City of Redmond Watershed Management Plan – Prioritization

1. **What do you use prioritization for - retrofits, new development and/or redevelopment?**
   Redmond uses the prioritization to focus stormwater retrofits, in stream projects, and buffer improvements into watersheds where the moderately degraded stream will see the most ecological lift with investments. Development/redevelopment can buy in to retrofits in “highest restoration” watersheds, allowing for consolidation of stormwater controls in watersheds where they will have the most immediate benefit.

2. **How did you develop your prioritization criteria?**
   Redmond initially used data (discussed below) to characterize individual fish barring water bodies and their watersheds. Redmond worked with Ecology to rerun the Puget Sound watershed characterization model locally, to prioritize watersheds based on hydrologic metrics (output bottom right). Output from the characterization was adjusted based on local data compilation.

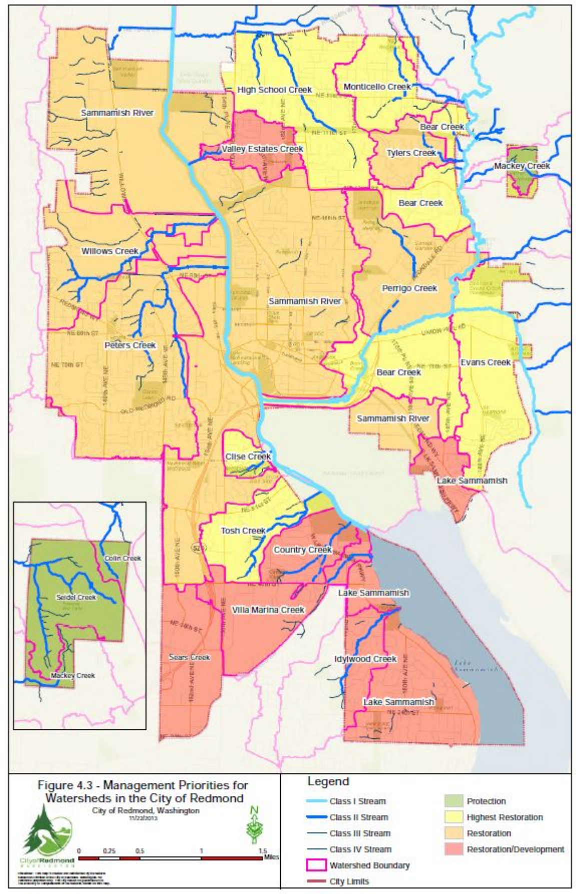
3. **What are the criteria?**
   Puget Sound Flow metrics included: storage, delivery, recharge, and discharge. Local data included: land cover (forest/impervious/landscape), land use (residential/commercial), fish use, habitat (LWD, buffer canopy), water quality (BIBI, DO, temp), stormwater characteristics (High AADT, area without flow/treatment, culverts, outfalls).

4. **How do you apply the criteria – weighting, etc.?**
   No weighting was used; the data did not lend itself to weighting. Puget Sound watershed characterization was the basis, then adjusted based on local data.

5. **Have you implemented policy or prioritized budget based on the prioritization (have you used the prioritization)?**
   Yes. Used to prioritize capital budget, allocating millions to restoring streams. Used prioritization in Ecology grant applications. Used to focus programs in prioritized watersheds.

6. **Who were the stakeholders when you set out to prioritize?**
   Washington Department of Ecology, Internal departments, Muckleshoot Tribe, Washington Department of Fish and Wildlife,

7. **What data sources did you use, and how readily available is the data?**
   We used local data, Puget Sound wide data, statewide data, and national data.



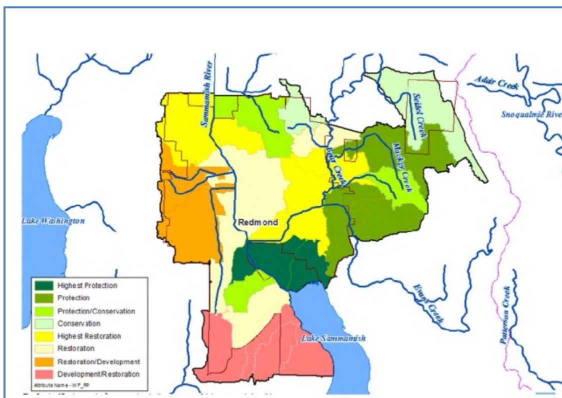


Figure 4.2. Puget Sound Watershed Characterization Water Flow Assessment Results for the City of Redmond.

Targeting Stormwater Retrofits Investments

Washington Department of Transportation's Experience

Larry E. Schaffner
NPDES Compliance & Planning Coordinator

BCiTR Working Group
September 23, 2014

Presentation Overview

- ✓ Our Stormwater Investment Challenge
- ✓ WSDOT's Initial Approach
- ✓ Lessons Learned
- ✓ "Retrofitting" the Approach to Prioritizing Retrofits
- ✓ The 3-Stage Assessment Process
- ✓ Reflections

Our Stormwater Investment Challenge

How do we optimize our stormwater investments to achieve maximum environmental benefit?

WSDOT's Initial Approach

A Stormwater Outfall Ranking Index

Apply a *random utility model to* *assign economic benefits to environmental quality changes for each stormwater outfall*

$$Vi = \sum_{k=1}^{n} b_k X_{ki}$$

Lessons Learned

The initial approach was:

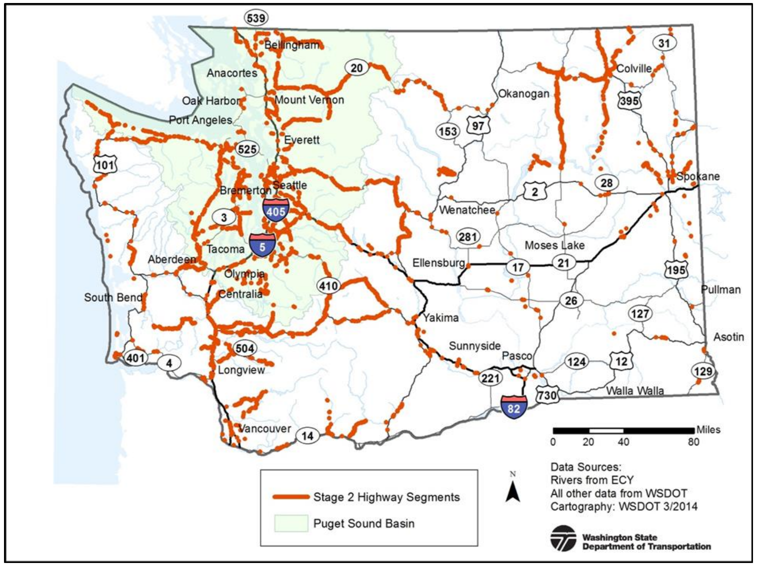
- ✓ Very data intensive
- ✓ Depended on assigning scores to outfalls, many of which had yet to be inventoried
- ✓ Expensive

"Retrofitting" the Approach to Prioritizing Retrofits

- ✓ Focus data collection on areas with the greatest stormwater retrofit needs;
- ✓ Target urban fringe areas before costs escalate;
- ✓ Reduce costs by identifying opportunities to combine stormwater retrofits with programmed construction projects; and
- ✓ Maximize immediate benefits by first targeting areas with highest benefits relative to cost.

3-Stage Assessment Process

1. **GIS Screen**
   – Applied to the entire highway system
2. **Reconnaissance**
   – For the top scoring *Stage 1* sites
3. **Detailed Site Assessment**
   – For the top scoring *Stage 2* sites



Results of GIS Criteria Screen

Washington State
Department of Transportation

Stage 1: GIS Screen

Prioritization Factors*

- ✓ Large, frequently traveled highways (1)
- ✓ Drinking water supply source (2)
- ✓ Fish bearing streams (2)
- ✓ Summer spawning areas (2)
- ✓ Small streams (3)
- ✓ High quality surface receiving waters (3)
- ✓ Urban fringe (3)

*Prioritization factor point weightings in parenthesis

Stage 2: Reconnaissance

Prioritization Factors*

- ✓ Untreated closed, curbed, and/or impervious-lined conveyance system (2)
- ✓ WSDOT observed erosion, pollution, or flooding problems (2)
- ✓ Discharges to 303(d) listed water bodies for certain pollutants of concern (2)
- ✓ Locally identified erosion, pollution, or flooding problems (3)
- ✓ Habitat suitability and value (3)

*Prioritization factor point weightings in parenthesis

Key Aspect of Stage 2

Gleaning Local Knowledge

Questionnaires utilized to target the following audiences:

- ✓WSDOT region staff
- ✓Local jurisdictions
- ✓Biologist

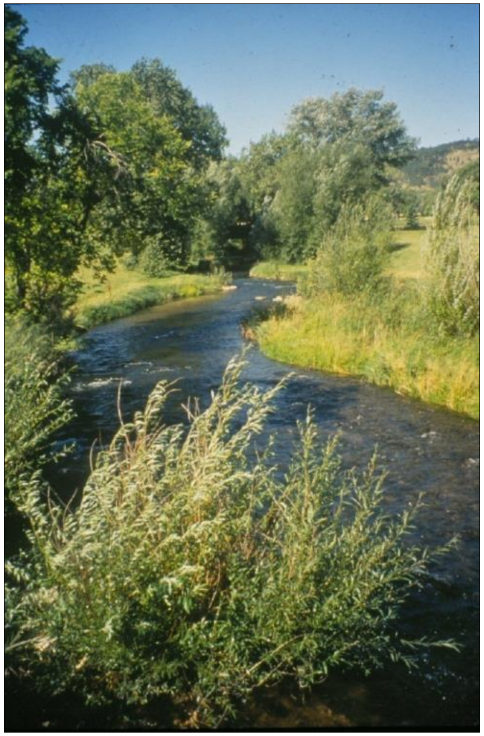
Please Check all that Apply											
State Route	Beginning Milepost	Ending Milepost	Length (mi)	Catch Basins with High Sediment Loading	Stormwater Culverts with High Sediment Loading	Roadways with Excessive Sediment Build-up	Areas with Frequent Slides	Areas with Eroding Soils	Noticeable Pollutants*	Other Stormwater Issues or Concerns	Comments
Examples:											
113	9.52	9.59	0.07					☒			south side
		Total Length:	0.07								
116	0.06	0.15	0.09			☒					
116	0.17	0.26	0.09								OK
116	1.64	1.82	0.18								OK
116	2.28	2.39	0.11								OK
116	5.69	5.79	0.10								OK
116	6.56	7.06	0.50								OK
116	7.86	7.96	0.10								OK
		Total Length:	1.17								

* Other Pollutants - Visible Oil-Sheen, Sewage Concerns, etc.

Stage 3: Detail Site Assessment

Prioritization Factors*

- ✓ *Stage 2 synthesis* – highway segment receiving score of 8 or greater (1)
- ✓ *Large drainage area* – drains greater than 5 acres of impervious surface (1)



*Prioritization factor point weightings in parenthesis

Stage 3 Results

Used to evaluate:

- ✓ Whether to package nearby retrofit priorities (and gaps in between) into a single retrofit project package
- ✓ If the potential exist to bundle retrofit priorities with programmed improvement projects

Reflections

Similarities Between Original & New Approach

Both approaches:

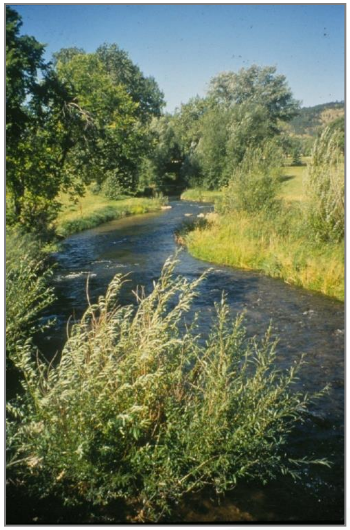
- ✓ Utilized weighted criteria (however, now there are fewer of them)
- ✓ Set criteria to reflect priorities and values from an interagency team

Reflections

Difference Between Original & New Approach

New approach:

- ✓ Factors in local knowledge
- ✓ Targets areas with highest environmental value rather than degraded areas
- ✓ Targets intensive data collection to a prescreened subset of candidate locations rather than gathering it everywhere
- ✓ Evaluates and assigns scores to highway segments rather than individual stormwater outfalls



Reflections

The End Result Produced

An approach:

- ✓ More transparent & cost-effective
- ✓ Embraced by resource agencies & stakeholders
- ✓ Agile enough to incorporate new information & changing conditions

Thank You Very Much for Your Attention!

I love a finished speaker, I really, truly do.
I don't mean one who's polished.
I just mean one who's through.

- Richard Armour, American Poet

Larry Schaffner
Thurston County Water Resources Division
Olympia, Washington

schaffl@co.thurston.wa.us

**TARGETING STORMWATER RETROFITS INVESTMENTS
WITHOUT BREAKING THE BANK**

Larry Schaffner
Thurston County Water Resources Division
(Previously with Washington State Department of Transportation)
Olympia, Washington

Overview

Our challenge: *How do we optimize investments for stormwater retrofit to achieve maximum environmental benefit?* Especially considering most development predates stormwater regulations and was built without any consideration for runoff treatment and flow attenuation.

Washington State Department of Transportation's (WSDOT) approach to prioritizing areas for stormwater retrofits embraces a *conservation biology* approach by focusing investments to protect the remaining relatively healthy receiving waters and their habitats. The approach emphasizes preventing degradation to high value aquatic resource areas rather than attempting to correct damage after it occurs. While WSDOT uses this approach for prioritizing stormwater retrofits for its highway system, the methodology could be adapted for use in other settings and customized to reflect alternative values. Our current approach reflects lessons learned from our previous endeavors and thus represents an evolution in our thinking on how to more cost-effectively evaluate and establish stormwater retrofit priorities.

Lessons Learned

Originally our retrofit prioritization methodology involved developing a stormwater outfall ranking index. This required assigning values for 16 independent variables for each stormwater outfall. Five of these variables required the additional step of selecting and applying a multiplier to the assigned value. The process essentially represented a cost/benefit tool. In applying this tool, we found ourselves expending more resources to score and rank stormwater retrofit priorities than we actually had budgeted for construction of the retrofit projects themselves. The high expenditures incurred resulted from the data intensive approach employed to determine retrofit priorities. Implementation was further complicated since the approach depended upon assigning scores to individual stormwater outfalls, many of which had yet to be inventoried and documented.

Applying the Learnings – Refining WSDOT's Prioritization Approach

WSDOT's current stormwater retrofit prioritization scheme (*scheme*) involves a three-stage assessment process for assigning a retrofit priority score to specific highway segment locations. The *scheme* (*Table 1*) includes criteria and rationale for each prioritization factor encompassed in this approach. This scheme emerged through collaborative engagement with Washington State Department of Ecology, U.S. Fish and Wildlife Service, and NOAA Fisheries staff. As a result, the criteria and their associated weightings reflect the priorities and values of these resource agencies. The criterion's *point weighting* represents their "significance" relative to other criteria falling within each stage.

Table 1: Stormwater Retrofit Prioritization Scheme			
Prioritization Factor	**Criteria**	**Rationale**	**Point Weighting**
Stage 1: GIS Screen			
Large, frequently traveled highways	Traffic level >30,000 annual average daily traffic (AADT).	For a variety of reasons, larger, frequently traveled highways are associated with greater pollutant generating potential.	1
Drinking water supply source	Mapped wellhead protection zones, sole sources aquifers, and drinking water source-protected watersheds.	Protect drinking water supplies.	2
Fish bearing streams	Waters identified by the Department of Fish and Wildlife as *fish bearing*.	Protect fish resources.	2
Summer spawning areas	Waters identified in state water quality standards as summer spawning areas.	Spawning areas and summer holding and migration areas provide critically important habitat for summer chum and summer steelhead.	2
Small streams	Waters with mean annual flows less than 20 cubic feet per second (i.e., waters that are not shorelines of the state).	Small streams are less able to assimilate runoff and more vulnerable to changes in flow.	3
High quality surface receiving waters	Waters identified in State water quality standards as *Char and Core salmon spawning and rearing*.	High quality streams provide important habitat.	3
Urban fringe	Urban fringe areas within designated Urban Growth Areas.	More economical to retrofit prior to development which significantly reduces stormwater management options and increases capital and operational costs.	3
Stage 2: Reconnaissance			
Untreated closed, curbed, and/or impervious-lined conveyance systems	Untreated runoff primarily conveyed by curbs, culverts, impervious-lined conveyances, and/or pipes to a receiving water body.	Closed, curbed, and impervious-lined conveyance systems have greater pollutant discharge potential than open drainage systems which have treatment and flow attenuation properties.	2
WSDOT observed erosion, pollution, or flooding problems	Eroded channels, embankments, excess sediment buildup/loading in stormwater infrastructure, visual observation of water pollution, or flood prone areas.	Gives consideration for known problems.	2
Discharges to 303(d) listed water bodies for certain pollutants of concern	303(d) listed water bodies for: PAH, metals (zinc and copper), turbidity, and herbicides used by WSDOT.	Gives consideration to known receiving water problems that could be exacerbated by discharges of untreated highway runoff.	2
Locally identified erosion, pollution, or flooding problems	Consult local basin plans, recovery plans, and associated TMDL implementation documents for identified stormwater runoff-related problems and/or retrofit priorities.	Factors in well informed local knowledge.	3
Habitat suitability and value	Waters identified by the Washington Department of Fish & Wildlife (WDFW) area habitat and Tribal biologist as important small stream habitat as well as highway segments with fish passages identified by WSDOT as high retrofit priorities.	Factors in well informed local knowledge.	3
Stage 3: Detail Site Assessment			
Stage 2 synthesis	Highway segments receiving a *Stage 2 Reconnaissance* score of 8 to 12.	Gives higher priority to factors evaluated in Stage 2.	1
Large highway drainage area	Draining area > 5 acres of impervious surface.	Larger drainage areas generate more runoff.	1

The prioritization process:

1. Focuses data collection on areas with the greatest stormwater retrofit needs;
2. Targets urban fringe areas before retrofit costs escalate;
3. Reduces costs by identifying opportunities to combine stormwater retrofits with programed highway construction projects; and
4. Maximizes immediate environmental benefits by first targeting areas with highest environmental benefits relative to cost.

The first stage in the prioritization process involves screening the entire state using Geographic Information Systems (GIS) map analysis tools. This screening identifies highway segments having predefined conditions known to present greater than average risks for highway stormwater impacts (*Figure 1*). This stage takes advantage of existing GIS datasets to rapidly narrow the field of candidate areas that undergo further evaluation in *Stage 2* of the prioritization process.

The second stage of the prioritization process involves a site-specific reconnaissance of the candidate sites emerging from *Stage 1* to identify those with closed conveyance systems; known high habitat value; and known or observable erosion, pollution, or flooding problems. In defining candidate sites to move to *Stage 2* of the process, the interagency team intentionally set the "point bar" low (i.e., *Stage 1* highway segments receiving scores of 8 to 16) to avoid narrowing the eligibility pool prematurely during the initial stage of the assessment process.

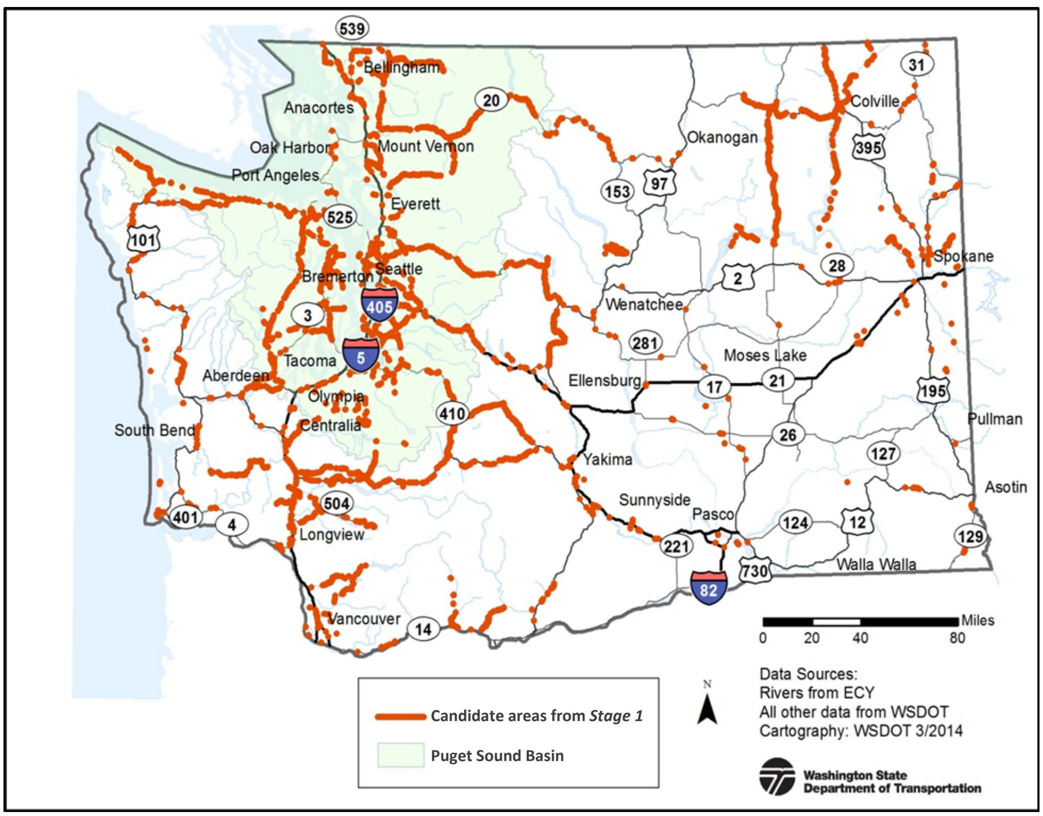


Figure 1: Results of Stage 1 GIS query identifying candidate segments for Stage 2 analysis

A key aspect of this second stage involves utilizing two questionnaires to glean local knowledge of the candidate sites. The first questionnaire's target audience includes WSDOT region staff and as well as local jurisdictions. This tool (*Table 2*), developed by region staff and simple in its approach, significantly improved our ability to gather information from maintenance field staff. WSDOT uses the second questionnaire (*Table 3*), developed with assistance from a consultant, to query biologists. These questionnaires aid in standardizing data collection and *Stage 2* evaluation scoring.

The third and final stage in the prioritization process involves collecting detailed site information to determine drainage areas and estimate retrofit costs. WSDOT uses the results of *Stage 3* to evaluate:

1) Whether it makes sense to package nearby highway segments targeted for retrofit (and the gaps between those segments) into a single stand-alone retrofit project; and
2) If the potential exists to bundle any of the retrofit priorities with programmed highway improvement projects rather than advancing them as a set of individual stand-alone retrofit projects.

Retrofit priorities not falling within a programmed highway project boundary get queued by geographic region for completion as stand-alone retrofit projects in order of their priority ranking score. The three geographic regions of the state include: the Puget Sound basin, western Washington sans the Puget Sound basin, and eastern Washington.

WSDOT updates stormwater retrofit prioritization scores to reflect new information and changing conditions brought to our attention.

Table 2: Questionnaire Use for Querying WSDOT Region Staff and Local Area Jurisdictions

Please Check all that Apply

State Route	Beginning Milepost	Ending Milepost	Length (mi)	Catch Basins with High Sediment Loading	Stormwater Culverts with High Sediment Loading	Roadways with Excessive Sediment Build-up	Areas with Frequent Slides	Areas with Eroding Soils	Noticeable Pollutants*	Other Stormwater Issues or Concerns	Comments
Examples:											
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116	7.86	7.96	0.10								OK
		Total Length:	**1.17**								

* Other Pollutants - Visible Oil-Sheen, Sewage Concerns, etc.

Table 3: Questionnaire Use for Querying State Fish & Wildlife and Tribal Biologist

Date:	
Biologist Interviewee:	Interviewer:
Highway Segment:	Stream Name:

C-1 Physical Spawning & Rearing Habitat Quality

Appropriate substrate and cover that promotes spawning and high survival rate for eggs and cover for early life stages of fishes (alevins and fingerlings) in upper channel reaches and provides adequate cover and substrate for rearing in lower channel reaches. Details of high-quality habitat include the following:

________ Riparian Zone	________ Spawning Habitat
________ Fish Cover	________ Habitat diversity
________ Bank stability	________ Lack of stream channel impairments

High-quality physical spawning & rearing habitat: ☐ Yes ☐ No

Comments:

C-2 Water Quality

Water quality includes the small stream meeting or exceeding chemical and physical characteristics (e.g., low water temperature, high dissolved oxygen concentrations, and moderate pH) of surface water per the Washington State water quality standards (WAC-173-201A) that are intended to protect aquatic life and promote survivability of all life stages.

Water quality conditions meet or exceed water quality standards: ☐ Yes ☐ No

Comments:

C-3 Lack of Stream Impairments

Impairments include the physical alteration of the natural riparian corridor and/or the stream channel that reduces the availability of fish habitat necessary for completing each of the life stages and diminishes survivability, resulting from altered habitat. Examples of impairments include dams, channelization, effects from urbanization, hardened streambank protection, forest harvesting, mining activities, and water diversions.

Lacks stream impairments: ☐ Yes ☐ No (i.e., stream impairments exist)

Comments:

C-4 Lack of Fish Passage Barriers

Lack of presence of fish passage barriers, including dams, culverts, water diversions, and natural passage barrier features (e.g., waterfalls, low dissolved oxygen, and high temperature barriers). The habitat suitability and value criteria is met if the regional WDFW or tribal biologist provides information that supports there is a lack of stream fish passage barriers for the small receiving stream.

Lacks fish passage barriers: ☐ Yes ☐ No (i.e., fish passage barriers exist)

Comments:

Reflections

In many respects WSDOT’s current prioritization approach resembles aspects of our original methodology. For example, it still includes weighted criteria. However, there are fewer of them, particularly when one considers the elimination of multipliers which previously applied to five of the 16 criteria contained in the original methodology. Similarly, the criteria in the original and existing approaches reflect priorities and values from an interagency team.

However, the similarities diverge with regards to the evolution of thought in establishing priorities. Most notably, now we factor in local knowledge and the target areas with highest environmental value rather than focusing on restoring significantly degraded areas. Another notable difference involves targeting the more intensive data gathering efforts to a prescreened subset of “candidate locations” rather than requiring intensive data gathering efforts everywhere. Additionally, moving away from scoring individual stormwater outfalls to evaluating highway segments reduced our dependency on closing existing knowledge gaps (i.e., outfall locations) which had significantly encumbered our original evaluation process.

Furthermore, collaborative engagement in developing the new approach, as well as “connecting the dots” between the criterion and their rationale, contributed greatly to building buy-in from resource agencies and other stakeholders. The end result produced a transparent and more cost-effective assessment tool. It also produced a method agile enough to revise priority rankings to reflect new information and changing conditions.

Biography

Larry recently joined the Thurston County Water Resources Division in July 2014 where he coordinates compliance with the County’s NPDES municipal stormwater permit as well as provides technical and policy support on water resource and stormwater management issues. Prior to joining the County, Larry worked 12 years for the Washington State Department of Transportation where he oversaw compliance-related activities associated with the department's NPDES municipal stormwater permit. These activities included developing, implementing, and evaluating the department's stormwater management program plan and stormwater design guidance manual.

Earlier in his career, Larry spent eight years as a planner in Oregon for Lane Council of Governments. There he managed projects that involved creating forums for agencies and stakeholders to collaboratively resolve natural resource, land use, and transportation issues. Before becoming a planner, Larry spent nearly ten years in parks operations and management.

Larry holds a master’s degree in Urban and Regional Planning from the University of Oregon and a bachelor’s degree in Outdoor Recreational Planning and Management from the University of Illinois at Urbana-Champaign.

Small Basin Program Retrofit Prioritization

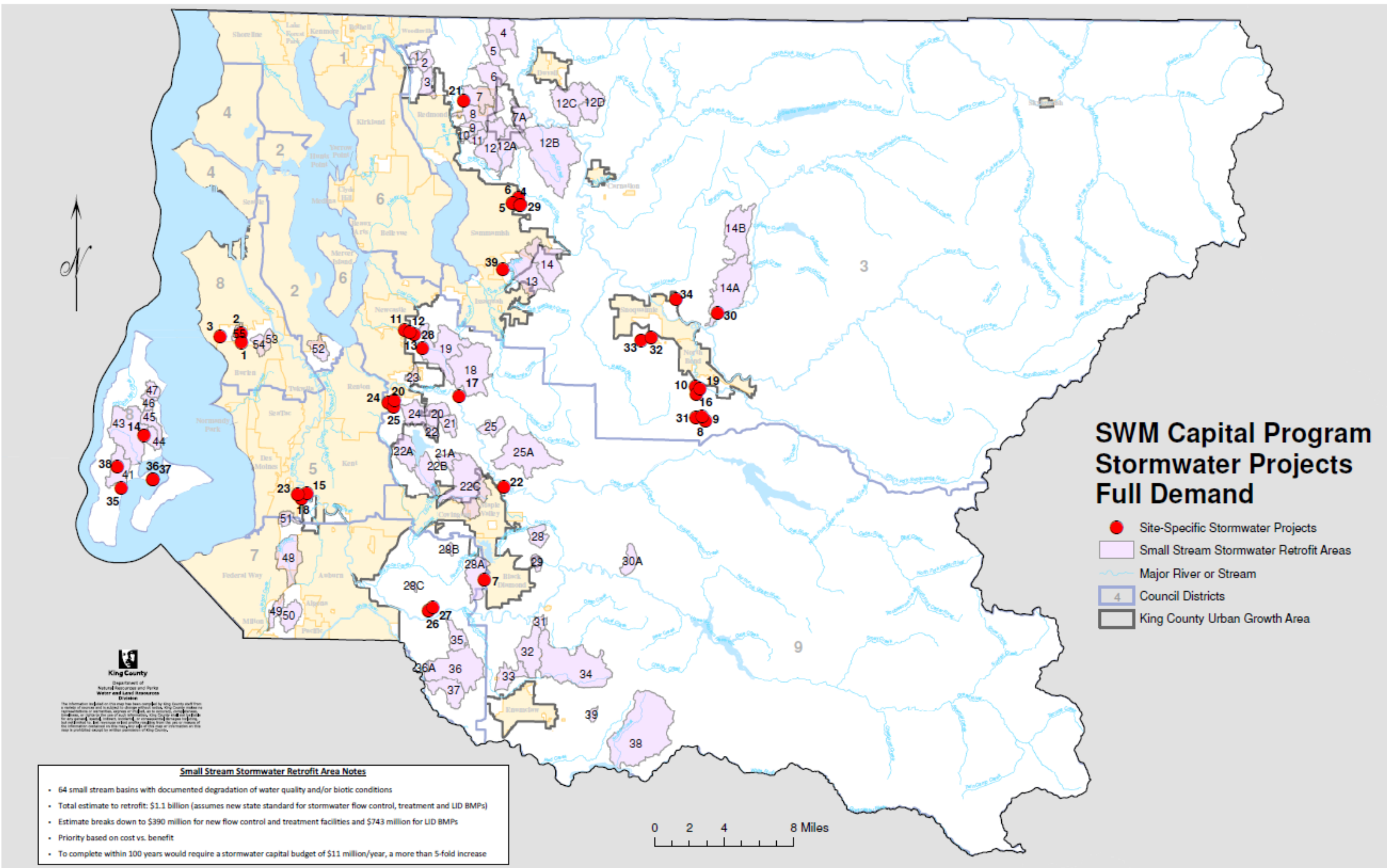
Presented by
Claire Jonson, Project Manager and
Dale Nelson, Project Engineer

King County
Water and Land Resources Division

Agenda

- 1. What do you use prioritization for - **retrofits**, new development and/or redevelopment?
- 2. How did you develop your prioritization criteria?
- 3. What are the criteria?
- 4. How do you apply the criteria – weighting, etc.?
- 5. Have you implemented policy or prioritized budget based on the stream prioritization (have you used the prioritization)?
- 6. Who were the stakeholders when you set out to prioritize?
- 7. What data sources did you use, and how readily available is the data?

67 Small Basin Retrofits



Basin Selection – B-IBI

- **Benthic Index of Biotic Integrity (B-IBI)** scoring system is a quantitative method for determining and comparing the biological condition of streams.
- http://www.pugetsoundstreambenthos.org/

Condition	General Description	BIBI Range
Excellent	Comparable to least disturbed reference condition; overall high taxa diversity, particularly of mayflies, stoneflies, caddis flies, long-lived, clinger, and intolerant taxa. Relative abundance of predators high.	46-50
Good	Slightly divergent from least disturbed condition; absence of some long-lived and intolerant taxa; slight decline in richness of mayflies, stoneflies, and caddis flies; proportion of tolerant taxa increases.	38-44
Fair	Total taxa richness reduced – particularly intolerant, long-lived, stonefly, and clinger taxa; relative abundance of predators declines; proportion of tolerant taxa continues to increase.	28-36
Poor	Overall taxa diversity depressed; proportion of predators greatly reduced as is long-lived taxa richness; few stoneflies or intolerant taxa present; dominance by three most abundant taxa often very high.	18-26
Very Poor	Overall taxa diversity very low and dominated by a few highly tolerant taxa; mayfly, stonefly, caddis fly, clinger, long-lived, and intolerant taxa largely absent; relative abundance of predators very low.	10-16

Basin Selection

- Benthic Index of Biotic Integrity
  - Tributary Basin
    - Poor → 4
    - Fair/Poor → 3.5
    - Fair → 3
    - No Rating → 0
  - Downstream B-IBI station
    - Very poor → 4
    - Poor → 3
    - Fair → 2
    - Good or better → 0
    - No rating → 0

Basin Selection – Ecology 303d listing

- http://www.ecy.wa.gov/programs/wq/303d/currentassessmt.html
- Category 2 is defined by DOE to be likely impaired
- Category 4 is impaired with a cleanup plan
- Category 5 is impaired without a cleanup plan

Basin Selection

- Tributary DOE 303(d)Water Quality Listing
  - Category 5 & 4 → 4
  - Category 2 → 3
  - No Category(NC) → 0
  - NC, Downstream BIBI >0 → 2
- Downstream DOE 303(d)Water Quality Listing
  - Category 5 & 4 → 3
  - Category 2 → 2
  - NC, Downstream BIBI >0 → 1
  - No Category(NC) → 0

Basin Selection

- Stream Channel Stability Indices
  - Ratio of 2-year developed to 10-year forested flow
    - No flow controls
    - Peak-matching flow controls – 1990 or later
  - Ratio > 1 indicates likely unstable stream channel
  - Weighted 5x for scale comparable to impact score

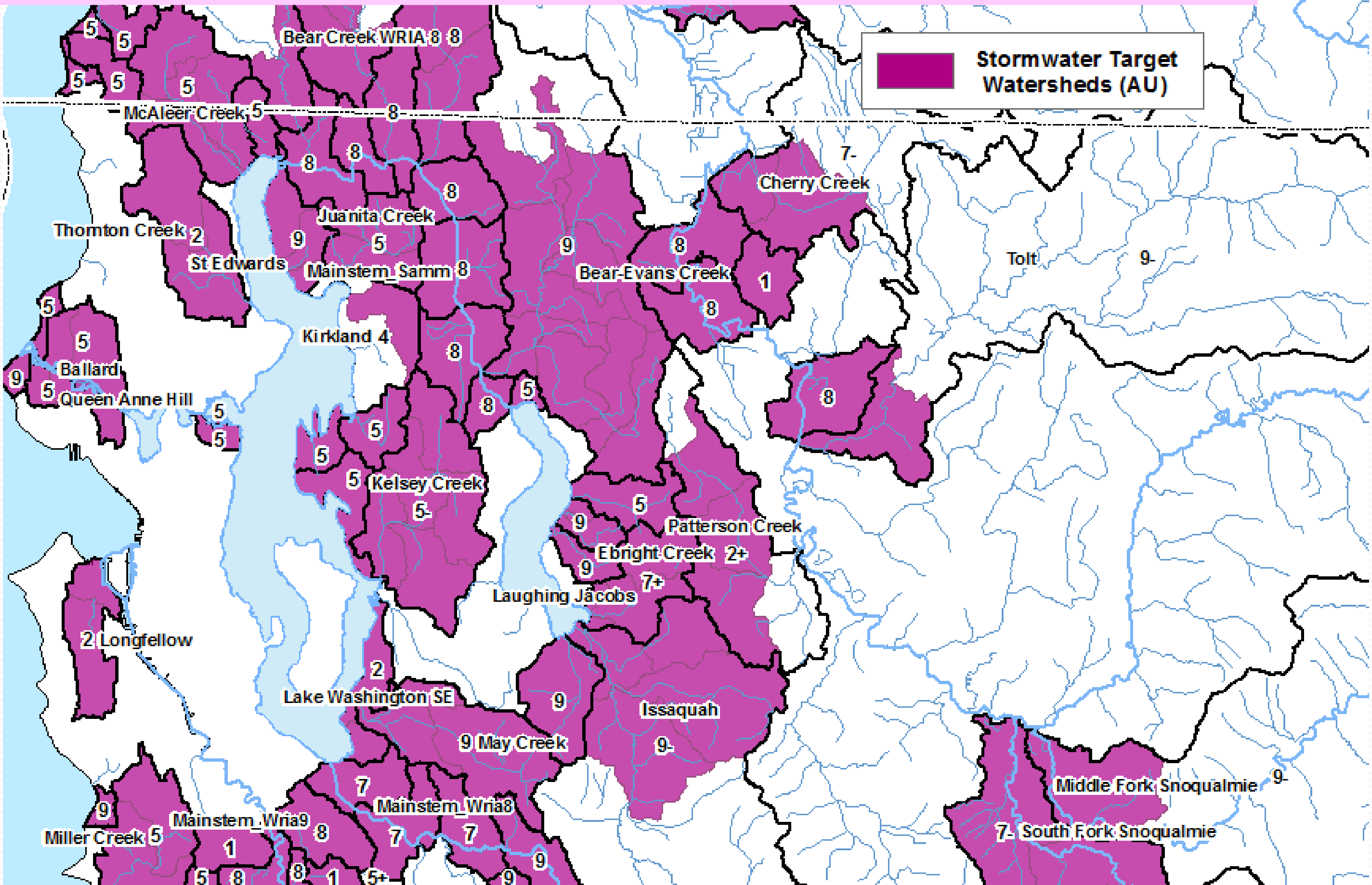
Basin Selection

- Percent of Basin Developed
  - Area > 60% → 4
  - Area > 50% and ≤ 60% → 3
  - Area > 40% and ≤ 50% → 2
  - Area > 30% and ≤ 40% → 1
  - Area ≤ 30% → 0
- Weighted 2.5x

Basin Selection

- Catchment Size
  - Area < 1.5 sq. mi. → 4
  - Area ≥ 1.5 and < 3 sq. mi. → 3
  - Area ≥ 3 and < 6 sq. mi. → 2
  - Area ≥ 6 and < 12 sq. mi. → 1
  - Area ≥ 12 sq. mi. → 0
- Weighted 2.5x

Department of Ecology Stormwater Target Watersheds



Small Basin Selection

				Scoring Used for Prioritization of Basins	
Map Ref No.	Stream Name	Small Stream or Lake Name	Downstream Receiving Water	Impact Scores + Trib Area Scores	DOE Flow Integrity Score
11	Evans Creek Trib 0108	No Name	Evans Creek	43.5	9.0
9	Bear Creek Trib 0114	No Name	Bear Creek	42.5	9.0
19C	May Creek Trib 291A	No Name	May Creek	42.0	9.0
19B	Honey Creek	Honey Creek	May Creek	42.0	9.0
8	Mackey Creek Trib 0129	Mackey Creek	Bear Creek	39.5	9.0
48	Mill Creek Trib 0051	Mill Creek	Mill Creek	39.0	9.0
1	Gold Creek Trib 0088	Gold Creek	Sammamish Riv	39.0	8.0
3	Sammamish Riv Trib 0095B	No Name	Sammamish Riv	38.5	8.0
2	Sammamish Riv Trib 0090	No Name	Sammamish Riv	38.0	8.0
10	Evans Creek Trib 0107	No Name	Evans Creek	36.0	9.0
23	Lower Cedar Riv Trib 0307	No Name	Lower Cedar Riv	36.0	7.0
12	Evans Creek Trib 0110	No Name	Evans Creek	35.0	9.0
49	Hylebos Creek Trib 49	No Name	Hylebos Creek	35.0	9.0
5	Bear Creek Trib 0134A	No Name	Bear Creek	34.5	9.0
6	Struve Creek Trib 0131	Struve Creek	Bear Creek	32.5	9.0
50	Trout Lake Trib 0033	Trout Lake	Lower White Riv	32.5	9.0
19	May Creek Valley Reach	May Creek	May Creek	32.0	9.0
12A	Evans Creek Trib 0106	Evans Creek	Evans Creek	30.0	9.0
13	Issaquah Creek Trib 0181	N Frk Issaq Crk	Issaquah Creek	28.5	8.7

Project Selection

- North Kitsap County, LID Retrofit Project Implementation Plan, 2013

Project Selection – Level 1

Score	Criteria
Site Slopes	
1	Site slopes (X) > 10%
2	5% > X ≤ 10%
3	X ≤ 5%
Available Area	
1	Available area in the existing drainage facilities
2	Available area in the right-of-way (0 to half width)
3	Available area in the right-of-way (full width)
Effective Impervious Area (EIA) Managed	
1	Low
2	Medium
3	High
Meets Multiple Objectives	
1	Meeting one of the following: water quaility improvement, peak flow reduction, or local drainage improvement
2	Meeting two of the following: water quaility improvement, peak flow reduction, or local drainage improvement
3	Meeting all of the following: water quaility improvement, peak flow reduction, and local drainage improvement
Risk to the Environment	
1	Sites located within required setback zones for existing wells, steep slopes, critical areas, or pose a risk to existing structure or features
2	Sites located near the same features, but considered minor risk
3	Site located outside of the same features

Project Selection – Level 2 Part 1

Score	Criteria
Water Quality	
0	The Water Quality scoringwas derived from the Benefit Calculation from Department of Ecology Phase I Municipal Stormwater Permit, Appendix 11, Pages 3 and 4. The Water Quality Benefit Calculation can be found at the following web address: http://www.ecy.wa.gov/programs/wq/stormwater/municipal/phaseIpermit/phipermit.html
1	
2	
3	
Drainage & Local Flooding	
0	Project expected to provide no effect on existing drainage or local flooding problems
1	Project expected to provide some drainage improvement
2	Project expected to improve local drainage and reduce local flooding
3	Project helps address specific drainage or local flooding issues based on record of historical
Utility Coordination	
1	Numerous potential utility conflicts
2	Moderate potential utility conflicts
3	Limited potential utility conflicts and/or good opportunity to coordinate retrofit with planned utility or roadway improvement projects.

Project Selection – Level 2 Part 2

Score	Criteria
Constructability	
0	Construction costs expected to exceed the project value; Potentially significant impacts to residents during construction
1	No major impacts to residents expected; Some utility conlicts may increase construction time/costs
2	No major impacts to residents expected; Construction not expected to be complicated by utility or other types of conflicts
3	No major impacts to residents expected; County crews can construct the project in approximately 2 weeks or less
Operation and Maintenance	
0	Long-term operation and maintenance of project is not feasible or cost effective
1	Project located outside of County-owned right-of-way and will require external O&M
2	Project may require purchase of new equipment, training staff, and/or allocation of additional budget to properly maintain the proposed retrofits
3	County has necessary equipment, staff experience, and budget allocated to maintain the proposed retrofits
Ease of Funding	
0	Expected cost of project exceeds value and/or funding is not available
1	Project funding depends on collaboration with tribes or other public agencies
2	Project not expected to be eligible for grant funding through Ecology's Stormwater LID Retrofit grant program
3	Project expected to be eligible and compete successfully for grant funding through Ecology's Stormwater LID Retrofit grant program

Contact Information

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206-477-4720

Dale Nelson, Project Engineer
dale.nelson@kingcounty.gov

206-477-4785

Kitsap County Stormwater Retrofit Program

Chris May
Kitsap County Public Works
Stormwater Division

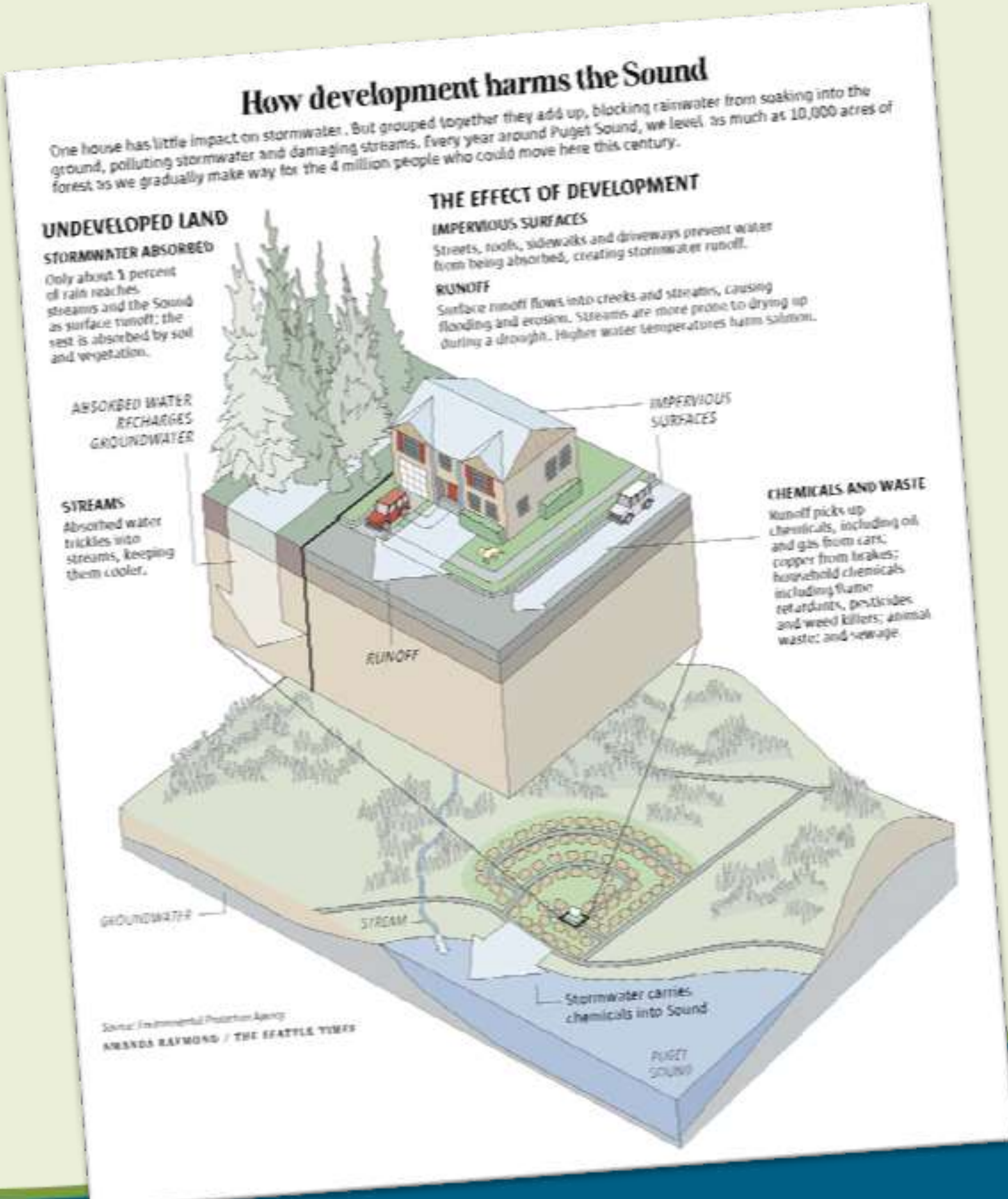
Clean Water Kitsap
Partners in Stormwater Solutions

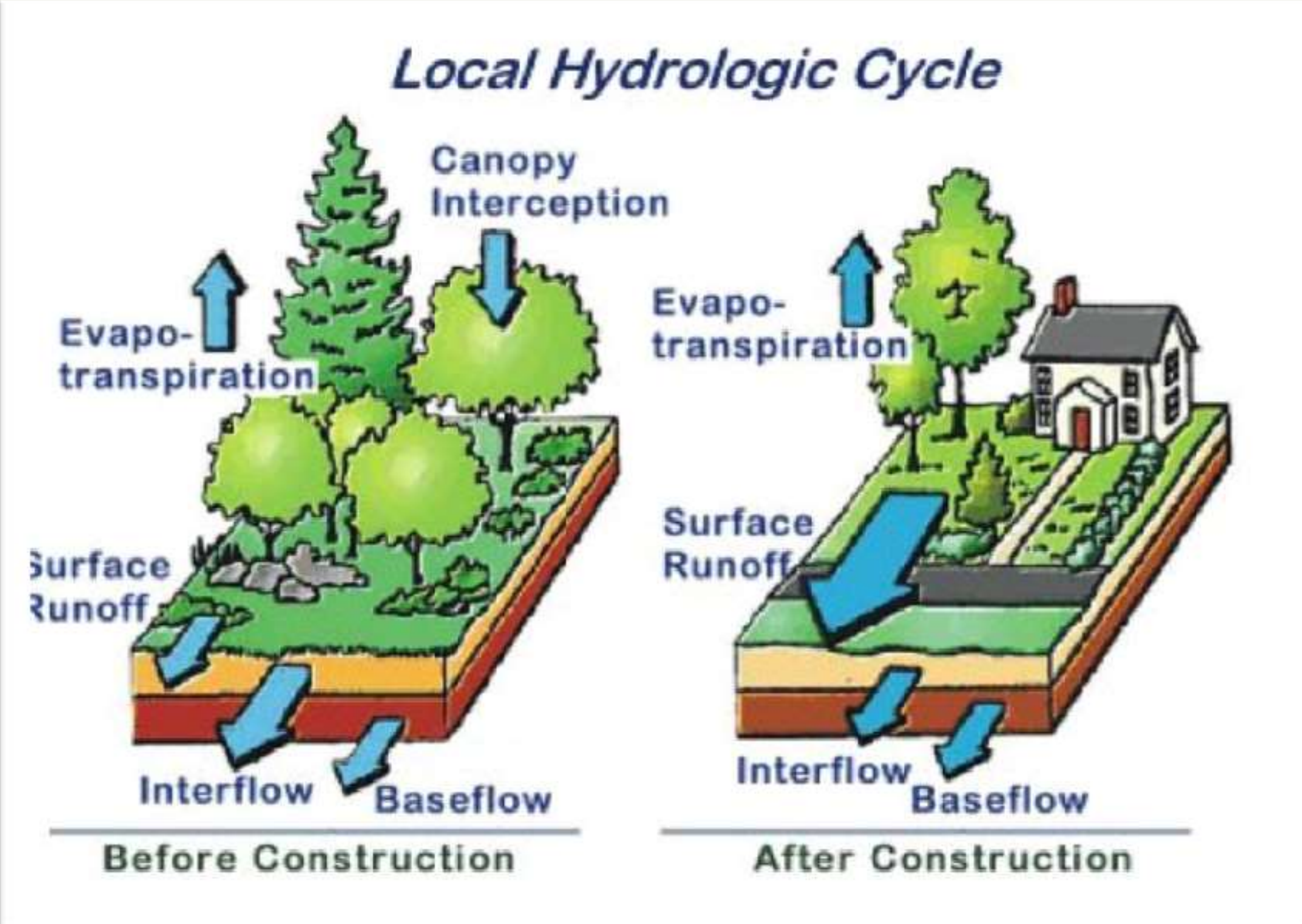
Managing Stormwater in the Built Environment

Kitsap County Washington

Overview

- Stormwater regulations typically only apply to NEW development (1980)
- Much of our developed (impervious) landscape is OLD and often has little or no stormwater treatment
- If we really want to improve WQ and protect Puget Sound, we need to do stormwater RETROFIT projects


How development harms the Sound
One house has little impact on stormwater. But grouped together they add up, blocking rainwater from soaking into the ground, polluting stormwater and damaging streams. Every year around Puget Sound, we level as much as 10,000 acres of forest as we gradually make way for the 4 million people who could move here this century.
UNDEVELOPED LAND
STORMWATER ABSORBED
Only about 1 percent of rain reaches streams and the Sound as surface runoff; the rest is absorbed by soil and vegetation.
THE EFFECT OF DEVELOPMENT
IMPERVIOUS SURFACES
Streets, roofs, sidewalks and driveways prevent water from being absorbed, creating stormwater runoff.
RUNOFF
Surface runoff flows into creeks and streams, causing flooding and erosion. Streams are more prone to drying up during a drought. Higher water temperatures harm salmon.
ABSORBED WATER RECHARGES GROUNDWATER
IMPERVIOUS SURFACES
STREAMS
Absorbed water trickles into streams, keeping them cooler.
CHEMICALS AND WASTE
Runoff picks up chemicals, including oil and gas from cars; copper from brakes; household chemicals including flame retardants, pesticides and weed killers; animal waste; and sewage
RUNOFF
GROUNDWATER
STREAM
Stormwater carries chemicals into Sound
PUGET SOUND
AMANDA RAYMOND / THE SEATTLE TIMES


Local Hydrologic Cycle
Canopy
Interception
Evapo-
transpiration
Surface
Runoff
Interflow
Baseflow
Before Construction
Evapo-
transpiration
Surface
Runoff
Interflow
Baseflow
After Construction

Kitsap County Stormwater Problems

Same problems throughout the Puget Sound

- Hydrologic Modification due to Stormwater Runoff Volume
- Water Quality Degradation due to Stormwater Pollution
- Fecal Pollution in Local Inlets, Embayments, and Shorelines
- Stream Habitat Degradation due to Frequent & Elevated Stormflows
- Localized Flooding of Urban Areas




Actions to Reduce Pollution Sources

- Septic & Sewer Repairs
- Stormwater System O&M
- Business Inspections
- IDDE & Source Control
- Mutt Mitt Program
- CB Cleaning
- New Stormwater Standards
- HE Street Sweeping
- Stormwater Retrofits
  - Green (LID) Solutions

Kitsap Stormwater Retrofit Program Goals

- Enhance GW Recharge
- Reduce Local Flooding
- Stabilize Stream Channels
- Reduce Pollutant Loading and Improve WQ
- Improve Habitat and Ecological Integrity

Kitsap Stormwater Retrofit Program Targets

- Replace or upgrade failing or damaged drainage infrastructure
- Add WQ enhancements in areas where there is little or no stormwater treatment
- Upgrade stormwater flood/flow-control in areas where runoff controls are inadequate

The Challenge of Stormwater Retrofit

- Often difficult to find opportunities and space
- Especially difficult in highly urbanized areas with lots of utility conflicts

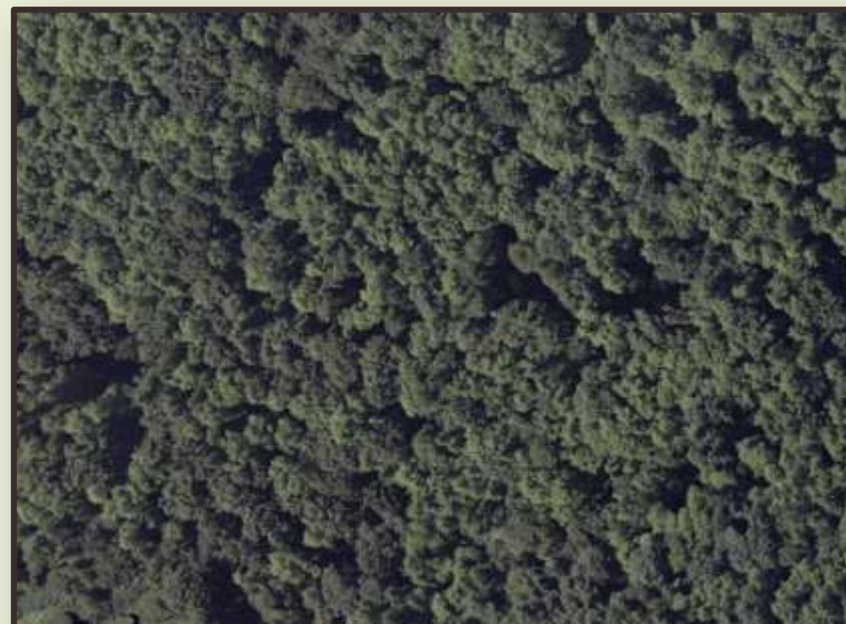
- Many more problems than retrofit options
- Flood and Flow Control and/or WQ Treatment
- Public Acceptance

Green Stormater Retrofit Solutions

Small-Scale Practices That:

- Manage rain where it falls
- Closely mimic natural hydrologic processes

Make this…



Function more like this…

Crafting a Retrofit Strategy

- Need to be systematic in identifying and prioritizing projects
- Need to have a multi-tiered implementation approach
    - Roads and ROW
    - Ponds
- Integrate with other watershed-based initiatives
- How do we pay for retrofits?

Basic Retrofit Strategy

1. Retrofit Scoping/Goals
2. Desktop (GIS) Analysis
3. Reconnaissance
4. Retrofit Inventory
5. Evaluation/Ranking
6. Design
7. Construction
8. Monitoring
9. O&M

Types of Green (LID) Stormwater Solutions (GSS)

- Bioretention (Rain Gardens) and Street-Tree Box Filters
- Permeable Pavement
- Green (Eco) Roofs
- Constructed Wetlands
- Infiltration Systems

- Infiltration
- Filtration
- Storage
- Evaporation
- Transpiration

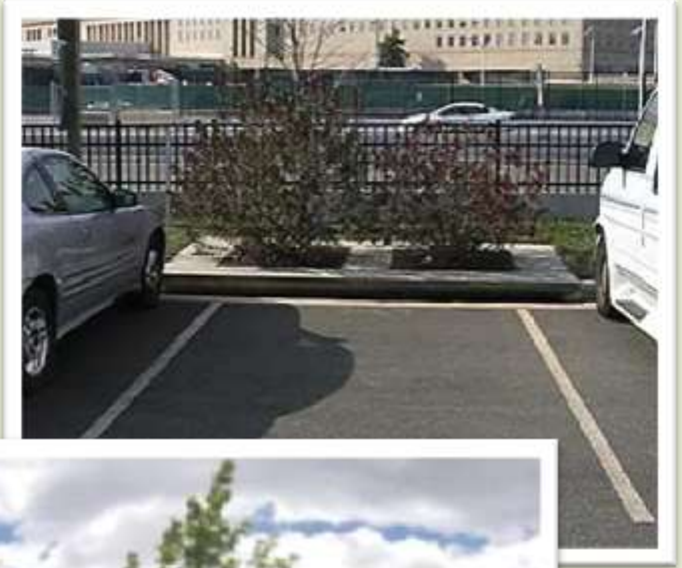
Utilize Natural Hydrologic Functions

- Soil
- Vegetation
- Fungi
- Micro-Organisms

Bioretention (Rain Garden Systems

Permeable Pavement

Constructed Wetlands



Tree Box Filters

Green Roofs and Green Walls

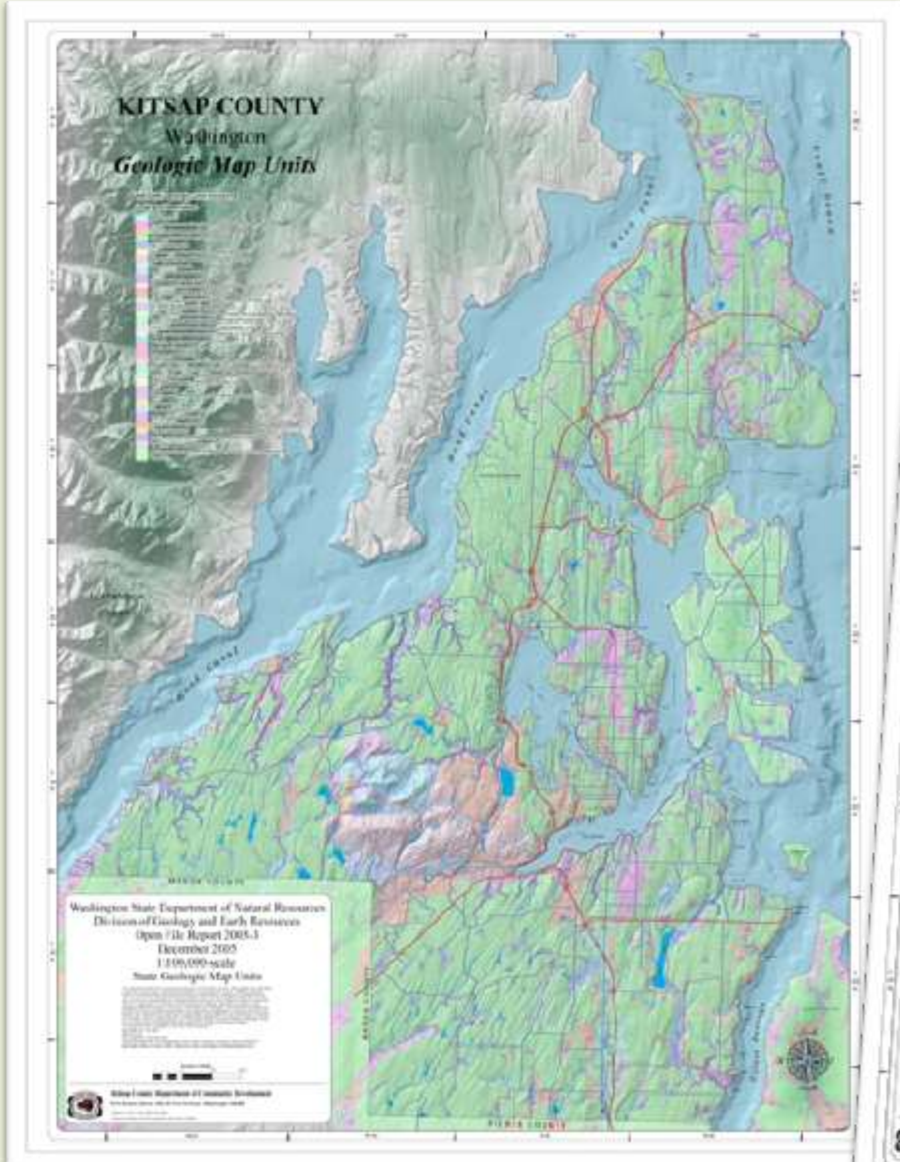
Benefits of Green Stormwater Solutions

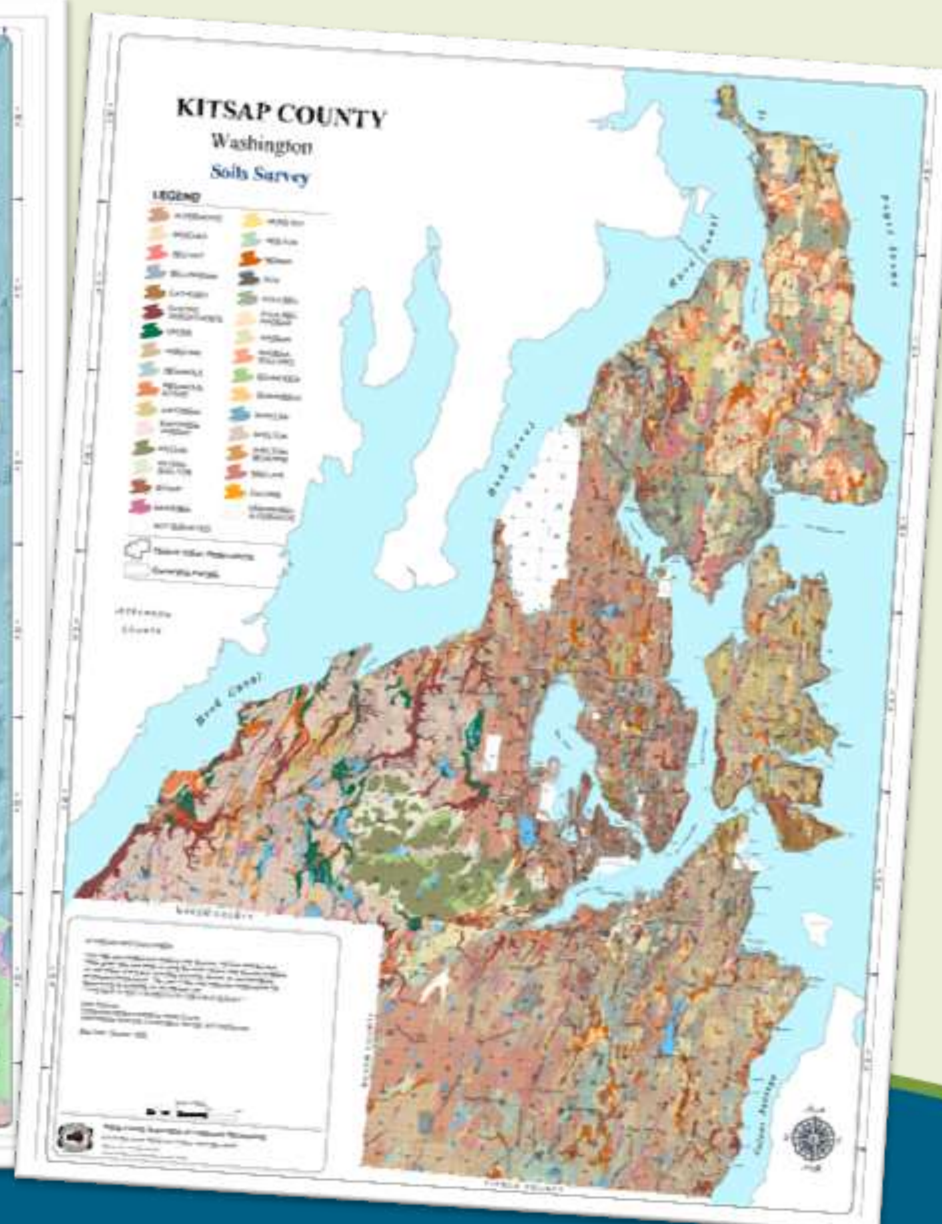
- Remove Pollutants
- Reduce Runoff Flows and Volume
- Replenish Groundwater
- Control Local Flooding
- Aesthetically Pleasing




Brookwood Green Street Retrofit Project

Forest Green Street Retrofit Project



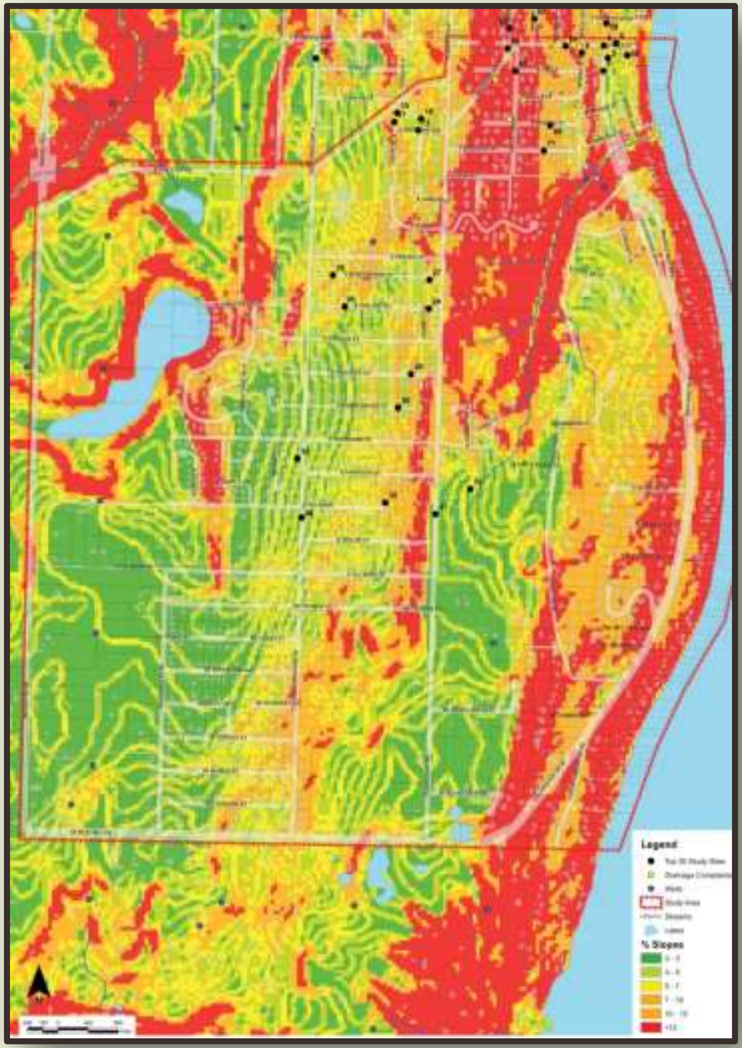


Retrofit (GSS) Feasiblity

Identify Constraints

- Criteria:
  - ✓ Proximity to Steep Slopes/ Landslide Prone Areas
  - ✓ High Groundwater
  - ✓ Low Permeability Soils

- Delineate Areas Suitable for:
  - ✓ Shallow Infiltration
  - ✓ Deep Infiltration

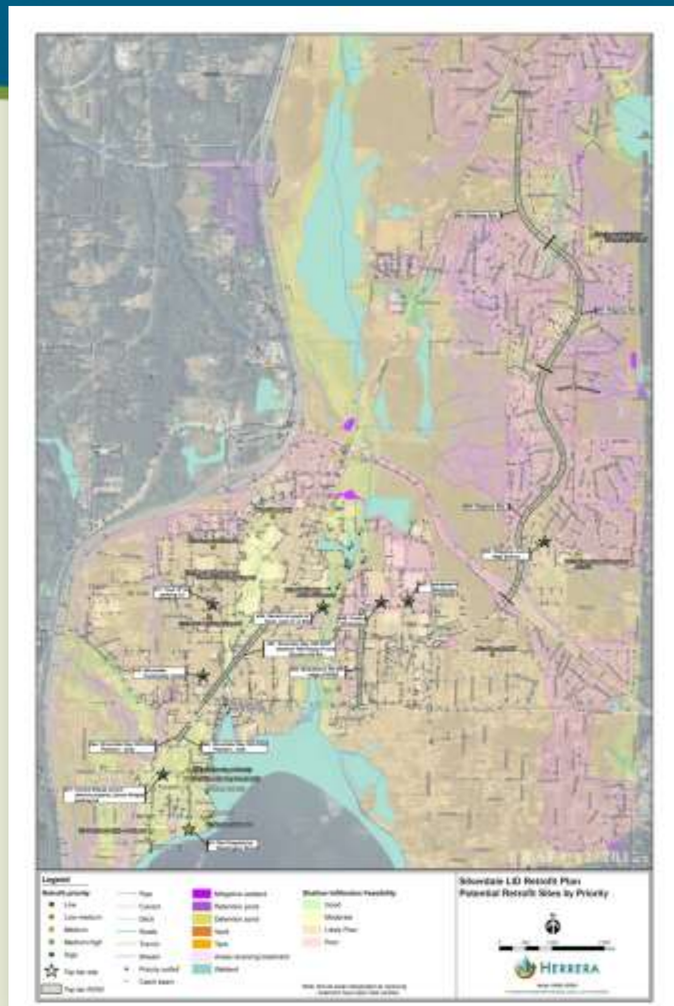


Evaluate Constraints

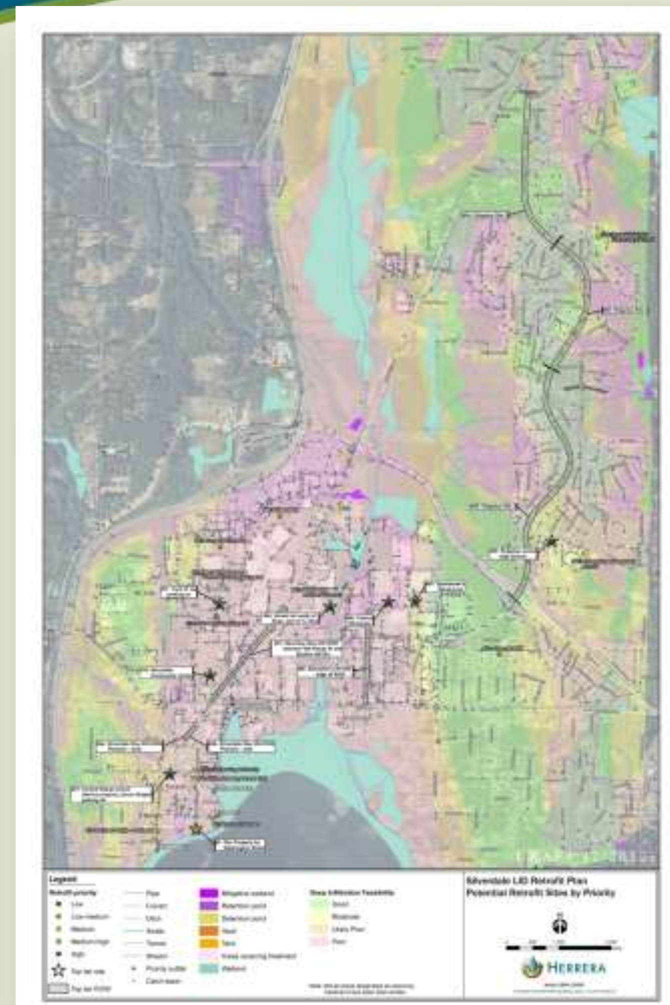
Infiltration Assessment

Infiltration Feasibility

- Good
- Moderate
- Likely Poor
- Poor



Shallow



Deep

Study Area

Known Problems

Impervious and Forest Cover

Existing Drainage System

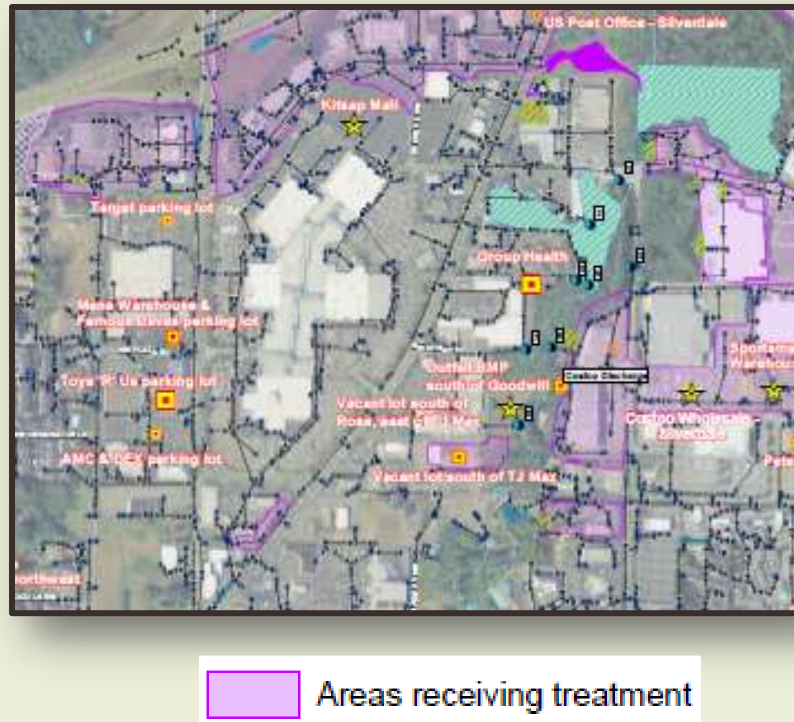
Soils and Infiltration

Steep Slopes

Opportunities and Constraints

Mapping Evaluation

- Delineate Drainage Areas
- Space for Green Stormwater Solutions
  - ROW Areas with Wide Medians or Planting Strips
  - Public or Private Sites with Nearby Open Space
- Large Pollution-Generating Area not Currently Treated



Identify Opportunity Areas

Evaluate Opportunity Area

Windshield Survey

- Benefit
  - ✓ Pollutant Loads
    (e.g., parking lot use)
  - ✓ Visibility/ Education opportunities
- Feasibility
  - ✓ Available Space
  - ✓ Topography
  - ✓ Existing Drainage Patterns

Evaluate Opportunity Area

Quantitative Ranking of Sites

- Benefit
  - ✓ Pollutant Loads
    (e.g., parking lot use)
  - ✓ Visibility/ Education opportunities
- Feasibility
  - ✓ Available Space
  - ✓ Topography
  - ✓ Existing Drainage Patterns

Top Potential Retrofit Sites

Feasibility Evaluation of Potential Sites

Field Evaluation to Confirm Feasiblity

- Sufficient Space Given Setbacks
  Existing Grading and Drainage Patterns
  Allow Gravity Flow
- Limited Impact to Site Uses
- Property Operations do Not Preclude Retrofit
- Drainage Infrastructure can be Reasonably Modified
- Confirm Stormwater is Not Treated

Evaluate of Potential Sites

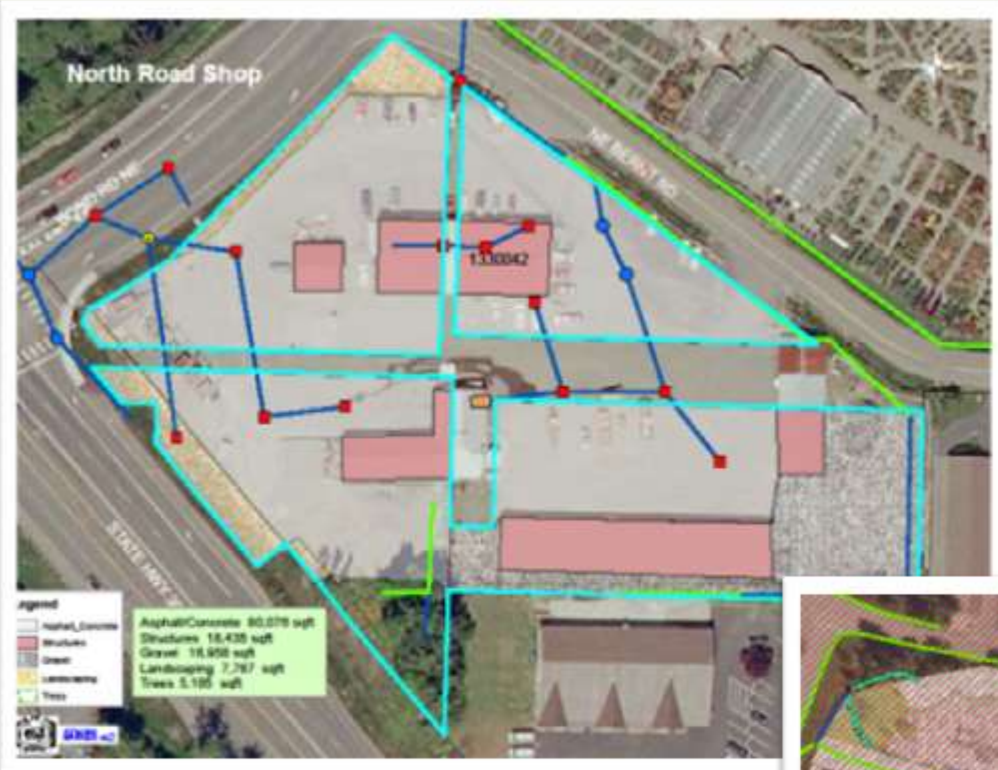
Effectiveness Evaluation and Ranking

- Net Treatment Benefit
  (Current Treatment Level vs. Retrofit Treatment Level)
- Removal of Priority Pollutants
  (e.g., Fecal Coliform)
- Removal of Other Pollutants
- Flow Control Benefits *(if drainage problem exists)*
- Public Visibility and Education Benefits
- Project Risks
- Grant Funding?

Top Potential Retrofit Sites

Develop Concepts for Top Sites

Design and Cost


North Road Shop
Asphalt/Concrete 80,076 sqft
Structures 18,435 sqft
Gravel 16,958 sqft
Landscaping 7,767 sqft
Trees 5,195 sqft


Kitsap County Public Works Annex
Landscaping 31,082 sqft
Structures 52,508 sqft
Asphalt/Concrete 114,644 sqft
Brick Paver 18,827 sqft
Gravel 74,091 sqft
Lawn 58,487 sqft
Trees 178,117 sqft
FM-5

Kitsap County Stormwater Retrofit Plans

- Manchester
- Silverdale
- Kingston
- Indianola
- Suquamish
- Keyport

SvR DESIGN COMPANY

MANCHESTER STORMWATER RETROFIT STUDY
Recommended Green Stormwater Infrastructure Typology Options
06.29.2011

Typology	Kitsap LID Manual Design Standards (DS)/Design Guidelines (DG)	Example
ROW Flat Streets - Commercial, Residential	DS Pervious Pavement - Asphalt, Concrete, Reinforced Grass & Gravel Systems, Pervious Pavers, Dispersion, Amendment of Disturbed Soils, Bioretention, Trees; DG Street Edge Treatments, Right of Way Sections, Bioretentation Facilities, Alternative Bioretention Strategies, Appendices - Bioretention Plant List, Street Tree List. Missing a DG to cover integrating sidewalks?	
ROW Cascades - Commercial, Residential	DS Pervious Pavement - Asphalt, Concrete, Reinforced Grass & Gravel Systems, Pervious Pavers, Dispersion, Amendment of Disturbed Soils, Bioretention, Trees; DG Street Edge Treatments, Right of Way Sections, Bioretentation Facilities, Alternative Bioretention Strategies, Appendices - Bioretention Plant List, Street Tree List. Missing a DG to cover steep connected planters/storage, missing a DG to cover integrating sidewalks with steep cascades (where cascades may go under sidewalk)	
Detention Pond Pocket Park	DS Dispersion, Amendment of Disturbed Soils, Bioretention, Trees; DG Bioretentation Facilities, Alternative Bioretention Strategies, Appendices - Bioretention Plant List, Street Tree List. Missing a DG to cover a larger site where detention and park are combined	
Commercial Parking Lot	DS Pervious Pavement - Asphalt, Concrete, Reinforced Grass & Gravel Systems, Pervious Pavers, Dispersion, Amendment of Disturbed Soils, Bioretention, Trees; DG Street Edge Treatments, Right of Way Sections, Bioretentation Facilities, Alternative Bioretention Strategies, Appendices - Bioretention Plant List, Street Tree List.	
Residential GSI Options	DS Dispersion, Amendment of Disturbed Soils, Bioretention, Trees; DG Bioretentation Facilities, Alternative Bioretention Strategies, Appendices - Bioretention Plant List, Street Tree List; DS Pervious Pavement - Asphalt, Concrete, Reinforced Grass & Gravel Systems, Pervious Pavers; DG Alley & Driveway Treatments	

NOTES: The intent of the typologies is to provide guidance on the best management practices most suitable for incorporation into the designs for the study sites.

MAIN STREET BASIN EXISTING CONDITIONS

MAIN STREET BASIN PROPOSED PROJECT LOCATIONS

MANCHESTER LID STORMWATER RETROFIT

Manchester, Washington

Conceptual Designs - November 2011

SSWM · DESIGN COMPANY

COVER / MAIN STREET BASIN MAPS

SITE 5 - MANCHESTER BUSINESS DISTRICT - COLCHESTER DRIVE E

Site Description

The site is located along the northernmost block of Colchester Drive E, which is relatively flat, coming into Manchester from the south and terminating at E Main Street and the village center. It is a main arterial connecting areas to the north and south of Manchester.

Context & Analysis

There is no formal parking along this block of Colchester, which is fronted by several small businesses and commercial buildings, a few houses, and the Post Office. Parking is provided in private lots along the right-of-way, with continuous access off the curbless street. No formal walkways or sidewalks are provided (pedestrians use the street shoulders) and there is a bus stop with shelter on the northbound lane midway along the block. Vacant parcels at the southeast corner of Colchester and Main could be purchased by the County and developed as public open space (see Site 3). The intersection with Main St has a stop sign and striped pedestrian crosswalk. This site is at the bottom of the Main Street drainage basin, which has a significant area upstream including numerous other project sites in this study.

Description of Retrofit

Street improvements along a main downtown street to facilitate complete street concepts and integrate bioretention facilities and permeable pavements. Streetscape improvements require a partnership with adjacent property owners to the west to allow for public walkway and amenities zone within the existing parking area that lies outside the right-of-way. Permeable pavement to reduce runoff and bioretention to provide water quality treatment prior to discharge to the downstream system. Water quality treatment is to be provided for surrounding pavement areas and upstream parcels surface draining through the site. Site improvements will improve collection of runoff from E Spruce St and convey to the downstream water quality facility proposed at Site 9. Street trees may not be a viable addition due to overhead power and Manchester's View Protection Overlay Zone.

Stormwater Benefits: Estimate of Treatment Potential

PGIS Site Area (acres)	On-site Treatment Facility Area (sf)	Percent of Site Mitigated (%)
0.3	2,200	100+%

Benefits shown are based on improvements shown in conceptual design and GIS site data.
See Stormwater Runoff Treatment Notes on page 1 for additional explanation of benefits.

Additional Benefits

- Mobility - Complete Street street elements provide formalized and controlled access to downtown businesses
- Community - Wide walkways would allow opportunity to integrate street furnishings to promote pedestrian activity and create a vibrant downtown center
- Community - Improvements maintain existing driveway access for adjacent parcels
- Safety - provides traffic calming and access control

Existing Site - Colchester Drive

Existing Site - Main at Colchester Drive

Project Site and Context

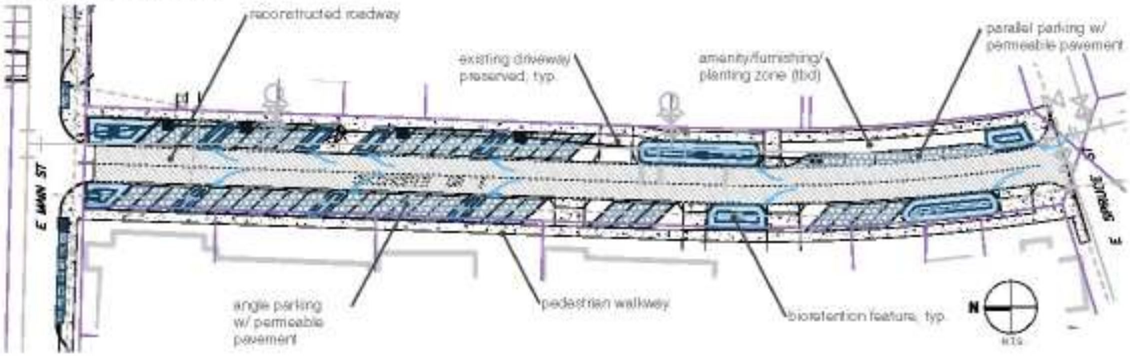
Context Diagram

Project Site and Sub-Basin Location

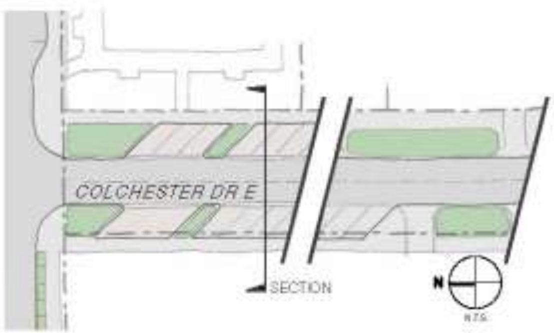
Construction Cost Range (does not include soft costs)

- $535,000 - $655,000
- Costs include:
  - pavement demolition, excavation and haul
  - roadway and walkways
  - permeable pavement for parking areas
  - storm drain infrastructure
  - bioretention soil and plantings
  - construction contingency

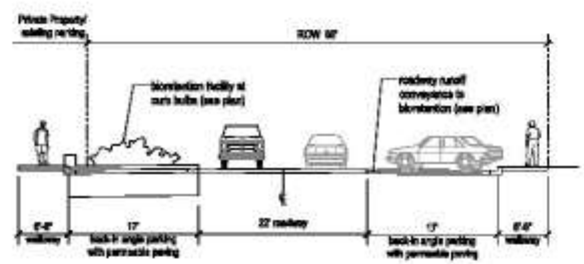
Conceptual Design Plan



Rendered Plan of Typical Site Treatments



Conceptual Design Section

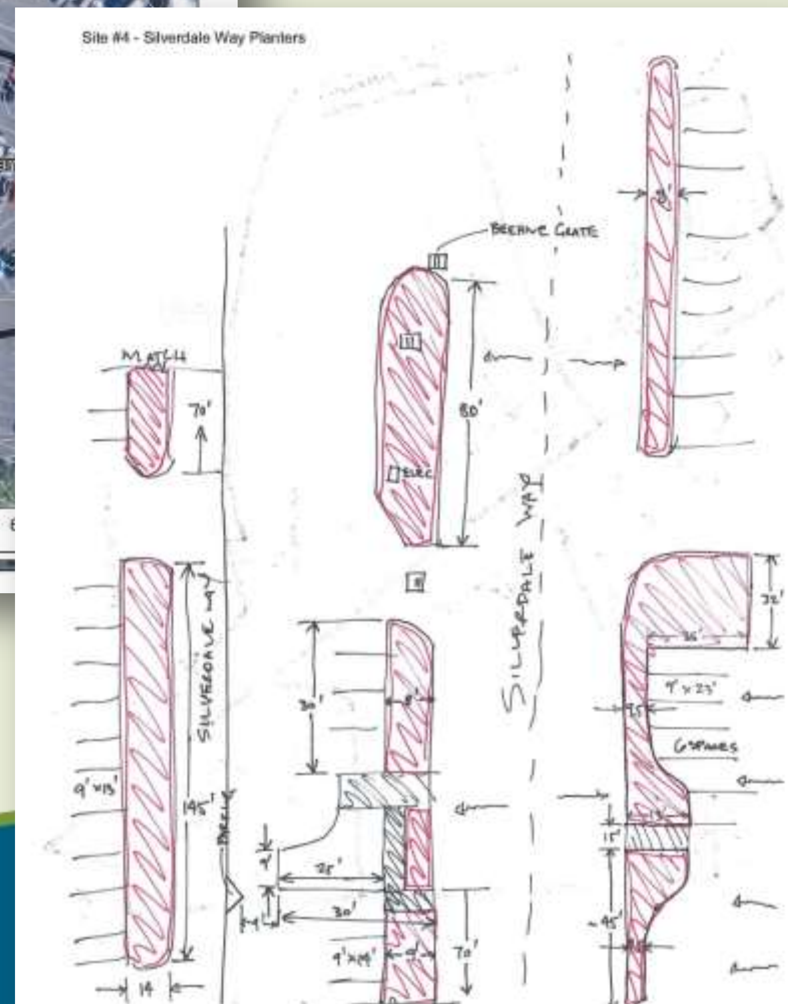


Bioretention facility, Water Street, Pt. Townsend, WA

Winslow Way, City of Bainbridge Island, WA

Bioretention facility, Port Townsend, WA


Site #4 - Silverdale Way Planters
PIPE
EXISTING 8' PAVED DIVIDER
6" ϕ PVC
#41 - Red Apple mall parking lot
SMALL GRATE
NO STRUCTURE
UTILITY CONFLICTS
0
30

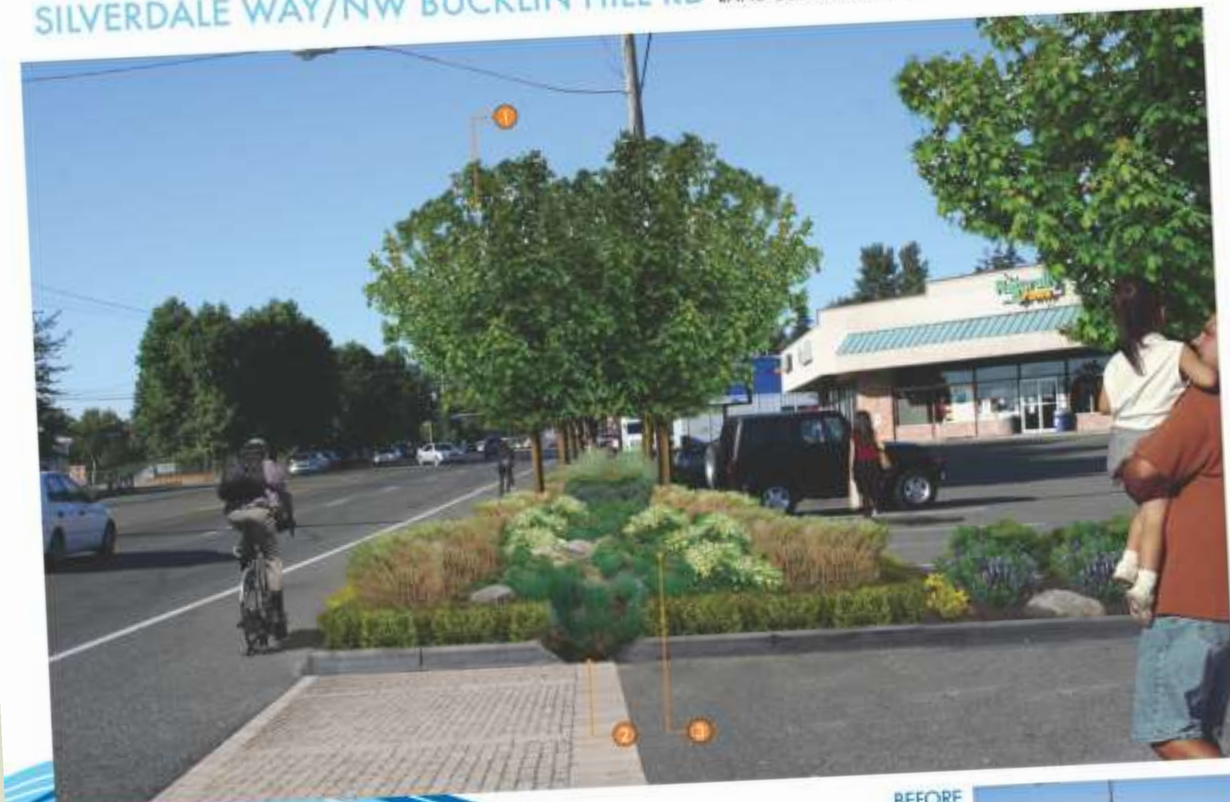

Site #4 - Silverdale Way Planters
BEEHIVE GRATE
MATCH
70'
80'
ELEC
SILVERDALE WAY
9'x13'
145'
14
30'
8'
25'
30'
9'x14'
9'
70'
32'
36'
9'x23'
6 SPACES
15'
45'


Manchester Stormwater Park
A final look
Your input, our design.
On schedule for Construction
Fall 2014
LEGEND
Bench
Concrete Pavers
Pedestrian Railing
LED Recessed Step Light
LED Strip Light
LED Controller
Electrical Outlet
Pavement Inset LED Lights
Rain Garden Plant Mix
Rain Garden Plant Mix
Lawn
Modular Wetland System
Crushed Granite
Inset LED Lights
Low Shrub Mix
E MAIN STREET
PLAN
Flowering Red Currant
Reed Grass
Tufted Hair Grass
Orchid Rock Rose
Western Rhododendron
Dwarf Japanese Silver Grass
Japanese Holly
Oregon Grape
Pacific Wax Myrtle

SILVERDALE LID RETROFIT

SILVERDALE WAY/NW BUCKLIN HILL RD

LAND USE TYPE: COUNTY RIGHT OF WAY



AFTER

OPPORTUNITIES AERIAL MAP

POTENTIAL LID AREAS

BEFORE

POTENTIAL LID STRATEGIES:

1. "Trees contribute to the control of stormwater runoff in the following ways: capturing and holding (interception) precipitation in the foliage, conveying water in the soil through the tree to the atmosphere (transpiration), and building soil structure through root growth (infiltration) increasing absorption of water in the root zone. Trees provide many additional benefits beyond stormwater mitigation. Canopies shade and cool paved areas reducing heat-island effect, moderate temperatures inside a structure, and act as wind buffers. These canopies provide ecological and habitat functions that are vital to wildlife and urban inhabitants, alike."
Kitsap County Low Impact Development (LID) Guidance Manual, p.143

2. Curb cut to allow street drainage into rain garden. "Curb cut should include rock or other erosion protection material in the channel entrance to dissipate energy."
Low Impact Development Technical Guidance Manual for Puget Sound, p.74

3. Native/adaptive plant species. "placed appropriately, tolerate local climate and biological stresses and usually require no nutrient or pesticide application in properly designed soil mixes. Natives can be used as the exclusive material in a rain garden or in combination with hardy cultivars that are not invasive and do not require chemical inputs."
Low Impact Development Technical Guidance Manual for Puget Sound, p.79

SSWM

BCRA

www.kitsapgov.com/sswm

KITSAP COUNTY
CLEAN STORMWATER
Our Community, Our Waterways

SILVERDALE LID RETROFIT

RIDGETOP BLVD

LAND USE TYPE: COUNTY RIGHT OF WAY

AFTER

OPPORTUNITIES AERIAL MAP

POTENTIAL LID AREAS

POTENTIAL LID STRATEGIES:

1. "Trees contribute to the control of stormwater runoff in the following ways: capturing and holding (interception) precipitation in the foliage, conveying water in the soil through the tree to the atmosphere (transpiration), and building soil structure through root growth (infiltration) increasing absorption of water in the root zone. Trees provide many additional benefits beyond stormwater mitigation. Canopies shade and cool paved areas reducing heat-island effect, moderate temperatures inside a structure, and act as wind buffers. These canopies provide ecological and habitat functions that are vital to wildlife and urban inhabitants, alike."
   Kitsap County Low Impact Development (LID) Guidance Manual, p.143

2. "In bioretention cells or swales, tree roots build soil structure that enhances infiltration capacity and reduces erosion."
   Low Impact Development Technical Guidance Manual for Puget Sound, p.44

3. Curb cut to allow street drainage into rain garden. "Curb cut should include rock or other erosion protection material in the channel entrance to dissipate energy."
   Low Impact Development Technical Guidance Manual for Puget Sound, p.74

4. Native/adaptive plant species. "placed appropriately, tolerate local climate and biological stresses and usually require no nutrient or pesticide application in properly designed soil mixes. Natives can be used as the exclusive material in a rain garden or in combination with hardy cultivars that are not invasive and do not require chemical inputs."
   Low Impact Development Technical Guidance Manual for Puget Sound, p.79

BEFORE

KITSAP COUNTY
CLEAN STORMWATER
Our Community, Our Waterways

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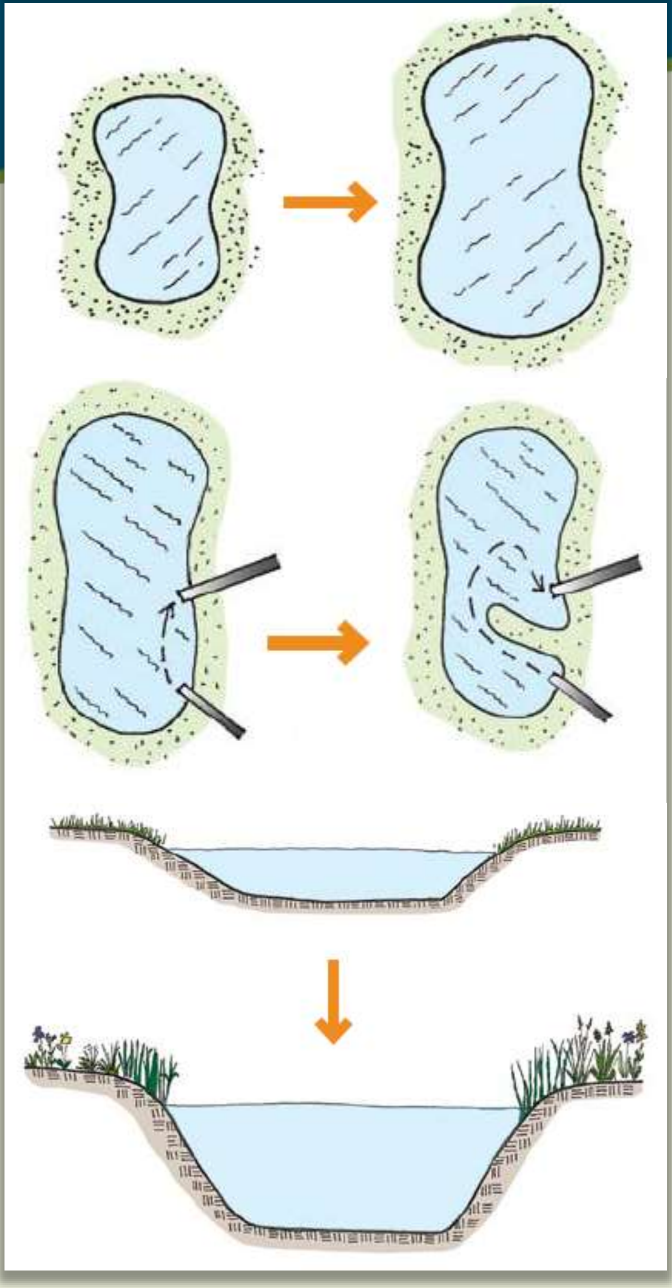
Stormwater Ponds

Retrofit Selection

- Wetland conversion
- Bioretention
- Pond expansion
- Pond outlet modification
- Configuration change
- Vegetation improvement
- Infiltration
- Multiple uses
- Subsurface gravel wetland

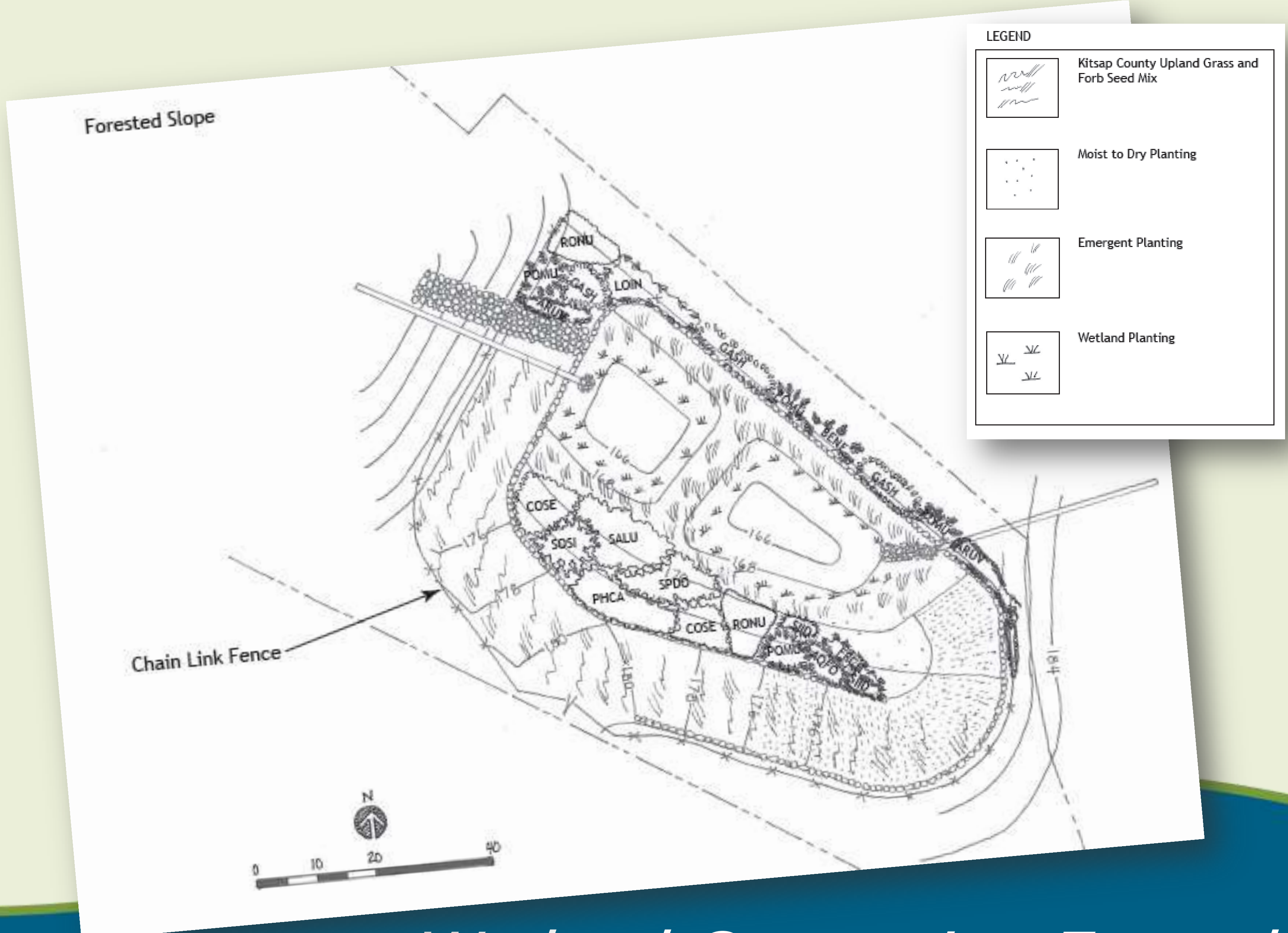


Criteria for Assessing Feasibility	Stormwater Pond Retrofit Options								
	Wetland Conversion	Bioretention	Pond Expansion	Pond Outlet Modification	Configuration Change	Vegetation Improvement	Infiltration	Multiple Uses	Subsurface Gravel Wetland
Unit Treatment Processes									
Class A/B soils		✓					✓		
Class D soils	✓								
Evidence of good infiltration		✓					✓		
Loam, sandy loam, or sand		✓					✓		
Minimal amount of standing water		✓					✓		
Significant amount of standing water	✓								
Outlet located near inlet					✓				
Vegetation and Aesthetic Assessment									
Functioning similarly to a wetland	✓								
Invasive species dominant						✓			
Low species diversity (non-native plants)						✓			
High visibility	✓	✓	✓			✓		✓	✓
Potential for community amenity								✓	
Shallow with minimal side slopes								✓	✓
Retrofit Feasibility Assessment									
Evidence of groundwater seepage into pond	✓								✓
Long linear pond		✓							
Single-cell pond		✓			✓				
Deepen pond to increase the storage volume			✓						
Space on parcel not fully utilized			✓						
Add a new outlet structure				✓					
Modify existing outlet structure				✓					
Raise or lower existing outlet structure				✓					

Wetland Conversion Example

Rationale for Retrofit Prioritization and Selection	Selected Retrofit Options
Receiving Water - Drains to Sinclair Inlet – 303(d) listings for dissolved oxygen and fecal coliform bacteria **Design Deficiencies** - Pond originally designed as a two-celled system, two separate cells were not observed during field visit **Unit Treatment Processes** **-** Class C soils, standing water near outlet and in bottom of pond **Retrofit Feasibility** - Some room for expansion, good access	- Restore to two-celled pond - Deepen and re-contour pond bottom and side slopes - Improve vegetation - Wetland conversion

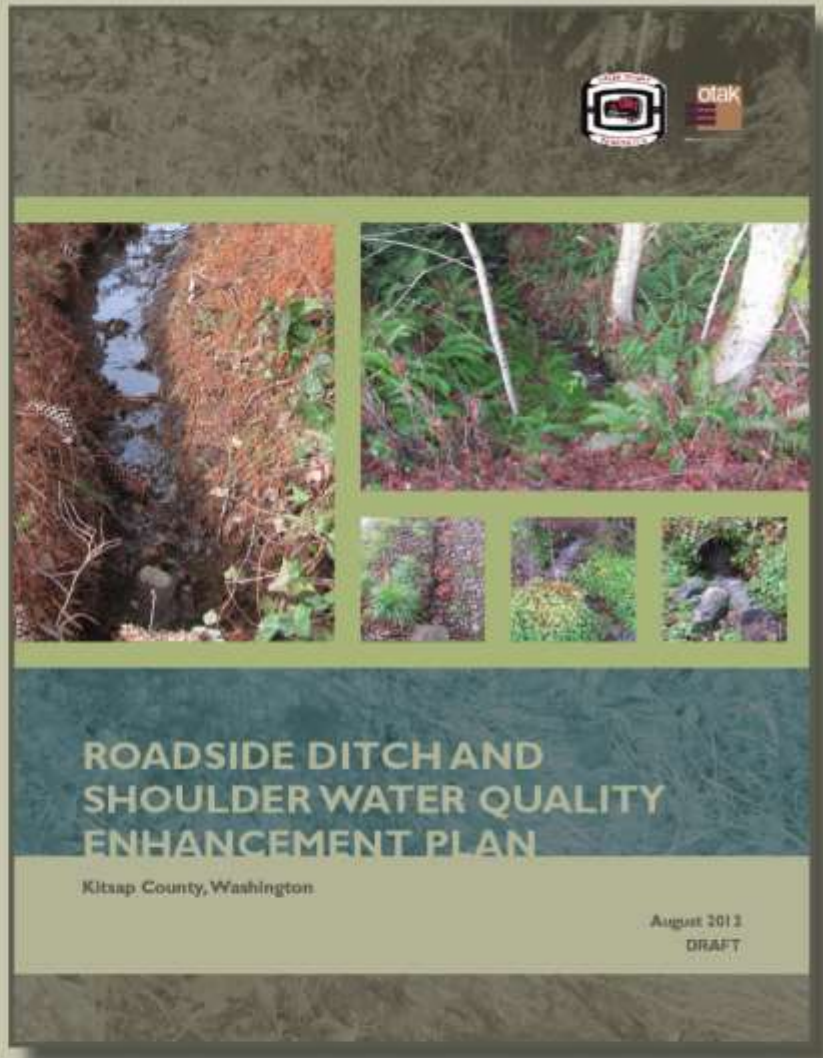
Wetland Conversion Example



Wetland Conversion Example

ROADSIDE DITCH AND SHOULDER WATER QUALITY ENHANCEMENT PLAN

ROADSIDE DITCH AND SHOULDER WATER QUALITY ENHANCEMENT PLAN



ROADSIDE DITCH AND SHOULDER WATER QUALITY ENHANCEMENT PLAN

Kitsap County, Washington

August 2012
DRAFT

GOAL:

To provide some guidelines for better roadside ditch and shoulder design and maintenance which will accomplish:

- ✓ Reduce your work load and your costs.
- ✓ Keep your stakeholders happy.
- ✓ Prevent erosion, protect water, and maintain a healthy environment.

ROADSIDE DITCHES:

An unrecognized factor in stormwater runoff management

Ditches increase the volume and velocity of runoff entering streams

Ditches are a source of sediment and associated contaminants to downstream waters, especially when scraped

Create and maintain a shallow, gentle sloping ditch.

- Easier to maintain
- Safer for traffic
- Less likely to erode

AVOID THE V-SHAPED DITCH:

The bottom is easily incised and starts the erosion process

Prevent erosive flows by using:

- **Check Dams**
- **Rock Lined**

REINFORCE SIDE SLOPES:

- Reinforced Soil Slope
- Rock Side Slope
- Reinforced Gabion

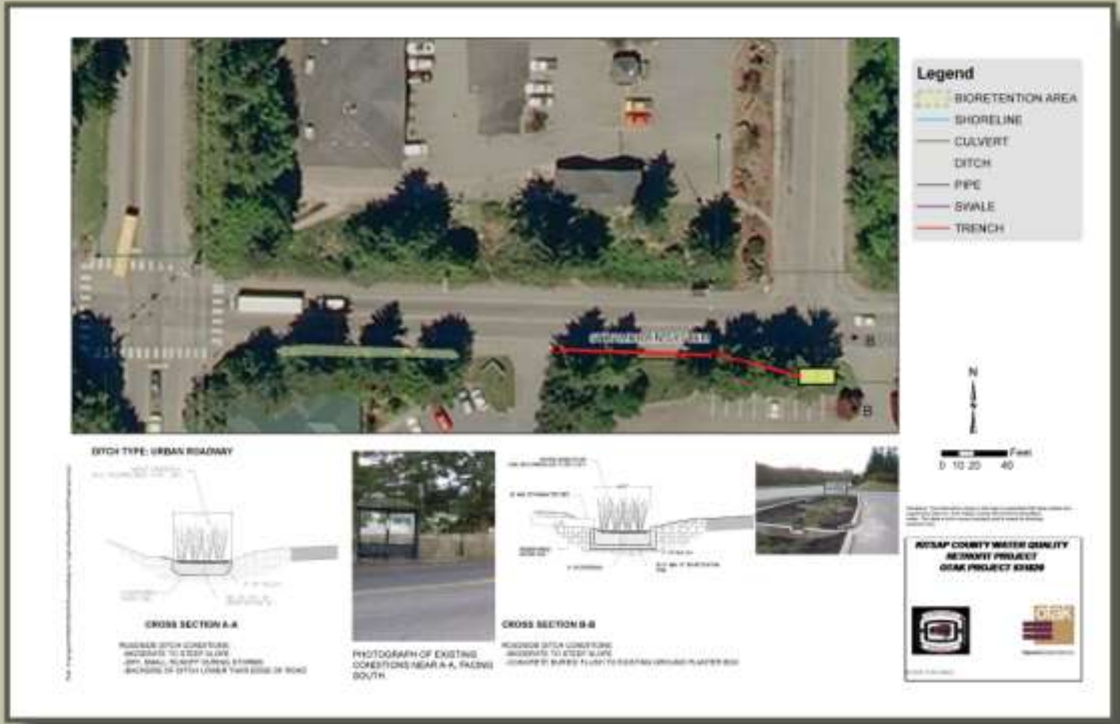
PLANTING

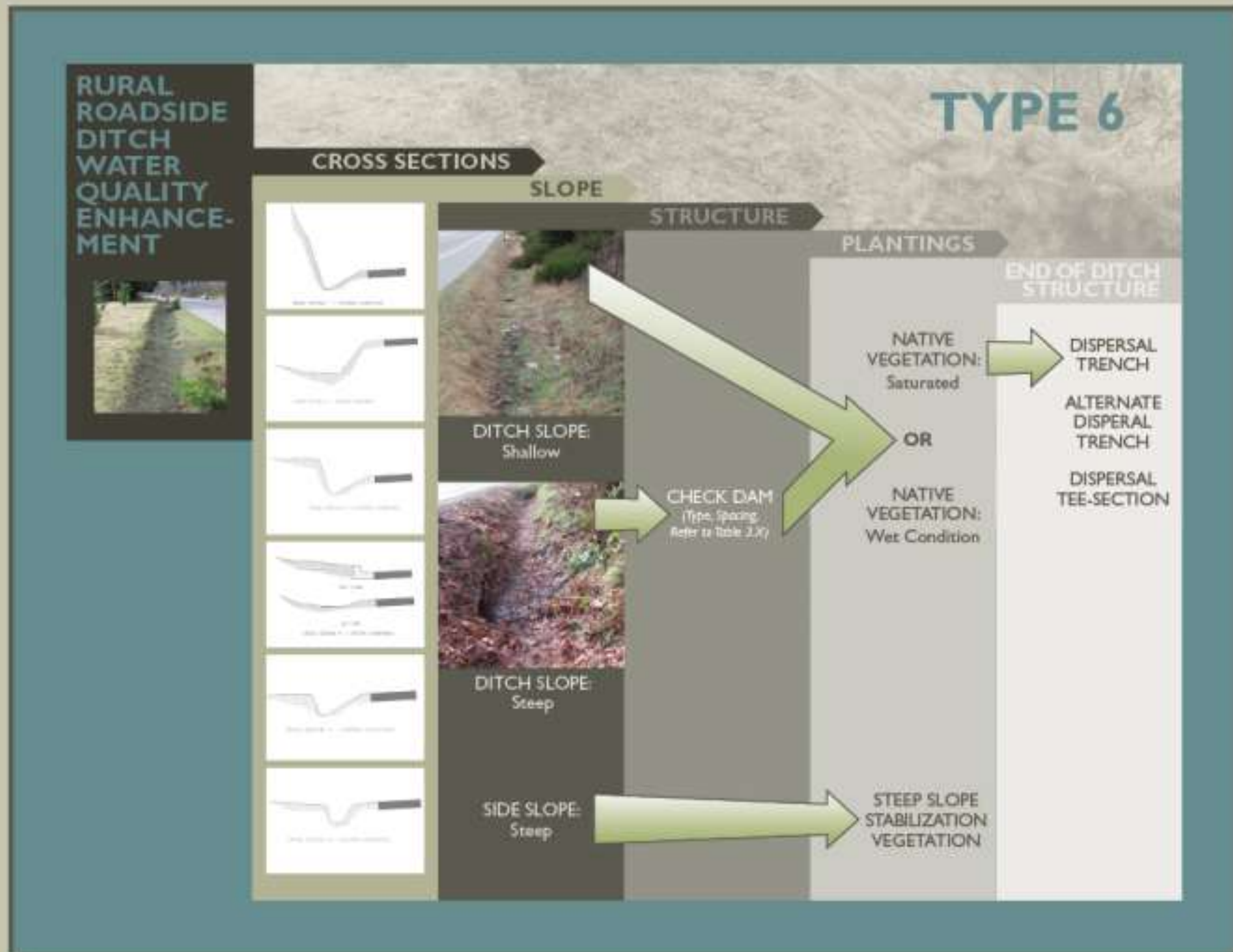
- Seed Mixes
- Plant List

HYDROSEED

- Immediately after ditching
- Early in the season; not before rain

Use treatment structures in areas with curb / gutter / sidewalks




RURAL ROADSIDE DITCH WATER QUALITY ENHANCEMENT
TYPE 6
CROSS SECTIONS
SLOPE
STRUCTURE
PLANTINGS
END OF DITCH STRUCTURE
DITCH SLOPE: Shallow
DITCH SLOPE: Steep
SIDE SLOPE: Steep
CHECK DAM
(Type, Spacing, Refer to Table 2.X)
NATIVE VEGETATION: Saturated
OR
NATIVE VEGETATION: Wet Condition
STEEP SLOPE STABILIZATION VEGETATION
DISPERSAL TRENCH
ALTERNATE DISPERAL TRENCH
DISPERSAL TEE-SECTION

ROADSIDE DITCH AND SHOULDER WATER QUALITY ENHANCEMENT PLAN

Thank You

Clean Water Kitsap

Partners in Stormwater Solutions

Questions?