combined into a single project, as were ES7 and ES44. Pre-design reports were developed for these projects and are provided in Appendix C.

Market Street and Madrona Street Stormwater Improvements

The Market Street Drainage System Upgrade and Madrona Street Conveyance Improvement (ES44 and ES7) projects were identified as high priority capital improvement projects. These projects would be implemented together to address drainage problems on Market Street and on Madrona Street north of Market and provide water quality treatment. They would address frequent flooding problems observed on private property and would provide water quality treatment for runoff from impervious surfaces. These projects were identified in the 2005 Eastsound Village long-range drainage plan as necessary to provide drainage to the storm main on Prune Alley and provide capacity for expected future development on Madrona Street. The estimated cost for these two projects is \$420,000.

Prune Alley and Fern Street Stormwater Improvements

The Prune Alley Drainage and Water Quality Improvements and Fern Street Conveyance and Water Quality Improvements (ES8 and ES9) projects would also be implemented together to address drainage problems on Prune Alley and Fern Street. Project ES8 addresses frequent flooding problems observed along Prune Alley on private property and in the roadway due to deteriorating curbs and improper road grading. Project ES9 will address groundwater seepage and ponding along Fern Street that is affecting private property and parts of the roadway. Both projects were identified in the 2005 long-range drainage plan as necessary to provide drainage capacity and treatment for a larger portion of the Eastsound Village UGA and water quality improvements have been added to the projects originally proposed in 2005. These retrofits would increase capacity and provide water quality treatment for the Prune Alley and Fern Street roadways as well as for a portion of the private property along Fern Street. The groundwater seepage along Fern Street would be collected and piped directly to the conveyance system to avoid surface ponding and icing as well as reduce flow rates into the proposed water quality treatment BMPs. The cost for these projects is estimated to be \$340,000.

High Priority Projects that were Not Advanced to Preliminary Design

A high priority project in the East Sound watershed for which a pre-design report was not prepared was the Olga Road Conveyance and Outfall Replacement (ES1). The County intends to address this project need through transportation planning rather than through the Stormwater Utility. This project poses a risk to human health and safety with the rapid erosion of the shoreline bluff along Ship Bay due to conveyance of surface water towards the shore over the bluff as well as wave action in this area. This project would divert the surface flow south along Olga Road to an outfall located where the shoreline is less prone to erosion.

The risk posed by the eroding shoreline was identified in the 2005 Eastsound Village Drainage Plan. This project would also provide conveyance capacity for future development on Buck Mountain by reducing stormwater impacts on downstream properties as flow volumes and intensities increase with development.

False Bay

The False Bay watershed is approximately 11,464 acres in size and is in the south central portion of San Juan Island, and is the largest watershed on San Juan Island. The watershed generally flows to the south and terminates in the relatively small receiving waters (232 acres) of False Bay. It consists of three main drainage basins with defined outlets into the receiving water; see Figure 6. There is a total elevation drop of about 900 feet across the watershed starting from the top of Cady Mountain. The watershed is characterized by steep slopes in the upper elevations, gentle slopes up to about 5 percent in the middle elevations that flatten to about 1 percent toward the bottom. The watershed flow crosses several County roads in culverts including Beaverton Valley Road, Boyce Road, Wold Road, San Juan Valley Road, and Bailer Hill Road.

Agricultural is the predominant land use in False Bay although land is being converted to rural-residential use with farming occurring on smaller acreages. Livestock operations include sheep, cattle, and horses primarily (SJC 1999, 2000). During the winter, much of the valley bottom is saturated with standing pools of water. On some farms, animals are pastured with free access to the creeks and saturated areas. Existing impervious area in this watershed is 1.5 percent and is estimated to increase to 10.5 percent at buildout.

A patchy but large distribution of wetlands is present throughout the watershed, encompassing 1,123 acres (10 percent) of the watershed. There are at least two streams of significance draining to False Bay with numerous tributaries stemming from all portions of the watershed. The largest creek, San Juan Valley Creek, is the only Class 2 creek in the County; False Bay Creek is its largest tributary. Most of the length of San Juan Valley Creek and its tributaries have minimal riparian vegetation or canopy cover.

Significant aquifer recharge areas are present near Bailer-Hill Road, and north of West Valley Road between Boyce Road and Egg Lake Road. Trout Lake is located in this watershed and is the main water supply for the town of Friday Harbor, and supplies water to a large portion of the island's population. It is the largest lake on San Juan Island. Lawson Lake is a 12.5-acre lake that augments Friday Harbor's water supply. Wood reservoir is a 29-acre impoundment. Zylstra Lake is 70 acres and was created to provide irrigation water. There also are several many smaller lakes and ponds.

Water Quality Conditions

Stormwater runoff in the False Bay watershed has been a water quality concern for a number of years. The San Juan County Watershed Management Action Plan, developed between 1997 and 1999, listed polluted stormwater runoff as a "high priority risk" for False Bay, along with Friday Harbor and East Sound (SJC 1999, 2000).



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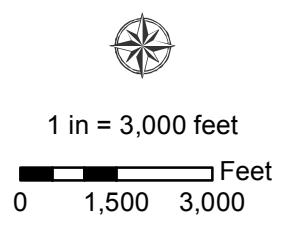


Figure 6:
Overview of False Bay Watershed Showing Drainage Basins and Aquatic Resources

More recent data for the False Bay watershed include 2012–2013 SJC pilot stormwater monitoring results reported in Stillwater Sciences (2014a); these results are summarized in the companion Volume 1 of this study (Herrera et al. 2014). 2013-2014 results are reported in Stillwater Sciences (2014b). Results from the first two years of the pilot program confirm that bacteria pollution is an ongoing problem. False Bay sites exhibit relatively high bacteria concentrations, with the median and average fecal coliform concentrations for False Bay sites frequently exceeding the Ecology freshwater instantaneous maximum of 100 CFU/100 mL during storm events. Dissolved oxygen at False Bay stormwater sites is variable, dropping below the Ecology required 1-day minimum of 8.0 mg/L during 2012-2013 but meeting the criterion during all sampled storm events in 2013-2014. No exceedances to hardness-adjusted acute or chronic numeric criteria for aquatic life toxicity due to metals (arsenic, cadmium, copper, lead, zinc) were reported during the first 2 years of the pilot program. Compared to national databases for stormwater concentrations, measurements at False Bay sites across the first two years of the pilot study for nitrate+nitrite (0.1–3.2 mg/L) and total nitrogen (1.6–1.9 mg/L) were moderate to high, while ammonium (0.04–0.2 mg/L), ortho-phosphorus (30–60 ug/L), and total phosphorus (77–200 ug/L) were low to moderate and highly variable.

Three stream reaches within the False Bay watershed are included on the 303(d) list as a Category 5 waterbodies impaired for bacteria:

- San Juan Valley Creek, from the intersection with Timber Lane downstream to False Bay (Listing 45246; <http://apps.ecy.wa.gov/wats/>)
- False Bay Creek (tributary to San Juan Valley Creek) just upstream of Bailer Hill Road (Listing 45712)
- Unnamed Creek (tributary to Trout Lake) (Listing 45627)

These listings are based on the freshwater primary contact recreation designated beneficial use, which has a fecal coliform criterion of < 100 CFU/100 mL (geometric mean), and with ≤ 10 percent of all samples > 200 CFU/100 mL (WAC-173-201A-200). Category 5 waterbodies require development and implementation of a total maximum daily load (TMDL).

Ecological Conditions

The False Bay watershed was ranked ninth in the 1988 San Juan County Watershed Ranking Report. It has the most stream miles of any watershed (just under 36) of which 3.6 miles are documented to be fish bearing; a fairly rare occurrence in San Juan County. False Bay contains sensitive habitat for shellfish including Dungeness crab. Eelgrass beds are present near the entrance of False Bay (WDFW 2014; FOSJ 2004a) and pocket estuaries may provide habitat areas for forage fish, bald eagles, and other sensitive species. False Bay Creek has coho salmon present (WDFW 2014). False Bay itself is a marine biological preserve belonging to the University of Washington Friday Harbor Laboratories (Labs). The Labs own 200 acres of tidelands and uplands at the bay. This area is used extensively for research purposes and consists of a large area of tidal flats which, in conjunction with the upland wildlife preserve, provides excellent habitat for a high diversity of plants, birds, and sea life, including many intertidal species generally found on the open coast (giant green anemones, gooseneck barnacles, and California mussels) (SJC 1999, 2000). False Bay has no recreational or

commercial fishing or shellfish harvest. Abalone and sea urchins have been harvested in the past in the outer coastal waters of the watershed. Due to its shallow nature and status as a preserve, there is no boating activity.

Substantial eel grass beds and kelp beds are located at the mouth and along the coastline adjacent to the bay (WDFW 2014; FOSJ 2004a). Nearby areas are used as seal haul outs. There are numerous breeding, nesting, and wintering sites for an abundance of resident and migratory birds in the watershed (SJC 1999, 2000). These birds utilize the shoreline, tidelands, and freshwater wetlands, as well as forested uplands.

Reported Stormwater Problems

Stormwater problems in the basin include periodic flooding of Bailer Hill Road but are mostly dominated by water quality concerns specifically related to elevated fecal coliform bacteria and low dissolved oxygen, particularly in the lower stream reaches. Agriculture and residential housing are expected to continue to dominate land use in this watershed. Given that impervious cover is estimated to increase to 10.5 percent under full build-out conditions, it is reasonable to assume these problems will continue and likely increase in severity.

The following sources were reviewed to evaluate discrete stormwater problems in the False Bay watershed:

- Citizen reported stormwater problems via the San Juan County Stormwater Issue Reporting Website
- County Public Works institutional knowledge of stormwater problems

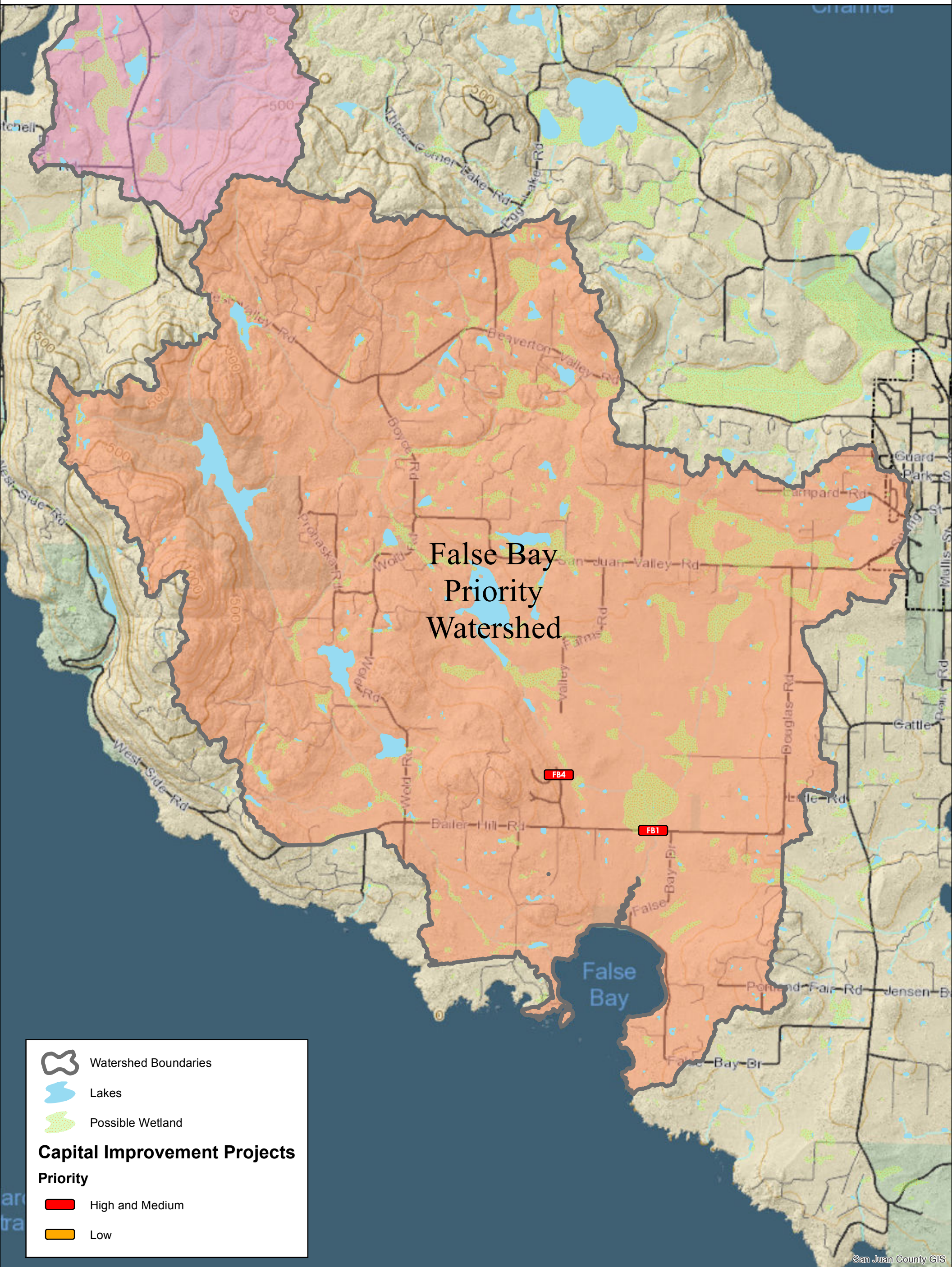
Seven complaints were submitted via the Stormwater Issue Reporting Website for the False Bay watershed. These complaints were focused on erosion, ponding, and water quality. Appendix A summarizes the category and locations of collected stormwater complaints from the San Juan County Stormwater Issue Reporting Website for False Bay watershed.

Capital Improvement Projects

Problem solutions were developed to address the stormwater complaints and known water quality issues in the False Bay watershed. These solutions are presented as potential capital improvement projects in Table 2 and are shown on Figure 7.

Predesign Projects

Projects were ranked using the seven criteria listed in the Problem Identification and Prioritization Process section and by taking into account feedback from San Juan County Public Works Staff and the CSWAC. Of the two potential projects identified in False Bay, only the San Juan Valley Creek Capacity Improvement project (FB1) was selected for development of a predesign report because it was identified as higher priority. A predesign report is provided in Appendix C.



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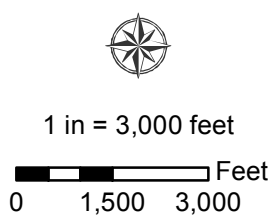


Figure 7:
Capital Improvement Projects Identified for False Bay Watershed

Table 2. False Bay Watershed Stormwater Capital Improvement Projects.

ID	Improvement Name	Description of Problem	Recommended Solutions	Estimate Cost	Design Level
FB1	San Juan Valley Creek Capacity Improvement	Upstream development and agricultural practices have altered the hydrology of False Bay watershed. Every five to ten years San Juan Valley Creek and False Bay Creek overtops Bailer Hill Road with up to 2 feet of water, which affects a primary route to Friday Harbor and increases response time for emergency responders. The reach downstream on the road may be capacity limited due to sediment aggradation, which also affects fish passage and habitat quality in the reach. Upstream development may be increasing runoff and contributing to the problem.	Conduct a design feasibility study including data collection and field investigation, preliminary design alternatives development and analysis, hydrologic and hydraulic modeling, and selection of the preferred alternative. The preferred alternative will likely include some or all of the following: remove sediment, reshape channel banks, strategically placed riparian wetlands and vernal pools to improve storage, expanding and planting the riparian corridor, raising road prism and/or upsizing the culvert, and retrofitting upstream ponds to provide additional detention.	\$237,000	Predesign
FB4	Ranchos Road at Oak Hill Drive Drainage Improvement	Drainage from hillside causes flooding at least annually impacting road safety, agricultural land, and a septic drain field.	Add cross culverts and widen ditch to direct flow south away from drainfield.	\$35,000	Conceptual

Notes:

Project cost estimates are in Appendix E.

The predesign report focuses on the alternatives analysis, including data collection and field investigation, preliminary alternatives development and analysis, hydrologic and hydraulic modeling, and selecting the preferred alternative. The design will likely include some or all of the following: removing accumulated sediment and/or instream vegetation downstream of the road to improve flow, reshaping channel banks to improve floodplain connectivity upstream and downstream, providing additional floodplain storage via strategically placed riparian wetlands and vernal pools upstream and downstream, expanding and planting the riparian corridor with native vegetation upstream and downstream, raising road prism and/or upsizing the culvert to improve flow, and retrofitting upstream ponds to provide additional detention.

The alternatives analysis is estimated to cost \$237,000. Initial high-level estimates of capacity improvement and floodplain enhancement options were in the range of \$2 to \$4 million. The floodplain and stream restoration component would be coordinated with the San Juan Islands Conservation District and with ongoing salmon recovery efforts in the County.

Fisherman Bay

Fisherman Bay is a shallow, poorly flushed waterbody that receives runoff from Lopez Village UGA and multiple drainage culverts located along its perimeter. The bay has a narrow inlet and widens to about one-half mile, forming a long bay between 6 and 24 feet deep. The west shore of the bay is a rock island that is connected to the mainland of Lopez by a barrier beach formed through accretion.

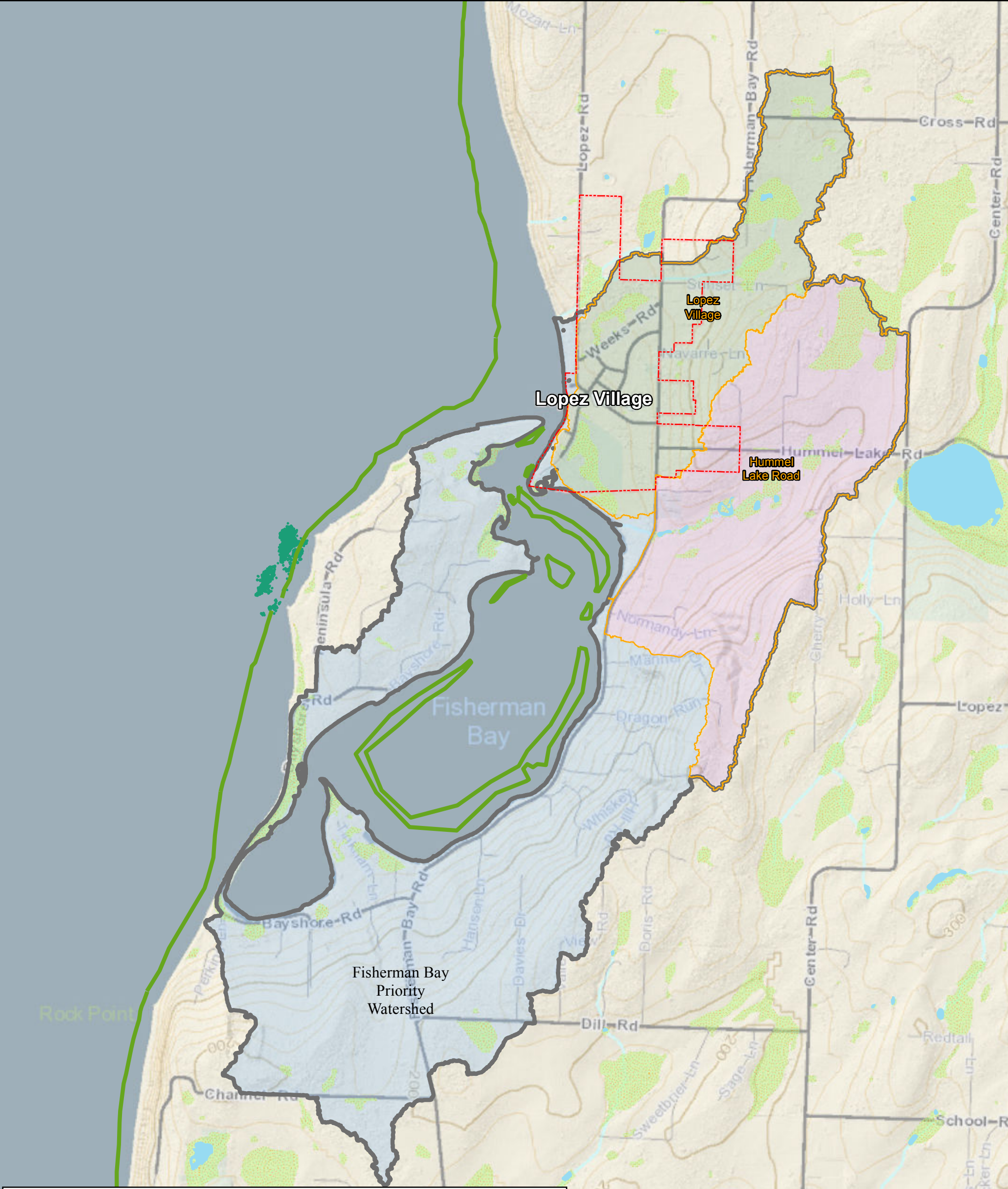
The watershed is approximately 1,439 acres in size and is in the west central portion of Lopez Island. The watershed generally flows to the west into Fisherman Bay, and consists of two main drainage basins with defined outlets into the receiving water (Figure 8). There is a total elevation drop of about 150 feet across the watershed. The watershed is characterized by slopes up to about 5 percent in the upper and middle elevations that flatten to about 1 percent toward the bottom. Drainage in the watershed crosses several County roads in culverts including Fisherman Bay Road and Hummel Lake Road.

Land use in the Fisherman Bay watershed is predominantly residential with the associated existing impervious cover representing approximately 5.4 percent of the total watershed area. Under full build-out conditions, impervious surfaces are expected to increase to 11.1 percent. That increase is for the entire watershed and impervious area at build out within the Lopez UGA could be higher as the UGA allows for higher density and greater lot coverage.

Lopez Village UGA is near the center of the watershed. It comprises mostly commercial uses and residential housing. Impervious areas are associated with the commercial uses in the village, the marinas, and a few businesses located along Fisherman Bay Road.

Water Quality Conditions

Results of 2012–2013 SJC pilot stormwater monitoring for Fisherman Bay are reported in Stillwater Sciences (2014a) and summarized in the companion Volume 1 of this study (Herrera et al. 2014). 2013-2014 results are reported in Stillwater Sciences (2014b).



- | | | | |
|--|-----------------------------------|--|--------------------------------|
| | UGA Boundaries | | Eelgrass Outer Line |
| | Watershed Boundaries | | Documented Sand Lance Spawning |
| | Watershed Basins (SJC) | | Documented Smelt Spawning |
| | Area Sheet Flows to Marine Waters | | Pacific Herring Spawning Areas |
| | Possible Wetland | | Bull Kelp |

San Juan County GIS



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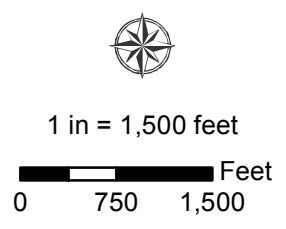


Figure 8:
Overview of Fisherman Bay Watershed Showing
Drainage Basins and Aquatic Resources

Monitoring data for the first 2 years of the pilot program indicate that stormwater at multiple sites discharging directly into Fisherman Bay can exhibit relatively low dissolved oxygen, dropping below the Ecology water quality objective of 8.0 mg/L as an instantaneous 1-day minimum during multiple storm events. Levels of dissolved copper, lead, and zinc measured during 2013-2014 included some exceedances to hardness-adjusted freshwater criteria, suggesting potential toxicity to aquatic life during storm events. Fisherman Bay sites also exhibit relatively high bacteria, with the median and average fecal coliform concentrations exceeding Ecology's freshwater instantaneous maximum of 100 CFU/100 mL during multiple storm events.

In 2013-2014, Fisherman Bay samples exhibited turbidity significantly greater than that measured in the five other San Juan County watersheds included in the program, with three turbidity measurements in excess of 100 NTU occurring during storm event sampling. Mean total suspended solids (TSS) was relatively high (e.g., greater than 100 mg/L) at Fisherman Bay sites during the first 2 years of the pilot program. Compared to national databases for stormwater concentrations, Fisherman Bay sites exhibited moderate to high nitrogen including organic nitrogen (0.6–2.0 mg/L) and ammonium nitrogen (0.2–1.1 mg/L), and low to moderate total phosphorus (75–400 ug/L) and ortho-phosphorus (20–120 ug/L).

Ecological Conditions

Fisherman Bay watershed contains large areas of tidal emergent wetlands including Weeks Point at the north end of the Bay and along Tinkham Lane and Bayshore Road at the south end. Week's Wetland, purchased by the San Juan County Land Bank in 1993, lies within Lopez Village. The watershed contains several freshwater wetlands and an associated stream that begins north of Hummel Lake Road and flows southwest to enter the bay. There are also wetlands near Sunset Lane and Redgate Lane, and along Weeks Road. An aquifer recharge area spans most of the length of the watershed from Hummel Lake Road extending southwest to Bayshore Road and Channel Road at Rock Point. Eelgrass is present in a patchy distribution throughout the watershed's marine shoreline (WDFW 2014). Some areas of bull kelp are present outside the bay adjacent to Fisherman Bay spit.

The Fisherman Bay watershed was ranked seventh by the San Juan County Watershed Ranking Committee in its 1988 watershed ranking report (SJC 1999, 2000). The bay was once used for recreational hard-shell clamming. Historically, finfish were harvested at the mouth of the bay.

Both flooding and water quality concerns are documented in this watershed.

Reported Stormwater Issues

The following sources were reviewed to evaluate discrete stormwater problems in the Fisherman Bay watershed:

- Citizen reported stormwater problems via the San Juan County Stormwater Issue Reporting Website
- Long Range Drainage Plan Proposal for Lopez Village Urban Growth Area (SJC DPW and Hart Pacific Inc. 2004)

- County Public Works institutional knowledge of stormwater problems

Five complaints were submitted via the Stormwater Issue Reporting Website in the Fisherman Bay watershed. These complaints included water quality issues and private property drainage problems, e.g., flooding of driveways from clogged ditch culverts. Appendix A summarizes the category and location of collected stormwater complaints from the San Juan County Stormwater Issue Reporting Website for Fisherman Bay watershed.

The Long Range Drainage Plan Proposal for Lopez Village Urban Growth Area identified two basic deficiencies in the village drainage system including undersized conveyance facilities along Lopez Road and Tower Drive (SJC DPW and Hart Pacific Inc. 2004). The deficiency associated with the Tower Drive conveyance system has since been addressed.

Capital Improvement Projects

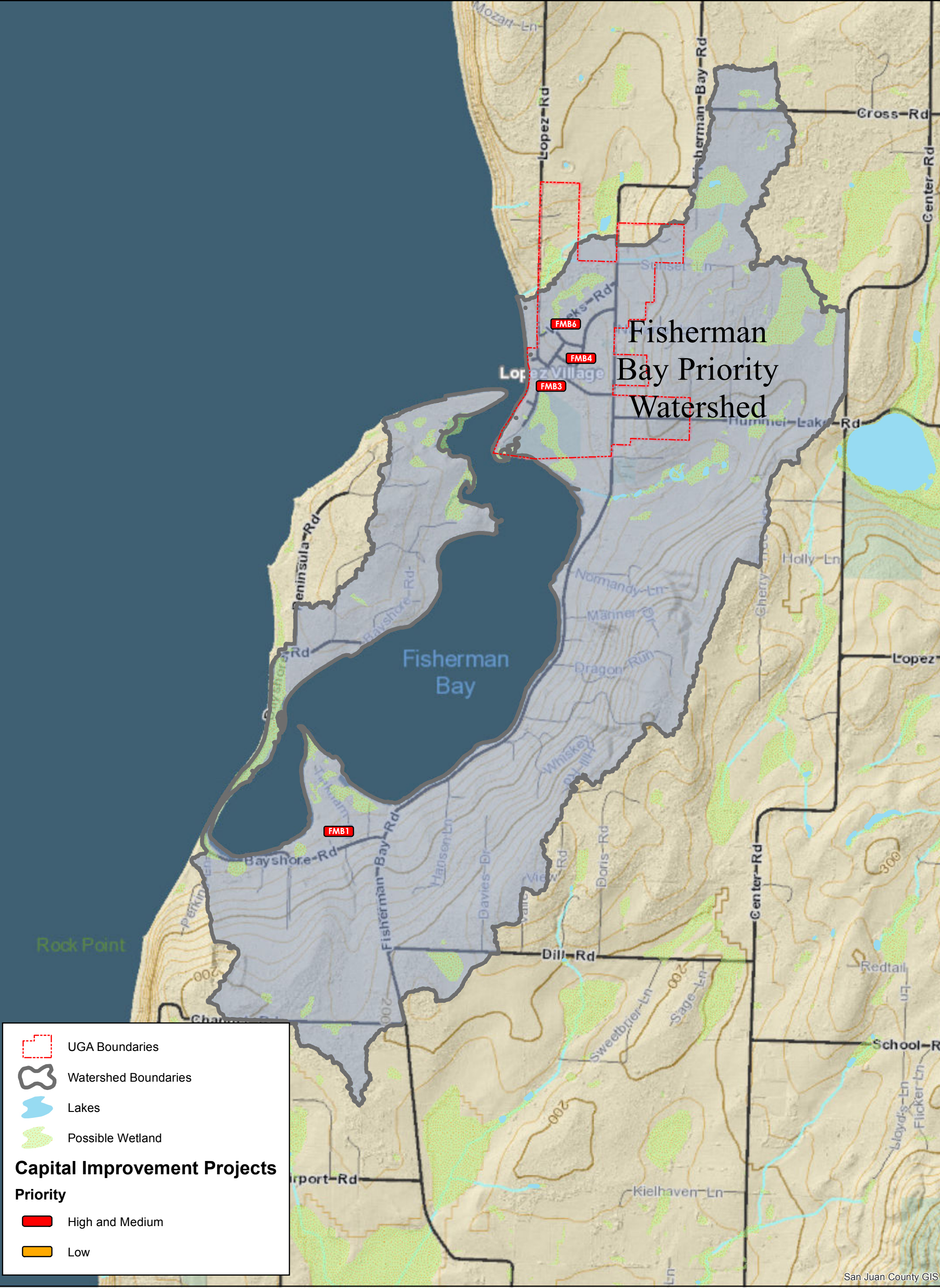
Problem solutions were developed to address the stormwater complaints and known water quality issues. In addition, the projects in the 2004 Lopez Village Drainage Plan were updated. The top solutions selected for further evaluation included four in the Fisherman Bay watershed. These solutions are presented as potential capital improvement projects in Table 3 and are shown on Figure 9.





Predesign Projects

Projects were ranked using the seven criteria listed in the Problem Identification and Prioritization Process section and by taking into account feedback from San Juan County Public Works Staff and the CSWAC. Of the four potential projects identified in Fisherman Bay, two, the Lopez Village Farmers Market Stormwater Improvements project (FMB4) and the Lopez Village Water Quality Treatment Facility project (FMB6) were selected for development of predesign reports. Both were identified as a high priority capital improvement project that would likely be grant eligible. The predesign reports for these projects are presented in Appendix C.

Project FMB4 includes installation of permeable pavement parking and infiltration system along Village Road to provide water quality treatment for stormwater from Village Road. The proposed constructed bypass channel will bypass flow from the upper basin around the pavement infiltration system and eliminate a capacity issue in the existing ditch adjacent to the Farmers Market. The expected cost for this project is \$450,000.



The Lopez Village Water Quality Treatment Facility project (FMB6) includes construction of a regional stormwater treatment wetland for treating runoff prior to entering Weeks Wetland and Fisherman Bay. The expected cost for this project is \$940,000.



 UGA Boundaries
 Watershed Boundaries
 Lakes
 Possible Wetland

Capital Improvement Projects

Priority

 High and Medium
 Low

San Juan County GIS



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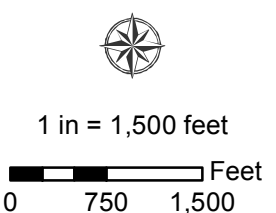


Figure 9:
Capital Improvement Projects Identified for Fisherman Bay Watershed

Table 3. Fisherman Bay Watershed Stormwater Capital Improvement Projects.

ID	Improvement Name	Description of Problem	Recommended Solutions	2014 Cost	Predesign
FMB4	Lopez Village Farmers Market Stormwater Improvements	Lopez Village Road is one of the most heavily used streets in Lopez Village. Ditch capacity is too low to convey flow from Village Road in addition to base flow coming from north of Fisherman Bay Road. The existing storm drain system is not consistent with the vision of the Lopez Village Planning Review Committee.	Install an infiltration system designed as a gravel reservoir with check dams below permeable pavement parking on the east side of Village Road from approximately Washburn Place to Eads Lane. Install a perforated pipe that will bypass high flows above the infiltration system. Construct a bypass channel through the Farmers Market area to route runoff from the upper basin around the infiltration system; this will bypass relatively clean flow around the system and provide an open water feature to the Farmers Market.	\$450,000	Predesign
FMB6	Lopez Village Water Quality Treatment Facility	Capacity improvements and easement issues have resulted in flow being diverted from an existing water quality treatment swale, thus reducing the amount of water quality treatment provided prior to discharge to Weeks Wetland. The swale downstream of this is undersized for the treatment area.	Construct a stormwater treatment wetland on the existing County owned parcel west of Tower Drive. Acquire an easement through the museum property and replace existing pipe to divert flow from the northwest.	\$940,000	Predesign
FMB1	Apple Tree Lane Conveyance to Outfall	Ditch across private property between Bayshore Road and shoreline is under capacity and causing flooding issues. County lacks an easement to conduct maintenance.	Rehabilitate the swale leading to Weeks Wetland. Dredge accumulated sediment, widen the channel to the extent practical, install weirs every 20 linear feet, and install a flared inlet. Remove reed canarygrass and plant native species.	\$63,000	Conceptual
FMB3	Weeks Wetland Swale Improvement	Weeks Wetland inlet swale is clogged and overgrown with reed canarygrass, preventing stormwater runoff from entering the swale and may impact water quality in Fisherman Bay.	Rehabilitate the swale leading to Weeks Wetland. Remove reed canarygrass and plant native species. This can be pursued as a maintenance project.	\$57,000	Conceptual

Note: Project cost estimates are in Appendix E.

Mud Bay

The Mud Bay watershed is approximately 1,130 acres in size and is in the southeastern portion of Lopez Island. The Mud Bay watershed was combined with the Hunter Bay watershed and was ranked sixth in the 1988 San Juan County Watershed Ranking Report. Mud Bay opens on the north to Lopez Sound. The bay is about one mile long and shallow, with a depth at center of 12 to 14 feet. The watershed generally flows to the northeast into Mud Bay, and consists of one main drainage basin with a defined outlet (Figure 10). There is a total elevation drop of about 150 feet across the watershed. The watershed is characterized by gentle slopes up to about 5 percent in the upper and middle elevations that flatten to about 1 percent toward the bottom. Drainage in the watershed crosses Mud Bay Road.

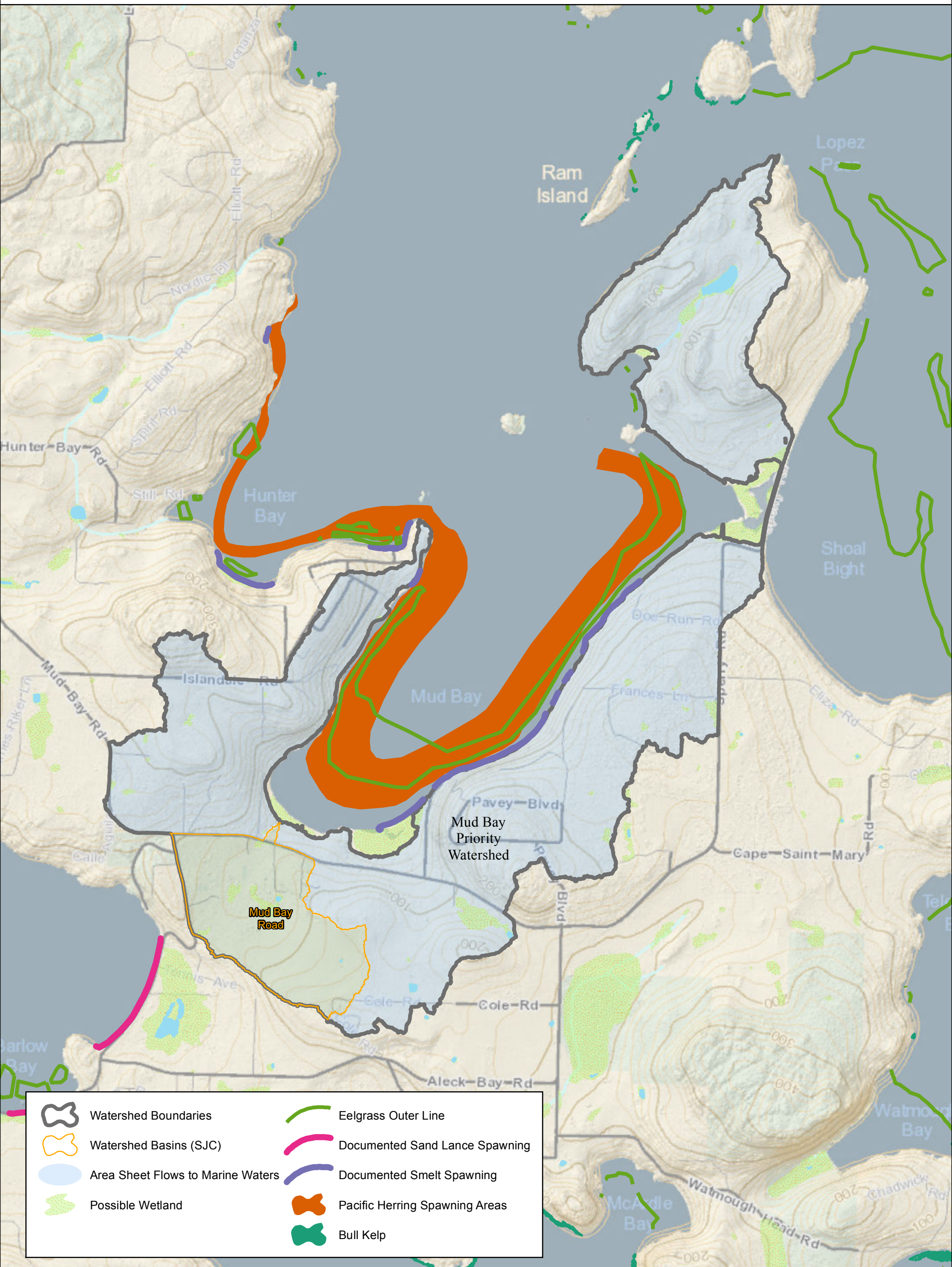
Existing land use in Mud Bay is a mix of single-family residential, agriculture, and open space. A significant portion of the watershed remains undeveloped. Impervious cover is only 1.8 percent of the total watershed area. Existing impervious area is 1.8 percent and is estimated to be 9.1 percent at buildout.

Aquifer recharge areas are relatively extensive within the watershed (71 percent). They are primarily west and south of Mud Bay, along Mud Bay Road, and near Pavey Boulevard. Freshwater wetlands are somewhat limited and occur as small patches. There are no significant streams in the watershed.

Water Quality Conditions

Water quality sampling at Mud Bay has been limited and results are based on a small sample size. Results of 2012–2013 SJC pilot stormwater monitoring for Mud Bay are reported in Stillwater Sciences (2014a) and are summarized in the companion Volume 1 of this study (Herrera et al. 2014). 2013-2014 results are reported in Stillwater Sciences (2014b). Bacteria data collected during the first two years of the pilot stormwater monitoring suggest variable levels of fecal coliform by storm event. During 2012-2013, instantaneous counts at the Mud Bay Road culvert were > 200 CFU/100 mL on one of two sampling occasions, indicating that bacteria levels may exceed the criteria for freshwater primary contact recreation at times. Mud Bay exhibited variable dissolved oxygen, turbidity, TSS, nutrients, and metals (i.e., arsenic, cadmium, copper, lead, zinc) during both years, albeit the sample sizes were small (n<5). Mud Bay is monitored bimonthly for fecal coliform counts by Washington State Department of Health and samples have consistently met the criteria for the marine primary contact recreation designated beneficial uses.

Under full buildout conditions, impervious surfaces are expected to increase to 9.1 percent, which is a five-fold increase. While there are currently no documented flooding problems, there are some water quality concerns to continue to monitor. Given the low sample size, we cannot yet identify the source of these contaminants or determine how problematic they are. During Year 3, water quality monitoring will occur more frequently at Mud Bay. When these results are available, the County will have more information on whether stormwater quality is an issue of concern in Mud Bay



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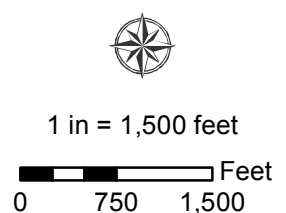


Figure 10:
Overview of Mud Bay Watershed Showing Drainage Basins and Aquatic Resources

Ecological Conditions

Mud Bay is an important Pacific herring spawning area (WDFW 2014; FOSJ 2004a) (Figure 10). Surf smelt spawning is documented along much of the shoreline, primarily along the east shoreline from Mud Bay Dock Road to Doe Run Road (WDFW 2014). The intertidal zone also supports a variety of clams and Dungeness crab. Significant emergent tidal wetlands are present at the south end of Mud Bay and between Mud Bay and Shoal Bight, adjacent to Sperry Road. Eelgrass is present continuously along the shoreline. Kelp is also present but with a more limited distribution.

Reported Stormwater Issues

The following sources were reviewed to evaluate discrete stormwater problems in the Mud Bay watershed:

- Citizen reported stormwater problems via the San Juan County Stormwater Issue Reporting Website
- County Public Works institutional knowledge of stormwater problems

No major stormwater problems were identified in the watershed from either of these sources.

Westcott and Garrison Bays

Westcott Bay watershed is approximately 1,822 acres in size and stormwater flows west into Westcott Bay via three main drainage basins with defined outlets (Figure 11). There is an elevation drop of about 300 feet across the watershed. The watershed is characterized by gentle slopes up to about 5 percent in the upper and middle elevations that flatten to about 1 percent toward the bottom. Flows cross several County roads in culverts including Roche Harbor Road, West Valley Road, and Westcott Drive.

Garrison Bay watershed is approximately 1,830 acres and stormwater generally flows west into Garrison Bay. It has one main drainage basin with a defined outlet (Mud Bay Road) (Figure 11). There is a total elevation drop of about 850 feet across the watershed. The watershed is characterized by steep slopes in the upper elevations, gentle slopes up to about 5 percent in the middle portion that flatten to about 1 percent toward the bottom. Drainage in the watershed crosses several County roads in culverts including West Valley Road, Blazing Tree Road, and Yacht Haven Road. Existing land uses in Westcott Bay and Garrison Bay are mostly designated forestland with some single family residential, agriculture, and parks.

Garrison and Westcott bays are the primary shellfish harvest areas (mussels, clams, and oysters) on San Juan Island. There is an active sea farm in Westcott Bay. Garrison Bay, which is bordered by English Camp National Historical Park, is a popular recreational harvesting area. Existing impervious cover in Westcott Bay is 3.2 percent and is expected to rise to 15.5 percent at build out. This is the highest increase in impervious area projected for County watersheds. Following closely is Garrison Bay watershed, where existing impervious cover is 1.1 percent and is expected to rise to 8.7 percent at buildout.

Water Quality Conditions

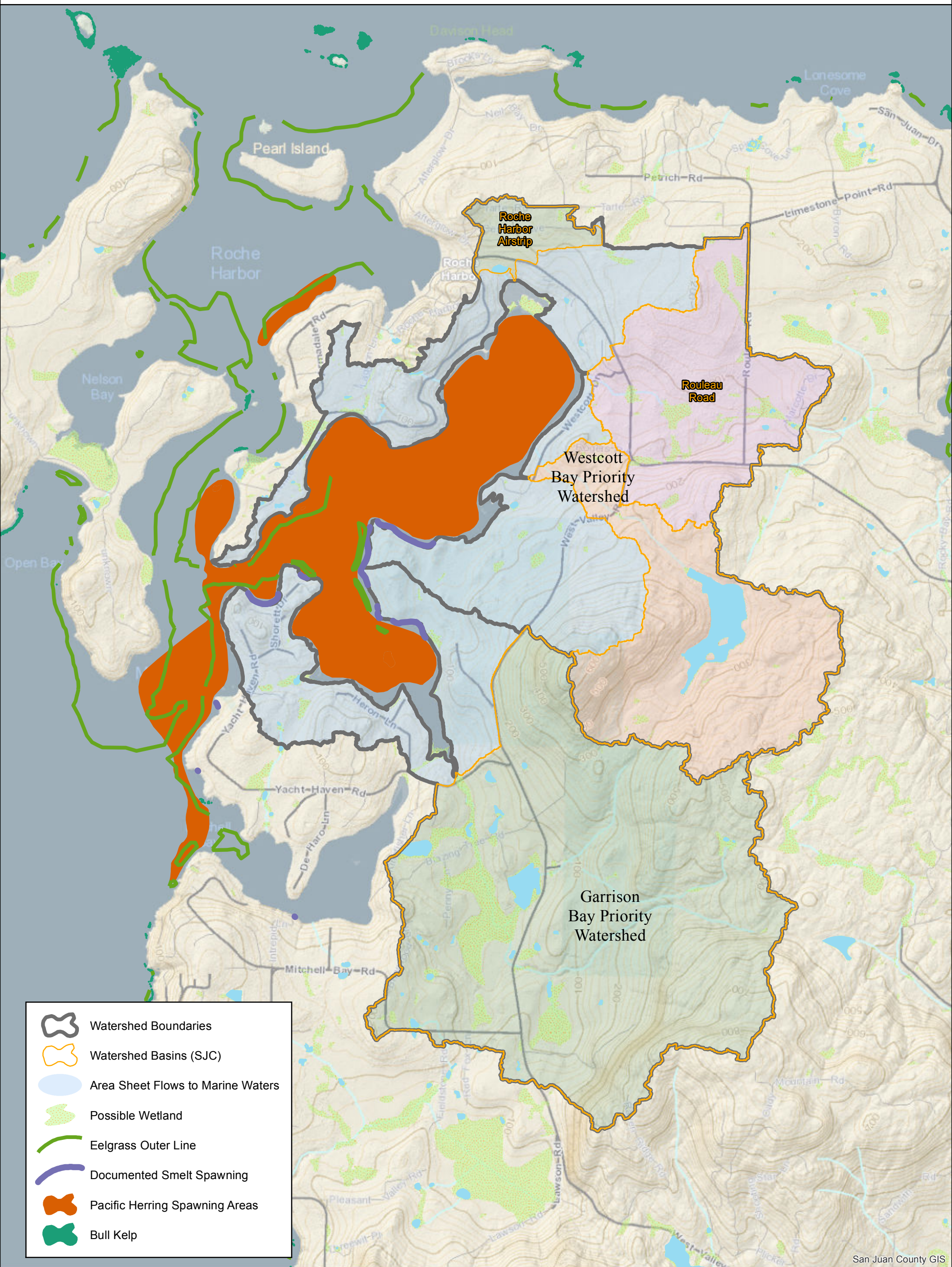
Results of 2012–2013 SJC pilot stormwater monitoring for Westcott and Garrison bays are reported in Stillwater Sciences (2014a) and summarized in the companion Volume 1 of this study (Herrera et al. 2014). 2013–2014 results are reported in Stillwater Sciences (2014b). Garrison and Westcott Bay sites exhibited relatively high dissolved oxygen during the first 2 years of the pilot study, consistently greater than 8.0 mg/L, the Ecology 1-day instantaneous minimum criterion. Bacteria concentrations were generally low, with only occasional occurrences of fecal coliform above Ecology’s freshwater instantaneous maximum of 100 CFU/100 mL during 2013–2014 sampled storm events. Westcott Bay sites exhibited moderate to high total nitrogen (0.6–3.3 mg/L) and total phosphorus (30–1,400 ug/L) compared with national database values, while lower total nitrogen (1–1.1 mg/L) and total phosphorus (40–70 ug/L) concentrations were measured at Garrison Bay sites. Sites in both watersheds also exhibited the lowest pH values measured during 2013–2014, with the median value across all storm events falling below the Ecology 6.5 s.u. instantaneous minimum for Garrison Bay sites, including a site considered a reference location.

Ecological Conditions

Westcott and Garrison bays are both significant spawning areas for Pacific herring and the north shoreline of Westcott Bay contains suitable habitats to support oyster beds. The forested shoreline of both bays provides habitat for surf smelt spawning. In Garrison Bay, sand lance and surf smelt spawning beaches are present primarily in Horseshoe Bay and along the eastern shoreline. Dungeness crab is found in both bays. Tidal wetlands are present near Garrison Drive and near the stormwater discharge point at the south end of the bay.

There is concern about reported eelgrass (*Zostera marina*) loss in Westcott Bay. Observed native eelgrass losses in shallow embayments in San Juan County have generated widespread concerns about the condition of *Z. marina* in the County. In particular, the loss of *Z. marina* at the head of Westcott Bay between 2001 and 2003 is the largest and most recognized *Z. marina* decline known in the San Juan Islands (Schanz et al. 2010). The presence of *Z. marina* throughout Westcott Bay was documented by Washington Department of Natural Resources (DNR) in 2000 and 2001 (Berry et al. 2003). In February 2003, an extensive loss of approximately 20 hectares of *Z. marina* was discovered during an annual Pacific herring spawn survey conducted by the Washington State Department of Fish and Wildlife (Wyllie-Echeverria et al. 2003). By 2007, the overall distribution of *Z. marina* changed from a virtually continuous ring along the shoreline of Westcott Bay reported in 1998 to very small and scattered *Z. marina* stands in 2007 that only persisted in close proximity to the entrance of the bay.

Alarmed by the drastic *Z. marina* losses in Westcott Bay, several scientific groups including scientists from the University of Washington, Friday Harbor Laboratories, US Geological Survey, Pacific Science Center, Friends of the San Juans, and DNR conducted initial multidisciplinary investigations in Westcott Bay and other sites in the San Juan Island Archipelago in order to identify the causes of the observed *Z. marina* declines (e.g., Wyllie-Echeverria et al. 2003; Dowty et al. 2007). Based on initial field observations and discussions, high levels of turbidity emerged as a central hypothesized stressor causing *Z. marina* decline at the head of Westcott Bay (Dowty et al. 2007).



San Juan County GIS



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1 in = 2,000 feet

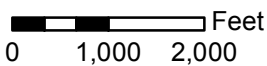


Figure 11:
Overview of Westcott / Garrison Bay Watershed
Showing Drainage Basins and Aquatic Resources

A more recent study of *Z. marina* transplants in Westcott Bay found causes of the die off to likely have been from a combination of different factors that they found affected the transplants. These factors included high water temperatures (daily maxima as well as mean values) in combination with green algae coverage and accumulation of snail spawn acting as stressors (Schanz et al. 2010). Moreover, *Z. marina* particularly at the head and inner bay, may suffer from high sediment sulfide concentrations during hypoxic or anoxic events in late summer and fall and during extreme low tides (Schanz et al. 2010).

Nutrient over-enrichment caused by anthropogenic activities has been considered a major cause of seagrass (eelgrass is a type of seagrass) decline worldwide (Orth et al. 2006). Increased nutrient levels in the water column can promote the proliferation of algae in seagrass beds (Moore and Wetzel 2000), which can reduce available light for seagrasses and compromise their ability to survive in the high sulfide levels typical of estuarine sediments. However, Schanz et al. (2010) reported low summertime nutrients in the Westcott Bay water column and hypothesized nutrient limitation, rather than over-enrichment, as a cause of *Z. marina* decline. Recent monitoring of nutrients (nitrogen, phosphorus) in stormwater (wintertime) discharges to Westcott Bay indicated low to moderate levels of nutrients in stormwater compared with other locations in Puget Sound; while comparison of nitrogen content in sediments indicated that they may be generally elevated compared with regional levels (Stillwater Sciences 2014a,b). Both monitoring studies indicate a need for further characterization of water column and/or sediment nutrient content in Westcott Bay, which may help to elucidate potential links between eelgrass health and water quality conditions in this location, as well as other eelgrass beds in San Juan County.

While, to date, no direct connection between the loss of eelgrass and stormwater discharges has been made, it is an ongoing concern; and the County plans to continue to monitor stormwater in these watersheds.

Reported Stormwater Issues

The following sources were reviewed to evaluate discrete stormwater problems in the Westcott/Garrison watershed:

- Citizen reported stormwater problems via the San Juan County Stormwater Issue Reporting Website
- County Public Works institutional knowledge of stormwater problems

No major stormwater problems with identified in the watershed from either of these sources.

PROGRAMMATIC ALTERNATIVES

Volume 1 of this report recommended a series of countywide and UGA focused stormwater programs (called programmatic alternatives) to assist with stormwater management issues that could be addressed by citizens or the County on a voluntary basis or that otherwise cannot be solved by capital improvement projects. These recommendations were presented to the CSWAC, narrowed down, and were then further developed for this report.

Two programs are UGA focused and include:

- Incentivize Rain Gardens and Stormwater Planters
- Incentivize Rainwater Harvesting

Five other programs have a countywide focus and include:

- Retrofit Ditches
- Maximize Use of Existing Ecological Systems through Watershed Planning
- Retrofit Problem Ponds
- Support Neighborhood-Based Stormwater Management Solutions
- Coordinate Stormwater Planning with Transportation

A summary of each program recommendation is provided below that includes a discussion of the problem, the suggested solution along with a list of implementation steps, benefits that would be obtained, other resources or considerations where helpful, and a high level cost estimate where applicable.

UGA Focused

Incentivize Rain Gardens and Stormwater Planters

Priority Watersheds: East Sound and Fisherman Bay

Focus Areas: Eastsound Village UGA, Lopez Village UGA

Rain gardens and stormwater planters are vegetated areas that collect and filter stormwater runoff through layers of vegetation and soil; see Figures 12 and 13. The plants and soil filter sediment, metals, nutrients, bacteria, and oil. These planters can either infiltrate stormwater or they can store and slowly release water to the storm drain. Even where infiltration is infeasible these systems can significantly reduce the volume and flow rate of stormwater released from a site by providing detention in the soil and encouraging evapotranspiration through the plants and soil. Rain gardens and stormwater planters provide ancillary benefits that traditional systems do not, such as wildlife habitat and enhanced landscaping.

Problem Description

In San Juan County development and growth has altered the watershed hydrology in several ways including increasing stormwater flows and volumes. This change in flow commonly results in increased erosion and sedimentation of ditches, ponds, and streams. Additionally, we know that changes in land cover can result in higher concentrations of pollutants, e.g., nutrients, metals, and bacteria in stormwater that can be toxic to humans, wildlife, and aquatic life.

Sediment, nutrients, trace metals, petroleum hydrocarbons, bacteria, and organic chemicals are common pollutants found in stormwater runoff and these are expected to be found in higher concentrations in San Juan County as areas develop. Water quality monitoring in San Juan County indicate that low dissolved oxygen and high fecal coliform bacteria concentrations are water quality concerns in surface water. Ten locations in San Juan County priority watershed are listed in Ecology's 2012 303(d) list as "waters of concern" (Category 2) or "impaired" waterbodies (Category 5) with respect to dissolved oxygen, pH, or bacteria (Herrera et al. 2014; Stillwater Sciences 2014a, 2014b).

Rain gardens and stormwater planters can provide water quality treatment, detention, and onsite management of stormwater flows; however, private developers and landowners are not likely to opt for these facilities when they are not required to under current County code.

A study conducted by the City of Portland Bureau of Environmental Services found that the top barriers preventing residents from installing stormwater management facilities were financial factors, lack of information, and the permitting process. Common issues described by residents include the belief that stormwater management is a municipal problem,

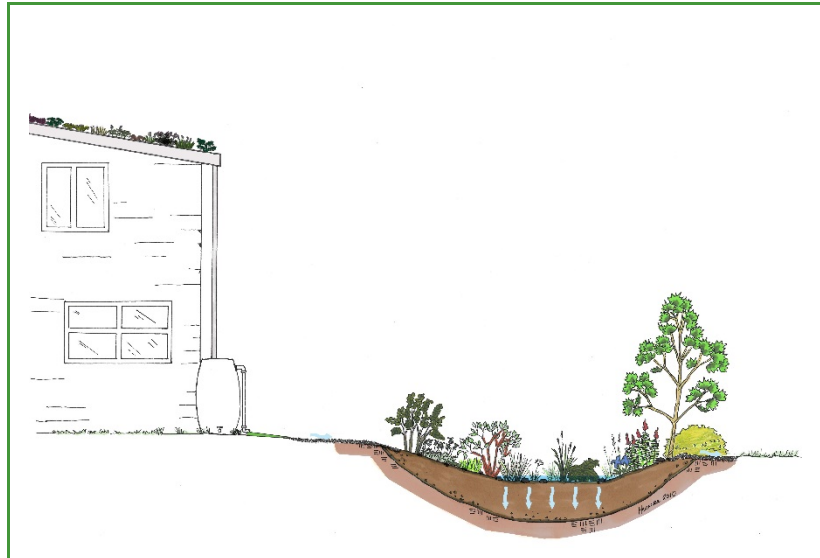


Figure 12. Illustration of Rain Garden.

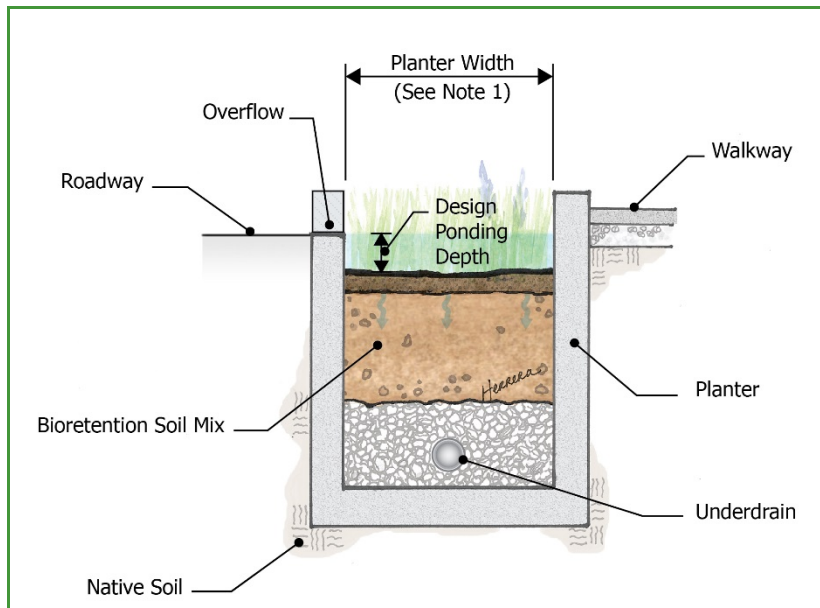


Figure 13. Illustration of Stormwater Planter.

difficulty with government bureaucracy, and a lack of information about program alternatives and facility effects on property (HANSA|GCR 2008a). Cost is the number one concern for homeowners and non-residential property owners (HANSA|GCR 2008b). Other issues identified include time commitment, property dedication (i.e., loss of use), and engaging the permitting process (HANSA|GCR 2008b).

Problem Solution

Several Puget Sound jurisdictions have implemented incentive programs to encourage commercial and residential property owners to manage stormwater on site using rain gardens and stormwater planters. These programs vary in the type of incentives provided, which are summarized in Table 4. Incentive programs typically include one or more of the following mechanisms:

- Utility fee reductions, such as reduced stormwater utility rate in return for installation of stormwater facilities
- Construction cost assistance, such as partial reimbursement for facility construction costs or low interest loans
- Technical assistance, such as siting, design, and permitting support
- Permitting assistance, such as streamlining the process to provide faster review times for retrofit projects
- Post construction support, such as financial or technical assistance with operations and maintenance
- “Green” recognition

Jurisdiction	Program	Incentive
City of Seattle	Rainwise Rebate Program	\$3.50 per square foot of runoff controlled.
Kitsap County	Rain Garden Cost-Share Program	Half the cost of the garden, up to \$1000, and planning and design assistance.
City of Shoreline	Soak it Up LID Rebate Program	\$2.00 per square foot of runoff controlled with a minimum of 400 sf and maximum of 800 sf.
City of Puyallup	Rain Garden Program	Up to \$1,000 for materials.
Thurston County	Rain Garden Incentive Program	Up to \$400 for plants and/or compost.
City of Lake Forest Park	Environmental/Legacy Mini-Grant Program	50% up to \$1,000 for single-family rain gardens or up to \$2,000 for community organizations.
City of Tacoma	Residential Rain Garden Rebate Program	\$2.00 per square foot of runoff controlled (up to \$2,000). Soil testing and design assistance.
City of Olympia	Rain Garden Incentive Program	Up to \$200 for plants and/or compost for limited number of applicants.
City of Lacey	Rain Garden Reimbursement Program	Up to \$200 for plants and/or compost for limited number of applicants.
City of Bellingham	Lake Whatcom Homeowner Incentive Program	100% of materials and 75% of services, up to \$6,000. Siting, design, and permitting assistance.
City of Everett	Rain Garden Rebate Program	Up to \$2,500.

In general, the incentive programs in the Puget Sound region provide construction cost assistance, technical assistance, and permit streamlining. Kitsap County and the City of Tacoma have incentive programs that provide technical assistance that may include a staff site visit, facility siting and sizing, and plant selection. The City of Olympia and City of Lacey started rain garden programs that provided rebates, initially for only ten applicants. Seattle's Rainwise Program provides technical and financial assistance for private property owners to construct rain gardens that manager impervious surface. The value of financial assistance is determined based on the contributing impervious area managed at a rate of \$3.50 per square foot for projects that manage up to 2,000 square feet of impervious area. For example, a system that manages 2,000 square feet of impervious area would be reimbursed for \$7,000 (i.e., 2,000 square feet times \$3.50 per square foot). The Rainwise program also has quality assurance elements including the requirement to use a contractor who has completed specific Rainwise installation training.

San Juan County should consider the following program elements to incentivize rain garden and stormwater planter retrofit projects on private properties:

- Full or partial construction cost assistance via grants, reimbursements, material supply (e.g., bioretention soil), or low interest loans
- Technical support for planning, siting, design, and permitting and operations and maintenance
- Post-construction inspection
- Post construction agreement for operations and maintenance via funding, labor technical assistance, or materials (e.g., mulch)

There are many technical resources available that provide assistance in design and construction of rain gardens in the Puget Sound region. Washington State University has developed a rain garden handbook for Western Washington (Hinman 2013). The Washington Department of Ecology has a technical guidance manual (Hinman 2012) and a maintenance manual for low impact development facilities (Herrera and WSC 2013). A rain garden handbook for the San Juan Islands has been developed by the San Juan Islands Conservation District and includes a list of contractors and material suppliers for rain gardens (Stewardship Network of the San Juans 2014).

An incentive program in San Juan County will educate landowners about and encourage the use of rain gardens and stormwater planters. Increased adoption of private stormwater facilities can potentially reduce the burden on the stormwater utility in the future. An incentive program that utilizes one of the above incentive mechanisms could gauge interest and provide a low-cost starting point for the County with the potential for growth in the future.

An incentive program should be made easy to participate (e.g., single point of contact, clear guidelines). The County should consider the highest priority motivators for homeowners and private landowners. The program should emphasize the direct connection between stormwater quality and ecological health and degradation of receiving waters.

Benefits

- Reduced pollutant loads (pollutants lost to infiltration)
- Reduced stormwater input to regional stormwater facilities
- Replenish groundwater, if water is infiltrated in facilities
- Provide native plant habitat for wildlife (native plants are not required for rain gardens or stormwater planters but are preferred as they also provide wildlife habitat)

Cost Estimate

Table 4 provides example costs for different types of incentive programs. San Juan County could begin by offering as little as \$200 for plants and/or compost for a limited number of applicants such as the programs offered by the cities of Lacey and Olympia to test public interest and response. Administering the program for a limited number of applicants is estimated to take about 40 hours annually.

Typical rain garden or stormwater planter costs range from \$1,000 to \$7,000 depending on the area being managed, site challenges, and aesthetic taste of the owner. This range is based on the following from our experience:

- Typical area managed ranges from 200 sf to 1,000 sf.
- Typical bottom area is 5 percent of the area managed (consistent with presizing provided in Ecology List#1 [Ecology 2012]).
- Footprint is two times the bottom area. (Footprints larger than two times bottom area may be preferred and cost would vary accordingly.)

Higher or lower costs are possible. For example, a very small rain garden for very small tributary area and good infiltrating soils will be lower cost and one with expensive plants or boulders will be higher.

Incentivize Rainwater Harvesting

Priority Watersheds: East Sound and Fisherman Bay

Focus Areas: Eastsound Village UGA, Lopez Village UGA

Potable rainwater harvesting systems provide several benefits including reduction of stormwater runoff volumes and flows, restoration of natural hydrology, and reduced demand on groundwater for water supply. Rainwater can be used as the sole source or as a supplement to household potable water uses and irrigation. Photographs of two types of cisterns are shown in Figures 14 and 15 (for household and commercial use, respectively).

Problem Description

There are several barriers to adoption of rainwater harvesting in cisterns for potable water use on a household level. A major obstacle is ensuring compliance with federal and local standards for drinking water, which can be complex and difficult for homeowners to navigate.

Rainwater harvesting systems can have a high capital cost which may discourage adoption despite long-term cost savings. There are more long-term operations and maintenance tasks associated with a rainwater harvesting system than with an owner using a well system or public water system. In addition, the majority of rain falls between November and March requiring a large storage system to supply enough water through the dry months of summer.

Potable rainwater harvesting systems must include continuous disinfection, filtration, annual service of equipment, and an approved operations and maintenance plan. Systems must comply with standards developed by the USEPA and the National Sanitation Foundation, the Food and Drug Administration, or the American Water Works Association. San Juan County Code provides brief guidance for alternative individual water systems including rainwater catchment. Additional technical support and incentives are necessary to encourage homeowners to adopt potable rainwater catchment systems.

Rain barrels provide the same hydrologic benefits as a potable rainwater catchment system on a smaller scale. Rain barrels can provide storage and supply for irrigation with a minimal space requirement. If used solely for irrigation, treatment is not required. The barriers for adoption of rain barrels are generally the inconvenience of making the change and a lack of education on how they work and their benefits.

Problem Solution

Potable rainwater harvesting incentive programs exist all over the country with some examples listed in Table 5. In general, incentive programs exist in dry regions where water supply is problematic; however, a program in San Juan County can provide the same benefits of restoring natural hydrology, protecting groundwater, and providing another source of potable water besides groundwater particularly as San Juan County has generally lower rainfall all year round than most of Western Washington.



Figure 14. Residential Cisterns for Storing Rainwater Stored Under a Deck.

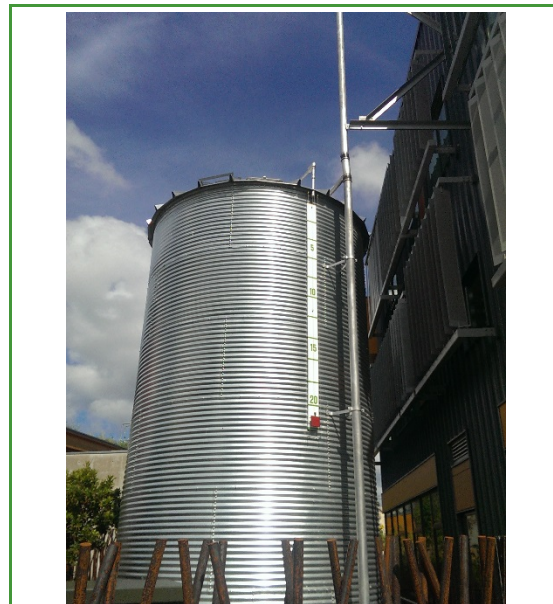


Figure 15. Commercial Cistern Included as an Architectural Element.

Table 5. Rainwater Harvesting Incentive Programs.

Jurisdiction	Program	Incentive
City of Austin, Texas	Rainwater Harvesting Rebate	\$0.50 per gallon for non-pressurized systems, \$1.00 per gallon for pressurized systems (not to exceed 50% of project costs or \$5,000).
City of Tucson, Arizona	Single Family Residential Rainwater Harvesting Incentives Rebate Program	\$0.25 per gallon for less than 800 gallons, \$1.00 per gallon for 800 gallons and greater (up to \$2,000).
Montgomery County, Maryland	RainScapes Rebates Rewards	\$1.00 per gallon up to \$500 for residential parcels and up to \$2,000 for commercial and industrial parcels (minimum 250 gallons).
Manatee County, Florida	Water Conservation Rebate Program	50% of cost up to \$500 for a minimum of 2,500 gallons.
Santa Monica, California	Rain Barrel and Cistern Rebate	\$2,000 for 500 gallons and greater, \$500 for 200 gallons and greater, \$200 for less than 200 gallons.

City of Seattle’s Rainwise Rebate Program includes a cost share program for cisterns that provides \$3.50 per square foot of contributing roof area. The program requires the use of an approved contractor to install the cistern and an inspection by program staff upon completion. Seattle provides training for contractors to ensure facilities are designed and installed properly.

An incentive program in San Juan County could educate homeowners about, and encourage the use of rain barrels or cisterns and other low impact development features in the County, which can potentially reduce future burden on the stormwater utility. A program should consider the program elements described in the rain garden section about how to incentivize onsite stormwater management. An incentive program should make participation easy (e.g., single point of contact, clear guidelines). The County should consider the highest priority motivators for homeowners and private landowners. The program should emphasize the connection between stormwater quality and ecological health and degradation of receiving waters.

Benefits

- Reduce flooding
- Provide water for irrigation or potable water to reduce pressure on groundwater supply
- Replenish groundwater where there is septic system treatment of wastewater or when used for irrigation

Cost Estimate

Table 5 provides example costs for different types of rainwater harvesting incentive programs. San Juan County could begin by offering 50 percent of cost up to \$500 for a

minimum of 2,500 gallons similar to what Manatee County in Florida has implemented. This could be offered for a limited number of applicants each year or every other year. Administering the program for a limited number of applicants is estimated to take about 40 hours annually.

Cistern systems with pumps range from \$2,500 to over \$10,000 for a non-potable system and \$10,000 to over \$35,000 for a potable system. The costs vary depending on the size, rainfall at the site, if usage is part-time seasonal or full-time, building configuration, whether the system is a retrofit or for new construction, site challenges, whether the cistern is above or below grade, and aesthetic taste of the owner. This range is based on the following from our experience:

- Assumes above grade cisterns range from \$1 to \$3 per gallon
- Assumes below grade cisterns range from \$2 to \$5 per gallon
- Assumes non-potable cistern size is 400 to 4,000 gallons
- Assumes potable cistern size is 10,000 to 20,000 gallons

The low end of this range could be a single above grade plastic tank and simple jet pump supplying toilets and irrigation. The higher end of this range would be a potable system with an underground tank serving a whole residence. Systems with pumps can be installed by a knowledgeable homeowner but are more typically installed by a contractor.

The cost of a typical rain barrel ranges from \$100 to \$2,000 depending on the size, site challenges, and aesthetic taste of the owner. This range is based on the following from our experience:

- Assumes rain barrel size is 50 to 400 gallons
- Cost per gallon range of \$0.50 to \$5

The low end of this range could be a simple 50-gallon reused plastic rain barrel installed by the homeowner. Most systems use new plastic tanks or corrugated metal tanks with plastic liners. High end of this range could be below grade tank with installation by a contractor.

Countywide Focus

Retrofit Ditches

Priority Watersheds: All

Focus Areas: Orcas and San Juan Islands

Enhancement of roadside ditches is an opportunity for the County to provide more water quality treatment within the right-of-way system for roadways and developed areas at relatively low cost.

Problem Description

Ditches are the primary stormwater conveyance in San Juan County. Roadside ditches convey runoff from the right of way and neighboring developments to receiving waters. County ditches have been designed to carry anticipated flows; however, development has strained the capacity of many roadside ditches in urban growth and steep rural areas. Many of the County's ditches have narrow widths making maintenance difficult. High groundwater, bedrock, sedimentation, and steep slopes are contributors to limited ditch capacity in San Juan County.

Roadside ditches have the potential to provide flow attenuation and water quality treatment of stormwater runoff; however, many existing ditches in the County are not designed to provide these additional benefits. Steep and narrow ditches can increase stormwater flow velocity causing scour. Erosion and sedimentation can clog ditches, deposit soil on roadways, cause localized flooding, and adversely affect downstream water bodies.

The Rosario Neighborhood on Orcas Island is an example of an area where roadside ditches do not provide adequate drainage conveyance for a steep and densely developed area. Gravel roads contribute to sedimentation in the roadside ditches and under capacity ditches flood roadways and private property during moderate rain events.

Problem Solution

A series of recommended ditch retrofits will enable the County to reconfigure, construct, and maintain appropriate and effective drainage ditches. Retrofitting ditches can reduce flooding and erosion, and provide removal of sediment and pollutants. Management and treatment of flow in roadside ditches relies on filtration, sedimentation, infiltration, contact with organic matter, and flow attenuation (Otak 2012).

The first step is to identify areas where ditches are problematic or where there is a treatment opportunity. Problem ditches are typically under capacity, clogged with sediment, or eroded. Problem ditches do not provide adequate drainage and are likely generating sediment and transporting sediment downstream. Roadway flooding or ditch erosion is an indication that the roadside ditch is a problem. UGAs and densely developed areas with high use roadways and higher pollutant generation are where retrofitting ditches to provide water quality treatment have the greatest potential benefit.

Retrofit components to reduce erosion include lining ditches (see *Ditch Stabilization* section below), widening and flattening ditches, and installing check dams. Retrofit options to improve water quality treatment include widening and flattening the ditch, installing check dams, planting vegetation, and dispersing flow. Additional water quality enhancements include increasing ditch flow length (contact time) and amending the soil (Otak 2012).

Widening and Flattening

Widening and flattening ditches creates shallower slower flow that can increase infiltration and maximize contact time with vegetation and amended soils. Topographic conditions and available right-of-way are factors that need to be considered prior to widening and flattening ditches.

Ditch Stabilization

Eroding ditches can be stabilized by planting vegetation if the ditch longitudinal slope is less than 6 percent and velocities are under 5 feet per second; rock lining should be considered when slopes or velocities are greater than 6 percent; piping should be considered when the longitudinal slope exceeds 9 percent (King County 2007, 2009). Synthetic or organic coconut blankets can be effective for any slope and can be used with or without vegetation. Plant ditches by direct seeding or seeding with slope mat protection if necessary. Widening ditches and constructing more gradual side slopes (3 horizontal-1 vertical is ideal) is another way to reduce flow velocities and stabilize ditches when space allows.

Check Dams

Check dams slow the flow of water through steep ditches by spreading the flow across the width of the ditch and allowing water to temporarily pond behind the dams. More infiltration occurs as water is slowed. Check dams can be appropriate for ditch stabilization on slopes greater than 3 percent (King County 2007) and even shallower slopes when the objective is treatment. Hard check dams can be constructed out of compacted soil, gravel, rock, or concrete. Soft check dams can be constructed using materials such as coir logs, straw bales, straw wattles, and mycelium impregnated fiber logs.

Vegetation

Leafy plants dissipate flows, filter pollutants, and stabilize slopes. Plant species should be carefully selected to match ditch hydrologic conditions such as duration of inundation and drought, as well as availability of sunlight. The design configuration and selected plant types should provide adequate sight distances, clear zones, and appropriate setbacks for roadway applications in accordance with County standards.

Dispersion

Dispersion of flow within the ditch or over an embankment will reduce channelization and erosion, promote treatment, and encourage infiltration. Dispersion should be avoided in locations where infiltration is infeasible.

Flow Length

Increasing the length of ditch prior to discharge to a receiving body will increase the water quality treatment provided.

Soil Amendment

Amending native soil or replacing native soil with imported, e.g., bioretention, soil can promote infiltration, treatment, flow attenuation, and plant growth. Soil compaction should be avoided during construction and maintenance. Figure 16 provides an example of a ditch amended with bioretention soil.

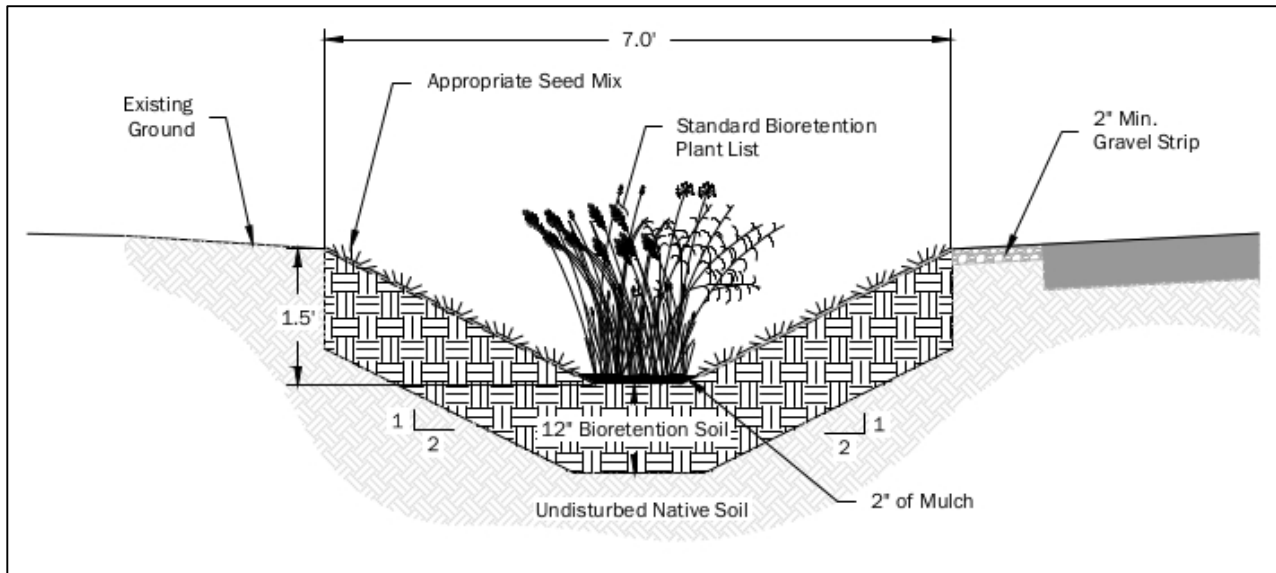


Figure 16. Ditch Section with Amended Bioretention Soil.

Identification of Candidate Ditches for Retrofit

Annual inspection of ditch culverts is currently conducted by the County. During these inspections, County staff should identify candidate ditches for retrofits using a ditch inspection checklist (example provided below). The objective of the inspection is to identify two different types of ditches:

1. Ditches that are eroding and good candidates for stabilization.
2. Ditches in the UGA or along heavily trafficked roads where the slope is gradual and there is adequate space to implement retrofits that improve treatment performance (e.g., widening and flattening, with amended soils and plantings). Inspection and maintenance of retrofit ditches should be added to annual maintenance activities.

Ditches should be inspected to ensure they are performing as designed. Maintenance should be performed to mow plants, remove sediment, and control erosion.

Developing a ditch retrofit program will include the tasks listed below. Some tasks have higher costs in the first year to initiate the program and construction costs will be higher in later years as the retrofit program is ramped up (Table 6).

- **Task 1. Problem Ditch Inventory** - Complete ditch inspection checklist during regular inspection, including development of the data collection and record keeping system.

- **Task 2. Prioritization of Retrofit** - Identify and prioritize retrofit opportunities based on ditch inventory information, impacts to property and environment, and available resources. The County should target a quantifiable length of ditch to retrofit each year.
- **Task 3. Retrofit Selection and Design** - Design retrofits to include one or more of the retrofit components described under *Problem Solution* in this section.
- **Task 4. Construction of Ditch Retrofit** - Actual length of ditch constructed each year will depend on results of Task 1 and 2 and available budget for construction. A typical water quality ditch retrofit will cost approximately \$50 per linear foot for construction (Herrera 2014).
- **Task 5. Maintenance and Inspection Plan for Retrofit Ditch** - Develop a plan to inspect performance of retrofit ditches and maintain vegetation and constructed features as needed.

Task	2015	2016	2017	2018	Notes
Task 1	\$17,000	\$3,000	\$3,000	\$3,000	For field time inspecting ditches in addition to existing inspection and maintenance work. Development of data collection system during first year.
Task 2	\$3,000	\$3,000	\$3,000	\$3,000	Assumes 20 hours per year of Engineering review of new data and ditch prioritization.
Task 3		\$1,500	\$3,000	\$3,000	Engineering cross-section and profile design. 10 hours per 1,000 linear feet of ditch.
Task 4		\$50,000	\$100,000	\$100,000	Assumes retrofit of 1,000 linear feet of ditch in the second year, and 2,000 linear feet of ditch each subsequent year.
Task 5			\$1,500	\$1,500	Assumes 10 hours per year of Engineer time to visit retrofit sites and decide on program modifications.
Total Cost	\$20,000	\$57,500	\$110,500	\$110,500	

Notes: Assumes \$150 per hour rate for Engineer.

Benefits

- Reduce erosion
- Reduce downstream sedimentation
- Improve water quality treatment
- Reduce flooding

Example Ditch Inspection Checklist

Below is an example of a checklist that could be used to identify ditches that are candidates for retrofit. These characteristics can be used in conjunction with the *Problem Solution* components listed in this section to identify the best enhancement design.

Cost Estimate

A cost estimate for a ditch retrofit program is provided in Table 6. The estimate is based on the assumption that ditch inspections will occur as part of the County's ongoing ditch maintenance program.

Maximize Use of Existing Ecological Systems through Watershed Planning

Priority Watersheds: All

Focus Areas: Eastsound Village UGA, Lopez Village UGA, False Bay

Use of natural systems such as existing wetlands, ponds, streams, swales, and ditches for stormwater management can effectively keep the public cost of stormwater management low while also being protective of the environment.

Problem Description

In some areas of the County, development and growth has increased runoff volumes leading to downstream flooding problems or more frequent standing water. As additional land is developed, we can reasonably expect property owners along these drainages to be further impacted by flooding and loss of developable property. In contrast, other nearby wetlands and drainages may have capacity and could benefit from more stormwater flow. Because stormwater management is determined on a project-by-project basis without benefit of a watershed-level understanding of water flow and watershed conditions, there is currently no avenue for watershed-based stormwater management solutions that could relieve stormwater pressure in some areas of a watershed while accommodating it in others. Developing watershed plans for priority basins would help provide that context.

Watershed scale planning would define the watershed landscape's natural capacity and limitations in order to develop more watershed specific stormwater requirements for development or capital projects that manage excess stormwater in ways that maintain and maximize use of existing resources. Critical drainage pathways would be evaluated to determine what hydraulic capacity there might be for added flow that would still be protective of biological resources, or whether biological resources would benefit from increased flow. This would require the development of hydrologic models to facilitate an understanding of each watershed studied.

Such watershed-specific studies would guide the selection of solutions within watersheds and identify projects that should be constructed, and property or drainage easements that should be acquired for flow and treatment benefits. Specific watershed studies could also identify whether onsite detention and treatment system requirements and impervious surface percent limitations should apply at thresholds that are more stringent for particular watersheds.



Inspector: _____

Date and Time of Inspection: _____

Ditch Location (intersection or culvert no.): _____

Field Analysis

Sedimentation:

Poor condition: Significant accumulation of sediment, obstruction of flow from over grown vegetation or other obstacle (ditch is at or over capacity), trash and debris, or reported flooding problems.

Good condition: Little to no sediment accumulation, no obstructions, no flooding problems.

Describe: _____

Filtration and Biological Uptake:

Poor condition: Sparse vegetation, unhealthy or invasive plant community.

Good condition: High vegetation coverage along bottom of ditch, healthy plant community

Describe: _____

Erosion:

Poor condition: Severe scour, channelization, or erosion visible.

Good condition: No scour, channelization, or erosion evident

Describe: _____

Desktop Analysis

Infiltration:

(Check San Juan County Soil Survey)

http://www.nrcs.usda.gov/Internet/FSE_MANUSCRIPTS/washington/WA055/0/SanJuanWA.pdf

Poor condition: Sparse vegetation, unhealthy or invasive plant community.

Good condition: High vegetation coverage along bottom of ditch, healthy plant community

Describe _____

Estimated longitudinal slope: _____ Distance to receiving water: _____

Name of receiving water: _____

Available space to widen ditch (consider ROW and utility conflicts)? Yes No

Evidence of groundwater seepage? Yes No

Is there a trail planned for the area? If yes, coordinate potential for associated trail with sponsoring group. Check trail plans: Yes No

<http://sanjuanislandtrails.org/>, <http://www.lopeztrails.org/>, <http://sjclandbank.org/>

Problem Solution

All of the watersheds reviewed for this study have some combination of water features along drainage flow paths to the sea and they play key roles in providing water quality treatment, flow control, and conveyance. Connecting wetlands, swales, and ditches in a network of small-scale features could allow flow reduction, water quality treatment, and habitat support to occur throughout a given watershed rather than at the bottom or just prior to discharge into a large receiving water body; this landscape-scale approach could be especially effective in agricultural areas.

Wetlands and swales are naturally effective treatment environments for bacteria and nutrients, which are the most prevalent water quality pollutants in the County. Maximizing the use of existing natural systems would be an effective and low cost way to improve the water quality issues of greatest concern in San Juan County. Use of natural systems would go hand in hand with ecological protection such that stormwater would receive treatment prior to discharge to a natural wetland or stream in accordance with Ecology's Stormwater Management Manual for Western Washington (Ecology 2012) and exceedance of thresholds for wetland hydroperiods would be avoided.

To evaluate the potential use of these systems for managing stormwater, watershed scale planning and hydrologic modeling should be performed to evaluate the capacity of existing drainage systems. Eastsound Village UGA has several large wetlands including the Eastsound Swale, North Shore Wetland, and Crescent Beach Wetland (Figure 17). Some of these natural wetlands may benefit from increased stormwater flow and could also provide water quality treatment. Similarly, Lopez Village UGA has Weeks Wetland. Many agricultural watersheds such as False Bay Creek have numerous streams and wetlands that are naturally occurring stormwater management resources.

The following are suggested tasks:

- **Task 1. Drainage System Inventory** - Inventory drainage system resources including wetlands, streams, swales, ponds, and ditches. Use GIS to prepare map showing key water features and major and minor flow paths (Figure 17).
- **Task2. Drainage System Field Assessment** - Assess the ecological condition of drainage features in the field to determine whether there is existing erosion, unstable banks, poorly established vegetation or other indicators the drainage feature is at capacity and is ecologically impacted. Field assessment tools that can assist with identifying whether a drainage feature can accommodate additional runoff include the Properly Functioning Condition (PFC) developed by the Bureau of Land Management for riparian areas and lentic and lotic waters or the Stream Visual Assessment Protocol 2 (SVAP2), developed by the US Department of Agriculture (USDA) and Natural Resources Conservation Service (NRCS). It is a national protocol that provides an initial evaluation of the overall condition of wadeable streams, their riparian zones, and their instream habitats. Wetland areas should be rated using the Washington State Department of Ecology Wetland Rating System (Hruby 2014) to identify their hydrologic, water quality, and habitat function scores.

- **Task 3. Select Drainage System Features for Hydrologic Analysis and Conduct Survey** - Identify on a map those drainage features that have the most opportunity to provide flow control and water quality treatment in the watershed, in other words not ecologically impacted, based on their field assessed capacity for additional flow and their proximity to an existing problem or likely future development. These will be the drainage features modeled in the hydrologic analysis. Field survey of the existing storm drainage features or existing topography may be required for model input and would be collected during this task after key drainage features are selected.
- **Task 4. Collect Calibration Data** - Collect relevant groundwater, stage, flow, and precipitation data for calibrating a hydrologic and hydraulic model of the system. This process will be informed by information collected in Tasks 1 through 3 and will likely include installation of groundwater wells to monitor water levels in area wetlands, a precipitation gauge to collect rainfall data, and at least one flow meter to collect data on surface flows.
- **Task 5. Hydrologic and Hydraulic Analysis** - Develop and calibrate a hydrologic model such as EPA Storm Water Management Model (SWMM) or Hydrological Simulation Program-FORTRAN (HSPF) to evaluate the changes in flows and water levels that would result from the addition of more runoff into the drainage system from new development. Take into account the effects of proposed capital improvement projects on the natural systems. Calibrated model results can facilitate understanding of and identification of the drainage system's capacity and limitations for effectively managing stormwater.

Task 6. Check for Adverse Hydrologic Impacts - Evaluate the model results to determine whether the drainage flow scenario(s) would have adverse impacts on drainage features, especially wetlands and streams. For wetlands, hydrologic impacts of existing and future development as well as potential capacity of the wetland to receive more runoff could be based on the criteria defined in Guide Sheet 3B in Appendix I-D of the 2012 Stormwater Management Manual for Western Washington (Ecology 2012). For streams, hydrologic impacts could be assessed based on the guidance provided in Appendix I-A of the 2012 manual for Basin Planning Applied to Flow Control (Minimum Requirement #7) (Ecology 2012).

- **Task 7. Refine Model and Select Preferred Drainage Scenario** - Refine model and run iterations of drainage flow scenarios as needed to select drainage system alterations that are protective of ecological resources while providing improved flow control and treatment.
- **Task 8. Select, Design, and Implement Solution(s)** - The task would include selection of the preferred solution(s), project design, and implementation/construction.



This map is derived from San Juan County's Geographic Information System (GIS). It is intended for reference only and is not guaranteed to survey accuracy. The information represented on this map is subject to change without notice

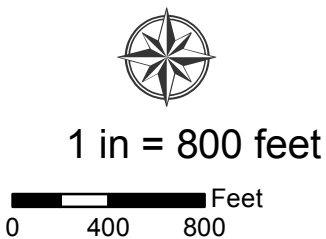


Figure 17:
Example of a Drainage System Inventory for Eastsound UGA

- **Task 9. Monitoring** - Conduct monitoring to identify whether there have been substantive changes in the ecological and physical condition of drainage features. Monitoring should be conducted annually following the introduction of additional flows for at least 2 years but could be reduced in frequency later if the drainage system is shown to have no adverse effects.
- **Task 10. Adaptive Management** - Identify contingency measures in advance of drainage system alterations that could be implemented should protective thresholds be exceeded.

Benefits

- Reduce flooding at lower cost
- Remove pollutants at lower cost
- Replenish groundwater
- Maintain native habitat through preservation of ecological resources²

Resources

- The US Environmental Protection Agency (USEPA) has watershed planning tools available at http://water.epa.gov/polwaste/nps/handbook_index.cfm.
- The Center for Watershed Protection also offers a number of useful documents and resources at <http://www.cwp.org/2013-04-05-16-15-03/watershed-planning>.
- USEPA's *Handbook for Developing Watershed Plans to Restore and Protect Our Waters* is available here: http://water.epa.gov/polwaste/nps/upload/2008_04_18_NPS_watershed_handbook_handbook-2.pdf

Cost Estimate

Table 7 provides a cost estimate to complete a study of how to maximize use of existing ecological systems for stormwater management through watershed planning including project construction. This cost estimate applies to Eastsound Village UGA only but is an example of typical associated costs for any watershed.

Retrofit Problem Ponds

Priority Watersheds: All

Focus Area: Instream ponds on private properties

² For example, the historical option to divert stormwater to pipes and then to East Sound has likely resulted in degradation of the hydrology of the Eastsound Swale. This assessment is based on observations of system hydrology over a twenty-five year period (A. Azous, Professional Wetland Scientist, Herrera Environmental Consultants, Inc., personal communication).

Table 7. Cost Estimate for Maximizing Use of Ecological Systems Program.

Task	2015	2016	2017	2018	2019	2020	Notes
Task 1	\$8,000						Initial field reconnaissance and GIS refinement.
Task 2	\$21,000						Develop field protocols and conduct field evaluation of physical and ecological conditions, write memo.
Task 3	\$9,000						Includes cost for limited topographic base mapping.
Task 4	\$26,000	\$11,000					Assumes automated monitoring system is installed and maintained monthly.
Task 5		\$9,000	\$20,000				Begin model development after first year of calibration data is collected.
Task 6			\$12,000				
Task 7			\$12,000				Initial solution definition and validation
Task 8				\$300,000	\$500,000		Based on cost for capital improvement project ES33 (West Airport Drainage Improvements)
Task 9						\$10,000	Ongoing cost of approximately \$10,000 to collect and QA data monthly.
Task 10							Future work. Cost depends on level of adaptation required.
Total Cost	\$64,000	\$20,000	\$44,000	\$300,000	\$500,000	\$10,000	

Notes:

Estimate assumes the work is performed by a consultant.

Costs for each task were based in the level of effort and material required for similar tasks on prior Herrera projects.

Retrofitting the outlet design of ponds that are within a fish-bearing stream to provide a minimum instream flow will help protect salmon spawning and rearing habitats and overall improve conditions for freshwater, estuarine, and marine species.

Problem Description

In San Juan County, there are hundreds of private ponds that collectively receive a large portion of runoff from agricultural lands, developed areas, and roadways. Ponds are used for stock watering, irrigation, recreation, and aesthetic enjoyment.

Ponds have many beneficial uses but they also allow for high rates of evaporation during the dry season, which can reduce available groundwater. Ponds generally have far lower plant diversity than natural wetlands, which substantially reduces their water quality treatment effectiveness. Moreover, many ponds in our County have significantly affected both the timing and volume of instream flows in County streams. This is because some ponds are designed such that they operate like bathtubs within a stream system, requiring they be filled before water passes downstream (Figure 18). This has the effect of preventing water needed for fish spawning from entering down gradient streams until later in the fall relative to historical conditions and may be directly affecting the viability of historical salmon runs. The effectiveness of ponds in allowing instream flow and has a direct impact on the condition of downstream receiving water bodies, especially fish-bearing streams.

Problem Solution

These issues could be improved through identification of problem ponds affecting fish species, and from strategic purchases of land or drainage easements that would allow the County to alter ponds located in important drainages where a retrofit could improve degraded instream flows, thus benefiting fish and other aquatic species. Retrofits would allow some water to pass through an instream pond to allow more downstream flow during the drier summer months, and especially during early fall.

This program could be limited to public outreach and education regarding the importance of instream flows and the multiple benefits a well-designed pond could have. In addition, the County could provide technical guidance on best pond retrofit designs and, in particular, outlet designs.

The following are suggested tasks for a public outreach-based effort:

- **Task 1. Public Education and Outreach** - Targeted public outreach program to reach out to pond owners in areas where downstream resources could benefit from pond retrofit. The County would provide guidance on ways to retrofit pond outlets in collaboration with the San Juan Islands Conservation District.
- **Task 2. Provide Technical Assistance for Pond Retrofit Designs** - County to assist willing owners with planning and design for their pond retrofit.

A cost estimate for this strategy is provided in Table 8 in the *Cost Estimates* section below.

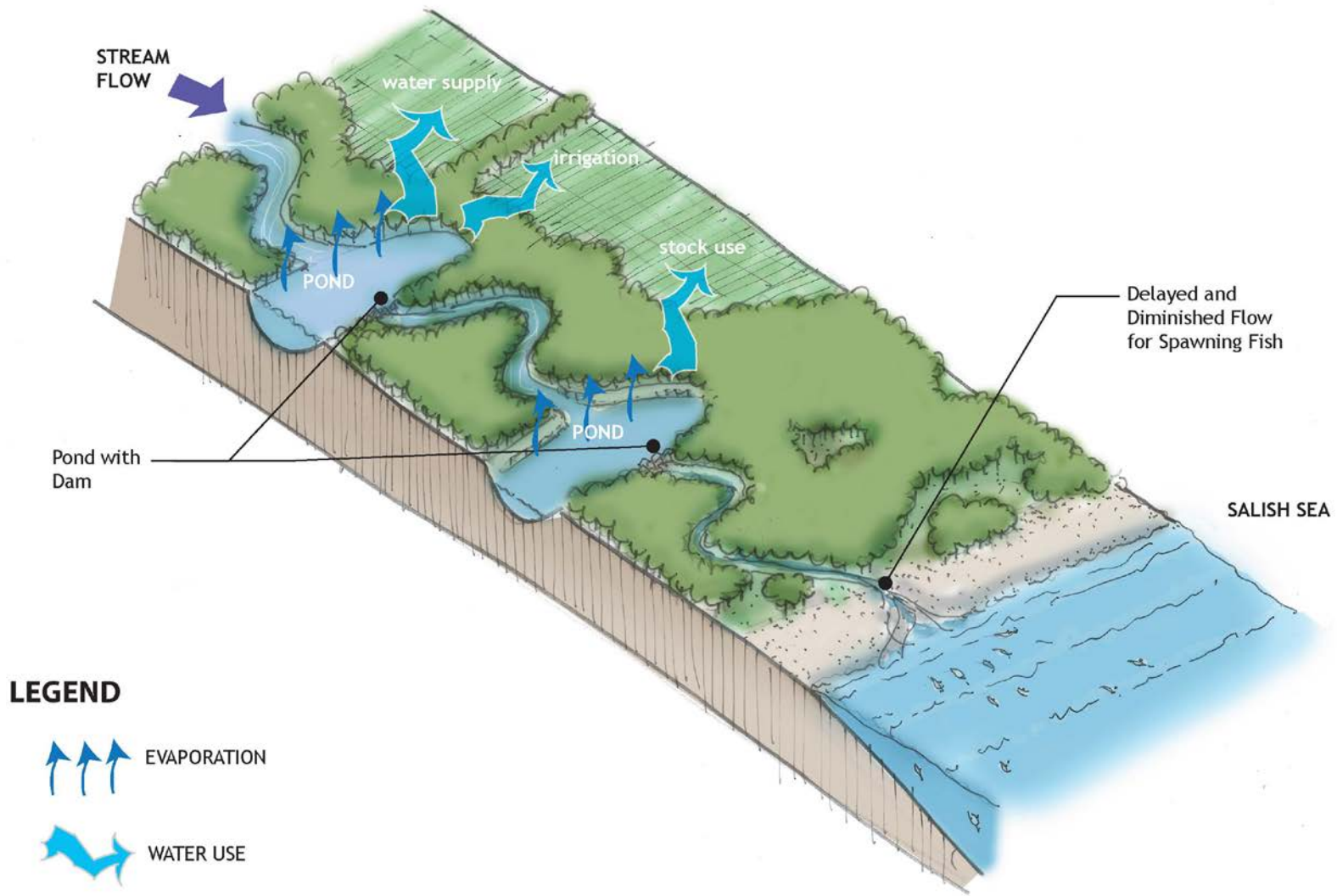


Figure 18. Illustration of How Instream Ponds can Delay and Diminish Stream Flows.

This programmatic recommendation is to address existing ponds that are adversely affecting downstream resources. As a separate effort, it may be prudent for the County to consider additional permit requirements for pond construction that would require minimum instream flows if a pond is connected to a Type F (fish bearing) stream as well as implementation of best management practices for construction of all ponds connected to a drainage network.

The County could also develop its own retrofit program that would include identification, prioritization, design, and construction of pond retrofits. A cost estimate for this strategy is provided in Table 9 (see *Cost Estimates* section below). The following are suggested tasks for the County should it develop a pond retrofit program:

- **Task 1. Problem Pond Inventory** - Conduct a desktop study to locate and identify problem ponds that are feasible and appropriate to retrofit. Use GIS and record drawings (if available) to facilitate identification of known problem ponds and potential problem ponds.

Inventory features gathered, at minimum, would include:

- Is pond located within a stream?
- Is the stream fish bearing (Type F)?
- Does the pond have known instream flow issues? (If not known, assume it does.)
- What is the location of the pond within the watershed? Headwaters, mid-elevation, or shoreline (within 1,000 feet of the shore).
- What is the estimated pond area

- **Task 2. Field Assessment of Candidate Problem Ponds** - Confirm pond problems, verify feasibility of retrofit, gather information on site-specific constraints, and design requirements.

Inventory features gathered, at minimum, would include:

- What is the estimated pond volume?
- How is the outlet controlled? Fixed dam or weir? Controllable flow?
- Confirmation of drainage flow path identified in GIS

- **Task 3. Prioritize Ponds for Retrofit Implementation** - Rank retrofits based on severity of existing problem and benefits associated with the retrofit.
- **Task 4. Retrofit Design** - Design pond retrofit elements (see suggested retrofit elements below).
- **Task 5. Construct Pond Retrofit** - Includes construction and materials to complete pond retrofit.
- **Task 6. Develop Maintenance and Monitoring Plan** - Develop maintenance and monitoring plan to monitor performance of retrofit over time to ensure no detrimental impacts on watershed resources.
- **Task 7. Acquisition of Drainage Easement or Fee Title.**

Retrofit Options

In order to provide instream flow during the dry season, a pond outlet must allow water to pass through in some fashion. The size and design of the outlet will depend on the contributing watershed area, pond size, and minimum depth desired by the pond owner. Weir designs that will allow water to pass while retaining pond depth include weirs that use vertical or V-notches in the weir. Figure 19 illustrates an example showing a log weir constructed with a chain saw that has a horizontal notch and a vertical cut within the horizontal notch. This or a similar type design will allow water to flow over a longer season. Other options are to construct a concrete cradle in which one to three boards can be placed to incrementally lower pond depth as the flow from the pond ceases (i.e., stop logs or flashboards). A combination of a flashboard weir with a V-notch or vertical cut in one or more of the boards could provide additional flexibility. A more expensive but effective solution would be to install a flow control structure that includes a pipe through the pond embankment such as what is typically used for stormwater detention ponds.



Figure 19. Sawn Log Weir with Horizontal and Vertical Notches.

Another option is to install an inline water level control structure through a pond dam, which will prevent debris from entering a pond inlet and allow a pond owner to control flow. An example of this type of feature can be found at this website:

<http://www.agridrain.com/watercontrolproductsinline.asp>

Many pond owners are concerned about the aesthetics of having their pond levels drop several feet over the summer season and are reluctant to allow more water flow to be diverted downstream. To improve this condition, ponds can be redesigned so there are one or more benches corresponding to seasonal water levels (e.g., one bench would be designed at a

height corresponding to typical summer low water levels). These benches would be planted with water tolerant species that would provide habitat for wildlife, improve water quality treatment, and provide for a more beautiful pond than what is often a muddy substrate when dry. An example of a pre- and post-retrofit pond with benches is illustrated in Figures 20 and 21.

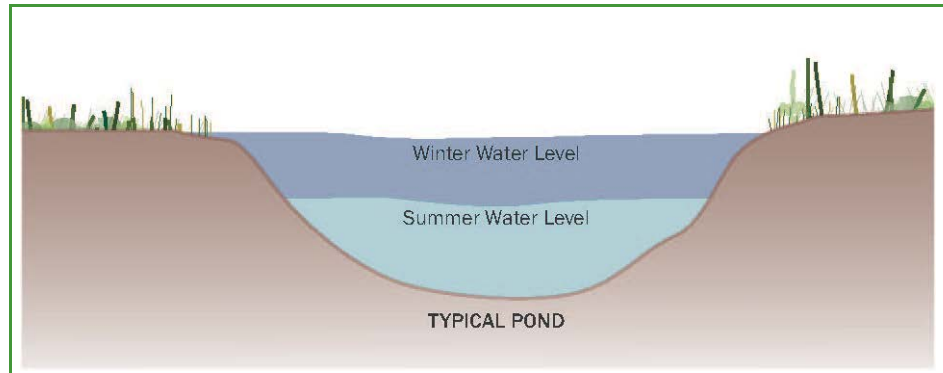


Figure 20. Illustration of a Typical Pond Profile.

To reduce costs the County could assemble a library of appropriate plantings, planting plan templates, grading plan alternatives and appropriate weir designs that could be modified as needed based on the pond condition and project goals.

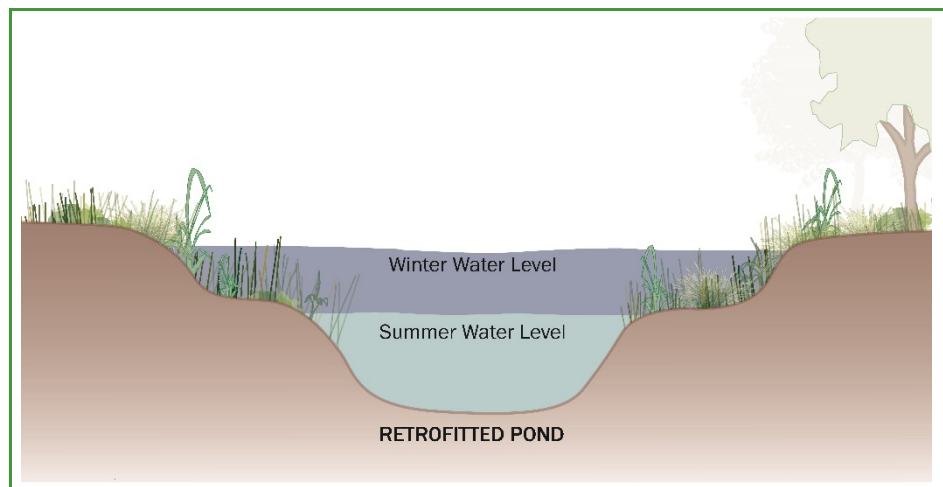


Figure 21. Retrofitted Pond with Habitat Benches.

Benefits:

- Improve habitat for fish and other aquatic species.
- Improve water quality treatment effectiveness of ponds through creation of benches and added vegetation.
- Provide native plant habitat

Cost Estimates

Table 8. Cost Estimate for Problem Ponds Outreach Program.					
Task	2015	2016	2017	2018	Notes
Task 1	\$5,000		\$5,000		Assumes 20 hours of time + materials costs for outreach every other year.
Task 2	\$4,500	\$4,500	\$4,500	\$4,500	Assumes 10 hours per pond and 3 ponds per year
Total Cost	\$9,500	\$4,500	\$9,500	\$4,500	

Notes: Assumes \$150 per hour rate for Engineer or Outreach Specialist.

Task	2015	2016	2017	2018	Notes
Task 1	\$5,000				Development of GIS tool for pond prioritization. Review results and iterative tool refinement.
Task 2	\$4,500				Assumes site visits to three islands. 10 hours per Island.
Task 3	\$1,500				10 hours for prioritization including 1 meeting.
Task 4		\$16,000	\$8,000	\$8,000	Assumes 2 pond designs are completed each year. 1 sheet per pond with plan and section. Excludes downstream analysis or dam safety office review (less than 10 acre-ft per pond).
Task 5		\$20,000	\$40,000	\$40,000	Assumes 1 pond constructed the second year and 2 ponds thereafter. \$10,000 for outlet control device and \$10,000 for installation.
Task 6		\$3,000	\$1,500	\$1,500	Assumes standard plan is developed that is modified for each retrofit
Total Cost	\$11,000	\$39,000	\$49,500	\$49,500	

Notes: Assumes \$150 per hour rate for Engineer

Support Neighborhood-Based Stormwater Management Solutions

Priority Watersheds: All

Focus Areas: Rosario

Measures that encourage stormwater projects sponsored by neighborhood groups and the community could provide innovative implementation of stormwater management solutions for private developments that do not have integrated stormwater management infrastructure.

Problem Description

There are a number of neighborhoods within the County with a high percentage of private roads that were constructed without an integrated stormwater management plan and with infrastructure that is inadequate to meet County standards. This is particularly problematic when County roads meet private developments with inadequate infrastructure. This can result in flooding of down gradient property owners. In addition, water quality treatment is rarely provided in private residential developments, roads tend to be gravel, and consequently sediment pollution can be high. An example would be the Rosario neighborhood on Orcas Island; see Figure 22.

The County would like to assist these property owners in finding solutions that can be implemented without the County taking ownership of private roads and stormwater infrastructure.

Problem Solution

The County would offer technical assistance and potentially some funding to assist neighborhoods in solving local stormwater management problems in ways that are cost effective and meet local needs. Neighborhood-based solutions could produce creative projects that provide

multiple benefits to the neighborhood such as a constructed wetland for flood control and treatment that also has a neighborhood trail and meeting area. Projects may be driven by the desire to protect an important natural resource, restore a drainage network, or solve ongoing flooding problems using environmentally sustainable solutions. Developing private public partnerships that support citizens voluntarily solving their stormwater problems could provide innovative successful solutions.



Figure 22. Photo of Stormwater Flowing from Rosario Road into a Private Drive.

Public-private partnerships are a means for the County to address private development stormwater issues without taking ownership. A public-private partnership is a contractual agreement between a public agency and a private sector entity where the skills and assets of each sector (public and private) are shared in delivering a service or facility for the benefit of the public. In addition to the sharing of resources, each party shares in the risks and rewards potential in the delivery of the service and/or facility.

Characteristics important to the success of private public partnerships include:

- Diversity in stakeholders
- Trust among stakeholders
- Development of clear and common goals
- Technical and financial support
- Establishment of governance rules and shared understanding of procedures

Benefits

Listed below are potential outcomes that may result from private public partnerships:

Stormwater

- Reduced erosion
- Reduced flooding
- Reduced pollutant loads

Infrastructure

- Reduced stress on existing infrastructure or need for new infrastructure.

Community

- Improved aesthetics from projects with multiple benefits
- Increased community support and participation for collaborative, sustainable stormwater management.

Economy

- Increased buy in and implementation from business community
- Mainstreaming of green infrastructure practices
- Economic savings for reduced repairs and maintenance

Government

- Stormwater policies that promote innovation and reward creative problem solving

There is a wide range of technical services that could be provided by the County to support the efforts of private entities to solve stormwater problems including:

- **Task 1. Project planning** - Identification of corrective actions to address issues and risks associated with the project. Identification of partners and funding sources.
- **Task 2. Project design and permitting** - Includes base mapping, limited conveyance calculations, basic design, cost estimating, and permitting. Assumes these services are performed by the County potentially with consultant support.
- **Task 3. General technical assistance** - County provides project management support through design and construction.
- **Task 4. Construction** - Construction of drainage improvements.
- **Task 5. Construction coordination and oversight** - Assumes construction management is provided by the County.

There is also a wide range of tools for enabling and encouraging public private partnerships including obtaining grants, public outreach, formation of local improvement districts, and low cost loans.

As an example of a similar program, King County's Water and Land Resources Division supports a Neighborhood Drainage Assistance Program (NDAP) that provides assistance for flooding, erosion and sedimentation problems affecting private property in unincorporated

King County. The NDAP will design and fund capital improvement projects, and repair existing drainage systems. Technical assistance is also available for questions about construction, permitting, and storm drainage design. If a project does not qualify for funding or funds are unavailable, Water and Land Resources will still assist with information and advice. This may include construction suggestions; lists of engineers, contractors, or mediation services if there is a dispute; providing information to meet permit requirements; and sketches and details of common drainage features that could be constructed.

Cost Estimate

Costs for this program will vary dependent on the scope of the problem, the number and financial commitment of partners, and the resources the County is able to commit. The estimate provided in Table 10 uses the Rosario Neighborhood as an example of project total costs. The County would need to decide to what extent they would participate.

Task	2015	2016	2017	2018	Notes
Task 1	\$8,000				50 percent of County project management costs for project ES19.
Task 2		\$41,500			50 percent of cost for survey, geotechnical analyses, design, and permitting for project ES19.
Task 3		\$4,000	\$4,000		50 percent of County project management costs for project ES19.
Task 4			\$80,000		Based on total construction cost for project ES19. Assumes 50/50 cost share between County and private property owners.
Task 5			\$32,300		County construction management costs for project ES19.
Total Cost	\$8,000	\$45,500	\$116,300		

Note: Based on cost estimate for project ES19.

Coordinate Stormwater Planning with Transportation Planning

Priority Watersheds: All

Focus Areas: Any new road or other transportation project

Continued coordination between County transportation projects and the Stormwater Utility will help maximize use of County resources by implementing stormwater treatment improvements at the same time that road construction projects are constructed.

Problem Description

County transportation projects such as road improvements or new roadways are an opportunity to improve stormwater treatment and flow control in existing and typically inadequate stormwater management systems. This coordination is occurring now as exemplified by the design of vegetated filter strips in conjunction with improvements

made to Mount Baker Road on Orcas Island in 2012; see Figure 23. Although treatment of stormwater in the County has historically not been a high priority, the County instituted a stormwater utility in 2005 to bring more focus to both flooding concerns and stormwater water quality.

Problem Solution

The Public Works Department is comprised of six divisions: Administrative, Roads, Utilities, Engineering, Facilities Maintenance, and Equipment Rental & Revolving Fund. Stormwater management for the County is provided by the Stormwater Utility, which has the following mission:

- Improve flood protection, water quality and groundwater recharge through education, coordination, development, maintenance, and management of stormwater systems
- Develop stormwater management plans that are used to direct infrastructure investment and protect water quality
- Support the operations division through evaluation of stormwater systems capacity to serve the road system as well as developments that use the roadside conveyance and culverts



Figure 23. Narrow Area Vegetated Filter Strips for Filtration and Treatment Were Used to Improve Stormwater Quality Coming From Mount Baker Road, Orcas Island.

To support this mission and ensure consideration of stormwater issues occurs as a routine part of project design, implementation, and maintenance programs, the following activities are suggested:

- Schedule project kick-off meetings with Stormwater Utility staff to allow opportunities to collaborate on stormwater issues and resources pertinent to the project.
- Use a project checklist to indicate that Engineering, Roads, and Facilities Maintenance are coordinating with the Stormwater Utility.


Benefits

- Maximize use of County resources by implementing stormwater treatment improvements at the same time that road construction projects are constructed

- Reduce existing and future flooding
- Reduce stormwater pollution by maximizing opportunities for treatment
- Replenish groundwater with greater infiltration where possible

Example Stormwater Utility Coordination Checklist

The responsibility for coordination between the Stormwater Utility, Engineering, Roads, and Facilities Maintenance as well as approval of project modifications lies with the Public Works Director. The example coordination checklist provided below is intended to be completed by Stormwater Utility staff to indicate this coordination has occurred.

 **HERRERA** Stormwater Utility Coordination Checklist

Project Name/Number: _____

Project Manager: _____

- Reviewed basin plan if there is one.
- Reviewed Stormwater Issue Reporting Website
- Completed field assessment
- Identified stormwater goals, issues, and/or conflicts if any
- Reviewed project design

Are there suggested project modifications? Yes No

Is additional coordination needed? Yes No

If modifications or additional coordination are needed, generally describe the implementation plan:

Coordination checklist completed by: _____

Cost Estimate

This program can be implemented as part of ongoing Public Works operations and is not expected to add to existing program costs.

IMPLEMENTATION

This stormwater basin planning study provides a blueprint for planning capital expenditures for managing stormwater in San Juan County. It identifies needs for infrastructure improvements as well as programs that would benefit County residents. Implementation of the projects and programs identified here will require coordination with the community, financial planning, and more detailed project development.

This plan is a working document and should be reviewed annually and amended every six years to reflect changing community needs, priorities, and funding opportunities. It can be used to guide strategic investments and ensure that stormwater management keeps pace with development and occurs consistent with the community's plans and vision.

There are a number of ways to finance capital improvement projects. Some of the most common are through general obligation bonds, state or federal loans and grants, and funding obtained from stormwater utility fees assessed on County landowners.

Keys to the successful implementation of this plan include:

- Coordination of capital needs and the operating budget.
- Identification of the most economical ways to finance capital projects and programs.
- Identification of opportunities to obtain federal and state aid.
- Coordination of stormwater infrastructure projects with other public and private development and redevelopment policies and plans.
- Coordination of stormwater infrastructure projects and programs with other County plans such as the Six Year Transportation Improvement Program and San Juan County Comprehensive Plan,
- Consistency with the Shoreline Master Program, Critical Areas Ordinance, and the Lopez Village and Eastsound Village subarea plans.
- Awareness of community objectives and fiscal capacity.
- Public outreach to ensure the public is informed about future needs and projects.
- Coordination with other County departments and private organizations to reduce duplication.
- Careful project planning and design to improve efficiencies while continually moving forward to meet the community's needs and goals for stormwater management.
- Captured lessons learned from completed projects. Lessons learned include technical, managerial, and process aspects of the project that are documented, approved by management, and transferred to a historical database.

Engineer's Stamp

This preliminary design report has been prepared under the supervision of a professional engineer registered in the State of Washington.



Matthew M. Fontaine, PE

06/12/2015
Date

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APPENDIX A

Reported Stormwater Issues

Table A-1. Stormwater Problems from San Juan County Stormwater Issue Reporting Web Site.

Watershed	Total	Environmental Damage	Erosion	Flooding	Nuisance	Ponding	Private Property Damage	Public Property Damage	Water Quality	Other
Eastsound	41		9	13	1	6	8			4
False Bay	7		3			2			1	1
Fisherman Bay	5						1		1	3
Mud Bay										
Wescott/Garrison Bay										
Deer Harbor	3			3						
Doe Bay	2			1			1			
Friday Harbor	19		6	6	2	2			1	2
Griffin Bay	7		1	4				1	1	
Guthrie and Grindstone Coves	3		1			1				1
Haro Strait	3		1			1				1
Juan de Fuca Strait	1									1
Lopez Sound	2					1			1	
North Shore	11		2	6		1				2
Presidents Channel	1			1						
Raccoon Point	3			2						1
San Juan Channel (San Juan)	3		1	2						
Shaw Island	5		1	4						
Shoal Bay	2	1		1						
Spieden Channel	1									1
Swift Bay	3			1		1	1			
West Sound	5		1	3			1			
Total	127	1	26	47	3	15	12	1	5	17

Note: Priority watersheds are highlighted

APPENDIX B

Capital Improvement Project Summary Sheets



**San Juan County
Capital Improvement Program
Project Summary Sheet**

Name: Market Street Drainage System Upgrade
 Site ID: ES44
 Project Priority: Top 23
 Estimated Cost: \$420,000

PROBLEM SUMMARY

The private drainage system on Market Street has been problematic and was not designed to accommodate future development in the area tributary to the system; however, modeling indicates the existing storm drain pipes have adequate capacity. The existing water quality swale is much too small. The swale is only large enough to provide water quality treatment for 5 percent of the tributary drainage area.

RANK JUSTIFICATION

Frequent flooding problems observed. Capacity issues contributed to flooding in Fall/Winter of 2013. Includes components from 2005 Eastsound drainage plan.

- Health and Safety Risk
- Capacity for future development
- Prior drainage plan project
- Obstacle for other projects
- Water quality treatment retrofit



Parking Lot on Market Street

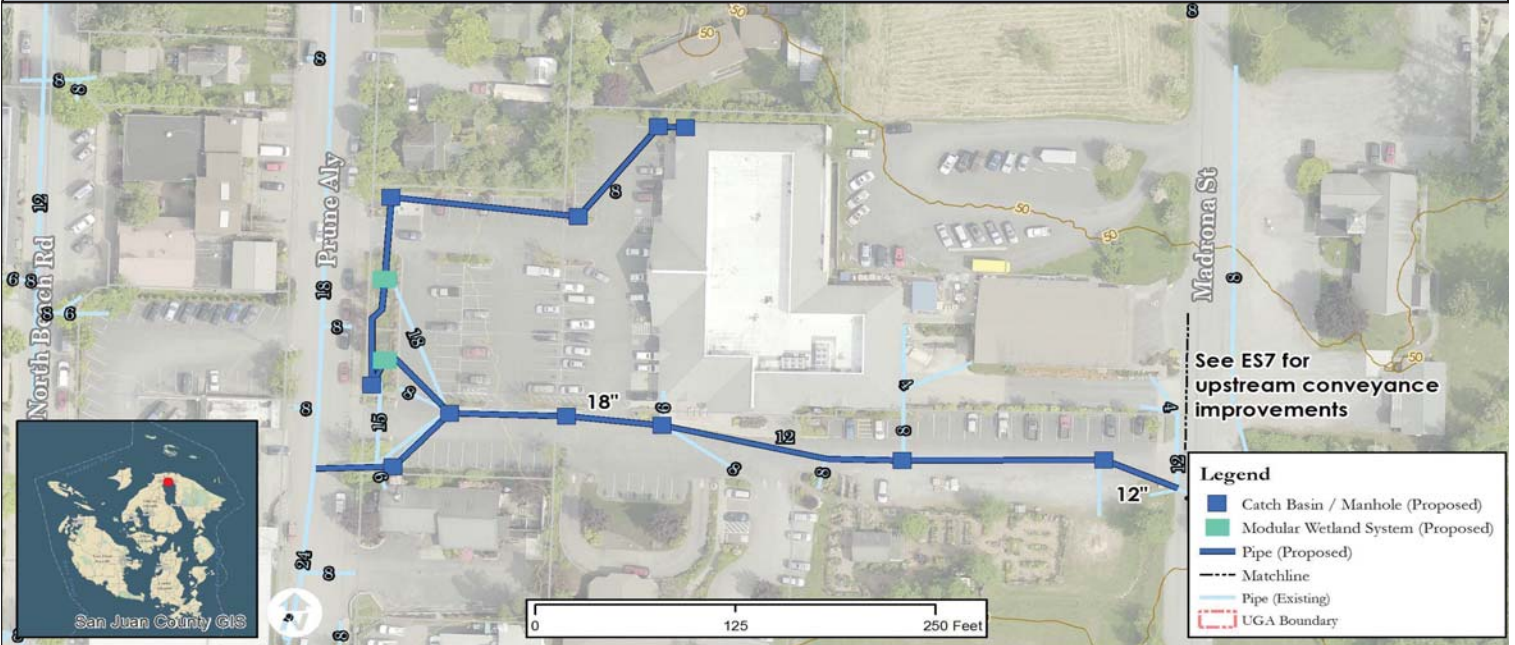
Parking lot and swale adjacent to Prune Alley

PROPOSED SOLUTION

Replace (as needed) and reconfigure the existing private storm drain on Market Street to route surface flow to two Modular Wetland Systems (MWS). The proposed MWS will replace the existing swale located in the planter strip at the west boundary of the parking lot and provide treatment for 5.2 acres. Similar to Project 1.6 from 2005 Eastsound drainage plan. Basis of cost: ES7 Option 1 is incorporated into the following quantities: 1014 LF of Storm Drain Pipe (assume replacement of all pipes flowing to the MWS units), 2 MWS Units, and 15 catch basins (assume all catch basins are replaced).

Future considerations: The project cost currently includes replacement of the entire pipe network. The pipe network should be video inspected and the existing pipes reused to the extent feasible as a means of reducing project costs. However, problems with existing surface drainage patterns and inlet locations will need to be addressed.

SOLUTION FIGURE





**San Juan County
Capital Improvement Program
Project Summary Sheet**

Name: Market Street and Madrona Street Conveyance Improvement
 Site ID: ES7
 Project Priority: Top 23
 Estimated Cost: See ES44

PROBLEM SUMMARY

Surface flow path across private property between Madrona Street and Crescent Beach wetland causes flooding.

RANK JUSTIFICATION

Identified in the Eastsound 2005 basin plan, this project provides capacity for development on Madrona Street and alleviates flooding on private property.

- Health and Safety Risk
- Capacity for future development
- Prior drainage plan project
- Water quality treatment retrofit



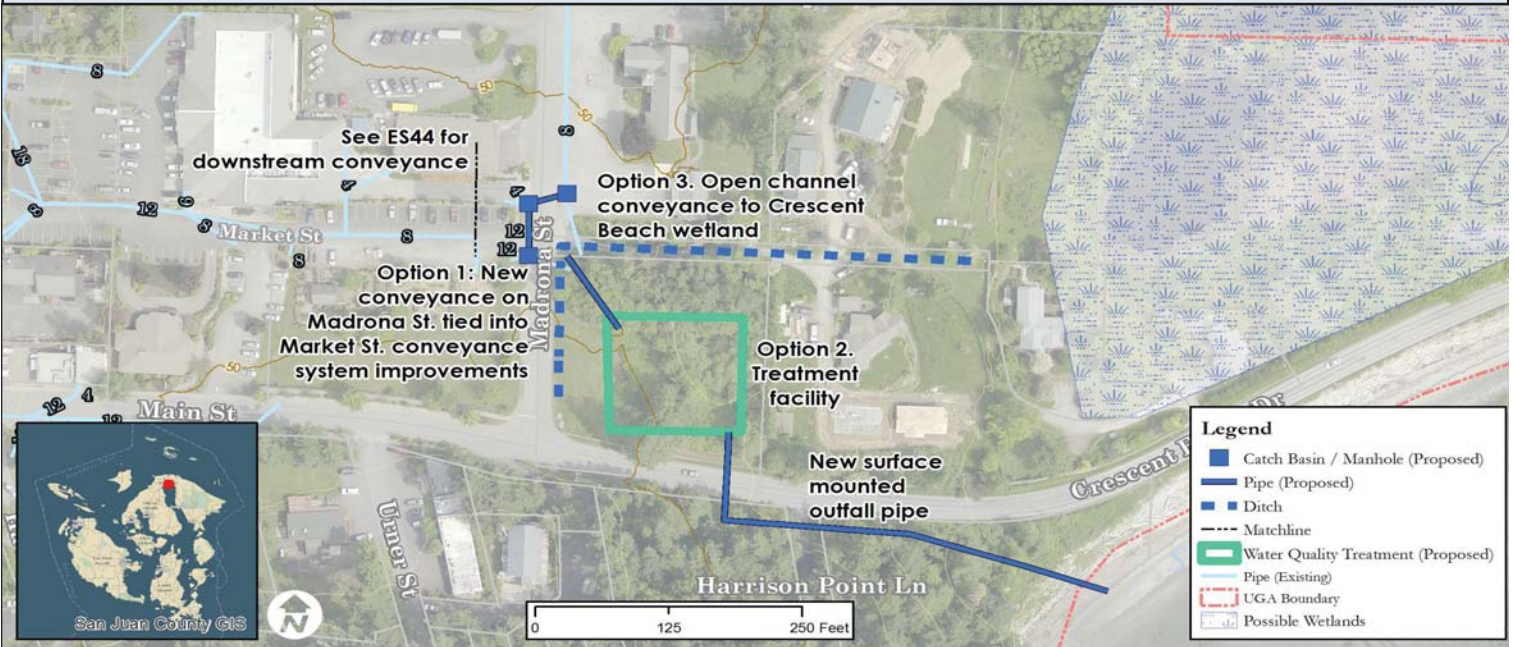
Private property where runoff from Madrona Street is problematic

View of Crescent Beach Dr from Madrona Street

PROPOSED SOLUTION

Options:
 1. Redirect runoff from the south end of Madrona Street into the public storm drain on Market Street (requires implementation of ES44). 2. Redirect flow from Madrona Street across Crescent Beach Drive with new culvert. Could include treatment BMP in vacant parcel at NW corner of intersection of Madrona Street and Crescent Beach Drive. 3. Easement and storm drain eastward across private property from Madrona Street.
 Basis of cost: Option 1 incorporated into ES44 costs. Initial high-level estimates of Options 2 and 3 were in the range of \$53,000 to \$740,000.

SOLUTION FIGURE





**San Juan County
Capital Improvement Program
Project Summary Sheet**

Name: Prune Alley Drainage and Water Quality Improvements
 Site ID: ES8
 Project Priority: Top 23
 Estimated Cost: \$340,000

PROBLEM SUMMARY

Poor road grades, deteriorated rolled curbs, and ineffective storm drain inlet locations are causing flooding of Prune Alley and surrounding private properties. Modeling indicates the existing main storm drain on Prune Alley has adequate capacity.

RANK JUSTIFICATION

One of the most significant problem areas in Eastsound Village; efficiency in implementing along with right-of-way improvement project; Ecology grant recipient.

- Prior drainage plan project
- Water quality treatment retrofit
- Capacity for future development
- Obstacle for other projects



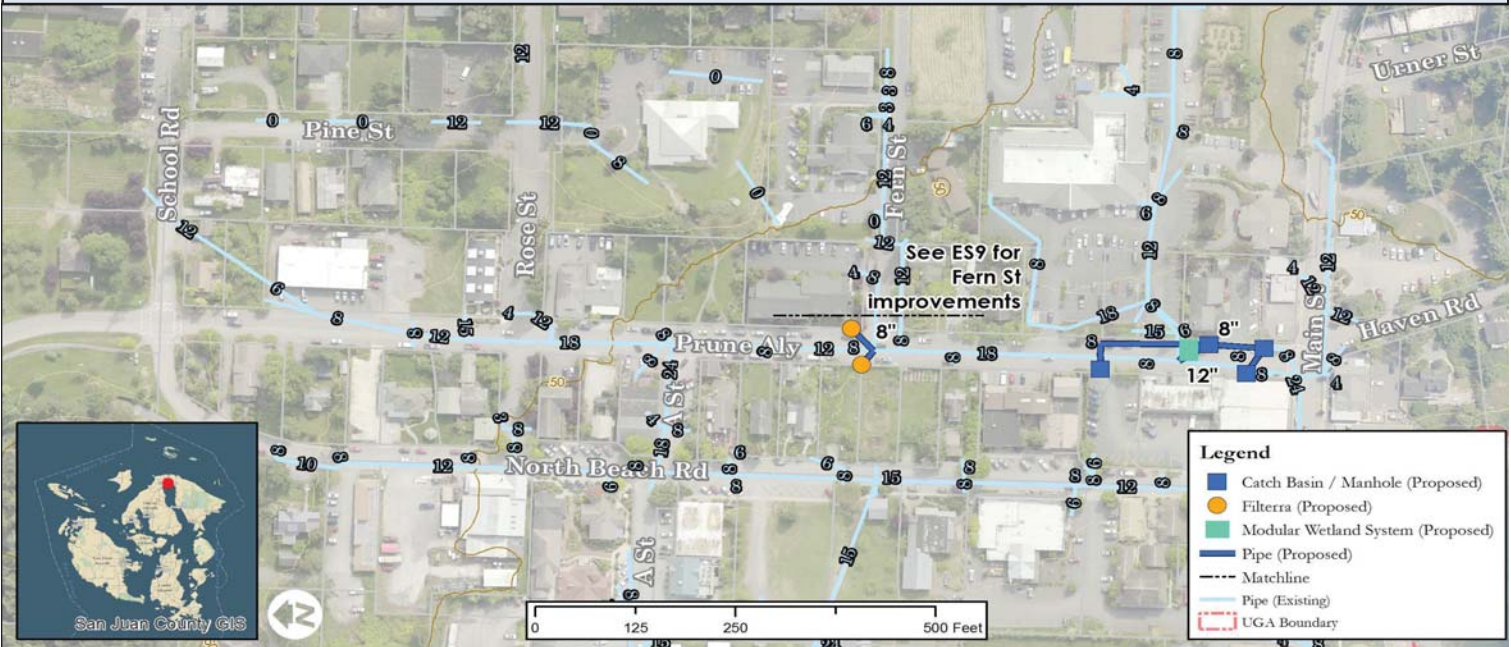
View South on Prune Alley

Templin's parking on Prune Alley where flooding has occurred

PROPOSED SOLUTION

Install water quality treatment BMPs, new storm drain pipe, and new inlets along Prune Alley to alleviate drainage problems and provide water quality treatment. ES8 should be implemented before or at the same time as ES7 and needs to be coordinated with the transportation improvement project planned for Prune Alley. ES8 and ES9 have been combined into a single project and received a grant offer from the Department of Ecology. Basis of cost: ES9 is incorporated into the following quantities: 798 LF of Storm Drain Pipe, 2 MWS Units, 2 Filterras, 8 catch basins.

SOLUTION FIGURE





**San Juan County
Capital Improvement Program
Project Summary Sheet**

Name: Fern Street Conveyance and Water Quality Improvements
 Site ID: ES9
 Project Priority: Top 23
 Estimated Cost: See ES8

PROBLEM SUMMARY

Deteriorating drainage system and groundwater seepage is causing ponding, icing, and pavement cracking along Fern Street. Modeling indicates that the existing storm drain pipes are adequately sized, though anecdotal evidence indicates there are issues with surface and groundwater sheet flowing across the street.

RANK JUSTIFICATION

Project identified in previous basin plan. Will provide capacity for development on Madrona Street to the north east. Safety issue in winter with high ground water freezing in driveways and on the street.

- Health and Safety Risk
- Capacity for future development
- Prior drainage plan project
- Water quality treatment retrofit



View West on Fern Street

View on Fern Street

PROPOSED SOLUTION

Reconfigure the existing public storm drain on Fern Street to route surface flow to two Modular Wetland Systems (MWS) and two Filterrass. The proposed MWS and Filterrass will provide treatment for 2.4 acres. Diversion of groundwater seepage to drainage system. ES8 and ES9 improvements have been combined into a single project. Project 1.2 in 2005 Eastsound drainage plan. Basis of cost: Incorporated into ES8 costs.

SOLUTION FIGURE





**San Juan County
Capital Improvement Program
Project Summary Sheet**

Name: Olga Road Conveyance and Outfall Replacement
 Site ID: ES1
 Project Priority: Top 23
 Estimated Cost: \$720,000

PROBLEM SUMMARY

Surface water and wave action is contributing to bluff erosion at the Inn at Ship Bay and further south on Olga Road an 18-inch diameter outfall pipe is rusted and deteriorated causing erosion of the steep sandy soils between the road and the shoreline. The drainage basin includes forested and developed land on Buck Mountain with more development expected in the future. The abandoned County road behind the Inn at Ship Bay is eroding badly at the outfall discharge point along the bluff. The rocky shoreline further south on Olga Road is more resistant to erosion. Model results indicate that the existing 18-inch diameter outfall pipe and ditch are undersized.

RANK JUSTIFICATION

The shoreline at Ship Bay Inn is eroding rapidly and the risk to human safety and property is very high. Project will also provide capacity for future development in the basin. Project identified in 2005 Eastsound drainage plan.

- Health and Safety Risk
- Prior drainage plan project
- Capacity for future development



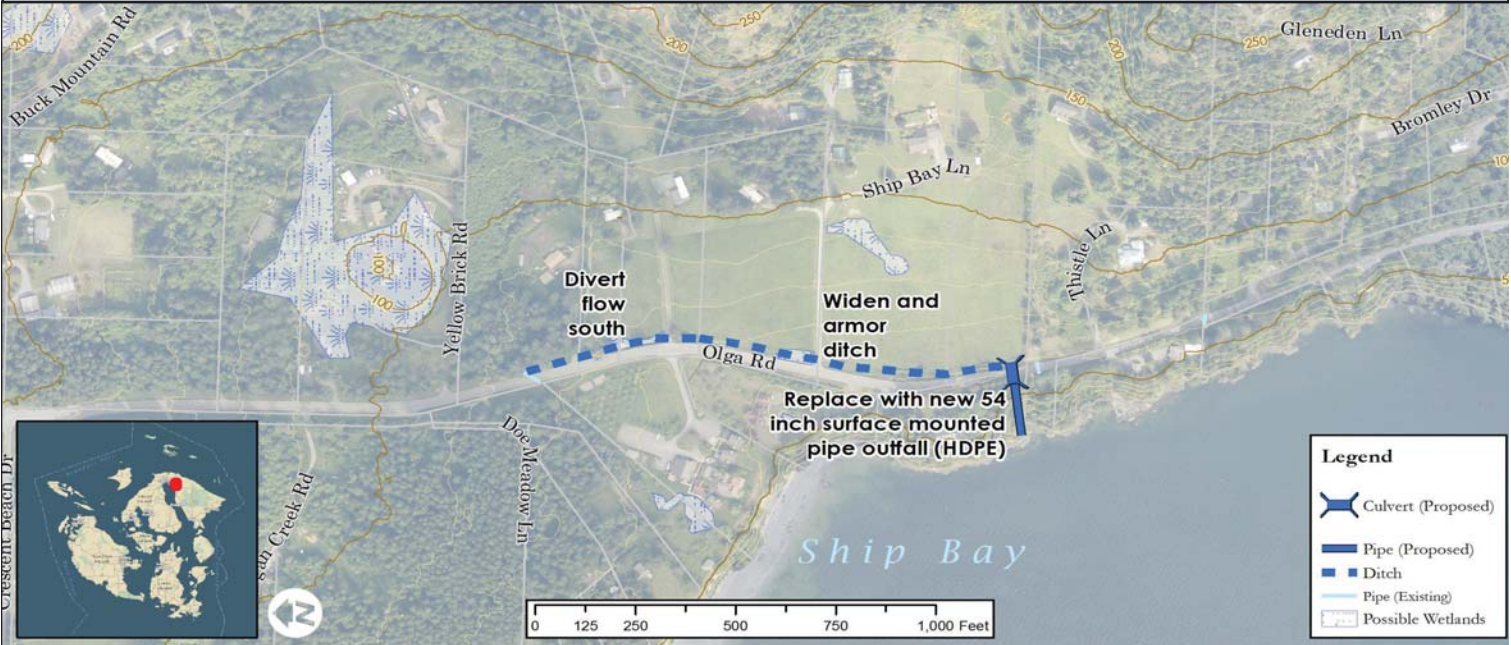
Eroded pipe at Olga Road

Ship Bay rocky shoreline where new outfall would be located

PROPOSED SOLUTION

Plug the culvert under Olga Road at the Inn at Ship Bay to divert flow away from the sand bluff towards the more stable rocky shoreline at the next outfall to the south. Widen and armor the existing ditch along the east side of Olga Road and replace the deteriorated outfall to accommodate the combined flow under future conditions. Model results indicate that a 54 inch diameter outfall pipe will be adequate. Basis of cost: 1300 LF ditch, 120 LF of 54" DIA CPEP culvert pipe under driveways, 300 LF of 54" Dia HDPE pipe (includes 40 LF segment under roadway, 20 LF buried pipe adjacent to roadway, and 240 LF of surface mounted pipe down the bluff). Deadman anchor at top of slope. Anchoring at shoreline with energy disipation tee in gabion baskets or boulders. Future considerations: Refine the model during final design. Evaluate options for reducing the future flow through improved stormwater management at future development or retrofits of existing ponds. ES1 combines portions of projects 8.1 and 8.2 from 2005 Eastsound drainage plan.

SOLUTION FIGURE





**San Juan County
Capital Improvement Program
Project Summary Sheet**

Name: North Beach Road Outfall
 Site ID: ES26
 Project Priority: Top 23
 Estimated Cost: \$260,000-\$4,500,000

PROBLEM SUMMARY

Outfall on the beach is buried and clogged with sediment due to wave action. Modeling confirmed the existing conveyance system has adequate capacity if free of sediment and not affected by tidal backwater.

RANK JUSTIFICATION

Identified in 2005 Eastsound basin plan. Affects drainage of upstream projects and future development potential in North Shore.

- Prior drainage plan project
- Capacity for future development
- Obstacle for other projects



View of North Beach (outfall under beach gravel)

Example of potential outfall configuration under Option 2

PROPOSED SOLUTION

Summary sheet cost range covers 3 options: 1. Reroute outfall to Brandt's Marina. 2. Replace outfall on shoreline in current location discharging to President Channel (lowest cost). 3. Directionally drill a new outfall to 30 vertical ft below MLLW (highest cost: \$3M-\$4.5M). All options assume a larger diameter outfall to conservatively account for tidal influences. Basis of cost: Option 1: 270 LF of 24" Dia CPEP under pavement, 190 LF of 24" Dia CPEP under gravel, and 2 catch basins. Option 2: 100 LF of 24" Dia HDPE, and 2 catch basins. Option 3: 1650 LF of 24" Dia directionally drilled outfall pipe.

Future considerations: Tidal influence should be considered during the project design phase to confirm required pipe size; 24-inch pipe size may be overly conservative. Any subtidal outfall cannot be located in eel grass beds. Potential for multiproject efficiency if a directional drilling option is selected and constructed in combination with ES28.

SOLUTION FIGURE





**San Juan County
Capital Improvement Program
Project Summary Sheet**

Name: School Road Conveyance Improvements
 Site ID: ES29
 Project Priority: Top 23
 Estimated Cost: \$140,000

PROBLEM SUMMARY

The main storm drain for School Road crosses private property and cannot be maintained easily by Public Works. Ditch along School Road is clogged with sediment.

RANK JUSTIFICATION

Project identified in 2005 Eastsound basin plan and pipe under private property poses high risk. Project would provide capacity for future development and may encourage school to improve conveyance along School Road

- Health and Safety Risk
- Prior drainage plan project
- Capacity for future development



View East on School Road

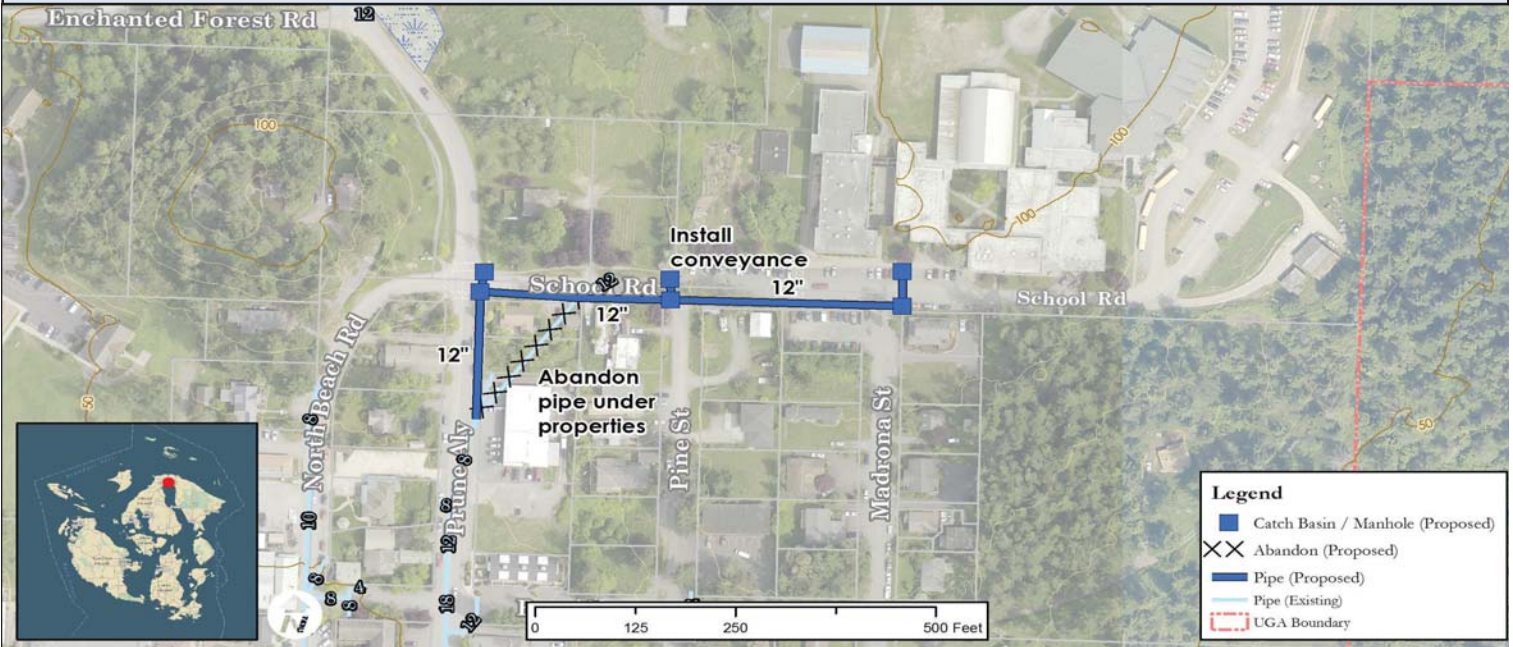


Partially clogged catch basin on School Road

PROPOSED SOLUTION

Install a new drainage system on School Road connecting to Prune Alley main storm drain. Model results indicate that installation of a 12-inch diameter storm drain should provide sufficient conveyance capacity. Project 1.5 in 2005 Eastsound drainage plan. Basis of cost: 2005 Eastsound Drainage Plan.

SOLUTION FIGURE





San Juan County Capital Improvement Program Project Summary Sheet

Name: Montgomery Lane to Crescent Beach Wetland
 Site ID: ES3
 Project Priority: Top 23
 Estimated Cost: \$670,000

PROBLEM SUMMARY

Ponding in ditches overflows to private property and contributes to bluff erosion. Capacity and erosion problems along Crescent Beach Road west of Montgomery Lane contribute to bluff erosion. Modeling results indicate the 25-year flow along Montgomery Lane and across Crescent Beach Drive is 1.22 cfs.

RANK JUSTIFICATION

Affects several private properties. Severity expected to increase with upland development. Contributing to bluff erosion. Would provide water quality treatment for currently untreated runoff. Included in 2005 Eastsound basin plan.

- Health and Safety Risk
- Prior drainage plan project
- Water quality treatment retrofits



Ship Bay bluff below Montgomery Lane houses

Existing outfall below Montgomery Lane houses

PROPOSED SOLUTION

Construct a ditch along the northeast side of Montgomery Lane, culverts under driveways, and a culvert across Crescent Beach Drive. Construct a small stormwater treatment BMP before discharging to the Crescent Beach Wetland on north side of Crescent Beach Drive. 9.1 and 9.2 from 2005 Eastsound drainage plan. Basis of cost: 800 LF of ditching, 160 lf of 12" Dia CPEP under 8 driveways, 60 LF of 12" Dia CPEP under Crescent Beach Dr, 80 LF of 12" Dia CPEP outfall with 4 anchors, 1 flow splitter, 500 LF of 18" Dia HDPE pipe along Crescent Beach Dr, 40 LF of 18" Dia CPEP to treatment facility, water quality treatment facility.

Future considerations: Wetland hydroperiod study should be conducted in the future to confirm the change in flow routing will not adversely affect the wetland. This project may offset impact of ES7.

SOLUTION FIGURE





**San Juan County
Capital Improvement Program
Project Summary Sheet**

Name: Crescent Beach Wetland Outfall
 Site ID: ES28
 Project Priority: Top 23
 Estimated Cost: \$300,000-\$3,600,000

PROBLEM SUMMARY

Outfall becomes clogged with sediment due to wave action and may contribute to flooding of a property on Crescent Beach Dr. Model results indicate that the current 12 inch outfall has sufficient capacity if free of sediment and not affected by tidal backwater.

RANK JUSTIFICATION

Requires frequent maintenance but currently only affects one private property. Several upstream projects may be affected by functionality of wetland outfall. Project may have effects on hydroperiod of Crescent Beach Wetland. Project would protect and maintain critical natural resource.

- Protects critical natural resource
- Obstacle for other projects



Crescent Beach Wetland outfall location

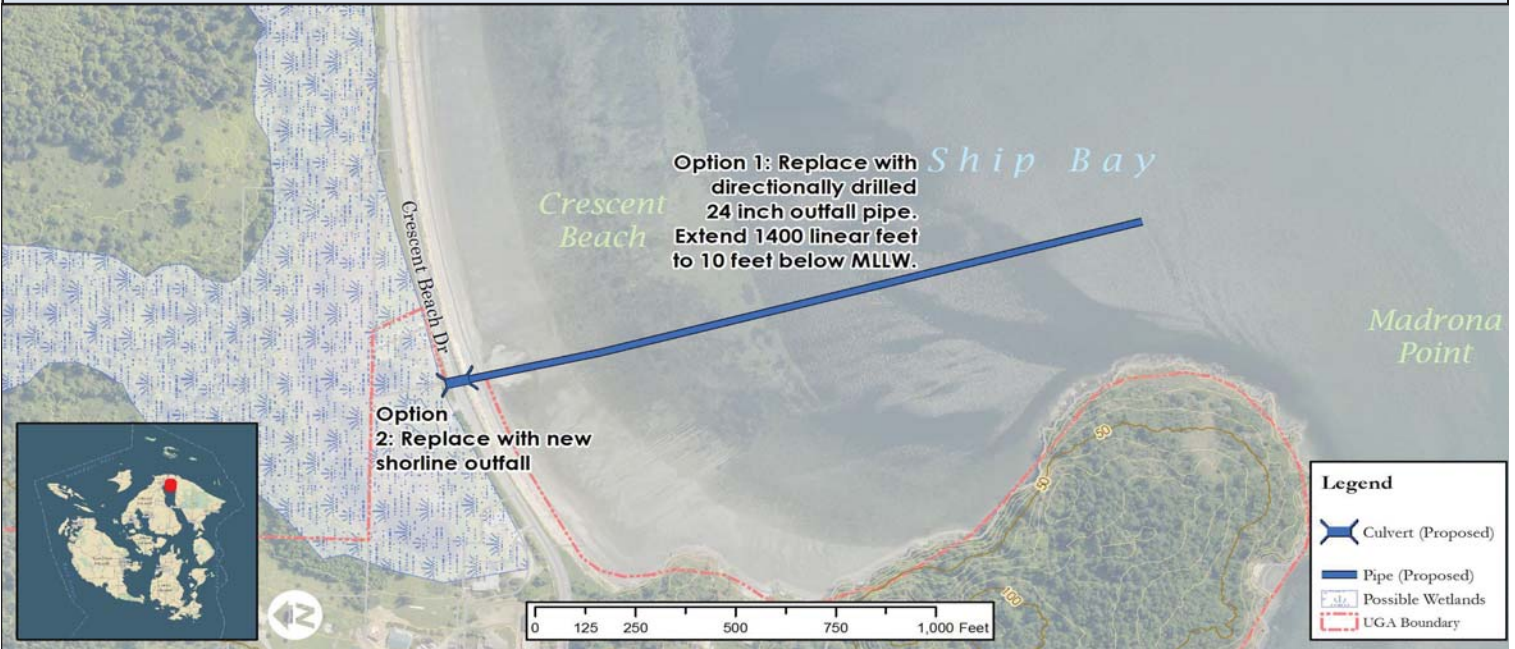
Example of potential outfall configuration under Option 1

PROPOSED SOLUTION

Options: 1. Replacement shoreline outfall to Ship Bay. 2. Directionally drill a new outfall to 10 vertical ft below MLLW at an estimated cost of \$2.5M-\$3.8M. 3. Other options (not costed) include continuing O&M, adding a high water alarm with telemetry, constructing a bridge, abandoning the road, or purchasing the affected properties. Options 1 and 2 assume a larger diameter outfall to conservatively account for tidal influences. Basis of cost: Option 1: 100 LF of 18" Dia HDPE, and 2 catch basins. Option 2: 1400 LF of 24" Dia directionally drilled outfall pipe.

Future considerations: During the design phase additional modeling should be conducted to account for tidal influences and potential for this project (in combination with other proposed CIPs) to affect wetland hydroperiod (wetland hydroperiod study).

SOLUTION FIGURE





**San Juan County
Capital Improvement Program
Project Summary Sheet**

Name: Rosario Road Drainage Improvements
 Site ID: ES18
 Project Priority: Top 23
 Estimated Cost: \$75,000

PROBLEM SUMMARY

Under capacity ditch and culvert conveyance system along Rosario Road is resulting in surface water and sediment from ditches and roadways flowing across the roadway. The intensity of development within the basin is contributing to the problem.

RANK JUSTIFICATION

Under capacity drainage network creates frequent maintenance problems and safety hazards on Rosario Road. There is neighborhood support to fix the problems.

- Health and Safety Risk
- Capacity for future development



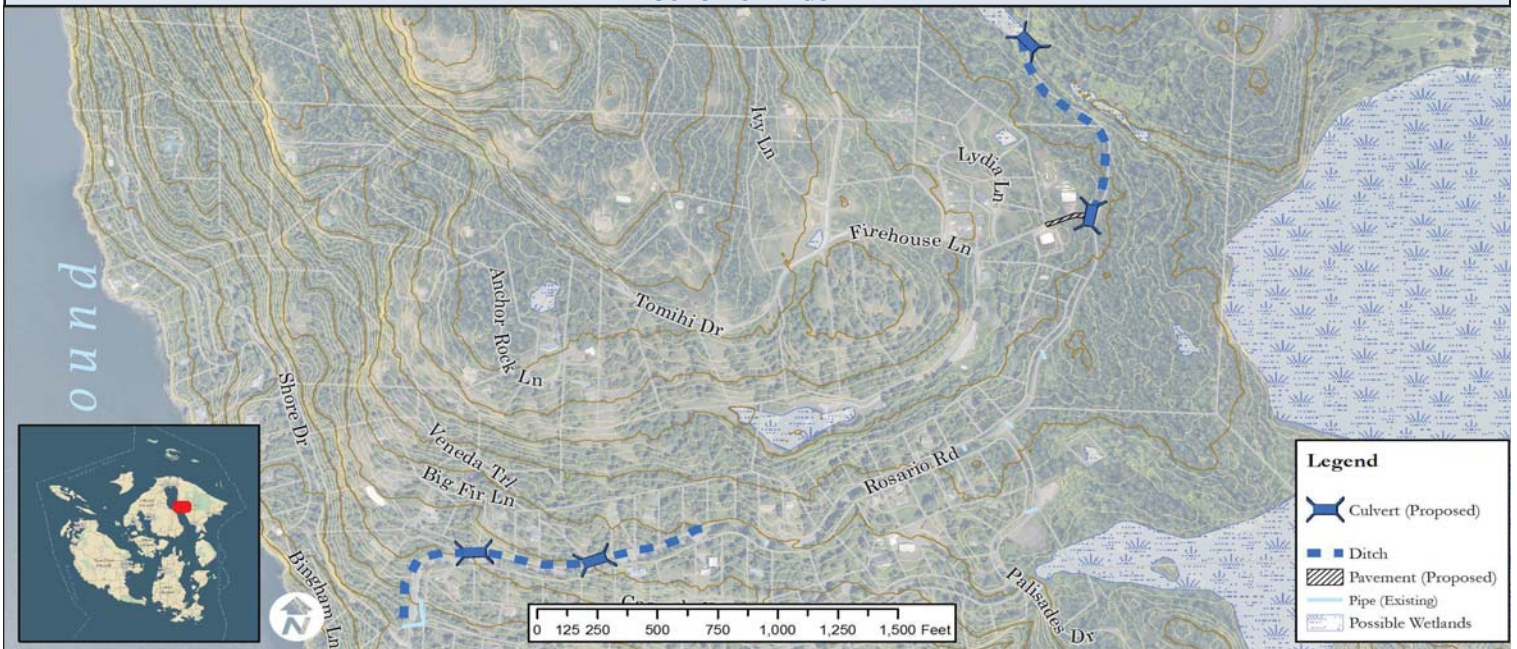
View East on Rosario Road

Firehouse Lane at Rosario Road

PROPOSED SOLUTION

Improvement of drainage system along Rosario Road including addressing sediment from Firehouse Lane gravel road. Basis of cost: 2,800 LF of ditch maintenance / widening, 80 LF of 12" Dia CPEP culvert, and bituminous surface treatment for the Firehouse Lane road entrance.

SOLUTION FIGURE





**San Juan County
Capital Improvement Program
Project Summary Sheet**

Name: Rosario Neighborhood Drainage Improvements
 Site ID: ES19
 Project Priority: Top 23
 Estimated Cost: \$440,000

PROBLEM SUMMARY

Poor road maintenance, under capacity drainage system, steep grades, and upland development is contributing to road flooding, potholes, erosion, and flooding on private property throughout the Rosario neighborhood. Upstream development is likely contributing increased flow relative to historic conditions.

RANK JUSTIFICATION

Multiple properties affected. Engaged public may enable a public-private partnership.

- Health and Safety Risk
- Capacity for future development



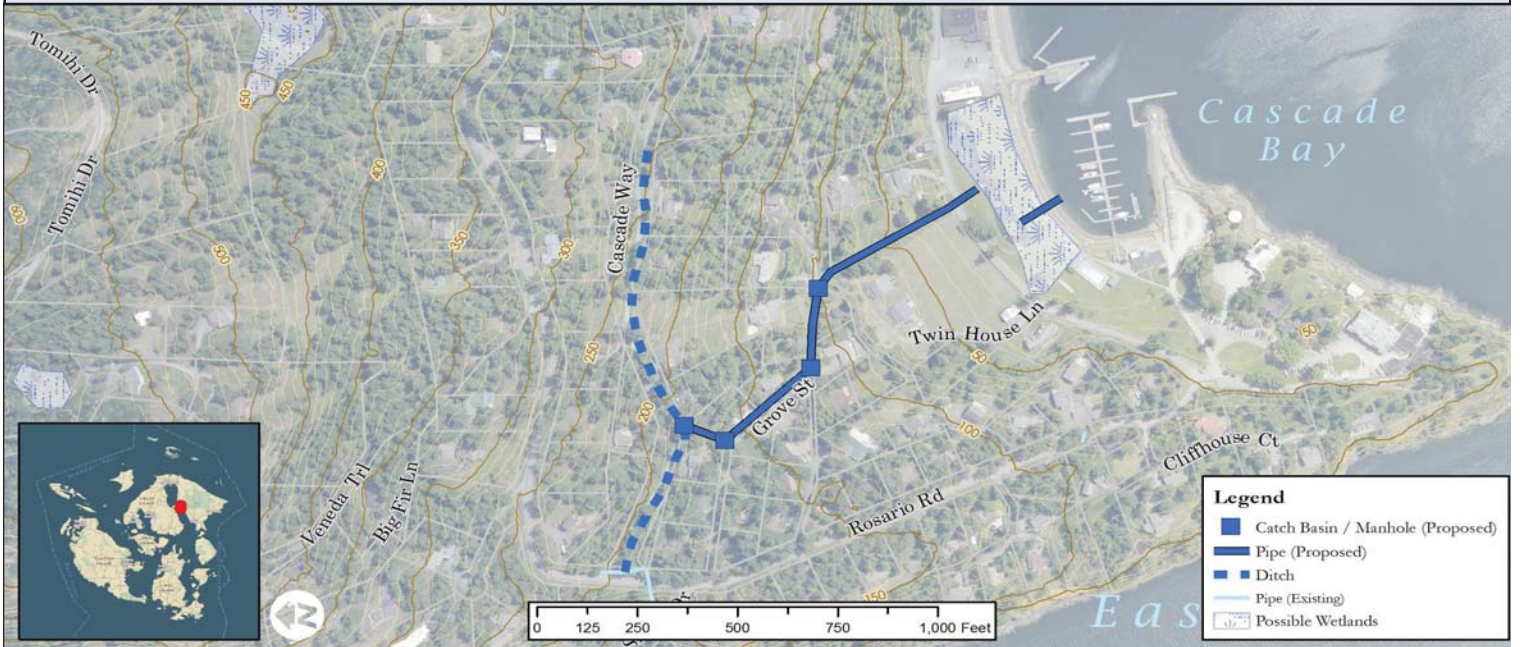
View East of Grove Street

View East on Cascade Way

PROPOSED SOLUTION

Install ditches and a piped storm drain system from Cascade Way down to the shoreline. This conceptual plan is an example of a solution residents could execute, potentially with County support. This conceptual solution may be used as a template for similar problems in Rosario and elsewhere in the County where public-private partnerships may be possible. Residential scale flow control retrofits such as rain barrels or cisterns may help alleviate the problem. Regional detention or infiltration does not seem appropriate given bedrock near ground surface and steep slopes. Basis of cost: 1,400 LF of 18" Dia HDPE to extend down slopes with anchors placed every 40 LF, 150 LF of 18" Dia CPEP to connect existing pond feature to shoreline, 1,400 LF of ditching, and 4 catch basins.

SOLUTION FIGURE





**San Juan County
Capital Improvement Program
Project Summary Sheet**

Name: Myer Street and Langell Lane Conveyance to Outfall
 Site ID: ES13
 Project Priority: Top 23
 Estimated Cost: \$180,000

PROBLEM SUMMARY

- 1: Runoff from the hillside is a problem for downslope properties below cross culvert.
- 2: Ditch near Langell Lane becomes clogged with sediment at the intersection with Langell Lane and surface water flows across the road and onto private property.

RANK JUSTIFICATION

Drainage across private property under capacity. Threat to health and safety. Project would provide capacity for future development.

- Health and Safety Risk
- Capacity for future development
- Water quality treatment retrofit



Myer Street

Low point in road on Myer Street

PROPOSED SOLUTION

Obtain easement and pipe or ditch flow across private property to shoreline to alleviate problems on Myer Street. Increase frequency of ditch maintenance at intersection of Myer Street and Langell Lane. Consider deepening ditch or raising road elevation. Infiltration / detention doesn't appear a viable option due to lack of space and bedrock near surface. Residential scale retrofits could be considered in addition to conveyance improvements. Basis of cost: 440 LF of 18" Dia HDPE pipe down slope to shoreline, 300 LF of ditching.

SOLUTION FIGURE





**San Juan County
Capital Improvement Program
Project Summary Sheet**

Name: Bracken Fern Ln Drainage Improvements
 Site ID: ES27
 Project Priority: Top 23
 Estimated Cost: \$90,000

PROBLEM SUMMARY

Ponding of up to 3 ft of water along Bracken Fern Lane, including at 32 Bracken Fern Lane. Also ponding and conveyance issues on Candlewood Lane. Both due to lack of conveyance system. Low lying area with seasonal high groundwater produces surface ponding with nowhere to drain.

RANK JUSTIFICATION

Severe private property issue. No public easement.

- Health and Safety Risk



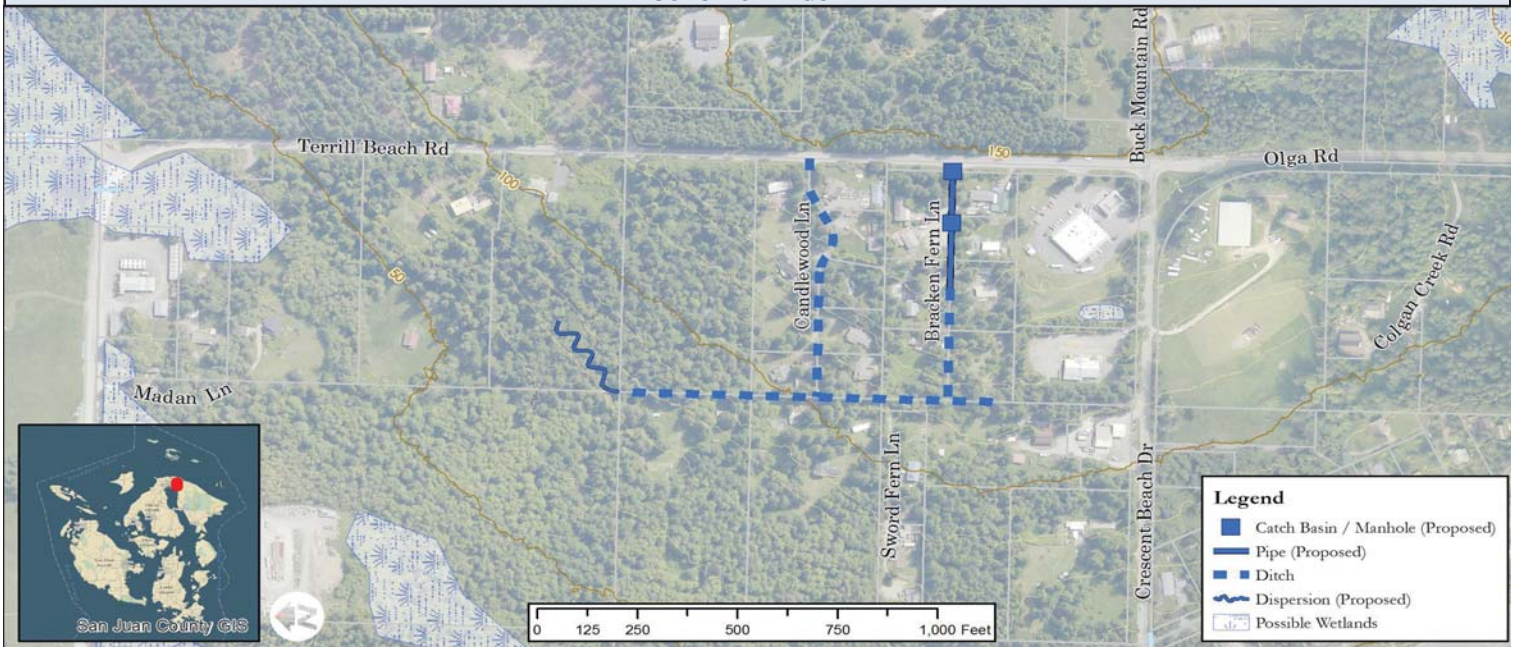
Bracken Fern Lodge parking off Bracken Fern Lane

Flooding at Bracken Fern Lodge

PROPOSED SOLUTION

Install new conveyance to connect with ditches to the west on Maidenhair Lane. Includes portion of Project 10.2 from 2005 Eastsound drainage plan. Basis of cost: 1,500 LF of ditching, 400 LF of 12" Dia CPEP, and 2 catch basins.

SOLUTION FIGURE





**San Juan County
Capital Improvement Program
Project Summary Sheet**

Name: West Airport Drainage Improvements
Site ID: ES33
Project Priority: Top 23
Estimated Cost: \$780,000

PROBLEM SUMMARY

Increased flow from recent development is causing flooding of the existing Airport storm drainage system and also may be affecting the Airport Wetland. Future development may exacerbate existing problems. Modeling results indicate that airport flooding may be due to an existing 6 inch culvert along the west side of the runway.

RANK JUSTIFICATION

Modeling indicates conveyance is undersized. Affects upland drainage and may affect Airport Wetland hydroperiod. Would provide capacity for future development.

- Prior drainage plan project
- Water quality treatment retrofit
- Capacity for future development
- Protects critical natural resource



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Wet season flow towards outfall (facing south at northwest corner of runway).

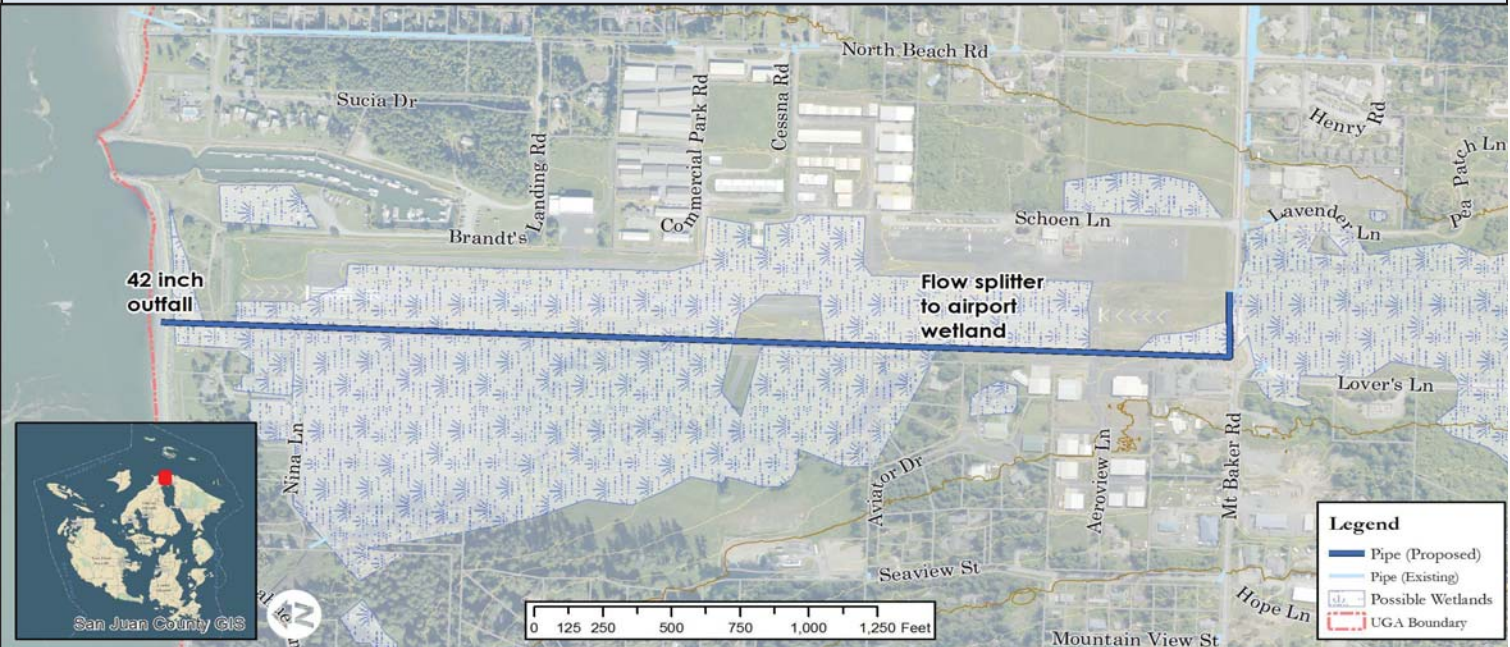
Wet season flow from Mount Baker Road towards airport (facing north at southwest corner of runway).

PROPOSED SOLUTION

The current solution and cost estimate is based on Project 5.1 from the 2005 Eastsound Drainage Plan and includes a large conveyance system along the west side of the airport with potential to divert controlled amounts of flow to the Airport Wetland. This solution is viewed as conservative because updated modeling indicates the existing system is adequate, except for one 6-inch diameter culvert. Modeling indicates upsizing the 6-inch culvert to 18-inches would provide adequate capacity. Basis of cost: 2005 Eastsound Drainage Plan.

Future considerations: Develop a wholistic solution for ES33, ES34, and ES35 including a study of potential affects on Airport Wetland (hydroperiod study). The existing conveyance on the west and east sides of the runway are interconnected.

SOLUTION FIGURE





**San Juan County
Capital Improvement Program
Project Summary Sheet**

Name: Blanchard Road and Nina Lane Conveyance & Outfall
 Site ID: ES34
 Project Priority: Top 23
 Estimated Cost: \$150,000

PROBLEM SUMMARY

The area around Nina Lane is flat and does not drain resulting in flooding of the roadways. Increased flows are stressing the existing conveyance and neighboring Airport Wetland. Modeling indicates the existing 8" outfall is undersized.

RANK JUSTIFICATION

Necessary to provide conveyance for increased flows along Donahue Lane and to protect Airport Wetland. Identified in 2005 Eastsound drainage plan. Complex and potentially severe problem. May improve water quality treatment through better management of Airport Wetland.

- Prior drainage plan project
- Water quality treatment retrofits
- Protects critical natural resource



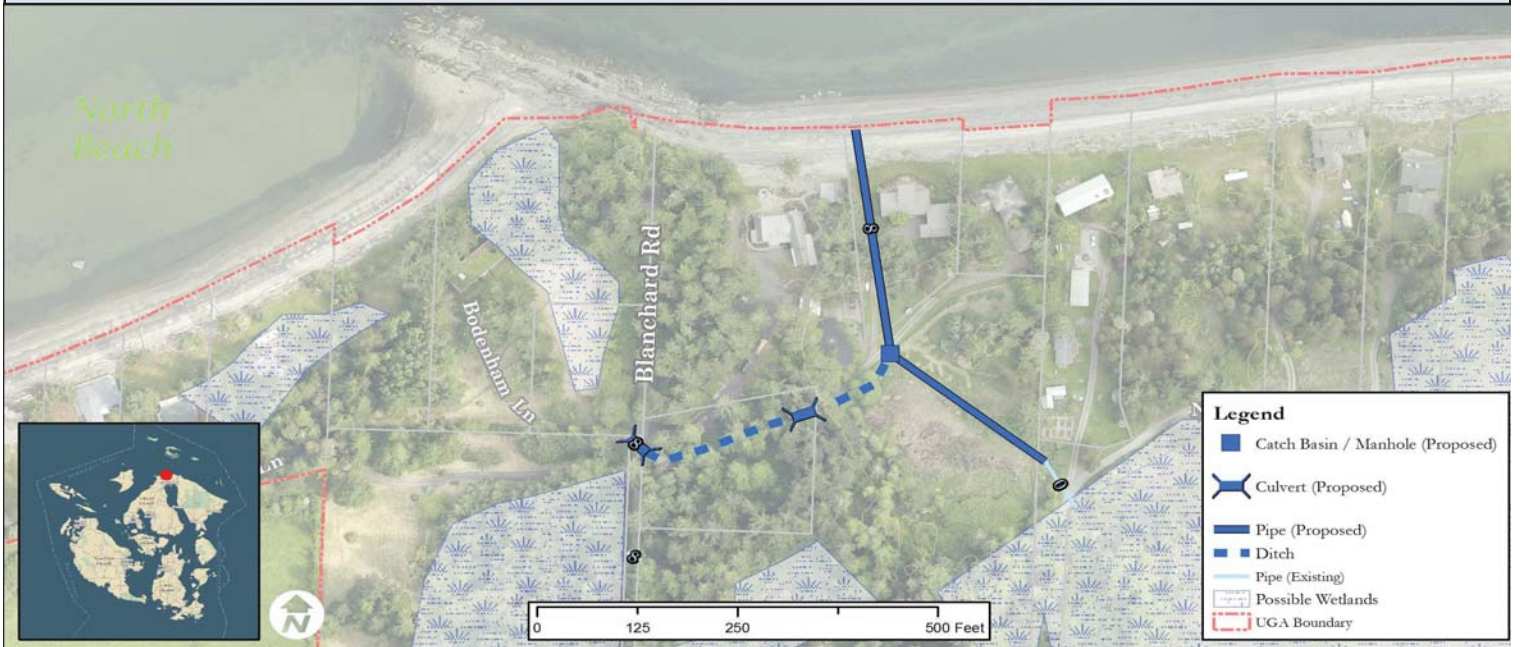
Looking Southeast from existing culvert under Donahue Lane

View East from Nina Lane

PROPOSED SOLUTION

Upsize the existing outfall to 18-inches and improve ditching along Donahue Lane. Project includes portions of projects 5.2 and 5.6 in 2005 Eastsound drainage plan. Basis of cost: 330 LF of ditching, 40 LF of 18" Dia CPEP culvert, 300 LF of 18" Dia CPEP across private property to the shoreline, and 1 catch basin. Future considerations: Develop a wholistic solution for ES33, ES34, and ES35 including a study of potential affects on Airport Wetland (hydroperiod study). In particular, the interaction between the Bunny Lane outfall (ES34) and the outfall to the northwest of the airport (ES33) is not well understood.

SOLUTION FIGURE





**San Juan County
Capital Improvement Program
Project Summary Sheet**

Name: Rose Street Conveyance Improvements
 Site ID: ES31
 Project Priority: Top 23
 Estimated Cost: \$210,000

PROBLEM SUMMARY

Drainage system is under capacity which may be exacerbated by Poplar roots along Rose Street.

RANK JUSTIFICATION

Rose Street drainage network under capacity. Identified in 2005 Eastsound basin plan. Will provide capacity for development on Madrona Street. Conveyance will direct flow to Eastsound Constructed Wetland to provide treatment.

- Prior drainage plan project
- Water quality treatment retrofit
- Capacity for future development



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07/31/2014 08:35

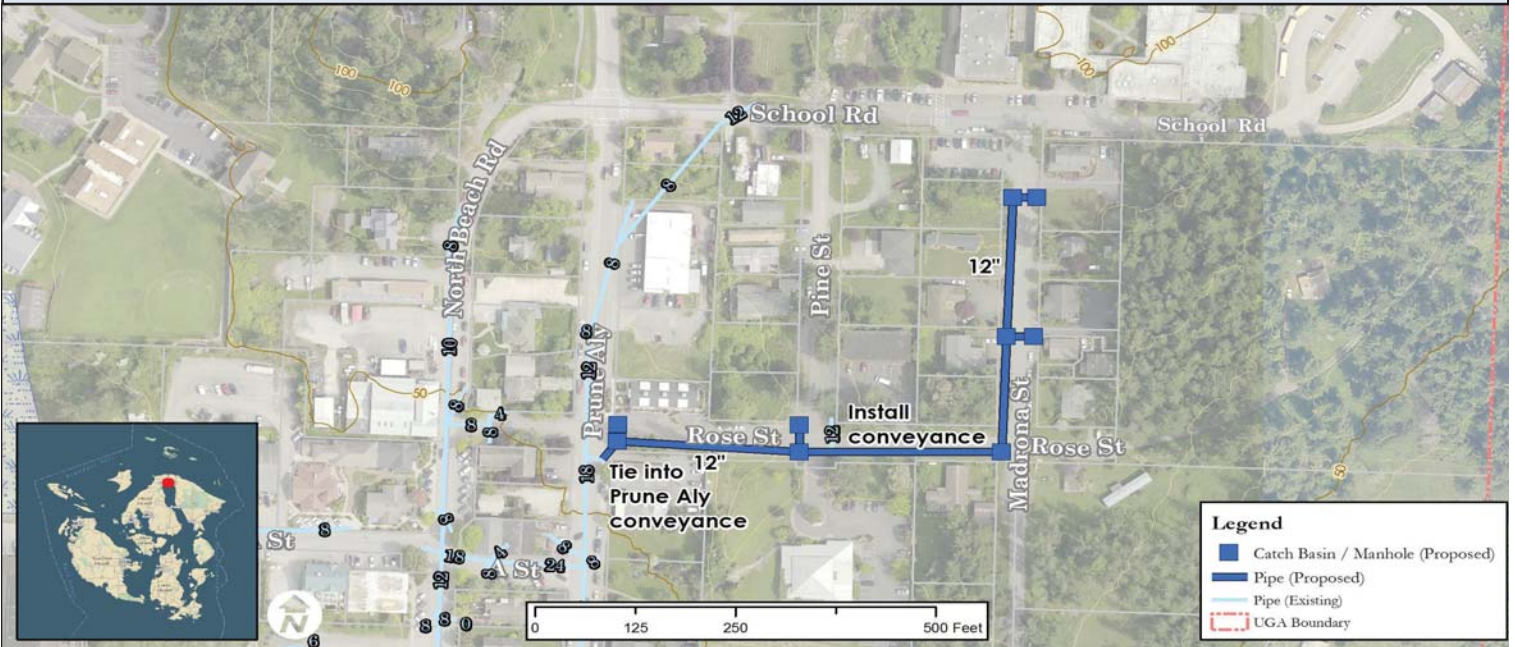
View West on Rose Street toward intersection with Prune Alley

View West on Rose Street from Madrona Street

PROPOSED SOLUTION

Installation of new drainage system on Rose Street including addressing Poplar roots in nearby catch basins. Project will improve conveyance of stormwater to the existing Eastsound Constructed Wetland. Model results indicate that the addition of 12 inch Storm Drain Pipe will provide sufficient capacity along Rose Street. Project 1.3 in Eastsound drainage plan. Basis of cost: 2005 Eastsound Drainage Plan.

SOLUTION FIGURE





**San Juan County
Capital Improvement Program
Project Summary Sheet**

Name: East Airport Drainage Improvements
 Site ID: ES35
 Project Priority: Top 23
 Estimated Cost: \$855,000

PROBLEM SUMMARY

Increased flows are stressing the conveyance along North Beach Road and Cessna Road to the marina outfall. No easement exists for County to perform maintenance. Model results indicate that the current 16 inch system is undersized.

RANK JUSTIFICATION

Flooding is affecting private property. Identified in 2005 Eastsound drainage plan. Affects drainage of commercial park and North Beach Road thus impacting capacity for future development.

- Health and Safety Risk
- Prior drainage plan project
- Capacity for future development



View north along runway

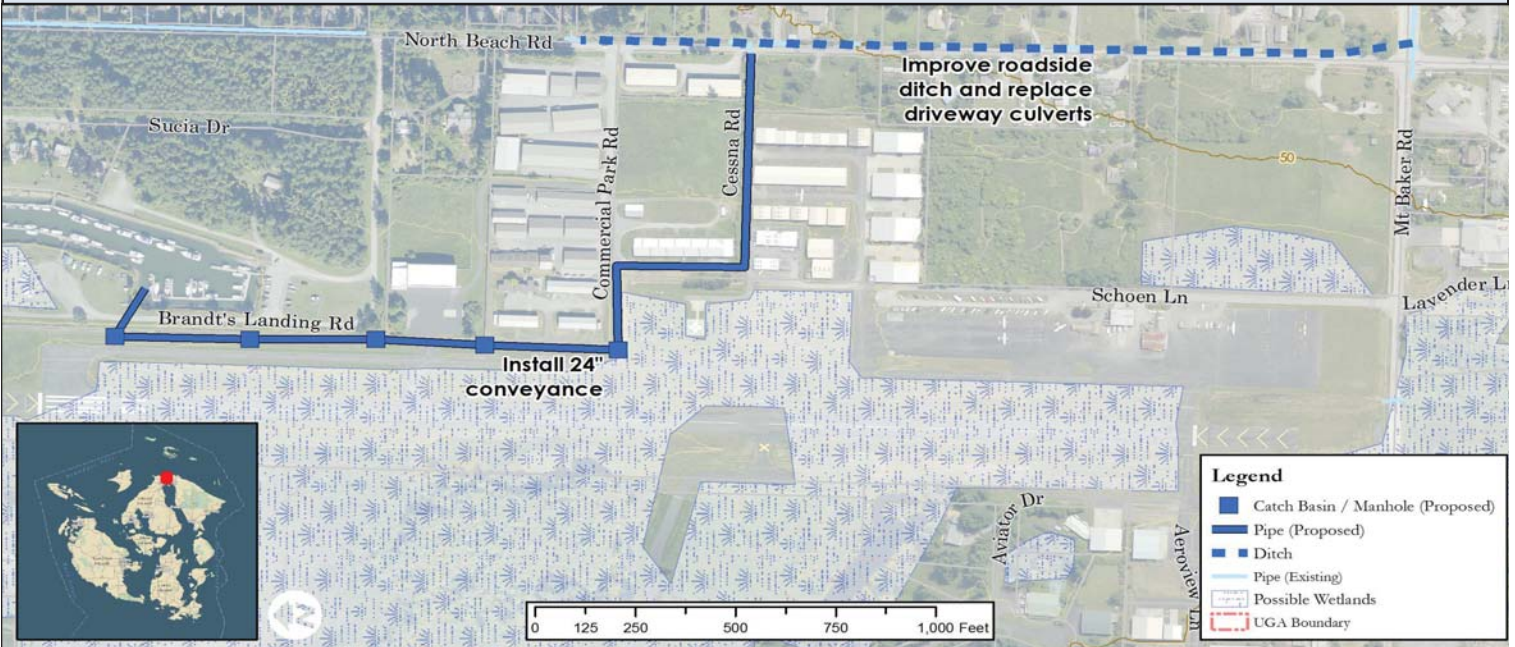
View west toward airport (near Commercial Park Road)

PROPOSED SOLUTION

Solution includes improvement of ditches, culverts, and outfall as well as acquisition of a new County easement to conduct maintenance. The existing solution and cost are based on Project 5.3 in Eastsound drainage plan, and should be refined prior to final design in order to ensure that the wetland is protected. Modeling indicates upsizing the existing outfall from 16-inch diameter to 24-inch diameter may solve the flooding problem along the east side of the airport runway (but tidal affects were not accounted for). Basis of cost: 2005 Eastsound Drainage Plan.

Future considerations: Develop a wholistic solution for ES33, ES34, and ES35 including a study of potential affects on Airport Wetland (hydroperiod study). The existing conveyance on the west and east sides of the runway are interconnected.

SOLUTION FIGURE





**San Juan County
Capital Improvement Program
Project Summary Sheet**

Name: San Juan Valley Creek Capacity Improvement
 Site ID: FB1
 Project Priority: Top 23
 Estimated Cost: \$237,000

PROBLEM SUMMARY

Upstream development and agricultural practices have altered the hydrology of False Bay watershed. Every five to ten years San Juan Valley Creek and False Bay Creek overtops Bailer Hill Road with up to 2 feet of water, which affects a primary route to Friday Harbor and increases response time for emergency responders. The reach downstream on the road may be capacity limited due to sediment aggradation, which also affects fish passage and habitat quality in the reach. Upstream development may be increasing runoff and contributing to the problem.

RANK JUSTIFICATION

Frequent flooding occurs (5 to 10 year) and causes a potentially dangerous increase in response time for emergency responders. Lack of adequate fish passage and habitat in the downstream reach. Project provides increased channel capacity to accommodate future development. Project enhances critical habitat for fish.

- Health and Safety Risk
- Capacity for future development
- Protects critical natural resource



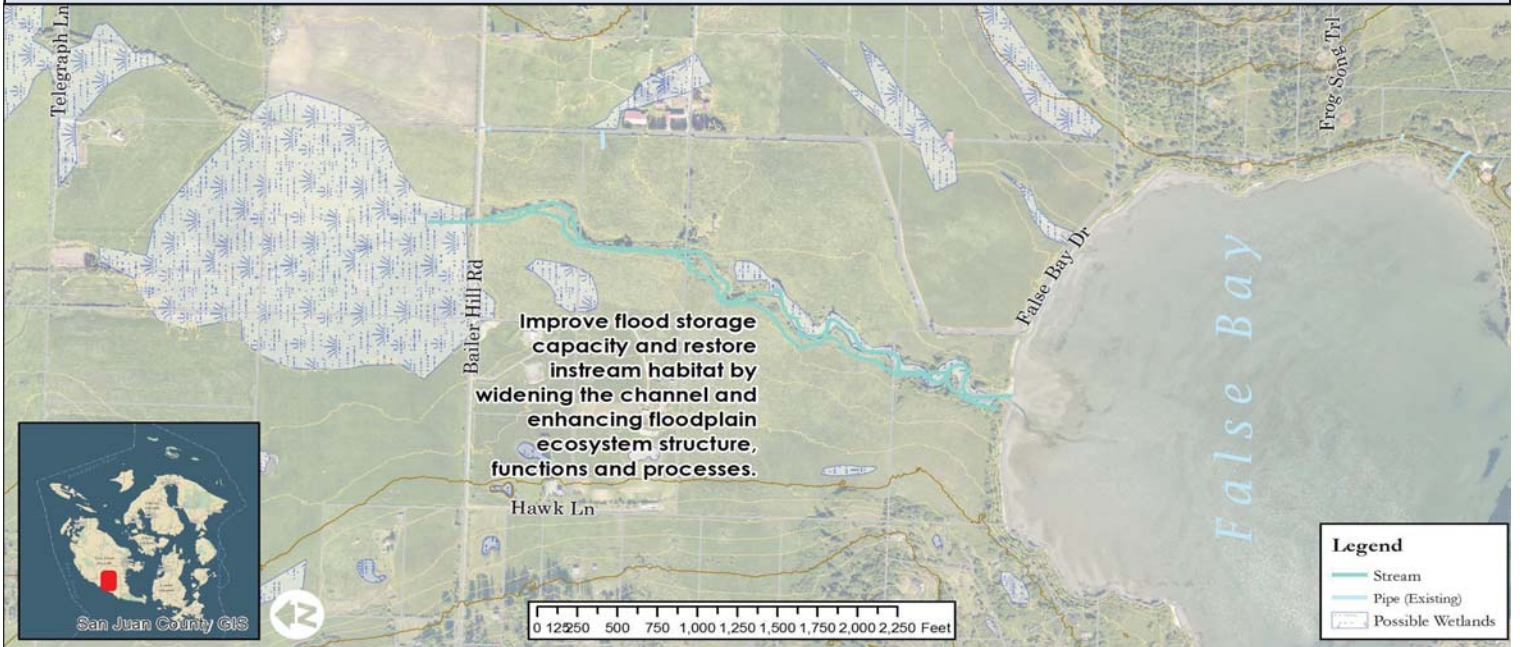
Dry conditions on Bailer Hill Rd at False Bay Creek

Flooded conditions on Bailer Hill Road at False Bay Creek

PROPOSED SOLUTION

The design will likely include some or all of the following: removing accumulated sediment and/or instream vegetation downstream of the road to improve flow; reshaping channel banks to improve floodplain connectivity upstream and downstream; providing additional floodplain storage via strategically placed riparian wetlands and vernal pools upstream and downstream; expanding and planting the riparian corridor with native vegetation upstream and downstream; raising road prism and/or upsizing the culvert to improve flow; retrofitting upstream ponds to provide additional detention. Basis of cost: Design feasibility study including data collection and field investigation, preliminary design alternatives development and analysis, hydrologic and hydraulic modeling, and selection of the preferred alternative. (Initial high-level estimates of capacity improvement and floodplain enhancement options were in the range of \$2M-\$4M). Future consideration: Coordinate with Douglas/Bailer Hill Roads Improvements (MP 3.15 - 5.95) and salmon recovery efforts.

SOLUTION FIGURE





**San Juan County
Capital Improvement Program
Project Summary Sheet**

Name: Ranchos Road at Oak Hill Drive Drainage Improvement
 Site ID: FB4
 Project Priority: Top 23
 Estimated Cost: \$35,000

PROBLEM SUMMARY

Drainage from hillside causes flooding at least annually impacting road safety, agricultural land, and a septic drain field.

RANK JUSTIFICATION

Impacting private property, electrical transformer, and drainfield. Would improve water quality by directing water away from drainfield.

- Health and Safety Risk
- Water quality treatment retrofit
- Capacity for future development
- Protects critical natural resource



View of North Star Ln from Ranchos Road

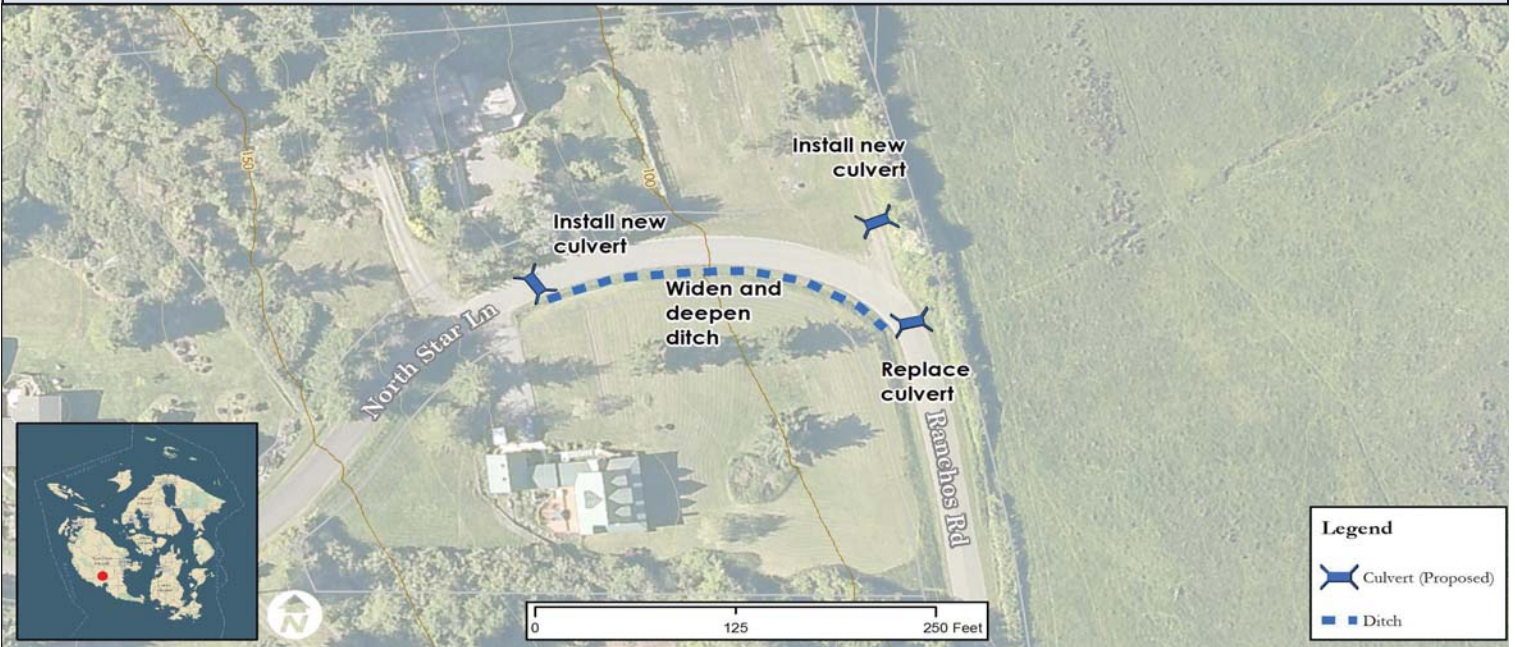
View North on North Star Ln of transformer, septic, and Ranchos Road

PROPOSED SOLUTION

Add cross culverts and widen ditch to direct flow south away from drainfield. Basis of cost: 230 LF of ditching, 60 LF of 18" Dia CPEP culvert pipe and 30 LF of 12" Dia CPEP Culvert pipe.

Future considerations: Residential retrofits may help alleviate problem. Regional detention or infiltration does not seem appropriate given bedrock near ground surface and steep slopes.

SOLUTION FIGURE





**San Juan County
Capital Improvement Program
Project Summary Sheet**

Name: Lopez Village Farmers Market Stormwater Improvements
 Site ID: FMB4
 Project Priority: Top 23
 Estimated Cost: \$450,000

PROBLEM SUMMARY

Lopez Village Road is one of the most heavily used streets in Lopez Village. Ditch capacity is too low to convey flow from Village Road in addition to base flow coming from north of Fisherman Bay Road. The existing storm drain system is not consistent with the vision of the Lopez Village Planning Review Committee.

RANK JUSTIFICATION

Safety issue, public asset potential (enhancing farmers market), and protect water quality in Weeks Wetland and Fisherman Bay. High visibility. Identified for improvement in 2002 and 2005 drainage plans.

- Health and Safety Risk
- Capacity for future development
- Prior drainage plan project
- Water quality treatment retrofit



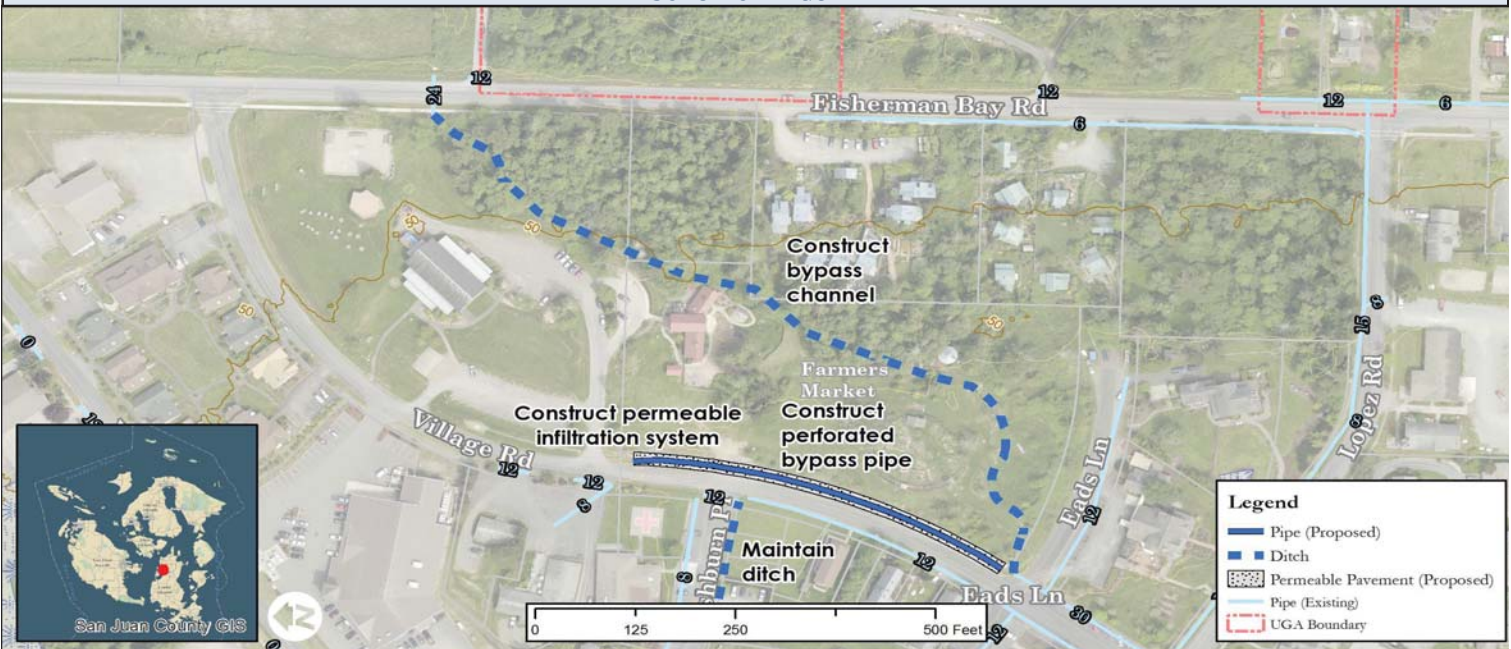
Ditch along Village Road

Lopez Village Farmers Market area

PROPOSED SOLUTION

Install an infiltration system designed as a gravel reservoir with check dams below permeable pavement parking on the east side of Village Road from approximately Washburn Place to Eads Lane. Install a perforated pipe that will bypass high flows above the infiltration system. Construct a bypass channel through the Farmers Market area to route runoff from the upper basin around the infiltration system; this will bypass relatively clean flow around the system and provide an open water feature to the Farmers Market. Basis of cost: 8,200 SF of permeable pavers with check dams every 43 LF, 470 LF of 8" Dia Perf Pipe, 30 In Dia Trash Rack, 3 pedestrian bridges, 1,100 LF of open channel with riparian planting, large wood, water quality treatment pools (if space and funding is available) and boulders.

SOLUTION FIGURE





**San Juan County
Capital Improvement Program
Project Summary Sheet**

Name: Lopez Village Water Quality Treatment Facility
 Site ID: FMB6
 Project Priority: Top 23
 Estimated Cost: \$940,000

PROBLEM SUMMARY

Capacity improvements and easement issues have resulted in flow being diverted from an existing water quality treatment swale, thus reducing the amount of water quality treatment provided prior to discharge to Weeks Wetland. The swale downstream of this is undersized for the treatment area.

RANK JUSTIFICATION

Project would protect and maintain critical natural resources in Fisherman Bay, provide additional water quality treatment for future development, and provide desired open water amenity to Lopez Village.

- Water quality treatment retrofit
- Capacity for future development



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Example water quality treatment facility

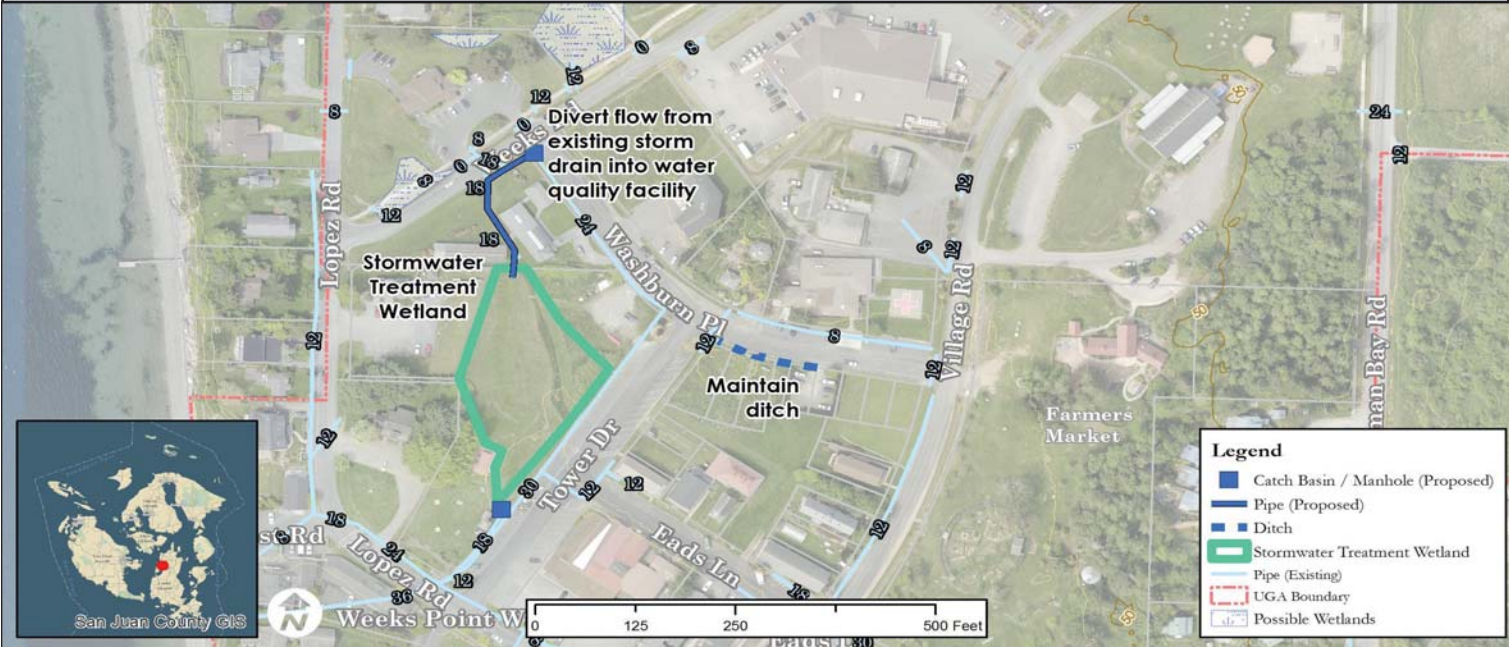
Weeks Wetland viewed from Lopez Road

PROPOSED SOLUTION

Construct a stormwater treatment wetland on the existing County owned parcel west of Tower Drive. Acquire an easement through the museum property and replace existing pipe to divert flow from the northwest. Basis of cost: Stormwater treatment wetland 0.4 acres in size with 1300 LF of trails, soil amendments over disturbed area outside of the wetland footprint, 1 pedestrian bridge, 2 project signs, and 1 water level indicator. 230 LF of 12" dia Storm Drain Pipe for inlet and outlet pipes. Flow diversion catch basin and outlet catch basin with trash racks.

Future considerations: Would need to be coordinated with any regional stormwater treatment facility plans at Weeks Wetland Swale (FMB3). Maintain ditch along Washburn Place as part of this project.

SOLUTION FIGURE





**San Juan County
Capital Improvement Program
Project Summary Sheet**

Name: Apple Tree Lane Conveyance to Outfall
 Site ID: FMB1
 Project Priority: Top 23
 Estimated Cost: \$63,000

PROBLEM SUMMARY

Ditch across private property between Bayshore Road and shoreline is under capacity and causing flooding issues. County lacks an easement to conduct maintenance.

RANK JUSTIFICATION

Ditch across private property between Bayshore Road and shoreline is under capacity and causing flooding issues. County lacks an easement to conduct maintenance.

- Health and Safety Risk
- Capacity for future development



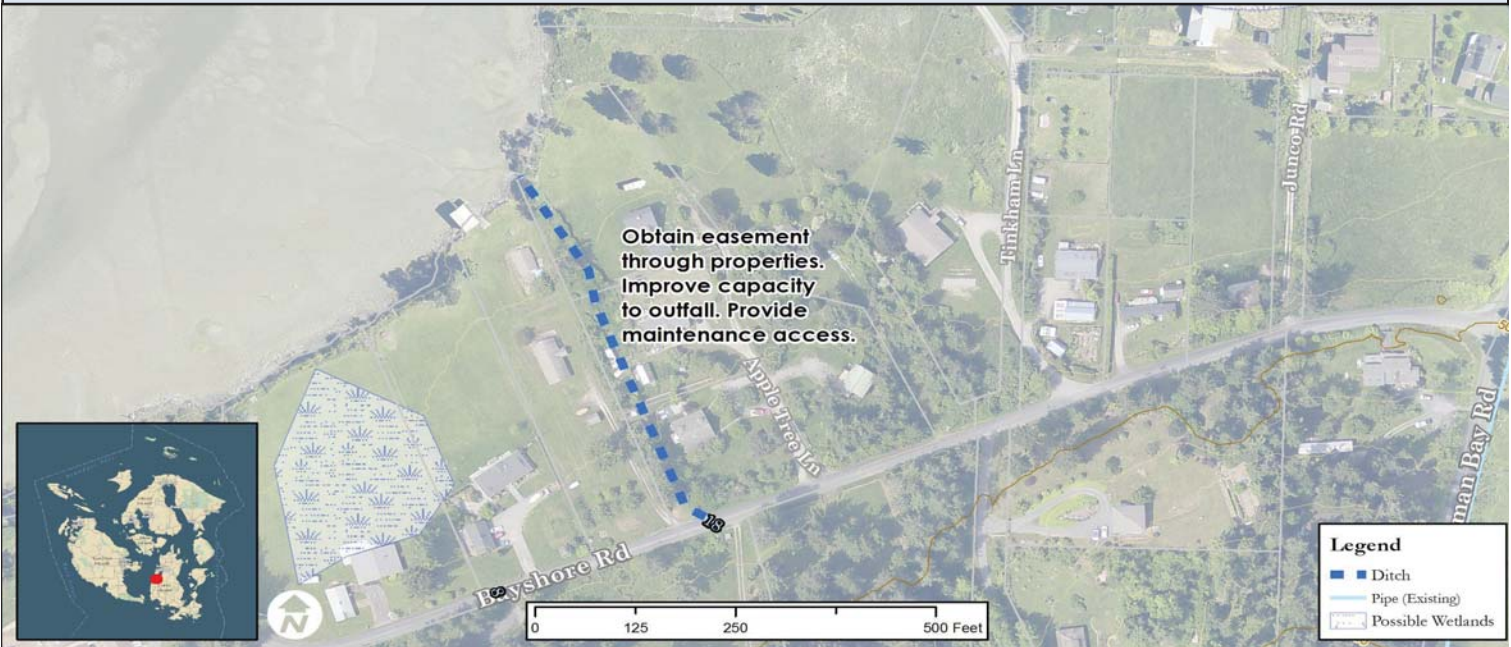
Channel off of Bayshore Road

Channel to outfall West of Apple Tree Lane

PROPOSED SOLUTION

Obtain easement and improve conveyance to shoreline. Other options under consideration include obtaining an easement and constructing a new drain/ditch south of 252 Bayshore Road. Basis of cost: 560 LF of ditching with 8' wide maintenance path constructed adjacent to the ditch for future maintenance.

SOLUTION FIGURE





**San Juan County
Capital Improvement Program
Project Summary Sheet**

Name: Weeks Wetland Swale Improvement
 Site ID: FMB3
 Project Priority: Top 23
 Estimated Cost: \$57,000

PROBLEM SUMMARY

Weeks wetland inlet swale is clogged and overgrown with reed canarygrass, which prevents stormwater runoff from entering the swale and may impact water quality in Fisherman Bay.

RANK JUSTIFICATION

Weeks Wetland swale is the primary stormwater treatment system for Lopez Village. Project would protect and maintain critical natural resources in Fisherman Bay.

- Water quality treatment retrofit
- Protects critical natural resource
- Capacity for future development



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Weeks Wetland swale inlet

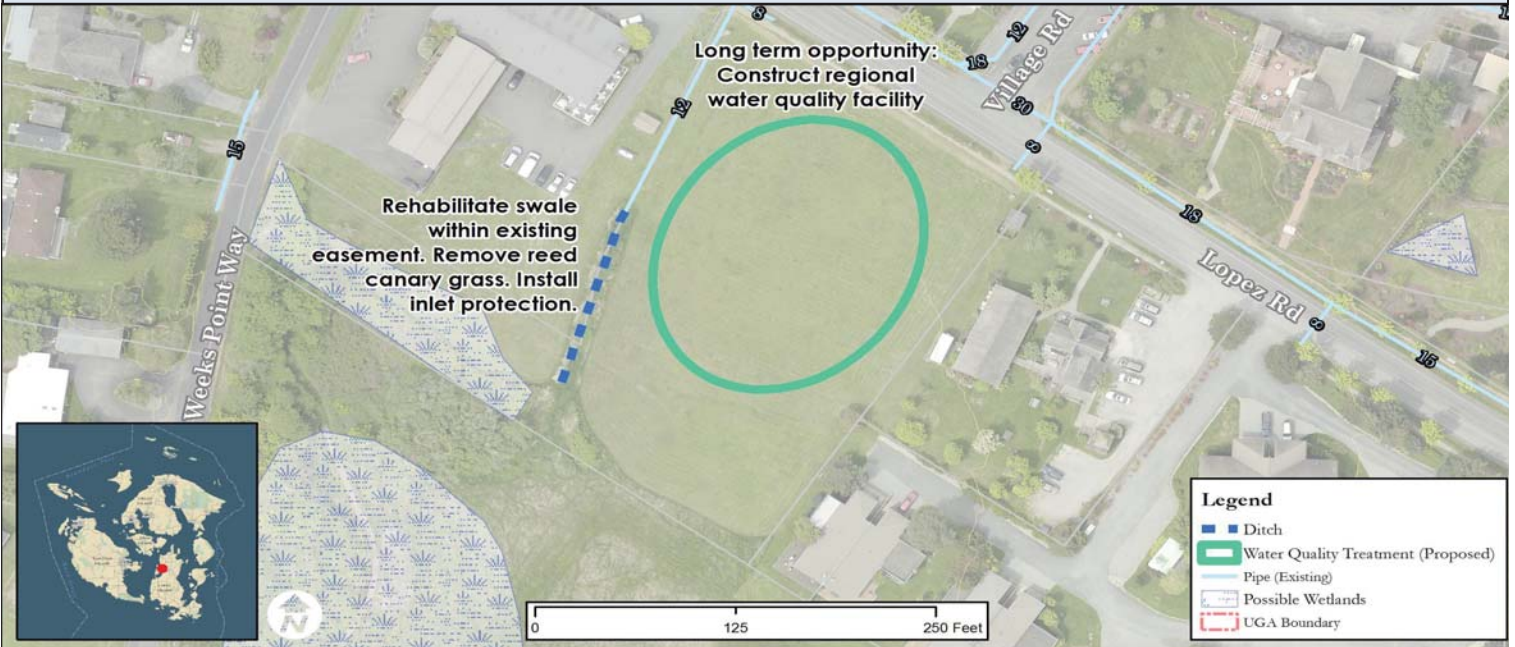
Weeks Wetland viewed from Lopez Road

PROPOSED SOLUTION

Rehabilitate the swale leading to Weeks Wetland. Dredge accumulated sediment, widen the channel to the extent practical, install weirs every 20 linear feet, and install a flared inlet. Remove reed canarygrass and plant native species. Basis of cost: 150 LF of swale dredging, 7 weirs spaced roughly every 20 LF, native plantings, erosion control blanket, and an informational sign.

Future considerations: Consider constructing a larger stormwater treatment BMP such as a treatment wetland (FMB6) on the vacant parcel to the east of the swale to provide stormwater treatment for future development in the Lopez Village UGA. However, any facility expansion should be coordinated with projects FBM4 and FMB6, both of which are upstream.

SOLUTION FIGURE



APPENDIX C

Predesign Reports

- C-1 Prune Alley and Fern Street Water Quality Improvements
Preliminary Design Report
- C-2 Market and Madrona Water Quality Improvements
Preliminary Design Report
- C-3 San Juan Valley Creek Capacity Improvement Project
Preliminary Design Report
- C-4 Lopez Village Farmers Market Stormwater Improvements
(FMB4) Predesign Report
- C-5 Lopez Village Water Quality Treatment Facility (FMB6)
Predesign Report

APPENDIX C-1

Prune Alley and Fern Street Water Quality Improvements Preliminary Design Report

PRUNE ALLEY AND FERN STREET
WATER QUALITY IMPROVEMENTS
PRELIMINARY DESIGN REPORT

VOLUME 2 PRIORITY WATERSHED PLANNING
SAN JUAN COUNTY, WASHINGTON

Prepared for
San Juan County Public Works

Prepared by
Herrera Environmental Consultants, Inc.



PRUNE ALLEY AND FERN STREET
WATER QUALITY IMPROVEMENTS
PRELIMINARY DESIGN REPORT

VOLUME 2 PRIORITY WATERSHED PLANNING
SAN JUAN COUNTY, WASHINGTON

Prepared for
San Juan County Public Works
915 Spring Street
P.O. Box 929
Friday Harbor, Washington 98250

Prepared by
Herrera Environmental Consultants, Inc.
2200 Sixth Avenue, Suite 1100
Seattle, Washington 98121
Telephone: 206/441-9080

June 12, 2015

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Engineer's Stamp

This preliminary design report has been prepared under the supervision of a professional engineer registered in the State of Washington.



Matthew M. Fontaine, PE

06/12/2015
Date

Introduction

San Juan County Public Works (County) is committed to effective stormwater management that cost effectively addresses flooding and water quality problems that may adversely affect property and the natural environment. The County seeks to address these issues proactively at two primary levels:

- Completion of an inventory and high-level evaluation of County watershed conditions that provides a resource for identifying problem areas and recommends countywide stormwater management strategies (Phase 1)
- A more detailed evaluation of conditions in five priority watersheds, including Eastsound and Lopez Village, including identification of land use planning and capital improvement project alternatives to address specific stormwater issues in these areas (Phase 2)

This preliminary design (predesign) report focuses on one of the priority capital improvement projects that resulted from Phase 2, the Prune Alley and Fern Street Water Quality Improvements project (identified as ES8 and ES9 in Volume 2 of the San Juan County Stormwater Management Plan). The project would install stormwater treatment units approved by the Washington State Department of Ecology (Ecology) to improve the quality of runoff from pollutant generating surfaces in Eastsound Village. The County submitted a grant application to Ecology for project funding in November 2014. This report is specifically tailored to address application requirements for grants provided by Ecology to fund completion of design and/or construction of stormwater treatment retrofit projects, as well as conditions of Ecology grants which require a Predesign Report submittal as part of fulfilling the grant.

Basin Description

The East Sound watershed was identified as a priority among the 37 watersheds in San Juan County based on known water quality problems, drainage conveyance and flooding issues, expected future development, and its rich natural resources. Within the watershed 41 citizens submitted comments on stormwater issues to the County, and 38 projects proposed in the Long Range Drainage Plan Proposal for Eastsound Village Urban Growth Area (Rasmussen et al. 2005) were compiled to develop 17 potential capital improvement projects needed in Eastsound. The Prune Alley and Fern Street Water Quality Improvements project was ranked as one of the highest priority projects by the County and the Citizen Stormwater Advisory Committee (CSWAC, a committee formed to advise the County on stormwater management issues), based on several criteria including the risk posed to property and health, longevity of the drainage issue, opportunity to provide water quality treatment, and ability to provide capacity and treatment for future development.

The Puget Sound Partnership identifies runoff from the built environment as one of three key pressures having a high level of significance to the San Juan County ecosystem (Puget Sound Partnership 2014). The Action Agenda lists actions and responsible entities for improving San Juan waters including: controlling and mitigating stormwater runoff, improving stormwater

management and polluted runoff, devise monitoring and management plans for priority or focus basins, increasing use of BMPs, and salmon recovery and habitat protection (Puget Sound Partnership 2014).

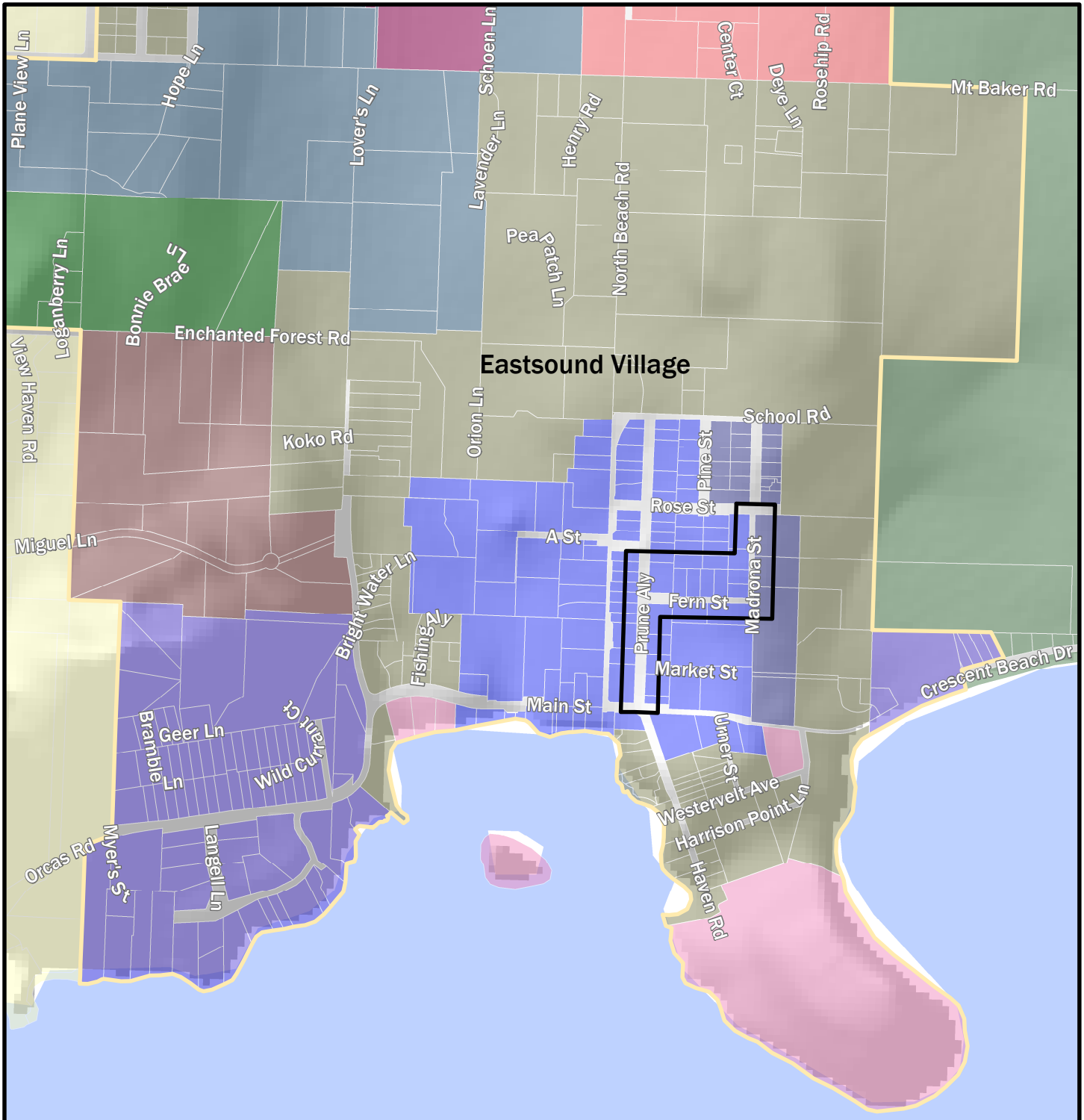
Healthy water quality in San Juan County is paramount as its location is a way-station for all 22 migrating populations of Puget Sound Chinook salmon as both juveniles and adults. Additionally, sockeye, pink, chum, and coho salmon, kokanee, steelhead, and rainbow and coastal cutthroat trout have been documented in the County (Puget Sound Partnership 2014). The San Juan Islands support outmigrating juvenile salmon including: Chinook, coho, chum and pink, and stocks from the Fraser River, Puget Sound and east and west coast Vancouver Island and the Strait of Georgia. Although most of the streams in San Juan County are small and do not support salmon, a small number of coho have recently been reported spawning in Cascade Creek and possibly other streams on Orcas Island, and a few creeks support cutthroat and introduced runs of chum.

East Sound is included on Ecology's Clean Water Act section 303(d) list as a Category 5 waterbody impaired for dissolved oxygen (listing #10101) and as a water of concern (Category 2) regarding pH (listing #10102). When compared across six other areas in San Juan County, the East Sound watershed exhibited relatively higher fecal coliform and E. coli levels in 2012-2013 monitoring with overall counts driven by contaminated discharges from Eastsound Village. Ortho-phosphorus monitoring at the Eastsound Village main stormwater outfall have not consistently met San Juan County Conservation District guidelines. Compared to national databases for stormwater concentrations, measurements for nitrate+nitrite, total nitrogen, and total phosphorus at East Sound monitoring sites were, on average, moderate but highly variable.

Site Description

Flooding, ponding, and erosion are a common complaint in the East Sound watershed. Flooding has occurred on Prune Alley and the surrounding private properties due to insufficient capacity of storm drain inlets, deteriorated curbs, and irregular road grades. Inadequate drainage conveyance, poor infiltration, and lack of treatment pose a human health and safety risk to residents, workers, and customers frequenting Prune Alley as well as a risk to the marine environment of East Sound, including a nearby shellfish farm. This project and coinciding road improvements planned by the County will address these problems. Efficiency will be gained by planning the water quality improvements to coincide with the right-of-way improvements to address flooding and safety problems.

The area tributary to the proposed runoff treatment facilities is predominantly commercial land use with some residential and industrial parcels nearby, as shown in Figure 1. Runoff from Prune Alley and Fern Street drains directly to East Sound without treatment. These roadways are located at the center of commercial and social activities on Orcas Island. Eastsound Village between Orcas Road and Olga Road has the highest Average Annual Daily Traffic (AADT) levels on the island with Prune Alley having an AADT ranging between 2000 and 3000. Runoff from commercial land use in the Puget Sound area is known to contain elevated concentrations of dissolved and total metals, nutrients, and fecal coliform bacteria.



Legend

- Project Area
- Eastsound UGA
- Eastsound Airport District
- Eastsound Natural (max. 1 unit per parcel)
- Eastsound Rural (max. 1 unit/5 acres)
- Eastsound Residential 1/acre P*
- Eastsound Residential 2/acre
- Eastsound Residential 2/acre P*
- Eastsound Residential 4/acre P*
- Eastsound Rural Residential (max. 1 unit/5 acres)
- Service & Light Industrial
- Village Commercial (min. 4 - max. 40 units/acre)
- Village Commercial Limited (see SJCC 16.55.210.D.3)
- Village Commercial Limited (see SJCC 16.55.210.D.3)

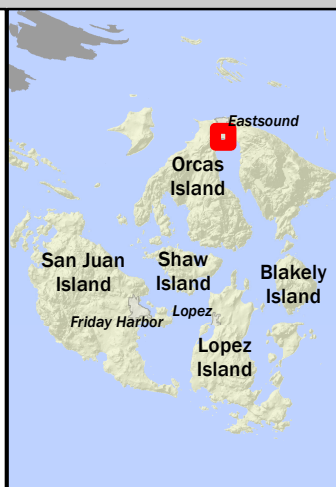
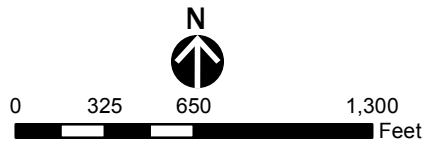


Figure 1.
Eastsound UGA Land Use,
Orcas Island, Washington.



In addition to these pollutants, runoff from roads can also contain organic pollutants such as hydrocarbons. Although results of monitoring in the watershed indicate dissolved metals concentrations are currently below applicable criteria in Washington State for preventing acute and chronic toxicity in aquatic life, concentrations of these pollutants are expected to increase along with further development and increased traffic in the UGA. Monitoring results from the existing Eastsound Village main stormwater outfall indicate this runoff is characterized by low concentrations of dissolved oxygen and elevated concentrations of fecal coliform bacteria, E. coli bacteria, and ortho-phosphorus.

This project will also demonstrate feasibility of compact stormwater treatment technology for water quality retrofits in the UGAs of San Juan County where space is limited and the shallow groundwater level is high. Success of this project will be relevant to future development throughout San Juan County and as water quality retrofits in San Juan County UGAs are completed.

Design Alternatives and Analysis

Thirty-seven watersheds in San Juan County were evaluated and compared based on their contribution to water supplies, and support of critical natural resource areas such as wetlands and streams, and the fish and wildlife species dependent on them. The Eastsound watershed was identified as one of the top five priority watersheds for stormwater management planning (Herrera et al. 2014a). Detailed analysis within the five priority watersheds identified 31 potential CIP projects; the Prune Alley and Fern Street Water Quality Improvement Project ranked among the top five (Herrera et al. 2014b).

The Prune Alley and Fern Street site in the Eastsound watershed was selected for several reasons:

- **Strong residential support.** This project has strong support among residents and businesses due to the use of pioneering technology to address water quality issues in the dense urban development area of Eastsound and the need for improved drainage conveyance. The County plans to use this project to demonstrate feasibility of retrofitting stormwater infrastructure in urban settings to address other conveyance and water quality problems in settings with high groundwater. This type of project has implications for other parts of Eastsound as well as the UGA on Lopez Island.
- **History of stormwater issues.** Prune Alley and Fern Street were identified as separate priority retrofit projects for the County in a 2005 Basin Plan for Eastsound (Rasmussen 2005). These locations were identified based on the lack of water quality treatment before discharge to Eastsound and the need for stormwater conveyance improvements. No action on these issues has yet to be taken. These two projects have been combined in the current basin planning work.
- **Treat pollution close to the source.** The County and the CSWAC have a goal to treat and manage stormwater as close to the source of pollution as possible and to protect the quality of groundwater and surface water. This project will be a template for other retrofit projects in the Eastsound UGA and Lopez Village UGA on Lopez Island.

Water Quality and Ecological Benefits

Water quality treatment is required for the protection of habitat for ESA-listed salmonids, protection of shellfish habitat, and protection of priority habitats including herring spawning areas and eelgrass beds. The result of this project will be installation of stormwater treatment systems along Prune Alley and Fern Street. Once constructed, this project will provide water quality treatment for road runoff, reducing the concentrations of common stormwater pollutants entering East Sound. Both of the stormwater treatment systems selected for this project have received GULDs from Ecology for Basic, Enhanced, and Total Phosphorous treatment. With these designations, the installed facilities are expected to remove total suspended solids, dissolved copper and zinc, and phosphorus. Suspended solids in runoff, especially the finer fraction, can reduce light penetration in water and can have a smothering effect on fish spawning and benthic biota. Suspended solids are also closely associated with other pollutants such as nutrients, bacteria, and organic compounds. Dissolved copper and zinc can be directly toxic to aquatic organisms; dissolved copper has also been linked to sublethal behavioral changes in salmonids due to olfactory inhibition. Phosphorus is a concern in freshwater because it can contribute to eutrophication.

The East Sound watershed comprises approximately 13,562 acres, of which Eastsound Village is approximately 100 acres. Eastsound Village is the most intensively developed area in the watershed and has more pollutant contributing land uses (i.e. dense residential and commercial) than the rest of the watershed which is primarily rural and forested in nature. Roadways north of A Street in Eastsound Village drain to the Eastsound Swale and to the Eastsound Constructed Wetland, which provide stormwater treatment prior to discharging to East Sound. Roadways south of A Street in Eastsound Village drain directly to marine waters via the storm drain system.

The volume of runoff that would be treated for the approximate 2.4-acre tributary drainage area is 5.5 acre-feet per year on average. The proposed design includes two Filterra systems and two Linear Modular Wetland Systems to provide enhanced treatment for more than 91 percent of the annual runoff volume in this drainage area. The roadways within this targeted drainage area represent approximately 22 percent of the currently unmanaged roadway runoff in the Eastsound Village UGA draining to East Sound.

Pollutant Load Reduction

Pollutant loading in runoff from Prune Alley and Fern Street was estimated using data from the Phase II Municipal NPDES Permit Fact Sheet (Table 1). Specifically, NPDES Phase I municipal permittee monitoring data submitted to the Washington State Department of Ecology (Ecology) and synthesized in Attachment A of the *Draft Western Washington Phase II Municipal Stormwater Permit Fact Sheet* (Ecology 2011) were used to define untreated runoff loading at this site. Pollutant removal rates for the MWS Linear Modular Wetland Systems were taken from the GULD documentation (Tables 2 and 3) (Ecology 2014a, Ecology 2014b). Table 4 defines the annual pollutant load reduction that is estimated to result from project implementation.

Table 1. Estimated Annual Pollutant Loads in Runoff from Prune Alley and Fern Street.

Water Quality Parameter	Annual Load (pounds)
Total suspended solids	1,140
Total nitrogen	31
Total phosphorus	2.9
Total zinc	1.9
Dissolved zinc	0.8
Total copper	0.4
Dissolved copper	0.17

Table 2. Stormwater Pollutant Removal Rates in Filterra Units (Source: Ecology 2014a).

Water Quality Parameter	Removal (%)
Total suspended solids	>80
Total phosphorus	>50
Dissolved zinc	>60
Dissolved copper	>30
Total petroleum hydrocarbons	<10 mg/L effluent concentration

Table 3. Stormwater Pollutant Removal Rates in MWS Linear Modular Wetland Removal Units (Source: Ecology 2014b).

Water Quality Parameter	Removal (%)
Total suspended solids	>80
Total phosphorus	>50
Dissolved zinc	>60
Dissolved copper	>30

Table 4. Estimated Pollutant Load Reduction Resulting from the Project.

Water Quality Parameter	Annual Pollutant Load Removed (pounds)
Total suspended solids	912
Total phosphorus	1.5
Dissolved zinc	0.5
Dissolved copper	0.1

Comparison to Stormwater Standards for New and Redevelopment

The proposed stormwater treatment facilities would provide enhanced treatment of tributary runoff, exceeding the requirements of the Stormwater Management Manual for Western

Washington (Ecology 2014a, Ecology 2014b). The receiving water body is flow control exempt and therefore flow control is not a project objective.

Table 5 provides water quality treatment performance data for each facility. Each facility is capable of treating at least 91 percent of the inflow volume and the equivalent new/redevelopment area treated is calculated to be 2.843 acres. Modeling of runoff from this drainage using MGSFlood software indicates that all facility treatment flow rates meet or exceed the online water quality treatment flow rate that would be required if these were new/redevelopment installations (i.e. the standards in the Stormwater Management Manual for Western Washington are fully met), as demonstrated by the treatment ratio shown in Table 5. The modeling documentation is provided in Appendix B.

Facility Name^a	Facility Type	Contributing Area (ac)^b	Facility Treatment Flow Rate (cfs)^c	On-line WQ Flow Rate For Contributing Area (cfs)^d	Treatment Ratio (WT-1)^e
MWS1	4x8 Linear-MWS	0.546	0.115	0.073	1.58
MWS2	4x15 Linear-MWS	1.563	0.175	0.157	1.11
F1	4x4 Filterra	0.104	0.037	0.014	2.64
F2	4x4 Filterra	0.141	0.037	0.019	1.95
Total		2.354			

Notes

^a See Figure 2 for facility locations.

^b See Figure 2 for delineated drainage areas.

^c Based on GULD facility design criteria from the manufacturer.

^d Calculated in MGSFlood. See Appendix B for modeling report.

^e Calculated as Facility Treatment Flow Rate divided by On-line Water Quality Flow Rate for Contributing Area.

ac = acres

cfs = cubic feet per second

Project Design Summary

Project Design

Two linear-MWS systems are proposed to treat surface runoff on Fern Street and Prune Alley. Two Filterra units are proposed in parallel to treat surface runoff on both sides of the roadway centerline crown on Prune Alley south of A Street. The proposed treatment configuration and drainage areas are shown in Figure 2. The concept design is provided in Appendix A. Modeling confirmed the existing pipes are adequately sized. Designers selected the smallest stormwater treatment unit size that is capable of treating the water quality flow rate from the drainage basin (See Table 5 and the corresponding discussion in the previous section). Table 6 documents that the facilities can adequately convey the 25-year design storm peak flow.

Facility Name ^a	Facility Type	Contributing Area (ac) ^b	25-Year Peak Flow (cfs) ^c	Peak Flow Through BMP (cfs) ^d
MWS1	4x8 Linear-MWS	0.546	0.365	3.98
MWS2	4x15 Linear-MWS	1.563	0.911	3.98
F1	4x4 Filterra	0.104	0.069	0.88
F2	4x4 Filterra	0.141	0.094	0.88
Total		2.354		

Notes

^a See Figure 2.

^b See Figure 2.

^c Calculated in MGS Flood. See Appendix B for modeling report.

^d Based on facility performance data from manufacturer (Filterra) and calculation of flow through orifice controlled outlet pipe (MWS).

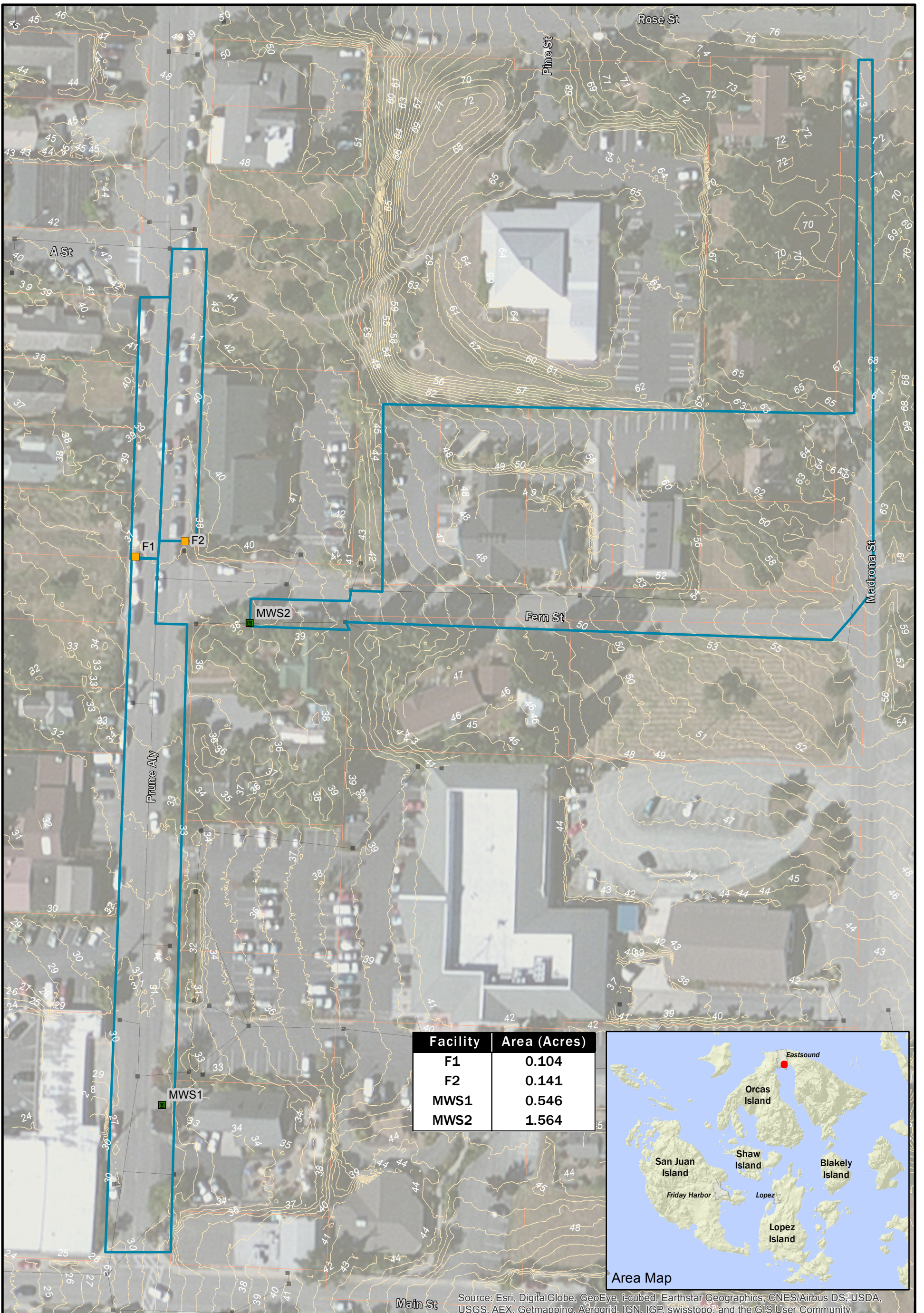
ac = acres

cfs = cubic feet per second

Project Team Responsibilities, Qualifications, and Commitment

Team Member Responsibilities

Teams	Members	Responsibilities
San Juan County	Ed Hale	Project Manager
	Shannon Wilbur, PE	Senior Project Manager
	Jessie Douglas-Seitz	Engineering Technician, Construction Manager
Design Consultant	Consultant Principal Engineer, PE	Oversee design quality control and ensure adequate staff resources are committed to the project. Assigned to the project for 5-10% of the time during design.
	Consultant Project Engineer, PE	Responsible for oversight and direction of the design calculations, drawings, and construction specifications. Responsible for ensuring design quality control processes are followed. Support construction oversight. Assigned to the project for 20-50% of the time during design and 10-20% of the time during construction.
	Consultant Design Engineer, PE or EIT	Responsible for conducting design calculations, developing design plans and profiles, writing specifications and cost estimating. Assigned to the project for 40-60% of the time during design and up to 20% of the time during construction.
	Consultant Drafting Technician	Responsible for drafting the design and implementation of CAD quality standards. Assigned to the project for 40-60% of the time during design.



Facility	Area (Acres)
F1	0.104
F2	0.141
MWS1	0.546
MWS2	1.564



Source: Esri, DigitalGlobe, GeoEye, i-cubed, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

Legend

- Filterra
- MWS
- Prune Fern Drainage Area
- Existing Storm Drain Structure
- Existing Storm Drain
- Existing Ditch
- Contour 1-ft (San Juan Co.)
- Parcel

Prune Alley and Fern Street - Water Quality Treatment Facility Drainage Areas

N

0 35 70 140 ft

HERRERA

NAD 1983 Washington State Plane North FIPS 4601 Feet
ESRI, Aerial (2011)

K:\Projects\Y2013\13-05676-000\Project\Prune and Fern Grant Application_KM.mxd (11/6/2014)

Team Member Qualifications

San Juan County Team

Ed Hale

Role: Grant Project Administration and Management

Time on project: 80 hours

Qualifications:

Education: B.S. in Environmental Science, Washington State University 1985; B.S. in Biology, Washington State University 1985

Professional Credential: Registered Environmental Health Specialist No. 9000842, National Environmental Health Association.

Experience: Mr. Hale has 29 years of experience working at the local government level with County, District and Tribal governments. Mr. Hale has managed grants from federal, state and local agencies including U.S. Environmental Protection Agency, U.S. Department of Agriculture, U.S. Department of Interior, Washington Department of Health, Washington State Department of Ecology, Idaho Department of Environmental Quality, and Idaho Department of Health and Welfare. Projects funded through the grants managed by Mr. Hale have included the design, installation and monitoring of stormwater treatment systems, implementing surface water and groundwater quality protection programs, treatment system design evaluation and regional water quality plans.

Shannon Wilbur, PE

Role: Senior Project Engineer at San Juan County Public Works

Qualifications:

Experience: Civil engineer since 1987 working in both the private and public sectors as a design engineer and project manager for numerous municipal utility projects in both California and Washington. Ms. Wilbur has developed state and federally funded projects from the planning phase through to construction, including extensive public outreach efforts. She has been with San Juan County since 2007 and managed the design and public outreach for the Eastsound Constructed Wetland, the Guardrail Safety Project and the Cattle Point Road Realignment project. Other local planning efforts have included the Eastsound Streetscape, and the Orcas Landing acquisition and master plan.

Preliminary Design Team

Matt Fontaine, PE

Role: Senior Engineer at Herrera Environmental Consultants and Project Engineer for the Preliminary Design

Qualifications:

Education: M.S. in Civil Engineering with an emphasis in Water Resources, University of Washington, 2007; B.S. in Civil/Environmental Engineering, Clarkson University, 2002

Registrations/Licenses: Washington Registered Professional Engineer # 46158

Experience: Mr. Fontaine is a water resources engineer with 10 years of experience. His stormwater engineering expertise is broad, spanning design of low impact development (LID) and traditional stormwater facility design, stormwater retrofit planning and design, stormwater program evaluation, stormwater guidance manual development, and regulatory compliance. He has completed analysis and design of stormwater projects for the public and private sector for both new development and retrofit projects in the public right of way, ranging from site-scale design to large and complex retrofit planning and design efforts. He has served as project engineer responsible for engineering designs, specifications, cost estimates, and operation and maintenance plans for multiple stormwater facility projects, including bioretention, permeable pavement, stormwater conveyance, stormwater treatment, and large traditional flow control and water quality treatment facilities. He is adept at stormwater retrofit site identification, prioritization, predesign report preparation, and design, most recently acting as project manager and project engineer for the City of Lacey's Chambers Lake Constructed Wetland Facility.

Kristen Matsumura, EIT

Role: Engineer at Herrera Environmental Consultants and Design Engineer for the Preliminary Design

Qualifications:

Education: M.S. in Civil Engineering, University of Colorado, Boulder, 2010; B.S. in Civil/Environmental Engineering, University of California, Davis, 2008

Experience: Ms. Matsumura is an engineer and modeler with experience working on water related design-build projects and research projects in five countries. She has a strong background in statistics, data analysis, and modeling. She has contributed hydrologic and hydraulic modeling for several local stormwater projects. She has manipulated time series data, provided precipitation and runoff summary statistics using R, and she has modeled complex drainage systems using the EPA SWMM program. In addition, she is proficient in the programming languages Python, Visual Basic, and C++, and is knowledgeable in ArcGIS and AutoCAD.

Final Consultant Design Team

Licensed Professional Engineer

Qualifications:

Experience: Sizing and designing stormwater conveyance and water quality facilities in accordance with the Stormwater Management Manual for Western Washington.

Experience designing projects in San Juan County.

Experience designing projects using the WSDOT Standard Specifications for Road, Bridge, and Municipal Construction.

Experience providing construction support to municipal projects.

Commitment to Maintain Staff Competencies and Responsibilities

The County and consultant staff outlined above are all committed to the ongoing advancement of stormwater management and the improvement of water quality in East Sound. This project would remove a source of pollutants currently discharging to East Sound. It is in the project team's interest to maintain involvement and ensure project success. Likewise, the team is composed of seasoned professionals that have a long history of successfully staffing and executing a wide range of public utility projects.

County staff would oversee long term maintenance of the project and employ contract equipment or staff when needed. The maintenance procedures for the stormwater treatment facilities would be demonstrated by the vendors during the first year following installation and observed by the County maintenance staff. County maintenance staff would repeat the maintenance process during subsequent years.

Readiness to Proceed and Commitment to the Project

This overall project, including right-of-way and water quality improvements, is a priority for the County, as the street improvements will address drainage and flooding problems. The water quality improvements will be sustained by annual maintenance conducted by the County. The County has completed a State Environmental Policy Act (SEPA) checklist for the 6-year transportation improvement plan that encompasses the proposed roadway improvements on Prune Alley and Fern Street.

The County has worked with the CSWAC to identify and prioritize capital improvement projects, and the CSWAC has been a part of County level decision making by providing documentation of existing stormwater problems and providing local perspective on potential projects. Additionally, three public outreach meetings were held in September 2014 to introduce the proposed project to the general public and to garner community feedback on project priorities and design. Public feedback was positive and no significant changes were made to the proposed water quality project design as a result of these meetings, though additional discussions with project stakeholders will be conducted regarding the right-of-way improvements.

The project will conform to the Eastsound Subarea Plan, which is administered by the Eastsound Planning Review Committee (EPRC). San Juan County Public Works is already coordinating with the EPRC for comment and review of the Prune Alley and Fern Street Water Quality Improvement project as an ongoing effort to ensure the project has wide public acceptance. The project is part of a larger Public Works redesign effort called the Prune Alley Streetscape Plan that addresses the entire streetscape and public amenities such as parking and open space as well as stormwater treatment and conveyance. The County's current design is based on the 2011 Prune Alley Streetscape Plan, which is the result of a two year effort involving several hundred hours of volunteer efforts, and has significant support by

property owners along Prune Alley as well as the EPRC. Major stakeholders are property and business owners along Prune Alley and Fern Street, residents and visitors in Eastsound who need access without flooding concerns, owners of a nearby oyster farm, and the Kwiáht Indian Island Marine Health Marine Observatory in Fishing Bay.

The water quality improvements will be executed within the current right-of-way, so no landowner agreements or letters of commitment are required.

Cost Estimate

A preliminary construction cost estimate was prepared based upon the collective experience of Herrera with projects of a similar scale and site settings, assuming a contractor would be hired to perform the construction. Except where otherwise noted, the cost estimate was developed based on the following:

- Construction bid items were based on Washington State Department of Transportation (WSDOT) standard specifications where applicable, including material, construction requirements, measurement, and payment.
- Line item unit prices used in the construction cost estimate were developed with sound engineering judgment and were derived from a combination of applicable sources, including contractor bid tabs from similar past projects, prices compiled by WSDOT and Seattle Public Utilities, quotes from vendors, cost estimating guides (e.g., RS Means and The Guide), site-specific understanding of probable contractor staging, access, and other project specific requirements and constraints that would affect contractor bids for the project.
- County sales tax of 8.1 percent was applied to the construction cost.

Allied costs (project management, survey, geotechnical analyses, design, permitting, property acquisition, and construction management) were developed by applying the following assumptions:

- The County would hire a consultant to perform the survey, geotechnical analysis, design, and permitting.
- The County would manage the project for a cost equal to 10 percent of the construction cost and perform construction management for a cost equal to 20 percent of the construction cost.
- Costs for survey, design, and permitting are based on experience with design and permitting similar projects and knowledge of site-specific job complexities and challenges. In some cases, professional judgment was used to estimate allied costs as a percentage of construction costs.
- No easements are required for this project.
- A 5 percent change order allowance is included in the cost estimate along with a 10 percent cost for utility protection and relocation during construction; however, no

contingency was included because the Ecology grant requirements do not allow for a contingency.

The total planning-level cost of this retrofit project, including survey, design, construction, and other miscellaneous costs, is estimated to be approximately \$340,000. Itemized costs are included in Attachment C.

Commitment to Long Term Operations and Maintenance

Water quality performance of the installed stormwater treatment facilities will be maintained in accordance with requirements identified in the GULD documentation and manufacturer's guidance. During maintenance visits, County staff will perform all required maintenance activities as specified by the manufacturer and summarized below. County staff will document functionality of the system during routine maintenance visits by simulating storm flow using a hydrant if necessary and will modify frequency of visits based on system performance over time. The performance of the filter media will be monitored by observing the facilities during storm events or simulated storm events (i.e. flow provided by hydrants) and the media will be replaced as needed for effective pollutant removal by County staff.

The proposed water quality treatment systems incorporate green techniques (i.e., plants and soil) to improve water quality treatment performance and are passive systems that do not require energy input other than for routine maintenance. Materials needed for operations and maintenance are commonly available for both systems. Maintenance contracts are available through Modular Wetlands and Americast for the Filterra systems if the County prefers to contract out the maintenance.

MWS Modular Wetland Systems

Every 6 to 12 months, trash should be removed from the screening device and vegetation trimmed. Every 12-24 months, sediment should be removed from the separation chambers and the cartridge media replaced (perlite is an acceptable alternate to filter media and the proposed models would not have a drain down filter).

Filterra Systems

Annually remove the tree grate and erosion stones, remove debris, trash, and mulch, replace mulch, evaluate plant health and take corrective action, and clean around the Filterra. The manufacturer's O&M manual specifies the number of mulch bags needed for each size system.

Project Success

Success of this project will be linked to effective filtration of stormwater runoff from Prune Alley and Fern Street, as observed during future storm events. Project success will be documented with (1) records of written observation of facility function and condition during scheduled maintenance activities, and (2) field visits during rain events to observe flow through the installed stormwater treatment facilities to ensure they are not bypassing the water quality treatment flow. If warranted, project maintenance activities and frequencies will be altered to ensure the facilities are functioning as per the design.

Long-term success of this project will be documented through the written measurements listed above and distribution of resulting operations and maintenance recommendations among County design engineers and maintenance staff to increase awareness of facility function and maintenance requirements for use on future projects in San Juan County.

Implementation Recommendations

The County should take the following key steps to ensure successful implementation of this project:

- Continue to engage the CSWAC, the Eastsound Planning Review Committee (EPRC), property and business owners along Prune Alley and Fern Street, residents, and other stakeholders to select an acceptable right-of-way configuration that can accommodate the water quality treatment units.
- Contact other nearby jurisdictions that have installed Modular Wetland System and Filterra units to get input on advantages and disadvantages of these systems as well as user satisfaction.
- Conduct utility locates and survey within the project area, identify utility conflicts, and adjust the design to minimize conflicts and associated costs.
- Monitor the Ecology website for release of the draft grant offer list, which is estimated to be on February 13, 2015.
- Complete a Project Review Sheet - EZ1 historical and cultural resources review and submit the form to the Washington State Department of Archaeology and Historic Preservation as soon as the draft grant offer list is released. This is very important if the County intends to construct the project in summer 2015. Submission of this form is often accompanied by project review by tribes, which can take several months. No ground disturbance is allowed until the historic and cultural resources review and review by tribes is complete.

References

Ecology. 2011. Fact Sheet for the Western Washington Phase II Municipal Stormwater Permit. Washington State Department of Ecology, Olympia, Washington. November 4, 2011.

Ecology. 2014a. General Use Level Designation for Basic (TSS), Enhanced, Phosphorous & Oil Treatment for Americast Filterra. Washington State Department of Ecology. June 2014.

Ecology. 2014b. General Use Level Designation for Basic (TSS), Enhanced, Phosphorous & Oil Treatment for the MWS-Linear Modular Wetland. Washington State Department of Ecology. April 2014.

Herrera et al. 2014a. San Juan County Stormwater Basin Planning: Volume 1 County Overview. Prepared for San Juan County Public Works by Herrera Environmental Consultants, Inc., AESI, ESA, Hart Pacific Engineering, and Stillwater Sciences. June 26, 2014.

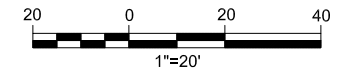
Herrera et al. 2014b. San Juan County Stormwater Basin Planning: Volume 2 Priority Watershed Planning. Prepared for San Juan County Public Works by Herrera Environmental Consultants, Inc., AESI, ESA, Hart Pacific Engineering, and Stillwater Sciences. June 26, 2014. Herrera. 2014. San Juan Stormwater Basin Planning. San Juan County Public Works. June 26, 2014.

Puget Sound Partnership. 2014. The 2014/2015 Action Agenda for Puget Sound. Puget Sound Partnership. May 2014.

Rasmussen, G.P., San Juan County Department of Public Works, Hart Pacific Engineering, Inc., MPD, Inc., and Herrera Environmental Consultants, Inc. 2005. Long Range Drainage Plan Proposal for Eastsound Village Urban Growth Area. Eastsound, Washington. May 2005.

ATTACHMENT A

Water Quality Improvements Plan



CONSTRUCTION NOTES:

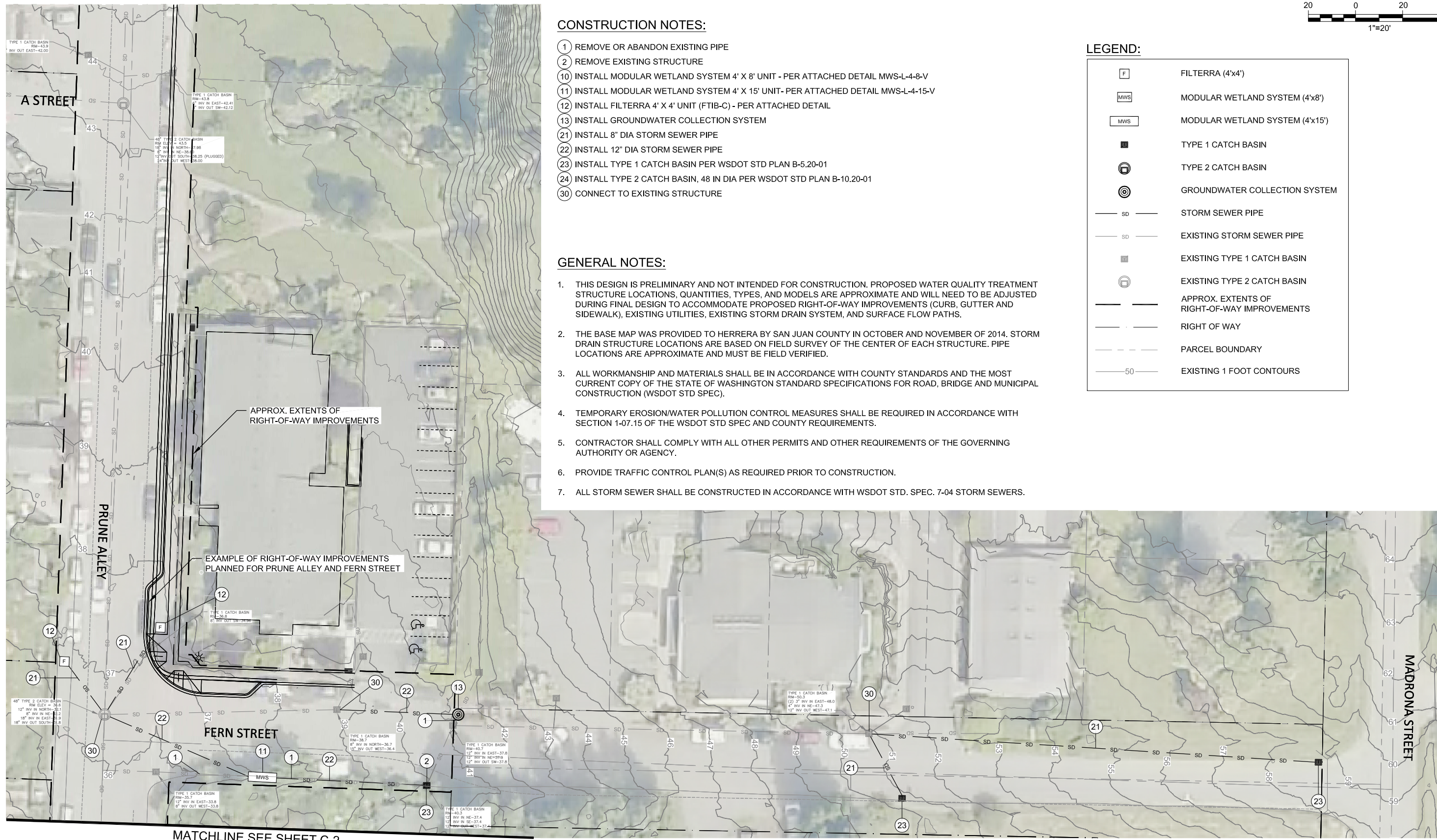
- ① REMOVE OR ABANDON EXISTING PIPE
- ② REMOVE EXISTING STRUCTURE
- ⑩ INSTALL MODULAR WETLAND SYSTEM 4' X 8' UNIT - PER ATTACHED DETAIL MWS-L-4-8-V
- ⑪ INSTALL MODULAR WETLAND SYSTEM 4' X 15' UNIT - PER ATTACHED DETAIL MWS-L-4-15-V
- ⑫ INSTALL FILTERRA 4' X 4' UNIT (FTIB-C) - PER ATTACHED DETAIL
- ⑬ INSTALL GROUNDWATER COLLECTION SYSTEM
- ⑳ INSTALL 8" DIA STORM SEWER PIPE
- ㉑ INSTALL 12" DIA STORM SEWER PIPE
- ㉒ INSTALL TYPE 1 CATCH BASIN PER WSDOT STD PLAN B-5.20-01
- ㉓ INSTALL TYPE 2 CATCH BASIN, 48 IN DIA PER WSDOT STD PLAN B-10.20-01
- ⑳ CONNECT TO EXISTING STRUCTURE

GENERAL NOTES:

- 1. THIS DESIGN IS PRELIMINARY AND NOT INTENDED FOR CONSTRUCTION. PROPOSED WATER QUALITY TREATMENT STRUCTURE LOCATIONS, QUANTITIES, TYPES, AND MODELS ARE APPROXIMATE AND WILL NEED TO BE ADJUSTED DURING FINAL DESIGN TO ACCOMMODATE PROPOSED RIGHT-OF-WAY IMPROVEMENTS (CURB, GUTTER AND SIDEWALK), EXISTING UTILITIES, EXISTING STORM DRAIN SYSTEM, AND SURFACE FLOW PATHS.
- 2. THE BASE MAP WAS PROVIDED TO HERRERA BY SAN JUAN COUNTY IN OCTOBER AND NOVEMBER OF 2014. STORM DRAIN STRUCTURE LOCATIONS ARE BASED ON FIELD SURVEY OF THE CENTER OF EACH STRUCTURE. PIPE LOCATIONS ARE APPROXIMATE AND MUST BE FIELD VERIFIED.
- 3. ALL WORKMANSHIP AND MATERIALS SHALL BE IN ACCORDANCE WITH COUNTY STANDARDS AND THE MOST CURRENT COPY OF THE STATE OF WASHINGTON STANDARD SPECIFICATIONS FOR ROAD, BRIDGE AND MUNICIPAL CONSTRUCTION (WSDOT STD SPEC).
- 4. TEMPORARY EROSION/WATER POLLUTION CONTROL MEASURES SHALL BE REQUIRED IN ACCORDANCE WITH SECTION 1-07.15 OF THE WSDOT STD SPEC AND COUNTY REQUIREMENTS.
- 5. CONTRACTOR SHALL COMPLY WITH ALL OTHER PERMITS AND OTHER REQUIREMENTS OF THE GOVERNING AUTHORITY OR AGENCY.
- 6. PROVIDE TRAFFIC CONTROL PLAN(S) AS REQUIRED PRIOR TO CONSTRUCTION.
- 7. ALL STORM SEWER SHALL BE CONSTRUCTED IN ACCORDANCE WITH WSDOT STD. SPEC. 7-04 STORM SEWERS.

LEGEND:

	FILTERRA (4'x4')
	MODULAR WETLAND SYSTEM (4'x8')
	MODULAR WETLAND SYSTEM (4'x15')
	TYPE 1 CATCH BASIN
	TYPE 2 CATCH BASIN
	GROUNDWATER COLLECTION SYSTEM
	STORM SEWER PIPE
	EXISTING STORM SEWER PIPE
	EXISTING TYPE 1 CATCH BASIN
	EXISTING TYPE 2 CATCH BASIN
	APPROX. EXTENTS OF RIGHT-OF-WAY IMPROVEMENTS
	RIGHT OF WAY
	PARCEL BOUNDARY
	EXISTING 1 FOOT CONTOURS



PRELIMINARY DESIGN

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No.	REVISION	BY	APP'D	DATE



DESIGNED: M. FONTAINE	DRAWN: T. PRESCOTT
DESIGNED: -	DRAWN: -
DESIGNED: -	CHECKED: B. BUSIEK
SCALE: AS NOTED	APPROVED: M. EWBANK

**PRUNE ALLEY AND
FERN STREET
WATER QUALITY IMPROVEMENTS**

WATER QUALITY IMPROVEMENT PLAN

DATE: NOVEMBER 2014
PROJECT NO: 13-05676-000
DRAWING NO: C-1
SHEET NO: 1 OF 2

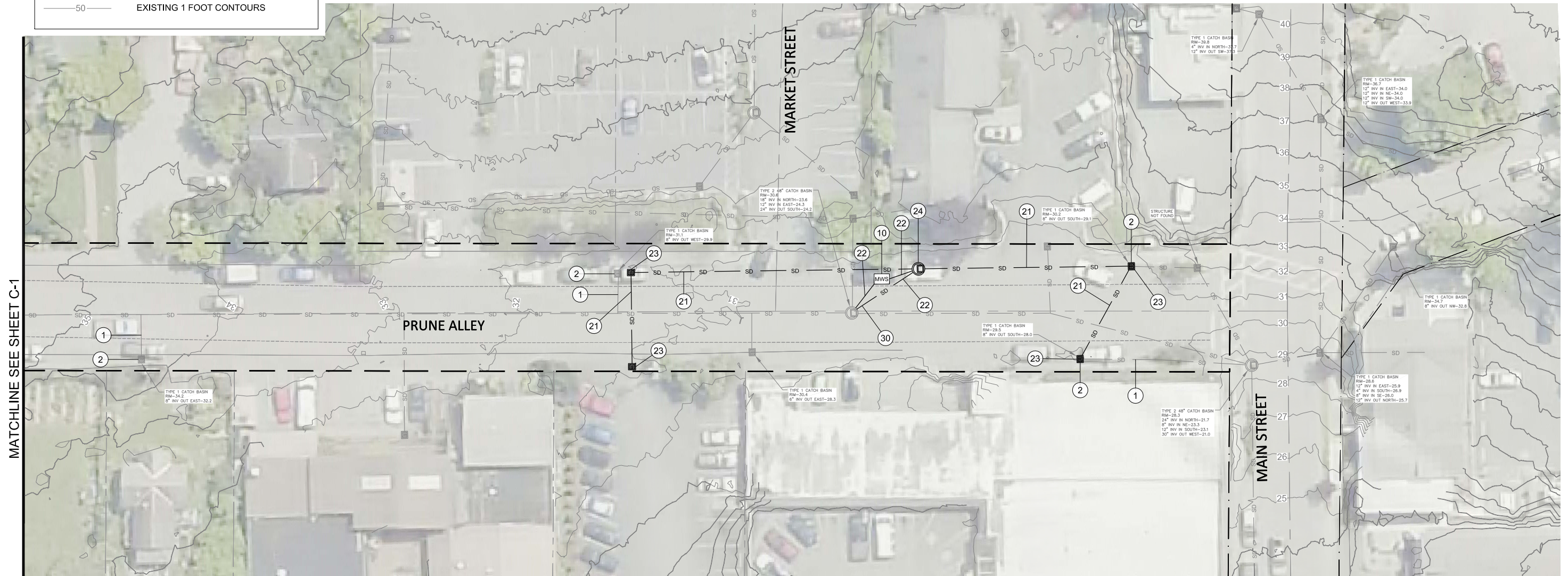
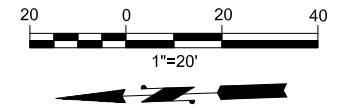
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AT FULL SIZE, IF NOT ONE
INCH SCALE ACCORDINGLY
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LEGEND:

	FILTERRA (4'x4')
	MODULAR WETLAND SYSTEM (4'x8')
	MODULAR WETLAND SYSTEM (4'x15')
	TYPE 1 CATCH BASIN
	TYPE 2 CATCH BASIN
	GROUNDWATER COLLECTION SYSTEM
	STORM SEWER PIPE
	EXISTING STORM SEWER PIPE
	EXISTING TYPE 1 CATCH BASIN
	EXISTING TYPE 2 CATCH BASIN
	APPROX. EXTENTS OF RIGHT-OF-WAY IMPROVEMENTS
	RIGHT OF WAY
	PARCEL BOUNDARY
	EXISTING 1 FOOT CONTOURS

CONSTRUCTION NOTES:

- 1 REMOVE OR ABANDON EXISTING PIPE
- 2 REMOVE EXISTING STRUCTURE
- 10 INSTALL MODULAR WETLAND SYSTEM 4' X 8' UNIT - PER ATTACHED DETAIL MWS-L-4-8-V
- 11 INSTALL MODULAR WETLAND SYSTEM 4' X 15' UNIT- PER ATTACHED DETAIL MWS-L-4-15-V
- 12 INSTALL FILTERRA 4' X 4' UNIT (FTIB-C) - PER ATTACHED DETAIL
- 13 INSTALL GROUNDWATER COLLECTION SYSTEM
- 21 INSTALL 8" DIA STORM SEWER PIPE
- 22 INSTALL 12" DIA STORM SEWER PIPE
- 23 INSTALL TYPE 1 CATCH BASIN PER WSDOT STD PLAN B-5.20-01
- 24 INSTALL TYPE 2 CATCH BASIN, 48 IN DIA PER WSDOT STD PLAN B-10.20-01
- 30 CONNECT TO EXISTING STRUCTURE

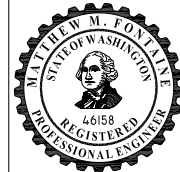


MATCHLINE SEE SHEET C-1

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DESIGNED:	-	DRAWN:	-
DESIGNED:	-	CHECKED:	B. BUSIEK
SCALE:	AS NOTED	APPROVED:	M. EW BANK

**PRUNE ALLEY AND
 FERN STREET
 WATER QUALITY IMPROVEMENTS**

WATER QUALITY IMPROVEMENT PLAN

DATE:	NOVEMBER 2014
PROJECT NO:	13-05676-000
DRAWING NO:	C-2
SHEET NO:	2 OF 2

ONE INCH
 AT FULL SIZE, IF NOT ONE
 INCH SCALE ACCORDINGLY
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FLOW RATES

PEAK TREATMENT FLOW RATE
= 0.102 CFS OR 45.73 GPM

PEAK BYPASS FLOW RATE
= DEPENDANT ON PIPE SIZE

SPECIFICATIONS

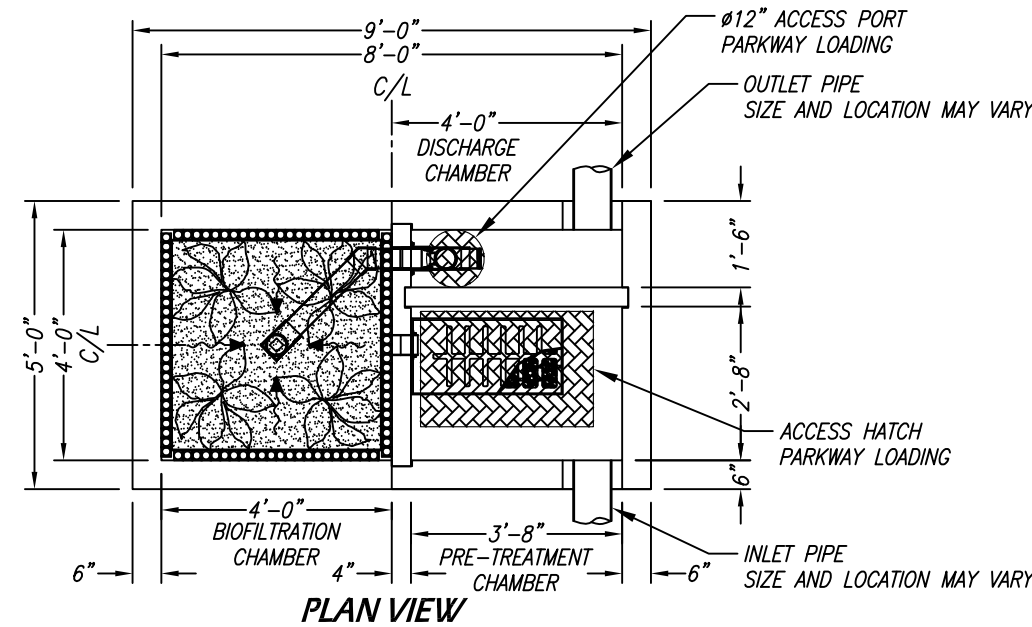
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O.D. DIMENSIONS
= 9' X 5' X 4.7'

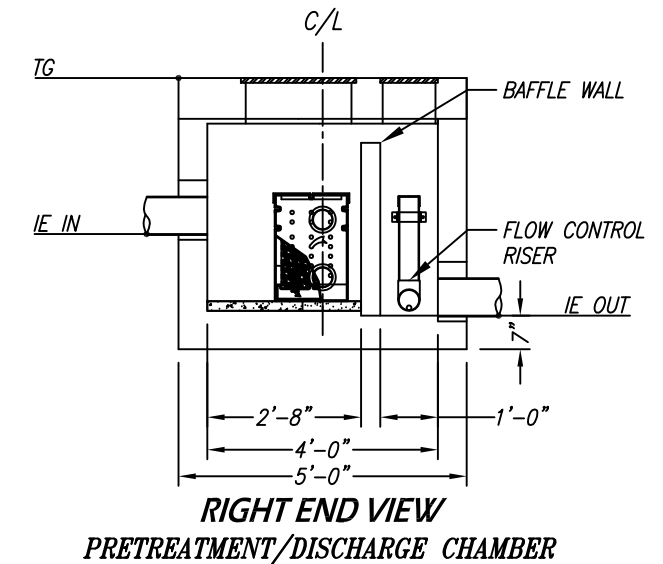
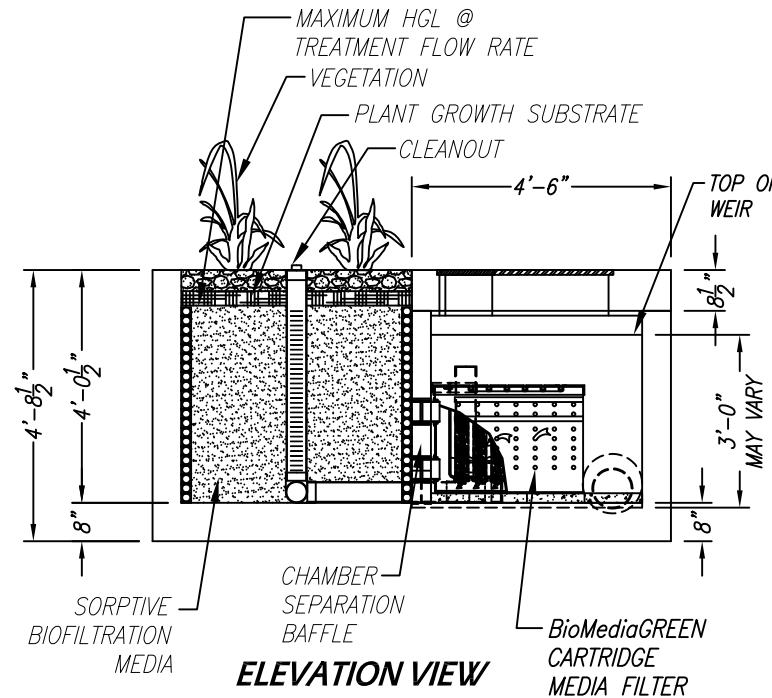
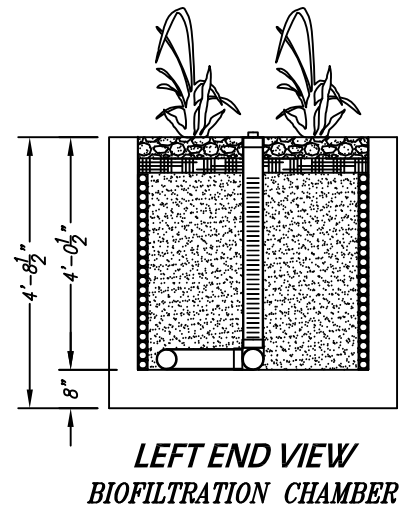
TOP OF VAULT TO INVERT OUT
= 4.13'

MODULAR WETLAND SYSTEMS - LINEAR 2.0 4-8 VAULT TYPE

***NOTE:**
MWS UNIT CAN BE CONSTRUCTED
WITH INLET ON EITHER SIDE.
FOR INLET ON OPPOSITE SIDE
ENTIRE UNIT WILL BE MIRRORED.



BIOFILTRATION CHAMBER SURFACE AREA CALCS	
SIDES = 4	
3.7' L x 3.0' H = 11.10 SF	
SIDE SURFACE AREA = 44.40 SF	
TOTAL WETLAND MEDIA SURFACE AREA = 44.40 SF	
WETLAND MEDIA LOADING RATE 45.73 GPM / 44.40 SF = 1.03 GPM/SF	
PRETREATMENT FILTER SURFACE AREA CALCS	
SIDES = 2	
0.50' L x 1.67' H = 0.84 SF	
SIDE SURFACE AREA = 1.68 SF	
ENDS = 2	
0.25' L x 1.67' H = 0.42 SF	
END SURFACE AREA = 0.84 SF	
TOTAL PRETREATMENT SURFACE AREA 2.52 SF x 14 FILTERS = 35.28 SF	
PRETREATMENT FILTER LOADING RATE 45.73 GPM / 35.28 SF = 1.29 GPM/SF	



LEGEND

- 2" DRAIN CELL PERIMETER INLET WATER TRANSFER SYSTEM
- WETLAND MEDIA
- PLANT/ROOT MOISTURE RETENTION LAYER
- MANHOLE / ACCESS HATCH

INSTALLATION NOTES:

1. INSTALL UNIT ON LEVEL BED OF GRAVEL OF AT LEAST 6" IN DEPTH.
2. CONCRETE 28 DAY COMPRESSIVE STRENGTH $f_c=5,000$ PSI.
3. REINFORCING: ASTM A-615, GRADE 60.
4. RATED FOR PARKWAY LOADING 300 PSF.
5. JOINT SEALANT: BUTYL RUBBER SS-S-00210
6. PLANTING SUPPLIED AND INSTALLED BY CONTRACTOR PER MANUFACTURERS RECOMMENDATIONS UNLESS OTHER WISE STATED ON CONTRACT.

MODULAR WETLAND SYSTEMS INC.
P.O. BOX 869
OCEANSIDE, CA 92049
www.ModularWetlands.com

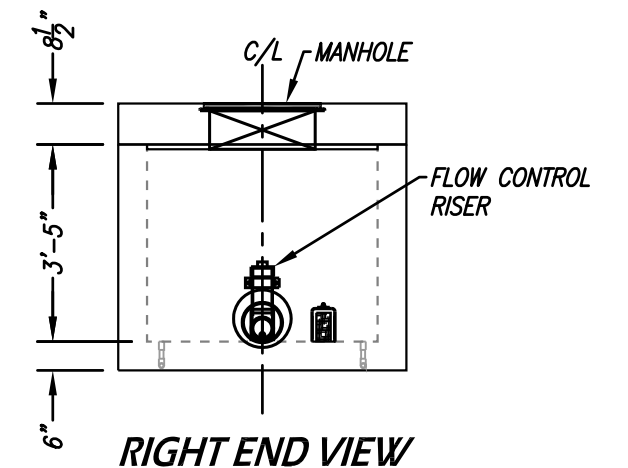
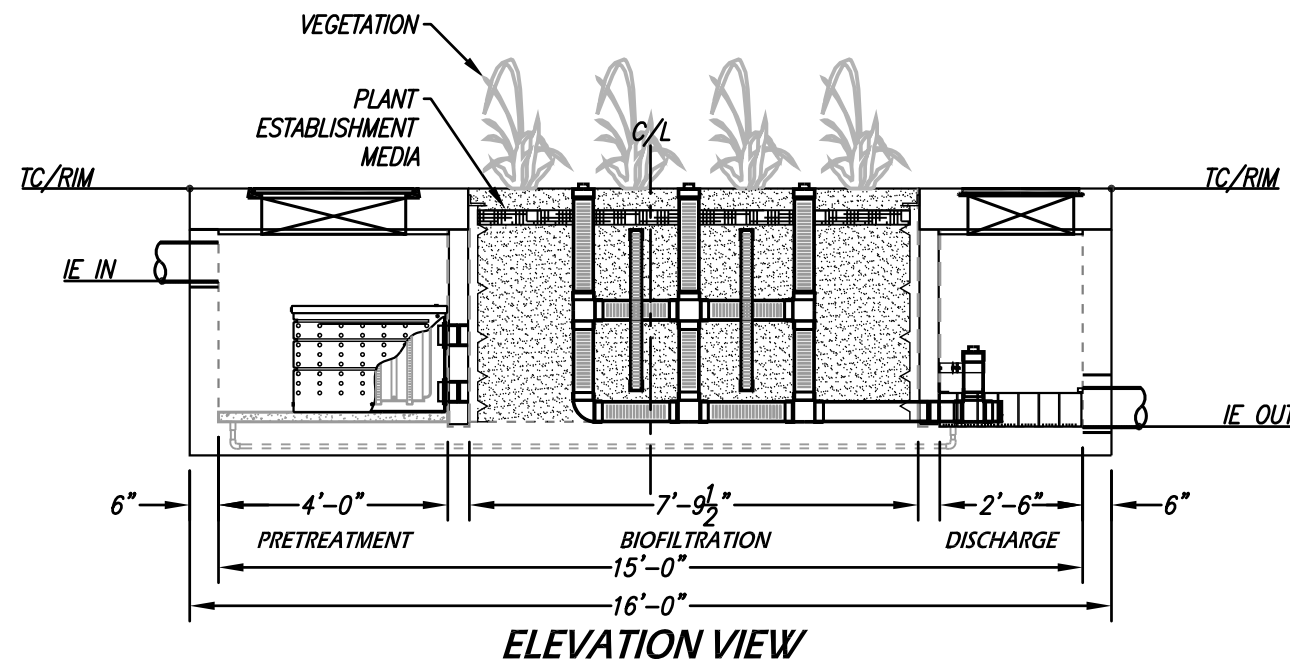
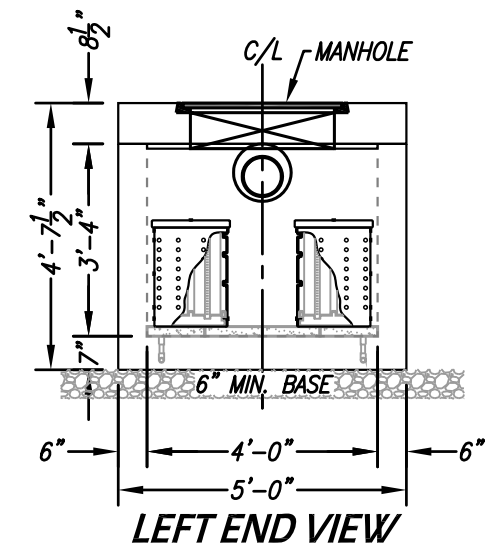
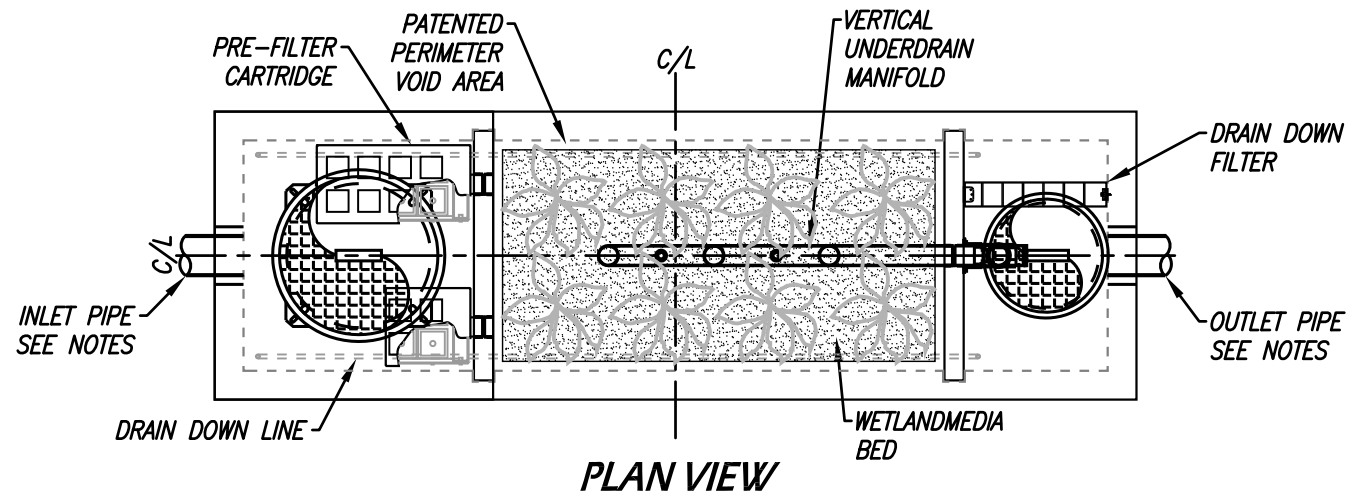
PROPRIETARY AND CONFIDENTIAL

THE INFORMATION CONTAINED IN THIS DRAWING IS THE SOLE PROPERTY OF MODULAR WETLAND SYSTEMS INC. ANY REPRODUCTION IN PART OR AS A WHOLE WITHOUT THE WRITTEN PERMISSION OF MODULAR WETLAND SYSTEMS INC. IS PROHIBITED.

	NAME	DATE
DRAWN	jrh	1/9/13
REVIEWED		
COMMENTS:		

TITLE: MWS LINEAR 2.0 VAULT TYPE		
SIZE	DWG. NO.	REV
	MWS-L-4-8-V	
SCALE	1:40	UNITS = INCHES
		SHEET 1 OF 1

SITE SPECIFIC DATA			
PROJECT NAME			
PROJECT LOCATION			
STRUCTURE ID			
TREATMENT REQUIRED			
VOLUME BASED (CF)		FLOW BASED (CFS)	
TREATMENT HGL AVAILABLE (FT)			
PEAK BYPASS REQUIRED (CFS) - IF APPLICABLE			
PIPE DATA	I.E.	MATERIAL	DIAMETER
INLET PIPE 1			
INLET PIPE 2			
OUTLET PIPE			
	PRETREATMENT	BIOFILTRATION	DISCHARGE
RIM ELEVATION			
SURFACE LOAD	PARKWAY	OPEN PLANTER	PARKWAY
FRAME & COVER	Ø30"	N/A	Ø24"
WETLANDMEDIA VOLUME (CY)	4.30		
WETLANDMEDIA DELIVERY METHOD	TBD		
ORIFICE SIZE (DIA. INCHES)	Ø1.89"		
MAXIMUM PICK WEIGHT (LBS)	31000		
NOTES:			



INSTALLATION NOTES

1. CONTRACTOR TO PROVIDE ALL LABOR, EQUIPMENT, MATERIALS AND INCIDENTALS REQUIRED TO OFFLOAD AND INSTALL THE SYSTEM AND APPURTENANCES IN ACCORDANCE WITH THIS DRAWING AND THE MANUFACTURERS SPECIFICATIONS, UNLESS OTHERWISE STATED IN MANUFACTURERS CONTRACT.
2. UNIT MUST BE INSTALLED ON LEVEL BASE. MANUFACTURER RECOMMENDS A MINIMUM 6" LEVEL ROCK BASE UNLESS SPECIFIED BY THE PROJECT ENGINEER. CONTRACTOR IS RESPONSIBLE TO VERIFY PROJECT ENGINEERS RECOMMENDED BASE SPECIFICATIONS.
3. ALL PIPES MUST BE FLUSH WITH INSIDE SURFACE OF CONCRETE. (PIPES CANNOT INTRUDE BEYOND FLUSH). INVERT OF OUTFLOW PIPE MUST BE FLUSH WITH DISCHARGE CHAMBER FLOOR. ALL GAPS AROUND PIPES SHALL BE SEALED WATER TIGHT WITH A NON-SHRINK GROUT PER MANUFACTURERS STANDARD CONNECTION DETAIL AND SHALL MEET OR EXCEED REGIONAL PIPE CONNECTION STANDARDS.
4. CONTRACTOR TO SUPPLY AND INSTALL ALL EXTERNAL CONNECTING PIPES.
5. CONTRACTOR RESPONSIBLE FOR INSTALLATION OF ALL RISERS, MANHOLES, AND HATCHES. CONTRACTOR TO GROUT ALL MANHOLES AND HATCHES TO MATCH FINISHED SURFACE UNLESS SPECIFIED OTHERWISE.
6. DRIP OR SPRAY IRRIGATION REQUIRED ON ALL UNITS WITH VEGETATION.

GENERAL NOTES

1. MANUFACTURER TO PROVIDE ALL MATERIALS UNLESS OTHERWISE NOTED.
2. ALL DIMENSIONS, ELEVATIONS, SPECIFICATIONS AND CAPACITIES ARE SUBJECT TO CHANGE. FOR PROJECT SPECIFIC DRAWINGS DETAILING EXACT DIMENSIONS, WEIGHTS AND ACCESSORIES PLEASE CONTACT MANUFACTURER.

THE PRODUCT DESCRIBED MAY BE PROTECTED BY ONE OR MORE OF THE FOLLOWING US PATENTS: 7,425,262; 7,470,362; 7,674,378; 8,303,816; RELATED FOREIGN PATENTS OR OTHER PATENTS PENDING

PROPRIETARY AND CONFIDENTIAL:

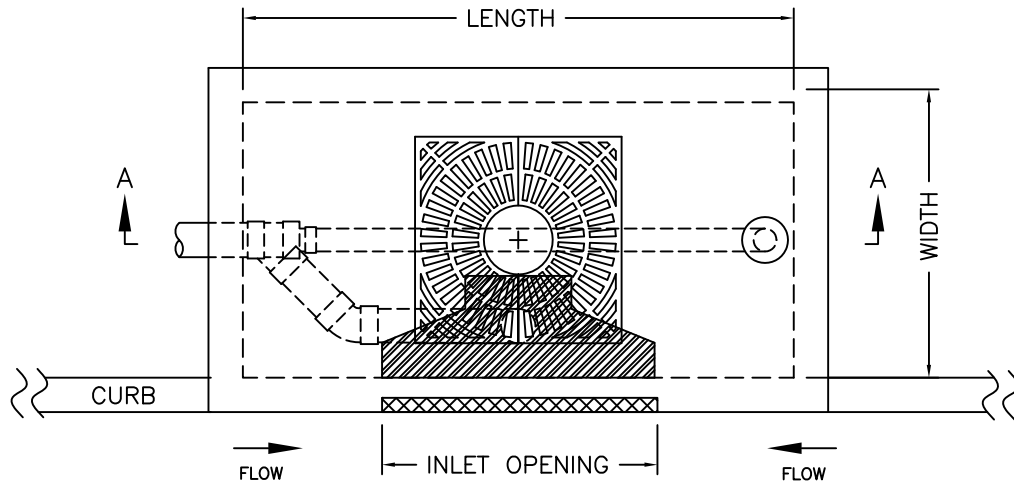
THE INFORMATION CONTAINED IN THIS DRAWING IS THE SOLE PROPERTY OF MODULAR WETLANDS SYSTEMS. ANY REPRODUCTION IN PART OR AS A WHOLE WITHOUT THE WRITTEN PERMISSION OF MODULAR WETLANDS SYSTEMS IS PROHIBITED.



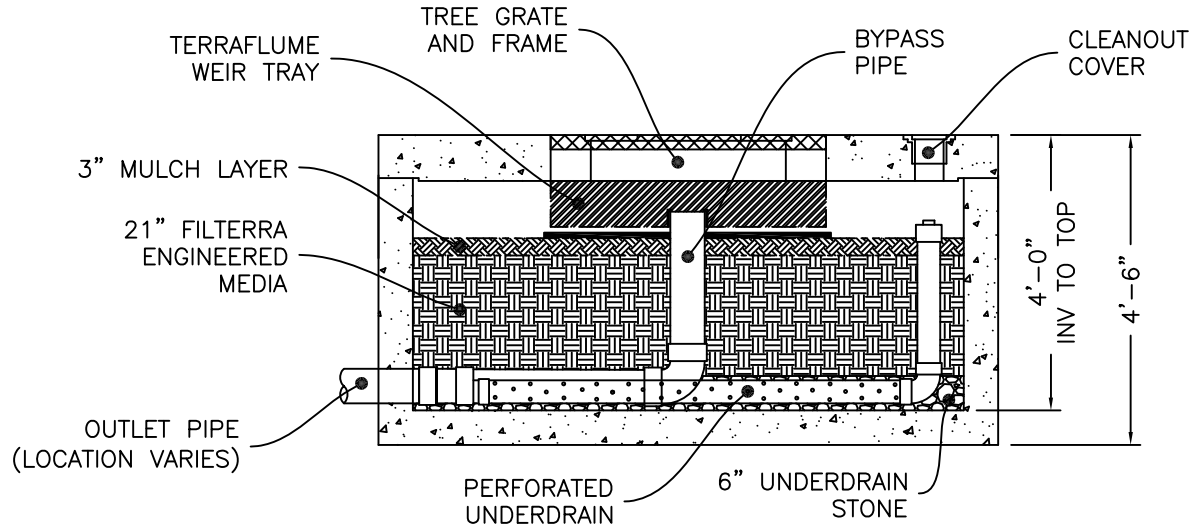
www.ModularWetlands.com | (855) 5MOD-WET

TREATMENT FLOW (CFS)	0.175
OPERATING HEAD (FT)	3.4
PRETREATMENT LOADING RATE (GPM/SF)	TBD
WETLAND MEDIA LOADING RATE (GPM/SF)	1.0

MWS-L-4-15-V
STORMWATER BIOFILTRATION SYSTEM
STANDARD DETAIL



PLAN VIEW



SECTION A-A

DESIGNATION (LENGTH x WIDTH)	INLET OPENING	MAX BYPASS PIPE SIZE	MAX BYPASS FLOW (CFS)	MAX OUTLET PIPE SIZE
4x4	4'-0"	6" PVC	0.88	6" PVC
4x6 OR 6x4	4'-0" *	8" PVC	1.57	8" PVC
4x8 OR 8x4	4'-0" *	8" PVC	1.57	8" PVC
6x6	4'-0" *	8" PVC	1.57	8" PVC
6x8 OR 8x6	4'-0" *	8" PVC	1.57	8" PVC
6x10 OR 10x6	4'-0" *	8" PVC	1.57	8" PVC
6x12 OR 12x6	4'-0" *	10" PVC	2.45	10" PVC
7x13 OR 13x7	4'-0" *	10" PVC	2.45	10" PVC

* CONTACT FILTERRA FOR LARGER INLET OPENINGS OR DIFFERENT AVAILABLE CONFIGURATIONS

UNIT TO BE SET PLUMB AND LEVEL

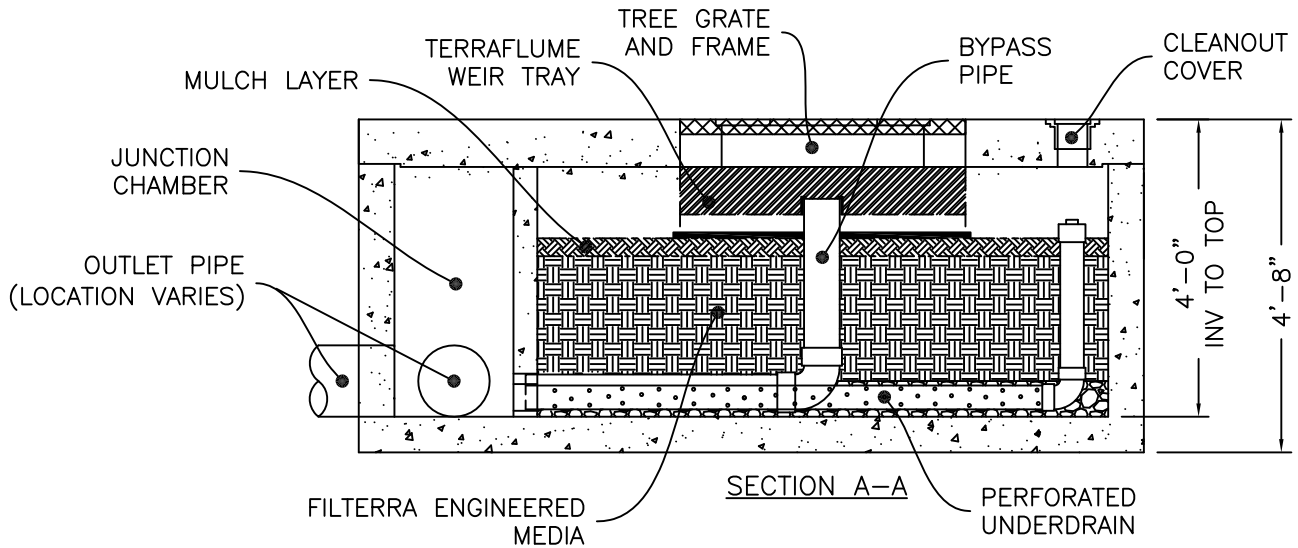
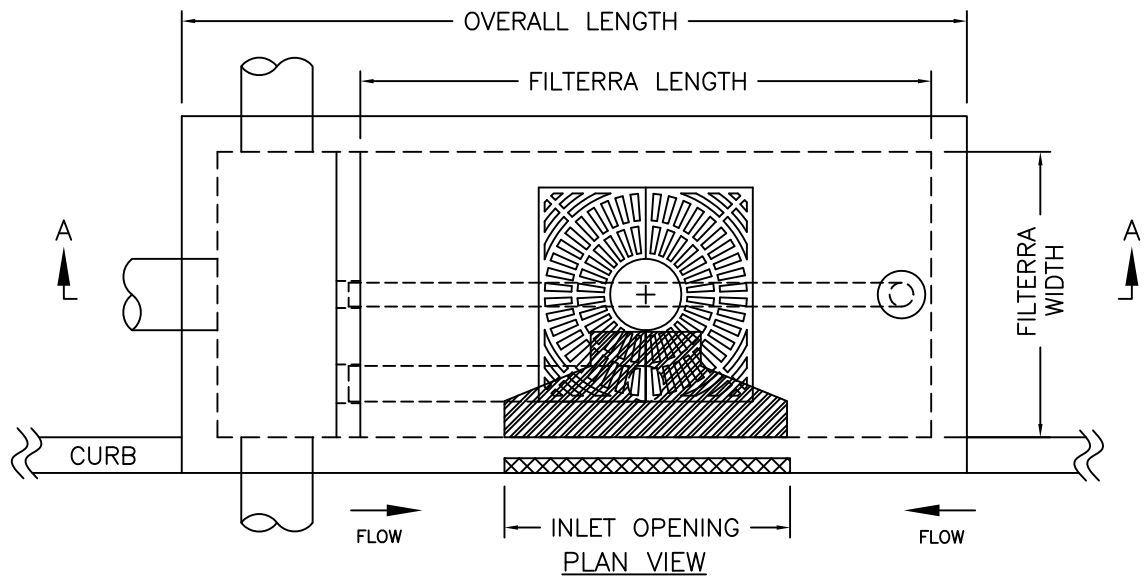
TERRAFLUME IS PATENTED BY AMERICAST (US PAT 7,833,412)



DATE: 06-26-14 DWG: FTIB-C

**PRECAST FILTERRA
INTERNAL BYPASS - CURB
WITH TERRAFLUME**





DESIGNATION (LENGTH x WIDTH)	INLET OPENING	MAX BYPASS PIPE SIZE	MAX BYPASS FLOW (CFS)	MAX OUTLET PIPE SIZE
4x4	4'-0"	6" PVC	0.88	6" PVC
4x6 OR 6x4	4'-0" *	8" PVC	1.57	8" PVC
4x8 OR 8x4	4'-0" *	8" PVC	1.57	8" PVC
6x6	4'-0" *	8" PVC	1.57	8" PVC
6x8 OR 8x6	4'-0" *	8" PVC	1.57	8" PVC
6x10 OR 10x6	4'-0" *	8" PVC	1.57	8" PVC
6x12 OR 12x6	4'-0" *	10" PVC	2.45	10" PVC
7x13 OR 13x7	4'-0" *	10" PVC	2.45	10" PVC

* CONTACT FILTERRA FOR LARGER INLET OPENINGS OR DIFFERENT AVAILABLE CONFIGURATIONS

UNIT TO BE SET PLUMB AND LEVEL

TERRAFLUME IS PATENTED BY
AMERICAST (US PAT 7,833,412)



Copyright © 2007 by Americast

DATE: 05-28-13

DWG: FTIB-C

**FILTERRA INTERNAL BYPASS
CURB WITH TERRAFLUME
JUNCTION CHAMBER MODEL**



ATTACHMENT B

Modeling Documentation

WATER QUALITY TREATMENT MODELING

Four drainage areas were modeled in MGS Flood v4.33 using a 15-minute time step to determine the on-line and offline water quality flow rates required. Dummy bioretention facilities were included in these models since a BMP is required to calculate the water quality runoff flow rates. The time series for 36-inch mean annual precipitation in Puget East Western Washington was selected for this project. Isopluvial maps indicate the project receives an average annual precipitation depth of 33.3 inches, indicating the 36-inch time series is conservative. Pervious land cover was modeled as till grass.

Four modeling reports are attached for each facility drainage area. It is important to note that the flow control performance is not reflective of expected performance since a dummy bioretention facility was included in the model.

MGS FLOOD PROJECT REPORT

Program Version: MGSFlood 4.33
Program License Number: 200210002
Run Date: 11/20/2014 9:58 AM

Input File Name: F2 - MAP E36.fld
Project Name:
Analysis Title:
Comments:

PRECIPITATION INPUT

Computational Time Step (Minutes): 15

Extended Precipitation Timeseries Selected
Climatic Region Number: 12

Full Period of Record Available used for Routing
Precipitation Station : 96003605 Puget East 36 in_5min 10/01/1939-10/01/2097
Evaporation Station : 961036 Puget East 36 in MAP
Evaporation Scale Factor : 0.750

HSPF Parameter Region Number: 1
HSPF Parameter Region Name : USGS Default

***** Default HSPF Parameters Used (Not Modified by User) *****

***** **WATERSHED DEFINITION** *****

-----**SCENARIO: PREDEVELOPED**

Number of Subbasins: 1

----- Subbasin : Existing Subbasin -----

	-----Area(Acres)-----
Till Forest	0.000
Till Pasture	0.000
Till Grass	0.000
Outwash Forest	0.000
Outwash Pasture	0.000
Outwash Grass	0.000
Wetland	0.000
Green Roof	0.000
User 2	0.000
Impervious	0.141

Subbasin Total 0.141

-----**SCENARIO: POSTDEVELOPED**

Number of Subbasins: 1

----- Subbasin : Proposed Subbasin -----

	-----Area(Acres) -----
Till Forest	0.000
Till Pasture	0.000
Till Grass	0.000
Outwash Forest	0.000
Outwash Pasture	0.000
Outwash Grass	0.000
Wetland	0.000
Green Roof	0.000
User 2	0.000
Impervious	0.141

Subbasin Total	0.141

***** LINK DATA *****

-----SCENARIO: PREDEVELOPED

Number of Links: 0

***** LINK DATA *****

-----SCENARIO: POSTDEVELOPED

Number of Links: 1

Link Name: Dummy Water Quality Facility

Link Type: Bioretention Facility

Downstream Link: None

Base Elevation (ft) : 100.00
Riser Crest Elevation (ft) : 100.50
Storage Depth (ft) : 0.50
Bottom Length (ft) : 15.0
Bottom Width (ft) : 15.0
Side Slopes (ft/ft) : L1= 0.00 L2= 0.00 W1= 0.00 W2= 0.00
Bottom Area (sq-ft) : 225.
Area at Riser Crest El (sq-ft) : 225.
(acres) : 0.005
Volume at Riser Crest (cu-ft) : 214.
(ac-ft) : 0.005

Infiltration on Bottom and Sideslopes Selected

Soil Properties

BioSoil Thickness (ft) : 1.50
BioSoil Saturated Hydraulic Conductivity (in/hr) : 3.00
BioSoil Porosity (Percent) : 30.00
Maximum Elevation of Bioretention Soil : 101.00
Native Soil Hydraulic Conductivity (in/hr) : 0.00

Underdrain Present
Orifice NOT Present in Under Drain

Riser Geometry
Riser Structure Type : Circular
Riser Diameter (in) : 12.00
Common Length (ft) : 0.000
Riser Crest Elevation : 100.50 ft

Hydraulic Structure Geometry

Number of Devices: 0

*****FLOOD FREQUENCY AND DURATION STATISTICS*****

-----SCENARIO: PREDEVELOPED

Number of Subbasins: 1
Number of Links: 0

-----SCENARIO: POSTDEVELOPED

Number of Subbasins: 1
Number of Links: 1

***** Link: Dummy Water Quality Facility ***** Link WSEL Stats
WSEL Frequency Data(ft)
(Recurrence Interval Computed Using Gringorten Plotting Position)
Tr (yrs) WSEL Peak (ft)

=====	
1.05-Year	100.242
1.11-Year	100.321
1.25-Year	100.424
2.00-Year	100.513
3.33-Year	100.522
5-Year	100.524
10-Year	100.529
25-Year	100.533
50-Year	100.541
100-Year	100.553

*****Groundwater Recharge Summary*****

Recharge is computed as input to PerInd Groundwater Plus Infiltration in Structures

Total Predeveloped Recharge During Simulation	
Model Element	Recharge Amount (ac-ft)

Subbasin: Existing Subbasin	0.000
<hr/>	
Total:	0.000

Total Post Developed Recharge During Simulation

Model Element	Recharge Amount (ac-ft)
Subbasin: Proposed Subbasin	0.000
Link: Dummy Water Quality	0.000
Total:	0.000

**Total Predevelopment Recharge Equals Post Developed
Average Recharge Per Year, (Number of Years= 158)
Predeveloped: 0.000 ac-ft/year, Post Developed: 0.000 ac-ft/year**

*******Water Quality Facility Data*******

-----**SCENARIO: PREDEVELOPED**

Number of Links: 0

-----**SCENARIO: POSTDEVELOPED**

Number of Links: 1

***** Link: Dummy Water Quality Facility *****

15-Minute Timestep, Water Quality Treatment Design Discharge
On-line Design Discharge Rate (91% Exceedance): 0.02 cfs
 Off-line Design Discharge Rate (91% Exceedance): 0.01 cfs

Design Data

~~Infiltration/Filtration Statistics~~
~~Total Runoff Volume (ac-ft): 57.60~~
~~Total Runoff Infiltrated (ac-ft): 0.00, 0.00%~~
~~Total Runoff Filtered (ac-ft): 56.60, 98.26%~~
~~Percent Treated (Infiltrated+Filtered)/Total Volume: 98.26%~~

*******Compliance Point Results*******

Scenario Predeveloped Compliance Subbasin: Existing Subbasin

Scenario Postdeveloped Compliance Link: Dummy Water Quality Facility

***** Point of Compliance Flow Frequency Data *****

Recurrence Interval Computed Using Gringorten Plotting Position

Predevelopment Runoff		Postdevelopment Runoff	
Tr (Years)	Discharge (cfs)	Tr (Years)	Discharge (cfs)
2-Year	4.992E-02	2-Year	4.992E-02
5-Year	6.645E-02	5-Year	6.645E-02
10-Year	7.850E-02	10-Year	7.850E-02
25-Year	9.414E-02	25-Year	9.414E-02
50-Year	0.121	50-Year	0.121
100-Year	0.144	100-Year	0.144
200-Year	0.155	200-Year	0.155

** Record too Short to Compute Peak Discharge for These Recurrence Intervals

****** Flow Duration Performance ******

Excursion at Predeveloped 50%Q2 (Must be Less Than 0%):	0.0%	FAIL	
Maximum Excursion from 50%Q2 to Q2 (Must be Less Than 0%):		0.1%	FAIL
Maximum Excursion from Q2 to Q50 (Must be less than 10%):	0.0%	PASS	
Percent Excursion from Q2 to Q50 (Must be less than 50%):	0.0%	PASS	

FLOW DURATION **FLOW DURATION ANALYSIS**

NOT APPLICABLE.

****** LID Duration Performance ******

Excursion at Predeveloped 8%Q2 (Must be Less Than 0%):	0.0%	FAIL
Maximum Excursion from 8%Q2 to 50%Q2 (Must be Less Than 0%):	0.1%	FAIL

LID DURATION DESIGN CRITERIA: FAIL

MGS FLOOD PROJECT REPORT

Program Version: MGSFlood 4.33
Program License Number: 200210002
Run Date: 11/20/2014 10:00 AM

Input File Name: F1 - MAP E36.fld
Project Name:
Analysis Title:
Comments:

PRECIPITATION INPUT

Computational Time Step (Minutes): 15

Extended Precipitation Timeseries Selected
Climatic Region Number: 12

Full Period of Record Available used for Routing
Precipitation Station : 96003605 Puget East 36 in_5min 10/01/1939-10/01/2097
Evaporation Station : 961036 Puget East 36 in MAP
Evaporation Scale Factor : 0.750

HSPF Parameter Region Number: 1
HSPF Parameter Region Name : USGS Default

***** Default HSPF Parameters Used (Not Modified by User) *****

***** **WATERSHED DEFINITION** *****

-----**SCENARIO: PREDEVELOPED**

Number of Subbasins: 1

----- Subbasin : Existing Subbasin -----

	-----Area(Acres)-----
Till Forest	0.000
Till Pasture	0.000
Till Grass	0.000
Outwash Forest	0.000
Outwash Pasture	0.000
Outwash Grass	0.000
Wetland	0.000
Green Roof	0.000
User 2	0.000
Impervious	0.104

Subbasin Total 0.104

-----**SCENARIO: POSTDEVELOPED**

Number of Subbasins: 1

----- Subbasin : Proposed Subbasin -----

	-----Area(Acres) -----
Till Forest	0.000
Till Pasture	0.000
Till Grass	0.000
Outwash Forest	0.000
Outwash Pasture	0.000
Outwash Grass	0.000
Wetland	0.000
Green Roof	0.000
User 2	0.000
Impervious	0.104

Subbasin Total	0.104

***** LINK DATA *****

-----SCENARIO: PREDEVELOPED

Number of Links: 0

***** LINK DATA *****

-----SCENARIO: POSTDEVELOPED

Number of Links: 1

Link Name: Dummy Water Quality Facility

Link Type: Bioretention Facility

Downstream Link: None

Base Elevation (ft) : 100.00
Riser Crest Elevation (ft) : 100.50
Storage Depth (ft) : 0.50
Bottom Length (ft) : 15.0
Bottom Width (ft) : 15.0
Side Slopes (ft/ft) : L1= 0.00 L2= 0.00 W1= 0.00 W2= 0.00
Bottom Area (sq-ft) : 225.
Area at Riser Crest El (sq-ft) : 225.
(acres) : 0.005
Volume at Riser Crest (cu-ft) : 214.
(ac-ft) : 0.005

Infiltration on Bottom and Sideslopes Selected

Soil Properties

BioSoil Thickness (ft) : 1.50
BioSoil Saturated Hydraulic Conductivity (in/hr) : 3.00
BioSoil Porosity (Percent) : 30.00
Maximum Elevation of Bioretention Soil : 101.00
Native Soil Hydraulic Conductivity (in/hr) : 0.00

Underdrain Present
Orifice NOT Present in Under Drain

Riser Geometry
Riser Structure Type : Circular
Riser Diameter (in) : 12.00
Common Length (ft) : 0.000
Riser Crest Elevation : 100.50 ft

Hydraulic Structure Geometry

Number of Devices: 0

*****FLOOD FREQUENCY AND DURATION STATISTICS*****

-----SCENARIO: PREDEVELOPED

Number of Subbasins: 1
Number of Links: 0

-----SCENARIO: POSTDEVELOPED

Number of Subbasins: 1
Number of Links: 1

***** Link: Dummy Water Quality Facility ***** Link WSEL Stats
WSEL Frequency Data(ft)
(Recurrence Interval Computed Using Gringorten Plotting Position)
Tr (yrs) WSEL Peak (ft)

=====	
1.05-Year	100.098
1.11-Year	100.135
1.25-Year	100.173
2.00-Year	100.343
3.33-Year	100.504
5-Year	100.511
10-Year	100.518
25-Year	100.522
50-Year	100.531
100-Year	100.537

*****Groundwater Recharge Summary*****

Recharge is computed as input to PerInd Groundwater Plus Infiltration in Structures

Total Predeveloped Recharge During Simulation	
Model Element	Recharge Amount (ac-ft)

Subbasin: Existing Subbasin	0.000
<hr/>	
Total:	0.000

Total Post Developed Recharge During Simulation

Model Element	Recharge Amount (ac-ft)
Subbasin: Proposed Subbasin	0.000
Link: Dummy Water Quality	0.000
Total:	0.000

**Total Predevelopment Recharge Equals Post Developed
Average Recharge Per Year, (Number of Years= 158)
Predeveloped: 0.000 ac-ft/year, Post Developed: 0.000 ac-ft/year**

*******Water Quality Facility Data*******

-----**SCENARIO: PREDEVELOPED**

Number of Links: 0

-----**SCENARIO: POSTDEVELOPED**

Number of Links: 1

***** Link: Dummy Water Quality Facility *****

15-Minute Timestep, Water Quality Treatment Design Discharge
On-line Design Discharge Rate (91% Exceedance): 0.01 cfs
 Off-line Design Discharge Rate (91% Exceedance): 0.01 cfs

Design Data

~~Infiltration/Filtration Statistics~~
~~Total Runoff Volume (ac-ft): 43.04~~
~~Total Runoff Infiltrated (ac-ft): 0.00, 0.00%~~
~~Total Runoff Filtered (ac-ft): 42.78, 99.41%~~
~~Percent Treated (Infiltrated+Filtered)/Total Volume: 99.41%~~

*******Compliance Point Results*******

Scenario Predeveloped Compliance Subbasin: Existing Subbasin

Scenario Postdeveloped Compliance Link: Dummy Water Quality Facility

***** Point of Compliance Flow Frequency Data *****

Recurrence Interval Computed Using Gringorten Plotting Position

Predevelopment Runoff		Postdevelopment Runoff	
Tr (Years)	Discharge (cfs)	Tr (Years)	Discharge (cfs)
2-Year	3.682E-02	2-Year	3.682E-02
5-Year	4.901E-02	5-Year	4.901E-02
10-Year	5.790E-02	10-Year	5.790E-02
25-Year	6.943E-02	25-Year	6.943E-02
50-Year	8.909E-02	50-Year	8.909E-02
100-Year	0.106	100-Year	0.106
200-Year	0.114	200-Year	0.114

** Record too Short to Compute Peak Discharge for These Recurrence Intervals

**** **Flow Duration Performance** ****

Excursion at Predeveloped 50%Q2 (Must be Less Than 0%):	0.0%	FAIL	
Maximum Excursion from 50%Q2 to Q2 (Must be Less Than 0%):		0.1%	FAIL
Maximum Excursion from Q2 to Q50 (Must be less than 10%):	0.0%	PASS	
Percent Excursion from Q2 to Q50 (Must be less than 50%):	0.0%	PASS	

FLOW DURATION DESIGN CRITERIA: **NOT APPLICABLE.**

**** **LID Duration Performance** ****

Excursion at Predeveloped 8%Q2 (Must be Less Than 0%):	0.0%	FAIL
Maximum Excursion from 8%Q2 to 50%Q2 (Must be Less Than 0%):	0.1%	FAIL

LID DURATION DESIGN CRITERIA: FAIL

MGS FLOOD PROJECT REPORT

Program Version: MGSFlood 4.33
Program License Number: 200210002
Run Date: 11/20/2014 10:02 AM

Input File Name: MWS1 - MAP E36.fld
Project Name:
Analysis Title:
Comments:

PRECIPITATION INPUT

Computational Time Step (Minutes): 15

Extended Precipitation Timeseries Selected
Climatic Region Number: 12

Full Period of Record Available used for Routing
Precipitation Station : 96003605 Puget East 36 in_5min 10/01/1939-10/01/2097
Evaporation Station : 961036 Puget East 36 in MAP
Evaporation Scale Factor : 0.750

HSPF Parameter Region Number: 1
HSPF Parameter Region Name : USGS Default

***** Default HSPF Parameters Used (Not Modified by User) *****

***** **WATERSHED DEFINITION** *****

-----**SCENARIO: PREDEVELOPED**

Number of Subbasins: 1

----- Subbasin : Existing Subbasin -----

	-----Area(Acres)-----
Till Forest	0.000
Till Pasture	0.000
Till Grass	0.000
Outwash Forest	0.000
Outwash Pasture	0.000
Outwash Grass	0.000
Wetland	0.000
Green Roof	0.000
User 2	0.000
Impervious	0.546

Subbasin Total 0.546

-----**SCENARIO: POSTDEVELOPED**

Number of Subbasins: 1

----- Subbasin : Proposed Subbasin -----

	-----Area(Acres) -----
Till Forest	0.000
Till Pasture	0.000
Till Grass	0.000
Outwash Forest	0.000
Outwash Pasture	0.000
Outwash Grass	0.000
Wetland	0.000
Green Roof	0.000
User 2	0.000
Impervious	0.546

Subbasin Total	0.546

***** LINK DATA *****

-----SCENARIO: PREDEVELOPED

Number of Links: 0

***** LINK DATA *****

-----SCENARIO: POSTDEVELOPED

Number of Links: 1

Link Name: Place Holder Water Quality Facility

Link Type: Bioretention Facility

Downstream Link: None

Base Elevation (ft) : 100.00
Riser Crest Elevation (ft) : 100.50
Storage Depth (ft) : 0.50
Bottom Length (ft) : 15.0
Bottom Width (ft) : 15.0
Side Slopes (ft/ft) : L1= 0.00 L2= 0.00 W1= 0.00 W2= 0.00
Bottom Area (sq-ft) : 225.
Area at Riser Crest El (sq-ft) : 225.
(acres) : 0.005
Volume at Riser Crest (cu-ft) : 214.
(ac-ft) : 0.005

Infiltration on Bottom and Sideslopes Selected

Soil Properties

BioSoil Thickness (ft) : 1.50
BioSoil Saturated Hydraulic Conductivity (in/hr) : 3.00
BioSoil Porosity (Percent) : 30.00
Maximum Elevation of Bioretention Soil : 101.00
Native Soil Hydraulic Conductivity (in/hr) : 0.00

Underdrain Present
Orifice NOT Present in Under Drain

Riser Geometry
Riser Structure Type : Circular
Riser Diameter (in) : 12.00
Common Length (ft) : 0.000
Riser Crest Elevation : 100.50 ft

Hydraulic Structure Geometry

Number of Devices: 0

*****FLOOD FREQUENCY AND DURATION STATISTICS*****

-----SCENARIO: PREDEVELOPED

Number of Subbasins: 1
Number of Links: 0

-----SCENARIO: POSTDEVELOPED

Number of Subbasins: 1
Number of Links: 1

***** Link: Place Holder Water Quality Facility ***** Link WSEL Stats
WSEL Frequency Data(ft)
(Recurrence Interval Computed Using Gringorten Plotting Position)
Tr (yrs) WSEL Peak (ft)

Tr (yrs)	WSEL Peak (ft)
1.05-Year	100.545
1.11-Year	100.549
1.25-Year	100.554
2.00-Year	100.566
3.33-Year	100.574
5-Year	100.581
10-Year	100.592
25-Year	100.604
50-Year	100.624
100-Year	100.641

*****Groundwater Recharge Summary*****

Recharge is computed as input to PerInd Groundwater Plus Infiltration in Structures

Model Element	Recharge Amount (ac-ft)
Subbasin: Existing Subbasin	0.000
Total:	0.000

Total Post Developed Recharge During Simulation

Model Element	Recharge Amount (ac-ft)
Subbasin: Proposed Subbasin	0.000
Link: Place Holder Water Q	0.000
Total:	0.000

**Total Predevelopment Recharge Equals Post Developed
Average Recharge Per Year, (Number of Years= 158)
Predeveloped: 0.000 ac-ft/year, Post Developed: 0.000 ac-ft/year**

*******Water Quality Facility Data*******

-----**SCENARIO: PREDEVELOPED**

Number of Links: 0

-----**SCENARIO: POSTDEVELOPED**

Number of Links: 1

***** Link: Place Holder Water Quality Facility *****

15-Minute Timestep, Water Quality Treatment Design Discharge
On-line Design Discharge Rate (91% Exceedance): 0.07 cfs
 Off-line Design Discharge Rate (91% Exceedance): 0.04 cfs

Design Data

~~Infiltration/Filtration Statistics~~
~~Total Runoff Volume (ac-ft): 217.14~~
~~Total Runoff Infiltrated (ac-ft): 0.00, 0.00%~~
~~Total Runoff Filtered (ac-ft): 161.99, 74.60%~~
~~Percent Treated (Infiltrated+Filtered)/Total Volume: 74.60%~~

*******Compliance Point Results*******

Scenario Predeveloped Compliance Subbasin: Existing Subbasin

Scenario Postdeveloped Compliance Link: Place Holder Water Quality Facility

***** Point of Compliance Flow Frequency Data *****

Recurrence Interval Computed Using Gringorten Plotting Position

Predevelopment Runoff		Postdevelopment Runoff	
Tr (Years)	Discharge (cfs)	Tr (Years)	Discharge (cfs)
2-Year	0.193	2-Year	0.193
5-Year	0.257	5-Year	0.257
10-Year	0.304	10-Year	0.304
25-Year	0.365	25-Year	0.365
50-Year	0.468	50-Year	0.468
100-Year	0.557	100-Year	0.557
200-Year	0.599	200-Year	0.599

** Record too Short to Compute Peak Discharge for These Recurrence Intervals

****** Flow Duration Performance ******

Excursion at Predeveloped 50%Q2 (Must be Less Than 0%):	0.0%	FAIL	
Maximum Excursion from 50%Q2 to Q2 (Must be Less Than 0%):		0.1%	FAIL
Maximum Excursion from Q2 to Q50 (Must be less than 10%):	0.0%	PASS	
Percent Excursion from Q2 to Q50 (Must be less than 50%):	0.0%	PASS	

FLOW DURATION DESIGN CRITERIA:

**FLOW DURATION ANALYSIS
NOT APPLICABLE.**

****** LID Duration Performance ******

Excursion at Predeveloped 8%Q2 (Must be Less Than 0%):	0.0%	FAIL
Maximum Excursion from 8%Q2 to 50%Q2 (Must be Less Than 0%):	0.1%	FAIL

LID DURATION DESIGN CRITERIA: FAIL

MGS FLOOD PROJECT REPORT

Program Version: MGSFlood 4.33
Program License Number: 200210002
Run Date: 11/20/2014 10:03 AM

Input File Name: MWS2 - MAP E36.fld
Project Name:
Analysis Title:
Comments:

PRECIPITATION INPUT

Computational Time Step (Minutes): 15

Extended Precipitation Timeseries Selected
Climatic Region Number: 12

Full Period of Record Available used for Routing
Precipitation Station : 96003605 Puget East 36 in_5min 10/01/1939-10/01/2097
Evaporation Station : 961036 Puget East 36 in MAP
Evaporation Scale Factor : 0.750

HSPF Parameter Region Number: 1
HSPF Parameter Region Name : USGS Default

***** Default HSPF Parameters Used (Not Modified by User) *****

***** **WATERSHED DEFINITION** *****

-----**SCENARIO: PREDEVELOPED**

Number of Subbasins: 1

----- Subbasin : Existing Subbasin -----

	-----Area(Acres) -----
Till Forest	0.000
Till Pasture	0.000
Till Grass	0.376
Outwash Forest	0.000
Outwash Pasture	0.000
Outwash Grass	0.000
Wetland	0.000
Green Roof	0.000
User 2	0.000
Impervious	1.187

Subbasin Total 1.563

-----**SCENARIO: POSTDEVELOPED**

Number of Subbasins: 1

----- Subbasin : Proposed Subbasin -----

	-----Area(Acres) -----
Till Forest	0.000
Till Pasture	0.000
Till Grass	0.376
Outwash Forest	0.000
Outwash Pasture	0.000
Outwash Grass	0.000
Wetland	0.000
Green Roof	0.000
User 2	0.000
Impervious	1.187

Subbasin Total	1.563

***** LINK DATA *****

-----SCENARIO: PREDEVELOPED

Number of Links: 0

***** LINK DATA *****

-----SCENARIO: POSTDEVELOPED

Number of Links: 1

Link Name: Place Holder Water Quality Facility

Link Type: Bioretention Facility

Downstream Link: None

Base Elevation (ft) : 100.00
Riser Crest Elevation (ft) : 100.50
Storage Depth (ft) : 0.50
Bottom Length (ft) : 15.0
Bottom Width (ft) : 15.0
Side Slopes (ft/ft) : L1= 0.00 L2= 0.00 W1= 0.00 W2= 0.00
Bottom Area (sq-ft) : 225.
Area at Riser Crest El (sq-ft) : 225.
(acres) : 0.005
Volume at Riser Crest (cu-ft) : 214.
(ac-ft) : 0.005

Infiltration on Bottom and Sideslopes Selected

Soil Properties

BioSoil Thickness (ft) : 1.50
BioSoil Saturated Hydraulic Conductivity (in/hr) : 3.00
BioSoil Porosity (Percent) : 30.00
Maximum Elevation of Bioretention Soil : 101.00
Native Soil Hydraulic Conductivity (in/hr) : 0.00

Underdrain Present
Orifice NOT Present in Under Drain

Riser Geometry
Riser Structure Type : Circular
Riser Diameter (in) : 12.00
Common Length (ft) : 0.000
Riser Crest Elevation : 100.50 ft

Hydraulic Structure Geometry

Number of Devices: 0

*****FLOOD FREQUENCY AND DURATION STATISTICS*****

-----SCENARIO: PREDEVELOPED

Number of Subbasins: 1
Number of Links: 0

-----SCENARIO: POSTDEVELOPED

Number of Subbasins: 1
Number of Links: 1

***** Link: Place Holder Water Quality Facility ***** Link WSEL Stats
WSEL Frequency Data(ft)
(Recurrence Interval Computed Using Gringorten Plotting Position)
Tr (yrs) WSEL Peak (ft)

=====	
1.05-Year	100.581
1.11-Year	100.588
1.25-Year	100.596
2.00-Year	100.622
3.33-Year	100.633
5-Year	100.646
10-Year	100.665
25-Year	100.688
50-Year	100.741
100-Year	100.781

*****Groundwater Recharge Summary*****

Recharge is computed as input to PerInd Groundwater Plus Infiltration in Structures

Total Predeveloped Recharge During Simulation	
Model Element	Recharge Amount (ac-ft)

Subbasin: Existing Subbasin	43.293
<hr/>	
Total:	43.293

Total Post Developed Recharge During Simulation

Model Element	Recharge Amount (ac-ft)
Subbasin: Proposed Subbasin	43.293
Link: Place Holder Water Q	0.000
Total:	43.293

Total Predevelopment Recharge Equals Post Developed Average Recharge Per Year, (Number of Years= 158)
Predeveloped: 0.274 ac-ft/year, Post Developed: 0.274 ac-ft/year

*******Water Quality Facility Data*******

-----**SCENARIO: PREDEVELOPED**

Number of Links: 0

-----**SCENARIO: POSTDEVELOPED**

Number of Links: 1

***** Link: Place Holder Water Quality Facility *****

15-Minute Timestep, Water Quality Treatment Design Discharge
On-line Design Discharge Rate (91% Exceedance): 0.16 cfs
 Off-line Design Discharge Rate (91% Exceedance): 0.09 cfs

Design Data

~~Infiltration/Filtration Statistics~~
~~Total Runoff Volume (ac-ft): 528.92~~
~~Total Runoff Infiltrated (ac-ft): 0.00, 0.00%~~
~~Total Runoff Filtered (ac-ft): 278.15, 52.59%~~
~~Percent Treated (Infiltrated+Filtered)/Total Volume: 52.59%~~

*******Compliance Point Results*******

Scenario Predeveloped Compliance Subbasin: Existing Subbasin

Scenario Postdeveloped Compliance Link: Place Holder Water Quality Facility

***** Point of Compliance Flow Frequency Data *****

Recurrence Interval Computed Using Gringorten Plotting Position

Predevelopment Runoff		Postdevelopment Runoff	
Tr (Years)	Discharge (cfs)	Tr (Years)	Discharge (cfs)
2-Year	0.458	2-Year	0.458
5-Year	0.593	5-Year	0.593
10-Year	0.713	10-Year	0.713
25-Year	0.911	25-Year	0.911
50-Year	1.168	50-Year	1.168
100-Year	1.409	100-Year	1.409
200-Year	1.485	200-Year	1.485

** Record too Short to Compute Peak Discharge for These Recurrence Intervals

****** Flow Duration Performance ******

Excursion at Predeveloped 50%Q2 (Must be Less Than 0%):	0.1%	FAIL	
Maximum Excursion from 50%Q2 to Q2 (Must be Less Than 0%):		0.2%	FAIL
Maximum Excursion from Q2 to Q50 (Must be less than 10%):	0.5%	PASS	
Percent Excursion from Q2 to Q50 (Must be less than 50%):	2.1%	PASS	

FLOW DURATION DESIGN CRITERIA: **FLOW DURATION ANALYSIS
NOT APPLICABLE.**

****** LID Duration Performance ******

Excursion at Predeveloped 8%Q2 (Must be Less Than 0%):	0.0%	FAIL
Maximum Excursion from 8%Q2 to 50%Q2 (Must be Less Than 0%):	0.1%	FAIL

LID DURATION DESIGN CRITERIA: FAIL

ATTACHMENT C

Itemized Cost Estimate



Subject: Prune Alley and Fern Street Water Quality Improvements

Prepared by: M. Fontaine and K. Matsumura

Checked by: Brian Busiek

Updated: December 5, 2014

Note: This cost estimate is approximate. Actual construction bids may vary significantly from this statement of probable costs due to timing of construction, changed conditions, labor rate changes, or other factors beyond the control of the engineers.

ESTIMATED COST OF PROJECT IMPLEMENTATION AT PRELIMINARY DESIGN STAGE

NO.	QUANT.	UNIT	ITEM	UNIT COST	AMOUNT	BASIS OF QUANTITY AND UNIT COST
1	1	LS	MOBILIZATION	8%	\$ 14,465	
2	1	LS	EROSION/WATER POLLUTION CONTROL	2%	\$ 3,091	Inlet protection, manage stock piles, and daily sweeping by hand.
3	1	LS	UTILITY PROTECTION AND RELOCATION	10%	\$ 15,454	Assumes facility placement is adjusted during design to minimize utility conflicts.
4	1	LS	PROJECT TEMPORARY TRAFFIC CONTROL	5%	\$ 7,727	Cones and rope to exclude pedestrians from work area in field, temporary parking stall closures on street edge, temporary lane closures, flaggers.
5	1,720	LF	SAWCUT ASPHALT PAVEMENT	\$ 2	\$ 3,440	Sawcut around structures and both sides of pipe trenches.
6	304	SY	REMOVE ASPHALT PAVEMENT	\$ 10	\$ 3,040	Remove pavement above pipes and structures.
7	2	SY	REMOVE STRUCTURE AND PLUG PIPE	\$ 500	\$ 1,000	Engineers estimate.
8	390	CY	STRUCTURE EXCAVATION CLASS B INCL. HAUL	\$ 20	\$ 7,800	WSDOT UBA.
9	100	CY	GRAVEL BACKFILL ABOVE PIPE ZONE	\$ 5	\$ 500	Use native material above pipe bedding.
10	89	TN	CRUSHED SURFACING TOP COURSE	\$ 75	\$ 6,675	High end for small qty.
10	289	SY	TRENCH PATCHING	\$ 45	\$ 13,005	The Guide Summer 2014. Trench patching.
11	573	LF	SCH A STORM SEWER PIPE 8 IN DIA	\$ 20	\$ 11,460	2/3 the price of 12" pipe
12	225	LF	SCH A STORM SEWER PIPE 12 IN DIA	\$ 30	\$ 6,750	WSDOT UBA.
13	7	LF	CATCH BASIN TYPE 1	\$ 1,800	\$ 12,600	WSDOT UBA.
14	1	LF	CATCH BASIN TYPE 2	\$ 3,200	\$ 3,200	WSDOT UBA.
15	1	EA	MWS-LINEAR 4' x 8' UNIT	\$ 19,723	\$ 19,723	Vendor quote for system and estimated installation plus 10% for contractor markup.
16	1	EA	MWS-LINEAR 4' x 15' UNIT	\$ 29,150	\$ 29,150	Vendor quote for system and estimated installation plus 10% for contractor markup.
17	2	EA	FILTERRA 4' x 4' UNIT	\$ 15,600	\$ 31,200	Vendor quote plus 20% for markup, incidentals, and installation.
18	1	EA	GROUNDWATER COLLECTION SYSTEM	\$ 5,000	\$ 5,000	Collect hillside seepage and convey to existing 18" storm drain and away from treatment BMP. Rough estimate. Assumes drywell with perforated collector pipes.
SUBTOTAL OF DIRECT COSTS					\$ 195,281	

NO.	QUANT.	UNIT	ITEM	UNIT COST	AMOUNT	BASIS OF QUANTITY AND UNIT COST
SALES TAX (DIRECT COSTS)				8.1%	\$ 15,818	
SUBTOTAL CONSTRUCTION COST					\$ 211,000	
ALLIED COSTS						
			ITEM	UNIT COST	AMOUNT	BASIS OF QUANTITY AND UNIT COST
			GRANT PROJECT ADMIN / MANAGEMENT	10%	\$ 21,000	Based on County experience managing similar projects.
			SURVEY	LS	\$ 10,000	Additional survey for utilities. Potholing for utilities.
			GEOTECHNICAL ANALYSES	LS		None required. Known groundwater issues.
			DESIGN	LS	\$ 35,000	3 storm drain plan and profile, 1 utility relocation sheet, 1 general sheet, 1 specifications for inclusion in County managed bid package. Plus Ecology design report. Custom details provided by vendor.
			PERMITTING	LS	\$ 8,000	Assumes project is outside the shoreline jurisdiction, no wetland or stream impacts, excavation under 500CY. Budget covers permit coordination and preparation of project specific SEPA checklist and cultural resources review.
			PROPERTY ACQUISITION	LS		None required. All work with right of way.
			CONSTRUCTION MANAGEMENT	20%	\$ 42,000	Based on input from County construction management experience.
			CHANGE ORDERS	5%	\$ 11,000	
SUBTOTAL OF ALLIED COSTS					\$ 127,000	
SUMMARY						
SUBTOTAL CONSTRUCTION COST					\$ 211,000	
SUBTOTAL OF ALLIED COST					\$ 127,000	
PROJECT TOTAL					\$ 340,000	
SUMMARY BY GRANT TASK						
TASK 1 - GRANT PROJECT ADMINISTRATION / MANAGEMENT					\$ 21,000	
TASK 2 - DESIGN PLANS AND SPECIFICATIONS, ENVIRONMENTAL REVIEW, AND PERMITTING					\$ 53,000	
TASK 3 - CONSTRUCTION MANAGEMENT					\$ 42,000	
TASK 4 - CONSTRUCTION					\$ 211,000	
TASK 5 - CHANGE ORDERS					\$ 11,000	
PROJECT TOTAL					\$ 340,000	

APPENDIX C-2

Market and Madrona Water Quality Improvements Preliminary Design Report

MARKET AND MADRONA
WATER QUALITY IMPROVEMENTS
PRELIMINARY DESIGN REPORT

VOLUME 2 PRIORITY WATERSHED PLANNING,
SAN JUAN COUNTY, WASHINGTON

Prepared for
San Juan County Public Works

Prepared by
Herrera Environmental Consultants, Inc.



MARKET AND MADRONA
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VOLUME 2 PRIORITY WATERSHED PLANNING,
SAN JUAN COUNTY, WASHINGTON

Prepared for
San Juan County Public Works
915 Spring Street
P.O. Box 929
Friday Harbor, Washington 98250

Prepared by
Herrera Environmental Consultants, Inc.
2200 Sixth Avenue, Suite 1100
Seattle, Washington 98121
Telephone: 206/441-9080

June 12, 2015

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Engineer's Stamp

This preliminary design report has been prepared under the supervision of a professional engineer registered in the State of Washington.



Matthew M. Fontaine, PE

06/12/2015
Date

Introduction

San Juan County Public Works (County) is committed to stormwater management that cost effectively addresses flooding and water quality problems that may adversely affect property and the natural environment. The County is addressing these issues proactively through:

- Completion of an inventory and high-level evaluation of County watershed conditions that provides a resource for identifying problem areas and recommends countywide stormwater management strategies (Phase 1)
- Completion of a more detailed evaluation of conditions in five priority watersheds, including the Eastsound Village and Lopez Village Urban Growth Areas (UGAs), that identifies capital improvement projects and programs for solving reported stormwater issues (Phase 2)

This preliminary design (predesign) report focuses on one of the priority capital improvement projects that resulted from Phase 2, the Market and Madrona Water Quality Improvements project. The project would install stormwater treatment units approved by the Washington State Department of Ecology (Ecology) to improve the quality of runoff from pollutant generating surfaces in Eastsound Village (identified as ES8 and ES9 in Volume 2 of the San Juan County Stormwater Management Plan). This report is specifically tailored to address application requirements for grants provided by Ecology to fund completion of design and/or construction of stormwater treatment retrofit projects, as well as the Ecology grant requirement for submitting a Predesign Report as one of the grant deliverables.

Basin Description

The East Sound watershed was identified as a priority among the 37 watersheds in San Juan County based on known water quality problems, drainage conveyance and flooding issues, expected future development, and its rich natural resources. Within this watershed, 41 citizens submitted comments on stormwater issues to the County. Their comments were combined with information associated with 38 potential projects proposed in the Long Range Drainage Plan Proposal for Eastsound Village Urban Growth Area (Rasmussen et al. 2005) to develop a total of 16 potential capital improvement projects needed in Eastsound. The Market and Madrona Water Quality Improvements project was ranked as one of the highest priority projects by the County and the Citizen Stormwater Advisory Committee (CSWAC, a committee formed to advise the County on stormwater management issues), based on several criteria including the risk posed to property and health, longevity of the drainage issue, opportunity to provide water quality treatment, and ability to provide conveyance capacity and treatment for future development.

The Puget Sound Partnership identifies runoff from the built environment as one of three key pressures having a high level of significance to the San Juan County ecosystem (Puget Sound Partnership 2014). The Action Agenda lists actions and responsible entities for improving San Juan waters including: controlling and mitigating stormwater runoff, improving stormwater management and polluted runoff, devise monitoring and management plans for priority or focus basins, increasing use of BMPs, and salmon recovery and habitat protection (Puget Sound Partnership 2014).

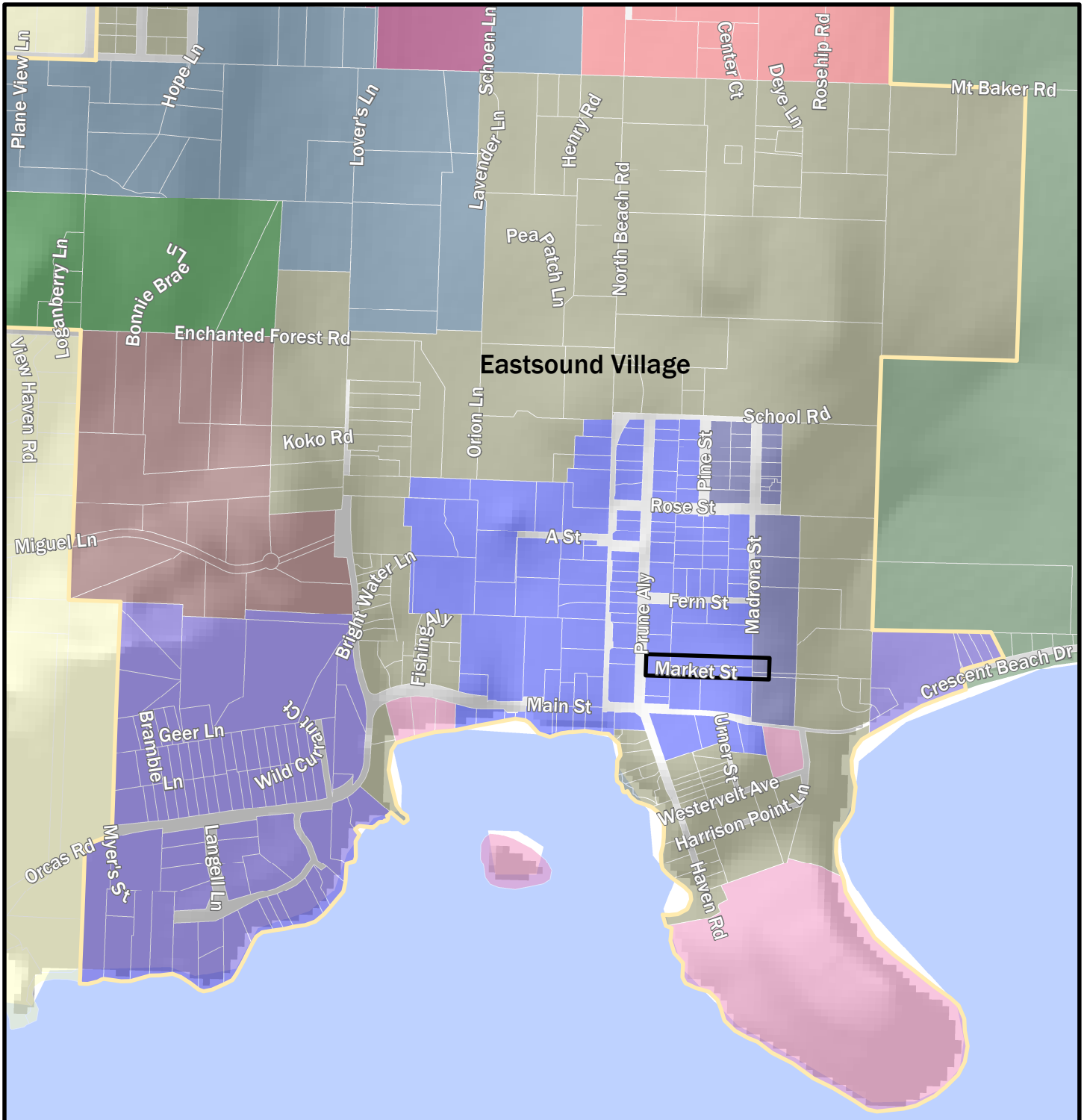
Healthy water quality in San Juan County is paramount as its location is a way-station for all 22 migrating populations of Puget Sound Chinook salmon as both juveniles and adults. Additionally, sockeye, pink, chum, and coho salmon, kokanee, steelhead, and rainbow and coastal cutthroat trout have been documented in the County (Puget Sound Partnership 2014). The San Juan Islands support outmigrating juvenile salmon including: Chinook, coho, chum and pink, and stocks from the Fraser River, Puget Sound and east and west coast Vancouver Island and the Strait of Georgia. Although most of the streams in San Juan County are small and do not support salmon, a small number of coho have recently been reported spawning in Cascade Creek and possibly other streams on Orcas Island, and a few creeks support cutthroat and introduced runs of chum.

East Sound is included on Ecology's Clean Water Act section 303(d) list as a Category 5 waterbody impaired for dissolved oxygen (listing #10101) and as a water of concern (Category 2) for pH (listing #10102). When compared across six other areas in San Juan County, the East Sound watershed exhibited relatively higher fecal coliform and E. coli bacteria levels in 2012-2013 monitoring with overall counts driven by contaminated runoff discharges from Eastsound Village. Ortho-phosphorus monitoring at the Eastsound Village main stormwater outfall have not consistently met San Juan County Conservation District guidelines. Compared to national databases for stormwater concentrations, measurements for nitrate+nitrite, total nitrogen, and total phosphorus at East Sound monitoring sites were, on average, moderate but highly variable.

Site Description

Flooding, ponding, and erosion are a common complaint in the East Sound watershed. Flooding has occurred on Market Street, nearby Prune Alley, and the surrounding private properties due to insufficient capacity of storm drain inlets, deteriorated curbs, and irregular road grades. Inadequate drainage conveyance, poor infiltration, and lack of treatment pose a human health and safety risk to residents, workers, and customers frequenting Market Street as well as a risk to the marine environment of East Sound, including a nearby shellfish farm. This project, in combination with a project planned by the County on Prune Alley and Fern Street, will address these problems.

The area tributary to the proposed runoff treatment facilities is predominantly commercial land use with some residential and industrial parcels nearby, as shown in Figure 1. Runoff from Market Street and Madrona Street drains to East Sound via an existing swale (Figure 2); however, the existing swale is only large enough to treat about 5 percent of the tributary area. These roadways are located at the center of commercial and social activities on Orcas Island. Eastsound Village between Orcas Road and Olga Road has the highest Average Annual Daily Traffic (AADT) levels on the island with Prune Alley, a street adjacent to the project, having an AADT ranging between 2000 and 3000. Runoff from commercial land use in the Puget Sound area is known to contain elevated concentrations of dissolved and total metals, nutrients, and fecal coliform bacteria. In addition to these pollutants, runoff from roads can also contain organic pollutants such as hydrocarbons. Although results of monitoring in the watershed indicate dissolved metals concentrations are currently below applicable criteria in Washington State for preventing acute and chronic toxicity to aquatic life, concentrations of these pollutants are expected to increase along with further development and increased traffic in the UGA.

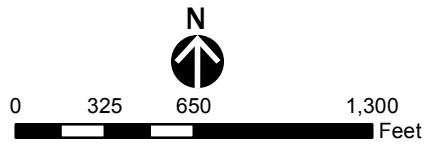


Legend

- Project Area
- Eastsound UGA
- Eastsound Airport District
- Eastsound Natural (max. 1 unit per parcel)
- Eastsound Rural (max. 1 unit/5 acres)
- Eastsound Residential 1/acre P*
- Eastsound Residential 2/acre
- Eastsound Residential 2/acre P*
- Eastsound Residential 4/acre P*
- Eastsound Rural Residential (max. 1 unit/5 acres)
- Service & Light Industrial
- Village Commercial (min. 4 - max. 40 units/acre)
- Village Commercial Limited (see SJCC 16.55.210.D.3)
- Village Commercial Limited (see SJCC 16.55.210.D.3)



Figure 1.
Eastsound UGA Land Use,
Orcas Island, Washington.



This project will also demonstrate feasibility of compact stormwater treatment technology for water quality retrofits in the UGAs of San Juan County where space is limited and the shallow groundwater level is high. Success of this project will be relevant to future development throughout San Juan County and as water quality retrofits in San Juan County UGAs are completed.

Alternatives Analysis and Project Selection

Thirty-seven watersheds in San Juan County were evaluated by the County and the San Juan County Citizen Stormwater Advisory Committee (CSWAC) and prioritized based on current development patterns, expected development trends, and presence of natural resources. Much of the predicted growth in the county is expected to be concentrated in the UGAs; therefore, they are an added focus of this stormwater planning study. Based on these factors, the Fisherman Bay watershed was selected as one of the top five priority watersheds for stormwater management planning (Herrera et al. 2014a). Detailed analysis within the five priority watersheds led to the selection of the Lopez Village Water Quality Treatment Facility (FMB6) project as among the top five for predesign development relative to alternative stormwater improvement projects (Herrera et al. 2014b).

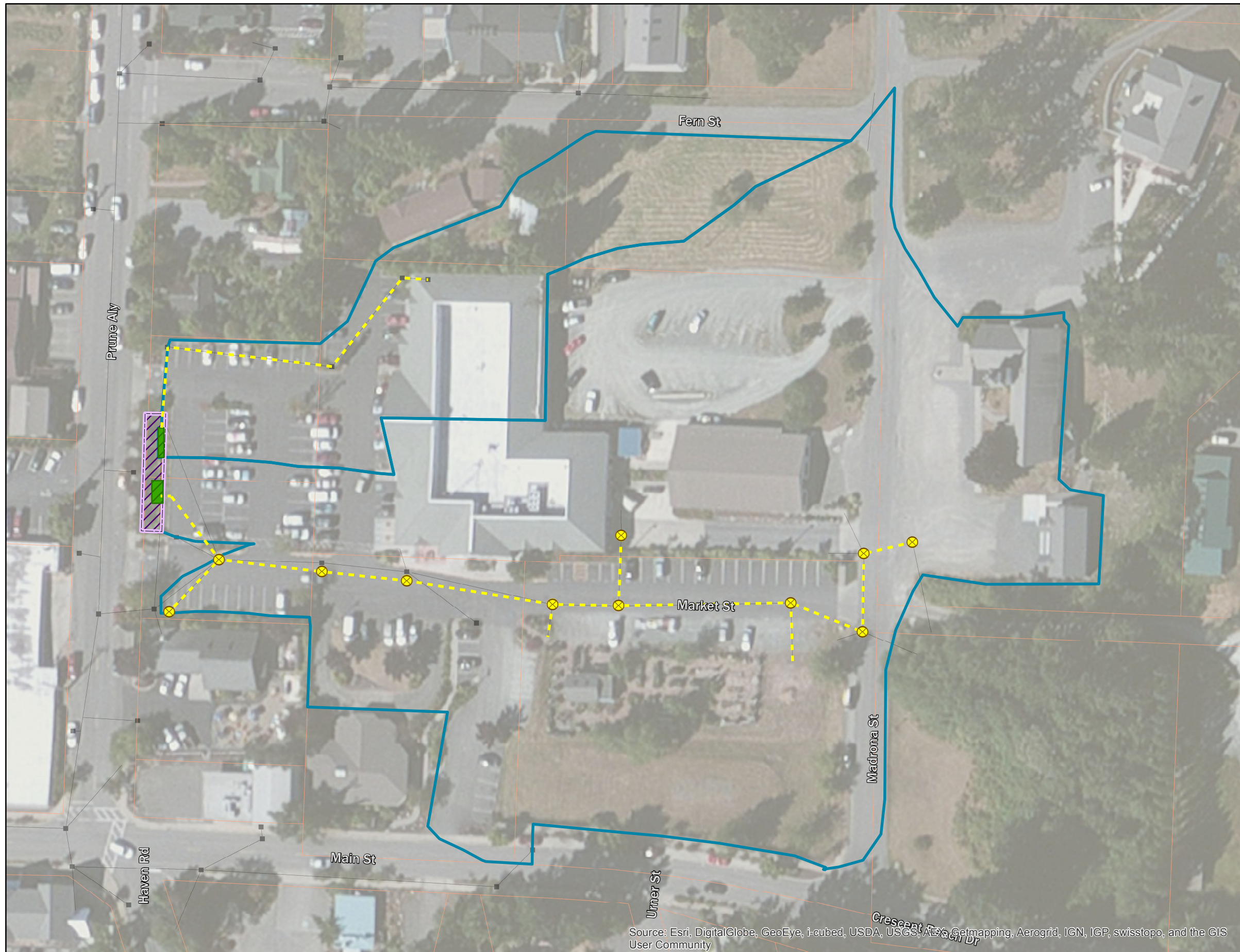
The Market and Madrona Water Quality Improvements project was selected for reasons that are consistent with several countywide recommendations and policies for stormwater management (Herrera et al. 2014a):

- **History of stormwater issues.** Market Street (includes Madrona Street) was identified as a retrofit project for the County in a 2005 Basin Plan for Eastsound (Rasmussen et al. 2005). This location was identified based on the lack of water quality treatment before discharge to East Sound and the need for stormwater conveyance improvements to alleviate localized flooding problems. No action on these issues has yet to be taken and addressing these issues is now a priority for the County.
- **Treat pollution close to the source.** The County and the CSWAC have a goal to treat and manage stormwater as close to the source of pollution as possible and to protect the quality of groundwater and surface water. This project will be a template for other retrofit projects in the Eastsound UGA and Lopez Village UGA on Lopez Island.

Water Quality and Ecological Benefits










Water quality treatment is required for the protection of habitat for ESA-listed salmonids, protection of shellfish habitat, and protection of priority habitats including herring spawning areas and eelgrass beds. The result of this project will be installation of stormwater treatment systems along Market Street and Madrona Street. Once constructed, this project will provide water quality treatment for road, parking lot, roof, and lawn runoff, reducing the concentrations of common stormwater pollutants entering East Sound. Both of the stormwater treatment systems selected for this project have received GULDs from Ecology for Basic, Enhanced, and Total Phosphorous treatment. With these designations, the installed facilities are expected to remove total suspended solids, dissolved copper and zinc, and phosphorus.

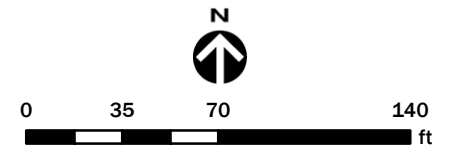
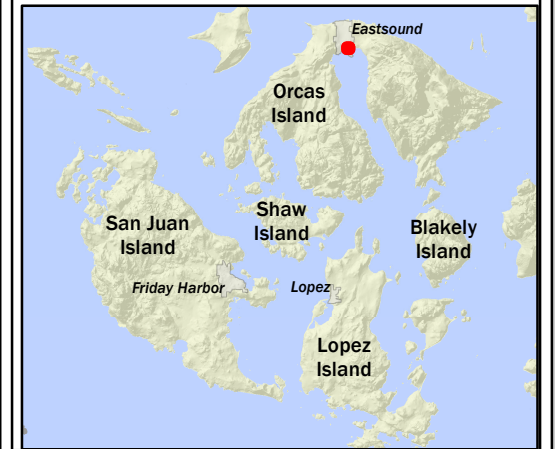
Figure 2.
Market Street and Madrona Street -
Water Quality Treatment Facility
Drainage Areas.



Source: Esri, DigitalGlobe, GeoEye, i-cubed, USDA, USGS, AeroGRID, IGN, IGP, swisstopo, and the GIS User Community

Legend

-  Proposed catch basin
-  Proposed stormwater pipe
-  MWS
-  Existing swale
-  Market and Madrona Drainage Area
-  Parcel
-  Existing Storm Drain Structure
-  Existing Storm Drain
-  Existing Ditch



Coordinates: NAD 1983 HARN
 Washington State Plane North FIPS 4601

Produced By: GIS
 Project: K:\Projects\Y2013\13-05676-000\Project\Market&Madrona_site.mxd (12/5/2014)

ESRI, Aerial (2011)

Suspended solids in runoff, especially the finer fraction, can reduce light penetration in water and can have a smothering effect on fish spawning and benthic biota. Suspended solids are also closely associated with other pollutants such as nutrients, bacteria, and organic compounds. Dissolved copper and zinc can be directly toxic to aquatic organisms; dissolved copper has also been linked to sublethal behavioral changes in salmonids due to olfactory inhibition. Phosphorus is a concern in freshwater because it can contribute to eutrophication.

The East Sound watershed comprises approximately 13,562 acres, of which Eastsound Village is approximately 100 acres. Eastsound Village is the most intensively developed area in the watershed and has more pollutant contributing land uses (i.e. dense residential and commercial) than the rest of the watershed which is primarily rural and forested in nature. Roadways north of A Street in Eastsound Village drain to the Eastsound Swale and to the Eastsound Constructed Wetland, which provide stormwater treatment prior to discharging to East Sound. Roadways south of A Street in Eastsound Village drain directly to marine waters via the storm drain system.

The calculated average annual volume of runoff that would be treated for the approximate 5.2-acre drainage area is 10.2 acre-feet. The proposed design includes three Linear Modular Wetland Systems to provide enhanced treatment for more than 91 percent of the annual runoff volume in this drainage area.

Pollutant Load Reduction

Pollutant loading in runoff from the Market Street and Madrona Street project area was estimated using data from the Phase II Municipal NPDES Permit Fact Sheet (Table 1). Specifically, NPDES Phase I municipal permittee monitoring data submitted to the Washington State Department of Ecology (Ecology) and synthesized in Attachment A of the *Draft Western Washington Phase II Municipal Stormwater Permit Fact Sheet* (Ecology 2011) for commercial land use were used to define untreated runoff loading at this site. Pollutant removal rates for the MWS Linear Modular Wetland Systems were taken from the GULD documentation (Ecology 2014a). Table 1 presents the annual pollutant load reduction that is estimated to result from project implementation.

Table 1. Estimated Annual Pollutant Loads and Removal in Runoff from the Market Street and Madrona Street Project Area.			
Water Quality Parameter	Annual Load (pounds)	Removal (%) (Source: Ecology 2014a)	Pollutant Removal (pounds)
Total suspended solids	2,092	>80	1,674
Total phosphorus	5.27	>50	2.64
Dissolved zinc	1.58	>60	0.95
Dissolved copper	0.31	>30	0.09

Comparison to Stormwater Standards for New and Redevelopment

The proposed stormwater treatment facilities would provide enhanced treatment of tributary runoff, exceeding the requirements of the Stormwater Management Manual for Western

Washington (Ecology 2012). The receiving water body is flow control exempt and therefore flow control is not a project objective.

Table 2 provides water quality treatment performance data for each proposed facility. Each facility is capable of treating at least 91 percent of the average annual inflow volume. Modeling of runoff from this drainage area using MGSFlood software indicates that each facility's treatment flow rate meets or exceeds the online water quality treatment flow rate that would be required if these were new/redevelopment installations (i.e. the standards in the Stormwater Management Manual for Western Washington are fully met), as demonstrated by the treatment ratio shown in Table 2. The modeling documentation is provided in Attachment B.

Facility Name^a	Facility Type	Contributing Area (ac)^b	Facility Treatment Flow Rate (cfs)^c	On-line WQ Flow Rate For Contributing Area (cfs)^d	Treatment Ratio (WT-1)^e	Equivalent Treatment Area^f
MWS1	4x13 Linear-MWS	0.995	0.144	0.122	1.18	1.17
MWS2	8x16 Linear-MWS	4.203	0.462	0.425	1.09	4.58
Total		5.198				

^a See Figure 2 for facility locations.

^b See Figure 2 for delineated drainage areas.

^c Based on GULD facility design criteria from the manufacturer.

^d Calculated in MGSFlood. See Attachment B for modeling report.

^e Calculated as Facility Treatment Flow Rate divided by On-line Water Quality Flow Rate for Contributing Area.

^f WT-1 multiplied by the Contributing Area.

ac = acres

cfs = cubic feet per second

Project Design Summary

Project Design

Two linear-MWS systems are proposed to treat surface runoff from the targeted drainage areas. The proposed treatment configuration and drainage areas are shown in Figure 2. Proposed pipe diameters are based on existing sizing because modeling confirmed the existing pipes are adequately sized. The concept design is provided in Attachment A. Designers selected the smallest stormwater treatment unit size that is capable of treating the water quality flow rate from the tributary drainage areas (see Table 2 and the corresponding discussion in the previous section). Table 3 documents that the facilities can adequately convey the 25-year design storm peak flow.

Facility Name^a	Facility Type	Contributing Area (ac)^b	25-Year Peak Flow (cfs)^c	Peak Flow Through BMP (cfs)^d
MWS1	4x13 Linear-MWS	0.995	0.635	8.97
MWS2	8x16 Linear-MWS	4.203	2.456	8.97
Total		5.198		

^a See Figure 2.

^b See Figure 2.

^c Calculated in MGS Flood. See Attachment B for modeling report.

^d Based on calculation of flow through orifice controlled outlet pipe on MWS.

ac = acres

cfs = cubic feet per second

Project Team Responsibilities, Qualifications, and Commitment

Team Member Responsibilities

Teams	Members	Responsibilities
San Juan County	Ed Hale	Project Manager
	Shannon Wilbur, PE	Senior Project Engineer, with lead role for review of design documents
	Jessie Douglas-Seitz	Engineering Technician, Construction Manager
Design Consultant	Consultant Principal Engineer, PE	Oversee design quality control and ensure adequate staff resources are committed to the project. Assigned to the project for 5-10% of the time during design.
	Consultant Project Engineer, PE	Responsible for oversight and direction of the design calculations, drawings, and construction specifications. Responsible for ensuring design quality control processes are followed. Support construction oversight. Assigned to the project for 20-50% of the time during design and 10-20% of the time during construction.
	Consultant Design Engineer, PE or EIT	Responsible for conducting design calculations, developing design plans and profiles, writing specifications and cost estimating. Assigned to the project for 40-60% of the time during design and up to 20% of the time during construction.
	Consultant Drafting Technician	Responsible for drafting the design and implementation of CAD quality standards. Assigned to the project for 40-60% of the time during design.

Team Member Qualifications

San Juan County Team

Ed Hale

Role: Grant Project Administration and Management

Qualifications:

Education: B.S. in Environmental Science, Washington State University 1985; B.S. in Biology, Washington State University 1985

Professional Credential: Registered Environmental Health Specialist No. 9000842, National Environmental Health Association.

Experience: Mr. Hale has 29 years of experience working at the local government level with County, District and Tribal governments. Mr. Hale has managed grants from federal, state and local agencies including US Environmental Protection Agency, US Department of Agriculture, US Department of Interior, Washington Department of Health, Washington State Department of Ecology, Idaho Department of Environmental Quality, and Idaho Department of Health and Welfare. Projects funded through the grants managed by Mr. Hale have included the design, installation and monitoring of stormwater treatment systems, implementing surface water and groundwater quality protection programs, treatment system design evaluation and regional water quality plans.

Shannon Wilbur, PE

Role: Senior Project Engineer at San Juan County Public Works

Qualifications:

Experience: Civil engineer since 1987 working in both the private and public sectors as a design engineer and project manager for numerous municipal utility projects in both California and Washington. Ms. Wilbur has developed state and federally funded projects from the planning phase through to construction, including extensive public outreach efforts. She has been with San Juan County since 2007 and managed the design and public outreach for the Eastsound Constructed Wetland, the Guardrail Safety Project and the Cattle Point Road Realignment project. Other local planning efforts have included the Eastsound Streetscape, and the Orcas Landing acquisition and master plan.

Preliminary Design Team

Matt Fontaine, PE

Role: Senior Engineer at Herrera Environmental Consultants and Project Engineer for the Preliminary Design

Qualifications:

Education: M.S. in Civil Engineering with an emphasis in Water Resources, University of Washington, 2007; B.S. in Civil/Environmental Engineering, Clarkson University, 2002

Professional Credential: Washington Registered Professional Engineer # 46158

Experience: Mr. Fontaine is a water resources engineer with 10 years of experience. His stormwater engineering expertise is broad, spanning design of low impact development (LID) and traditional stormwater facility design, stormwater retrofit planning and design, stormwater program evaluation, stormwater guidance manual development, and regulatory compliance. He has completed analysis and design of stormwater projects for the public and private sector for both new development and retrofit projects in the public right of way, ranging from site-scale design to large and complex retrofit planning and design efforts. He has served as project engineer responsible for engineering designs, specifications, cost estimates, and operation and maintenance plans for multiple stormwater facility projects, including bioretention, permeable pavement, stormwater conveyance, stormwater treatment, and large traditional flow control and water quality treatment facilities. He is adept at stormwater retrofit site identification, prioritization, predesign report preparation, and design, most recently acting as project manager and project engineer for the City of Lacey's Chambers Lake Constructed Wetland Facility.

Caitlyn Echterling, EIT

Role: Engineer at Herrera Environmental Consultants and Design Engineer for the Preliminary Design

Qualifications:

Education: B.S. in Civil Engineering, Seattle University, Seattle, 2013

Professional Credential: Engineer-in-Training

Experience: Ms. Echterling is an engineer and modeler with experience working on stormwater management and stream restoration design projects and related research projects. She has a strong background in data analysis and GIS. She has contributed hydrologic and hydraulic modeling for several local stormwater projects.

Final Consultant Design Team

Licensed Professional Engineer

Qualifications:

Experience: Sizing and designing stormwater conveyance and water quality facilities in accordance with the Stormwater Management Manual for Western Washington.

Experience designing projects in San Juan County.

Experience designing projects using the WSDOT Standard Specifications for Road, Bridge, and Municipal Construction.

Experience providing construction support to municipal projects.

Commitment to Maintain Staff Competencies and Responsibilities

The County and consultant staff outlined above are all committed to the ongoing advancement of stormwater management and the improvement of water quality in East Sound. This project would remove a source of pollutants currently discharging to East Sound. It is in the project team's interest to maintain involvement and ensure project success. Likewise, the team is composed of seasoned professionals that have a long history of successfully staffing and executing a wide range of public utility projects.

County staff would oversee long term maintenance of the project and employ contract equipment or staff when needed. The maintenance procedures for the stormwater treatment facilities would be demonstrated by the vendor during the first year following installation and observed by the County maintenance staff. County maintenance staff would repeat the maintenance process during subsequent years.

Readiness to Proceed and Commitment to the Project

This overall project, including right-of-way and water quality improvements, is a priority for the County, as the street improvements will address drainage and flooding problems. The water quality improvements will be sustained by annual maintenance conducted by the County.

The County has worked with the CSWAC to identify and prioritize capital improvement projects, and the CSWAC has been a part of County level decision making by providing review of reported stormwater problems and providing local perspective on potential projects.

The project will conform to the Eastsound Subarea Plan, which is administered by the Eastsound Planning Review Committee (EPRC). Major stakeholders are property and business owners along Market Street and Madrona Street, residents and visitors in Eastsound who need access without flooding concerns, owners of a nearby oyster farm, and the Kwiáht Indian Island Marine Health Marine Observatory in Fishing Bay.

Cost Estimate

A preliminary construction cost estimate was prepared based upon the collective experience of Herrera with projects of a similar scale and site settings, assuming a contractor would be hired to perform the construction. Except where otherwise noted, the cost estimate was developed based on the following:

- Construction bid items were based on Washington State Department of Transportation (WSDOT) standard specifications where applicable, including material, construction requirements, measurement, and payment.
- Line item unit prices for construction were based on sound engineering judgment and were derived from a combination of applicable sources, including contractor bid tabs from similar past projects, prices compiled by WSDOT and Seattle Public Utilities, quotes from vendors, cost estimating guides (e.g., The Guide [Guide 2014]), site-specific understanding of probable contractor staging, access, and other

project specific requirements and constraints that would affect contractor bids for the project.

- County sales tax of 8.1 percent was applied to the construction cost.

Allied costs (project management, survey, geotechnical analyses, design, permitting, property acquisition, and construction management) were developed by applying the following assumptions:

- The County would hire a consultant to perform the survey, geotechnical analysis, design, and permitting.
- The County would manage the project for a cost equal to 10 percent of the construction cost and perform construction management for a cost equal to 20 percent of the construction cost.
- Costs for survey, design, and permitting are based on experience with design and permitting similar projects and knowledge of site-specific job complexities and challenges. In some cases, professional judgment was used to estimate allied costs as a percentage of construction costs.
- This project would require an easement for the storm drain system across Market Street. Costs for obtaining the easement are estimated to be \$5,000.
- A 5 percent change order allowance is included in the cost estimate along with a 10 percent cost for utility protection and relocation during construction; however, no contingency was included because the Ecology grant requirements do not allow for a contingency.

The total planning-level cost of this retrofit project, including survey, design, construction, and other miscellaneous costs, is estimated to be approximately \$420,000. Itemized costs are included in Attachment C.

Commitment to Long Term Operations and Maintenance

Water quality performance of the installed stormwater treatment facilities will be maintained in accordance with requirements identified in the GULD documentation and manufacturer's guidance. During maintenance visits, County staff will perform all required maintenance activities as specified by the manufacturer and summarized below. County staff will document functionality of the system during routine maintenance visits by simulating storm flow using a hydrant if necessary and will modify frequency of visits based on system performance over time. The performance of the filter media will be monitored by observing the facilities during storm events or simulated storm events (i.e. flow provided by hydrants) and the media will be replaced as needed for effective pollutant removal by County staff.

The proposed water quality treatment systems incorporate green techniques (i.e., plants and soil) to improve water quality treatment performance and are passive systems that do not require energy input other than for routine maintenance. Materials needed for operations and maintenance are commonly available for the wetland system. Maintenance contracts are available through Modular Wetlands if the County prefers to contract out the maintenance.

Every 6 to 12 months, trash should be removed from the MWS screening device and vegetation trimmed. Every 12 to 24 months, sediment should be removed from the separation chambers and the cartridge media replaced (perlite is an acceptable alternate to filter media and the proposed models would not have a drain down filter).

Project Success

Success of this project will be linked to effective filtration of stormwater runoff from the Market Street and Madrona Street project drainage area, as observed during future storm events. Project success will be documented with (1) records of written observation of facility function and condition during scheduled maintenance activities, and (2) field visits during rain events to observe flow through the installed stormwater treatment facilities to ensure they are not bypassing the water quality treatment flow. If warranted, project maintenance activities and frequencies will be altered to ensure the facilities are functioning as per the design.

Long-term success of this project will be documented through the written measurements listed above and distribution of resulting operations and maintenance recommendations among County design engineers and maintenance staff to increase awareness of facility function and maintenance requirements for use on future projects in San Juan County.

Implementation Recommendations

The County should take the following key steps to ensure successful implementation of this project:

- Work with private property owners to obtain the necessary easements prior to proceeding with grant application or construction.
- Conduct utility locates and survey within the project area, identify utility conflicts, and adjust the design to minimize conflicts and associated costs.
- Consider this project in combination with the County's plans on Prune Alley and Fern Street. If easements can be obtained for installation of stormwater treatment BMPs in the existing swale, construct a single set of stormwater treatment BMPs to manage flow from Market Street and Madrona Street and from Prune Alley and Fern Street at the same time in the footprint of the existing swale.
- Complete a video inspection of the existing storm drain system under Market Street and inspect associated surface draining patterns. This project assumes that all conveyance pipes require replacement because significant flooding issues have occurred on Market Street and adequate conveyance is needed to direct flow to the water quality facilities (as well as to protect life and property); however, modeling indicates the existing pipes are adequately sized and if less pipe replacement is necessary the project would cost less.
- Contact other nearby jurisdictions that have installed Modular Wetland Systems to get input on advantages and disadvantages of these systems as well as user satisfaction.

References

Ecology. 2011. Fact Sheet for the Western Washington Phase II Municipal Stormwater Permit. Washington State Department of Ecology, Olympia, Washington. November 4, 2011.

Ecology. 2012. Stormwater Management Manual for Western Washington. Washington State Department of Ecology, Olympia, Washington.

Ecology. 2014a. General Use Level Designation for Basic (TSS), Enhanced, Phosphorous & Oil Treatment for the MWS-Linear Modular Wetland. Washington State Department of Ecology. April 2014.

Herrera et al. 2014a. San Juan County Stormwater Basin Planning: Volume 1 County Overview. Prepared for San Juan County Public Works by Herrera Environmental Consultants, Inc., AESI, ESA, Hart Pacific Engineering, and Stillwater Sciences. June 26, 2014.

Herrera et al. 2014b. San Juan County Stormwater Basin Planning: Volume 2 Priority Watershed Planning. Prepared for San Juan County Public Works by Herrera Environmental Consultants, Inc., AESI, ESA, Hart Pacific Engineering, and Stillwater Sciences. June 26, 2014.

Puget Sound Partnership. 2014. The 2014/2015 Action Agenda for Puget Sound. Puget Sound Partnership. May 2014.

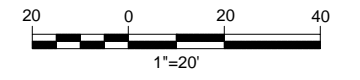
Rasmussen, G.P., San Juan County Department of Public Works, Hart Pacific Engineering, Inc., MPD, Inc., and Herrera Environmental Consultants, Inc. 2005. Long Range Drainage Plan Proposal for Eastsound Village Urban Growth Area. Eastsound, Washington. May 2005.

ATTACHMENT A

Water Quality Improvements Plan

CONSTRUCTION NOTES:

- 1 REMOVE OR ABANDON EXISTING PIPE
- 2 REMOVE EXISTING STRUCTURE
- 10 INSTALL MODULAR WETLAND SYSTEM 4' X 13' UNIT - PER ATTACHED DETAIL MWS-L-4-13-C
- 11 INSTALL MODULAR WETLAND SYSTEM 8' X 16' UNIT - PER ATTACHED DETAIL MWS-L-8-16-C
- 21 INSTALL 8" DIA STORM SEWER PIPE
- 22 INSTALL 12" DIA STORM SEWER PIPE
- 23 INSTALL TYPE 1 CATCH BASIN PER WSDOT STD PLAN B-5.20-01, PROVIDE CONNECTIONS TO EXISTING PIPES.
- 24 INSTALL TYPE 2 CATCH BASIN, 48 IN DIA PER WSDOT STD PLAN B-10.20-01, PROVIDE CONNECTIONS TO EXISTING PIPES.



LEGEND:

- FILTERRA (4'x4')
- MODULAR WETLAND SYSTEM (4'x13')
- MODULAR WETLAND SYSTEM (8'x16')
- TYPE 1 CATCH BASIN
- TYPE 2 CATCH BASIN
- GROUNDWATER COLLECTION SYSTEM
- STORM SEWER PIPE
- EXISTING STORM SEWER PIPE
- EXISTING TYPE 1 CATCH BASIN
- EXISTING TYPE 2 CATCH BASIN
- APPROX. EXTENTS OF RIGHT-OF-WAY IMPROVEMENTS
- RIGHT OF WAY
- PARCEL BOUNDARY
- EXISTING 1 FOOT CONTOURS

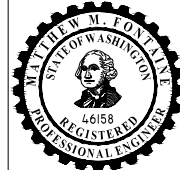
GENERAL NOTES:

1. THIS DESIGN IS PRELIMINARY AND NOT INTENDED FOR CONSTRUCTION. PROPOSED WATER QUALITY TREATMENT STRUCTURE LOCATIONS, QUANTITIES, TYPES, AND MODELS ARE APPROXIMATE AND WILL NEED TO BE ADJUSTED DURING FINAL DESIGN TO ACCOMMODATE EXISTING UTILITIES, EXISTING STORM DRAIN SYSTEM, AND SURFACE FLOW PATHS.
2. THE BASE MAP WAS PROVIDED TO HERRERA BY SAN JUAN COUNTY IN OCTOBER AND NOVEMBER OF 2014. STORM DRAIN STRUCTURE LOCATIONS ARE BASED ON FIELD SURVEY OF THE CENTER OF EACH STRUCTURE. PIPE LOCATIONS ARE APPROXIMATE AND MUST BE FIELD VERIFIED.
3. ALL WORKMANSHIP AND MATERIALS SHALL BE IN ACCORDANCE WITH COUNTY STANDARDS AND THE MOST CURRENT COPY OF THE STATE OF WASHINGTON STANDARD SPECIFICATIONS FOR ROAD, BRIDGE AND MUNICIPAL CONSTRUCTION (WSDOT STD SPEC).
4. TEMPORARY EROSION/WATER POLLUTION CONTROL MEASURES SHALL BE REQUIRED IN ACCORDANCE WITH SECTION 1-07.15 OF THE WSDOT STD SPEC AND COUNTY REQUIREMENTS.
5. CONTRACTOR SHALL COMPLY WITH ALL OTHER PERMITS AND OTHER REQUIREMENTS OF THE GOVERNING AUTHORITY OR AGENCY.
6. PROVIDE TRAFFIC CONTROL PLAN(S) AS REQUIRED PRIOR TO CONSTRUCTION.
7. ALL STORM SEWER SHALL BE CONSTRUCTED IN ACCORDANCE WITH WSDOT STD. SPEC. 7-04 STORM SEWERS.

PRELIMINARY DESIGN

Path: O:\proj\2013\13-05676-000\CAD\dwgs\Market SVC-1.dwg
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 Plot Style Table: Herrera - 14.ctb
 Cad User: Todd Prescott
 Plotter: DWG To PDF.pc3

No.	REVISION	BY	APPD	DATE



DESIGNED: M. FONTAINE	DRAWN: T. PRESCOTT
DESIGNED: -	DRAWN: -
DESIGNED: -	CHECKED: B. BUSIEK
SCALE: AS NOTED	APPROVED: M. EWBANK

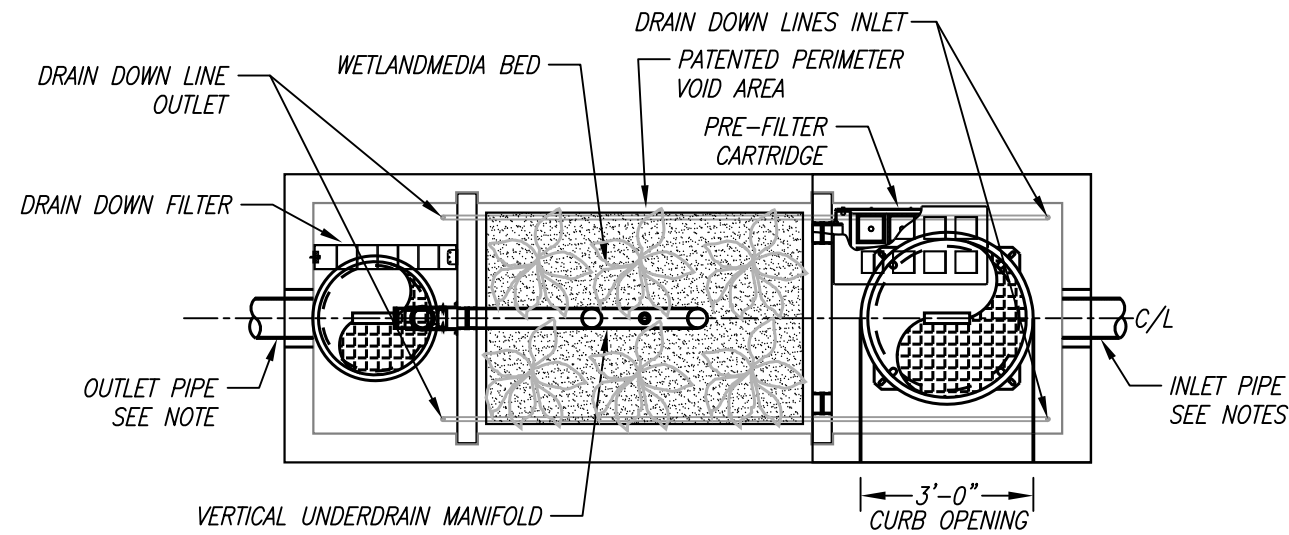
**MARKET STREET AND
MADRONA STREET
WATER QUALITY IMPROVEMENTS**

 PROPOSED SITE

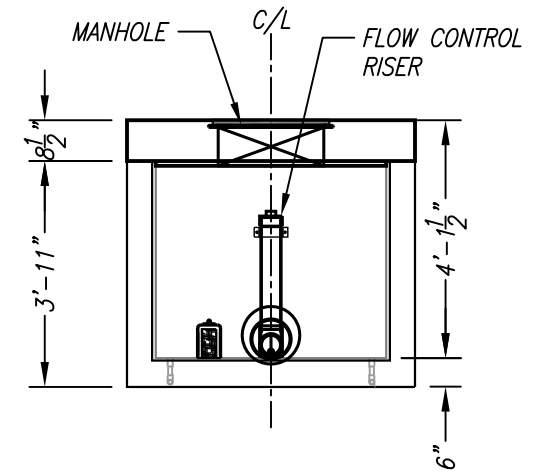
DATE: DECEMBER 2014
PROJECT NO: 13-05676-000
DRAWING NO: C-1
SHEET NO: 1 OF 1

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 ONE INCH
 AT FULL SIZE, IF NOT ONE
 INCH SCALE ACCORDINGLY

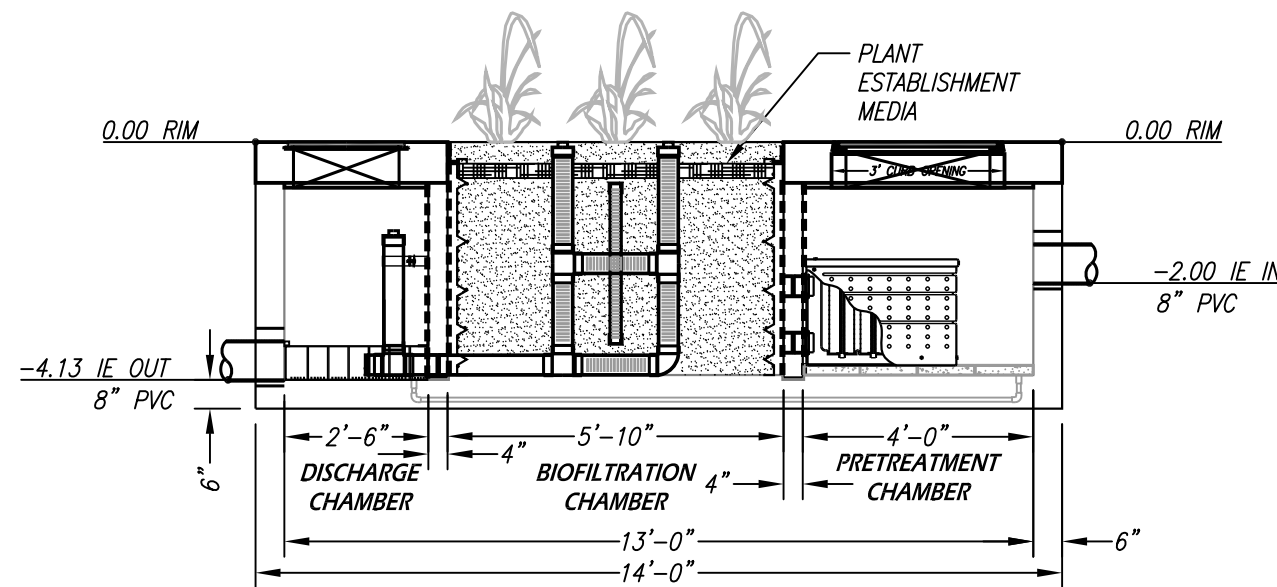
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PROJECT LOCATION	EASTSOUNDS, WA		
STRUCTURE ID	MWS #1		
PERFORMANCE DATA			
TREATMENT FLOW (CFS)	0.122		
TREATMENT HGL (FT)	3.0		
BYPASS FLOW RATE (CFS)	N/A		
PROJECT PARAMETERS			
PIPE DATA	I.E.	MATERIAL	DIAMETER
INLET PIPE 1	-2.00	PVC	8"
OUTLET PIPE 1	-4.13	PVC	8"
RIM ELEVATION	0.00		0.00
SURFACE LOADING REQUIREMENT	TBD		
FRAME & COVER	PRETREATMENT	BIOFILTRATION	DISCHARGE
	30"	OPEN MEDIA	24"
WETLANDMEDIA VOLUME (CY)	TBD		
MEDIA DELIVERED	TBD		
ORIFICE SIZE (DIA)	TBD		
MAX PICK WEIGHT (LBS)	TBD		
NOTES:			
*PER ENGINEER OF RECORD			



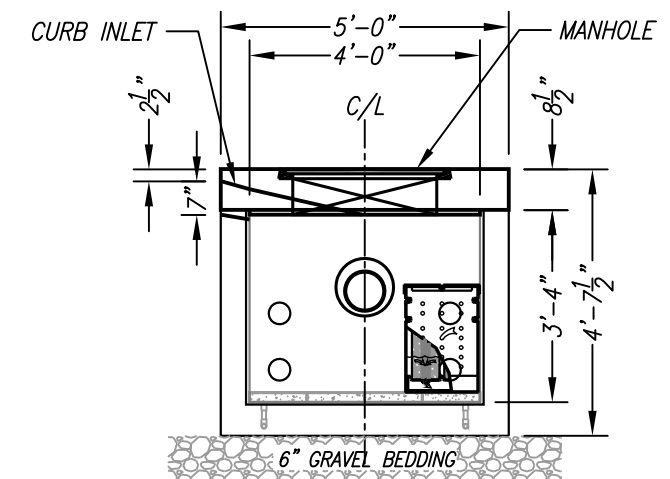
PLAN VIEW



LEFT END VIEW



ELEVATION VIEW



RIGHT END VIEW

INSTALLATION NOTES

1. CONTRACTOR TO PROVIDE ALL LABOR, EQUIPMENT, MATERIALS AND INCIDENTALS REQUIRED TO OFFLOAD AND INSTALL THE SYSTEM AND APPURTENANCES IN ACCORDANCE WITH THIS DRAWING AND THE MANUFACTURERS SPECIFICATIONS, UNLESS OTHERWISE STATED IN MANUFACTURERS CONTRACT.
2. MANUFACTURER RECOMMENDS A MINIMUM 6" LEVEL ROCK BASE UNLESS SPECIFIED BY THE PROJECT ENGINEER. CONTRACTOR IS RESPONSIBLE TO VERIFY PROJECT ENGINEERS RECOMMENDED BASE SPECIFICATIONS.
3. ALL PIPES MUST BE FLUSH WITH INSIDE SURFACE OF CONCRETE. (PIPES CANNOT INTRUDE BEYOND FLUSH).
4. INVERT OF OUTFLOW PIPE MUST BE FLUSH WITH DISCHARGE CHAMBER FLOOR.
5. ALL GAPS AROUND PIPES SHALL BE SEALED WATER TIGHT WITH A NON-SHRINK GROUT PER MANUFACTURERS STANDARD CONNECTION DETAIL AND SHALL MEET OR EXCEED REGIONAL PIPE CONNECTION STANDARDS.
6. CONTRACTOR RESPONSIBLE FOR INSTALLATION OF ALL RISERS, MANHOLES, AND HATCHES. CONTRACTOR TO GROUT ALL MANHOLES AND HATCHES TO MATCH FINISHED SURFACE UNLESS SPECIFIED OTHERWISE.

GENERAL NOTES

1. MANUFACTURER TO PROVIDE ALL MATERIALS UNLESS OTHERWISE NOTED.
2. ALL DIMENSIONS, ELEVATIONS, SPECIFICATIONS AND CAPACITIES ARE SUBJECT TO CHANGE. FOR PROJECT SPECIFIC DRAWINGS DETAILING EXACT DIMENSIONS, WEIGHTS AND ACCESSORIES PLEASE CONTACT MANUFACTURER.

MWS UNIT DESIGN DATA	
TREATMENT CAPACITY (CFS)	.144
OPERATING HEAD (FT)	3.4
PRETREATMENT LOADING RATE (GPM/SF)	2.9
WETLAND LOADING RATE (GPM/SF)	1.0

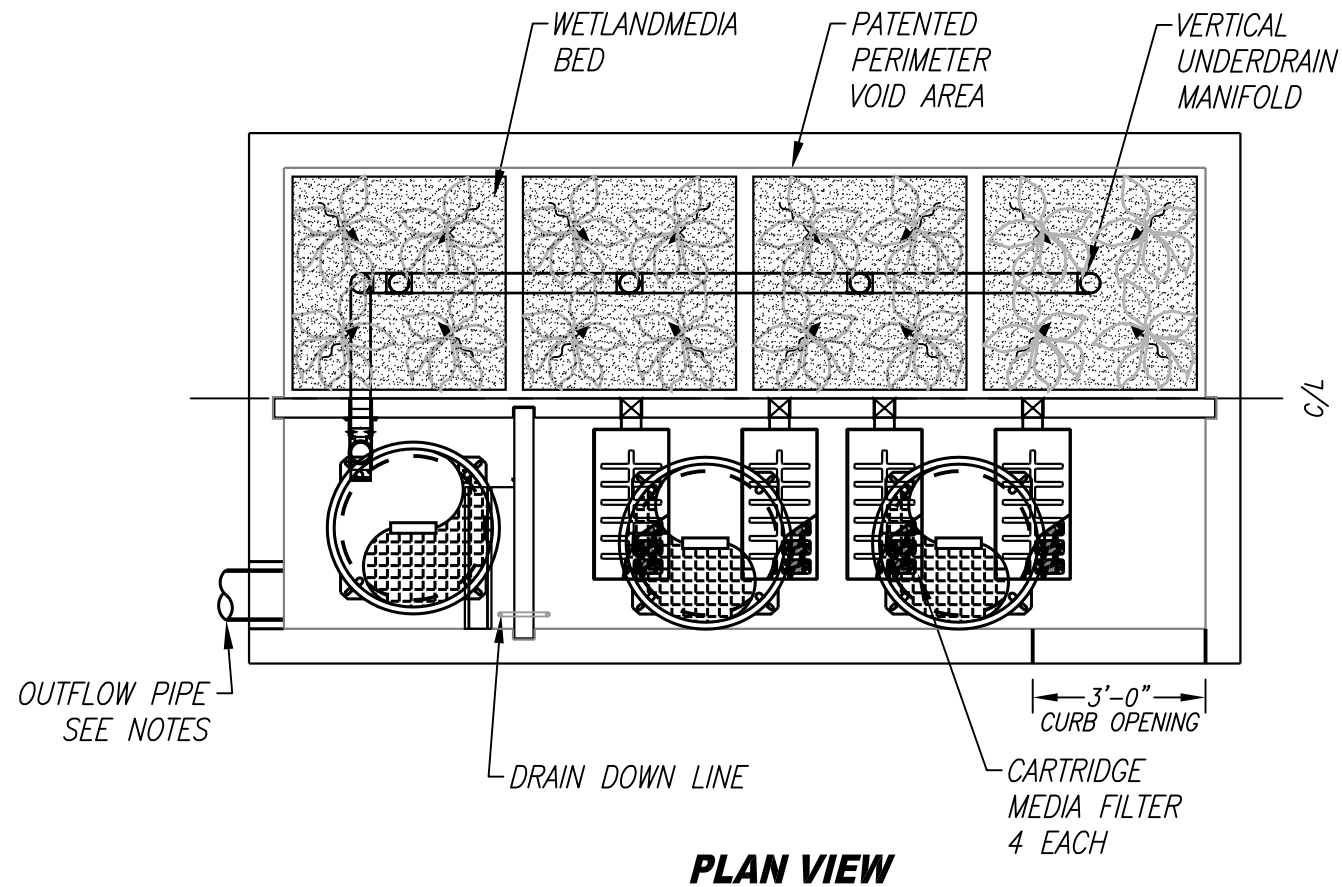
MWS-L-4-13-C
STORMWATER BIOFILTRATION SYSTEM
STANDARD DETAIL

THE PRODUCT DESCRIBED MAY BE PROTECTED BY ONE OR MORE OF THE FOLLOWING US PATENTS: 7,425,262; 7,470,362; 7,674,378; 8,303,816; RELATED FOREIGN PATENTS OR OTHER PATENTS PENDING

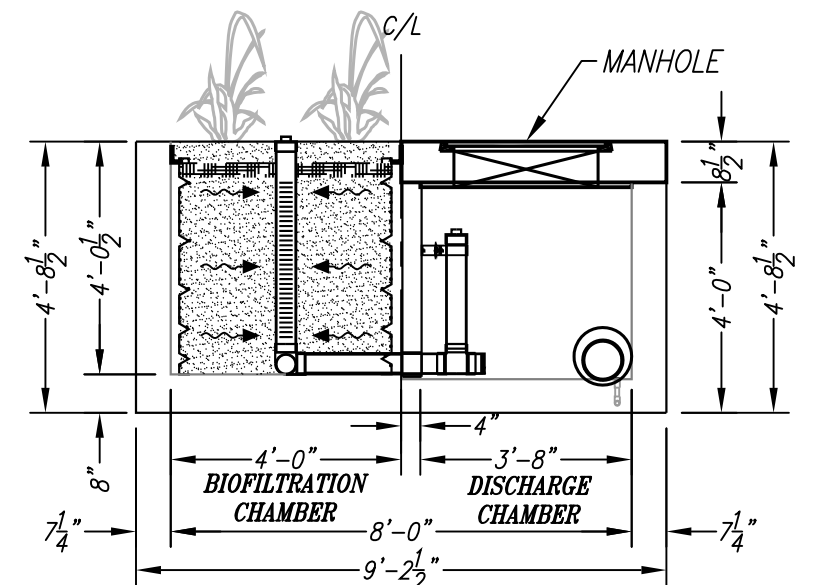
PROPRIETARY AND CONFIDENTIAL:
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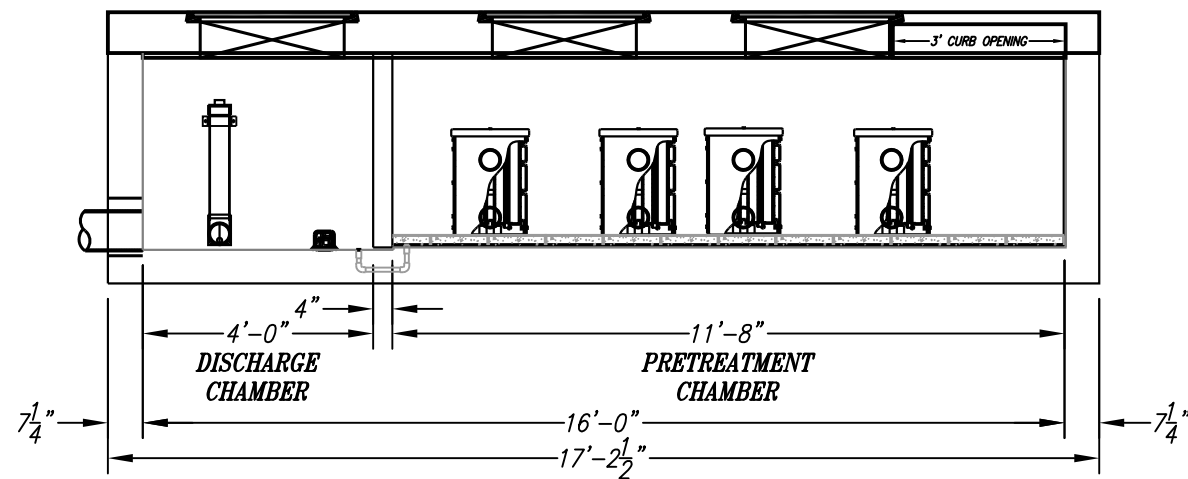
SITE SPECIFIC DATA*			
PROJECT NAME	MADRONA - MARKET ST.		
PROJECT LOCATION	EASTSOUNDS, WA		
STRUCTURE ID	MWS #2		
PERFORMANCE DATA			
TREATMENT FLOW (CFS)	0.425		
TREATMENT HGL (FT)	3.2		
BYPASS FLOW RATE (CFS)			
PROJECT PARAMETERS			
PIPE DATA	I.E.	MATERIAL	DIAMETER
OUTLET PIPE 1		PVC	8"
RIM ELEVATION			
SURFACE LOADING REQUIREMENT		PARKWAY	
FRAME & COVER	PRETREATMENT	BIOFILTRATION	DISCHARGE
	30"	N/A	30"
WETLAND MEDIA VOLUME (CY)		TBD	
MEDIA DELIVERED		TBD	
ORIFICE SIZE (DIA)		TBD	
MAX PICK WEIGHT (LBS)		TBD	
NOTES:			
*PER ENGINEER OF RECORD			



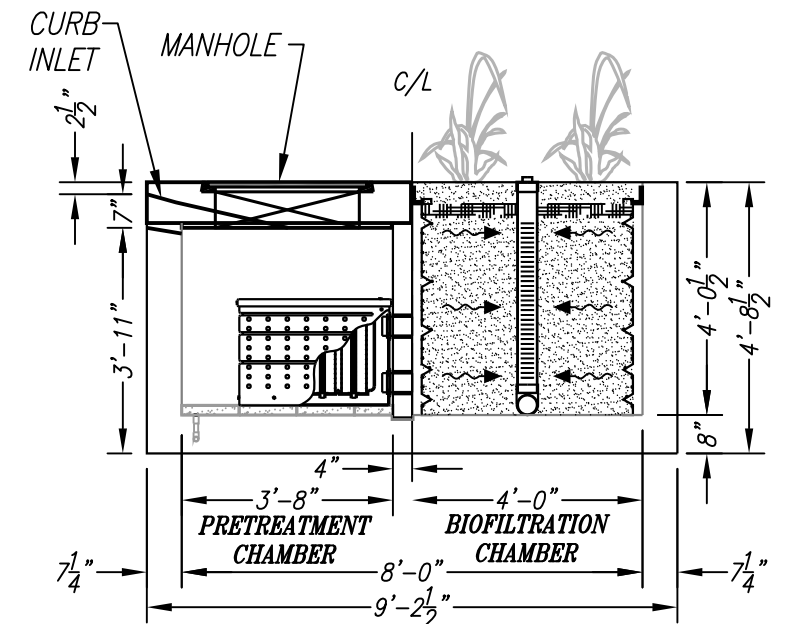
PLAN VIEW



LEFT END VIEW



ELEVATION VIEW



RIGHT END VIEW

INSTALLATION NOTES

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PROPRIETARY AND CONFIDENTIAL:

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MWS UNIT DESIGN DATA	
TREATMENT CAPACITY (CFS)	0.462
OPERATING HEAD (FT)	3.4
PRETREATMENT SURFACE AREA (SF)	141.12
WETLAND LOADING RATE (GPM/MIN)	1.03

MWS-L-8-16-C
STORMWATER BIOFILTRATION SYSTEM
STANDARD DETAIL

ATTACHMENT B

Modeling Documentation

WATER QUALITY TREATMENT MODELING

Two drainage areas were modeled in MGS Flood v4.33 using a 15-minute time step to determine the on-line and offline water quality flow rates required. Dummy bioretention facilities were included in these models because a BMP is required to calculate the water quality runoff flow rates. The time series for 36-inch mean annual precipitation in Western Washington was selected for this project. Isopluvial maps indicate the project receives an average annual precipitation depth of 33.3 inches, indicating the 36-inch time series is conservative. Pervious land cover was modeled as till grass.

Two modeling reports are attached, one for each facility drainage area. It is important to note that the flow control performance is not reflective of expected performance since a dummy bioretention facility was included in the model and flow control is not a project objective.

MGS FLOOD PROJECT REPORT

Program Version: MGSFlood 4.33
Program License Number: 200210002
Run Date: 12/03/2014 6:12 PM

Input File Name: MWS1 - MAP E36.fld
Project Name: MWS 1
Analysis Title:
Comments:

PRECIPITATION INPUT

Computational Time Step (Minutes): 15

Extended Precipitation Timeseries Selected
Climatic Region Number: 12

Full Period of Record Available used for Routing
Precipitation Station : 96003605 Puget East 36 in_5min 10/01/1939-10/01/2097
Evaporation Station : 961036 Puget East 36 in MAP
Evaporation Scale Factor : 0.750

HSPF Parameter Region Number: 1
HSPF Parameter Region Name : USGS Default

***** Default HSPF Parameters Used (Not Modified by User) *****

***** WATERSHED DEFINITION *****

-----SCENARIO: PREDEVELOPED

Number of Subbasins: 1

----- Subbasin : Existing Subbasin -----

	-----Area(Acres) -----
Till Forest	0.000
Till Pasture	0.000
Till Grass	0.083
Outwash Forest	0.000
Outwash Pasture	0.000
Outwash Grass	0.000
Wetland	0.000
Green Roof	0.000
User 2	0.000
Impervious	0.912

Subbasin Total 0.995

-----SCENARIO: POSTDEVELOPED

Number of Subbasins: 1

----- Subbasin : Proposed Subbasin -----

	-----Area(Acres) -----
Till Forest	0.000
Till Pasture	0.000
Till Grass	0.083
Outwash Forest	0.000
Outwash Pasture	0.000
Outwash Grass	0.000
Wetland	0.000
Green Roof	0.000
User 2	0.000
Impervious	0.912

Subbasin Total	0.995

***** LINK DATA *****

-----SCENARIO: PREDEVELOPED

Number of Links: 0

***** LINK DATA *****

-----SCENARIO: POSTDEVELOPED

Number of Links: 1

Link Name: Dummy Water Quality Facility

Link Type: Bioretention Facility

Downstream Link: None

Base Elevation (ft) : 100.00
Riser Crest Elevation (ft) : 100.50
Storage Depth (ft) : 0.50
Bottom Length (ft) : 15.0
Bottom Width (ft) : 15.0
Side Slopes (ft/ft) : L1= 0.00 L2= 0.00 W1= 0.00 W2= 0.00
Bottom Area (sq-ft) : 225.
Area at Riser Crest El (sq-ft) : 225.
(acres) : 0.005
Volume at Riser Crest (cu-ft) : 214.
(ac-ft) : 0.005

Infiltration on Bottom and Sideslopes Selected

Soil Properties

BioSoil Thickness (ft) : 1.50
BioSoil Saturated Hydraulic Conductivity (in/hr) : 3.00
BioSoil Porosity (Percent) : 30.00
Maximum Elevation of Bioretention Soil : 101.00
Native Soil Hydraulic Conductivity (in/hr) : 0.00

Underdrain Present
Orifice NOT Present in Under Drain

Riser Geometry
Riser Structure Type : Circular
Riser Diameter (in) : 12.00
Common Length (ft) : 0.000
Riser Crest Elevation : 100.50 ft

Hydraulic Structure Geometry

Number of Devices: 0

*****FLOOD FREQUENCY AND DURATION STATISTICS*****

-----SCENARIO: PREDEVELOPED

Number of Subbasins: 1
Number of Links: 0

-----SCENARIO: POSTDEVELOPED

Number of Subbasins: 1
Number of Links: 1

***** Link: Dummy Water Quality Facility ***** Link WSEL Stats
WSEL Frequency Data(ft)
(Recurrence Interval Computed Using Gringorten Plotting Position)
Tr (yrs) WSEL Peak (ft)

=====	
1.05-Year	100.566
1.11-Year	100.572
1.25-Year	100.579
2.00-Year	100.597
3.33-Year	100.607
5-Year	100.617
10-Year	100.632
25-Year	100.650
50-Year	100.680
100-Year	100.710

*****Groundwater Recharge Summary*****

Recharge is computed as input to PerInd Groundwater Plus Infiltration in Structures

Total Predeveloped Recharge During Simulation	
Model Element	Recharge Amount (ac-ft)

Subbasin: Existing Subbasin	9.557
<hr/>	
Total:	9.557

Total Post Developed Recharge During Simulation

Model Element	Recharge Amount (ac-ft)
Subbasin: Proposed Subbasin	9.557
Link: Dummy Water Quality	0.000
Total:	9.557

Total Predevelopment Recharge Equals Post Developed Average Recharge Per Year, (Number of Years= 158)
Predeveloped: 0.060 ac-ft/year, Post Developed: 0.060 ac-ft/year

*******Water Quality Facility Data*******

-----**SCENARIO: PREDEVELOPED**

Number of Links: 0

-----**SCENARIO: POSTDEVELOPED**

Number of Links: 1

Design Criteria

***** Link: Dummy Water Quality Facility

15-Minute Timestep, Water Quality Treatment Design Discharge
On-line Design Discharge Rate (91% Exceedance): 0.12 cfs
 Off-line Design Discharge Rate (91% Exceedance): 0.07 cfs

Infiltration/Filtration Status: Not Applicable
 Total Runoff Volume (ac-ft): Not Applicable
 Total Runoff Infiltrated (ac-ft): Not Applicable
 Total Runoff Filtered (ac-ft): Not Applicable
 Percent Treated (Infiltrated+Filtered)/Total Volume: 59.20%

*******Compliance Point Results*******

Scenario Predeveloped Compliance Subbasin: Existing Subbasin

Scenario Postdeveloped Compliance Link: Dummy Water Quality Facility

*** **Point of Compliance Flow Frequency Data** ***

Recurrence Interval Computed Using Gringorten Plotting Position

Predevelopment Runoff		Postdevelopment Runoff	
Tr (Years)	Discharge (cfs)	Tr (Years)	Discharge (cfs)
2-Year	0.332	2-Year	0.332
5-Year	0.435	5-Year	0.435
10-Year	0.516	10-Year	0.516
25-Year	0.635	25-Year	0.635
50-Year	0.798	50-Year	0.798
100-Year	0.974	100-Year	0.974
200-Year	1.041	200-Year	1.041

Design Criteria

** Record too Short to Compute Peak Discharge for These Recurrence Intervals

**** **Flow Duration Performance** ****

Excursion at Predeveloped 50%Q2 (Must be Less Than 0%):	0.0%	FAIL	
Maximum Excursion:	0.3%	FAIL	FAIL
Maximum Excursion:	0.0%	PASS	
Percent Excursion:	0.0%	PASS	

Flow Duration Analysis Not Applicable

FLOW DURAT

**** **LID Duration Performance** ****

Excursion at Predeveloped 8%Q2 (Must be Less Than 0%):	0.0%	FAIL
Maximum Excursion from 8%Q2 to 50%Q2 (Must be Less Than 0%):	0.0%	FAIL

LID DURATION DESIGN CRITERIA: FAIL

MGS FLOOD PROJECT REPORT

Program Version: MGSFlood 4.33
Program License Number: 200210002
Run Date: 12/03/2014 6:17 PM

Input File Name: MWS2&3 - MAP E36.fld
Project Name: MWS 2&3
Analysis Title:
Comments:

PRECIPITATION INPUT

Computational Time Step (Minutes): 15

Extended Precipitation Timeseries Selected
Climatic Region Number: 12

Full Period of Record Available used for Routing
Precipitation Station : 96003605 Puget East 36 in_5min 10/01/1939-10/01/2097
Evaporation Station : 961036 Puget East 36 in MAP
Evaporation Scale Factor : 0.750

HSPF Parameter Region Number: 1
HSPF Parameter Region Name : USGS Default

***** Default HSPF Parameters Used (Not Modified by User) *****

***** WATERSHED DEFINITION *****

-----SCENARIO: PREDEVELOPED

Number of Subbasins: 1

----- Subbasin : Existing Subbasin -----

	-----Area(Acres) -----
Till Forest	0.000
Till Pasture	0.000
Till Grass	0.995
Outwash Forest	0.000
Outwash Pasture	0.000
Outwash Grass	0.000
Wetland	0.000
Green Roof	0.000
User 2	0.000
Impervious	3.208

Subbasin Total 4.203

-----SCENARIO: POSTDEVELOPED

Number of Subbasins: 1

----- Subbasin : Proposed Subbasin -----

	-----Area(Acres) -----
Till Forest	0.000
Till Pasture	0.000
Till Grass	0.995
Outwash Forest	0.000
Outwash Pasture	0.000
Outwash Grass	0.000
Wetland	0.000
Green Roof	0.000
User 2	0.000
Impervious	3.208

Subbasin Total	4.203

***** LINK DATA *****

-----SCENARIO: PREDEVELOPED

Number of Links: 0

***** LINK DATA *****

-----SCENARIO: POSTDEVELOPED

Number of Links: 1

Link Name: Dummy Water Quality Facility

Link Type: Bioretention Facility

Downstream Link: None

Base Elevation (ft) : 100.00
Riser Crest Elevation (ft) : 100.50
Storage Depth (ft) : 0.50
Bottom Length (ft) : 15.0
Bottom Width (ft) : 15.0
Side Slopes (ft/ft) : L1= 0.00 L2= 0.00 W1= 0.00 W2= 0.00
Bottom Area (sq-ft) : 225.
Area at Riser Crest El (sq-ft) : 225.
(acres) : 0.005
Volume at Riser Crest (cu-ft) : 214.
(ac-ft) : 0.005

Infiltration on Bottom and Sideslopes Selected

Soil Properties

BioSoil Thickness (ft) : 1.50
BioSoil Saturated Hydraulic Conductivity (in/hr) : 3.00
BioSoil Porosity (Percent) : 30.00
Maximum Elevation of Bioretention Soil : 101.00
Native Soil Hydraulic Conductivity (in/hr) : 0.00

Underdrain Present
Orifice NOT Present in Under Drain

Riser Geometry
Riser Structure Type : Circular
Riser Diameter (in) : 12.00
Common Length (ft) : 0.000
Riser Crest Elevation : 100.50 ft

Hydraulic Structure Geometry

Number of Devices: 0

*****FLOOD FREQUENCY AND DURATION STATISTICS*****

-----SCENARIO: PREDEVELOPED

Number of Subbasins: 1
Number of Links: 0

-----SCENARIO: POSTDEVELOPED

Number of Subbasins: 1
Number of Links: 1

***** Link: Dummy Water Quality Facility ***** Link WSEL Stats
WSEL Frequency Data(ft)
(Recurrence Interval Computed Using Gringorten Plotting Position)
Tr (yrs) WSEL Peak (ft)

=====	
1.05-Year	100.663
1.11-Year	100.677
1.25-Year	100.695
2.00-Year	100.752
3.33-Year	100.779
5-Year	100.818
10-Year	100.890
25-Year	101.026
50-Year	101.500
100-Year	101.943

*****Groundwater Recharge Summary*****

Recharge is computed as input to PerInd Groundwater Plus Infiltration in Structures

Total Predeveloped Recharge During Simulation	
Model Element	Recharge Amount (ac-ft)

Subbasin: Existing Subbasin	114.565
<hr/>	
Total:	114.565

Total Post Developed Recharge During Simulation

Model Element	Recharge Amount (ac-ft)
Subbasin: Proposed Subbasin	114.565
Link: Dummy Water Quality	0.000
Total:	114.565

Total Predevelopment Recharge Equals Post Developed Average Recharge Per Year, (Number of Years= 158)
Predeveloped: 0.725 ac-ft/year, Post Developed: 0.725 ac-ft/year

*******Water Quality Facility Data*******

-----**SCENARIO: PREDEVELOPED**

Number of Links: 0

-----**SCENARIO: POSTDEVELOPED**

Number of Links: 1

Design Criteria

***** Link: Dummy Water Quality Facility

15-Minute Timestep, Water Quality Treatment Design Discharge
On-line Design Discharge Rate (91% Exceedance): 0.43 cfs
 Off-line Design Discharge Rate (91% Exceedance): 0.23 cfs

Infiltration/Filtration Station
 Total Runoff Volume (ac-ft)
 Total Runoff Infiltrated (ac-ft)
 Total Runoff Filtered (ac-ft)
 Percent Treated (Infiltrated+Filtered)/Total Volume: 29.02%

Not Applicable

*******Compliance Point Results*******

Scenario Predeveloped Compliance Subbasin: Existing Subbasin

Scenario Postdeveloped Compliance Link: Dummy Water Quality Facility

***** Point of Compliance Flow Frequency Data *****

Recurrence Interval Computed Using Gringorten Plotting Position

Predevelopment Runoff		Postdevelopment Runoff	
Tr (Years)	Discharge (cfs)	Tr (Years)	Discharge (cfs)
2-Year	1.236	2-Year	1.236
5-Year	1.602	5-Year	1.602
10-Year	1.923	10-Year	1.923
25-Year	2.456	25-Year	2.456
50-Year	3.148	50-Year	3.148
100-Year	3.796	100-Year	3.796
200-Year	4.004	200-Year	4.004

Design Criteria

** Record too Short to Compute Peak Discharge for These Recurrence Intervals

**** **Flow Duration Performance** ****

Excursion at Predeveloped 50%Q2 (Must be Less Than 0%):	0.0%	FAIL	
Maximum Excursion		0.1%	FAIL
Maximum Excursion	0.0%	PASS	
Percent Excursion	0.0%	PASS	

Flow Duration Analysis Not Applicable

FLOW DURATI

**** **LID Duration Performance** ****

Excursion at Predeveloped 8%Q2 (Must be Less Than 0%):	0.0%	FAIL
Maximum Excursion from 8%Q2 to 50%Q2 (Must be Less Than 0%):	0.0%	FAIL

LID DURATION DESIGN CRITERIA: FAIL

ATTACHMENT C

Itemized Cost Estimate



Subject: Market Street and Madrona Street Water Quality Improvements

Prepared by: C. Echterling

Checked by: Brian Busiek

Updated: December 5, 2014

Note: This cost estimate is approximate. Actual construction bids may vary significantly from this statement of probable costs due to timing of construction, changed conditions, labor rate changes, or other factors beyond the control of the engineers.

ESTIMATED COST OF PROJECT IMPLEMENTATION AT PRELIMINARY DESIGN STAGE

NO.	QUANT.	UNIT	ITEM	UNIT COST	AMOUNT	BASIS OF QUANTITY AND UNIT COST
1	1	LS	MOBILIZATION	10%	\$ 22,551	
2	1	LS	EROSION/WATER POLLUTION CONTROL	2%	\$ 3,855	Inlet protection, manage stock piles, and daily sweeping by hand.
3	1	LS	UTILITY PROTECTION AND RELOCATION	10%	\$ 19,274	Assumes facility placement is adjusted during design to minimize utility conflicts. Conflicts are anticipated to be low because most piping follows existing pipe alignments.
4	1	LS	PROJECT TEMPORARY TRAFFIC CONTROL	5%	\$ 9,637	Cones and rope to exclude pedestrians from work area in field, temporary parking stall closures on street edge, temporary lane closures, flaggers, traffic control plan.
5	398	SY	REMOVING ASPHALT CONC. PVMT., INCL. HAUL	\$ 11	\$ 4,378	The Guide Summer 2014. Excavate pavement, export within 10 mile radius, dump fees.
6	515	CY	STRUCTURE EXCAVATION CLASS B, INCL. HAUL	\$ 30	\$ 15,450	The Guide Summer 2014. Excavation, export within 10 mile radius, dump fees.
7	123	CY	BANK RUN GRAVEL FOR TRENCH BACKFILL	\$ 5	\$ 615	Use native material above pipe bedding.
8	113	TN	CRUSHED SURFACING TOP COURSE	\$ 75	\$ 8,475	High end for small quantity.
9	368	SY	PAVEMENT REPAIR	\$ 43	\$ 15,824	The Guide Summer 2014. Trench patching. Includes 2" asphaltic concrete, no base.
10	1	EA	MWS-LINEAR 4' x 13' UNIT	\$ 23,100	\$ 23,100	Vendor quote for system and estimated installation plus 10% for contractor markup.
11	1	EA	MWS-LINEAR 8' x 16' UNIT	\$ 49,500	\$ 49,500	Vendor quote for system and estimated installation plus 10% for contractor markup.
12	717	LF	SCH A STORM SEWER PIPE 8 IN DIA	\$ 20	\$ 14,300	WSDOT UBA. Assume all existing pipes are replaced.
13	297	LF	SCH A STORM SEWER PIPE 12 IN DIA	\$ 30	\$ 8,900	WSDOT UBA. Assume all existing pipes are replaced.
14	12	EA	CATCH BASIN TYPE 1	\$ 1,800	\$ 21,600	WSDOT UBA. Assume all existing CBs are replaced.
15	3	EA	CATCH BASIN TYPE 2	\$ 3,200	\$ 9,600	WSDOT UBA. Assume all existing CBs are replaced.
16	1	LS	DEMO PIPE AND CATCH BASIN	\$ 1,000	\$ 1,000	Remove approximately 55 LF of pipe and (1) Type 1 catch basin not incidental to pipe and catch basin replacements.
17	2000	SF	DEMO AND PLANT EXISTING SWALE	\$ 10	\$ 20,000	Assumes grading as needed to raise existing swale to match surrounding grade and planting at \$5 per SF.
SUBTOTAL OF DIRECT COSTS					\$ 248,059	

NO.	QUANT.	UNIT	ITEM	UNIT COST	AMOUNT	BASIS OF QUANTITY AND UNIT COST
SALES TAX (DIRECT COSTS)				8.1%	\$ 20,093	
SUBTOTAL CONSTRUCTION COST					\$ 268,000	
ALLIED COSTS						
			ITEM	UNIT COST	AMOUNT	BASIS OF QUANTITY AND UNIT COST
			GRANT PROJECT ADMIN / MANAGEMENT	10%	\$ 27,000	Based on County experience managing similar projects.
			SURVEY	LS	\$ 5,000	Additional survey and limited potholing for utilities.
			GEOTECHNICAL ANALYSES	LS	\$ -	None required.
			DESIGN	LS	\$ 30,000	2 storm drain plan and profile, 1 utility relocation sheet, 1 general sheet, 1 specifications for inclusion in County managed bid package. Plus Ecology design report. Custom details provided by vendor.
			PERMITTING	LS	\$ 15,000	Assumes project is outside the shoreline jurisdiction and no wetland or stream impacts. Excavation over 500CY. Budget covers permit coordination and preparation of project specific SEPA checklist, cultural resources review, grading permit, and support during property owner coordination.
			PROPERTY ACQUISITION	LS	\$ 5,000	Prucure easement for long term maintenance of storm drain system. Discussions with property owner indicate that a no cost easement may be possible.
			CONSTRUCTION MANAGEMENT	20%	\$ 53,600	Based on input from County construction management experience.
			CHANGE ORDERS	5%	\$ 13,000	Ecology grant allowance of 5% for change orders.
SUBTOTAL OF ALLIED COSTS					\$ 148,600	
SUMMARY						
SUBTOTAL CONSTRUCTION COST					\$ 268,000	
SUBTOTAL OF ALLIED COST					\$ 148,600	
PROJECT TOTAL					\$ 420,000	
SUMMARY BY GRANT TASK						
TASK 1 - GRANT PROJECT ADMINISTRATION / MANAGEMENT					\$ 27,000	
TASK 2 - DESIGN PLANS AND SPECIFICATIONS, ENVIRONMENTAL REVIEW, AND PERMITTING					\$ 55,000	Includes cost for procuring easement.
TASK 3 - CONSTRUCTION MANAGEMENT					\$ 53,600	
TASK 4 - CONSTRUCTION					\$ 268,000	
TASK 5 - CHANGE ORDERS					\$ 13,000	
PROJECT TOTAL					\$ 420,000	

APPENDIX C-3

San Juan Valley Creek Capacity Improvement Project Preliminary Design Report

SAN JUAN VALLEY CREEK
CAPACITY IMPROVEMENT PROJECT
PRELIMINARY DESIGN REPORT

VOLUME 2 PRIORITY WATERSHED PLANNING
SAN JUAN COUNTY, WASHINGTON

Prepared for
San Juan County Public Works

Prepared by
Herrera Environmental Consultants, Inc.



SAN JUAN VALLEY CREEK
CAPACITY IMPROVEMENT PROJECT
PRELIMINARY DESIGN REPORT

VOLUME 2 PRIORITY WATERSHED PLANNING
SAN JUAN COUNTY, WASHINGTON

Prepared for
San Juan County Public Works
915 Spring Street
P.O. Box 929
Friday Harbor, Washington 98250

Prepared by
Herrera Environmental Consultants, Inc.
2200 Sixth Avenue, Suite 1100
Seattle, Washington 98121
Telephone: 206/441-9080

June 12, 2015

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FIGURES

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Engineer's Stamp

This preliminary design report has been prepared under the supervision of a professional engineer registered in the State of Washington.



Matthew M. Fontaine, PE

6/12/2015

Date

Introduction

San Juan County Public Works (County) is committed to stormwater and watershed management that cost effectively addresses flooding and water quality problems that may adversely affect property and the natural environment. The County is addressing these issues proactively through:

- Completion of an inventory and high-level evaluation of County watershed conditions that provides a resource for identifying problem areas and recommends Countywide stormwater management and restoration strategies (Phase 1).
- Completion of a more detailed evaluation of conditions in five priority watersheds, including the Eastsound Village and Lopez Village Urban Growth Areas (UGAs), that identifies capital improvement projects and programs for solving reported stormwater and flooding issues (Phase 2).

This preliminary design (predesign) report focuses on one of the priority capital improvement projects that resulted from Phase 2, called the San Juan Valley Creek Capacity Improvement project (identified as FB1 in Volume 2 of the San Juan County Stormwater Management Plan). This project was identified as a high priority to address chronic flooding of Bailer Hill Road and degraded habitat in San Juan Valley Creek downstream and immediately upstream of the road. This project will require more investigation beyond what is documented in this report to fully evaluate the design alternatives and to support selection of a preferred project configuration. The preferred option at this predesign level of analysis is to enhance the creek's floodplain to improve flood storage capacity and to increase channel capacity downstream of Bailer Hill Road, thereby reducing flooding downstream, and to restore instream habitat as part of the creek modifications. An existing planned County capital project, Project #23 - Douglas/Bailer Hill Roads Improvements (MP 3.15 - 5.95) may include some components (including culvert replacement) that would benefit or impact the San Juan Valley Creek Capacity Improvement project. Coordination between both projects is recommended. Floodplain and stream restoration would be further coordinated with the San Juan Islands Conservation District and with ongoing salmon recovery efforts in the county.

Watershed Description

The False Bay watershed is in the south central portion of San Juan Island. At approximately 11,464 acres in size, it is the largest watershed on San Juan Island. The watershed drains generally to the south and terminates in the relatively small receiving water (232 acres) of False Bay. The False Bay watershed was identified as a priority among the 37 watersheds in San Juan County based on known water quality problems, drainage conveyance and flooding issues, expected future development, and its rich natural resources.

False Bay contains sensitive habitat for shellfish including Dungeness crab. Eelgrass beds are present near the entrance of False Bay (WDFW 2014; FOSJ 2004), and pocket estuaries may provide habitat areas for forage fish, bald eagles, and other sensitive species. False Bay is a marine biological preserve belonging to the University of Washington Friday Harbor Laboratories, which owns 200 acres of tidelands and uplands in the bay. This area is used

extensively for research purposes and consists of a large area of tidal flats that provides excellent habitat for a high diversity of plants, birds, and sea life (SJC 1999, SJC 2000). False Bay has no recreational or commercial fishing or shellfish harvest; and due to its shallow nature and status as a preserve, there is no boating activity.

Agriculture is the predominant land use in the False Bay watershed, although land is being converted to rural-residential use with farming occurring on smaller acreages. Livestock operations include sheep, cattle, and horses primarily (SJC 1999, SJC 2000). During the winter, much of the valley bottom in the watershed is saturated with standing pools of water. On some farms, animals are pastured with free access to creek channels and saturated areas.

Concentrated flow from the watershed crosses several county roads in culverts including Beaverton Valley Road, Boyce Road, Wold Road, San Juan Valley Road, and Bailer Hill Road. There are at least two streams of significance draining to False Bay with numerous tributaries stemming from all portions of the watershed. The largest creeks, San Juan Valley Creek and False Bay Creek, converge immediately upstream of Bailer Hill Road. It should be noted that some sources refer to the resultant creek below this confluence as False Bay Creek, while others refer to it as San Juan Valley Creek. The County's designation, which is San Juan Valley Creek, is used in this report.

Stormwater problems in the watershed include periodic flooding of Bailer Hill Road, as noted, but also include water quality concerns specifically related to elevated fecal coliform bacteria and low dissolved oxygen, particularly in the lower stream reaches. Agriculture and residential housing are expected to continue to dominate land use in this watershed. Given that impervious cover is estimated to increase to 10.5 percent of the watershed land area under full build-out conditions, it is reasonable to assume that many of these problems will continue and likely increase in severity.

Three stream reaches within the False Bay watershed are included on Ecology's Clean Water Act section 303(d) list as Category 5 waterbodies impaired due to bacteria:

- San Juan Valley Creek, from its crossing of Timber Lane downstream to False Bay (listing number 45246; <http://apps.ecy.wa.gov/wats/>).
- False Bay Creek (tributary to San Juan Valley Creek) just upstream of Bailer Hill Road (listing number 45712).
- Unnamed creek (tributary to Trout Lake) (listing number 45627).

These listings are based on the freshwater primary contact recreation designated beneficial use, for which Ecology has established the following criteria in state's surface water quality standards (WAC-173-201A-200):

- Fecal coliform bacteria count of less than 100 colony-forming units (CFU) per 100 mL (geometric mean).
- 10 percent or less of all samples have greater than 200 CFU/100 mL.

Category 5 waterbodies require development and implementation of a total maximum daily load (TMDL) to control sources of runoff pollution and to treat polluted runoff as necessary to achieve the water quality standards.

Site Description

The San Juan Valley Creek Capacity Improvement project was ranked as one of the highest priority projects by the County and the Citizen Stormwater Advisory Committee (CSWAC, a committee formed to advise the County on stormwater management issues), based on several criteria including the risk posed to property and health, longevity of the drainage issue, and the ability to simultaneously provide flood risk reduction and ecological restoration and enhancement.

Flood Hazard

Upstream development and agricultural practices have altered the hydrology of the False Bay watershed. Every 5 to 10 years flooding of San Juan Valley Creek and False Bay Creek overtops Bailer Hill Road with up to 2 feet of water (see Figure 1). This affects a primary vehicular route to the town of Friday Harbor and increases response time for emergency responders. The reach of the creek downstream of the road is capacity limited due to sediment aggradation. Upstream development may be increasing runoff and contributing to the problem.



Figure 1. Flooding Over Bailer Hill Road.

Ecological Conditions

There are few creeks in the watershed that have the potential to support fish populations because of seasonal flow issues, but anadromous fish populations have been reported in San Juan Valley Creek in the past (SJC 2000). As noted above, sediment aggradation has occurred in the creek downstream of Bailer Hill Road. The sediment has reduced viability of the creek for spawning, and induces shallow flow conditions that hinder fish passage. Degraded water quality in the creek also hinders its habitat potential. Primary amongst these water quality concerns is high ammonia concentrations that trigger low dissolved oxygen conditions in the summer months due to low flow rates and nutrient-rich runoff from pastures. Minimal riparian vegetation or tree canopy cover is present along most of the length of San Juan Valley Creek and its tributaries. The riparian corridor is routinely used as cattle pasture in these poorly vegetated areas. Negligible instream flows in the summer months can be partially attributed to upstream impoundments and water rights diversions. Further water quality issues stem from outdoor use of spray pesticides and untreated runoff from county roads (Kwiáht 2010).

Project Design Work Plan

Project Design

The goals of the San Juan Valley Creek Capacity Improvement project will be accomplished by designing, permitting, and constructing channel and floodplain improvement projects along as much as 7,000 feet of the stream. Specifically, the project will increase flood flow-conveyance capacity by widening the channel and enhancing floodplain ecosystem structure, functions, and processes. Other options, including raising the Bailer Hill Road prism and replacing the creek culvert beneath the road, will also be considered. Figure 2 provides an overview of these project design features.

Design Next Steps

As previously noted, this project is in the preliminary design phase and will require more investigation to fully evaluate the preferred design components. The tasks below articulate the steps needed to evaluate the design alternatives and eventually develop a full design and construction cost estimate.

- **Task 1. Data Collection and Field Investigation** - Understanding the existing conditions within a stream and its watershed are critical for determining the relationship between land-use activities and stream and floodplain processes, identifying specific stream-channel stability and capacity issues, and formulating an appropriate design strategy, both in the channel and within the adjacent floodplain. This task will facilitate analysis of the existing characteristics of San Juan Valley Creek including its habitat, ecology, geomorphology, hydrology, hydraulics, and natural history. Existing data will be reviewed first, including as-built plans for Bailer Hill Road and the creek culvert that crosses it. Plans associated with other Bailer Hill Road capital improvements will also be evaluated. This will be followed by additional field data collection to completely characterize existing conditions. Field investigation will include photo documentation and collection of data needed for design and permitting, including, at a minimum, channel physical dimensions (e.g., surveyed profiles and

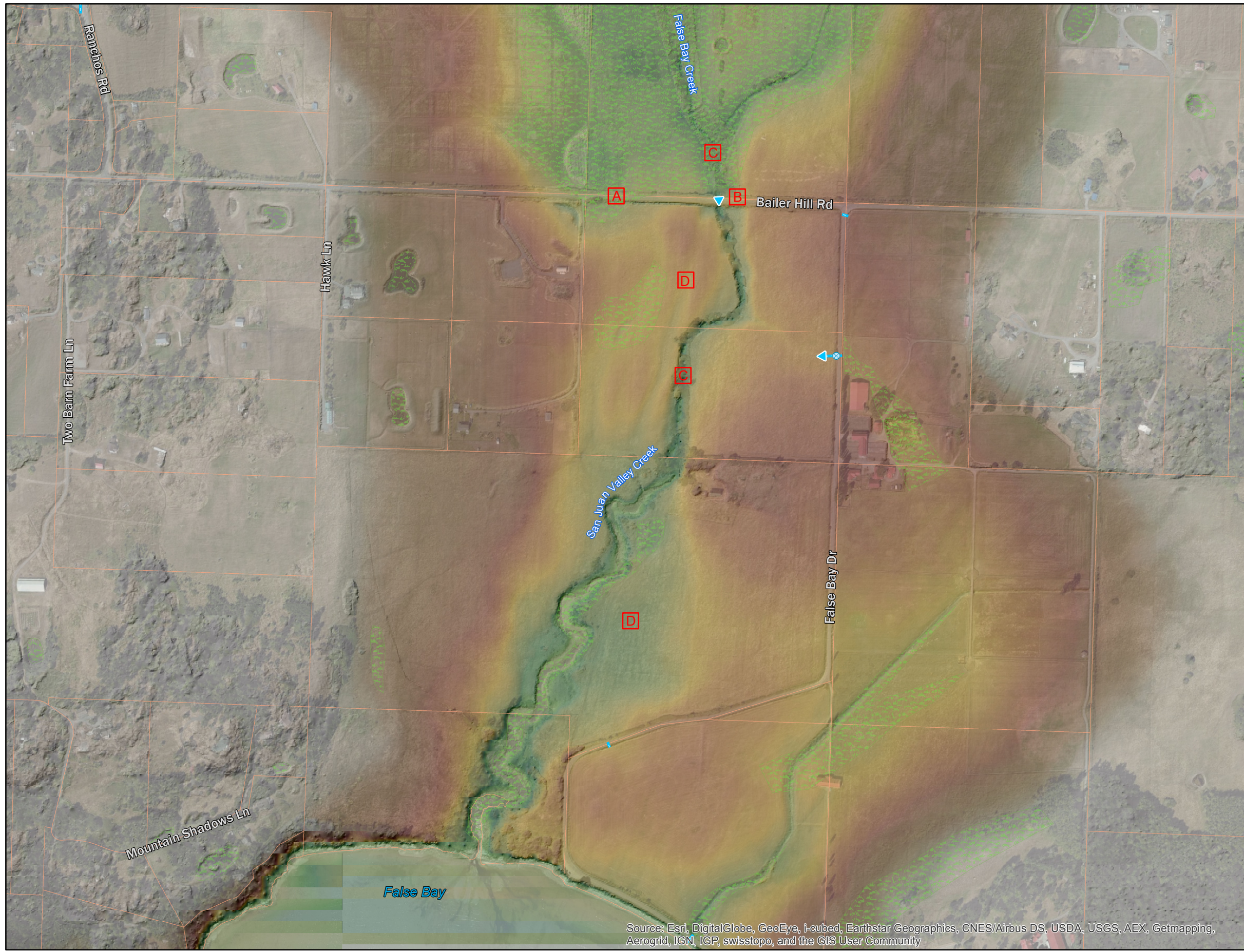


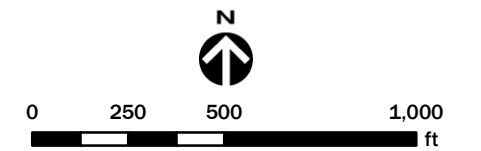
Figure 2.
San Juan Valley Creek Capacity
Improvement - Overview of Project
Design Features

Legend

- Stormwater Structure
- Stormwater Pipe
- Wetlands
- Parcel
- Elevation
(High: 60 ft; Low: 0 ft)

Preliminary Design Alternatives

- A** Raise the road prism in floodprone area (including necessary safety improvements)
- B** Upsize and replace road culvert to improve through-flow and fish passage
- C** Remove accumulated sediment and/or instream vegetation to improve channel flow and reshape channel banks to improve floodplain connectivity
- D** Regrade floodplain to create additional storage in strategically placed riparian wetlands and vernal pools



Coordinates: NAD 1983 HARN
 Washington State Plane North FIPS 4601

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 Project: K:\Projects\Y2013\13-05676-000\Project\FalseBayFlooding_FB1_v2.mxd (12/16/2014)

Source: Esri, DigitalGlobe, GeoEye, i-cubed, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

cross sections, and the ordinary high water level that is essential for permitting purposes), streambed sediment gradation, floodplain and instream habitat features, and existing habitat deficiencies. Stream and floodplain habitat characteristics and deficiencies will be identified through field observations and will include potential accelerated bank erosion, accelerated channel migration, signs of channel instability (aggradation/degradation), types and quality of in-channel habitat, and floodplain connectivity.

- **Task 2. Preliminary Alternatives Development and Analysis** - Once the existing conditions are well understood, preliminary alternative design options will be developed. The preliminary design alternatives may include some or all of the following components to meet the objectives of flood risk reduction and ecological restoration and enhancement:
 - Removing accumulated sediment and/or instream vegetation downstream of Bailer Hill Road to improve channel flow.
 - Reshaping channel banks to improve floodplain connectivity in the reach immediately upstream of the road and in the reach downstream of the road.
 - Providing additional floodplain storage via strategically placed riparian wetlands and vernal pools upstream and downstream of the road.
 - Expanding and planting the riparian corridor with native vegetation upstream and downstream of the road.
 - Raising the road prism (including necessary safety improvements) and/or upsizing the culvert to improve through-flow and fish passage.
 - Retrofitting upstream ponds to provide additional detention.

The alternatives will be developed to a level of detail that enables thorough comparison against each other and the existing conditions to determine the cost and benefits of each alternative. Construction cost estimates for the alternatives will be developed based on experience with similar projects.

- **Task 3. Hydrologic and Hydraulic Modeling** - A hydrologic model (such as HSPF) will be used to estimate the flow inputs for hydraulic modeling. The hydrologic model development will include acquiring GIS data for topography, soils, and land cover; acquiring rainfall and evapotranspiration data; conducting a site visit; delineating watersheds and sub-drainages; and model calibration. A one-dimensional steady-state hydraulic model (such as HEC-RAS) will be used to estimate design parameters and evaluate project risks and performance. There is no flow gauging in the watershed, and thus reasonably accurate hydrologic modeling of watershed runoff characteristics is needed to enable hydraulic modeling in the project area. Hydrologic modeling will be used to estimate peak flows and flow durations during a range of return period storms. One year of continuous flow data will be collected to be used for model calibration and validation. These results will serve as inputs to the hydraulic model.

The hydraulic model will first be developed to represent existing conditions and survey data will be collected to develop stream cross sections. The hydrologic and hydraulic models will then be modified to represent preliminary design alternatives (assume four alternative projects) developed in Task 2 to predict changes in road flooding frequency, floodplain inundation, flow velocity, shear stress, stream power, and flow depths. A draft and final Technical Memorandum will be prepared describing the hydrologic and hydraulic modeling method and results.

- **Task 4. Select Preferred Alternative** - Based on objectives and constraints further refined through consultation with the County and project stakeholders, a screening-level analysis will be used to narrow the number of possible design options down to the most feasible alternatives that provide the most benefit and meet the project objectives most effectively. The screening-level analysis will be presented as a comparison matrix that captures flood-reduction benefits, risks, uncertainties, habitat gains, permitting considerations, and estimated construction costs. From this process, a preferred alternative will be selected by the County that will be carried forward to full design.
- **Task 5. Design and Obtain Permits for the Preferred Alternative** - The preferred project design will be developed in detail to enable competitive construction contract bidding. Permit applications will be developed based upon selected design information, and the County will coordinate with applicable local, state and federal agencies to obtain required permits.

Project Benefits

Flood Reduction

The San Juan Valley Creek Capacity Improvement project will reduce the frequency and severity of flooding on Bailer Hill Road.

Ecological Restoration and Enhancement

The San Juan Valley Creek Capacity Improvement project will also enhance instream and floodplain ecosystem structure, functions, and processes. This will directly benefit native fish populations and the stream benthic community that fish depend on.

Other Benefits

Agricultural Viability

Expanding the flood-flow conveyance capacity of San Juan Valley Creek by widening the channel will reduce creek stage in a wide range of flood events, thereby reducing the frequency and duration of floodplain inundation on pasture lands. Livestock exclusion fences could be placed along the creek to protect both the restored habitat of the riparian zone and prevent livestock from accessing the stream.

Water Quality Improvement

Native vegetation in the riparian corridor within the project area will create the ability to naturally filter runoff pollutants before they enter the creek, addressing water quality issues associated with bacteria and nutrients. The shading created in the riparian area, coupled with pollutant filtering, is expected to greatly improve dissolved oxygen concentrations in the warm months of the year, thereby improving habitat suitability for fish and other aquatic organisms. The improved water quality in San Juan Valley Creek will also lead to improved water quality in False Bay, benefitting its habitat for a variety of fish and wildlife species.

Cost Effectiveness

Cost Estimate

Table 1 provides a preliminary cost estimate to fully evaluate alternatives and select a preferred approach (Tasks 1 through 4 listed above).

Table 1. Cost Estimate to Complete Alternatives Analysis.		
Task	Cost	Notes
Task 1 Data Collection and Field Investigation	\$16,000	Assumes data review and field investigation with two field teams (two people per team) for three days.
Task 2 Preliminary Alternatives Development and Analysis	\$50,000	Assumes preliminary development of up to four concepts.
Task 3 Hydrologic and Hydraulic Modeling	\$94,000	Assumes existing conditions hydrologic and hydraulic model development and refinement for up to four alternatives. Hydrologic model development assumes data collection, site visit, basin delineations, and calibration. Hydraulic modeling assumes site survey, one-year of flow monitoring, and calibration.
Task 4 Select Preferred Alternative	\$22,000	Assumes alternative screening, two meetings with County and stakeholders, and report development
Subtotal	\$182,000	
Contingency (30%)	\$55,000	
Total Cost	\$237,000	

Funding Alternatives

There are a number of Ecology grant programs that could provide funding for at least a portion of the San Juan Valley Creek Capacity Improvement project. Several factors associated with each grant, including availability of funds, competitiveness, and project applicability may limit the number of truly viable grant options for this project. Nonetheless, the following grant options would be worth further evaluation as the project moves forward in the design process.

Water Quality Financial Assistance - This includes several grant programs (e.g., Centennial Clean Water Program, Clean Water Act Section 319 Program) being considered for funding

other stormwater projects in San Juan County. These grants are primarily oriented towards projects that provide a water quality benefit. To successfully secure this grant, a strong connection would need to be made between the project and water quality improvements in San Juan Valley Creek and False Bay.

Flood Control Assistance Account Program (FCAAP) - This is a legislatively established flood-control maintenance program that has been in place for more than 50 years. The purpose of this grant program is to assist local jurisdictions in planning and flood-control maintenance efforts. Due to state budget reductions, this grant program is currently unfunded through June 30, 2015. Ecology expects that this is a temporary situation and that they will be able to resume offering grant funding in subsequent state biennial budgets.

2015 - 2017 Floodplains by Design Project Grant - This is an innovative grant program that is intended to fund projects that integrate flood risk reduction with other ecosystem benefits. The call for applications for funding in the 2015-2017 state biennial budget under this grant program is closed. Based on significant momentum that has formed throughout the state for this new grant program, it is reasonable to expect that future rounds of grant applications will be invited in subsequent bienniums. This is, however, a very competitive program that, during this past application cycle, seemed to be more oriented to larger river systems.

Stakeholder Engagement

The watershed and project prioritization process conducted to date has included input from the San Juan County CSWAC. San Juan County prepared a website for citizens to report stormwater problems, which can be found at: <http://sjcgis.maps.arcgis.com/home/item.html?id=cd645b044c5445e3a3799ce94e1d0524>. Fifty-three stormwater problems were submitted through this website within five priority watersheds in categories including erosion, flooding, private-property damage, water quality, and environmental damage. Stormwater problems and their conceptual solutions were ranked using the following seven criteria:

- The problem poses a risk to human health and safety.
- The solution was proposed in a previous UGA drainage plan.
- The solution provides a water quality treatment retrofit.
- The solution provides conveyance capacity for future development.
- The solution protects critical natural resources.
- The problem poses an obstacle for completing other projects.
- The solution funding potential, e.g., low cost or with high grant potential.

The top 25 retrofit project concepts, including the San Juan Valley Creek Capacity Improvement project, were then presented to the public to garner feedback for further prioritization. Members of the public provided review comments on these projects at four public workshops, two held on Orcas Island, and one each on Lopez and San Juan Islands. The CSWAC and the County reviewed and provided a final ranking of the top five conceptual

retrofits. As the project design process continues for this project, it is expected that the CSWAC as well as additional local stakeholders will be asked to participate.

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APPENDIX C-4

Lopez Village Farmers Market Stormwater Improvements (FMB4) Predesign Report

LOPEZ VILLAGE FARMERS MARKET
STORMWATER IMPROVEMENT
PRELIMINARY DESIGN REPORT

VOLUME 2 PRIORITY WATERSHED PLANNING
SAN JUAN COUNTY, WASHINGTON

Prepared for
San Juan County Public Works

Prepared by
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June 12, 2015

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Engineer's Stamp

This preliminary design report has been prepared under the supervision of a professional engineer registered in the State of Washington.



Matthew M. Fontaine, PE

6/12/2015

Date

Introduction

San Juan County Public Works (County) is committed to stormwater management that cost effectively addresses flooding and water quality problems that may adversely affect property and the natural environment. The County is addressing these issues proactively through:

- Completion of an inventory and high-level evaluation of County watershed conditions that provides a resource for identifying problem areas and recommends countywide stormwater management strategies (Phase 1)
- Completion of a more detailed evaluation of conditions in five priority watersheds, including the Eastsound Village and Lopez Village Urban Growth Areas (UGAs), that identifies capital improvement projects and programs for solving reported stormwater issues (Phase 2)

This preliminary design (predesign) report focuses on one of the priority capital improvement projects that resulted from Phase 2 called the Lopez Village Farmers Market Stormwater Improvements project. The project would install permeable pavement and a bypass channel to improve the quality of runoff from pollutant-generating surfaces in Lopez Village (identified as FMB6 in Volume 2 of the San Juan County Stormwater Management Plan). This report is specifically tailored to address application requirements for grants provided by the Washington State Department of Ecology (Ecology) to fund completion of design and/or construction of stormwater treatment retrofit projects, as well as the Ecology grant requirement for submitting a Predesign Report as one of the grant deliverables.

Basin Description

Fisherman Bay is a shallow, poorly flushed estuarine water body that receives runoff from Lopez Village UGA and multiple drainage culverts located along its perimeter. It has a narrow inlet and widens to about 0.5 mile, forming a long bay between 6 and 24 feet deep. The west shore of the bay is a rock island that is connected to the much larger Lopez Island by a barrier beach formed through accretion.

The watershed area draining to Fisherman Bay comprises approximately 1,439 acres in the west central portion of Lopez Island. The watershed generally drains from east to west into Fisherman Bay, and consists of two main drainage basins with defined outlets into the receiving water. There is a total elevation drop of about 150 feet across the watershed. The watershed is characterized by ground surface slopes up to about 5 percent in the upper and middle elevations that flatten to about 1 percent toward the shoreline. The watershed runoff crosses several county roads in culverts, including Fisherman Bay Road and Hummel Lake Road.

Land use in the Fisherman Bay watershed is predominantly residential with the associated existing impervious cover representing approximately 5.4 percent of the total watershed area. Under full build-out conditions, impervious surfaces are expected to increase to 11.1 percent of the total watershed area. The percentage of impervious surface area at build out within the Lopez UGA could be higher since the UGA allows for higher density and greater lot coverage.

The Fisherman Bay watershed contains large areas of tidal emergent wetlands including those at Weeks Point at the north end of the bay and along Tinkham Lane and Bayshore Road at the south end of the bay. Week's Wetland, purchased by the San Juan County Land Bank in 1993, lies within Lopez Village. The watershed contains several freshwater wetlands and an associated stream that begins north of Hummel Lake Road and flows southwest to enter Fisherman Bay. There are also wetlands near Sunset Lane and Redgate Lane, and along Weeks Road.

Eelgrass is present in a patchy distribution throughout the watershed's marine shoreline (WDFW 2014). Bull kelp is present in some areas outside the bay adjacent to Fisherman Bay spit.

Both flooding and water quality concerns are documented in this watershed.

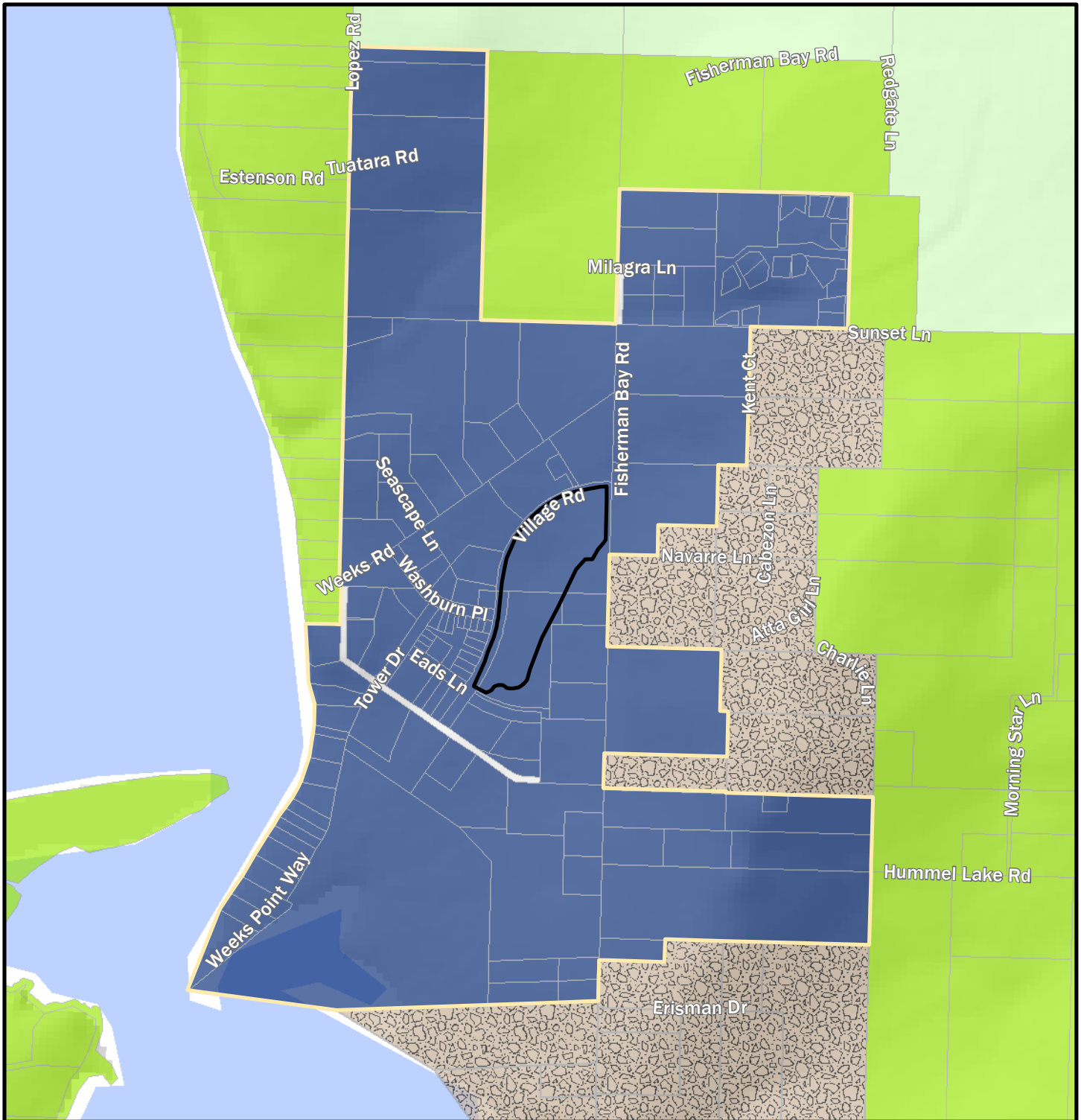
Site Description

The Lopez Village subbasin is several hundred acres in size and is located in the northern portion of the watershed. There is a total elevation drop of about 150 feet across this subbasin, with gentle ground surface slopes up to about 2 percent in the upper and middle portions that flatten to about 1 percent toward the bottom. Runoff from the subbasin connects several wetland and pond areas northeast of Fisherman Bay Road, crosses Fisherman Bay Road within a 24-inch culvert, and then connects into the Lopez Village storm drain system, which has a 36-inch outfall to Fisherman Bay and a 12-inch outlet to the Weeks wetland area.

The project area is in the center of the Lopez Village UGA along Village Road. The Lopez Village UGA base density is single-family residential, but allows commercial and industrial uses (SJCC 2003). The Lopez Village UGA is zoned for the most intensive development on Lopez Island (Figure 1) and the village core is currently the most densely developed and trafficked area on Lopez Island with multiple commercial properties. Village Road connects the village core to Fisherman Bay Road, which is the primary north-to-south route on the island (Figure 1). The proposed project provides water quality treatment by infiltrating runoff from a portion of Village Road (Figure 2) and directs high flows from the upper portion of the Lopez Village subbasin around the water quality treatment facility in a bypass channel through the Farmers Market area.

Alternatives Analysis and Project Selection

Thirty-seven watersheds in San Juan County were evaluated by the County and the San Juan County Citizen Stormwater Advisory Committee (CSWAC) and prioritized based on current development patterns, expected development trends, and presence of natural resources. Much of the predicted growth in the county is expected to be concentrated in the UGAs; therefore, they are an added focus of this stormwater planning study. Based on these factors, the Fisherman Bay watershed was selected as one of the top five priority watersheds for stormwater management planning (Herrera et al. 2014a). Detailed analysis within the five priority watersheds led to the selection of the Lopez Village Farmers Market Stormwater Improvements project as among the top five for predesign reports relative to alternative stormwater improvement projects (Herrera et al. 2014b).



Legend

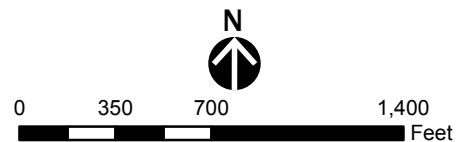
- Project area
- Lopez Village UGA
- Agricultural resource
- Lopez Village Urban Growth Area*
- Lopez Village Growth Reserve Area**
- Rural farm forest

*The Lopez Village UGA base density is single-family residential, but allows commercial and industrial uses (18.30.210 of SJCC 2003).

**The Lopez Village growth reserve area shall follow the land use designation standards of the rural farm forest designation (18.30.210 of SJCC 2003).



Figure 1.
Lopez Village UGA Land Use, Lopez Island, Washington.



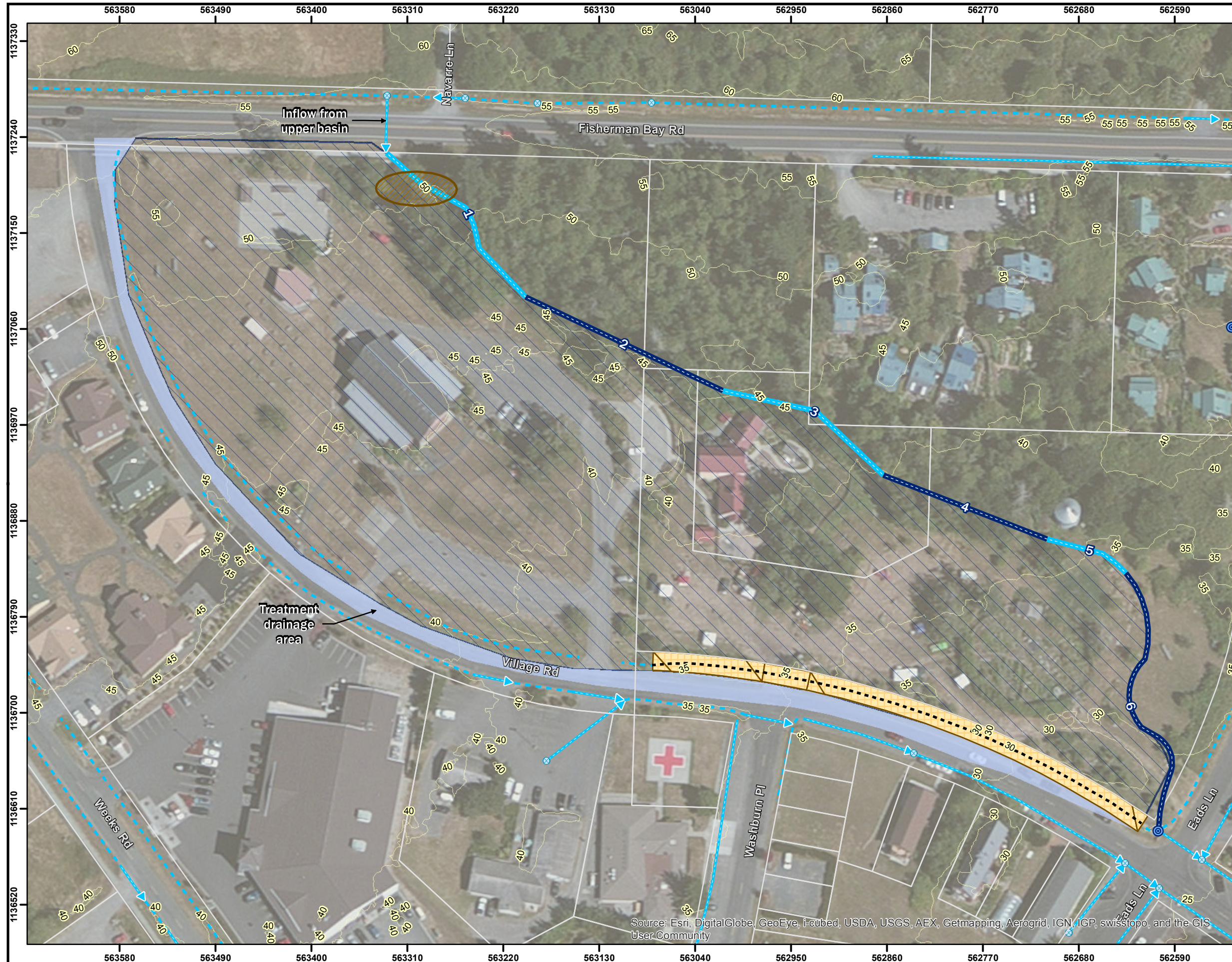
The Lopez Village Farmers Market Stormwater Improvements project was selected for reasons that are consistent with several countywide recommendations and policies for stormwater management (Herrera et al. 2014a):

- **Support neighborhood-based stormwater management solutions.** The proposed off-street permeable paver parking, infiltration system, and bypass channel is consistent with the County's goal of supporting neighborhood based stormwater management solutions. The Lopez Village Planning Review Committee (LVPRC) has given extensive consideration to the potential for stormwater management solutions within the village (LVPRC 2010, LVPRC 2014a, LVPRC 2014b), and the proposed projects have been developed in coordination with members of the LVPRC. The project also meets an identified need for more parking near the Farmers Market and addresses safety and capacity concerns related to the existing ditch. The proposed channel will provide multiple benefits including an aesthetic amenity and an intermittent stream with aquatic habitat.
- **Retrofit ditches.** Ditches are the primary stormwater conveyance features in San Juan County. Poorly constructed ditches like the one adjacent to the Farmers Market can cause erosion and subsequent sedimentation that can adversely affect downstream water bodies. Currently, the ditch capacity is too low to convey flow from Village Road in addition to base flow coming from north of Fisherman Bay Road. The proposed channel will increase flow conveyance capacity and slow velocities to reduce erosion and allow infiltration, which will enhance pollutant removal.
- **Treat close to the source.** The County and the CSWAC have a policy goal to treat and manage stormwater as close to the source of pollution as possible and to protect the quality of ground water and surface water. The proposed permeable pavement parking and infiltration system will infiltrate 95.55 percent of precipitation and runoff from the east side of Village Road.

During project development, several conceptual alternatives were evaluated, including use of bioretention for water quality treatment instead of permeable pavement, as well as expanding the footprint of the infiltration reservoir (i.e., expanding the area of permeable pavement). In addition, the County conducted a drainage options analysis in 2013 to consider options for routing flow through Lopez Village (Drahn 2013). The preliminary design presented in this report was selected for six reasons:

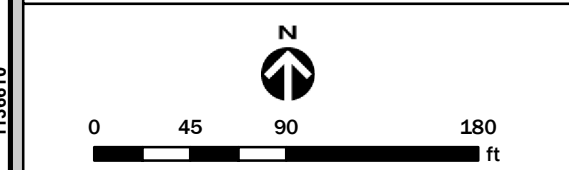
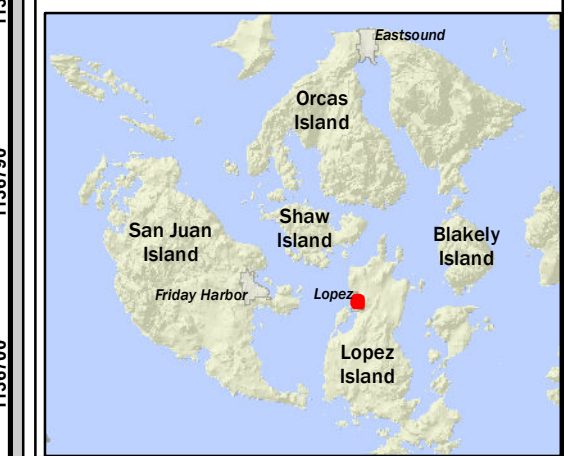
- Provides treatment of stormwater by infiltration into native soils within the available space between Village Road and the Farmers Market.
- Maximizes usable space adjacent to the Farmers Market by providing angle parking.
- Eliminates hazards related to the open channel between Village Road and the Farmers Market by relocating the open channel away from the roadside.
- Bypasses high flows from adjacent land through the treatment facility using a perforated pipe between the pavement and the reservoir.
- Bypasses high flows from the upper basin through the park in a water amenity feature.
- Consistency with prior recommendations for an open channel that extends across the Farmers Market area, which was found to be acceptable to the Lopez Center for Community and the Arts board.

Figure 2.
Lopez Village Farmers Market - Water Quality Treatment Drainage Areas and Facility Plan.



- Legend**
- Sediment trap
 - Proposed trash rack
 - 5-foot contours
 - Proposed constructed channel segment
 - Proposed perforated bypass pipe*
 - Parcel boundary
 - Proposed pavement infiltration system
 - Stormwater structure
 - Ditch
 - Stormwater pipe
 - Treatment drainage area
 - Bypass drainage area*

*The perforated bypass pipe is sized to convey the bypass drainage area during high flows. During low flows, the bypass drainage area is infiltrated into the permeable paver reservoir course.



Source: Esri, DigitalGlobe, GeoEye, i-cubed, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

Water Quality Benefits

Results of 2012–2013 SJC pilot stormwater monitoring for Fisherman Bay are reported in Stillwater Sciences (2014a) and summarized in the companion Volume 1 of this study (Herrera et al. 2014). 2013–2014 results are reported in Stillwater Sciences (2014b). Monitoring data for the first 2 years of the pilot program indicate that stormwater at multiple sites discharging directly into Fisherman Bay can exhibit relatively low dissolved oxygen, dropping below the Ecology water quality objective of 8.0 mg/L as an instantaneous 1-day minimum during multiple storm events. Levels of dissolved copper, lead, and zinc measured during 2013–2014 included some exceedances to hardness-adjusted freshwater criteria, suggesting potential toxicity to aquatic life during storm events. Fisherman Bay sites also exhibit relatively high bacteria, with the median and average fecal coliform concentrations exceeding Ecology’s freshwater instantaneous maximum of 100 CFU/100 mL during multiple storm events.

In 2013–2014, Fisherman Bay samples exhibited turbidity significantly greater than that measured in the five other San Juan County watersheds included in the program, with three turbidity measurements in excess of 100 NTU occurring during storm-event sampling. Mean total suspended solids (TSS) was relatively high (e.g., greater than 100 mg/L) at Fisherman Bay sites during the first 2 years of the pilot program. Compared to national databases for stormwater concentrations, Fisherman Bay sites exhibited moderate-to-high nitrogen including organic nitrogen (0.6 to 2.0 mg/L) and ammonium nitrogen (0.2 to 1.1 mg/L), and low-to-moderate total phosphorus (75 to 400 ug/L) and ortho-phosphorus (20 to 120 ug/L).

The project would treat runoff from 0.43 acres of pollutant generating impervious surface in Lopez Village UGA, reducing concentrations of suspended solids, metals, nutrients, and other pollutants in the runoff.

Pollutant Load Reduction

Pollutant loading in runoff from Village Road was estimated using data from the Phase II Municipal NPDES Permit Fact Sheet (Table 1). Specifically, NPDES Phase I municipal permittee monitoring data submitted to Ecology and synthesized in Attachment A of the *Draft Western Washington Phase II Municipal Stormwater Permit Fact Sheet* (Ecology 2011) were used to define untreated runoff loading at this site. The pollutant removal rate for the proposed permeable pavement is 95.55 percent for all parameters analyzed because 95.55 percent of all runoff is infiltrated. Table 1 defines the annual pollutant loads and the reduction that is estimated to result from project implementation.

Water Quality Parameter	Annual Load (lbs)	Pollutant Removal (lbs)
Total suspended solids	350	334
Total nitrogen	9.74	9.31
Total phosphorus	0.88	0.84
Total zinc	0.58	0.55
Dissolved zinc	0.26	0.25
Total copper	0.13	0.13
Dissolved copper	0.05	0.05

Comparison to Stormwater Standards for New and Redevelopment

By infiltrating 95.55 percent of all runoff from 0.43 acres of roadway, the proposed infiltration system would meet the runoff treatment requirements of the *Stormwater Management Manual for Western Washington* (Ecology 2014a, Ecology 2014b) and provide a water quality treatment ratio of 1.05 (calculated as 95.55 percent of volume infiltrated divided by 91 percent of volume requiring treatment). The equivalent new/redevelopment area treated would be 0.45 acres (0.43 total acres multiplied by a water quality treatment ratio of 1.05).

The receiving water body is flow control exempt, and therefore flow control is not a project objective.

Project Design Summary

The design includes three primary elements:

- An infiltration system designed as a gravel reservoir with check dams below permeable pavement parking.
- A perforated pipe that will bypass high flows above the infiltration system.
- A constructed bypass channel that will route runoff from the upper basin (runoff from north of Fisherman Bay Road) around the infiltration system; this will bypass relatively clean flow around the system while at the same time adding an open water feature to the Farmers Market.

Figure 2 shows the proposed configuration and drainage areas for the pavement infiltration system water quality treatment and high-flow bypass system, and the constructed channel.

The basis of design for each component is summarized in more detail below.

Infiltration System

The infiltration system will be constructed as the reservoir course below a permeable pavement parking area. The infiltration system drainage area was modeled in MGSFlood v4.33 using a 15-minute time step to size the reservoir course depth to infiltrate at least 91 percent of the runoff from Village Road using the following assumptions:

- The surface dimensions of the infiltration system (permeable pavers) were based on the minimum dimensions for 45-degree parking stalls in Table 6.5 of the San Juan County Unified Development Code (SJCC 2000) and the available area for siting off-street parking along Village Road adjacent to the Farmer's Market.
- The precipitation time series for the 32-inch mean annual precipitation in Puget East Western Washington was selected in MGS Flood for this project. Isopluvial maps indicate the project receives an average annual precipitation depth of 28.9 inches, indicating the 32-inch time series is conservative.

- The reservoir course depth was sized in MGSFlood assuming a longitudinal surface slope of 0.023 ft/ft (i.e., matching existing surface slope).
- A design infiltration rate of 0.1 inches per hour was selected based on review of a custom soil report generated using the Natural Resource Conservation Service soil web application (See Attachment C).

The reservoir course depth, check dam spacing, and number of check dams were iterated until the infiltration volume goal of 91 percent was met. A reservoir course of 12 inches with 11 check dams spaced 43 feet apart is required to meet the goal of 91 percent infiltration. The design cross section includes an additional 8 inches of reservoir course to provide space for the perforated pipe making the total reservoir depth 20 inches. The receiving water body (Fisherman Bay) is flow control exempt, and therefore flow control is not a project objective. Figure 3 shows the design of the permeable pavement cross section.

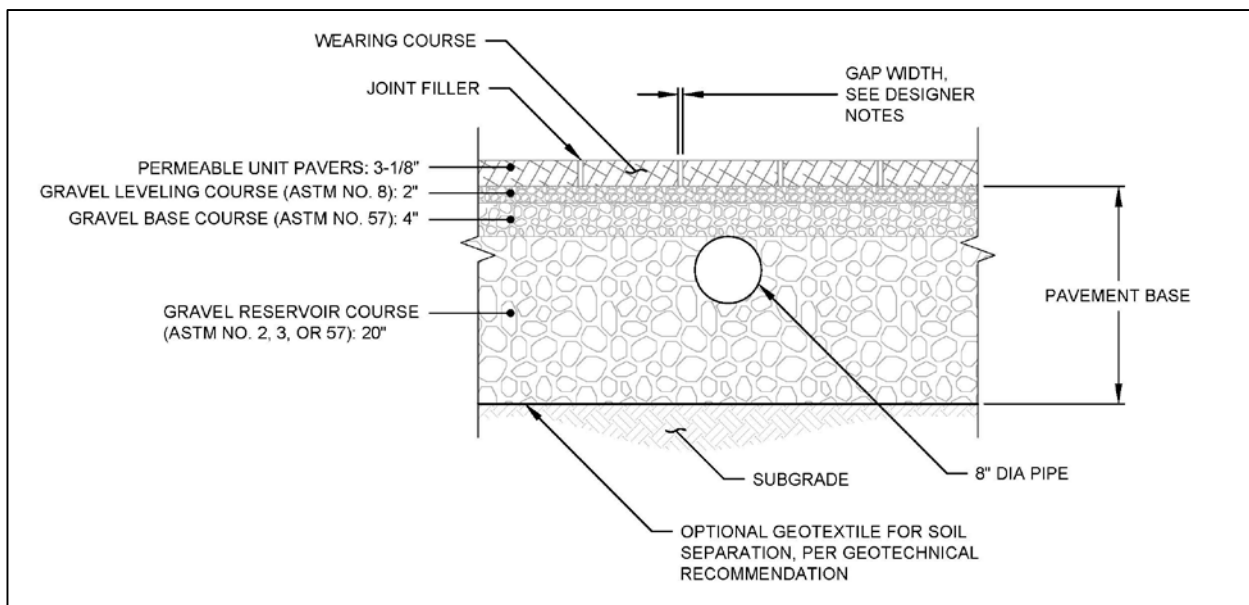


Figure 3. Pavement Infiltration System Cross Section for Parking at the Lopez Village Farmers Market (Assumes Light Vehicular Traffic and Poor Soils).

Perforated Bypass Pipe

A perforated bypass pipe is proposed in the pavement infiltration system reservoir course (see Figures 2 and 3) to provide extra conveyance for high flow received from surrounding land in the drainage basin. Runoff from the contributing drainage area north of Village Road, south of Fisherman Bay Road, and west of the infiltration system (bypass drainage area shown in Figure 2) will infiltrate in the pavement infiltration system reservoir course when there is capacity for that to occur, or will otherwise be conveyed through a perforated bypass to the downstream conveyance system.

The 8-inch-diameter perforated polyvinyl chloride (PVC) bypass pipe was modeled using Manning's equation (Equation 1) for pipe flow to confirm that it can convey the 100-year peak

flow rate. The 100-year peak flow rate was calculated in MGSFlood based on the contributing drainage area and land cover, as shown in Table 2. Assuming the pipe slope will match the existing ground surface slope (approximately 0.023 ft/ft), the conveyance capacity through the 8-inch pipe (2.647 cfs) will be sufficient to convey the calculated 100-year peak flow rate (2.646 cfs). The MGSFlood modeling and Manning’s equation documentation are provided in Attachment A.

$$Q = \frac{1.49S^{1/2}AR_h^{2/3}}{n} \quad \text{Manning's Equation (Equation 1)}$$

Where:

S = Slope (ft/ft)

R_h = Hydraulic radius (ft)

Q = discharge (cfs)

A = Cross-sectional area of flow (ft²)

n = Roughness coefficient

Land Cover	Area (acres)
Till grass	5.08
Impervious	1.61

Constructed Bypass Channel

The proposed constructed bypass channel will bypass flow from the upper basin around the pavement infiltration system and eliminate a capacity issue in the existing ditch adjacent to the Farmers Market. The bypass channel was designed using Manning’s equation for open channel flow (Equation 1) and maximum shear stress. The Hydraulic Toolbox 4.1, created by the Federal Highway Administration, was used to conduct these calculations (created July 1, 2013). The channel was divided into six segments with varying slopes and cross sections, as shown in Figure 2. Figure 4 shows the preferred bypass channel cross section for each of those segments. For each segment, the flow depth was calculated using Equation 1 assuming the 25-year, 24-hour peak flow rate for build-out conditions of 15.1 cfs (Hart Pacific 2002), 2:1 side slopes, at least 6 inches of freeboard, and a channel depth of 1.5 feet. All sections would convey the 100-year, 24-hour peak flow (based on the 100-year flow for build-out conditions documented by Hart Pacific [2002]) without overtopping, as shown in Table 3. Designing the channels to accommodate these flow rates will be conservative given that more recent analysis using western Washington hydrologic model indicates lower design flow rates (Drahn 2013). The channel analysis documentation is provided in Attachment A.

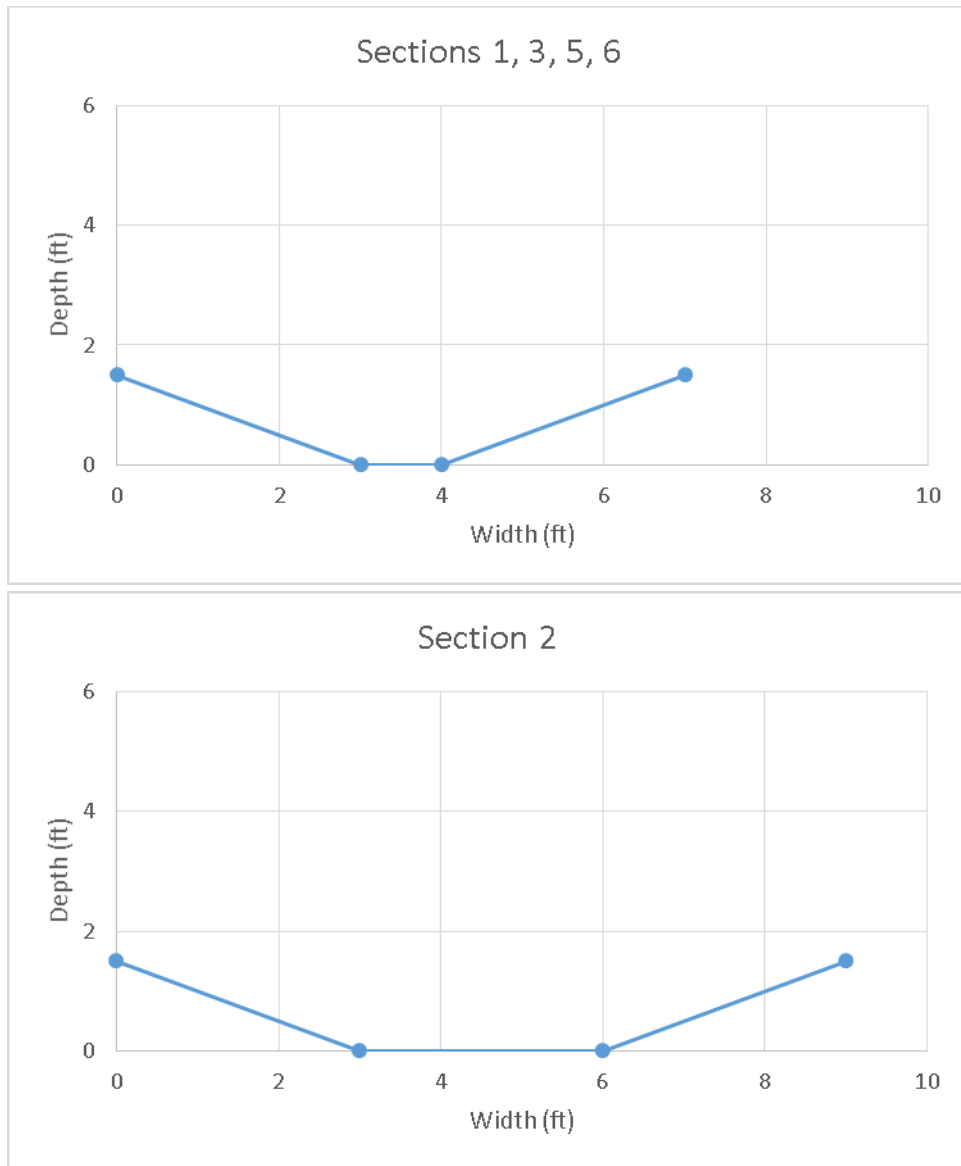


Figure 4. Bypass Channel Cross Sections.

The proposed bypass channel will be lined with Class A vegetation, which includes a combination of regionally appropriate sedges and rushes (30 to 36 inches in height). Shrubs, trees, and groundcovers are proposed along the banks of the channel to stabilize and protect the banks from erosion, to provide habitat, and to serve as a park amenity. The maximum shear stress values calculated for the proposed channel are within the tolerated range for Class A vegetation (< 3.7 pounds per square foot) for all channel sections analyzed, as shown in Table 3 (WDFW 2003).

Table 3. Bypass Channel Flow Depths and Shear Stresses at Representative Cross Sections.

Section	Top Width (ft)^a	Depth (ft)	Slope (ft/ft)	Length (ft)	25-Year Flow Depth (ft)	100-Year Flow Depth (ft)^b	100-Year Max Shear (lb/sf)^c
1	7	1.5	0.025	200	0.98	1.16	1.53
2	9	1.5	0.008	205	0.94	1.15	0.47
3	7	1.5	0.029	170	0.95	1.13	1.72
4	7.5	1.5	0.018	165	0.97	1.16	1.09
5	7	1.5	0.038	80	0.89	1.06	2.12
6	7	1.5	0.030	270	0.94	1.12	1.76

Notes

^a Assumes 2:1 side slopes.

^b 100-year flow for build-out conditions in the Lopez Village Drainage Analysis (22.16 cfs) (Hart Pacific 2002).

^c Maximum shear allowable is 3.7 lb/sf based on Class A vegetation tolerated shear stress from the Integrated Streambank Protection Guidelines (WDFW 2003).

All parameters determined using Manning's equation assume a Manning's "n" value of 0.03 for lawn and 0.5 feet of freeboard.

ft = feet

lb/sf = pounds per square foot

cfs = cubic feet per second

Project Team Responsibilities, Qualifications, and Commitment

Team Member Responsibilities

Table 4. Project Team Members and Responsibilities.		
Teams	Members	Responsibilities
San Juan County	Ed Hale	Project Manager
	Shannon Wilbur, PE	Senior Project Engineer
	Jessie Douglas-Seitz	Engineering Technician, Construction Manager
Design Consultant	Consultant Principal Engineer, PE	Oversee design quality control and ensure adequate staff resources are committed to the project. Assigned to the project for 5 to 10% of the time during design.
	Consultant Project Engineer, PE	Responsible for oversight and direction of the design calculations, drawings, and construction specifications. Responsible for ensuring design quality control processes are followed. Support construction oversight. Assigned to the project for 20 to 50% of the time during design and 10 to 20% of the time during construction.
	Consultant Design Engineer, PE or EIT	Responsible for conducting design calculations, developing design plans and profiles, writing specifications and cost estimating. Assigned to the project for 40 to 60% of the time during design and up to 20% of the time during construction.
	Consultant Drafting Technician	Responsible for drafting the design and implementation of CAD quality standards. Assigned to the project for 40 to 60% of the time during design.

Team Member Qualifications

San Juan County Team

Ed Hale

Role: Grant Project Administration and Management

Qualifications:

Education: B.S. in Environmental Science, Washington State University 1985; B.S. in Biology, Washington State University 1985

Professional Credential: Registered Environmental Health Specialist No. 9000842, National Environmental Health Association

Experience: Mr. Hale has 29 years of experience working at the local government level with county, district and tribal governments. Mr. Hale has managed grants from federal, state and local agencies including the US Environmental Protection Agency, US Department of

Agriculture, US Department of Interior, Washington Department of Health, Washington State Department of Ecology, Idaho Department of Environmental Quality, and Idaho Department of Health and Welfare. Projects funded through the grants managed by Mr. Hale have included the design, installation, and monitoring of stormwater treatment systems, implementing surface water and groundwater quality protection programs, treatment system design evaluation, and regional water quality plans.

Shannon Wilbur, PE

Role: Senior Project Engineer at San Juan County Public Works

Experience: Civil engineer since 1987 working in both the private and public sectors as a design engineer and project manager for numerous municipal utility projects in both California and Washington. Ms. Wilbur has developed state and federally funded projects from the planning phase through to construction, including extensive public outreach efforts. She has been with San Juan County since 2007 and managed the design and public outreach for the Eastsound Constructed Wetland, the Guardrail Safety Project, and the Cattle Point Road Realignment project. Other local planning efforts have included the Eastsound Streetscape, and the Orcas Landing acquisition and master plan.

Preliminary Design Team

Matt Fontaine, PE

Role: Senior Engineer at Herrera Environmental Consultants and Project Engineer for the Preliminary Design

Qualifications:

Education: M.S. in Civil Engineering with an emphasis in Water Resources, University of Washington, 2007; B.S. in Civil/Environmental Engineering, Clarkson University, 2002

Professional Credential: Washington Registered Professional Engineer #46158

Experience: Mr. Fontaine is a water resources engineer with ten years of experience. His stormwater engineering expertise is broad, spanning design of low impact development (LID) and traditional stormwater facility design, stormwater retrofit planning and design, stormwater program evaluation, stormwater guidance manual development, and regulatory compliance. He has completed analysis and design of stormwater projects for the public and private sector for both new development and retrofit projects in the public right-of-way, ranging from site-scale design to large and complex retrofit planning and design efforts. He has served as project engineer responsible for engineering designs, specifications, cost estimates, and operation and maintenance plans for multiple stormwater facility projects, including bioretention, permeable pavement, stormwater conveyance, stormwater treatment, and large traditional flow control and water quality treatment facilities. He is adept at stormwater retrofit site identification, prioritization, predesign report preparation, and design, most recently acting as project manager and project engineer for the City of Lacey's Chambers Lake Constructed Wetland Facility.

Caitlyn Echterling, EIT

Role: Engineer at Herrera Environmental Consultants and Design Engineer for the Preliminary Design

Qualifications:

Education: B.S. in Civil Engineering, Seattle University, Seattle, 2013

Professional Credential: Engineer-in-Training

Experience: Ms. Echterling is an engineer and modeler with experience working on stormwater management and stream restoration design projects and related research projects. She has a strong background in data analysis and GIS. She has contributed hydrologic and hydraulic modeling for several local stormwater projects.

Final Consultant Design Team

Licensed Professional Engineer

Qualifications:

- Experience with sizing and designing stormwater conveyance and pavement infiltration systems in accordance with the *Stormwater Management Manual for Western Washington* (Ecology 2012).
- Experience with stream channel design and restoration projects.
- Experience designing projects in San Juan County.
- Experience designing projects using the WSDOT *Standard Specifications for Road, Bridge, and Municipal Construction*.
- Experience providing construction support to municipal projects.

Commitment to Maintain Staff Competencies and Responsibilities

The County and consultant staff outlined above are all committed to the ongoing advancement of stormwater management and the improvement of water quality in Lopez Village UGA. This project would remove a source of pollutants currently discharging to Fisherman Bay. It is in the project team's interest to maintain involvement and ensure project success. Likewise, the team is comprised of seasoned professionals that have a long history of successfully staffing and executing a wide range of public utility projects.

County staff would oversee long-term maintenance of the project and employ contract equipment or staff when needed. The maintenance procedures for the stormwater treatment facilities would be demonstrated by the vendors during the first year following installation and observed by County maintenance staff. County maintenance staff would repeat the maintenance process during subsequent years.

Readiness to Proceed and Commitment to the Project

This project is a priority for the County because the added channel conveyance and water quality treatment provided by the pavement infiltration system will address flooding and water quality problems in an area intensively used by residents, visitors, and local farmers.

The County has worked with the CSWAC to identify and prioritize capital improvement projects, and the CSWAC has been a part of County level decision making by providing review of reported stormwater problems and providing local perspective on potential projects.

The proposed project is consistent with the community vision for stormwater management and community gathering areas outlined by the LVPRC (LVPRC 2010), including using open stormwater features for treatment, habitat, public education and enjoyment (LVPRC 2014a, 2014b).

The bypass channel would traverse property owned by the Lopez Village Center for Community and the Arts (LCCA) and the corner of a property owned by the Lopez Community Land Trust. The LCCA board has been supportive of the open-channel concept (Drahn 2013). The channel will also traverse the edges of private property not owned by LCCA. Easements will need to be obtained by the County prior to applying for grant funding or proceeding with construction.

Cost Estimate

A preliminary construction cost estimate was prepared based upon the collective experience of Herrera with projects of a similar scale and site setting, assuming a contractor would be hired to perform the construction. Except where otherwise noted, the cost estimate was developed based on the following:

- Construction bid items from the Washington State Department of Transportation (WSDOT) standard specifications where applicable, including material, construction requirements, measurement, and payment.
- Line item unit prices for construction were based on sound engineering judgment and were derived from a combination of applicable sources, including contractor bid tabs from similar past projects; prices compiled by WSDOT and Seattle Public Utilities; quotes from vendors; cost-estimating guides (e.g., The Guide [Guide 2014]); and site-specific understanding of probable contractor staging, access, and other project-specific requirements and constraints that would affect contractor bids for the project.
- County sales tax of 8.1 percent was applied to the construction cost.

Allied costs (project management, survey, geotechnical analyses, design, permitting, property acquisition, and construction management) were developed based on the following assumptions:

- The County would hire a consultant to perform the survey, geotechnical analysis, design, and permitting.
- The County would manage the project for a cost equal to 10 percent of the construction cost and perform construction management for a cost equal to 20 percent of the construction cost.
- Costs for survey, design, and permitting are based on experience with design and permitting similar projects and knowledge of site-specific job complexities and challenges. In some cases, professional judgment was used to estimate allied costs as a percentage of construction costs.
- Property acquisition cost was estimated as a minimum cost to document an easement for the conveyance of stormwater to the facility inlet and does not include costs for acquiring real estate if required by the property owner.
- A 5 percent change order allowance is included in the cost estimate along with a 10 percent cost for utility protection and relocation during construction; however, no contingency was included because the Ecology grant requirements do not allow for a contingency.

The total planning-level cost of this retrofit project, including survey, design, construction, and other miscellaneous costs, is estimated to be approximately \$450,000. Itemized costs are included in Attachment B.

Commitment to Long-Term Operations and Maintenance

Water quality performance of the installed stormwater treatment system will be maintained in accordance with requirements identified in the *Stormwater Management Manual for Western Washington* (Ecology 2012). During maintenance visits, County staff will perform all required maintenance activities as specified by the manual and summarized below. County staff will document functionality of the system during routine maintenance visits by simulating storm flow, using a hydrant if necessary, and will modify the frequency of visits based on observed system performance over time.

The proposed water quality treatment systems incorporate green techniques (i.e., plants and soil) to improve water quality treatment performance and are passive systems that do not require energy input other than for routine maintenance. Materials needed for operations and maintenance are commonly available for the pavement infiltration system and the channel.

Pavement Infiltration System

This preliminary design analysis assumes permeable concrete pavers will be used (e.g., Eco-Priora), but Grasspave or other types are also options depending on aesthetic preferences, anticipated use, and maintenance requirements. Typical maintenance requirements are provided for three types of pavement infiltration systems to support final design decisions.

Permeable Concrete Pavers

Routine maintenance should be conducted one to two times per year. Routine maintenance includes: clean the pavement by removing sediment, debris, trash, and vegetation, and vacuum/sweep the surface. Nonroutine maintenance required if triggered by inspection includes: moss removal, unclogging the surface, replacing missing or damaged pavers, refilling aggregate material, and resetting the surface if settling has occurred (Herrera et al. 2013).

Grasspave

Routine maintenance should be conducted one to two times per year. Routine maintenance includes: clean the pavement by removing sediment, debris, trash, and vegetation. Nonroutine maintenance required if triggered by inspection includes: weeding, repairing damaged grid segments, mulch mowing, composting, and resetting the surface if settling has occurred (Herrera et al. 2013).

Gravel Paving Grid

Routine maintenance should be conducted one to two times per year. Routine maintenance includes: clean the pavement by removing sediment, debris, trash, and vegetation, and vacuum/sweep the surface. Nonroutine maintenance required if triggered by inspection includes: replenishing aggregate material using a vacuum truck and rake, repairing damaged grid segments, weeding, and resetting the surface if settling has occurred (Herrera et al. 2013).

Bypass Channel

Routine maintenance should be conducted on an annual basis and after major storm events. Routine maintenance includes: stabilizing eroded slopes; repairing scour greater than 2 inches around the inlet, outlet, and side slopes; filling rodent holes and eliminating pests that could compromise the vegetation or side slope stability; cleaning out trash and debris; removing accumulated sediment; repairing inlet/outlet pipe damage; pruning and replacing vegetation as needed; and removing noxious weeds.

Project Success

Success of this project will be linked to effective infiltration of stormwater runoff from Lopez Village Farmers Market, as observed during future storm events. Project success will be documented with (1) records of written observation of facility function and condition during scheduled maintenance activities, and (2) field visits during rain events to observe flow through the installed stormwater treatment facilities to ensure they are not bypassing the water quality treatment flow. If warranted, project maintenance activities and frequencies will be altered to ensure the facilities are functioning as per the design.

Long-term success of this project will be documented through the written observations listed above and distribution of resulting operations and maintenance recommendations by County design engineers and maintenance staff. These will be used to increase awareness of facility function and maintenance requirements for use on future projects in San Juan County.

Implementation Recommendations

The County should take the following key steps to ensure successful implementation of this project:

- Continue to engage the LVPRC, property and business owners along Village Road, residents, and other stakeholders to select an acceptable pavement infiltration system and bypass channel configuration.
- Conduct utility locates and survey within the project area, identify utility conflicts, and adjust the design to minimize conflicts and associated costs.
- Conduct geotechnical analysis of the site, including at least two test pits and one Pilot Infiltration Test (Ecology 2012) to determine a design infiltration rate and depth to groundwater. Testing during the wet season is recommended if project scheduling allows.
- Further evaluate site geometry, including permeable pavement area, infiltration reservoir sizing, and area managed. If infiltration rates are adequate and groundwater levels are deep enough below ground surface, it may be possible to reduce the reservoir thickness and infiltration runoff from a larger drainage area. For example, the design could be modified to include a cross culvert conveying flow from the south side of Village Road into the infiltration reservoir thus increasing pollutant removal. If parallel parking is desired or more economical due to underground utility constraints, then the parking area could be extended west and north as far as Fisherman Bay Road to maintain the proposed facility footprint in a narrower cross section.
- If space and funding is available, add water quality treatment pools, potentially planted with hard stemmed native vegetation, to the proposed bypass channel to increase hydraulic residence time, reduce velocities, and provide water quality treatment of the bypass flow.
- Consider installation of permeable pavement parking areas in other areas of Lopez Village as part of the same project to realize project efficiencies.
- Select the type of pavement infiltration system surfacing. This preliminary design analysis assumes permeable concrete pavers will be used (e.g., Eco-Priora) to create an adequately conservative cost estimate, but Grasspave or other types are also options depending on aesthetic preferences, anticipated use, and maintenance requirements.
- Evaluate alternatives for the perforated bypass pipe if there are utility conflicts with the proposed pavement infiltration system cross section or if groundwater is too high to accommodate the permeable pavement section depth.
- Conduct value engineering of the permeable pavement section and the bypass channel conveyance design. Flow rates have been calculated using multiple methodologies.

This design is based upon the more conservative flow estimates produced by Hart Pacific (Hart Pacific 2002).

- Monitor and apply for grant opportunities.

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ATTACHMENT A

Ditch Retrofit to Infiltration System Drainage Area Sizing Calculations

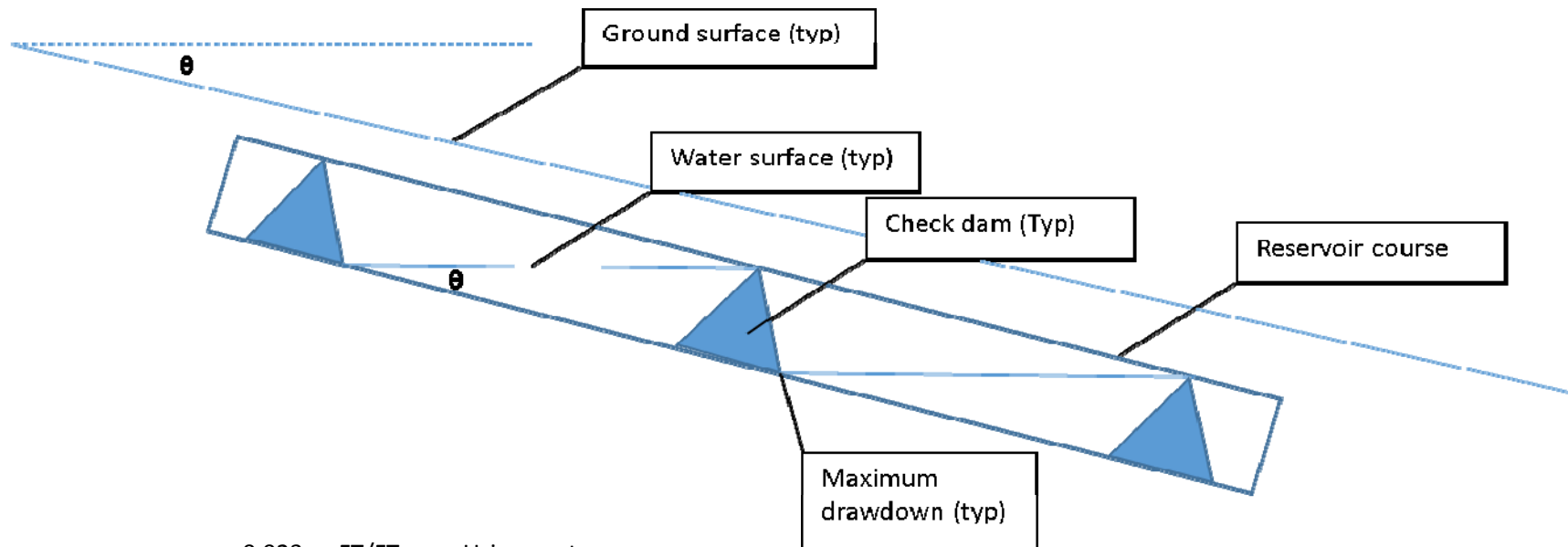
WATER QUALITY TREATMENT MODELING

Permeable Paver Modeling – MGS Flood

An infiltration system is proposed along Village Road in Lopez Village, San Juan County, Washington. The system was constructed as the reservoir course below a permeable pavement parking area. The infiltration system drainage area was modeled in MGS Flood v4.33 using a 15-minute time step to size the reservoir course depth to infiltrate at least 91 percent of the runoff from Village Road using the following assumptions:

- The surface dimensions of the infiltration system (permeable pavers) were based on the minimum dimensions for 45-degree parking stalls in Table 6.5 of the San Juan County Unified Development Code (SJCC 2000) and the available area for siting off-street parking along Village Road adjacent to the farmer's market.
- The precipitation time series for 32-inch mean annual precipitation in Puget East Western Washington was selected in MGS Flood for this project. Isopluvial maps indicate the project receives an average annual precipitation depth of 28.9 inches, indicating the 32-inch time series is conservative.
- The reservoir course depth was sized in MGS Flood assuming a longitudinal surface slope of 0.023 ft/ft (i.e. matching existing surface slope)
- A design infiltration rate of 0.1 inches per hour was selected based on review of a custom soil report generated using the Natural Resource Conservation Service soil web application (See Attachment C).

The reservoir course depth, check dam spacing, and number of check dams were iterated until the infiltration volume goal of 91 percent was met. The check dam spacing was calculated in Excel as the distance required between check dams to provide complete drawdown for a given depth of reservoir course. The number of check dams required was determined by dividing the total length of permeable paver by the check dam spacing in Excel.



PP slope 0.023 FT/FT Using contours
 PP θ 1.33222 DEG
 PP θ

Length of PP	469	FT
Reservoir course depth	1	FT
Check dam spacing	43.0	FT
Number of check dams	11	EA

MGS FLOOD PROJECT REPORT

Program Version: MGSFlood 4.33
Program License Number: 200210002
Run Date: 12/02/2014 2:47 PM

Input File Name: Permeable_Pavement_FMB4_32in.fld
Project Name: Lopez Village Farmers Market
Analysis Title: Puget East 32
Comments:

PRECIPITATION INPUT

Computational Time Step (Minutes): 15

Extended Precipitation Timeseries Selected
Climatic Region Number: 11

Full Period of Record Available used for Routing
Precipitation Station : 96003205 Puget East 32 in_5min 10/01/1939-10/01/2097
Evaporation Station : 961032 Puget East 32 in MAP
Evaporation Scale Factor : 0.750

HSPF Parameter Region Number: 1
HSPF Parameter Region Name : USGS Default

***** Default HSPF Parameters Used (Not Modified by User) *****

***** **WATERSHED DEFINITION** *****

-----**SCENARIO: PREDEVELOPED**

Number of Subbasins: 1

----- Subbasin : Subbasin 1 -----

	-----Area(Acres)-----
Till Forest	0.618
Till Pasture	0.000
Till Grass	0.000
Outwash Forest	0.000
Outwash Pasture	0.000
Outwash Grass	0.000
Wetland	0.000
Green Roof	0.000
User 2	0.000
Impervious	0.000

Subbasin Total 0.618

-----**SCENARIO: POSTDEVELOPED**

Number of Subbasins: 1

----- Subbasin : Subbasin 1 -----

-----Area(Acres) -----	
Till Forest	0.000
Till Pasture	0.000
Till Grass	0.000
Outwash Forest	0.000
Outwash Pasture	0.000
Outwash Grass	0.000
Wetland	0.000
Green Roof	0.000
User 2	0.000
Impervious	0.430

Subbasin Total	0.430

***** LINK DATA *****

-----SCENARIO: PREDEVELOPED
Number of Links: 0

***** LINK DATA *****

-----SCENARIO: POSTDEVELOPED
Number of Links: 1

Link Name: New Por Pavemt Lnk1
Link Type: Porous Pavement Structure
Downstream Link: None

Pavement Length (ft)	: 469.00
Pavement Width (ft)	: 17.50
Pavement Slope (ft/ft)	: 0.023
Pavement Infiltration Rate (in/hr)	: 100.000
Number of Infiltration Cells	: 11
Trench Cell Length (ft)	: 43.00
Trench Cell Width (ft)	: 17.50
Trench Cell Depth (ft)	: 1.00
Trench Gravel Porosity (%)	: 30.00
Trench Bed Slope (ft/ft)	: 0.022
Native Soil Infiltration Rate (in/hr)	: 0.100

***** FLOOD FREQUENCY AND DURATION STATISTICS *****

-----SCENARIO: PREDEVELOPED
Number of Subbasins: 1
Number of Links: 0

-----SCENARIO: POSTDEVELOPED

Number of Subbasins: 1
Number of Links: 1

*****Groundwater Recharge Summary *****

Recharge is computed as input to Perind Groundwater Plus Infiltration in Structures

Total Predeveloped Recharge During Simulation	
Model Element	Recharge Amount (ac-ft)
Subbasin: Subbasin 1	79.882
Total:	79.882

Total Post Developed Recharge During Simulation	
Model Element	Recharge Amount (ac-ft)
Subbasin: Subbasin 1	0.000
Link: New Por Pavemt Lnk1	215.299
Total:	215.299

Total Predevelopment Recharge is Less than Post Developed Average Recharge Per Year, (Number of Years= 158)
Predeveloped: 0.506 ac-ft/year, Post Developed: 1.363 ac-ft/year

*****Water Quality Facility Data *****

-----SCENARIO: PREDEVELOPED

Number of Links: 0

-----SCENARIO: POSTDEVELOPED

Number of Links: 1

***** Link: New Por Pavemt Lnk1 *****

Infiltration/Filtration Statistics-----
 Total Runoff Volume (ac-ft): 225.32
 Total Runoff Infiltrated (ac-ft): 215.30, 95.55%
 Total Runoff Filtered (ac-ft): 0.00, 0.00%
Percent Treated (Infiltrated+Filtered)/Total Volume: 95.55%



*****Compliance Point Results *****

Scenario Predeveloped Compliance Subbasin: Subbasin 1

Scenario Postdeveloped Compliance Link: New Por Pavemt Lnk1

***** Point of Compliance Flow Frequency Data *****
Recurrence Interval Computed Using Gringorten Plotting Position

Predevelopment Runoff		Postdevelopment Runoff	
Tr (Years)	Discharge (cfs)	Tr (Years)	Discharge (cfs)
2-Year	7.321E-03	2-Year	0.131
5-Year	1.235E-02	5-Year	0.215
10-Year	1.918E-02	10-Year	0.256
25-Year	2.303E-02	25-Year	0.323
50-Year	2.881E-02	50-Year	0.367
100-Year	3.271E-02	100-Year	0.394
200-Year	4.022E-02	200-Year	0.431

** Record too Short to Compute Peak Discharge for These Recurrence Intervals

**** **Flow Duration Performance** ****

Excursion at Predeveloped 50%Q2 (Must be Less Than 0%):	-69.5% PASS
Maximum Excursion from 50%Q2 to 80%Q2 (Must be Less Than 0%):	30.5% FAIL
Maximum Excursion from 80%Q2 to 95%Q2 (Must be Less Than 0%):	99999.0% FAIL
Percent Excursion from 50%Q2 to 95%Q2 (Must be Less Than 0%):	100.0% FAIL
FLOW DURATION DESIGN CRITERIA:	

Flow Duration Analysis Not Applicable

**** **LID Duration Performance** ****

Excursion at Predeveloped 8%Q2 (Must be Less Than 0%):	-95.4% PASS
Maximum Excursion from 8%Q2 to 50%Q2 (Must be Less Than 0%):	-69.5% PASS

MEETS ALL LID DURATION DESIGN CRITERIA: PASS

HIGH FLOW BYPASS CONVEYANCE MODELING

Perforated Bypass Pipe – MGS Flood

The bypass drainage area was modeled in MGS Flood v4.33 using a 15-minute time step to determine the 100-year flow rate to be used in conveyance sizing calculations. The time series for 32-inch mean annual precipitation in Puget East Western Washington was selected for this project. Isopluvial maps indicate the project receives an average annual precipitation depth of 28.9 inches, indicating the 32-inch time series is conservative.

The existing land cover for the bypass drainage area was delineated in GIS and modeled as the predeveloped scenario. Pervious land cover was modeled as till grass. The 100-year flow rate used to size the perforated bypass pipe.

Perforated Bypass Pipe – Mannings Equation

The perforated bypass pipe was sized using Mannings Equation for pipes assuming 8-inch CPVC beneath the full length of the permeable pavers. The 100-year flow from MGS Flood was compared to the Mannings Equation results to ensure the pipe could convey runoff from the 100-year storm.

PERFORATED BYPASS PIPE: MANNINGS EQUATION

Calculations by: Caitlyn Echterling
Calculated: 11/25/2014
Reviewed by: Kristen Matsumura
Reviewed:

Mannings Calculations - Partial Flow in Pipes
For pipes free of sediment or material (up to 10 feet diameter)

$Q = (1.49/n) * A * R^{2/3} * S^{1/2}$ (English Units)

Pipe Sizing via Manning's Equation

pipe slope =	0.0230	ft/ft	Assuming surface slope = pipe slope
Manning's 'n' =	0.009		For CPVC
diameter, d =	0.67	ft	8-inch pipe
flow depth, y =	0.53	ft	Assume 80% full
y/d =	0.800		
A/d ² =	0.6736		
x-sec area, A =	0.2993778	ft ²	
P/d =	2.2143		
wet perim., P =	1.4762	ft	
hyd. radius, R =	0.2028		
Q =	2.588	cfs	Compare to MGS 25-year flow rate below.
V =	8.643	fps	
Q =	0.0732601	cms	

Drainage area not captured by PP	6.685	ac	
Drainage are captured by PP	0.43	ac	
PP slope	0.023	ft/ft	Using contours

Ocalc- Use MGS and landuse below to determine Q100

Till grass	5.078	ac
Impervious	1.607	ac
Total area	6.685	ac

*Plug into Predeveloped conditions. Run model. Record Predeveloped 100-yr flow rate

MGS Predeveloped 25-year flow rate

Q25 - MAP 32	2.305	cfs
--------------	-------	-----

CONSTRUCTED CHANNEL CONVEYANCE MODELING

The channel was designed using Mannings equation for channel flow and maximum shear. The Hydraulic Toolbox 4.1, by the Federal Highways Administration, was used to conduct these calculations (created July 1, 2013). The channel was divided into six segments with varying slopes and cross-sections. For each segment, the flow depth was calculated using Mannings Equation assuming the 25-year, 24-hour flow rate for buildout conditions of 15.12 cfs (Hart Pacific 2002), 2 to 1 side slopes, at least 6-inches of freeboard, and 1.5-foot deep channel. All sections were sized to convey the 100-year, 24-hour flow (based on the 100-year flow for buildout conditions in Hart Pacific 2002) without overtopping.

Channel Cross-Sections.						
Section	Top Width (ft) ^a	Depth (ft)	Length (ft)	25-Year Flow Depth (ft)	Max Shear (lb/sf) ^b	100-Year Flow Depth (ft) ^d
1	7	1.5	200	0.98	1.53	1.16
2	9	1.5	205	0.94	0.47	1.15
3	7	1.5	170	0.95	1.72	1.13
4	7.5	1.5	165	0.97	1.09	1.16
5	7	1.5	80	0.89	2.12	1.06
6	7	1.5	270	0.94	1.76	1.12

Hydraulic Analysis Report

Project Data

Project Title: 25-year flow

Designer:

Project Date: Monday, November 10, 2014

Project Units: U.S. Customary Units

Notes:

Channel Analysis: Segment 1

Notes:

Input Parameters

Channel Type: Trapezoidal

Side Slope 1 (Z1): 2.0000 ft/ft

Side Slope 2 (Z2): 2.0000 ft/ft

Channel Width: 1.0000 ft

Longitudinal Slope: 0.0250 ft/ft

Manning's n: 0.0300

Flow: 22.1600 cfs

Result Parameters

Depth: 1.1642 ft

Area of Flow: 3.8747 ft²

Wetted Perimeter: 6.2063 ft

Average Velocity: 5.7191 ft/s

Top Width: 5.6566 ft

Froude Number: 1.2178

Critical Depth: 1.2760 ft

Critical Velocity: 4.8892 ft/s

Critical Slope: 0.0164 ft/ft

Critical Top Width: 6.1040 ft

Calculated Max Shear Stress: 1.8161 lb/ft²

Calculated Avg Shear Stress: 0.9739 lb/ft²

Channel Analysis: Segment 2

Notes:

Input Parameters

Channel Type: Trapezoidal

Side Slope 1 (Z1): 2.0000 ft/ft

Side Slope 2 (Z2): 2.0000 ft/ft

Channel Width: 3.0000 ft

Longitudinal Slope: 0.0080 ft/ft

Manning's n: 0.0300

Flow: 22.1600 cfs

Result Parameters

Depth: 1.1471 ft

Area of Flow: 6.0731 ft²

Wetted Perimeter: 8.1301 ft

Average Velocity: 3.6489 ft/s

Top Width: 7.5885 ft

Froude Number: 0.7188

Critical Depth: 0.9576 ft

Critical Velocity: 4.7078 ft/s

Critical Slope: 0.0162 ft/ft

Critical Top Width: 6.8306 ft

Calculated Max Shear Stress: 0.5726 lb/ft²

Calculated Avg Shear Stress: 0.3729 lb/ft²

Channel Analysis: Segment 3

Notes:

Input Parameters

Channel Type: Trapezoidal

Side Slope 1 (Z1): 2.0000 ft/ft

Side Slope 2 (Z2): 2.0000 ft/ft

Channel Width: 1.0000 ft

Longitudinal Slope: 0.0290 ft/ft

Manning's n: 0.0300

Flow: 22.1600 cfs

Result Parameters

Depth: 1.1268 ft

Area of Flow: 3.6659 ft²

Wetted Perimeter: 6.0390 ft

Average Velocity: 6.0449 ft/s

Top Width: 5.5070 ft

Froude Number: 1.3057

Critical Depth: 1.2757 ft

Critical Velocity: 4.8910 ft/s

Critical Slope: 0.0164 ft/ft

Critical Top Width: 6.1030 ft

Calculated Max Shear Stress: 2.0390 lb/ft²

Calculated Avg Shear Stress: 1.0985 lb/ft²

Channel Analysis: Segment 4

Notes:

Input Parameters

Channel Type: Trapezoidal

Side Slope 1 (Z1): 2.0000 ft/ft

Side Slope 2 (Z2): 2.0000 ft/ft

Channel Width: 1.5000 ft

Longitudinal Slope: 0.0180 ft/ft

Manning's n: 0.0300

Flow: 22.1600 cfs

Result Parameters

Depth: 1.1549 ft

Area of Flow: 4.4001 ft²

Wetted Perimeter: 6.6650 ft

Average Velocity: 5.0363 ft/s

Top Width: 6.1197 ft

Froude Number: 1.0467

Critical Depth: 1.1810 ft

Critical Velocity: 4.8587 ft/s

Critical Slope: 0.0163 ft/ft

Critical Top Width: 6.2239 ft

Calculated Max Shear Stress: 1.2972 lb/ft²

Calculated Avg Shear Stress: 0.7415 lb/ft²

Channel Analysis: Segment 5

Notes:

Input Parameters

Channel Type: Trapezoidal

Side Slope 1 (Z1): 2.0000 ft/ft

Side Slope 2 (Z2): 2.0000 ft/ft

Channel Width: 1.0000 ft

Longitudinal Slope: 0.0380 ft/ft

Manning's n: 0.0300

Flow: 22.1600 cfs

Result Parameters

Depth: 1.0610 ft

Area of Flow: 3.3125 ft²

Wetted Perimeter: 5.7450 ft

Average Velocity: 6.6898 ft/s

Top Width: 5.2440 ft

Froude Number: 1.4833

Critical Depth: 1.2762 ft

Critical Velocity: 4.8877 ft/s

Critical Slope: 0.0164 ft/ft

Critical Top Width: 6.1050 ft

Calculated Max Shear Stress: 2.5159 lb/ft²

Calculated Avg Shear Stress: 1.3672 lb/ft²

Channel Analysis: Segment 6

Notes:

Input Parameters

Channel Type: Trapezoidal

Side Slope 1 (Z1): 2.0000 ft/ft

Side Slope 2 (Z2): 2.0000 ft/ft

Channel Width: 1.0000 ft

Longitudinal Slope: 0.0300 ft/ft

Manning's n: 0.0300

Flow: 22.1600 cfs

Result Parameters

Depth: 1.1183 ft

Area of Flow: 3.6192 ft²

Wetted Perimeter: 6.0010 ft

Average Velocity: 6.1228 ft/s

Top Width: 5.4730 ft

Froude Number: 1.3269

Critical Depth: 1.2758 ft

Critical Velocity: 4.8903 ft/s

Critical Slope: 0.0164 ft/ft

Critical Top Width: 6.1034 ft

Calculated Max Shear Stress: 2.0934 lb/ft²

Calculated Avg Shear Stress: 1.1290 lb/ft²

Hydraulic Analysis Report

Project Data

Project Title: 100-year flow
Designer: Caitlyn Echterling
Project Date: Monday, November 10, 2014
Project Units: U.S. Customary Units
Notes: Hydraulic Toolbox 4.1
Federal Highways Administration
Created July 1, 2013

Channel Analysis: Segment 1

Notes:

Input Parameters

Channel Type: Trapezoidal
Side Slope 1 (Z1): 2.0000 ft/ft
Side Slope 2 (Z2): 2.0000 ft/ft
Channel Width: 1.0000 ft
Longitudinal Slope: 0.0250 ft/ft
Manning's n: 0.0300
Flow: 22.1600 cfs

Result Parameters

Depth: 1.1642 ft
Area of Flow: 3.8747 ft²
Wetted Perimeter: 6.2063 ft
Average Velocity: 5.7191 ft/s
Top Width: 5.6566 ft
Froude Number: 1.2178
Critical Depth: 1.2760 ft
Critical Velocity: 4.8892 ft/s
Critical Slope: 0.0164 ft/ft
Critical Top Width: 6.1040 ft
Calculated Max Shear Stress: 1.8161 lb/ft²
Calculated Avg Shear Stress: 0.9739 lb/ft²

Channel Analysis: Segment 2

Notes:

Input Parameters

Channel Type: Trapezoidal

Side Slope 1 (Z1): 2.0000 ft/ft

Side Slope 2 (Z2): 2.0000 ft/ft

Channel Width: 3.0000 ft

Longitudinal Slope: 0.0080 ft/ft

Manning's n: 0.0300

Flow: 22.1600 cfs

Result Parameters

Depth: 1.1471 ft

Area of Flow: 6.0731 ft²

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Channel Analysis: Segment 3

Notes:

Input Parameters

Channel Type: Trapezoidal

Side Slope 1 (Z1): 2.0000 ft/ft

Side Slope 2 (Z2): 2.0000 ft/ft

Channel Width: 1.0000 ft

Longitudinal Slope: 0.0290 ft/ft

Manning's n: 0.0300

Flow: 22.1600 cfs

Result Parameters

Depth: 1.1268 ft

Area of Flow: 3.6659 ft²

Wetted Perimeter: 6.0390 ft

Average Velocity: 6.0449 ft/s

Top Width: 5.5070 ft

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Critical Velocity: 4.8910 ft/s

Critical Slope: 0.0164 ft/ft

Critical Top Width: 6.1030 ft

Calculated Max Shear Stress: 2.0390 lb/ft²

Calculated Avg Shear Stress: 1.0985 lb/ft²

Channel Analysis: Segment 4

Notes:

Input Parameters

Channel Type: Trapezoidal

Side Slope 1 (Z1): 2.0000 ft/ft

Side Slope 2 (Z2): 2.0000 ft/ft

Channel Width: 1.5000 ft

Longitudinal Slope: 0.0180 ft/ft

Manning's n: 0.0300

Flow: 22.1600 cfs

Result Parameters

Depth: 1.1549 ft

Area of Flow: 4.4001 ft²

Wetted Perimeter: 6.6650 ft

Average Velocity: 5.0363 ft/s

Top Width: 6.1197 ft

Froude Number: 1.0467

Critical Depth: 1.1810 ft

Critical Velocity: 4.8587 ft/s

Critical Slope: 0.0163 ft/ft

Critical Top Width: 6.2239 ft

Calculated Max Shear Stress: 1.2972 lb/ft²

Calculated Avg Shear Stress: 0.7415 lb/ft²

Channel Analysis: Segment 5

Notes:

Input Parameters

Channel Type: Trapezoidal

Side Slope 1 (Z1): 2.0000 ft/ft

Side Slope 2 (Z2): 2.0000 ft/ft

Channel Width: 1.0000 ft

Longitudinal Slope: 0.0380 ft/ft

Manning's n: 0.0300

Flow: 22.1600 cfs

Result Parameters

Depth: 1.0610 ft

Area of Flow: 3.3125 ft²

Wetted Perimeter: 5.7450 ft

Average Velocity: 6.6898 ft/s

Top Width: 5.2440 ft

Froude Number: 1.4833

Critical Depth: 1.2762 ft

Critical Velocity: 4.8877 ft/s

Critical Slope: 0.0164 ft/ft

Critical Top Width: 6.1050 ft

Calculated Max Shear Stress: 2.5159 lb/ft²

Calculated Avg Shear Stress: 1.3672 lb/ft²

Channel Analysis: Segment 6

Notes:

Input Parameters

Channel Type: Trapezoidal

Side Slope 1 (Z1): 2.0000 ft/ft

Side Slope 2 (Z2): 2.0000 ft/ft

Channel Width: 1.0000 ft

Longitudinal Slope: 0.0300 ft/ft

Manning's n: 0.0300

Flow: 22.1600 cfs

Result Parameters

Depth: 1.1183 ft

Area of Flow: 3.6192 ft²

Wetted Perimeter: 6.0010 ft

Average Velocity: 6.1228 ft/s

Top Width: 5.4730 ft

Froude Number: 1.3269

Critical Depth: 1.2758 ft

Critical Velocity: 4.8903 ft/s

Critical Slope: 0.0164 ft/ft

Critical Top Width: 6.1034 ft

Calculated Max Shear Stress: 2.0934 lb/ft²

Calculated Avg Shear Stress: 1.1290 lb/ft²

ATTACHMENT B

Itemized Cost Estimate



Subject: FMB4 - Lopez Village Farmers Market

Prepared by: M. Fontaine and C. Echterling

Checked by: B. Busiek

Updated: December 4, 2014

Note: This cost estimate is approximate. Actual construction bids may vary significantly from this statement of probable costs due to timing of construction, changed conditions, labor rate changes, or other factors beyond the control of the engineers.

ESTIMATED COST OF PROJECT IMPLEMENTATION AT INITIAL CONCEPT DESIGN STAGE

NO.	QUANT.	UNIT	ITEM	UNIT COST	AMOUNT	BASIS OF QUANTITY AND UNIT COST
1	1	LS	MOBILIZATION	10%	\$ 25,181	
2	1	LS	EROSION/WATER POLLUTION CONTROL	3%	\$ 7,195	Inlet protection, manage stock piles, and daily sweeping by hand.
3	1	LS	PROJECT TEMPORARY TRAFFIC CONTROL	2%	\$ 4,796	Cones and rope to exclude pedestrians from work area in field, and temporary parking stall closures on street edge.
4	0.3	ACRE	CLEARING AND GRUBBING	\$ 8,000	\$ 2,400	Clearing area for stream channel excavation.
5	805	CY	COMMON EXCAVATION, INCL. HAUL	\$ 20	\$ 16,100	Excavation for permeable pavement and channel.
6	29	CY	STREAMBED COBBLES 4 INCH	\$ 75	\$ 2,180	4" streambed cobbles for channel bottom. Recent bids 230th St. and Eastsound Wetland. Assumes 0.5 ft thick.
7	8,900	SF	BIOENGINEERED BANK TREATMENTS	\$ 2	\$ 17,800	Assume 2 per sf for planting.
8	3	EACH	PEDESTRIAN BRIDGE WITH RAILINGS	\$ 3,500	\$ 10,500	Architect's estimate.
9	11	EACH	LARGE WOOD PIECES	\$ 750	\$ 8,250	1 per 100 LF on average.
10	11	EACH	STREAMBED BOULDERS - 3 MAN	\$ 200	\$ 2,200	1 per 100 LF on average.
11	8208	SF	PERMEABLE UNIT PAVER	\$ 10	\$ 82,080	3-1/8 inch. Based on Rick Crooks estimate for installed costs.
12	113	TON	GRAVEL LEVELING COURSE	\$ 35	\$ 3,950	ASTM NO. 8. 2-inch thick. From Chambers bid tabs - Crushed surfacing top course.
13	226	TON	GRAVEL BASE COURSE	\$ 60	\$ 13,540	ASTM NO. 57. 4-inch thick. From Chambers bid tabs - Choker course.
14	1129	TON	GRAVEL RESERVOIR COURSE	\$ 26	\$ 29,340	ASTM NO. 57. 12-inch thick. From SPU 2012 Unit Cost Report for Mineral Aggregate Type 2 (401002) for quantities ≥ 200 TONS.
15	11	EACH	CHECK DAM	\$ 300	\$ 3,300	Reset ponding every 43 LF. Simple weirs.
16	0.06	ACRE	WATER QUALITY TREATMENT POOLS	\$ 250,000	\$ 15,000	4 pools. All inclusive of excavation and planting for treatment pools. Based on per acre cost for treatment wetland construction.
17	1	EACH	30-INCH TRASH RACK	\$ 825	\$ 830	Based on email correspondance with Aaron Zachry at Cuz Concrete (11/26/2014).
19	470	LF	8-INCH PERFORATED BYPASS PIPE	\$ 55	\$ 25,850	SPU 2012 Unit Cost Report (Item 717668).
20	2	EACH	PROJECT SIGN	\$ 750	\$ 1,500	Basic educational sign fabrication and installation. No site-specific graphic design. Unit cost from SPU unit cost report.
21	1	LS	SITE RESTORATION	\$ 5,000	\$ 5,000	Assumes seeding and mulching disturbed lawn areas, pavemenet edge repair, and forest restoration along side of trail.
SUBTOTAL OF DIRECT COSTS					\$ 276,992	

NO.	QUANT.	UNIT	ITEM	UNIT COST	AMOUNT	BASIS OF QUANTITY AND UNIT COST
SALES TAX (DIRECT COSTS)				8.1%	\$ 22,436	
TOTAL CONSTRUCTION COST					\$ 299,400	
ALLIED COSTS						
			ITEM	UNIT COST	AMOUNT	BASIS OF QUANTITY AND UNIT COST
			GRANT PROJECT ADMIN / MANAGEMENT	10%	\$ 30,000	Based on County experience managing similar projects.
			SURVEY	LS	\$ 5,000	Base mapping.
			GEOTECHNICAL ANALYSES	LS	\$ 10,000	PIT test and geotech report for permeable pavement. Test pits along stream channel to characterize soils. Cost depends on local backhoe availability. Based on input from AESI.
			DESIGN	LS	\$ 40,000	2 general sheets, 1 clearing and grading sheet, 1 TESC sheet, 3 civil sheets (proposed site plan, channel profile and sections, pavement sections and details, site furnishings), 4 landscape sheets (planting plan, planting schedule, planting details, irrigation plan).
			PERMITTING	LS	\$ 5,000	Clearing and grading permit.
			PROPERTY ACQUISITION	LS	\$ 5,000	Easement acquisition.
			CONSTRUCTION MANAGEMENT	15%	\$ 44,910	Based on input from County
			CHANGE ORDERS	5%	\$ 15,000	
SUBTOTAL OF ALLIED COSTS					\$ 154,900	
SUMMARY						
SUBTOTAL CONSTRUCTION COST					\$ 299,400	
SUBTOTAL OF ALLIED COST					\$ 154,900	
PROJECT TOTAL					\$ 450,000	
SUMMARY BY GRANT TASK						
TASK 1 - GRANT PROJECT ADMINISTRATION / MANAGEMENT					\$ 30,000	
TASK 2 - DESIGN PLANS AND SPECIFICATIONS, ENVIRONMENTAL REVIEW, AND PERMITTING					\$ 65,000	
TASK 3 - CONSTRUCTION MANAGEMENT					\$ 44,910	
TASK 4 - CONSTRUCTION					\$ 299,400	
TASK 5 - CHANGE ORDERS					\$ 15,000	
PROJECT TOTAL					\$ 450,000	

ATTACHMENT C

NRCS Soil Report



United States
Department of
Agriculture

NRCS

Natural
Resources
Conservation
Service

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

Custom Soil Resource Report for **San Juan County, Washington**

Lopez Village



Preface

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

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

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

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

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

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

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How Soil Surveys Are Made

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

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

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

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

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

Custom Soil Resource Report

individual soils with similar soils in the same taxonomic class in other areas so that they could confirm data and assemble additional data based on experience and research.

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

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

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

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

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

After soil scientists located and identified the significant natural bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and identified each as a specific map unit. Aerial photographs show trees, buildings, fields, roads, and rivers, all of which help in locating boundaries accurately.

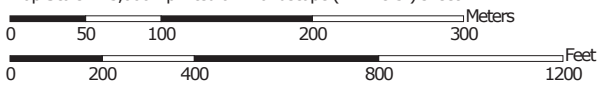
Soil Map

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

Custom Soil Resource Report Soil Map




Map Scale: 1:5,000 if printed on A landscape (11" x 8.5") sheet.



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

MAP LEGEND

Area of Interest (AOI)

 Area of Interest (AOI)


Soils


 Soil Map Unit Polygons

 Soil Map Unit Lines


 Soil Map Unit Points

Special Point Features

 Blowout

 Borrow Pit

 Clay Spot

 Closed Depression

 Gravel Pit

 Gravelly Spot


 Landfill

 Lava Flow

 Marsh or swamp

 Mine or Quarry

 Miscellaneous Water

 Perennial Water

 Rock Outcrop

 Saline Spot

 Sandy Spot

 Severely Eroded Spot

 Sinkhole


 Slide or Slip

 Sodic Spot


 Spoil Area

 Stony Spot


 Very Stony Spot

 Wet Spot

 Other

 Special Line Features

Water Features

 Streams and Canals

Transportation

 Rails


 Interstate Highways

 US Routes

 Major Roads

 Local Roads

Background

 Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:12,000.

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

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

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

Source of Map: Natural Resources Conservation Service
 Web Soil Survey URL: <http://websoilsurvey.nrcs.usda.gov>
 Coordinate System: Web Mercator (EPSG:3857)

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

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

Soil Survey Area: San Juan County, Washington
 Survey Area Data: Version 15, Sep 2, 2014

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

Date(s) aerial images were photographed: Jul 9, 2010—Aug 28, 2011

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

Map Unit Legend

San Juan County, Washington (WA055)			
Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
1001	Coveland loam, 0 to 5 percent slopes	0.2	0.2%
1014	Beaches-Endoaquents, tidal-Xerorthents association, 0 to 5 percent slopes	5.0	5.3%
1053	Dugualla muck, 0 to 2 percent slopes	1.0	1.1%
2001	Mitchellbay gravelly sandy loam, 5 to 15 percent slopes	4.2	4.4%
2004	Mitchellbay gravelly sandy loam, 0 to 5 percent slopes	59.7	62.7%
2011	Roche-Killebrew complex, 2 to 10 percent slopes	6.4	6.7%
4003	Hoypus-Whidbey complex, 10 to 30 percent slopes	15.6	16.4%
Subtotals for Soil Survey Area		92.2	96.8%
Totals for Area of Interest		95.2	100.0%

Map Unit Descriptions

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

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

Most minor soils have properties similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting, or similar, components. They may or may not be mentioned in a particular map unit description. Other minor components, however, have properties and behavioral characteristics divergent enough to affect use or to require different management. These are called contrasting, or dissimilar, components. They generally are in small areas and could not be mapped separately because of the scale used. Some small areas of strongly contrasting soils or miscellaneous areas are identified

Rock outcrop

Percent of map unit: 5 percent
Landform: Hillslopes
Down-slope shape: Linear
Across-slope shape: Linear

2004—Mitchellbay gravelly sandy loam, 0 to 5 percent slopes

Map Unit Setting

National map unit symbol: 17nmy
Elevation: 0 to 300 feet
Mean annual precipitation: 25 to 40 inches
Mean annual air temperature: 48 to 50 degrees F
Frost-free period: 200 to 240 days
Farmland classification: All areas are prime farmland

Map Unit Composition

Mitchellbay and similar soils: 90 percent
Minor components: 10 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Mitchellbay

Setting

Landform: Valley sides, valleys
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Glacial drift over dense glaciomarine deposits

Typical profile

Oi - 0 to 1 inches: slightly decomposed plant material
A - 1 to 6 inches: gravelly sandy loam
Bw - 6 to 15 inches: sandy loam
E - 15 to 20 inches: sandy loam
2Btg1 - 20 to 26 inches: loam
2Btg2 - 26 to 38 inches: loam
2Cd - 38 to 60 inches: loam

Properties and qualities

Slope: 0 to 5 percent
Depth to restrictive feature: 20 to 40 inches to densic material
Natural drainage class: Somewhat poorly drained
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately low (0.00 to 0.06 in/hr)
Depth to water table: About 0 to 8 inches
Frequency of flooding: None
Frequency of ponding: Occasional
Available water storage in profile: Moderate (about 6.2 inches)

Use 0.1 inches per hour for design assuming we'll be infiltrating above the most restrictive layer. If site specific geotechnical evaluation indicates a lower infiltration rate, then the pavement section may need to be reconfigured.



Custom Soil Resource Report

Interpretive groups

Land capability classification (irrigated): 4w

Land capability classification (nonirrigated): 4w

Hydrologic Soil Group: C/D

Ecological site: Thuja plicata-pseudotsuga menziesii/gaultheria shallon/polystichum munitum (F002XN903WA)

Other vegetative classification: Seasonally Wet Soils (G002XN202WA)

Minor Components

Coupeville

Percent of map unit: 10 percent

Landform: Valleys

Down-slope shape: Concave

Across-slope shape: Concave

Ecological site: Picea sitchensis-alnus rubra/rubus spectabilis/equisetum arvense (F002XN904WA)

Other vegetative classification: Wet Soils (G002XN102WA)

2011—Roche-Killebrew complex, 2 to 10 percent slopes

Map Unit Setting

National map unit symbol: 1vf1p

Elevation: 0 to 510 feet

Mean annual precipitation: 25 to 35 inches

Mean annual air temperature: 48 to 50 degrees F

Frost-free period: 200 to 240 days

Farmland classification: All areas are prime farmland

Map Unit Composition

Roche and similar soils: 60 percent

Killebrew and similar soils: 25 percent

Minor components: 15 percent

Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Roche

Setting

Landform: Hillslopes

Landform position (two-dimensional): Backslope

Landform position (three-dimensional): Side slope

Down-slope shape: Linear

Across-slope shape: Linear

Parent material: Glacial drift over dense glaciomarine deposits

Typical profile

O_i - 0 to 1 inches: slightly decomposed plant material

A - 1 to 5 inches: loam

Bw₁ - 5 to 15 inches: gravelly sandy loam

2Bw₂ - 15 to 23 inches: loam

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APPENDIX C-5

Lopez Village Water Quality Treatment Facility (FMB6) Predesign Report

LOPEZ VILLAGE WATER QUALITY
TREATMENT FACILITY (FMB6)
PREDESIGN REPORT

VOLUME 2 PRIORITY WATERSHED PLANNING,
SAN JUAN COUNTY, WASHINGTON

Prepared for
San Juan County Public Works

Prepared by
Herrera Environmental Consultants, Inc.



LOPEZ VILLAGE WATER QUALITY
TREATMENT FACILITY (FMB6)
PREDESIGN REPORT

VOLUME 2 PRIORITY WATERSHED PLANNING
SAN JUAN COUNTY, WASHINGTON

Prepared for
San Juan County Public Works
915 Spring Street
P.O. Box 929
Friday Harbor, Washington 98250

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Seattle, Washington 98121
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June 12, 2014

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Engineer's Stamp

This preliminary design report has been prepared under the supervision of a professional engineer registered in the State of Washington.



Matthew M. Fontaine, PE

06/12/2015
Date

Introduction

San Juan County Public Works (County) is committed to stormwater management that cost effectively addresses flooding and water quality problems that may adversely affect property and the natural environment. The County is addressing these issues proactively through:

- Completion of an inventory and high-level evaluation of County watershed conditions that provides a resource for identifying problem areas and recommends countywide stormwater management strategies (Phase 1)
- Completion of a more detailed evaluation of conditions in five priority watersheds, including the Eastsound Village and Lopez Village Urban Growth Areas (UGAs), that identifies capital improvement projects and programs for solving reported stormwater issues (Phase 2)

This preliminary design (predesign) report focuses on one of the priority capital improvement projects that resulted from Phase 2 called the Lopez Village Water Quality Treatment Facility project. The project would install a stormwater treatment wetland to improve the quality of runoff from pollutant generating surfaces in Lopez Village (identified as FMB6 in Volume 2 of the San Juan County Stormwater Management Plan). This report is specifically tailored to address application requirements for grants provided by the Washington State Department of Ecology (Ecology) to fund completion of design and/or construction of stormwater treatment retrofit projects, as well as the Ecology grant requirement for submitting a Predesign Report as one of the grant deliverables.

Basin Description

Fisherman Bay is a shallow, poorly flushed estuarine water body that receives runoff from Lopez Village UGA and multiple drainage culverts located along its perimeter. It has a narrow inlet and widens to about one-half mile, forming a long bay between six and 24 feet deep. The west shore of the bay is a rock island that is connected to the much larger Lopez Island by a barrier beach formed through accretion.

The watershed area draining to Fisherman Bay comprises approximately 1,439 acres in the west central portion of Lopez Island. The watershed generally drains from east to west into Fisherman Bay, and consists of two main drainage basins with defined outlets into the receiving water. There is a total elevation drop of about 150 feet across the watershed. The watershed is characterized by ground surface slopes up to about 5 percent in the upper and middle elevations that flatten to about 1 percent toward the shoreline. The watershed runoff crosses several County roads in culverts, including Fisherman Bay Road and Hummel Lake Road.

Land use in the Fisherman Bay watershed is predominantly residential with the associated existing impervious cover representing approximately 5.4 percent of the total watershed area. Under full buildout conditions, impervious surfaces are expected to increase to 11.1 percent of the total watershed area. The percentage of impervious surface area at buildout within the Lopez UGA could be higher as the UGA allows for higher density and greater lot coverage.

The Fisherman Bay watershed contains large areas of tidal emergent wetlands including those at Weeks Point at the north end of the bay and along Tinkham Lane and Bayshore Road at the south end of the bay. Weeks Wetland, purchased by the San Juan County Land Bank in 1993, lies within Lopez Village. The watershed contains several freshwater wetlands and an associated stream that begins north of Hummel Lake Road and flows southwest to enter Fisherman Bay. There are also wetlands near Sunset Lane and Redgate Lane, and along Weeks Road.

Eelgrass is present in a patchy distribution throughout the watershed's marine shoreline (WDFW 2014). Bull kelp is present in some areas outside the bay adjacent to Fisherman Bay spit.

Both flooding and water quality concerns are documented in this watershed, as described further below.

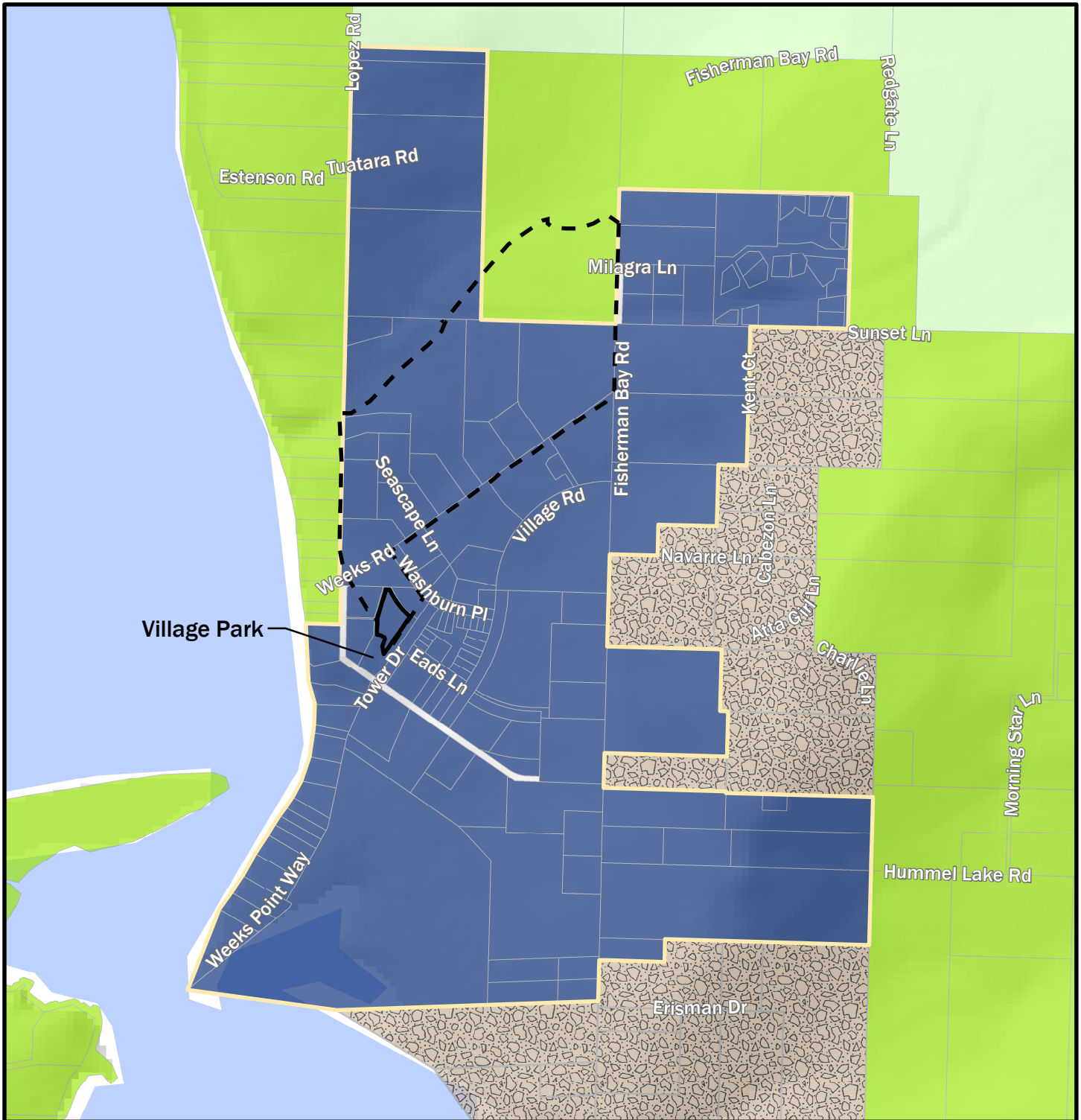
Site Description

The Lopez Village basin is several hundred acres in size and is located in the northern portion of the watershed. There is a total elevation drop of about 150 feet across this basin, with gentle ground surface slopes up to about 2 percent in the upper and middle portions that flatten to about 1 percent toward the bottom. Runoff from the basin connects several wetland and pond areas northeast of Fisherman Bay Road, crosses Fisherman Bay Road within a 24-inch culvert, and then connects into the Lopez Village storm drain system, which has a 36-inch outfall to Fisherman Bay and a 12-inch outlet to the Weeks Wetland area.

The project area is in the center of the Lopez Village UGA along Tower Road. The Lopez Village UGA base development density is single-family residential, but allows commercial and industrial uses (SJCC 2003). The Lopez Village UGA is zoned for the most intensive development on Lopez Island (Figure 1) and the village core is currently the most densely developed and trafficked area on Lopez Island with multiple commercial properties. Tower Road is adjacent to Village Park, which provides public restrooms and picnic tables in the heart of Lopez Village (Figure 1). The intensive use of this park by residents and visitors makes this an excellent location for public educational opportunities. The proposed project will provide water quality treatment for runoff from 30.8 acres of existing impervious surface area, most of which is within the Lopez Village UGA (Figure 2).

Alternatives Analysis and Project Selection

Thirty-seven watersheds in San Juan County were evaluated by the County and the San Juan County Citizen Stormwater Advisory Committee (CSWAC) and prioritized based on current development patterns, expected development trends, and presence of natural resources. Much of the predicted growth in the county is expected to be concentrated in the UGAs; therefore, they are an added focus of this stormwater planning study. Based on these factors, the Fisherman Bay watershed was selected as one of the top five priority watersheds for stormwater management planning (Herrera et al. 2014a). Detailed analysis within the five priority watersheds led to the selection of the Lopez Village Water Quality Treatment Facility (FMB6) project as among the top five for predesign development relative to alternative stormwater improvement projects (Herrera et al. 2014b).



Legend

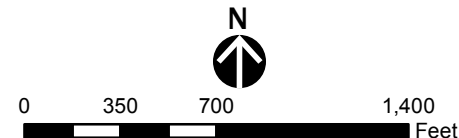
- Drainage area
- Project Area
- Lopez Village UGA
- Agricultural Resource
- Lopez Village Urban Growth Area*
- Lopez Village Growth Reserve Area**
- Rural Farm Forest

*The Lopez Village UGA base density is single-family residential, but allows commercial and industrial uses (18.30.210 of SJCC 2003).

**The Lopez Village growth reserve area shall follow the land use designation standards of the rural farm forest designation (18.30.210 of SJCC 2003).



Figure 1.
Lopez Village UGA Land Use,
Lopez Island, Washington.



The Lopez Village Water Quality Treatment Facility project was selected for reasons that are consistent with several countywide recommendations and policies for stormwater management (Herrera et al. 2014a):

- **Support neighborhood-based stormwater management solutions**. The Lopez Village Planning Review Committee (LVPRC) has conducted multiple studies to evaluate the potential for stormwater management solutions within the village and the proposed project has been developed in coordination with members of the LVPRC. The proposed project is consistent with direction provided by the LVPRC, including incorporating open water features in the Village (LVPRC 2014a, LVPRC 2014b), and this facility is one of two preferred water feature locations identified within the village (LVPRC 2010).
- **Treat close to the source**. Capacity improvements and easement issues have resulted in flow being diverted from an existing water quality treatment swale, thus reducing the amount of water quality treatment provided prior to discharge to Weeks Wetland. The swale downstream of this is undersized for the treatment area.
- **Public amenity**. In addition to improving the water quality of runoff discharged to Fisherman Bay, the stormwater wetland will provide an additional open water amenity and native species habitat at an existing community gathering area.

Water Quality Benefits











Results of 2012–2013 San Juan County pilot stormwater monitoring for Fisherman Bay are reported in Stillwater Sciences (2014a) and summarized in the companion Volume 1 of this study (Herrera et al. 2014a). 2013-2014 monitoring results are reported in Stillwater Sciences (2014b). Monitoring data for the first two years of the pilot program indicate that stormwater at several sites discharging directly into Fisherman Bay can exhibit relatively low dissolved oxygen concentrations, dropping below the Ecology water quality objective of 8.0 mg/L as an instantaneous 1-day minimum during multiple storm events. Levels of dissolved copper, lead, and zinc measured in runoff to Fisherman Bay during 2013-2014 included some exceedances of Ecology's hardness-adjusted freshwater quality criteria, suggesting potential toxicity to aquatic life during storm events. Fisherman Bay monitoring sites also exhibit relatively high bacteria content, with the median and average fecal coliform bacteria concentrations exceeding Ecology's freshwater instantaneous maximum of 100 colony-forming units (CFU) per 100 mL during multiple storm events.

In 2013-2014, samples of stormwater discharges to Fisherman Bay exhibited turbidity levels significantly greater than that measured in the four other San Juan County watersheds included in the monitoring program, with three turbidity measurements in excess of 100 nephelometric turbidity units (NTU) occurring during storm event sampling. The mean total suspended solids (TSS) concentration measured in 2014 was relatively high (e.g., greater than 100 mg/L) at Fisherman Bay sites during the first 2 years of the pilot program. Compared to national databases for stormwater runoff concentrations, Fisherman Bay sites exhibited moderate to high nitrogen concentrations including organic nitrogen (0.6 to 2.0 mg/L) and ammonium nitrogen (0.2 to 1.1 mg/L), and low to moderate total phosphorus concentrations (75 to 400 ug/L) and ortho-phosphorus (20 to 120 ug/L).

Figure 2.
Lopez Village Water Quality Treatment Facility Drainage Area.




Legend

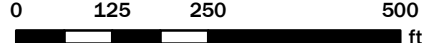
-  Wetland footprint
-  Lopez Village UGA
- Drainage area**
-  Lawn
-  Roof
-  Road
-  Existing stormwater structure
-  Existing ditch
-  Existing stormwater flowlines
-  Existing stormwater pipe
-  5-foot contours




N



0 125 250 500
ft



 **HERRERA**

Coordinates: NAD 1983
Washington State Plane North FIPS 4601

ESRI, Aerial (2011)

Produced By: GIS
Project: K:\Projects\Y2013\13-05676-000\Project\FMB6_wetland_drainage.mxd (12/8/2014)

Source: Esri, DigitalGlobe, GeoEye, i-cubed, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

The project would treat runoff from 30.8 acres of pollutant generating impervious surface in Lopez Village UGA, reducing concentrations of suspended solids, metals, nutrients, and other pollutants in the runoff.

Pollutant Load Reduction

Pollutant loading in runoff from Lopez Village UGA was estimated using data from the Phase II Municipal NPDES Permit Fact Sheet (Table 1). Specifically, NPDES Phase I municipal permittee monitoring data submitted to Ecology and synthesized in Attachment A of the *Draft Western Washington Phase II Municipal Stormwater Permit Fact Sheet* (Ecology 2011) for commercial land use were used to define untreated runoff loading at this site. The proposed facility will treat 91 percent of the total annual runoff volume, with a flow splitter to bypass the remainder of high flows around the facility (Attachment A). Pollutant removal in the proposed stormwater treatment wetland was estimated for six pollutants based on a review of the best available science (Herrera 2011, 2013). Table 1 lists the estimated annual pollutant loads and the reduction that is estimated to result from project implementation.

Table 1. Estimated Annual Pollutant Loads and Removal in Runoff from Lopez Village UGA.				
Water Quality Parameter	Units	Average Annual Load	Removal (%)^a	Annual Pollutant Removal
Total suspended solids	lbs	5,600	61	3,400
Total nitrogen	lbs	160	11	17
Total phosphorus	lbs	14	92	13
Dissolved zinc	lbs	4.2	50	2.1
Dissolved copper	lbs	0.82	73	0.60
Fecal coliform bacteria	MPN in billions ^b	1,700	77	1,300

^a Total suspended solids, total nitrogen, dissolved zinc, and fecal coliform bacteria removal rates are based on a literature review conducted as part of the Silverdale Low Impact Development Retrofit Plan project (Herrera 2013). Total phosphorus and dissolved copper removal rates are based on a Best Available Science Literature Review prepared for San Juan County (Herrera 2011).

^b MPN: Most Probable Number of fecal coliform bacteria per unit volume of sample.

Comparison to Stormwater Management Standards for New and Redevelopment

By diverting the “off-line” water quality design flow rate to the stormwater treatment wetland, the system will treat 91 percent of the average annual runoff volume and thus meet the runoff treatment requirements of the Stormwater Management Manual for Western Washington (Ecology 2012). The facility will be designed to provide the required surface area of 15,520 square feet, which equates to a 1:1 water quality treatment ratio. Even though the site allows for additional wetland surface area, an emphasis has been placed on aesthetics and creating a public amenity in order to engage the community with planning and implementation of this facility.

The receiving water body is flow control exempt and therefore flow control is not a project objective.

Project Design Summary

The preliminary project design includes two primary elements:

- A stormwater treatment wetland
- Community amenities, including: trails, native plantings, a bridge, and a water level indicator

Figure 3 shows the proposed configuration for the stormwater treatment wetland and these amenities.

The basis of design for each component is summarized in more detail below.

Stormwater Treatment Wetland

The stormwater treatment wetland was modeled in MGS Flood v4.33 software using a 15-minute time step to size the total volume required to treat at least 91 percent of the average annual runoff from the tributary drainage area in Lopez Village using the following assumptions:

- The precipitation time series for the 32-inch mean annual precipitation in Puget East Western Washington was selected in MGS Flood for this project. Isopluvial maps indicate the project area receives an average annual precipitation depth of 28.9 inches, thus the 32-inch time series is conservative.
- The 30.8 acres of contributing drainage area was modeled based upon its existing land cover, which is composed of 26.0 acres of till grass and 4.8 acres of impervious roof and road surfaces. It was assumed that future development will require onsite BMPs and thus will not increase total runoff volumes to the wetland.
- The stormwater treatment wetland was sized using the guidelines in the Stormwater Management Manual for Western Washington (Ecology 2012).
- The computed basic wet pond volume with 91 percent exceedance was used as the design volume for the stormwater treatment wetland (Ecology 2012).
- The stormwater treatment wetland is assumed to be an off-line facility. A flow splitter will divert water into the facility up to the off-line water quality design flow rate and any excess flows to the existing stormwater system (0.42 cubic feet per second).
- The off-line water quality design flow rate was computed in MGS Flood and used to preliminarily size the inflow and outflow conveyance. The preliminary results indicate that 12-inch-diameter pipe will be sufficient.
- The average depth of the facility is designed to be 3 feet.

The stormwater wetland will be composed of a pre-setting cell and a wetland cell, which are separated by a berm. A total of 15,520 square feet of facility surface area is required to meet the design criteria, assuming an average facility depth of 3 feet. Approximately 5,120 square feet is required for the pre-setting cell and 10,400 square feet is required for the wetland cell. The proposed site plan meets these requirements (Figure 3). The wetland will have a bridge and perimeter trails for pedestrians.

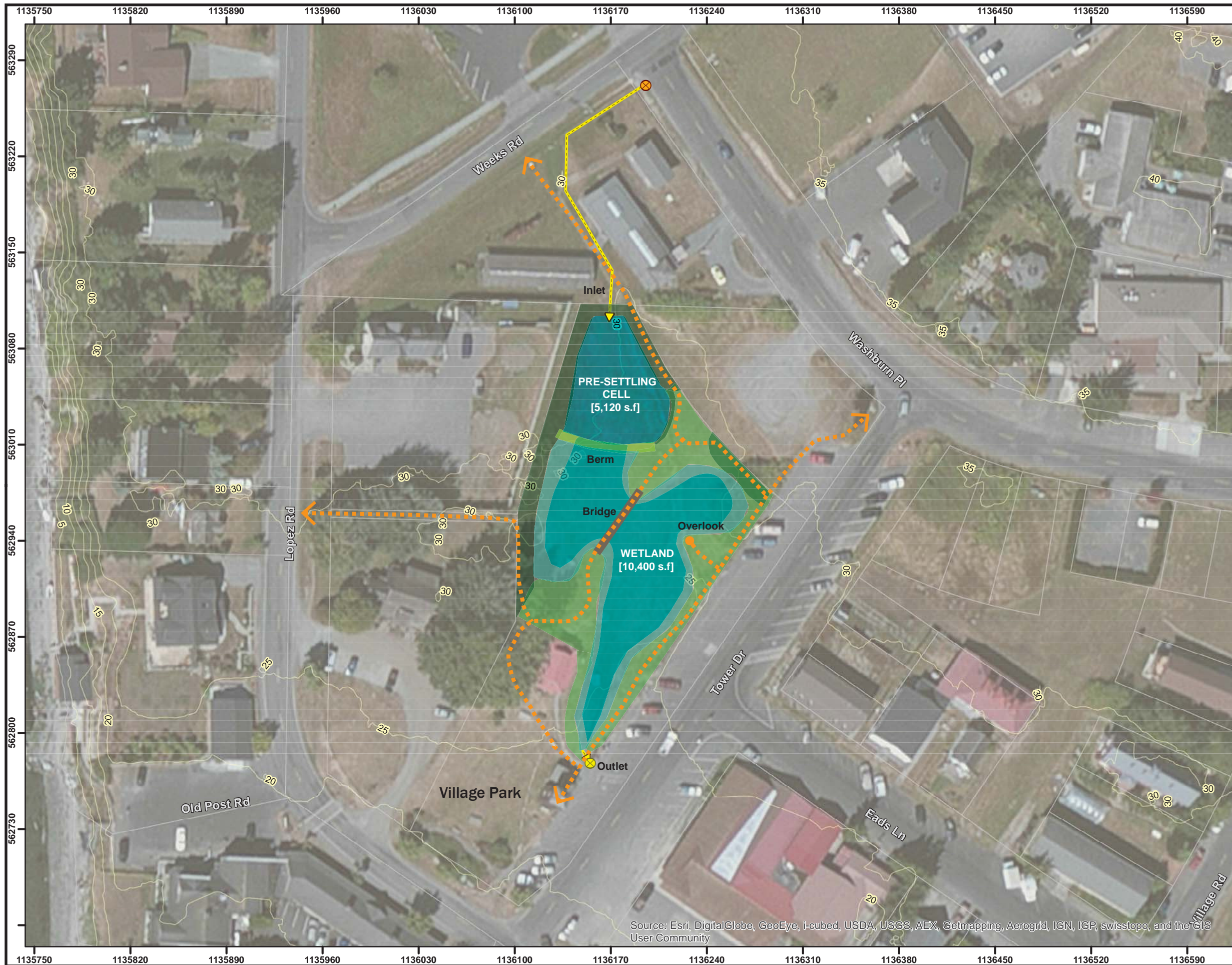


Figure 3.
Lopez Village Water Quality Treatment Facility Configuration.

Legend

- Proposed catch basin
- Proposed diversion structure
- 5-foot contours
- Proposed stormwater pipe
- Parcel
- Pre-Settling Cell
- Berm
- Wetland Cell
- Wetland Planting (Edges)
- Upland Vegetation Area
- Reinforced Geotextile Wall (Vegetated)
- Bridge
- Potential Trail



N

0 35 70 140
ft

Coordinates: NAD 1983
Washington State Plane North FIPS 4601

ESRI, Aerial (2011)

Produced By: GIS
Project: K:\Projects\Y2013\13-05676-000\Project\FMB6_wetland.mxd (12/8/2014)

Source: Esri, DigitalGlobe, GeoEye, i-cubed, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

Project Team Responsibilities, Qualifications, and Commitment

Team Member Responsibilities

Teams	Members	Responsibilities
San Juan County	Ed Hale	Project Manager
	Shannon Wilbur, PE	Senior Project Engineer
	Jessie Douglas-Seitz	Engineering Technician, Construction Manager
Design Consultant	Consultant Principal Engineer, PE	Oversee design quality control and ensure adequate staff resources are committed to the project. Assigned to the project for 5-10% of the time during design.
	Consultant Project Engineer, PE	Responsible for oversight and direction of the design calculations, drawings, and construction specifications. Responsible for ensuring design quality control processes are followed. Support construction oversight. Assigned to the project for 20-50% of the time during design and 10-20% of the time during construction.
	Consultant Design Engineer, PE or EIT	Responsible for conducting design calculations, developing design plans and profiles, writing specifications and cost estimating. Assigned to the project for 40-60% of the time during design and up to 20% of the time during construction.
	Consultant Drafting Technician	Responsible for drafting the design and implementation of CAD quality standards. Assigned to the project for 40-60% of the time during design.

Team Member Qualifications

San Juan County Team

Ed Hale

Role: Grant Project Administration and Management

Qualifications:

Education: B.S. in Environmental Science, Washington State University 1985; B.S. in Biology, Washington State University 1985

Professional Credential: Registered Environmental Health Specialist No. 9000842, National Environmental Health Association.

Experience: Mr. Hale has 29 years of experience working at the local government level with County, District and Tribal governments. Mr. Hale has managed grants from federal, state and local agencies including the US Environmental Protection Agency, US Department of

Agriculture, US Department of Interior, Washington Department of Health, Washington State Department of Ecology, Idaho Department of Environmental Quality, and Idaho Department of Health and Welfare. Projects funded through the grants managed by Mr. Hale have included the design, installation and monitoring of stormwater treatment systems, implementing surface water and groundwater quality protection programs, treatment system design evaluation and regional water quality plans.

Shannon Wilbur, PE

Role: Senior Project Engineer at San Juan County Public Works

Qualifications:

Experience: Civil engineer since 1987 working in both the private and public sectors as a design engineer and project manager for numerous municipal utility projects in both California and Washington. Ms. Wilbur has developed state and federally funded projects from the planning phase through to construction, including extensive public outreach efforts. She has been with San Juan County since 2007 and managed the design and public outreach for the Eastsound Constructed Wetland, the Guardrail Safety Project and the Cattle Point Road Realignment project. Other local planning efforts have included the Eastsound Streetscape, and the Orcas Landing acquisition and master plan.

Preliminary Design Team

Matt Fontaine, PE

Role: Senior Engineer at Herrera Environmental Consultants and Project Engineer for the Preliminary Design

Qualifications:

Education: M.S. in Civil Engineering with an emphasis in Water Resources, University of Washington, 2007; B.S. in Civil/Environmental Engineering, Clarkson University, 2002

Professional Credential: Washington Registered Professional Engineer # 46158

Experience: Mr. Fontaine is a water resources engineer with 10 years of experience. His stormwater engineering expertise is broad, spanning design of low impact development (LID) and traditional stormwater facility design, stormwater retrofit planning and design, stormwater program evaluation, stormwater guidance manual development, and regulatory compliance. He has completed analysis and design of stormwater projects for the public and private sector for both new development and retrofit projects in the public right of way, ranging from site-scale design to large and complex retrofit planning and design efforts. He has served as project engineer responsible for engineering designs, specifications, cost estimates, and operation and maintenance plans for multiple stormwater facility projects, including bioretention, permeable pavement, stormwater conveyance, stormwater treatment, and large traditional flow control and water quality treatment facilities. He is adept at stormwater retrofit site identification, prioritization, predesign report preparation, and design, most recently acting as project manager and project engineer for the City of Lacey's Chambers Lake Constructed Wetland Facility.

Caitlyn Echterling, EIT

Role: Engineer at Herrera Environmental Consultants and Design Engineer for the Preliminary Design

Qualifications:

Education: B.S. in Civil Engineering, Seattle University, Seattle, 2013

Professional Credential: Engineer-in-Training

Experience: Ms. Echterling is an engineer and modeler with experience working on stormwater management and stream restoration design projects and related research projects. She has a strong background in data analysis and GIS. She has contributed hydrologic and hydraulic modeling for several local stormwater projects.

Final Consultant Design Team

Licensed Professional Engineer

Qualifications:

- Experience with sizing and designing stormwater conveyance and stormwater treatment wetlands in accordance with the Stormwater Management Manual for Western Washington (Ecology 2012)
- Experience designing projects in San Juan County
- Experience designing projects using the WSDOT Standard Specifications for Road, Bridge, and Municipal Construction
- Experience providing construction support to municipal projects

Commitment to Maintain Staff Competencies and Responsibilities

The County and consultant staff outlined above are all committed to the ongoing advancement of stormwater management and the improvement of water quality in Lopez Village UGA. This project would remove a source of pollutants currently discharging to Fisherman Bay. It is in the project team's interest to maintain involvement and ensure project success. Likewise, the team is comprised of seasoned professionals that have a long history of successfully staffing and executing a wide range of public utility projects.

County staff would oversee long-term maintenance of the project and employ contract equipment or staff when needed. The maintenance procedures for the stormwater treatment facility will be in accordance with Ecology guidance and recommendations, to be implemented by County staff who are experienced in a variety of stormwater management facility maintenance activities.

Readiness to Proceed and Commitment to the Project

This project is a priority for the County as the stormwater treatment wetland will address water quality problems in an area intensively used by residents and visitors while creating attractive public amenities.

The County has worked with the CSWAC to identify and prioritize capital improvement projects, and the CSWAC has been a part of County level decision making by providing review of reported stormwater problems and providing local perspective on potential projects.

The proposed project is consistent with the community vision for stormwater management and community gathering areas outlined by the LVPRC (LVPRC 2010), including using open stormwater features for treatment, habitat, public education and enjoyment (LVPRC 2014a, 2014b).

Cost Estimate

A preliminary construction cost estimate was prepared based upon the collective experience of Herrera with projects of a similar scale and site setting, assuming a contractor would be hired to perform the construction. Except where otherwise noted, the cost estimate was developed based on the following:

- Construction bid items from the Washington State Department of Transportation (WSDOT) standard specifications where applicable, including material, construction requirements, measurement, and payment.
- Line item unit prices for construction were based on sound engineering judgment and were derived from a combination of applicable sources, including contractor bid tabs from similar past projects, prices compiled by WSDOT and Seattle Public Utilities, quotes from vendors, cost estimating guides (e.g., The Guide [Guide 2014]), site-specific understanding of probable contractor staging, access, and other project specific requirements and constraints that would affect contractor bids for the project.
- County sales tax of 8.1 percent was applied to the construction cost.

Allied costs (project management, survey, geotechnical analyses, design, permitting, property acquisition, and construction management) were developed based on the following assumptions:

- The County would hire a consultant to perform the survey, geotechnical analysis, design, and permitting.
- The County would manage the project for a cost equal to 10 percent of the construction cost and perform construction management for a cost equal to 20 percent of the construction cost.
- Costs for survey, design, and permitting are based on experience with design and permitting similar projects and knowledge of site-specific job complexities and

challenges. In some cases, professional judgment was used to estimate allied costs as a percentage of construction costs.

- Property acquisition cost was estimated as a minimum cost to document an easement for the conveyance of stormwater to the facility inlet and does not include costs for acquiring real estate if required by the property owner.
- A 5 percent change order allowance is included in the cost estimate along with a 10 percent cost for utility protection and relocation during construction; however, no contingency was included because the Ecology grant requirements do not allow for a contingency.

The total planning-level cost of this retrofit project, including survey, design, construction, and other miscellaneous costs, is estimated to be approximately \$940,000. Itemized costs are included in Attachment B.

Commitment to Long Term Operations and Maintenance

Water quality performance of the installed stormwater treatment wetland will be maintained in accordance with the requirements identified in the Stormwater Management Manual for Western Washington (Ecology 2012). During maintenance visits, County staff will perform all required maintenance activities as specified by the manual and summarized below. County will modify the frequency of visits based on observed system performance over time.

The proposed stormwater treatment wetland incorporates green techniques (i.e., plants and soil) to improve water quality treatment performance and is a passive system that does not require energy input other than routine maintenance.

Stormwater Treatment Wetland

Routine maintenance should be conducted on a biannual basis for the first three years and annually thereafter. Routine maintenance includes: stabilizing eroded slopes, repairing scour around the inlet, outlet, and side slopes, filling rodent holes and eliminating pests that could compromise the vegetation or side slope stability, cleaning out trash and debris, removing accumulated sediment, repairing inlet/outlet pipe damage, pruning and replacing vegetation as needed, and removing noxious weeds.

Project Success

Success of this project will be linked to effective treatment of stormwater runoff from Lopez Village, as observed during future storm events. Project success will be documented with (1) records of written observation of facility function and condition during scheduled maintenance activities, and (2) field visits during rain events to observe flow through the installed stormwater treatment wetland to ensure the facility is operating as planned up to the water quality treatment design flow. If warranted, project maintenance activities and frequencies will be altered to ensure the facility is functioning as per the design.

Long-term success of this project will be documented through the written observations listed above and distribution of resulting operations and maintenance recommendations by County

design engineers and maintenance staff. These will be used to increase awareness of facility function and maintenance requirements for use on future projects in San Juan County.

Implementation Recommendations

The County should take the following key steps to ensure successful implementation of this project:

- Continue to engage the LVPRC, property and business owners along Tower Road, residents, and other stakeholders to develop an acceptable wetland configuration, including developing a vision for how the facility would be used and establishing criteria for amenities at the facility, including those that would promote community engagement
- Conduct utility locates and survey within the project area, identify utility conflicts, and adjust the design to minimize conflicts and associated costs
- Ensure that future development in Lopez Village includes onsite stormwater management to minimize increases in runoff under buildout conditions, thus maximizing the long-term effectiveness of the stormwater treatment wetland
- This project is located upstream of another potential future water quality opportunity location at the existing downstream swale. The property around the swale is not owned by the County, but if a project is pursued at the swale location in the future, it should be coordinated with FMB6 to maximize treatment efficiency.
- Conduct value engineering of the stormwater treatment wetland design plans. Flow rates have been calculated using current land cover (assumes onsite stormwater management will be provided for buildout conditions and will mimic current till grass to impervious land cover ratios) and possibly outdated stormwater drainage information.
- Monitor and apply for grant opportunities

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ATTACHMENT A

Stormwater Treatment Wetland Sizing Calculations

WATER QUALITY TREATMENT MODELING

The stormwater treatment wetland drainage area was modeled in MGS Flood v4.33 using a 15-minute time step to determine the on-line and offline water quality flow rates required. Dummy bioretention facilities were included in these models because a best management practice (BMP) is required to make the model calculate water quality runoff flow rates. The time series for 32-inch mean annual precipitation in Western Washington was selected for this project. Isopluvial maps indicate the project receives an average annual precipitation depth of 28.9 inches, indicating the 32-inch time series is conservative. Previous land cover was modeled as till grass. The modeling report is provided on the following pages of this attachment.

It is important to note that the flow control performance is not reflective of expected performance because a dummy bioretention facility was included in the model and flow control is not a project objective.

MGS FLOOD PROJECT REPORT

Program Version: MGSFlood 4.33
Program License Number: 200210002
Run Date: 12/05/2014 10:03 AM

Input File Name: Wetland_FMB6_offline_32-nosplitter.fld
Project Name: Stormwater Treatment Wetland
Analysis Title:
Comments:

PRECIPITATION INPUT

Computational Time Step (Minutes): 15

Extended Precipitation Timeseries Selected
Climatic Region Number: 11

Full Period of Record Available used for Routing
Precipitation Station : 96003205 Puget East 32 in_5min 10/01/1939-10/01/2097
Evaporation Station : 961032 Puget East 32 in MAP
Evaporation Scale Factor : 0.750

HSPF Parameter Region Number: 1
HSPF Parameter Region Name : USGS Default

***** Default HSPF Parameters Used (Not Modified by User) *****

***** **WATERSHED DEFINITION** *****

-----**SCENARIO: PREDEVELOPED**

Number of Subbasins: 1

----- Subbasin : Existing Subbasin -----

	-----Area(Acres) -----
Till Forest	30.844
Till Pasture	0.000
Till Grass	0.000
Outwash Forest	0.000
Outwash Pasture	0.000
Outwash Grass	0.000
Wetland	0.000
Green Roof	0.000
User 2	0.000
Impervious	0.000

Subbasin Total 30.844

-----**SCENARIO: POSTDEVELOPED**

Number of Subbasins: 1

----- Subbasin : Proposed Subbasin -----

	-----Area(Acres) -----
Till Forest	0.000
Till Pasture	0.000
Till Grass	26.007
Outwash Forest	0.000
Outwash Pasture	0.000
Outwash Grass	0.000
Wetland	0.000
Green Roof	0.000
User 2	0.000
Impervious	4.780

Subbasin Total	30.787

***** LINK DATA *****

-----SCENARIO: PREDEVELOPED

Number of Links: 0

***** LINK DATA *****

-----SCENARIO: POSTDEVELOPED

Number of Links: 1

Link Name: Place Holder Water Quality Facility

Link Type: Bioretention Facility

Downstream Link: None

Base Elevation (ft) : 100.00
Riser Crest Elevation (ft) : 100.50
Storage Depth (ft) : 0.50
Bottom Length (ft) : 50.0
Bottom Width (ft) : 50.0
Side Slopes (ft/ft) : L1= 3.00 L2= 3.00 W1= 3.00 W2= 3.00
Bottom Area (sq-ft) : 2500.
Area at Riser Crest El (sq-ft) : 2,809.
(acres) : 0.064
Volume at Riser Crest (cu-ft) : 2,452.
(ac-ft) : 0.056

Infiltration on Bottom and Sideslopes Selected

Soil Properties

BioSoil Thickness (ft) : 1.50
BioSoil Saturated Hydraulic Conductivity (in/hr) : 3.00
BioSoil Porosity (Percent) : 30.00
Maximum Elevation of Bioretention Soil : 101.00
Native Soil Hydraulic Conductivity (in/hr) : 0.00

Underdrain Present
Orifice NOT Present in Under Drain

Riser Geometry
Riser Structure Type : Circular
Riser Diameter (in) : 36.00
Common Length (ft) : 0.000
Riser Crest Elevation : 100.50 ft

Hydraulic Structure Geometry

Number of Devices: 0

*****FLOOD FREQUENCY AND DURATION STATISTICS*****

-----SCENARIO: PREDEVELOPED

Number of Subbasins: 1
Number of Links: 0

-----SCENARIO: POSTDEVELOPED

Number of Subbasins: 1
Number of Links: 1

***** Link: Place Holder Water Quality Facility ***** Link WSEL Stats
WSEL Frequency Data(ft)
(Recurrence Interval Computed Using Gringorten Plotting Position)
Tr (yrs) WSEL Peak (ft)

Tr (yrs)	WSEL Peak (ft)
1.05-Year	100.594
1.11-Year	100.608
1.25-Year	100.627
2.00-Year	100.682
3.33-Year	100.735
5-Year	100.762
10-Year	100.830
25-Year	100.906
50-Year	101.116
100-Year	101.147

*****Groundwater Recharge Summary*****

Recharge is computed as input to PerInd Groundwater Plus Infiltration in Structures

Model Element	Recharge Amount (ac-ft)
Subbasin: Existing Subbasin	3986.844
Total:	3986.844

Total Post Developed Recharge During Simulation

Model Element	Recharge Amount (ac-ft)
Subbasin: Proposed Subbasin	2696.837
Link: Place Holder Water Q	0.000
Total:	2696.837

Total Predevelopment Recharge is Greater than Post Developed Average Recharge Per Year, (Number of Years= 158)
Predeveloped: 25.233 ac-ft/year, Post Developed: 17.069 ac-ft/year

*******Water Quality Facility Data*******

-----**SCENARIO: PREDEVELOPED**

Number of Links: 0

-----**SCENARIO: POSTDEVELOPED**

Number of Links: 1

***** Link: Place Holder Water Quality Facility

Basic Wet Pond Volume (91% Exceedance): 46548. cu-ft
 Computed Large Wet Pond Volume, 1.5*Basic Volume: 69821. cu-ft

15-Minute Timestep, Water Quality Treatment Design Discharge
On-line Design Discharge Rate (91% Exceedance): 0.76 cfs
Off-line Design Discharge Rate (91% Exceedance): 0.42 cfs

Infiltration/Filtration Statistics-----
Total Runoff Volume (ac-ft): 4723.53
 Total Runoff Infiltrated (ac-ft): 0.00, 0.00%
 Total Runoff Filtered (ac-ft): 3637.59, 77.01%
 Percent Treated (Infiltrated+Filtered)/Total Volume: 77.01%

Design Criteria

Design Criteria

Design Criteria
Total Runoff Volume x 91%

*******Compliance Point Results*******

Scenario Predeveloped Compliance Subbasin: Existing Subbasin

Scenario Postdeveloped Compliance Link: Place Holder Water Quality Facility

*** **Point of Compliance Flow Frequency Data** ***

Recurrence Interval Computed Using Gringorten Plotting Position

Predevelopment Runoff		Postdevelopment Runoff	
Tr (Years)	Discharge (cfs)	Tr (Years)	Discharge (cfs)
2-Year	0.365	2-Year	2.808
5-Year	0.616	5-Year	4.449
10-Year	0.957	10-Year	6.186
25-Year	1.149	25-Year	9.643

50-Year	1.438	50-Year	14.788
100-Year	1.632	100-Year	15.728
200-Year	2.008	200-Year	15.938

** Record too Short to Compute Peak Discharge for These Recurrence Intervals

**** Flow Duration Performance ****

Excursion at Predeveloped 5%Q2 (Must be Less Than 0%):	478.5% FAIL
Maximum Excursion from 8%Q2 to 50%Q2 (Must be Less Than 0%):	821.6% FAIL
Maximum Excursion from 50%Q2 to 95%Q2 (Must be Less Than 0%):	99999.0% FAIL
Percent Excursion Exceeding 0%:	100.0% FAIL

Flow Duration Analysis Not Applicable

FLOW DURATION DESIGN CRITERIA: FAIL

**** LID Duration Performance ****

Excursion at Predeveloped 8%Q2 (Must be Less Than 0%):	187.3% FAIL
Maximum Excursion from 8%Q2 to 50%Q2 (Must be Less Than 0%):	478.5% FAIL

LID DURATION DESIGN CRITERIA: FAIL

ATTACHMENT B

Itemized Cost Estimate



Subject: FMB6 - Lopez Village Water Quality Treatment Facility

Prepared by: C. Echterling

Checked by: Brian Busiek

Updated: December 8, 2014

Note: This cost estimate is approximate. Actual construction bids may vary significantly from this statement of probable costs due to timing of construction, changed conditions, labor rate changes, or other factors beyond the control of the engineers.

ESTIMATED COST OF PROJECT IMPLEMENTATION AT INITIAL CONCEPT DESIGN STAGE

NO.	QUANT.	UNIT	ITEM	UNIT COST	AMOUNT	BASIS OF QUANTITY AND UNIT COST
1	1	LS	MOBILIZATION	10%	\$ 52,365	
2	1	LS	EROSION/WATER POLLUTION CONTROL	10%	\$45,535	Could involve significant work in the wet.
3	1	LS	PROJECT TEMPORARY TRAFFIC CONTROL	5%	\$22,767	Limited traffic control on Tower Drive, Weeks Road, and Washburn Place. Most of work is out of right of way. Close parking on west side of Tower during construction. Traffic control plan.
4	3,400	CY	POND EXCAVATION, INCL. HAUL	\$ 20	\$ 68,000	Excavation for stormwater treatment wetland.
5	120	CY	STRUCTURE EXCAVATION CLASS B INCL. HAUL	\$ 30	\$ 3,600	The Guide Summer 2014. Excavation, export within 10 mile radius, dump fees.
6	69	CY	BANK RUN GRAVEL FOR TRENCH BACKFILL	\$ 5	\$ 345	Use native soil.
7	176	TON	CRUSHED SURFACING TOP COURSE	\$ 75	\$ 13,200	High end for small quantity.
8	230	LF	SCH A STORM SEWER PIPE 12 IN DIA	\$ 30	\$ 6,900	WSDOT UBA.
9	2	EACH	12" TRASH RACK	\$ 500	\$ 1,000	Recent bids, chambers lake.
10	1	EACH	DIVERSION STRUCTURE	\$ 15,000	\$ 15,000	Recent bids, chambers lake.
11	1	EACH	CATCH BASIN TYPE 2	\$ 3,200	\$ 3,200	WSDOT UBA.
12	22,000	SF	WETLAND PLANTINGS	\$ 2	\$ 44,000	Assume \$2 per sf for planting. Assumes 2/3 of site is planted.
13	0.4	AC	SOIL AMENDMENT	\$ 15,000	\$ 6,000	Recent bids, chambers lake. Assumes disturbed area outside of the wetland footprint.
14	2,200	SF	REINFORCED GEOTEXTILE WALL	\$ 100	\$ 220,000	Recent bids, chambers lake.
15	17,000	SF	IRRIGATION SYSTEM	\$ 0.30	\$ 5,100	Recent bids, chambers lake - LS/117,500 SF of irrigated area. Assumes 1/2 of site is irrigated.
16	1	LS	SEDIMENT FOREBAY	\$ 20,000	\$ 20,000	Recent bids, chambers lake. Small armorflex pad and boulders.
17	1	EACH	SITE FURNISHINGS - WATER LEVEL INDICATOR	\$ 2,500	\$ 2,500	Recent bids, chambers lake.
18	2	EACH	PROJECT SIGN	\$ 750	\$ 1,500	Basic educational sign fabrication and installation. No site-specific graphic design. Unit cost from SPU unit cost report.
19	1	LS	PEDESTRIAN BRIDGE	\$ 40,000	\$ 40,000	Assume 4ft wide and approximately 60 ft long.
20	1	LS	SITE RESTORATION	\$ 5,000	\$ 5,000	Order of Magnitude.
SUBTOTAL OF DIRECT COSTS					\$ 576,011	

NO.	QUANT.	UNIT	ITEM	UNIT COST	AMOUNT	BASIS OF QUANTITY AND UNIT COST
SALES TAX (DIRECT COSTS)				8.1%	\$ 46,657	
TOTAL CONSTRUCTION COST					\$ 620,000	
ALLIED COSTS						
			ITEM	UNIT COST		
			GRANT PROJECT ADMIN / MANAGEMENT	10%	\$ 62,000	Based on County experience managing similar projects.
			SURVEY	LS	\$ 5,000	Base mapping.
			GEOTECHNICAL ANALYSES	LS	\$ 5,000	Monitor groundwater level on site for 1 year. Geotechnical report with recommendations for short (5') MSE wall around the cut slope edges of the site. Includes \$20k for geotech and \$10k for monitoring well install.
			DESIGN	LS	\$ 80,000	4 general sheets, 1 clearing and grading sheet, 1 TESC sheet, 6 civil sheets (proposed site plan, grading, storm drain profiles, storm details, wall details, site furnishings), 4 landscape sheets (planting plan, planting schedule, planting details, irrigation plan).
			PERMITTING	LS	\$ 5,000	Grading permit.
			PROPERTY ACQUISITION	LS	\$ 5,000	Easement acquisition.
			CONSTRUCTION MANAGEMENT	20%	\$ 124,000	Based on input from County.
			CHANGE ORDERS	5%	\$ 31,000	
SUBTOTAL OF ALLIED COSTS					\$ 320,000	
SUMMARY						
			SUBTOTAL CONSTRUCTION COST		\$ 620,000	
			SUBTOTAL OF ALLIED COST		\$ 320,000	
PROJECT TOTAL					\$ 940,000	
SUMMARY BY GRANT TASK						
TASK 1 - GRANT PROJECT ADMINISTRATION / MANAGEMENT					\$ 62,000	
TASK 2 - DESIGN PLANS AND SPECIFICATIONS, ENVIRONMENTAL REVIEW, AND PERMITTING					\$ 100,000	
TASK 3 - CONSTRUCTION MANAGEMENT					\$ 124,000	
TASK 4 - CONSTRUCTION					\$ 620,000	
TASK 5 - CHANGE ORDERS					\$ 31,000	
PROJECT TOTAL					\$ 940,000	

APPENDIX D

Status of Long-Range Drainage Plan Projects

STATUS OF LONG RANGE DRAINAGE PLAN PROJECTS FOR EASTSOUND VILLAGE URBAN GROWTH AREA

The status of projects and their estimated cost from the 2005 Long Range Drainage Plan Projects for Eastsound Village Urban Growth Area are presented here. Cost estimates for the capital improvement projects presented in this report were updated from costs developed in the 2005 Long Range Drainage Plan. Costs were escalated to 2014 dollars and the cost for water quality facilities were added to some projects. A new estimate was developed for the seven projects where the project design changed significantly.

Table D-1. Status of 2005 Eastsound Long Range Drainage Plan Projects.

2005 Project ID	Project Name	Project Implementation	2005 Cost ^a	Current CIP Project ID	Additional Water Quality Component ^b	2014 Cost ^c
1.1	Prune Alley to "Mount Property" Storm Drain	Partially Implemented				\$340,000
1.2	Fern Street Storm Drain: Madrona Street to Prune Alley		\$127,414	ES9	4 Facilities	
1.3	Rose Street Storm Drain: Madrona Street to Prune Alley		\$122,856	ES31	None	\$210,000
1.4	Pine Street Storm Drain		\$67,091	ES30	None	\$116,000
1.5	School Road Storm Drain: Madrona Street to Prune Alley		\$83,119	ES29	None	\$140,000
1.6	Market Street Storm Drain Improvements			ES44		\$420,000 ^d
2.1	Lover's Lane Storm Drain: Greer Lane to Waterfront Park		\$46,096	ES10	None	\$80,000
2.2	Greer Lane Roadside Ditch Improvements	Removed from List				
3.1	Orcas Road Storm Drain and Outfall: Gailey's First Addition	Removed from List				
4.1	"Mount Property" to Main Street Storm Drain	Completed				
4.2	"Mount Property" Stormwater Treatment Facility	Completed				
4.3	"A" Street to "Mount Property" Storm Drain with Flow Splitter	Partially Implemented				
4.4	Eastsound Swale Bypass Storm Drain	Obsolete				
4.5	Enchanted Forest Road Improvements	Removed from List				
4.6	Fishing Bay Outfall Erosion Protection	Completed				
4.7	Eastsound Swale Wetland Assessment and Enhancement	Removed from List				
5.1	West Airport Storm Drain: Lovers Lane to North Shore		\$450,236	ES33	None	\$780,000
5.2	Nina Lane Storm Drain			ES34	None	\$150,000 ^d
5.3	East Airport Storm Drain: North Beach Road to Marina		\$496,643	ES35	None	\$855,000
5.4	Mt. Baker Rd Ditch Improvement: Gibson Road to Lover's Lane		\$101,226	ES36	None	\$180,000
5.5	Mountain View Street Ditch Improvements		\$21,646	ES37	None	\$38,000
5.6	Blanchard Road Ditch Improvements: Nina Lane to Bunny Lane					
5.7	Blanchard Road Ditch Improvements: to Shady Lane		\$49,569	ES39	None	\$86,000
5.8	Twiggs Lane Ditch Improvements	Completed				

Table D-1 (continued). Status of 2005 Eastsound Long Range Drainage Plan Projects.

2005 Project ID	Project Name	Project Implementation	2005 Cost ^a	Current CIP Project ID	Additional Water Quality Component ^b	2014 Cost ^c
6.1	North Beach Road Storm Drain			ES26		\$260,000 to \$4,500,000 ^d
6.2a	Spruce, Alder and Hemlock Streets Storm Drain	Removed from List				
6.2b	Sunset Avenue Storm Drain	Removed from List				
6.3	Bartel Street Storm Drain	Removed from List				
7.1	Terrill Beach Road Storm Drain and Outfall	Completed				
7.2	Terrill Beach Wetland Assessment and Enhancement	Completed				
7.3	Terrill Beach Road and Mt. Baker Road Ditch Improvements	Removed from List				
8.1	Ship Bay Outfall Improvements			ES1		\$720,000 ^d
8.2	Olga Road and Ship Bay Ditch Improvements			ES1		
9.1	Montgomery Lane to Crescent Beach Storm Drain			ES3		\$640,000 ^d
9.2	Montgomery Lane Conveyance Improvement			ES3		
10.1	Buck Park Storm Drain	Removed from List				
10.2	Bracken Fern Lane Storm Drain			ES27		\$90,000 ^d
10.3	Crescent Beach Overflow Outfall			ES28		\$300,000 to \$3,600,000 ^d
10.4	Crescent Beach Wetland Enhancement	Removed from List				

Notes:

- ^a Cost estimates from Long Range Drainage Plan Proposal for Eastsound Village Urban Growth Area (2005) including a contingency equal to 20% of construction cost.
- ^b Additional water quality treatment facility, e.g., Filterra or Modular Wetland System, at an estimated \$35,000 per facility.
- ^c Cost escalated from 2005 dollars to 2014 dollars using Historic ENR CCI (7398.03 for May 2005) and Current ENR CCI (9845.59 for 2014) with a 50% contingency.
- ^d Cost developed independently based on significant scope and design differences from 2005 Drainage Plan Project including a 50% contingency.

2005 LONG RANGE DRAINAGE PLAN PROJECTS FOR LOPEZ VILLAGE URBAN GROWTH AREA

The status of projects and their estimated cost from the 2005 Long Range Drainage Plan Projects for Lopez Village Urban Growth Area are presented here. Cost estimates for the capital improvement projects presented in this report were updated from costs developed in the 2005 Long Range Drainage Plan. Costs were escalated to 2014 dollars and the cost for water quality facilities were added to some projects. A new estimate was developed for a handful of projects where the project design changed significantly.

2005 Project	Project Name	Implementation	2004 Cost ^a	2014 CIP Project	2014 Cost
A	Village Road Storm Drain (South)		\$35,000	FMB4	\$450,000 ^b
B	Lopez Center Drainage Ditch		\$45,000	FMB4	
C	Fisherman Bay Road Reconstruction	Removed from List	\$95,000		
D	Village Bypass Storm Drain	Removed from List	\$170,000		
E	Washburn Place Storm Drain		\$40,000		
F	Village Road Storm Drain (North)		\$50,000	FMB4	(see above)

Notes:

^a Cost estimates from Long Range Drainage Plan Proposal for Lopez Village Urban Growth Area (2005).

^b Cost developed independently based on significant scope and design differences from 2005 Drainage Plan Project.

APPENDIX E

Capital Improvement Project Cost Estimates



Subject: ES7 & ES44 - Market Street and Madrona Street Water Quality Improvements

Prepared by: C. Echterling

Checked by: Brian Busiek

Updated: May 12, 2015

Note: This cost estimate is approximate. Actual construction bids may vary significantly from this statement of probable costs due to timing of construction, changed conditions, labor rate changes, or other factors

ESTIMATED COST OF PROJECT IMPLEMENTATION AT PRELIMINARY DESIGN STAGE

NO.	QUANT.	UNIT	ITEM	UNIT COST	AMOUNT	BASIS OF QUANTITY AND UNIT COST
1	1	LS	MOBILIZATION	10%	\$ 22,551	
2	1	LS	EROSION/WATER POLLUTION CONTROL	2%	\$ 3,855	Inlet protection, manage stock piles, and daily sweeping by hand.
3	1	LS	UTILITY PROTECTION AND RELOCATION	10%	\$ 19,274	Assumes facility placement is adjusted during design to minimize utility conflicts. Conflicts are anticipated to be low because most piping follows existing pipe alignments.
4	1	LS	PROJECT TEMPORARY TRAFFIC CONTROL	5%	\$ 9,637.1	Cones and rope to exclude pedestrians from work area in field, temporary parking stall closures on street edge, temporary lane closures, flaggers, traffic control plan.
5	398	SY	REMOVING ASPHALT CONC. PVT., INCL. HAUL	\$ 11	\$ 4,378	The Guide Summer 2014. Excavate pavement, export within 10 mile radius, dump fees.
6	515	CY	STRUCTURE EXCAVATION CLASS B, INCL. HAUL	\$ 30	\$ 15,450	The Guide Summer 2014. Excavation, export within 10 mile radius, dump fees.
7	123	CY	BANK RUN GRAVEL FOR TRENCH BACKFILL	\$ 5	\$ 615	Use native material above pipe bedding.
8	113	TN	CRUSHED SURFACING TOP COURSE	\$ 75	\$ 8,475	High end for small quantity.
9	368	SY	PAVEMENT REPAIR	\$ 43	\$ 15,824	The Guide Summer 2014. Trench patching. Includes 2" asphaltic concrete, no base.
10	1	EA	MWS-LINEAR 4' x 13' UNIT	\$ 23,100	\$ 23,100	Vendor quote for system and estimated installation plus 10% for contractor markup.
11	1	EA	MWS-LINEAR 8' x 16' UNIT	\$ 49,500	\$ 49,500	Vendor quote for system and estimated installation plus 10% for contractor markup.
12	717	LF	SCH A STORM SEWER PIPE 8 IN DIA	\$ 20	\$ 14,300	WSDOT UBA. Assume all existing pipes are replaced.
13	297	LF	SCH A STORM SEWER PIPE 12 IN DIA	\$ 30	\$ 8,900	WSDOT UBA. Assume all existing pipes are replaced.
14	12	EA	CATCH BASIN TYPE 1	\$ 1,800	\$ 21,600	WSDOT UBA. Assume all existing CBs are replaced.
15	3	EA	CATCH BASIN TYPE 2	\$ 3,200	\$ 9,600	WSDOT UBA. Assume all existing CBs are replaced.
16	1	LS	DEMO PIPE AND CATCH BASIN	\$ 1,000	\$ 1,000	Remove approximately 55 LF of pipe and (1) Type 1 catch basin not incidental to pipe and catch basin replacements.
17	2000	SF	DEMO AND PLANT EXISTING SWALE	\$ 10	\$ 20,000	Assumes grading as needed to raise existing swale to match surrounding grade and planting at \$5 per SF.
SUBTOTAL OF DIRECT COSTS					\$ 248,059	
SALES TAX (DIRECT COSTS)				8.1%	\$ 20,093	
SUBTOTAL CONSTRUCTION COST					\$ 268,000	

ALLIED COSTS			UNIT COST	AMOUNT	BASIS OF QUANTITY AND UNIT COST
ITEM					
GRANT PROJECT ADMIN / MANAGEMENT			10%	\$ 27,000	Based on County experience managing similar projects.
SURVEY			LS	\$ 5,000	Additional survey and limited potholing for utilities.
GEOTECHNICAL ANALYSES			LS	\$ -	None required.
DESIGN			LS	\$ 30,000	2 storm drain plan and profile, 1 utility relocation sheet, 1 general sheet, 1 specifications for inclusion in County managed bid package. Plus Ecology design report. Custom details provided by vendor.
PERMITTING			LS	\$ 15,000	Assumes project is outside the shoreline jurisdiction and no wetland or stream impacts. Excavation over 500CY. Budget covers permit coordination and preparation of project specific SEPA checklist, cultural resources review, grading permit, and support during property owner coordination.
PROPERTY ACQUISITION			LS	\$ 5,000	Prucure easement for long term maintenance of storm drain system. Discussions with property owner indicate that a no cost easement may be possible.
CONSTRUCTION MANAGEMENT			20%	\$ 53,600	Based on input from County construction management experience.
CHANGE ORDERS			5%	\$ 13,000	Ecology grant allowance of 5% for change orders.
SUBTOTAL OF ALLIED COSTS				\$ 148,600	
SUMMARY					
SUBTOTAL CONSTRUCTION COST				\$ 268,000	
SUBTOTAL OF ALLIED COST				\$ 148,600	
PROJECT TOTAL				\$ 420,000	
SUMMARY BY GRANT TASK					
TASK 1 - GRANT PROJECT ADMINISTRATION / MANAGEMENT				\$ 27,000	
TASK 2 - DESIGN PLANS AND SPECIFICATIONS, ENVIRONMENTAL REVIEW, AND PERMITTING				\$ 55,000	Includes cost for procuring easement.
TASK 3 - CONSTRUCTION MANAGEMENT				\$ 53,600	
TASK 4 - CONSTRUCTION				\$ 268,000	
TASK 5 - CHANGE ORDERS				\$ 13,000	
PROJECT TOTAL				\$ 420,000	



Subject: ES8 & ES9 - Prune Alley and Fern Street Water Quality Improvements

Prepared by: M. Fontaine and K. Matsumura

Checked by: Brian Busiek

Updated: May 12, 2015

Note: This cost estimate is approximate. Actual construction bids may vary significantly from this statement of probable costs due to timing of construction, changed conditions, labor rate changes, or other factors

ESTIMATED COST OF PROJECT IMPLEMENTATION AT PRELIMINARY DESIGN STAGE

NO.	QUANT.	UNIT	ITEM	UNIT COST	AMOUNT	BASIS OF QUANTITY AND UNIT COST
1	1	LS	MOBILIZATION	8%	\$ 14,465	
2	1	LS	EROSION/WATER POLLUTION CONTROL	2%	\$ 3,091	Inlet protection, manage stock piles, and daily sweeping by hand.
3	1	LS	UTILITY PROTECTION AND RELOCATION	10%	\$ 15,454	Assumes facility placement is adjusted during design to minimize utility conflicts.
4	1	LS	PROJECT TEMPORARY TRAFFIC CONTROL	5%	\$ 7,727	Cones and rope to exclude pedestrians from work area in field, temporary parking stall closures on street edge, temporary lane closures, flaggers.
5	1,720	LF	SAWCUT ASPHALT PAVEMENT	\$ 2	\$ 3,440	Sawcut around structures and both sides of pipe trenches.
6	304	SY	REMOVE ASPHALT PAVEMENT	\$ 10	\$ 3,040	Remove pavement above pipes and structures.
7	2	SY	REMOVE STRUCTURE AND PLUG PIPE	\$ 500	\$ 1,000	Engineers estimate.
8	390	CY	STRUCTURE EXCAVATION CLASS B INCL. HAUL	\$ 20	\$ 7,800	WSDOT UBA.
9	100	CY	GRAVEL BACKFILL ABOVE PIPE ZONE	\$ 5	\$ 500	Use native material above pipe bedding.
10	89	TN	CRUSHED SURFACING TOP COURSE	\$ 75	\$ 6,675	High end for small qty.
10	289	SY	TRENCH PATCHING	\$ 45	\$ 13,005	The Guide Summer 2014. Trench patching.
11	573	LF	SCH A STORM SEWER PIPE 8 IN DIA	\$ 20	\$ 11,460	2/3 the price of 12" pipe
12	225	LF	SCH A STORM SEWER PIPE 12 IN DIA	\$ 30	\$ 6,750	WSDOT UBA.
13	7	LF	CATCH BASIN TYPE 1	\$ 1,800	\$ 12,600	WSDOT UBA.
14	1	LF	CATCH BASIN TYPE 2	\$ 3,200	\$ 3,200	WSDOT UBA.
15	1	EA	MWS-LINEAR 4' x 8' UNIT	\$ 19,723	\$ 19,723	Vendor quote for system and estimated installation plus 10% for contractor markup.
16	1	EA	MWS-LINEAR 4' x 15' UNIT	\$ 29,150	\$ 29,150	Vendor quote for system and estimated installation plus 10% for contractor markup.
17	2	EA	FILTERRA 4' x 4' UNIT	\$ 15,600	\$ 31,200	Vendor quote plus 20% for markup, incidentals, and installation.
18	1	EA	GROUNDWATER COLLECTION SYSTEM	\$ 5,000	\$ 5,000	Collect hillside seepage and convey to existing 18" storm drain and away from treatment BMP. Rough estimate. Assumes drywell with perforated collector pipes.
SUBTOTAL OF DIRECT COSTS					\$ 195,281	
SALES TAX (DIRECT COSTS)				8.1%	\$ 15,818	
SUBTOTAL CONSTRUCTION COST					\$ 211,000	

		ALLIED COSTS			
		ITEM	UNIT COST	AMOUNT	BASIS OF QUANTITY AND UNIT COST
		GRANT PROJECT ADMIN / MANAGEMENT	10%	\$ 21,000	Based on County experience managing similar projects.
		SURVEY	LS	\$ 10,000	Additional survey for utilities. Potholing for utilities.
		GEOTECHNICAL ANALYSES	LS		None required. Known groundwater issues.
		DESIGN	LS	\$ 35,000	3 storm drain plan and profile, 1 utility relocation sheet, 1 general sheet, 1 specifications for inclusion in County managed bid package. Plus Ecology design report. Custom details provided by vendor.
		PERMITTING	LS	\$ 8,000	Assumes project is outside the shoreline jurisdiction, no wetland or stream impacts, excavation under 500CY. Budget covers permit coordination and preparation of project specific SEPA checklist and cultural resources review.
		PROPERTY ACQUISITION	LS		None required. All work with right of way.
		CONSTRUCTION MANAGEMENT	20%	\$ 42,000	Based on input from County construction management experience.
		CHANGE ORDERS	5%	\$ 11,000	
SUBTOTAL OF ALLIED COSTS				\$ 127,000	
SUMMARY					
		SUBTOTAL CONSTRUCTION COST		\$ 211,000	
		SUBTOTAL OF ALLIED COST		\$ 127,000	
PROJECT TOTAL				\$ 340,000	
SUMMARY BY GRANT TASK					
TASK 1 - GRANT PROJECT ADMINISTRATION / MANAGEMENT				\$ 21,000	
TASK 2 - DESIGN PLANS AND SPECIFICATIONS, ENVIRONMENTAL REVIEW, AND PERMITTING				\$ 53,000	
TASK 3 - CONSTRUCTION MANAGEMENT				\$ 42,000	
TASK 4 - CONSTRUCTION				\$ 211,000	
TASK 5 - CHANGE ORDERS				\$ 11,000	
PROJECT TOTAL				\$ 340,000	



Subject: ES1 - Olga Road Conveyance and Outfall

Prepared by: M. Fontaine

Checked by: Brian Busiek

Updated: November 20, 2014

Note: This cost estimate is approximate. Actual construction bids may vary significantly from this statement of probable costs due to timing of construction, changed conditions, labor rate changes, or other factors beyond the control of the engineers.

ESTIMATED COST OF PROJECT IMPLEMENTATION AT INITIAL CONCEPT DESIGN STAGE

NO.	QUANT.	UNIT	ITEM	UNIT COST	AMOUNT	BASIS OF QUANTITY AND UNIT COST
1	1	LS	MOBILIZATION	10%	\$ 24,853	10% of total.
2	1	LS	EROSION/WATER POLLUTION CONTROL	5%	\$ 11,297	
3	1	LS	PROJECT TEMPORARY TRAFFIC CONTROL	5%	\$ 11,297	Traffic control on Olga Rd.
4	36	SY	REMOVING ASPHALT CONC. PVMT., INCL. HAUL	\$ 11	\$ 396	The Guide Summer 2014. Excavate pavement, export within 10 mile radius, dump fees.
5	371	CY	STRUCTURE EXCAVATION CLASS B INCL. HAUL	\$ 30	\$ 11,130	The Guide Summer 2014. Excavation, export within 10 mile radius, dump fees.
6	385	CY	DITCH EXCAVATION	\$ 20	\$ 7,700	WSDOT UBA
7	55	CY	BANK RUN GRAVEL FOR TRENCH BACKFILL	\$ 5	\$ 275	Use native soil.
8	38	TON	CRUSHED SURFACING TOP COURSE	\$ 75	\$ 2,850	High end for small qty.
9	36	SY	PAVEMENT REPAIR	\$ 43	\$ 1,548	The Guide Summer 2014. Trench patching. Includes 2" asphaltic concrete, no base.
10	120	LF	54" DIA CPEP	\$ 204	\$ 24,480	Based on price quote on phone from HDFowler. Quoted \$163/lf including freight to Eastsound. Add 20% for installation.
11	300	LF	54" HDPE	\$ 525	\$ 157,560	Based on price quote on phone from HDFowler. Quoted \$404/lf including freight to Anacortes. Add 30% for freight and installation.
12	1	LS	HEADWALL	\$ 2,000	\$ 2,000	Rough cost based on input from Contech on other projects.
13	1	LS	ANCHORS	\$ 15,000	\$ 15,000	Based on input from AESI. Deadman anchor at top of slope (\$10k), draping pipe down slope and anchoring at shoreline with gabion baskets or boulders (\$5k).
14	1	LS	HYDROSEED	\$ 3,000	\$ 3,000	Hydroseeding ditch and disturbed areas.
SUBTOTAL OF DIRECT COSTS					\$ 273,386	
SALES TAX (DIRECT COSTS)				8.1%	\$ 22,144	
TOTAL CONSTRUCTION COST					\$ 295,500	

ALLIED COSTS					
		ITEM	UNIT COST	AMOUNT	BASIS OF QUANTITY AND UNIT COST
		PROJECT ADMIN / MANAGEMENT	10%	\$ 30,000	Based on County experience managing similar projects.
		SURVEY	LS	\$ 5,000	Base mapping.
		GEOTECHNICAL ANALYSES	LS	\$ 20,000	Explorations and geotech report for anchoring pipe. Cost included input from AESI.
		DESIGN	LS	\$ 40,000	2 general sheets, 2 plan sheets, 1 sheet for outfall profile, 3 detail sheets.
		PERMITTING	LS	\$ 20,000	Assumes all work is above high water.
		PROPERTY ACQUISITION	LS	\$ 5,000	Easement acquisition.
		CONSTRUCTION MANAGEMENT	20%	\$ 59,100	
SUBTOTAL OF ALLIED COSTS				\$ 179,100	
SUMMARY					
		SUBTOTAL OF DIRECT COSTS		\$ 273,386	
		SUBTOTAL OF ALLIED COST		\$ 179,100	
		SALES TAX (ON DIRECT COSTS)		\$ 22,144	
PROJECT TOTAL				\$ 475,000	
CONTINGENCY 50%				\$ 240,000	
TOTAL WITH CONTINGENCY				\$ 720,000	



Subject: ES26 North Beach Road Outfall. Option 1 - Outfall to Smugglers Marina

Prepared by: M. Fontaine and K. Matsumura

Checked by: Brian Busiek

Updated: December 4, 2014

Note: This cost estimate is approximate. Actual construction bids may vary significantly from this statement of probable costs due to timing of construction, changed conditions, labor rate changes, or other factors beyond the control of the engineers.

ESTIMATED COST OF PROJECT IMPLEMENTATION AT INITIAL CONCEPT DESIGN STAGE

NO.	QUANT.	UNIT	ITEM	UNIT COST	AMOUNT	BASIS OF QUANTITY AND UNIT COST
1	1	LS	MOBILIZATION	10%	\$ 5,842.20	
2	1	LS	EROSION/WATER POLLUTION CONTROL	2%	\$ 1,113	
3	1	LS	PROJECT TEMPORARY TRAFFIC CONTROL	3%	\$ 1,669	Close beach access. Signs and occasional flaggers on Hunt Road.
4	135	SY	REMOVING ASPHALT CONC. PVMT., INCL. HAUL	\$ 11	\$ 1,485	The Guide Summer 2014. Excavate pavement, export within 10 mile radius, dump fees.
5	325	CY	STRUCTURE EXCAVATION CLASS B, INCL. HAUL	\$ 30	\$ 9,750	The Guide Summer 2014. Excavation, export within 10 mile radius, dump fees.
6	65	CY	BANK RUN GRAVEL FOR TRENCH BACKFILL	\$ 5	\$ 325	Use native soil.
7	57	TN	CRUSHED SURFACING TOP COURSE	\$ 75	\$ 4,275	High end for small quantity.
8	135	TN	PAVEMENT REPAIR	\$ 43	\$ 5,805	The Guide Summer 2014. Trench patching. Includes 2" asphaltic concrete, no base.
9	2	EA	CATCH BASIN TYPE 2	\$ 3,200	\$ 6,400	WSDOT UBA
10	460	LF	24" DIA CPEP	\$ 60	\$ 27,600	WSDOT UBA. Confirmed material price of \$34/lf with HD Fowler.
			SUBTOTAL OF DIRECT COSTS		\$ 64,264	
			SALES TAX (DIRECT COSTS)	8.1%	\$ 5,205	
			TOTAL CONSTRUCTION COST		\$ 69,500	

		ALLIED COSTS			
		ITEM	UNIT COST	AMOUNT	BASIS OF QUANTITY AND UNIT COST
		PROJECT ADMIN / MANAGEMENT	10%	\$ 7,000	Based on County experience managing similar projects.
		SURVEY	LS	\$ 5,000	Base mapping.
		GEOTECHNICAL ANALYSES	LS	\$ -	Assumes none required.
		DESIGN	LS	\$ 10,000	Including hydrologic and hydraulic modeling.
		PERMITTING	LS	\$ 60,000	
		PROPERTY ACQUISITION	LS	\$ 5,000	Procure easement.
		CONSTRUCTION MANAGEMENT	20%	\$ 13,900	
SUBTOTAL OF ALLIED COSTS				\$ 100,900	
SUMMARY					
		SUBTOTAL OF DIRECT COSTS		\$ 64,264	
		SUBTOTAL OF ALLIED COST		\$ 100,900	
		SALES TAX (ON DIRECT COSTS)		\$ 5,205	
PROJECT TOTAL				\$ 170,000	
CONTINGENCY				50% \$ 90,000	
TOTAL WITH CONTINGENCY				\$ 260,000	



Subject: ES26 North Beach Road Outfall. Option 2 - Replacement Beach Outfall

Prepared by: M. Fontaine and K. Matsumura

Checked by: Brian Busiek

Updated: December 4, 2014

Note: This cost estimate is approximate. Actual construction bids may vary significantly from this statement of probable costs due to timing of construction, changed conditions, labor rate changes, or other factors beyond the control of the engineers.

ESTIMATED COST OF PROJECT IMPLEMENTATION AT INITIAL CONCEPT DESIGN STAGE

NO.	QUANT.	UNIT	ITEM	UNIT COST	AMOUNT	BASIS OF QUANTITY AND UNIT COST
1	1	LS	MOBILIZATION	10%	\$ 3,726.42	
2	1	LS	EROSION/WATER POLLUTION CONTROL	2%	\$ 717	
3	1	LS	PROJECT TEMPORARY TRAFFIC CONTROL	2%	\$ 717	Close beach access and signs at road end.
4	100	LF	24" DIA HDPE PIPE	\$ 90	\$ 9,000	Based on \$63/lf quoted from HD Fowler. Add 30% for shipping, connections, and markup. Roundup.
5	46	CY	STRUCTURE EXCAVATION CLASS B, INCL. HAUL	\$ 30	\$ 1,380	The Guide Summer 2014. Excavation, export within 10 mile radius, dump fees.
6	18	CY	BANK RUN GRAVEL FOR TRENCH BACKFILL	\$ 5	\$ 90	Use native soil.
7	8	TN	CRUSHED SURFACING TOP COURSE	\$ 75	\$ 600	High end for small quantity.
8	27	SY	PAVEMENT REPAIR	\$ 43	\$ 1,161	The Guide Summer 2014. Trench patching. Includes 2" asphaltic concrete, no base.
9	2	EA	CATCH BASIN TYPE 1	\$ 1,800	\$ 3,600	WSDOT UBA. Includes tying into existing storm line.
10	1	LS	MITIGATION AND SITE RESTORATION	\$ 20,000	\$ 20,000	Beach nourishment or other low cost mitigation.
SUBTOTAL OF DIRECT COSTS					\$ 40,991	
SALES TAX (DIRECT COSTS)				8.1%	\$ 3,320	
TOTAL CONSTRUCTION COST					\$ 44,300	

ALLIED COSTS				
	ITEM	UNIT COST	AMOUNT	BASIS OF QUANTITY AND UNIT COST
	PROJECT ADMIN / MANAGEMENT	10%	\$ 4,000	Based on County experience managing similar projects.
	SURVEY	LS	\$ 2,500	Base mapping.
	GEOTECHNICAL ANALYSES	LS	\$ -	Assume none required.
	DESIGN	LS	\$ 20,000	2 sheets. 1 plan and profile. 1 notes and details. Hydrologic and hydraulic modeling.
	PERMITTING	LS	\$ 120,000	Complex permitting and public involvement.
	PROPERTY ACQUISITION	LS		Assume none required.
	CONSTRUCTION MANAGEMENT	20%	\$ 8,860	
SUBTOTAL OF ALLIED COSTS			\$ 155,400	
SUMMARY				
	SUBTOTAL OF DIRECT COSTS		\$ 40,991	
	SUBTOTAL OF ALLIED COST		\$ 155,400	
	SALES TAX (ON DIRECT COSTS)		\$ 3,320	
PROJECT TOTAL			\$ 200,000	
CONTINGENCY			50% \$ 100,000	
TOTAL WITH CONTINGENCY			\$ 300,000	



Subject: ES26 North Beach Road Outfall. Option 3 - New 24" Outfall to 30' Below MLLW

Prepared by: M. Fontaine and K. Matsumura

Checked by: Brian Busiek

Updated: December 4, 2014

Note: This cost estimate is approximate. Actual construction bids may vary significantly from this statement of probable costs due to timing of construction, changed conditions, labor rate changes, or other factors beyond the control of the engineers.

ESTIMATED COST OF PROJECT IMPLEMENTATION AT INITIAL CONCEPT DESIGN STAGE

NO.	QUANT.	UNIT	ITEM	UNIT COST	AMOUNT	BASIS OF QUANTITY AND UNIT COST
1	1	LS	DIRECTIONAL DRILL 24" DIA TO -30 MLLW	\$ 1,100,000	\$ 1,100,000	Budgetary estimate from HDD company.
2	1650	LF	24" DIA HDPE PIPE	\$ 90	\$ 148,500	
3	1	LS	MARINE ACTIVITIES	\$ 700,000	\$ 700,000	Budgetary estimate from HDD company.
SUBTOTAL OF DIRECT COSTS					\$ 1,948,500	
SALES TAX (DIRECT COSTS)				8.1%	\$ 157,829	
TOTAL CONSTRUCTION COST					\$ 2,100,000	

			ALLIED COSTS			
			ITEM	UNIT COST	AMOUNT	BASIS OF QUANTITY AND UNIT COST
			PROJECT ADMIN / MANAGEMENT	10%	\$ 210,000	Based on County experience managing similar projects.
			SURVEY	LS	\$ 20,000	Base mapping and bathymetry.
			GEOTECHNICAL ANALYSES	LS	\$ 250,000	Assumes borings spaced every 100 linear feet on-shore and off-shore.
			DESIGN	5%	\$ 110,000	
			PERMITTING	LS	\$ 100,000	Complex Permitting. JARPA for HPA and Corps Permit.
			PROPERTY ACQUISITION	LS	\$ -	Assumed no cost.
			CONSTRUCTION MANAGEMENT	10%	\$ 210,000	
SUBTOTAL OF ALLIED COSTS					\$ 900,000	
SUMMARY						
			SUBTOTAL OF DIRECT COSTS		\$ 1,948,500	
			SUBTOTAL OF ALLIED COST		\$ 900,000	
			SALES TAX (ON DIRECT COSTS)		\$ 157,829	
PROJECT TOTAL					\$ 3,000,000	
CONTINGENCY				50%	\$ 1,500,000	
TOTAL WITH CONTINGENCY					\$ 4,500,000	



Subject: ES3 - Montgomery Lane to Crescent Beach Conveyance

Prepared by: M. Fontaine and K. Matsumura

Checked by: Brian Busiek

Updated: June 12, 2015

Note: This cost estimate is approximate. Actual construction bids may vary significantly from this statement of probable costs due to timing of construction, changed conditions, labor rate changes, or other factors beyond the control of the engineers.

ESTIMATED COST OF PROJECT IMPLEMENTATION AT INITIAL CONCEPT DESIGN STAGE

NO.	QUANT.	UNIT	ITEM	UNIT COST	AMOUNT	BASIS OF QUANTITY AND UNIT COST
1	1	LS	MOBILIZATION	10%	\$ 20,422	
2	1	LS	EROSION/WATER POLLUTION CONTROL	5%	\$ 9,283	
3	1	LS	PROJECT TEMPORARY TRAFFIC CONTROL	5%	\$ 9,283	Traffic control on Crescent Beach Dr and Montgomery lane.
4	394	CY	STRUCTURE EXCAVATION CLASS B INCL. HAUL	\$ 30	\$ 11,820	The Guide Summer 2014. Excavation, export within 10 mile radius, dump fees.
5	23	SY	REMOVING ASPHALT CONC. PVMT., INCL. HAUL	\$ 11	\$ 253	The Guide Summer 2014. Excavate pavement, export within 10 mile radius, dump fees.
6	414	CY	DITCH EXCAVATION	\$ 20	\$ 8,280	WSDOT UBA
7	147	CY	BANK RUN GRAVEL FOR TRENCH BACKFILL	\$ 5	\$ 735	Use native soil.
8	21	TON	CRUSHED SURFACING TOP COURSE	\$ 75	\$ 1,580	High end for small qty.
9	23	SY	PAVEMENT REPAIR	\$ 43	\$ 989	The Guide Summer 2014. Trench patching. Includes 2" asphaltic concrete, no base.
10	220	LF	12" DIA CPEP	\$ 30	\$ 6,600	WSDOT UBA
11	540	LF	18" DIA CPEP	\$ 50	\$ 27,000	WSDOT UBA.
12	80	LF	12" DIA HDPE	\$ 30	\$ 2,400	WSDOT UBA. For outfall.
13	1	EA	DIVERSION STRUCTURE	\$ 15,000	\$ 15,000	Recent bids, chambers lake.
14	4	EACH	ANCHORS	\$ 2,500	\$ 10,000	Helical anchors w/ pipe saddle every 20 lf of pipe. Based on input by AESI.
15	1	LS	HYDROSEED	\$ 1,000	\$ 1,000	Hydroseeding ditch and disturbed areas.
16	1	LS	WATER QUALITY FACILITY	\$ 100,000	\$ 100,000	Order of Magnitude. Unsized.
SUBTOTAL OF DIRECT COSTS					\$ 224,645	
SALES TAX (DIRECT COSTS)					8.1%	\$ 18,196
TOTAL CONSTRUCTION COST					\$ 242,841	

ALLIED COSTS					
		ITEM	UNIT COST	AMOUNT	BASIS OF QUANTITY AND UNIT COST
		PROJECT ADMIN / MANAGEMENT	10%	\$ 24,000	Based on County experience managing similar projects.
		SURVEY	LS	\$ 5,000	Base mapping.
		GEOTECHNICAL ANALYSES	LS	\$ 15,000	PIT test and test pits for small water quality treatment facility. Geotech report. Cost included input from AESI.
		DESIGN	20%	\$ 49,000	
		PERMITTING	LS	\$ 60,000	Complex permitting due to wetland precence and steep slopes.
		PROPERTY ACQUISITION	LS		Assumes none. Uses land bank property for WQ facility.
		CONSTRUCTION MANAGEMENT	20%	\$ 49,000	
SUBTOTAL OF ALLIED COSTS				\$ 202,000	
SUMMARY					
		SUBTOTAL OF DIRECT COSTS		\$ 224,645	
		SUBTOTAL OF ALLIED COST		\$ 202,000	
		SALES TAX (ON DIRECT COSTS)		\$ 18,196	
PROJECT TOTAL				\$ 445,000	
CONTINGENCY 50%				\$ 220,000	
TOTAL WITH CONTINGENCY				\$ 670,000	



Subject: ES28 Crescent Beach Wetland Outfall. Option 1 - New Shoreline Outfall

Prepared by: M. Fontaine and K. Matsumura

Checked by: Brian Busiek

Updated: December 4, 2014

Note: This cost estimate is approximate. Actual construction bids may vary significantly from this statement of probable costs due to timing of construction, changed conditions, labor rate changes, or other factors beyond the control of the engineers.

ESTIMATED COST OF PROJECT IMPLEMENTATION AT INITIAL CONCEPT DESIGN STAGE

NO.	QUANT.	UNIT	ITEM	UNIT COST	AMOUNT	BASIS OF QUANTITY AND UNIT COST
1	1	LS	MOBILIZATION	10%	\$ 3,409	
2	1	LS	EROSION/WATER POLLUTION CONTROL	5%	\$ 1,593	
3	1	LS	PROJECT TEMPORARY TRAFFIC CONTROL	2%	\$ 637	Temporary closure of Crescent Beach Drive.
4	100	LF	18" DIA HDPE PIPE	\$ 50	\$ 5,000	Based on \$35/lf quoted from HD Fowler. Add 30% for shipping, connections, and markup. Roundup.
5	46	CY	STRUCTURE EXCAVATION CLASS B, INCL. HAUL	\$ 30	\$ 1,380	The Guide Summer 2014. Excavation, export within 10 mile radius, dump fees.
6	23	CY	BANK RUN GRAVEL FOR TRENCH BACKFILL	\$ 5	\$ 115	Use native soil.
7	8	TN	CRUSHED SURFACING TOP COURSE	\$ 75	\$ 600	High end for small quantity.
8	27	SY	PAVEMENT REPAIR	\$ 43	\$ 1,161	The Guide Summer 2014. Trench patching. Includes 2" asphaltic concrete, no base.
9	2	EA	CATCH BASIN TYPE 1	\$ 1,800	\$ 3,600	WSDOT UBA.
10	1	LS	MITIGATION AND SITE RESTORATION	\$ 20,000	\$ 20,000	Beach nourishment or other low cost mitigation.
SUBTOTAL OF DIRECT COSTS					\$ 37,495	
SALES TAX (DIRECT COSTS)				8.1%	\$ 3,037	
TOTAL CONSTRUCTION COST					\$ 40,500	

ALLIED COSTS				
ITEM	UNIT COST	AMOUNT	BASIS OF QUANTITY AND UNIT COST	
PROJECT ADMIN / MANAGEMENT	10%	\$ 4,000	Based on County experience managing similar projects.	
SURVEY	LS	\$ 2,500	Base mapping.	
GEOTECHNICAL ANALYSES	LS	\$ -	Assume none required.	
DESIGN	LS	\$ 20,000	2 sheets. 1 plan and profile. 1 notes and details. Additional hydrologic and hydraulic modeling and conduct wetland hydroperiod study.	
PERMITTING	LS	\$ 120,000	Complex permitting and public involvement.	
PROPERTY ACQUISITION	LS	\$ 5,000	Procure easement.	
CONSTRUCTION MANAGEMENT	20%	\$ 8,100		
SUBTOTAL OF ALLIED COSTS		\$ 159,600		
SUMMARY				
SUBTOTAL OF DIRECT COSTS		\$ 37,495		
SUBTOTAL OF ALLIED COST		\$ 159,600		
SALES TAX (ON DIRECT COSTS)		\$ 3,037		
PROJECT TOTAL		\$ 200,000		
CONTINGENCY 50%		\$ 100,000		
TOTAL WITH CONTINGENCY		\$ 300,000		



Subject: ES28 Crescent Beach Wetland Outfall. Option 2 - New 24" Outfall to 10' Below MLLW

Prepared by: M. Fontaine and K. Matsumura

Checked by: Brian Busiek

Updated: May 12, 2015

Note: This cost estimate is approximate. Actual construction bids may vary significantly from this statement of probable costs due to timing of construction, changed conditions, labor rate changes, or other factors beyond the control of the engineers.

ESTIMATED COST OF PROJECT IMPLEMENTATION AT INITIAL CONCEPT DESIGN STAGE

NO.	QUANT.	UNIT	ITEM	UNIT COST	AMOUNT	BASIS OF QUANTITY AND UNIT COST
1	1	LS	DIRECTIONAL DRILL 24" DIA TO -10 MLLW	\$ 989,000	\$ 989,000	Budgetary estimate from HDD company.
2	1400	LF	24" DIA HDPE PIPE	\$ 90	\$ 126,000	
3	1	LS	MARINE ACTIVITIES	\$ 500,000	\$ 500,000	Budgetary estimate from HDD company.
SUBTOTAL OF DIRECT COSTS					\$ 1,615,000	
SALES TAX (DIRECT COSTS)				8.1%	\$ 130,815	
TOTAL CONSTRUCTION COST					\$ 1,700,000	

			ALLIED COSTS			
			ITEM	UNIT COST	AMOUNT	BASIS OF QUANTITY AND UNIT COST
			PROJECT ADMIN / MANAGEMENT	10%	\$ 170,000	Based on County experience managing similar projects.
			SURVEY	LS	\$ 20,000	Base mapping and bathymetry.
			GEOTECHNICAL ANALYSES	LS	\$ 125,000	Assumes borings spaced every 100 linear feet on-shore and off-shore.
			DESIGN	5%	\$ 90,000	
			PERMITTING	LS	\$ 100,000	Complex Permitting. JARPA for HPA and Corps Permit.
			PROPERTY ACQUISITION	LS	\$ -	Assumed no cost.
			CONSTRUCTION MANAGEMENT	10%	\$ 170,000	
SUBTOTAL OF ALLIED COSTS					\$ 675,000	
SUMMARY						
			SUBTOTAL OF DIRECT COSTS		\$ 1,615,000	
			SUBTOTAL OF ALLIED COST		\$ 675,000	
			SALES TAX (ON DIRECT COSTS)		\$ 130,815	
PROJECT TOTAL					\$ 2,400,000	
CONTINGENCY 50%					\$ 1,200,000	
TOTAL WITH CONTINGENCY					\$ 3,600,000	



Subject: ES18 - Rosario Road Drainage Improvements

Prepared by: M. Fontaine and K. Matsumura

Checked by: Brian Busiek

Updated: November 20, 2014

Note: This cost estimate is approximate. Actual construction bids may vary significantly from this statement of probable costs due to timing of construction, changed conditions, labor rate changes, or other factors beyond the control of the engineers.

ESTIMATED COST OF PROJECT IMPLEMENTATION AT INITIAL CONCEPT DESIGN STAGE

NO.	QUANT.	UNIT	ITEM	UNIT COST	AMOUNT	BASIS OF QUANTITY AND UNIT COST
1	1	LS	MOBILIZATION	10%	\$ 2,276	
2	1	LS	EROSION/WATER POLLUTION CONTROL	5%	\$ 990	
3	1	LS	PROJECT TEMPORARY TRAFFIC CONTROL	10%	\$ 1,979	Complex traffic control on curvy steep road.
4	311	CY	DITCH EXCAVATION	\$ 20	\$ 6,220	Assumes 3 cf per lf of ditch. WSDOT UBA.
5	41	CY	STRUCTURE EXCAVATION CLASS B INCL. HAUL	\$ 30	\$ 1,230	The Guide Summer 2014. Excavation, export within 10 mile radius, dump fees.
6	11	CY	BANK RUN GRAVEL FOR TRENCH BACKFILL	\$ 5	\$ 55	Use native soil.
7	8	TN	CRUSHED SURFACING TOP COURSE	\$ 100	\$ 800	High end for small quantity.
8	333	SY	PAVEMENT FOR APRON	\$ 20	\$ 6,667	200' x 15' x 2" BST apron. Price per SY for BST from Russ Harvey.
9	33	SY	PAVEMENT REPAIR	\$ 43	\$ 1,419	The Guide Summer 2014. Trench patching. Includes 2" asphaltic concrete, no base.
10	80	LF	12" DIA CPEP	\$ 30	\$ 2,400	WSDOT UBA
11	1	LS	SITE RESTORATION	\$ 1,000	\$ 1,000	Some plantings on private property.
SUBTOTAL OF DIRECT COSTS					\$ 25,035	
SALES TAX (DIRECT COSTS)				8.1%	\$ 2,028	
TOTAL CONSTRUCTION COST					\$ 27,100	

		ALLIED COSTS			
		ITEM	UNIT COST	AMOUNT	BASIS OF QUANTITY AND UNIT COST
		PROJECT ADMIN / MANAGEMENT	10%	\$ 3,000	Based on County experience managing similar projects.
		SURVEY	LS		
		GEOTECHNICAL ANALYSES	LS	\$ -	Assume none required.
		DESIGN	LS	\$ 10,000	2 sheets. 1 plan and profile. 1 notes, details, and sections
		PERMITTING	LS	\$ 5,000	Clearing and grading permit.
		PROPERTY ACQUISITION	LS	\$ -	Assume none required.
		CONSTRUCTION MANAGEMENT	20%	\$ 5,420	
SUBTOTAL OF ALLIED COSTS				\$ 23,400	
SUMMARY					
		SUBTOTAL OF DIRECT COSTS		\$ 25,035	
		SUBTOTAL OF ALLIED COST		\$ 23,400	
		SALES TAX (ON DIRECT COSTS)		\$ 2,028	
PROJECT TOTAL				\$ 50,000	
CONTINGENCY				50% \$ 25,000	
TOTAL WITH CONTINGENCY				\$ 75,000	



Subject: ES19 - Rosario Neighborhood Drainage

Prepared by: M. Fontaine and K. Matsumura

Checked by: Brian Busiek

Updated: May 12, 2015

Note: This cost estimate is approximate. Actual construction bids may vary significantly from this statement of probable costs due to timing of construction, changed conditions, labor rate changes, or other factors beyond the control of the engineers.

ESTIMATED COST OF PROJECT IMPLEMENTATION AT INITIAL CONCEPT DESIGN STAGE

NO.	QUANT.	UNIT	ITEM	UNIT COST	AMOUNT	BASIS OF QUANTITY AND UNIT COST
1	1	LS	MOBILIZATION	10%	\$ 13,578	
2	1	LS	EROSION/WATER POLLUTION CONTROL	3%	\$ 3,772	
3	1	LS	PROJECT TEMPORARY TRAFFIC CONTROL	5%	\$ 6,286	Traffic control on private roads.
4	155	CY	DITCH EXCAVATION	\$ 20	\$ 3,100	Assumes 3 cf per lf of ditch. WSDOT UBA.
5	20	CY	STRUCTURE EXCAVATION CLASS B INCL. HAUL	\$ 30	\$ 600	The Guide Summer 2014. Excavation, export within 10 mile radius, dump fees.
6	5	CY	BANK RUN GRAVEL FOR TRENCH BACKFILL	\$ 5	\$ 25	Use native soil.
7	4	TN	CRUSHED SURFACING TOP COURSE	\$ 75	\$ 300	High end for small quantity.
8	150	LF	18" DIA CPEP PIPE	\$ 50	\$ 7,500	WSDOT UBA
9	1,400	LF	18" DIA HDPE PIPE	\$ 50	\$ 70,000	Based on \$35/lf quoted from HD Fowler. Add 30% for shipping, connections, and markup. Roundup.
10	4	EA	CATCH BASIN TYPE 1	\$ 1,800	\$ 7,200	WSDOT UBA
11	1	LS	SITE RESTORATION	\$ 2,000	\$ 2,000	Some plantings on private property.
12	35	EACH	ANCHORS	\$ 1,000	\$ 35,000	Grouted rock anchor w/ pipe saddle every 40 lf of pipe. Base on input from AESI.
SUBTOTAL OF DIRECT COSTS					\$ 149,361	
SALES TAX (DIRECT COSTS)				8.1%	\$ 12,098	
TOTAL CONSTRUCTION COST					\$ 161,500	

ALLIED COSTS				
ITEM	UNIT COST			
PROJECT ADMIN / MANAGEMENT	10%	\$ 16,000		Based on County experience managing similar projects.
SURVEY	LS	\$ 3,000		Base mapping.
GEOTECHNICAL ANALYSES	LS	\$ 5,000		Explorations and geotech report for anchoring pipe. Based on input from AESI.
DESIGN	LS	\$ 20,000		4 sheets. 2 plan and profile. 2 notes, details, and sections.
PERMITTING	LS	\$ 50,000		If shoreline outfall is included cost could be 100,000. If shoreline outfall is not included, cost could go down to 20,000.
PROPERTY ACQUISITION	LS	\$ 5,000		Easement acquisition.
CONSTRUCTION MANAGEMENT	20%	\$ 32,300		
SUBTOTAL OF ALLIED COSTS		\$ 131,300		
SUMMARY				
SUBTOTAL OF DIRECT COSTS		\$ 149,361		
SUBTOTAL OF ALLIED COST		\$ 131,300		
SALES TAX (ON DIRECT COSTS)		\$ 12,098		
PROJECT TOTAL		\$ 290,000		
CONTINGENCY 50%		\$ 150,000		
TOTAL WITH CONTINGENCY		\$ 440,000		



Subject: ES13 - Myer Street and Langell Lane Conveyance

Prepared by: M. Fontaine and K. Matsumura

Checked by: Brian Busiek

Updated: November 20, 2014

Note: This cost estimate is approximate. Actual construction bids may vary significantly from this statement of probable costs due to timing of construction, changed conditions, labor rate changes, or other factors beyond the control of the engineers.

ESTIMATED COST OF PROJECT IMPLEMENTATION AT INITIAL CONCEPT DESIGN STAGE

NO.	QUANT.	UNIT	ITEM	UNIT COST	AMOUNT	BASIS OF QUANTITY AND UNIT COST
1	1	LS	MOBILIZATION	10%	\$ 4,354	
2	1	LS	EROSION/WATER POLLUTION CONTROL	5%	\$ 1,979	
3	1	LS	PROJECT TEMPORARY TRAFFIC CONTROL	5%	\$ 1,979	Traffic control on Myer Street and Langell Lane.
4	33	CY	DITCH EXCAVATION	\$ 20	\$ 660	300 lf of ditch at 3 cf per lf of ditch. WSDOT UBA.
5	20	CY	STRUCTURE EXCAVATION CLASS B, INCL. HAUL	\$ 30	\$ 600	The Guide Summer 2014. Excavation, export within 10 mile radius, dump fees.
6	5	CY	BANK RUN GRAVEL FOR TRENCH BACKFILL	\$ 5	\$ 25	Use native soil.
7	4	TN	CRUSHED SURFACING TOP COURSE	\$ 75	\$ 300	High end for small quantity.
8	440	LF	18" DIA HDPE PIPE	\$ 50	\$ 22,000	Based on \$35/lf quoted from HD Fowler. Add 30% for shipping, connections, and markup. Roundup.
9	1	LS	SITE RESTORATION	\$ 5,000	\$ 5,000	Some plantings on private property.
10	11	EACH	ANCHORS	\$ 1,000	\$ 11,000	Grouted rock anchor w/ pipe saddle every 40 lf of pipe. Based on input from AESI.
SUBTOTAL OF DIRECT COSTS					\$ 47,898	
SALES TAX (DIRECT COSTS)				8.1%	\$ 3,880	
TOTAL CONSTRUCTION COST					\$ 51,800	

ALLIED COSTS				
	ITEM	UNIT COST	AMOUNT	BASIS OF QUANTITY AND UNIT COST
	PROJECT ADMIN / MANAGEMENT	10%	\$ 5,000	Based on County experience managing similar projects.
	SURVEY	LS	\$ 3,000	Base mapping.
	GEOTECHNICAL ANALYSES	LS		
	DESIGN	LS	\$ 20,000	2 sheets. 1 plan and profile. 1 notes and details.
	PERMITTING	LS	\$ 20,000	Assumes work is restricted to above OHWM but project includes work in shoreline jurisdiction.
	PROPERTY ACQUISITION	LS	\$ 5,000	Easement acquisition.
	CONSTRUCTION MANAGEMENT	20%	\$ 10,360	
SUBTOTAL OF ALLIED COSTS			\$ 63,400	
SUMMARY				
	SUBTOTAL OF DIRECT COSTS		\$ 47,898	
	SUBTOTAL OF ALLIED COST		\$ 63,400	
	SALES TAX (ON DIRECT COSTS)		\$ 3,880	
PROJECT TOTAL			\$ 120,000	
CONTINGENCY			50% \$ 60,000	
TOTAL WITH CONTINGENCY			\$ 180,000	



Subject: ES27 - Bracken Fern Ln Drainage Improvements

Prepared by: M. Fontaine and K. Matsumura

Checked by: Brian Busiek

Updated: May 12, 2014

Note: This cost estimate is approximate. Actual construction bids may vary significantly from this statement of probable costs due to timing of construction, changed conditions, labor rate changes, or other factors beyond the control of the engineers.

ESTIMATED COST OF PROJECT IMPLEMENTATION AT INITIAL CONCEPT DESIGN STAGE

NO.	QUANT.	UNIT	ITEM	UNIT COST	AMOUNT	BASIS OF QUANTITY AND UNIT COST
1	1	LS	MOBILIZATION	10%	\$ 3,537.96	
2	1	LS	EROSION/WATER POLLUTION CONTROL	5%	\$ 1,653	
3	1	LS	PROJECT TEMPORARY TRAFFIC CONTROL	2%	\$ 661	Traffic control on private roads.
4	166	CY	DITCH EXCAVATION	\$ 20	\$ 3,320	Assumes 3 cf per lf of ditch. WSDOT UBA.
5	168	CY	STRUCTURE EXCAVATION CLASS B, INCL. HAUL	\$ 30	\$ 5,040	The Guide Summer 2014. Excavation, export within 10 mile radius, dump fees.
6	51	CY	BANK RUN GRAVEL FOR TRENCH BACKFILL	\$ 5	\$ 255	Use native soil.
7	38	TN	CRUSHED SURFACING TOP COURSE	\$ 75	\$ 2,850	High end for small quantity.
8	400	LF	12" DIA CPEP	\$ 40	\$ 16,000	WSDOT UBA
9	2	EA	CATCH BASIN TYPE 1	\$ 1,800	\$ 3,600	WSDOT UBA. Includes tying into storm line.
10	1	LS	SITE RESTORATION	\$ 2,000	\$ 2,000	Hydroseed ditches and disturbed areas.
SUBTOTAL OF DIRECT COSTS					\$ 38,918	
SALES TAX (DIRECT COSTS)				8.1%	\$ 3,152	
TOTAL CONSTRUCTION COST					\$ 42,100	

ALLIED COSTS				
	ITEM	UNIT COST	AMOUNT	BASIS OF QUANTITY AND UNIT COST
	PROJECT ADMIN / MANAGEMENT	10%	\$ 4,000	Based on County experience managing similar projects.
	SURVEY	LS	\$ 3,000	Base mapping.
	GEOTECHNICAL ANALYSES	LS	\$ -	Assume none required.
	DESIGN	LS		
	PERMITTING	LS	\$ 5,000	Grading permit.
	PROPERTY ACQUISITION	LS	\$ -	Assumes none required. System will be turned over to property owners.
	CONSTRUCTION MANAGEMENT	20%	\$ 5,000	
SUBTOTAL OF ALLIED COSTS			\$ 17,000	
SUMMARY				
	SUBTOTAL OF DIRECT COSTS		\$ 38,918	
	SUBTOTAL OF ALLIED COST		\$ 17,000	
	SALES TAX (ON DIRECT COSTS)		\$ 3,152	
PROJECT TOTAL			\$ 59,000	
CONTINGENCY 50%			\$ 30,000	
TOTAL WITH CONTINGENCY			\$ 90,000	



Subject: ES34 - Blanchard Road and Nina Lane

Prepared by: M. Fontaine and K. Matsumura

Checked by: Brian Busiek

Updated: November 20, 2014

Note: This cost estimate is approximate. Actual construction bids may vary significantly from this statement of probable costs due to timing of construction, changed conditions, labor rate changes, or other factors beyond the control of the engineers.

ESTIMATED COST OF PROJECT IMPLEMENTATION AT INITIAL CONCEPT DESIGN STAGE

NO.	QUANT.	UNIT	ITEM	UNIT COST	AMOUNT	BASIS OF QUANTITY AND UNIT COST
1	1	LS	MOBILIZATION	10%	\$ 3,119.08	
2	1	LS	EROSION/WATER POLLUTION CONTROL	3%	\$ 891	
3	1	LS	PROJECT TEMPORARY TRAFFIC CONTROL	2%	\$ 594	Traffic control on small gravel road.
4	98	CY	DITCH EXCAVATION	\$ 20	\$ 1,956	Assumes 8 cf per lf of ditch. WSDOT UBA.
5	177	CY	STRUCTURE EXCAVATION CLASS B, INCL. HAUL	\$ 30	\$ 5,310	The Guide Summer 2014. Excavation, export within 10 mile radius, dump fees.
6	68	CY	BANK RUN GRAVEL FOR TRENCH BACKFILL	\$ 5	\$ 340	Use native soil.
7	4	TN	CRUSHED SURFACING TOP COURSE	\$ 75	\$ 300	High end for small quantity.
8	340	LF	18" DIA CPEP	\$ 50	\$ 17,000	WSDOT UBA
9	1	EA	CATCH BASIN TYPE 1	\$ 1,800	\$ 1,800	WSDOT UBA.
10	1	LS	SITE RESTORATION	\$ 3,000	\$ 3,000	Hydroseed ditches and disturbed areas. Some private property plantings required.
SUBTOTAL OF DIRECT COSTS					\$ 34,310	
SALES TAX (DIRECT COSTS)				8.1%	\$ 2,779	
TOTAL CONSTRUCTION COST					\$ 37,100	

ALLIED COSTS				
	ITEM	UNIT COST	AMOUNT	BASIS OF QUANTITY AND UNIT COST
	PROJECT ADMIN / MANAGEMENT	10%	\$ 4,000	Based on County experience managing similar projects.
	SURVEY	LS	\$ 1,500	Base mapping.
	GEOTECHNICAL ANALYSES	LS	\$ -	None required.
	DESIGN	LS		
	PERMITTING	LS	\$ 50,000	May include complex permitting for shoreline outfall. Range could be from 5,000 (all above high water) to 120,000.
	PROPERTY ACQUISITION	LS	\$ 5,000	Easement acquisition.
	CONSTRUCTION MANAGEMENT	20%	\$ 5,000	
SUBTOTAL OF ALLIED COSTS			\$ 65,500	
SUMMARY				
	SUBTOTAL OF DIRECT COSTS		\$ 34,310	
	SUBTOTAL OF ALLIED COST		\$ 65,500	
	SALES TAX (ON DIRECT COSTS)		\$ 2,779	
PROJECT TOTAL			\$ 100,000	
CONTINGENCY			50% \$ 50,000	
TOTAL WITH CONTINGENCY			\$ 150,000	



Subject: FB1 - San Juan Valley Creek Capacity Improvement Project Design Feasibility Study

Prepared by: B. Busiek and C. Echterling

Checked by: M. Fontaine

Updated: May 19, 2015

Note: This cost estimate is approximate. Actual construction bids may vary significantly from this statement of probable costs due to timing of construction, changed conditions, labor rate changes, or other factors beyond the control of the engineers.

ESTIMATED COST OF PROJECT IMPLEMENTATION AT INITIAL CONCEPT DESIGN STAGE

San Juan Valley Creek -- Flood Control and Habitat Improvement	Price
Task 1: Data Collection and Field Investigation	\$16,000
Item #1. Analysis of existing data <i>Evaluate as-builts for Bailer Hill Road, creek culvert, and other CIPs</i>	
Item #2. Field investigation of existing conditions <i>Field data collection of channel dimensions, streambed sediment gradation, floodplain and instream habitat features, and existing habitat deficiencies</i>	
Task 2: Preliminary Alternatives Development and Analysis	\$50,000
Item #1. Develop preliminary design alternatives	
Item #2. Develop cost estimates	

Task 3: Hydrologic and Hydraulic Modeling	\$94,000
Item #1. HSPF hydrologic model development	
<i>Acquire topography, soils, land cover and other GIS files needed for model development</i>	
<i>Acquire rainfall data, ET data; perform QA/QC</i>	
<i>Conduct watershed site visit</i>	
<i>Delineate watershed and sub-drainages based topography, road and culvert data (San Juan Valley Creek and False Bay Creek)</i>	
<i>Construct HSPF model for the watershed</i>	
<i>Perform course calibration to reproduce historical flooding along Bailer Hill Road</i>	
<i>Perform model QA/QC; compile notes, documentation</i>	
Item #2. HEC-RAS hydraulic model development	
<i>Prepare LiDAR-based stream and floodplain cross-sections</i>	
<i>Gather site specific stream survey data (assume 18 cross sections + structures; starting 1,000 u/s of creeks' confluence to False Bay ~ 6,000 feet)</i>	
<i>Prepare HEC-RAS model - from 1,000 feet u/s of confluence of San Juan Valley Creek and False Bay Creek to False Bay</i>	
<i>Conduct flow monitoring in San Juan Valley Creek and False Bay Creek u/s of Bailer Hill Road</i>	
<i>Calibrate HEC-RAS model to observed stream flows and levels</i>	
<i>Estimate water levels and floodplain inundation for overbank events</i>	
<i>Perform model QA/QC; compile notes, documentation</i>	
Item #3. Characterize existing conditions and evaluate project alternatives	
<i>Evaluate the impacts of proposed projects on water levels, flow velocities, etc.; assume 4 alternative projects</i>	
<i>Coordinate with design staff</i>	
Item #4. Document results	
<i>Prepare draft TM describing hydrologic and modeling method and results</i>	
<i>Respond to comments and prepare final TM describing hydrologic and modeling method and results</i>	
Task 4: Select Preferred Alternative	\$22,000
Item #1. Screening-level analysis	
<i>Develop and conduct a screening-level analysis to select preferred alternative</i>	
<i>Present results as a comparison matrix that captures cost and benefits</i>	
<i>Meet with County and Stakeholders (assume 2 meetings)</i>	
Item #2. Alternative selection and documentation	
<i>County to select preferred alternative</i>	
<i>Report development for preferred alternative</i>	
Design Feasibility Study Total	\$ 182,000
CONTINGENCY 30%	\$ 55,000
TOTAL WITH CONTINGENCY	\$ 237,000



Subject: FB4 - Ranchos Road at Oak Hill Drive

Prepared by: M. Fontaine and K. Matsumura

Checked by: Brian Busiek

Updated: November 20, 2014

Note: This cost estimate is approximate. Actual construction bids may vary significantly from this statement of probable costs due to timing of construction, changed conditions, labor rate changes, or other factors beyond the control of the engineers.

ESTIMATED COST OF PROJECT IMPLEMENTATION AT INITIAL CONCEPT DESIGN STAGE

NO.	QUANT.	UNIT	ITEM	UNIT COST	AMOUNT	BASIS OF QUANTITY AND UNIT COST
1	1	LS	MOBILIZATION	10%	\$ 958	
2	1	LS	EROSION/WATER POLLUTION CONTROL	5%	\$ 436	
3	1	LS	PROJECT TEMPORARY TRAFFIC CONTROL	5%	\$ 436	Cones and rope to exclude pedestrians from work area in field, and temporary parking stall closures on street edge.
4	42	CY	DITCH EXCAVATION	\$ 20	\$ 840	Assumes 5 cf per lf of ditch. WSDOT UBA.
5	25	SY	REMOVING ASPHALT CONC. PVMT., INCL. HAUL	\$ 11	\$ 275	The Guide Summer 2014. Excavate pavement, export within 10 mile radius, dump fees.
6	43	CY	STRUCTURE EXCAVATION CLASS B, INCL. HAUL	\$ 30	\$ 1,290	The Guide Summer 2014. Excavation, export within 10 mile radius, dump fees.
7	30	CY	BANK RUN GRAVEL FOR TRENCH BACKFILL	\$ 5	\$ 150	Use native soil.
8	9	TN	CRUSHED SURFACING TOP COURSE	\$ 75	\$ 675	High end for small quantity.
9	25	SY	PAVEMENT REPAIR	\$ 43	\$ 1,080	High end for small qty.
10	30	LF	12" DIA CPEP	\$ 30	\$ 900	WSDOT UBA
11	60	LF	18" DIA CPEP	\$ 50	\$ 3,000	WSDOT UBA
12	1	LS	SITE RESTORATION	\$ 500	\$ 500	Hydroseed ditches and disturbed areas.
SUBTOTAL OF DIRECT COSTS					\$ 10,539	
SALES TAX (DIRECT COSTS)				8.1%	\$ 854	
TOTAL CONSTRUCTION COST					\$ 11,400	

ALLIED COSTS				
ITEM	UNIT COST	AMOUNT	BASIS OF QUANTITY AND UNIT COST	
PROJECT ADMIN / MANAGEMENT	10%			
SURVEY	LS	\$ 1,500	Base mapping.	
GEOTECHNICAL ANALYSES	LS	\$ -	Assume none required.	
DESIGN	LS	\$ 5,000	1 plan, profile, and sections.	
PERMITTING	LS	\$ 3,000	Clearing and grading permit.	
PROPERTY ACQUISITION			Assume none required.	
CONSTRUCTION MANAGEMENT	20%	\$ 2,280		
SUBTOTAL OF ALLIED COSTS		\$ 11,800		
SUMMARY				
SUBTOTAL OF DIRECT COSTS		\$ 10,539		
SUBTOTAL OF ALLIED COST		\$ 11,800		
SALES TAX (ON DIRECT COSTS)		\$ 854		
PROJECT TOTAL		\$ 23,000		
CONTINGENCY 50%		\$ 12,000		
TOTAL WITH CONTINGENCY		\$ 35,000		



Subject: FMB4 - Lopez Village Farmers Market

Prepared by: M. Fontaine and C. Echterling

Checked by: B. Busiek

Updated: May 12, 2015

Note: This cost estimate is approximate. Actual construction bids may vary significantly from this statement of probable costs due to timing of construction, changed conditions, labor rate changes, or other factors beyond the control of the engineers.

ESTIMATED COST OF PROJECT IMPLEMENTATION AT INITIAL CONCEPT DESIGN STAGE

NO.	QUANT.	UNIT	ITEM	UNIT COST	AMOUNT	BASIS OF QUANTITY AND UNIT COST
1	1	LS	MOBILIZATION	10%	\$ 25,181	
2	1	LS	EROSION/WATER POLLUTION CONTROL	3%	\$ 7,195	Inlet protection, manage stock piles, and daily sweeping by hand.
3	1	LS	PROJECT TEMPORARY TRAFFIC CONTROL	2%	\$ 4,796	Cones and rope to exclude pedestrians from work area in field, and temporary parking stall closures on street edge.
4	0.3	ACRE	CLEARING AND GRUBBING	\$ 8,000	\$ 2,400	Clearing area for stream channel excavation.
5	805	CY	COMMON EXCAVATION, INCL. HAUL	\$ 20	\$ 16,100	Excavation for permeable pavement and channel.
6	29	CY	STREAMBED COBBLES 4 INCH	\$ 75	\$ 2,180	4" streambed cobbles for channel bottom. Recent bids 230th St. and Eastsound Wetland. Assumes 0.5 ft thick.
7	8,900	SF	BIOENGINEERED BANK TREATMENTS	\$ 2	\$ 17,800	Assume 2 per sf for planting.
8	3	EACH	PEDESTRIAN BRIDGE WITH RAILINGS	\$ 3,500	\$ 10,500	Architect's estimate.
9	11	EACH	LARGE WOOD PIECES	\$ 750	\$ 8,250	1 per 100 LF on average.
10	11	EACH	STREAMBED BOULDERS - 3 MAN	\$ 200	\$ 2,200	1 per 100 LF on average.
11	8,208	SF	PERMEABLE UNIT PAVER	\$ 10	\$ 82,080	3-1/8 inch. Based on Rick Crooks estimate for installed costs.
12	113	TON	GRAVEL LEVELING COURSE	\$ 35	\$ 3,950	ASTM NO. 8. 2-inch thick. From Chambers bid tabs - Crushed surfacing top course.
13	226	TON	GRAVEL BASE COURSE	\$ 60	\$ 13,540	ASTM NO. 57. 4-inch thick. From Chambers bid tabs - Choker course.
14	1129	TON	GRAVEL RESERVOIR COURSE	\$ 26	\$ 29,340	ASTM NO. 57. 12-inch thick. From SPU 2012 Unit Cost Report for Mineral Aggregate Type 2 (401002) for quantities ≥ 200 TONS.
15	11	EACH	CHECK DAM	\$ 300	\$ 3,300	Reset ponding every 43 LF. Simple weirs.
16	0.06	ACRE	WATER QUALITY TREATMENT POOLS	\$ 250,000	\$ 15,000	4 pools. All inclusive of excavation and planting for treatment pools. Based on per acre cost for treatment wetland construction.
17	1	EACH	30-INCH TRASH RACK	\$ 825	\$ 830	Based on email correspondence with Aaron Zachry at Cuz Concrete (11/26/2014).
19	470	LF	8-INCH PERFORATED BYPASS PIPE	\$ 55	\$ 25,850	SPU 2012 Unit Cost Report (Item 717668).
20	2	EACH	PROJECT SIGN	\$ 750	\$ 1,500	Basic educational sign fabrication and installation. No site-specific graphic design. Unit cost from SPU unit cost report.
21	1	LS	SITE RESTORATION	\$ 5,000	\$ 5,000	Assumes seeding and mulching disturbed lawn areas, pavement edge repair, and forest restoration along side of trail.
SUBTOTAL OF DIRECT COSTS					\$ 276,992	
SALES TAX (DIRECT COSTS)				8.1%	\$ 22,436	
TOTAL CONSTRUCTION COST					\$ 299,400	

ALLIED COSTS			UNIT COST	AMOUNT	BASIS OF QUANTITY AND UNIT COST
ITEM					
GRANT PROJECT ADMIN / MANAGEMENT			10%	\$ 30,000	Based on County experience managing similar projects.
SURVEY			LS	\$ 5,000	Base mapping.
GEOTECHNICAL ANALYSES			LS	\$ 10,000	PIT test and geotech report for permeable pavement. Test pits along stream channel to characterize soils. Cost depends on local backhoe availability. Based on input from AESI.
DESIGN			LS	\$ 40,000	2 general sheets, 1 clearing and grading sheet, 1 TESC sheet, 3 civil sheets (proposed site plan, channel profile and sections, pavement sections and details, site furnishings), 4 landscape sheets (planting plan, planting schedule, planting details, irrigation plan).
PERMITTING			LS	\$ 5,000	Clearing and grading permit.
PROPERTY ACQUISITION			LS	\$ 5,000	Easement acquisition.
CONSTRUCTION MANAGEMENT			15%	\$ 44,910	Based on input from County
CHANGE ORDERS			5%	\$ 15,000	
SUBTOTAL OF ALLIED COSTS				\$ 154,900	
SUMMARY					
SUBTOTAL CONSTRUCTION COST				\$ 299,400	
SUBTOTAL OF ALLIED COST				\$ 154,900	
PROJECT TOTAL				\$ 450,000	
SUMMARY BY GRANT TASK					
TASK 1 - GRANT PROJECT ADMINISTRATION / MANAGEMENT				\$ 30,000	
TASK 2 - DESIGN PLANS AND SPECIFICATIONS, ENVIRONMENTAL REVIEW, AND PERMITTING				\$ 65,000	
TASK 3 - CONSTRUCTION MANAGEMENT				\$ 44,910	
TASK 4 - CONSTRUCTION				\$ 299,400	
TASK 5 - CHANGE ORDERS				\$ 15,000	
PROJECT TOTAL				\$ 450,000	



Subject: FMB6 - Lopez Village Water Quality Treatment Facility

Prepared by: C. Echterling

Checked by: Brian Busiek

Updated: May 12, 2015

Note: This cost estimate is approximate. Actual construction bids may vary significantly from this statement of probable costs due to timing of construction, changed conditions, labor rate changes, or other factors beyond the control of the engineers.

ESTIMATED COST OF PROJECT IMPLEMENTATION AT INITIAL CONCEPT DESIGN STAGE

NO.	QUANT.	UNIT	ITEM	UNIT COST	AMOUNT	BASIS OF QUANTITY AND UNIT COST
1	1	LS	MOBILIZATION	10%	\$ 52,365	
2	1	LS	EROSION/WATER POLLUTION CONTROL	10%	\$45,535	Could involve significant work in the wet.
3	1	LS	PROJECT TEMPORARY TRAFFIC CONTROL	5%	\$22,767	Limited traffic control on Tower Drive, Weeks Road, and Washburn Place. Most of work is out of right of way. Close parking on west side of Tower during construction. Traffic control plan.
4	3,400	CY	POND EXCAVATION, INCL. HAUL	\$ 20	\$ 68,000	Excavation for stormwater treatment wetland.
5	120	CY	STRUCTURE EXCAVATION CLASS B INCL. HAUL	\$ 30	\$ 3,600	The Guide Summer 2014. Excavation, export within 10 mile radius, dump fees.
6	69	CY	BANK RUN GRAVEL FOR TRENCH BACKFILL	\$ 5	\$ 345	Use native soil.
7	176	TON	CRUSHED SURFACING TOP COURSE	\$ 75	\$ 13,200	High end for small quantity.
8	230	LF	SCH A STORM SEWER PIPE 12 IN DIA	\$ 30	\$ 6,900	WSDOT UBA.
9	2	EACH	12" TRASH RACK	\$ 500	\$ 1,000	Recent bids, chambers lake.
10	1	EACH	DIVERSION STRUCTURE	\$ 15,000	\$ 15,000	Recent bids, chambers lake.
11	1	EACH	CATCH BASIN TYPE 2	\$ 3,200	\$ 3,200	WSDOT UBA.
12	22,000	SF	WETLAND PLANTINGS	\$ 2	\$ 44,000	Assume \$2 per sf for planting. Assumes 2/3 of site is planted.
13	0.4	AC	SOIL AMENDMENT	\$ 15,000	\$ 6,000	Recent bids, chambers lake. Assumes disturbed area outside of the wetland footprint.
14	2,200	SF	REINFORCED GEOTEXTILE WALL	\$ 100	\$ 220,000	Recent bids, chambers lake.
15	17,000	SF	IRRIGATION SYSTEM	\$ 0.30	\$ 5,100	Recent bids, chambers lake - LS/117,500 SF of irrigated area. Assumes 1/2 of site is irrigated.
16	1	LS	SEDIMENT FOREBAY	\$ 20,000	\$ 20,000	Recent bids, chambers lake. Small armorflex pad and boulders.
17	1	EACH	SITE FURNISHINGS - WATER LEVEL INDICATOR	\$ 2,500	\$ 2,500	Recent bids, chambers lake.
18	2	EACH	PROJECT SIGN	\$ 750	\$ 1,500	Basic educational sign fabrication and installation. No site-specific graphic design. Unit cost from SPU unit cost report.
19	1	LS	PEDESTRIAN BRIDGE	\$ 40,000	\$ 40,000	Assume 4ft wide and approximately 60 ft long.
20	1	LS	SITE RESTORATION	\$ 5,000	\$ 5,000	Order of Magnitude.
SUBTOTAL OF DIRECT COSTS					\$ 576,011	
SALES TAX (DIRECT COSTS)				8.1%	\$ 46,657	
TOTAL CONSTRUCTION COST					\$ 620,000	

		ALLIED COSTS			
		ITEM	UNIT COST		
		GRANT PROJECT ADMIN / MANAGEMENT	10%	\$ 62,000	Based on County experience managing similar projects.
		SURVEY	LS	\$ 5,000	Base mapping.
		GEOTECHNICAL ANALYSES	LS	\$ 5,000	Monitor groundwater level on site for 1 year. Geotechnical report with recommendations for short (5') MSE wall around the cut slope edges of the site. Includes \$20k for geotech and \$10k for monitoring well install.
		DESIGN	LS	\$ 80,000	4 general sheets, 1 clearing and grading sheet, 1 TESC sheet, 6 civil sheets (proposed site plan, grading, storm drain profiles, storm details, wall details, site furnishings), 4 landscape sheets (planting plan, planting schedule, planting details, irrigation plan).
		PERMITTING	LS	\$ 5,000	Grading permit.
		PROPERTY ACQUISITION	LS	\$ 5,000	Easement acquisition.
		CONSTRUCTION MANAGEMENT	20%	\$ 124,000	Based on input from County.
		CHANGE ORDERS	5%	\$ 31,000	
SUBTOTAL OF ALLIED COSTS				\$ 320,000	
SUMMARY					
		SUBTOTAL CONSTRUCTION COST		\$ 620,000	
		SUBTOTAL OF ALLIED COST		\$ 320,000	
PROJECT TOTAL				\$ 940,000	
SUMMARY BY GRANT TASK					
TASK 1 - GRANT PROJECT ADMINISTRATION / MANAGEMENT				\$ 62,000	
TASK 2 - DESIGN PLANS AND SPECIFICATIONS, ENVIRONMENTAL REVIEW, AND PERMITTING				\$ 100,000	
TASK 3 - CONSTRUCTION MANAGEMENT				\$ 124,000	
TASK 4 - CONSTRUCTION				\$ 620,000	
TASK 5 - CHANGE ORDERS				\$ 31,000	
PROJECT TOTAL				\$ 940,000	



Subject: FMB1 - Apple Tree Lane Conveyance to Outfall

Prepared by: M. Fontaine and K. Matsumura

Checked by: Brian Busiek

Updated: November 20, 2014

Note: This cost estimate is approximate. Actual construction bids may vary significantly from this statement of probable costs due to timing of construction, changed conditions, labor rate changes, or other factors beyond the control of the engineers.

ESTIMATED COST OF PROJECT IMPLEMENTATION AT INITIAL CONCEPT DESIGN STAGE

NO.	QUANT.	UNIT	ITEM	UNIT COST	AMOUNT	BASIS OF QUANTITY AND UNIT COST
1	1	LS	MOBILIZATION	10%	\$ 1,107	
2	1	LS	EROSION/WATER POLLUTION CONTROL	2%	\$ 213	
3	1	LS	PROJECT TEMPORARY TRAFFIC CONTROL	2%	\$ 213	Minimal.
4	103	CY	DITCH EXCAVATION	\$ 20	\$ 2,060	560 LF of ditch at 5 cf per lf. WSDOT UBA.
5	101	TON	CRUSHED SURFACING TOP COURSE	\$ 75	\$ 7,580	Assumes 8' wide path beside ditch. 4" thick CSTC on path. Conservative cost assumption for maintenance access.
6	1	LS	HYDROSEED	\$ 1,000	\$ 1,000	Hydroseeding ditch and disturbed areas.
SUBTOTAL OF DIRECT COSTS					\$ 12,172	
SALES TAX (DIRECT COSTS)				8.1%	\$ 986	
TOTAL CONSTRUCTION COST					\$ 13,200	

ALLIED COSTS					
		ITEM	UNIT COST	AMOUNT	BASIS OF QUANTITY AND UNIT COST
		PROJECT ADMIN / MANAGEMENT	10%	\$ 1,000	Based on County experience managing similar projects.
		SURVEY	LS	\$ 3,000	Base mapping for easement and initial staking.
		GEOTECHNICAL ANALYSES	LS	\$ -	None required.
		DESIGN	LS	\$ 10,000	2 sheets. 1 plan and profile. 1 sections and details.
		PERMITTING	LS	\$ 10,000	Grading permit. Assumes all work is above OHWM and considered maintenance activity.
		PROPERTY ACQUISITION	LS	\$ 5,000	Easement acquisition.
		CONSTRUCTION MANAGEMENT	20%		
SUBTOTAL OF ALLIED COSTS				\$ 29,000	
				\$ 5,000.00	
SUMMARY					
		SUBTOTAL OF DIRECT COSTS		\$ 12,172	
		SUBTOTAL OF ALLIED COST		\$ 29,000	
		SALES TAX (ON DIRECT COSTS)		\$ 986	
PROJECT TOTAL				\$ 42,000	
CONTINGENCY 50%				\$ 21,000	
TOTAL WITH CONTINGENCY				\$ 63,000	



Subject: FMB3 - Weeks Wetland Swale Improvement

Prepared by: M. Fontaine and K. Matsumura

Checked by: Brian Busiek

Updated: November 20, 2014

Note: This cost estimate is approximate. Actual construction bids may vary significantly from this statement of probable costs due to timing of construction, changed conditions, labor rate changes, or other factors beyond the control of the engineers.

ESTIMATED COST OF PROJECT IMPLEMENTATION AT INITIAL CONCEPT DESIGN STAGE

NO.	QUANT.	UNIT	ITEM	UNIT COST	AMOUNT	BASIS OF QUANTITY AND UNIT COST
1	1	LS	MOBILIZATION	10%	\$ 1,373	
2	1	LS	EROSION/WATER POLLUTION CONTROL	2%	\$ 257	
3	1	LS	PROJECT TEMPORARY TRAFFIC CONTROL	5%	\$ 642	Cones and rope to exclude pedestrians from work area in field, and temporary parking stall closures on street edge.
4	66	CY	SWALE EXCAVATION	\$ 30	\$ 1,980	Channel excavation. 6' bottom width, 2' depth, 1H/1V side slopes.
5	1350	SF	NATIVE PLANTINGS	\$ 5	\$ 6,750	Native planting. Small quantity.
6	150	SY	EROSION CONTROL BLANKET	\$ 5	\$ 750	WSDOT UBA
7	7	EACH	WEIRS	\$ 300	\$ 2,100	Reset ponding every 20 LF. Simple weirs. Kitsap County weir prices.
8	1	EACH	PROJECT SIGN	\$ 750	\$ 750	Basic educational sign fabrication and installation. No site-specific graphic design. Unit cost from SPU unit cost report.
9	1	LS	SITE RESTORATION	\$ 500	\$ 500	Assumes seeding and mulching disturbed lawn areas.
SUBTOTAL OF DIRECT COSTS					\$ 15,101	
SALES TAX (DIRECT COSTS)				8.1%	\$ 1,223	
TOTAL CONSTRUCTION COST					\$ 16,300	

ALLIED COSTS					
		ITEM	UNIT COST	AMOUNT	BASIS OF QUANTITY AND UNIT COST
		PROJECT ADMIN / MANAGEMENT	10%	\$ 2,000	Based on County experience managing similar projects.
		SURVEY	LS	\$ 5,000	Base mapping.
		GEOTECHNICAL ANALYSES	LS		None required.
		DESIGN	LS		
		PERMITTING	LS	\$ 5,000	Clearing and grading permit.
		PROPERTY ACQUISITION	LS	\$ 5,000	Easement acquisition.
		CONSTRUCTION MANAGEMENT	20%	\$ 5,000	
SUBTOTAL OF ALLIED COSTS				\$ 22,000	
SUMMARY					
		SUBTOTAL OF DIRECT COSTS		\$ 15,101	
		SUBTOTAL OF ALLIED COST		\$ 22,000	
		SALES TAX (ON DIRECT COSTS)		\$ 1,223	
PROJECT TOTAL				\$ 38,000	
CONTINGENCY 50%				\$ 19,000	
TOTAL WITH CONTINGENCY				\$ 57,000	

APPENDIX F

Hydraulic/Hydrologic Model Development and Alternatives Analysis

May 4, 2015

To: Matt Fontaine – Herrera Environmental Consultants, Inc.

From: Rizwan Hamid – Aqualyze, Inc.

Cc: John Lenth - Herrera Environmental Consultants, Inc.
Andrew Henson – Aqualyze, Inc.

Subject: Model Development and Alternatives Analysis
San Juan County Stormwater Basin Planning Project

Introduction

As part of the Stormwater Basin Plan for San Juan County, Herrera Environmental Consultants, Inc. (HEC) added Aqualyze, Inc. to their team to provide services required in developing a hydraulic/hydrologic (H/H) model. The modeled areas include the Eastsound village area (ES Village), Ship Bay basin to the east of Eastsound (Ship Bay), and areas tributary to the stormwater system in the urban growth area along the North Shore (North Shore) of Orcas Island. All H/H modeling was conducted in the EPA Storm Water Management Model version 5.0.022 (SWMM5). Best available data was utilized in model development, including GIS data, field surveys, prior work conducted in these basins, and best engineering judgment.

Objective

The objective of this task was to construct the SWMM5 H/H model for the aforementioned areas and conduct 25-year design storm analysis of the existing system and proposed alternatives. The long term goal of establishing this model is to determine capacities of primary pipe and channel networks in the basins, to continue to assist with capital improvement project development, and to create a tool that can be used in the future to consider the impacts of future development and capital projects on natural wetland systems.

Project Area Extents

The extents of this modeling assignment were limited to the four key basins: Eastsound, Crescent Beach Ship Bay / Olga Road, and North Shore. The total modeled area is approximately 1,529 acres. ES Village area is the most developed portion within the project area, and is smallest in total area with 49 acres. ES Village area is bounded by School Rd to the north, Madrona St to the east, and Outlook Inn to the west. Additional open surface runoff in the Eastsound basin from Mt Baker Rd to the north and Lookout Mountains to the west discharge to the Outlook Inn pond through a series of open channels. The controlled discharge from the pond connects back to the ES Village conveyance through a 48-inch pipe before discharging into the bay through a 54-inch culvert south of Main St. This additional area from the

north and west amounts to 171 acres.

The North Shore areas are served by 5 outfalls into the bay and serve a large tributary area of 700 acres. This includes the airport and adjoining facilities (64 acres). Areas both east and west of the airport are low density residential areas and include large areas of open land. The Crescent Beach outfall serves a large area of 203 acres, but a very small portion (16 acres) is developed, which lies on the eastern fringes of the ES Village. The Ship Bay basins are the eastern most subcatchments that amount to 406 acres and are served by 3 outfalls. The primary land use for this basin is low density residential.

Figure 1 presents the project area extents along with modeled subcatchments and stormwater conveyance system.

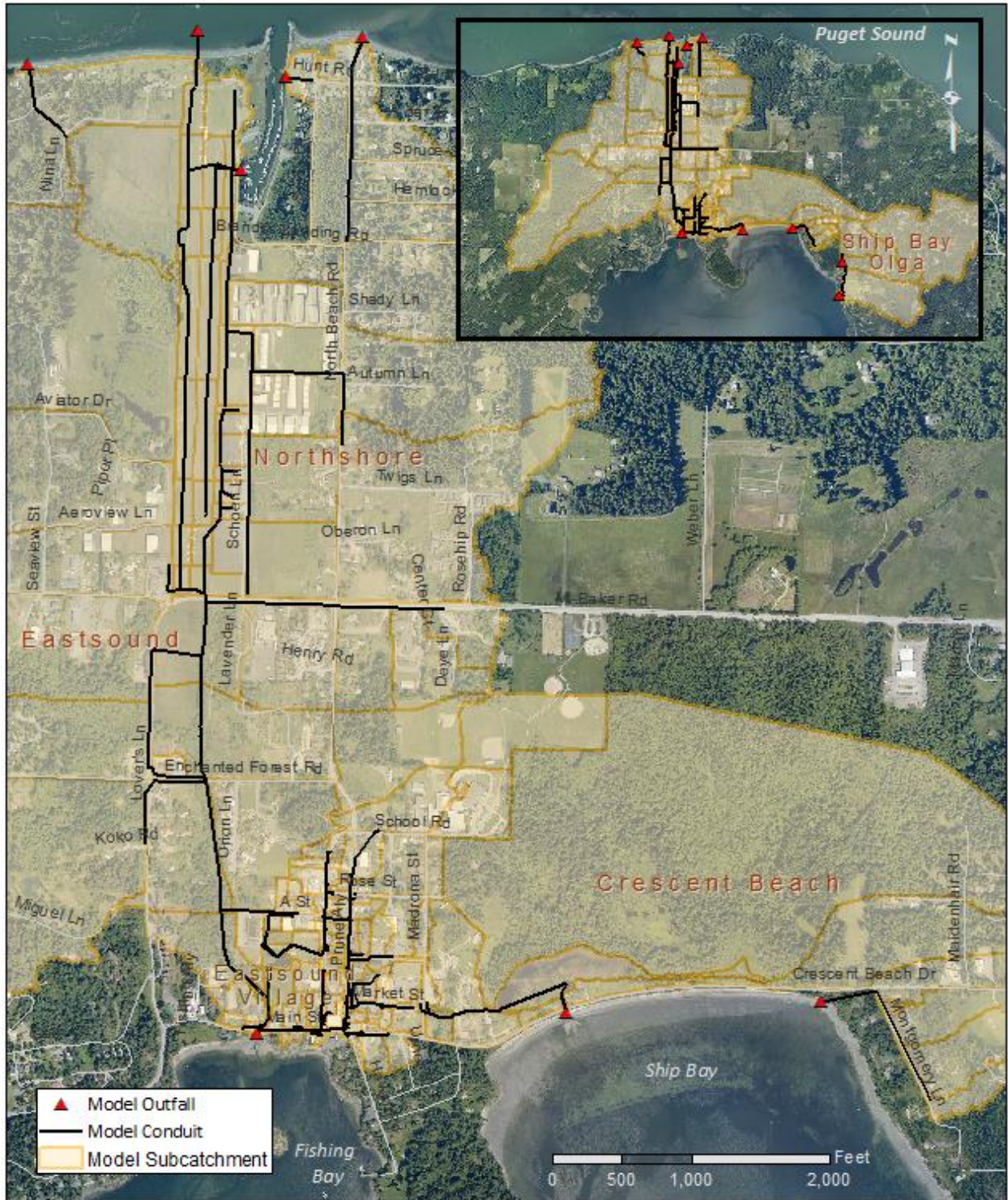


FIGURE 1. Project Study Area

Model Development

EPA SWMM version 5.0.022 (SWMM5) was used as the platform to conduct all modeling under this task. SWMM5 is a public domain software and can be downloaded for free to run or review results of the modeling files generated under this contract. Any H/H model has two primary components: hydraulics and hydrology. The following sections describe the model H/H development of San Juan County's stormwater model of the project area described above.

Hydrologic Model Development

This section discusses the hydrologic setup of the model and any assumptions to be made. SWMM5 uses subcatchments in conjunction with climate data (rainfall, evaporation, etc.) to generate flow to be routed through the hydraulic components.

Basin Characterization

The three model basins (ES Village, Ship Bay, and North Shore) are spread over approximately 1,529 acres of mixed land use. The ES Village basin is the most developed of the three. It has some hills in the NE portion of the basin but the downstream portions in the south are generally flat according to the 5-ft contour data from the GIS. Ship Bay and North Shore basins are sparsely developed with a combination of flat and hilly areas.

During the model development phase, County's GIS data from the following layers was analyzed to develop basin characteristics parameters: land use, soils, parcels/buildings, roadways, and aerial photography.

County GIS layer of soils data was used in characterizing the subcatchments in the model by superimposing soils layer on top of the model subcatchments. Pre-dominant soil type for each subcatchment was used to determine the soil infiltration characteristics to be used in the model. The subcatchment delineation process is described below.

Subcatchment Delineation

The GIS data provided by the County has subcatchments delineated under the layer "basins_orcas". This was used as a starting point to develop a more detailed subcatchment layer for the model. Subcatchment delineation involved identifying areas tributary to key inlet points in the hydraulic conveyance system of the basin. The delineation was performed in ESRI's ArcGIS. The key reference layers required for this exercise were contours, land use, existing hydraulic infrastructure, streets/right-of-way, previously delineated wastesheds, and aerial maps. The delineated subcatchments boundaries were generally verified by HEC staff, and in some cases revised based on field surveys and other relevant site observations.

A total of 172 subcatchments were delineated for the project area (Figure 1). The subcatchment size varied in acreage from 0.025 acres to 211 acres, with 8.9 acres as the average. The total impervious area

is 127 acres, which is 8.3% of the total area.

Hydrologic parameters for each subcatchment were estimated using best available data, theoretical values and engineering judgment. The parameter estimation process is described below.

Parameter Estimation

Model parameters were estimated for each subcatchment delineated within the model basin. These include the following:

- Total area: computed in GIS as the area of the delineated subcatchment polygon
- Percent imperviousness: computed as the percent of total subcatchment area contributing to direct surface runoff. Land used, roads, buildings, and driveways layers were used to compute this parameter.
- Subcatchment slope: Slope was estimated as the difference in elevation along the longest travel path within the subcatchment. Mathematical assumptions were used to derive this parameter in conjunction with the GIS overlay features as well as visual inspection.
- Subcatchment width: This was calculated as total area divided by the longest flow travel path.
- Green-Ampt infiltration parameters: There are three parameters used in infiltration over pervious land when using this method. These include hydraulic conductivity (in/hr), suction head (in.) and initial deficit (fraction). Theoretical values for each parameter were used based on the type of soil for each subcatchment. The soil types for each subcatchment were derived from GIS overlay of the soils layer with the subcatchments layer. A single average parameter set was computed using area-weighted average per subcatchment.

Loading Points

Catchments were loaded to the nearest downstream conveyance (i.e. MH/ditch section) present in the model. Preliminary loading points were selected based on available GIS information. Revisions were made to some of the loading points based on discussions with HEC staff who had evaluated the conveyance network in the field; however, not all conveyances were field verified.

Rainfall

All modeling was performed using the 25-year, 24-hour recurrence interval storm. The design rainfall hyetograph was generated using the SCS Type 1A rainfall distribution. Rainfall amount of 3.0 inches was inferred from National Oceanic and Atmospheric Association (NOAA) published data (Figure 2).

Considering the northwest climate and antecedent conditions, and to build some conservatism into the uncalibrated model, the design storm was preceded by a 6-month, 24-hour storm (1.05 inches). See Figure 3 for the hyetograph of the 2-day storm used.

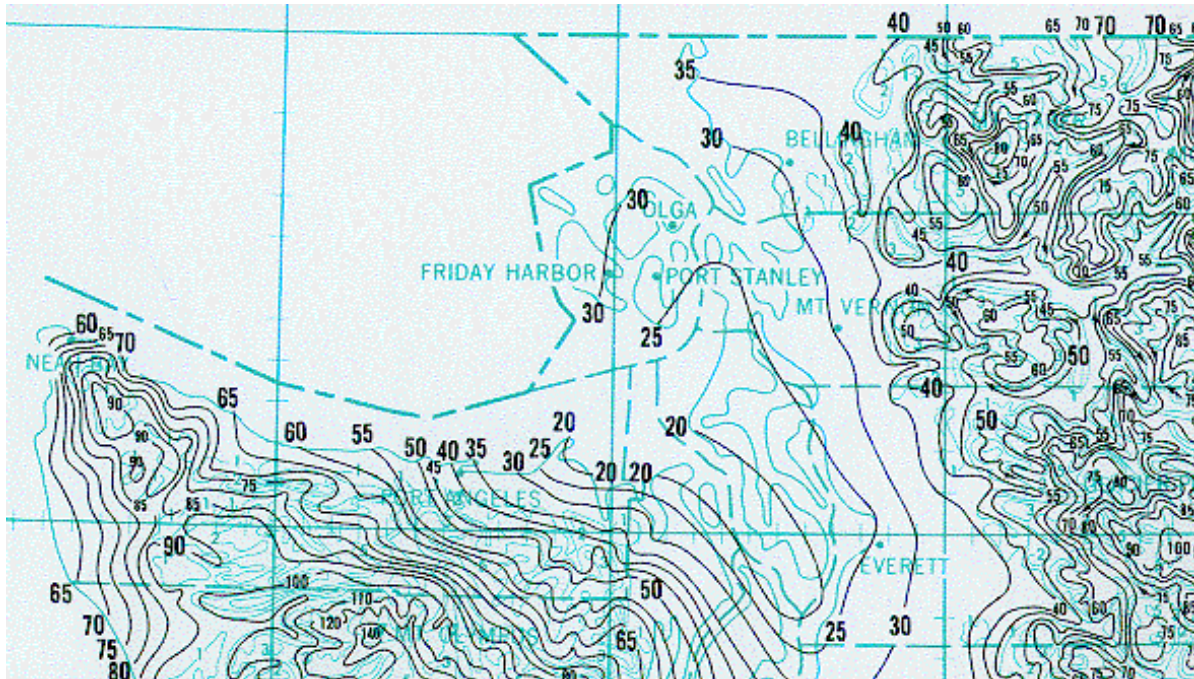


Figure 2. Isopluvials of 25-yr 24-hr Precipitation in Tenths of an inch (*NOAA Atlas 2, Volume IX, Figure 28*)

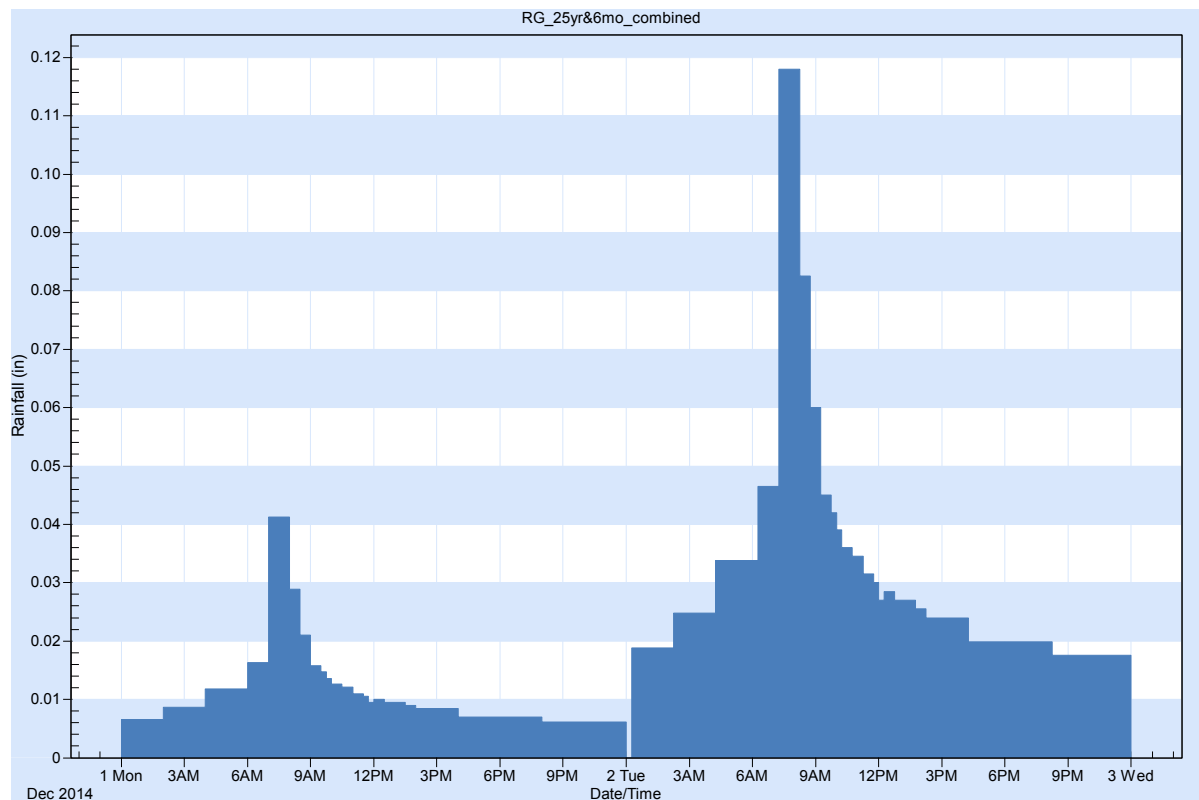


Figure 3. SCS Type 1A Design Hydrograph – 25-yr, 24-hr (preceded by 6-mo, 24-hr storm)

Model Hydraulics

Model hydraulics represent the physical stormwater infrastructure. A hydraulic model is a combination of nodes and links connected to together to depict the stormwater infrastructure. A node represents any junction where two or more links meet, and a link represents any connection between two nodes. Examples of a node include catch-basins, manholes, retention/detention pond, or a pump station wet well. Examples of a link include pipe, culvert, channel (natural or constructed), weir, or a pump.

Conveyance System

The conveyance system in the ES Village basin has the most infrastructure of three basins, consisting of a network of stormwater pipes, culverts and ditches. Ship Bay basin has only ditches, culverts, and outfall pipe infrastructure while North Shore basin has a ditch and culvert system that runs south to north on either side of the airport runway.

The model development for this project utilized data primarily from GIS and other previously completed watershed reports. Other data sources were used as required and available, included limited survey data from 2002. GIS data was the key source of existing stormwater structures in the model.

A review of the GIS layers provided showed large amounts of missing data and gaps in the SW structures inventory primarily in the ES Village basin. Almost no infrastructure information existed for the Ship Bay basin and ditch cross sections there were based on field observation. Airport Ditch Survey (Port of Orcas Islands Surveying, 2002) was used to fill data gaps for the infrastructure at the airport. Other Data gaps were filled using generally accepted fundamentals for a stormwater conveyance system. The section below describes assumptions made to complete the hydraulic inventory for modeling.

Filling Data Gaps

Different levels of assumptions were used to overcome data deficiencies. Below is a list of examples of missing data and assumptions used.

- Pipe invert missing: Used invert of adjacent MH invert that fits with the profile
- Pipe and MH invert missing: Interpolated between the next upstream and downstream known points.
- All inverts missing: Used the ground slope for pipe slope.
- MH Rim elevation missing: Inferred from surface elevation interpolating between contour lines.
- Missing diameter: Assumed logical size inferred from adjacent pipes.
- Manning's coefficient (n) assumptions: RCP = 0.013, CMP = 0.024, DWP = 0.011, SWP = 0.015, UNK = 0.013.
- Missing Natural Channel: Assumed trapezoidal channels with standard side slopes, widths and depths. Typical residential ditches were assumed to have 1-ft bottom width, 1.5-ft deep, with side slopes of 1:1. In cases where aerial photographs showed wider swales and open channels or field observations were made, widths were estimated to scale. Airport swales and the ditches along Olga Road are a good example of this case.

- **Storage Ponds:** Stage-Storage data for ponds was derived using the best available contour data. The current model includes seven storage ponds as summarized in Table 1 below. The Eastsound wetland stage-storage data was estimated using record drawings.

The existing conditions model include 252 junctions, 268 conduit links, 172 subcatchments, 2 orifices, 1 weir, 7 storage units, and 10 outfalls. A total of 16,397 lineal feet of pipes and 21,934 lineal feet of channels are modeled.

Table 1. Modeled Storage Nodes Summary

Model Storage Node	Description	Volume 1000 cu-ft
J_AEL-02	Confluence of culverts and ditch system east of runway near outfall	33.76
J_NS-18_1	Northwest of airport, ditch-culvert system near Nina Ln, representing low-lying surrounding area	58.00
J_NS-19_1	Northwest of airport, ditch-culvert system near Nina Ln, representing low-lying surrounding area	58.00
J_NS-19_2	Northwest of airport, ditch-culvert system near Donohue Ln, representing low-lying surrounding area	58.00
STOR_CB-POND	Large area north of Crescent Beach Rd	781.50
STOR_ESV-Wetland	Wetland in the ES Village just south of A-Street with outlet flow control	93.42
STOR_Outlook_Inn	Outlook Inn pond with outlet flow control	22.74

Model Calibration and Validation

Since to observed flow, depth and rainfall data was available, the model was not calibrated to any observed field conditions as part of this study. However, best available data was used to depict conditions that best represent the modeled basins.

Modeling Results

The SWMM5 model constructed, as described in the previous sections, was used to conduct capacity analysis of the existing system under the 25-year, 24-hour design storm event (see Figure 3). Additional analysis was conducted to analyze future build-out conditions including modeling of proposed alternatives as well as climate change scenario. The following sections provide the results from these analyses.

Existing Conditions Scenario

The results of the 25-year design storm were evaluated to determine capacity issues in the piped or ditch and culvert systems throughout the project area. Table 2 summarizes the flooding predicted by the model.

Table 2. Flooding Summary – Existing Conditions

Model Node	Location	Hours Flooded	Peak Rate (cfs)	Flooded Volume (cu-ft)
J_ACL-04	Airport center ditch-culvert system	1.08	0.03	43
J_AEL-04	Airport east ditch-culvert system near Brandt's Landing Rd	3.21	2.41	5,749
J_AEL-05	Airport east ditch-culvert system near Brandt's Landing Rd	1.35	1.27	1,070
J_AEL-06	Airport east ditch-culvert system near Brandt's Landing Rd	1.26	0.94	936
J_AWL-09	Airport west ditch-culvert system	9.21	0.22	1,203
J_SB-07_2	Olga ditch system	1.69	4.61	9,626
J_SB-08_1	Olga ditch system	4.85	20.1	75,802
J_NS-19_2	Northshore ditch-culvert system near Donahue Ln	5.23	0.45	4,813

As shown in Table 2, the model did not predict much flooding throughout the system. Some key profile sections of concern were evaluated in more detail. Peak hydraulic grade line (HGL) profiles of these sections were generated to show the peak HGL. Figure 4 shows the locations of these sections. Four profiles in the Northshore and Airport area and one profile in the Olga area are shown in Figures 5 through 10.

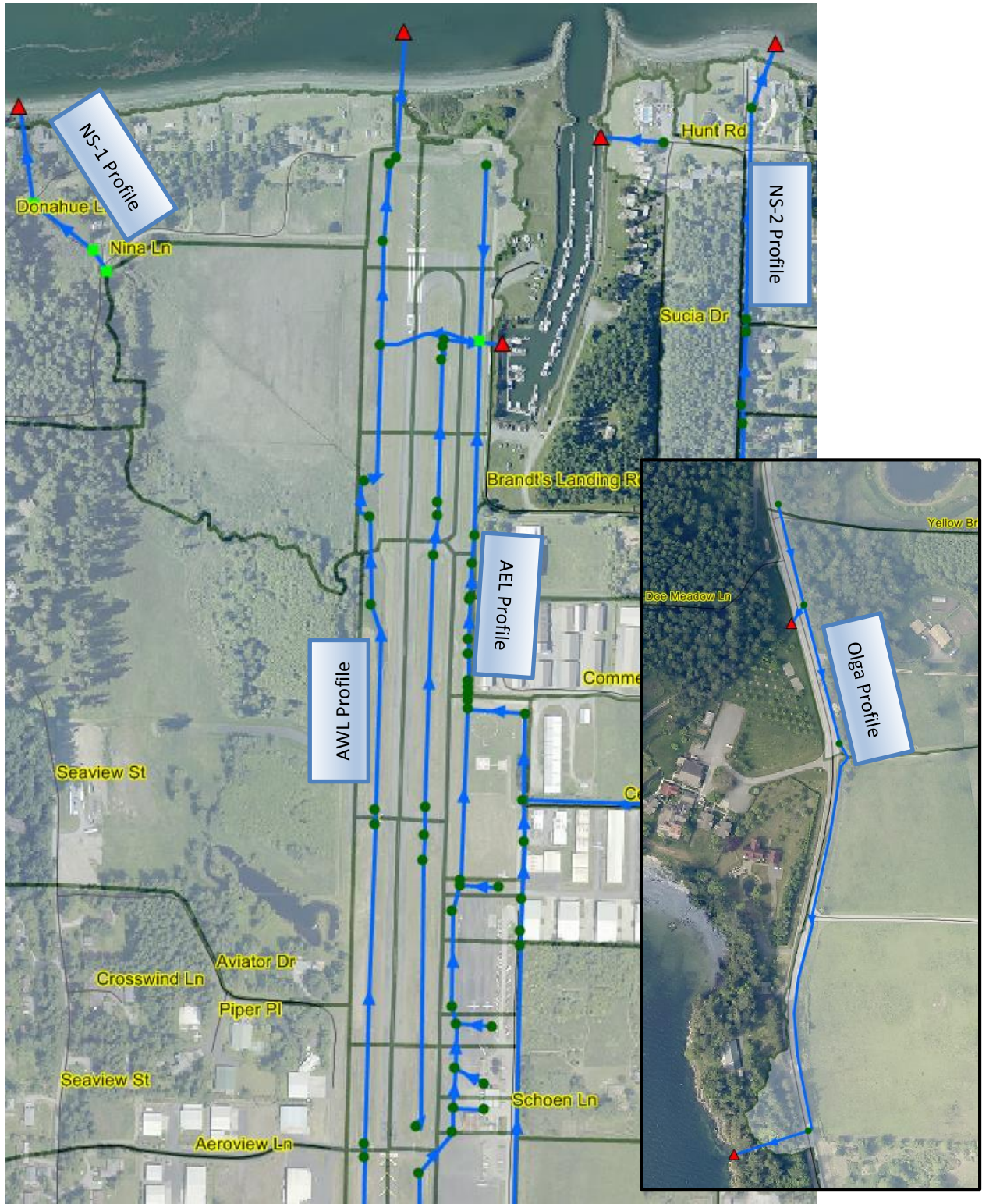


Figure 4. Locations of Hydraulic Profile shown in Figures 5 to 9 – Existing Conditions

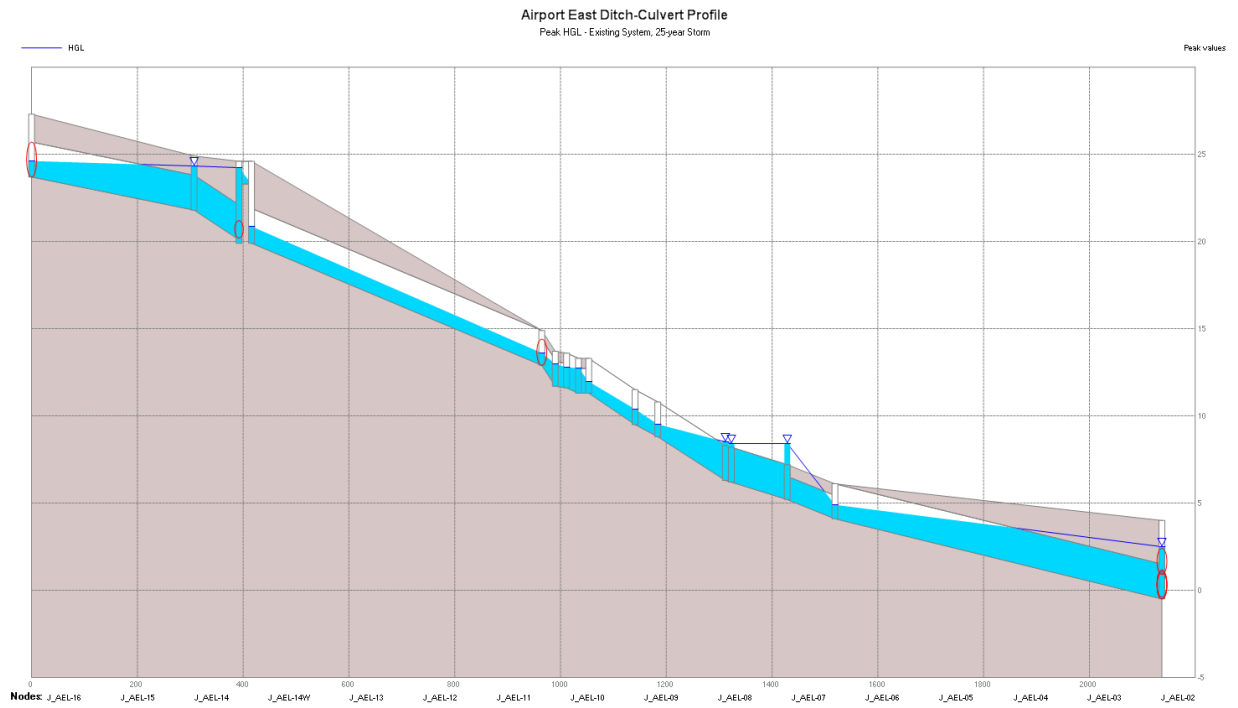


Figure 5. Airport East Ditch & Culvert System Profile – Existing Conditions

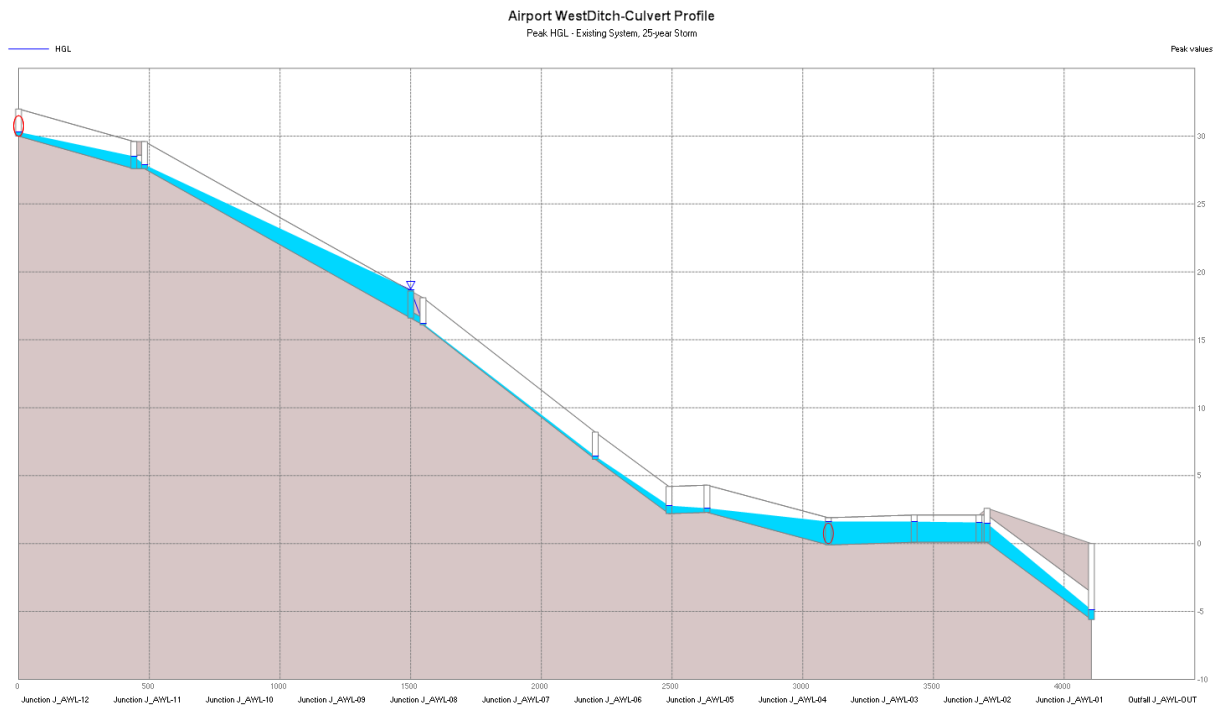


Figure 6. Airport West Ditch & Culvert System Profile – Existing Conditions

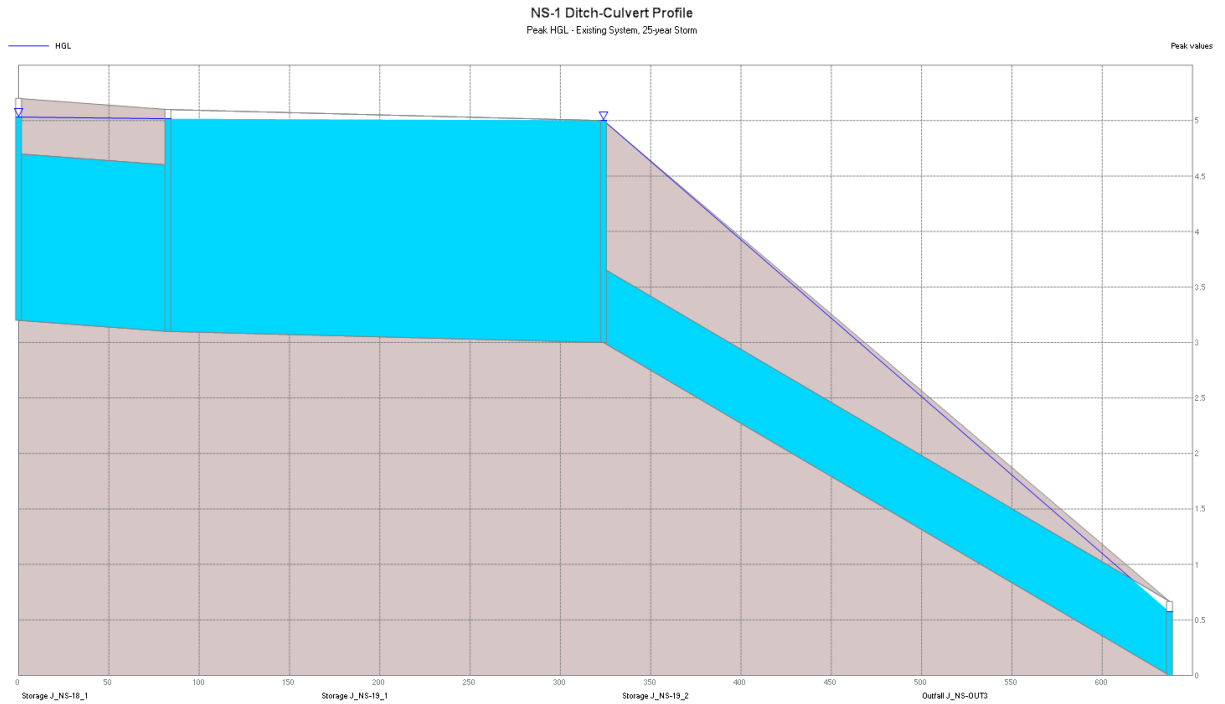


Figure 7. NS-1 Ditch & Culvert System Profile – Existing Conditions

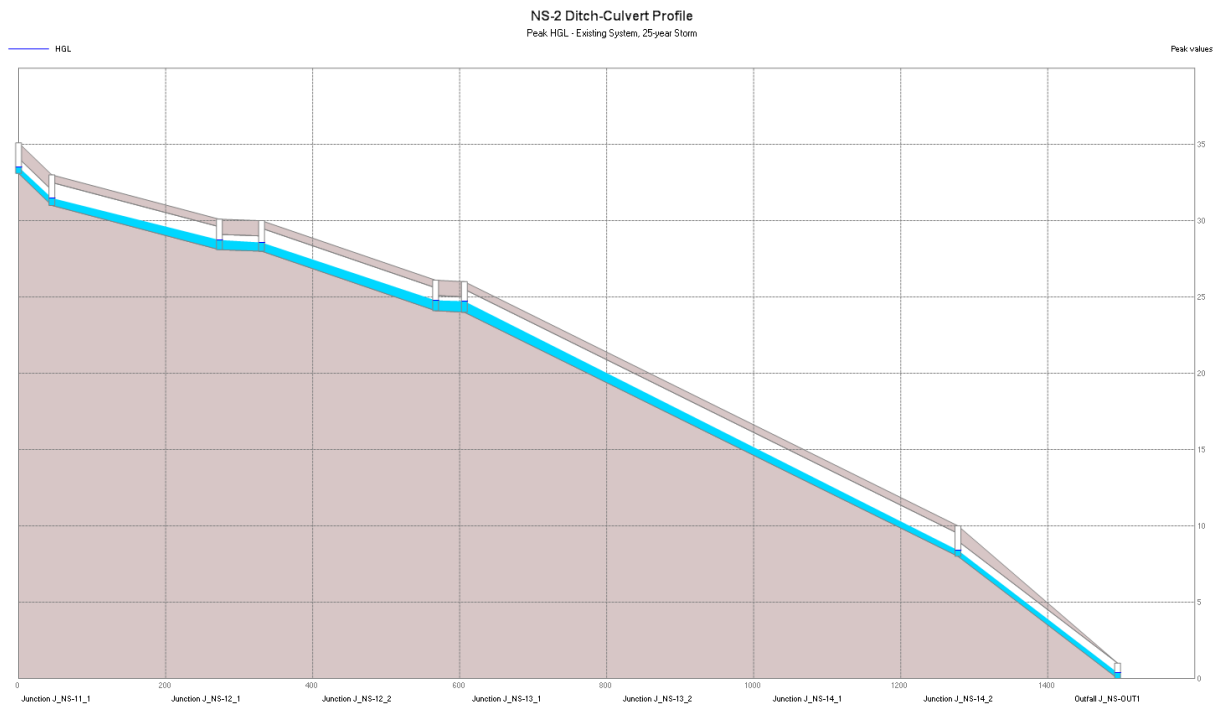


Figure 8. NS-2 Ditch & Culvert System Profile – Existing Conditions

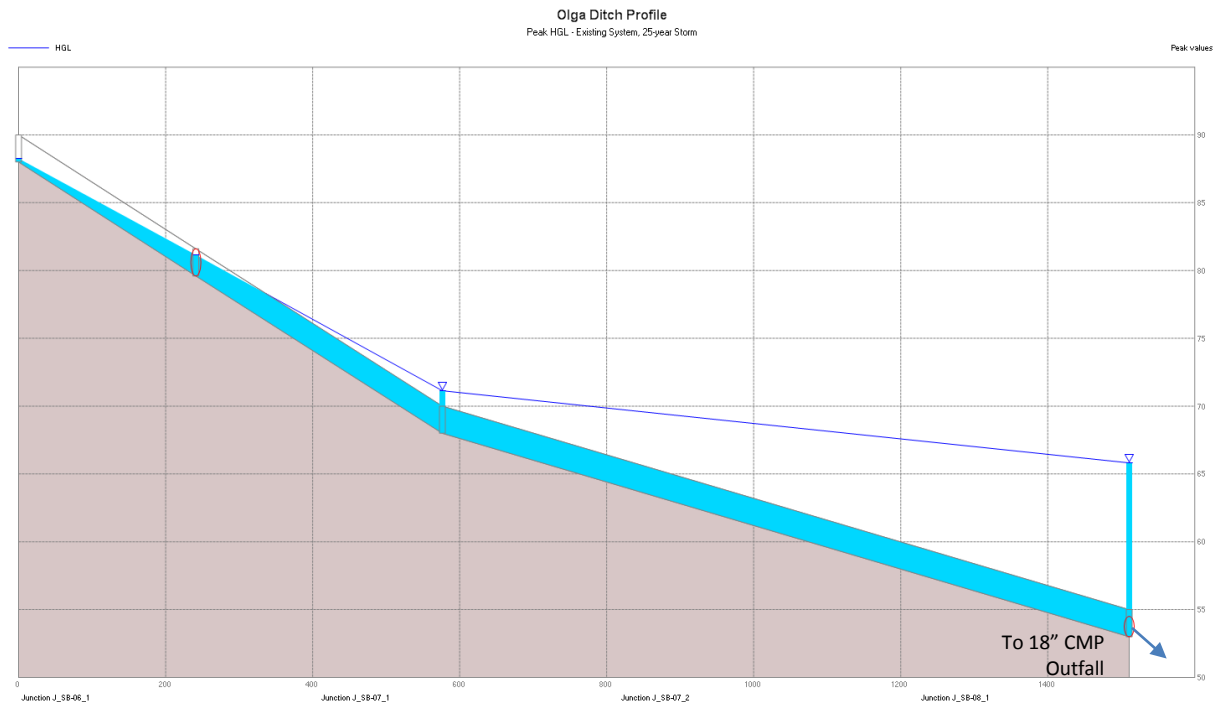


Figure 9. Olga Ditch System Profile – Existing Conditions

As seen in Figures 5 through 9, there are some undersized culverts in the airport’s ditch and culvert system that are causing upstream surcharging resulting in flooding. Airport East profile shows restriction due to a 16-inch culvert, between nodes J_AEL-04 and J_AEL-03 near Brandt’s Landing Rd, surcharges the upstream ditch system (nodes J_AEL-04, 05, & 06; see Table 2 and Figure 5). There is a 6-inch culvert identified in the airport survey, which causes flooding at J_AWL-09 node (see Table 2 and Figure 6). The ditch and culverts system west of the airport shows severe restrictions due to the under-sized culvert (see Table 2 and Figure 7). It is recommended that the sizes of these culverts be verified. The ditch system is not surveyed either and best assumptions were used to model the ditches. Cross-sectional survey of the ditch system is also recommended.

The ditch-culvert system along the North Beach Rd showed no surcharging (see Figure 8).

The Olga ditch system is severely under capacity under the current model setup (see Figure 9). Model over-prediction is a possibility as the model is not calibrated. It is also possible that ditch capacity, as modeled, is lower than the actual ditch capacity. The existing 18-inch outfall pipe appears to be under capacity. Flow monitoring during wet season and cross-sectional survey of the ditch system is recommended for this area.

Peak flows at key critical locations were also reviewed for reference. These results are tabulated in the Table 3 below.

Table 3. Peak Flow Summary at Key Locations – Existing Conditions

Model Link	Location	Peak Flow (cfs)
Pipe_OR521	ES Village Main St Outfall	19.97
CB-POND_Outlet	Crescent Beach Outfall	0.88
Culv_SB-07_1	Olga Outfall North	19.39
Culv_SB-08_1	Olga Outfall South	33.78
Culv_JNS-25_2	Northshore Outfall near Donahue Ln	1.47
Culv_AWL-12	Northshore Outfall Airport West	7.31
Culv_AEL-21	Northshore Outfall Airport East	6.74
Pipe_JNS-23_2	Northshore Outfall near North Beach Rd	1.75
Culv_AEL-01-1	Flow across Mt Baker Rd (positive flow: south to north)	4.64
Pipe_OR773	Flow from Outlook Inn Pond into 48-inch pipe	6.29
Pipe_OR771	Flow from the Wetland	5.37
Pipe_OR636	Flow into Strctr_OR164 Market St	1.56

Build-out Conditions Scenario

The build-out conditions scenario was developed by increasing the percent imperviousness of all parcels and applying them to each of the 172 subcatchments in the existing conditions model. The percent imperviousness values for the build-out conditions were provided by HEC. The total impervious area for the build-out conditions is 212.5 acres or 13.9% of the total area of 1529 acres. This is an increase of about 6.7% from the existing conditions scenario.

In addition to the increase in impervious area, several capital projects were incorporated in the build-out conditions model. These projects included:

- Hydraulic updates related to the Market Street and Madrona Street Water Quality Improvements
- Rose Street Conveyance Improvements (Site ID ES31)
- School Road Conveyance Improvements (Site ID ES29)

To incorporate these projects in the existing system required some modifications to the model inventory, which resulted in a net increase of 597 lineal feet of pipe and 5 additional subcatchments.

Other changes included upsizing pipes causing surcharge. These include:

- 6-inch pipe Culv_AWL-04 (airport west ditch-culvert system) to 18-inch
- 16-inch pipe Culv_AEL-19 (airport east ditch-culvert system) to 24-inch
- 8-inch culvert Culv_JNS-25_2 to 18-inch
- Olga ditch size increased along with the outfall pipe increase from 18-inch to 48-inch.

The build-out conditions model was evaluated to check if increase in imperviousness, and inclusion of

capital projects as described above. Table 4 below summarizes the flooding predicted in the build-out conditions model.

Table 4. Flooding Summary – Build-out Conditions Scenario

Model Node	Location	Hours Flooded	Peak Rate (cfs)	Flooded Volume (cu-ft)
J_ACL-02	Airport center ditch-culvert system	0.44	0.07	42
J_ACL-04	Airport east ditch-culvert system near Brandt's Landing Rd	2.79	0.15	401
J_LL-03	Lover's Lane ditch south of Enchanted Forest Rd	1.20	0.71	936
J_SL-06	Schoen Lane ditch east of airport	1.51	0.92	2,139

Table 4 shows that the capital projects added in the ES Village area and culverts upsized at the airport are performing as expected. However, some new locations are showing flooding. The two junctions at the airport (J_ACL-02, 04) are showing very small volume of flooding. Given that they are within the center swale, they may or may not need additional attention. Cross-section survey of the swale is recommended. The other two junctions showing flooding may be attributed to the increased imperviousness in tributary subcatchments. Nodes J_LL-03 and J_SL-06 receive 110 acres and 92 acres, respectively. It is recommended that these results be verified with field knowledge about existing problems or complaints as model results based on an uncalibrated model and assumed ditch sizes may be questionable.

Table 5 summarizes the peak flows at the same key locations as in Table 3 for existing conditions.

Table 5. Peak Flow Summary at Key Locations – Build-out Conditions Scenario

Model Link	Location	Peak Flow (cfs)
Pipe_OR521	ES Village Main St Outfall	29.57
CB-POND_Outlet	Crescent Beach Outfall	2.01
Culv_SB-07_1	Olga Outfall North (Removed for future scenarios)	N/A
Culv_SB-08_1	Olga Outfall South	71.31
Culv_JNS-25_2	Northshore Outfall near Donahue Ln	5.15
Culv_AWL-12	Northshore Outfall Airport West	9.43
Culv_AEL-21	Northshore Outfall Airport East	8.98
Pipe_JNS-23_2	Northshore Outfall near North Beach Rd	3.30
Culv_AEL-01-1	Flow across Mt Baker Rd (positive flow: south to north)	6.00
Pipe_OR773	Flow from Outlook Inn Pond into 48-inch pipe	11.98
Pipe_OR771	Flow from the Wetland	7.68
Pipe_OR636	Flow into Strctr_OR164 Market St	1.87

There is a noticeable increase in peak flows between the existing and build-out conditions. The ES Village outfall shows a 48% increase in peak flow, while the airport west and east outfalls show increase of 29% and 33% respectively. The North Beach Road outfall flow increases by about 89%, which is in direct correlation with the increase in imperviousness of its tributary areas. The outfall pipe is still showing adequate capacity. The Northshore outfall near Donahue Ln shows a 250% increase mainly due to the previously restricted flow through the 6-inch culvert in the airport west ditch approximately 1000 feet north of Aeroview Ln. This culvert was upsized to 18-inch in the build-out scenario.

A summary of new and upsized pipes is provided in the Table 6.

Table 6. Summary of Upsized and New Pipes

Conduit ID	Upstream Junction	Downstream Junction	Note	Ex Dia (in)	New Dia (in)
Pipe_ES31_1	J_ES31_1	J_ES31_2	New: ES31 Rose Road Conveyance Improvements	n/a	12
Pipe_ES31_2	J_ES31_2	J_ES31_3	New: ES31 Rose Road Conveyance Improvements	n/a	12
Pipe_ES31_3	J_ES31_3	J_ES31_4	New: ES31 Rose Road Conveyance Improvements	n/a	12
Pipe_ES31_4	J_ES31_4	Strctr_OR117	New: ES31 Rose Road Conveyance Improvements	n/a	12
Pipe_ES29_1	J_ES29_1	J_ES29_2	New: ES29 School Road Conveyance Improvements	n/a	12
Pipe_ES29_2	J_ES29_2	J_ES29_3	New: ES29 School Road Conveyance Improvements	n/a	12
Pipe_ES29_3	J_ES29_3	Strctr_OR156	New: ES29 School Road Conveyance Improvements	n/a	12
Culv_AEL-19	J_AEL-04	J_AEL-03	Upsized: Airport East ditch-culvert system	16	24
Culv_JNS-25_2	J_NS-19_2	J_NS-OUT3	Upsized: Northshore outfall near Donahue Ln	8	18
Culv_SB-08_1	J_SB-08_1	OLGA-OUT1	Upsized: Olga outfall	18	48
Culv_AWL-04	J_AWL-09	J_AWL-08	Upsized: Airport west ditch-culvert system	6	18

Climate Change Scenario

The climate change scenario was developed by increasing the design rainfall by 25% in the build-out scenario. The purpose of this scenario was to show relative increase in flows and HGLs at identified key locations. No additional upsizing was done under this scenario.

Table 7 shows the flooding summary under the climate change scenario.

Table 7. Flooding Summary– Climate Change Scenario

Model Node	Location	Hours Flooded	Peak Rate (cfs)	Flooded Volume (cu-ft)
J_ACL-01	Airport center ditch-culvert system	1.40	0.19	134
J_ACL-02	Airport center ditch-culvert system	3.24	0.60	1,337
J_ACL-04	Airport center ditch-culvert system	6.40	0.36	1,203
J_AWL-04	Airport west ditch-culvert system	3.43	1.67	4,278
J_EFR_S-01	Lover's Lane ditch at Enchanted Forest Rd	0.58	0.10	134
J_LL-03	Lover's Lane ditch south of Enchanted Forest Rd	3.13	1.79	6,150
J_LL-04	Lover's Lane ditch south of Enchanted Forest Rd	2.33	4.94	11,096
J_SB-07_2	Olga ditch system	1.16	6.75	12,299
J_SB-08_1	Olga ditch system	1.51	9.28	8,556
J_SL-05	Schoen Lane ditch east of airport	1.14	5.11	802
J_SL-06	Schoen Lane ditch east of airport	2.85	4.35	8,957
Strctr_OR156	Prune Aly south of School Rd	1.78	1.20	2,674
Strctr_OR255	A St to North Beach Rd	1.30	0.96	1,337
Strctr_OR276	Mt Baker Rd east of North Beach Rd	1.35	0.54	668

As expected, an increase of 25% in the design rainfall causes a significant increase in flooding volume and also identifies new flooding locations. Further investigation at these locations should be done as deemed appropriate.

Table 8 presents peak flows at the same locations as in the previous two scenarios (see Tables 3 and 5).

Table 9. Peak Flow Summary at Key Locations – Climate Change Scenario

Model Link	Location	Peak Flow (cfs)
Pipe_OR521	ES Village Main St Outfall	38.79
CB-POND_Outlet	Crescent Beach Outfall	2.88
Culv_SB-07_1	Olga Outfall North (Removed for future scenarios)	#N/A
Culv_SB-08_1	Olga Outfall South	108.91
Culv_JNS-25_2	Northshore Outfall near Donahue Ln	7.71
Culv_AWL-12	Northshore Outfall Airport West	11.40
Culv_AEL-21	Northshore Outfall Airport East	10.84
Pipe_JNS-23_2	Northshore Outfall near North Beach Rd	4.12
Culv_AEL-01-1	Flow across Mt Baker Rd (positive flow: south to north)	7.23
Pipe_OR773	Flow from Outlook Inn Pond into 48-inch pipe	18.26
Pipe_OR771	Flow from the Wetland	8.98
Pipe_OR636	Flow into Strctr_OR164 Market St	2.39

As expected, peak flow at each locations increased from the build-out scenario in the range of 16% and 53%. Figures 10 to 18 show peak HGL profiles comparing the profiles for all three scenarios at key locations previously identified as well as new locations showing flooding as identified in Table 7.

Green line represents existing conditions, black represents build-out scenario, and red represents climate change scenario.

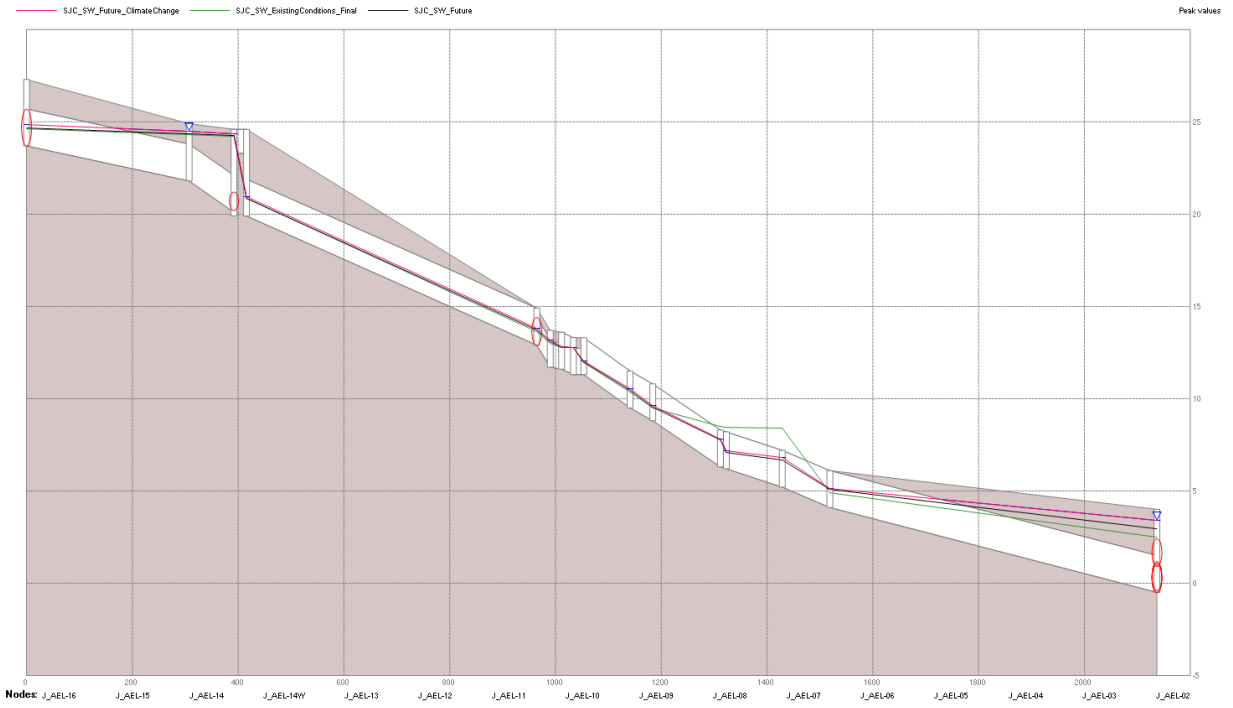


Figure 10. Airport East Ditch & Culvert System Profile – Scenario Comparison

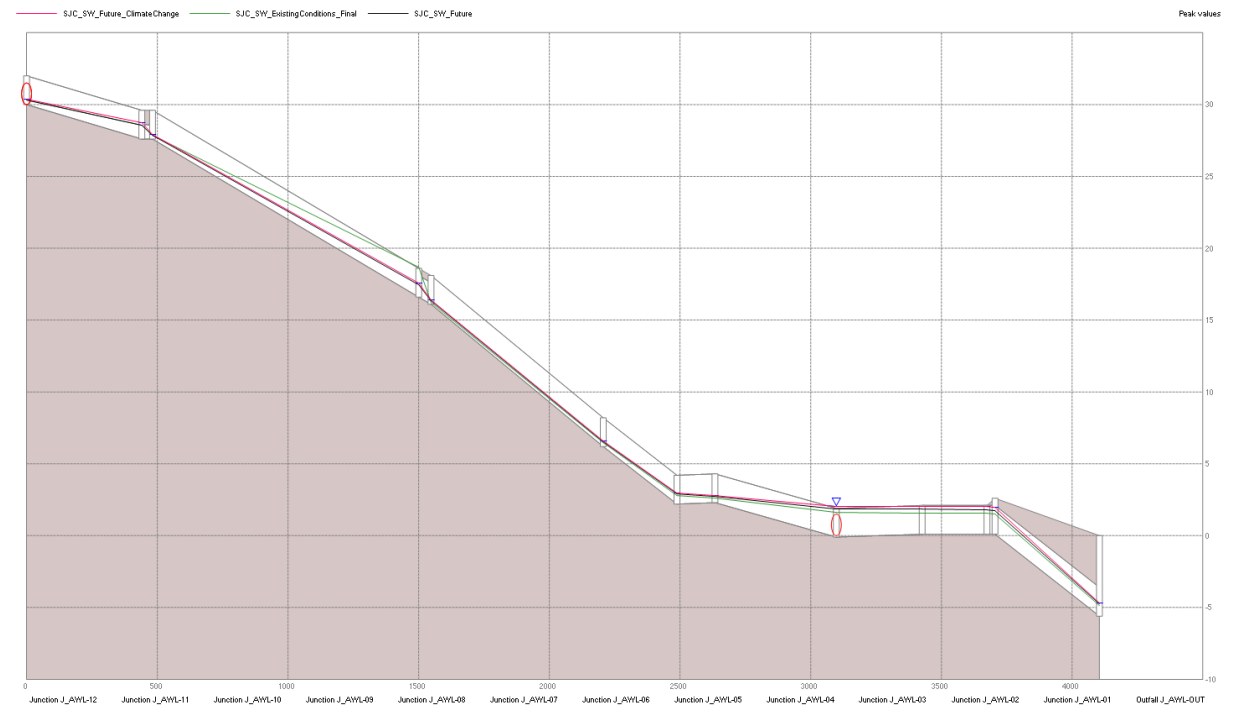


Figure 11. Airport West Ditch & Culvert System Profile – Scenario Comparison

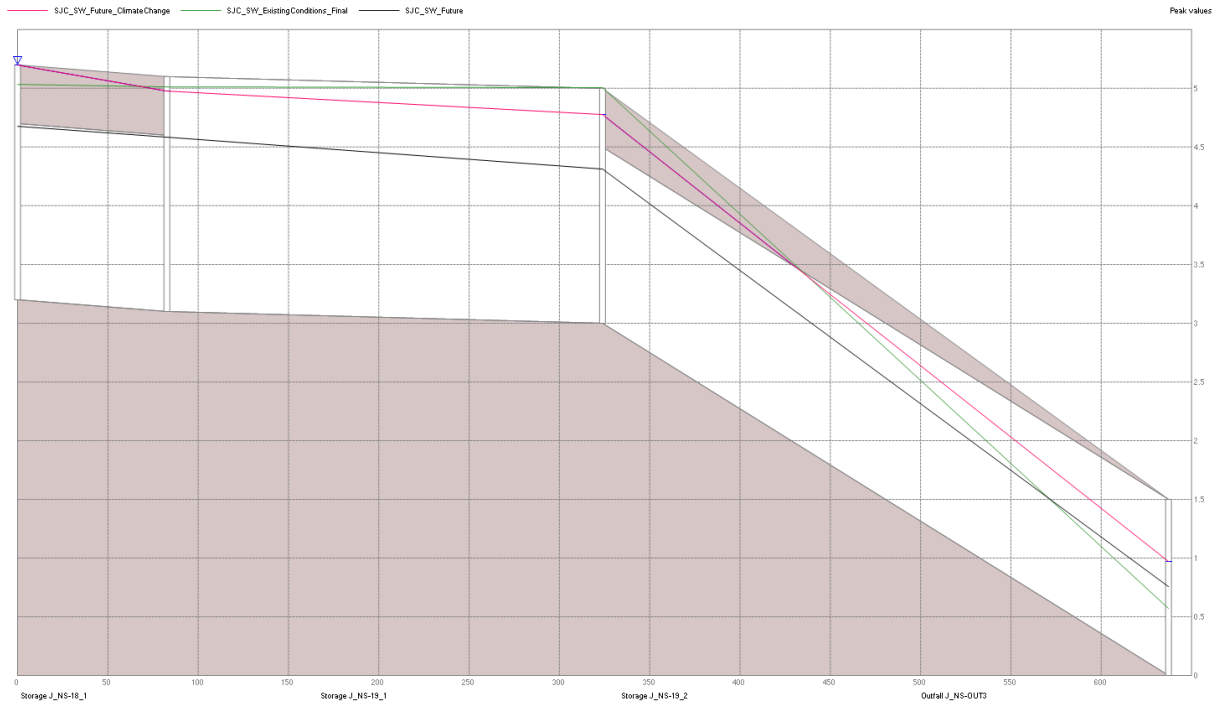


Figure 12. NS-1 Ditch & Culvert System Profile (Donahue Ln) – Scenario Comparison

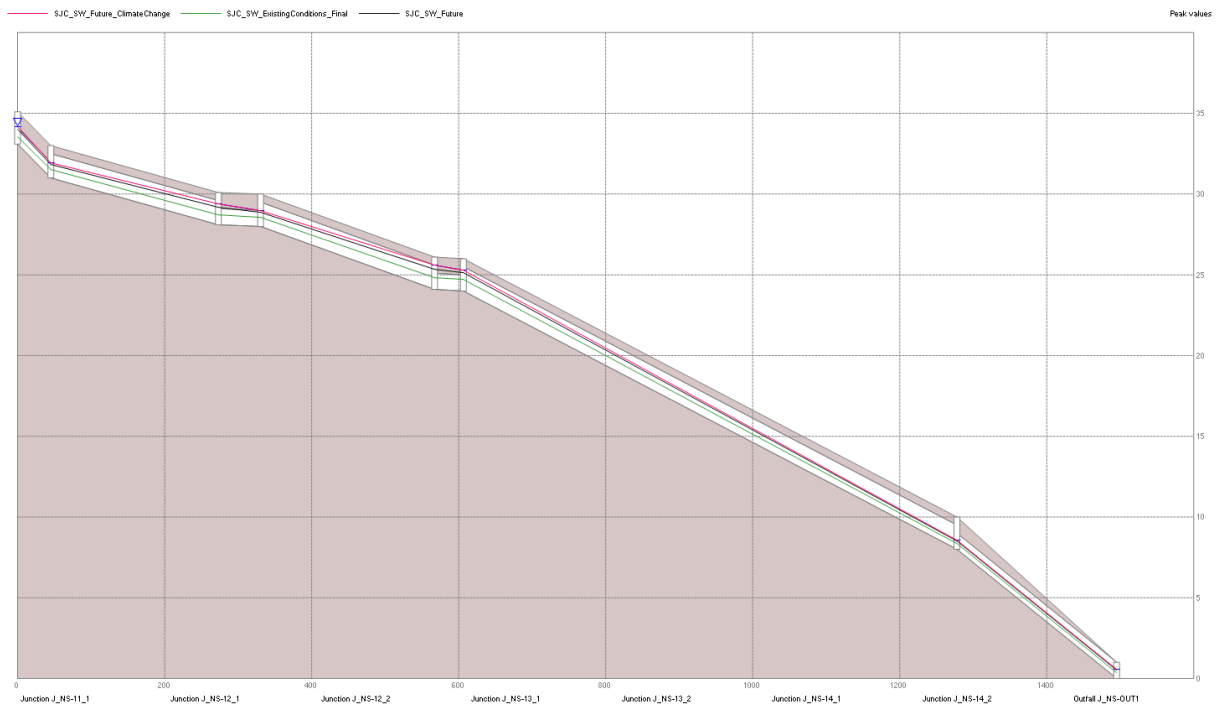


Figure 13. NS-2 Ditch & Culvert System Profile (North Beach Rd) – Scenario Comparison

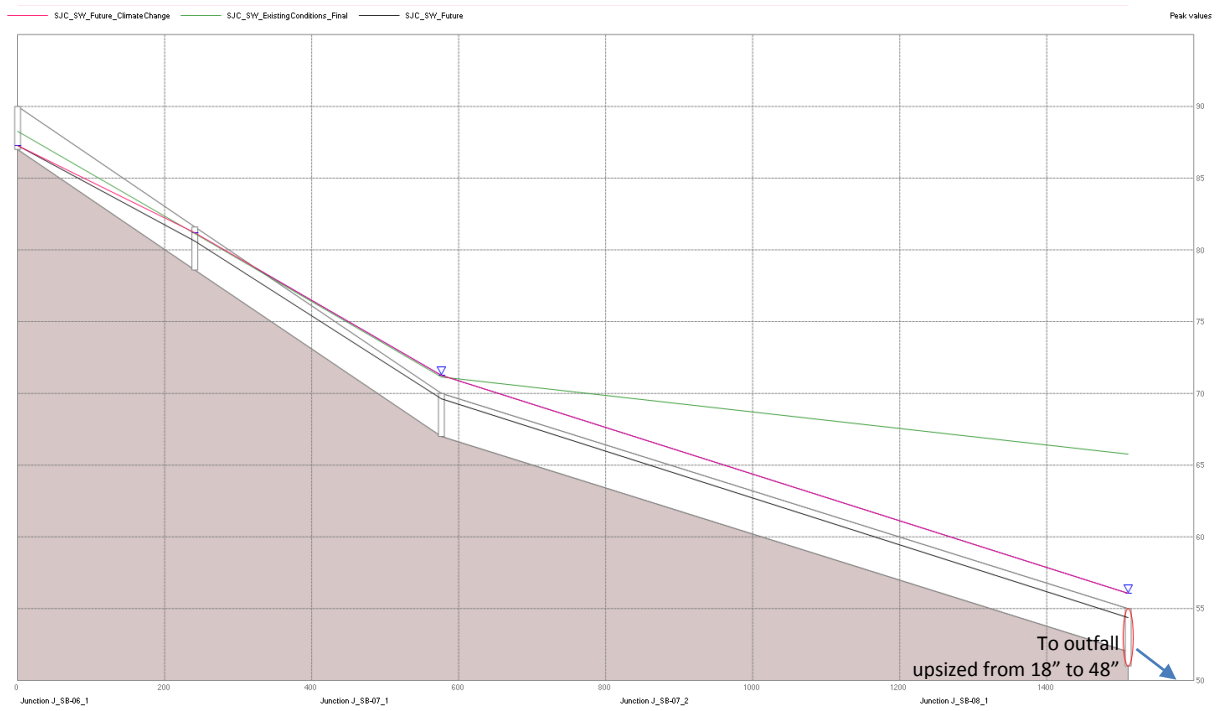


Figure 14. Olga Ditch System Profile – Scenario Comparison

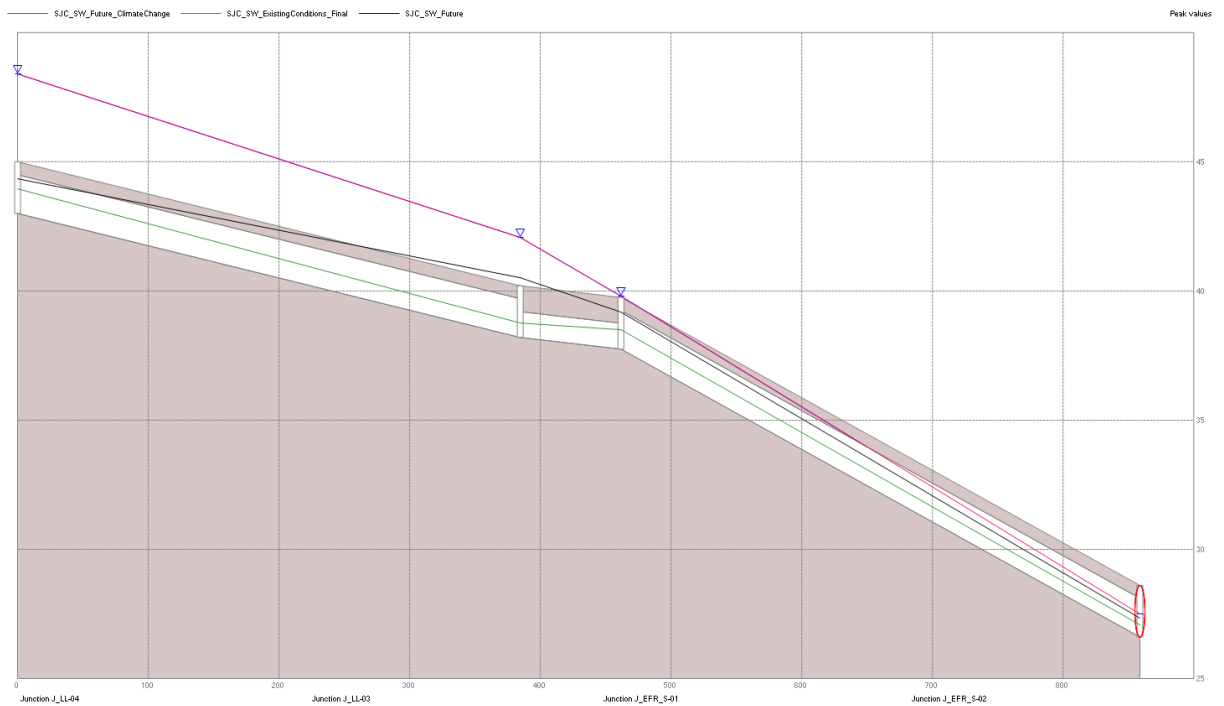


Figure 15. Lover's Ln / Enchanted Forest Rd Ditch System Profile – Scenario Comparison

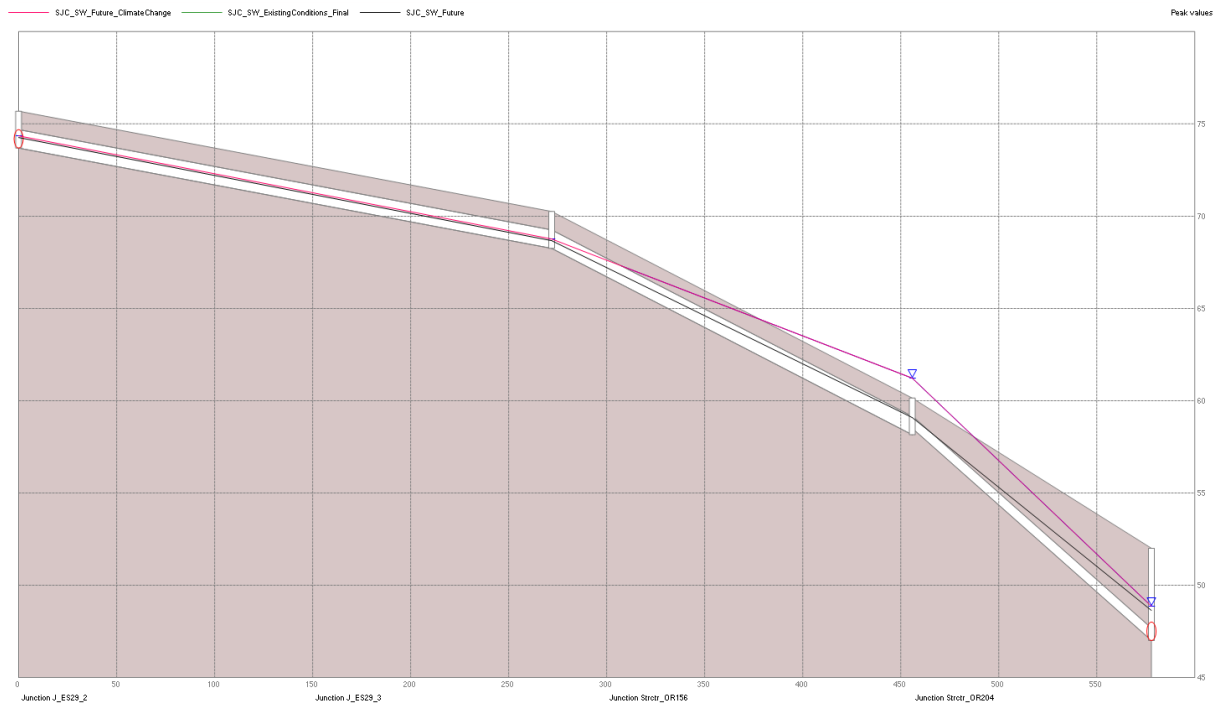


Figure 16. School Rd and North Beach Rd Pipe Profile – Scenario Comparison

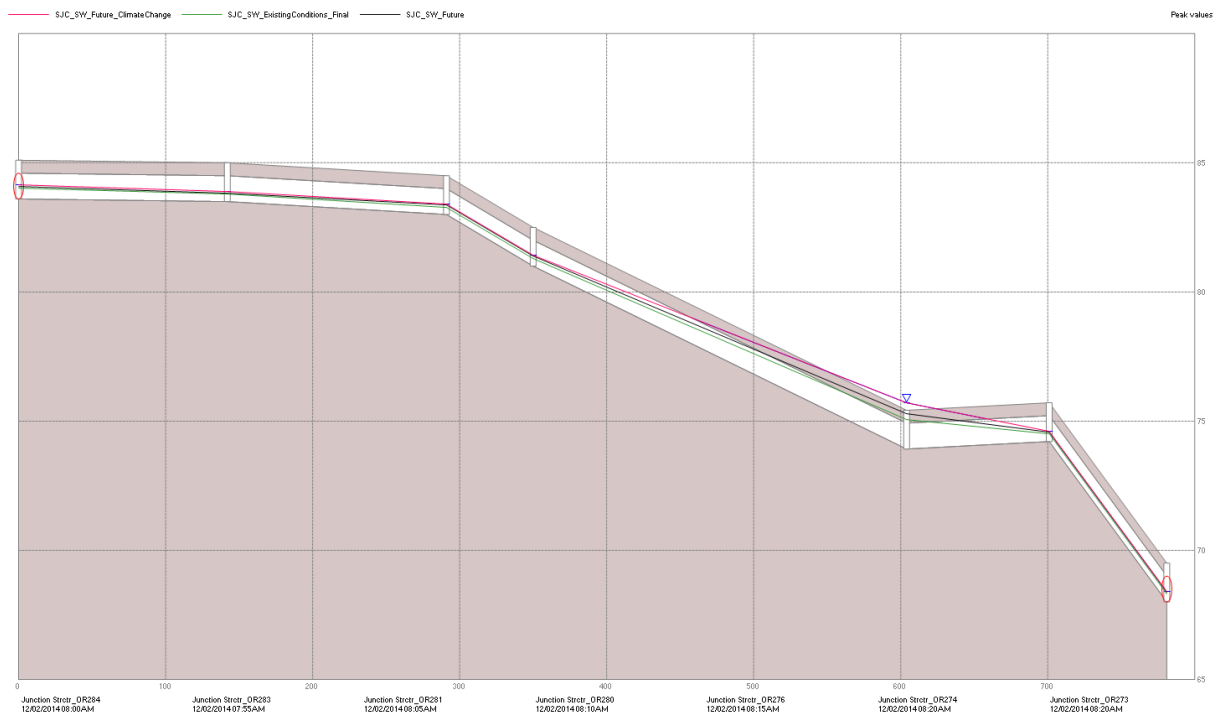


Figure 17. Mt Baker Rd Culvert System Profile – Scenario Comparison

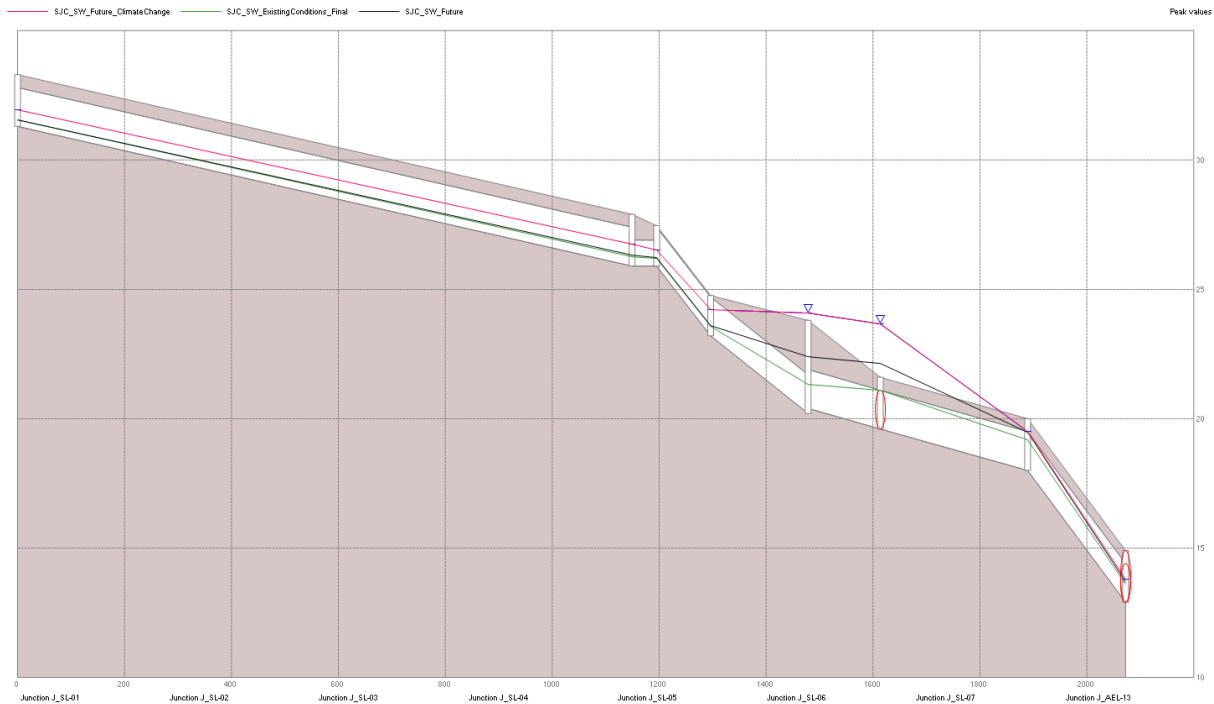


Figure 18. Schoen Lane Ditch System Profile – Scenario Comparison

As shown in Figure 10 through 18, peak HGL profiles increase significantly under the climate change scenario and significant flooding is predicted. Climate change projections for western Washington are continuously improving and improved projections should be incorporated into future evaluations. Risk tolerance should also be taken into consideration when deciding whether to plan future projects based on climate change scenario flows or based on flows generated using standard design storm size. Rainfall scaling factors should be carefully evaluated and adjusted as it has a direct correlation to peak flow and subsequent impact on capital projects.

Model Limitations and Future Recommendations

The modeling process used for this project relied on assumptions listed in the model development section, and as such, inferred model parameters may not always best represent actual field conditions. Model results may not be completely reflective of basin and conveyance system flow magnitudes due to the absence of flow monitoring data to conduct model calibration and/or validation. The current version of the model is a good tool for relative comparison between existing conditions to proposed alternatives.

The model should be used with its limitations in mind. These limitations may be resolved through future model development if warranted for design of CIP projects or evaluation of natural resources impacts.

Below is a summary of assumptions used in the model:

- Model parameters were estimated using best data available (GIS, as-built drawings) and engineering judgment. Typically, these parameters are adjusted during modeling calibration process if observed flow/depth data is available.
- SWMM5 is a fully dynamic model and flow is generated from precipitation input and subcatchment parameters provided, which get routed through the conveyance system as input in the model. No external flow data was provided as model input.
- Missing rim and invert elevations were inferred as described in the Model Development section.
- Wetland and other storage areas were inferred from contour data. For more detailed analysis in the future, it is recommended that field survey data be used to update the model.
- Strctr_OR236 is modeled per latest improvement with all flow discharging west via 15-inch pipe. If minor losses at this junction is a concern, appropriate coefficients should be added to the model in future updates.
- There is a flow split at the intersection of Prune Alley and A Street (Strctr_OR114). The County GIS data does not provide details of pipe offset and weir splitting the flow between the south and west pipes. The current model results show that the flow going west is higher than that going south. However, as-built drawing of field survey data should be added to the model for more accurate depiction of flow split at this location.
- No tidal influence was considered in current modeling of the outfalls. If model calibration is performed in the future, it is recommended that tidal data for period corresponding to the flow monitoring period be used.
- Minor losses were not incorporated in conveyance infrastructure.