APPENDIX A

2001 STORMWATER MASTER PLAN POLICY AND CIP IMPLEMENTATION STATUS

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2001 STORMWATER MASTER PLAN POLICY AND CIP IMPLEMENTATION STATUS

The 2001 Stormwater Master Plan identified a number of recommended policies and CIPs for the City to implement. This Appendix provides the status of implementation of these policies and CIPs.

A.1 POLICY IMPLEMENTATION STATUS

The following section numbers correspond to the section numbers of the 2001 Stormwater Master Plan.

9.2 GENERAL STORMWATER MANAGEMENT POLICIES

The following policies address both stormwater quantity and stormwater quality, as well as fish and wildlife enhancement –

Policy 9.2.1

The City of Wilsonville shall manage stormwater on or as close as is practical to the development site in order to mitigate water quantity and water quality discharge impacts near the source.

Implementation Measure:

9.2.1.1. Both public and private stormwater facilities will be reviewed by the City Engineer to determine their overall effectiveness in meeting the intent of the Stormwater Master Plan.

STATUS: City adopted new stormwater standards into the Public Works Standards in 2006.

Policy 9.2.2.

The City of Wilsonville shall assure that stormwater management has, to the maximum extent practicable, no negative impact on nearby streams, wetlands, groundwater or other water bodies.

Implementation Measure:

9.2.2.1. The location of new projects will be based on consideration of the presence of existing wetlands. Depending on the circumstances, an expansion or improvement to existing wetlands may be preferred over the creation of new wetlands. Such a determination should be made in conjunction with all applicable law.

STATUS: Requirements of the Significant Resource Overlay Zone (SROZ) adopted in 2001.

Policy 9.2.3.

The City of Wilsonville shall preserve existing open surface water facilities and encourage the expansion of surface facilities where practical.

Implementation Measure:

9.2.3.1 The City Engineer shall consider surface water facilities as a preferred approach but may specify underground facilities where warranted because of efficiency, capacity, maintenance concerns, lack of perennial surface water flow or other considerations.

STATUS: Public Works Standards, Section 301.5.

Policy 9.2.4.

The City of Wilsonville shall require that the maintenance of water quality control facilities be the responsibility of the private or public owner.

Implementation Measures:

9.2.4.1. New developments shall be required to record approved maintenance agreements that include an easement for access to enforce the agreement. If maintenance is not adequately performed, the maintenance standards and schedule shall be reviewed and enforced by the City, as set forth in the maintenance agreement. Such maintenance shall be performed at the expense of the property owner.

STATUS: Public Works Standards, Section 301.6.

9.2.4.2. All City-maintained conveyance systems shall be located in drainage easements, tracts, or right-of-way granted to the City of Wilsonville.

STATUS: Public Works Standards, Section 101.8.

Policy 9.2.5.

The City of Wilsonville shall assure that all stormwater facilities receive adequate maintenance.

Implementation Measures:

9.2.5.1. Structural controls, like catch basins, oil/water separators, bioswales and detention ponds are routinely inspected during site visits. Water quality samples are collected at the point of discharge to the public storm sewer system to determine compliance with water quality standards for the Willamette River Basin. If the samples indicate that acceptable water quality parameters are not being met, upstream maintenance of structural controls will be required of the property owner.

STATUS: Public Works Standards, Section 301.6, and identified in the current NPDES Stormwater Management Plan.

9.2.5.2. Catch basins and pollution control manholes in the City's right-of-way are cleaned on a two-year cycle. Public detention ponds and trash racks are inspected and serviced annually, or as needed.

STATUS: Identified in current Stormwater Management Plan

9.2.5.3. Routine facility inspections and inspection records should be used to determine where special maintenance conditions exist, determine optimal frequencies for future inspection and maintenance, and assure ongoing facility operation and maintenance. Inspections should be conducted at least semi-annually.

STATUS: Identified in current Stormwater Management Plan for annual inspections.

9.2.5.4. Performance measures are intended to function as the minimum acceptable operational standard for a given water quality facility, and are used as part of the inspection program to schedule maintenance activities. The owner of a water quality facility that does not meet the performance measures will be required to perform the maintenance activities necessary to restore an acceptable level of performance. Failure to comply with the maintenance requirements and performance measures will result in enforcement action. The City may enforce these provisions by any appropriate legal avenue including, but not limited to, nuisance abatement.

STATUS: Public Works Standards, Section 301.6; also required in the City of Wilsonville's Maintenance Covenant and Access Easement.

9.2.5.5. General performance measures require that:

- Trash and debris accumulation does not exceed 50 percent of the designed sediment storage depth or inhibit facility operation.

STATUS: Public Works Standards, Section 301.6.

- Amount of freeboard is not less than 1 foot.

STATUS: Public Works Standards, Appendix D.

- No oil, gasoline, or other contaminants are allowed to accumulate in amounts that could violate or contribute to a violation of water quality standards, Total Maximum Daily Load (TMDL) limits, or general discharge prohibitions adopted by the City of Wilsonville.

STATUS: Public Works Standards, Section 301.6

- No erosion damage over 2 inches deep. Surfaces are stabilized using appropriate erosion control measures.

STATUS: Public Works Standards, Erosion Control Requirements; Section 101.9.

- Trees do not hinder maintenance access or threaten the structural integrity of the facility.

STATUS: Public Works Standards, Section 301.6; also required in the City of Wilsonville's Maintenance Covenant and Access Easement.

- No more than 40 percent of the inlet/outlet structure is blocked by trash, debris, or vegetation.

STATUS: Public Works Standards, Section 301.6; also required in the City of Wilsonville's Maintenance Covenant and Access Easement.

FISH PASSAGE CULVERTS

Oregon Revised Statutes chapters 498.351 and 509.605 require any person, municipal corporation or government agency placing an artificial obstruction across a stream to provide a fishway for anadromous, food and game fish species where these are present, or could be present in the future. Pursuant to these statutes:

Policy 9.2.6. The City of Wilsonville shall require the use of culvert designs that meet *Oregon Department of Fish and Wildlife Guidelines and Criteria for Stream-Road Crossings*.

Implementation Measure:

9.2.6.1 Both public and private culvert designs will be reviewed by the City Engineer to determine their overall effectiveness in meeting the fish passage requirements specified by the state or federal agencies.

STATUS: Public Works Standards, Section 301.8

DEVELOPMENT REVIEW

Policy 9.2.7. Based on the need to demonstrate protection of habitat and water quality and quantity for endangered species listed as threatened under section 4(d) of the ESA, design and construction of storm water facilities shall be reviewed by the Planning Division through a Class II administrative review process, as may be amended. However, such administrative process shall be expedited when time is of the essence in planning and constructing necessary facilities. Review of a facility may also be accomplished as part of an application for development review by the Development Review Board (DRB) or City Council.

Implementation Measures:

Policy 9.2.7.1. The standards for Class II review of stormwater facilities shall be based on applicable City of Wilsonville ordinances and regional, state, and federal law.

STATUS: Development Code, Section 4.008.

Policy 9.2.7.2. The process for Class II review of stormwater facilities shall include a provision for posting of a bond by any person appealing such administrative or quasi-judicial decision.

STATUS: Development Code, Section 4.008.

EROSION CONTROL POLICIES

Erosion control is important in terms of both water quantity and quality. The City's Erosion Control Ordinance (Ordinance No. 482) was adopted in April 1997. Its requirements are based on the February 1994 *Erosion Prevention and Sediment Control Plans—Technical Guidance Handbook*, prepared by the City of Portland and the Unified Sewerage Agency.

STATUS: Public Works Standards; Section 101.9; and the 2008 Erosion Prevention and Sediment Control – Planning and Design Manual.

Policy 9.2.8. The City of Wilsonville shall take steps to minimize erosion resulting from land use and development activities.

Implementation Measures:

9.2.8.1. The City shall continue to implement Ordinance No. 482 as may be amended, including the following:

- An erosion control permit is required for all construction activities disturbing an area larger than 500 square feet.
- Construction on slopes steeper than 5 percent is subject to excavation limitations from November 1 through April 30.
- All erosion control facilities must be effectively maintained throughout construction. If a permittee is notified that the approved plans are not effective, a revised plan that addresses deficiencies in the original plan must be promptly submitted.

STATUS: Erosion control ordinance being updated; will include performance measures.

9.2.8.2. The City shall continue to retain staff who are knowledgeable and effective in the enforcement of erosion control measures.

STATUS: Being implemented.

9.3 STORMWATER QUALITY POLICIES

Policy 9.3.1. The City of Wilsonville shall, as much as is practical, assure that the quality of stormwater leaving the site after development will be equal to or better than the quality of stormwater leaving the site before development.

Design Standards

Wilsonville's current standards for stormwater facility construction are contained in the City's *Public Works Standards*. These standards provide construction details and design criteria for water quality facilities.

Implementation Measures:

9.3.1.1. Proposed new conveyance systems shall be constructed and aligned to emulate the natural conveyance system to the extent feasible. In fish-bearing waters or in any stream that has a history or potential for fish production, water-crossing structures shall provide for fish and wildlife passage as required by state or federal agencies, including Oregon Department of Fish and Wildlife.

STATUS: Public Works Standards, Sections 101.7, 301.1 and 301.7.

9.3.1.2. Water quality control facilities shall be landscaped using diverse, native vegetation in order to provide wildlife habitat and provide shading for water temperature control. Landscaping shall be arranged so that it facilitates maintenance access.

STATUS: Public Works Standards, Appendix B.

9.3.1.3. Stormwater facility design should encourage the use of new and creative alternatives such as Eco-roofs, bioswales, etc.

STATUS: Public Works Standards, Sections 301.1 and 301.5.

9.3.1.4 On an annual basis, City staff will continue to monitor about 40 major storm sewer outfalls for compliance with water quality standards. "Major outfall" is defined as a 36-inch diameter or greater storm sewer line that serves more than 50 acres of residential/commercial zoned property, or 12-inch diameter or greater storm sewer line that serves more than 2 acres of industrially zoned property. At each site, flow is estimated by the velocity/area method. Monitoring parameters include total suspended solids, total dissolved solids, chemical oxygen demand, biological oxygen demand, oil and grease, fecal coliform, total phosphorous, total Kjeldahl nitrogen, pH, and temperature, as appropriate for the specific site. Sample collection is done by the grab method, with sample bottles prepared by private, contract laboratory. Quality assurance/quality control (QA/QC) procedures are followed according to 40 Code of Federal Regulations (CFR) Part 136.

STATUS: Implemented through Stormwater Management Plan in response to NPDES Permit.

9.3.1.5. If monitoring detects noncompliance with water quality standards, staff systematically begins sampling upstream in an effort to identify the source of the illicit discharge. Enforcement procedures for the correction of an illicit discharge are performed under the legal authority of the Wilsonville Code, Section 6.202(1)(e).

STATUS: Implemented through Stormwater Management Plan in response to NPDES Permit.

On-Site Water Quality Facilities

Studies have shown that development increases the concentration in runoff of suspended sediment, oil and grease, and nutrients. Because existing development includes few or no water quality facilities, proposed regional facilities are targeted downstream of existing development where suitable to protect existing wetland and riparian areas.

Policy 9.3.2. The City of Wilsonville shall use a combination of regional and on-site facilities to achieve the recommended pollution reduction outlined in this Stormwater Master Plan.

Implementation Measures:

9.3.2.1. Locate regional facilities downstream of existing development where suitable to protect existing wetland and riparian areas.

STATUS: In process; new list of CIPs being developed with Stormwater Master Plan Update.

9.3.2.2. The City of Wilsonville shall continue to require on-site water quality facilities when proposed development increases impervious area by more than 5,000 square feet.

STATUS - Public Works Standards; Section 301.5.

9.3.2.3. Water quality facilities typically will be wet or dry detention ponds, but other types of facilities—such as vaults or tanks, bioswales, filters or constructed wetlands—may be appropriate.

STATUS - Public Works Standards; Section 301.5 and Appendix D.

Source Controls for Development

Policy 9.3.3. The City of Wilsonville shall continue to require on-site facilities to serve new or expanding developments, subject to prescribed standards.

Implementation Measures:

9.3.3.1. Pollution control manholes shall be required downstream of newly installed storm drainage systems. In addition, all catchbasins shall contain sumps to trap particulates.

STATUS: Public Works Standards, Section 301.5; also addressed in new policies provided in Stormwater Master Plan Update.

9.3.3.2. Maintenance plans for on-site facilities shall be required prior to approval for occupancy of the associated development.

STATUS: Public Works Standards, Section 301.6; also required in the City of Wilsonville's Maintenance Covenant and Access Easement.

9.3.3.3 Special requirements may be warranted for development that poses a higher-than-normal risk of contamination of surface waters. This could include projects with heavy vehicular use or chemical storage, or developments that discharge directly to wetlands, lakes, or other sensitive areas.

STATUS: Public Works Standards, Appendix E.

Shading of Waterbodies

Policy 9.3.4. The City of Wilsonville shall require shading of surface facilities in order to reduce water temperatures in existing and new surface water facilities.

Implementation Measures:

9.3.4.1 The City shall discourage the use of unshaded, shallow *(less than 3 feet average depth)* surface water facilities where water would be ponded more than two days.

STATUS - Public Works Standards; Appendix D

9.3.4.2 Within power easements, the City must require trees and vegetation with shorter mature heights to avoid conflicts with power lines and power line maintenance. Other design features may be needed to shade ponded water in these areas.

STATUS - Public Works Standards; Appendix B

9.4 LANDSCAPING POLICIES

In order to improve the function of the stormwater facility, reduce maintenance requirements and enhance the aesthetics of surface water facilities, landscape standards are needed. Water quality facility design standards must be supplemented with landscaping standards to ensure community acceptance and long term maintainability. Other jurisdictions that have employed design standards that overlooked the landscape aspect of these facilities have witnessed a variety of failures.

Policy 9.4.1 The City of Wilsonville shall require landscaping in conjunction with stormwater facilities.

Implementation Measures:

9.4.1.1. Unless specifically waived for good cause, the following standards will apply:

- Shrub and wetland plantings shall be designed to minimize solar exposure of open water. Trees shall be located along the east, south and west sides of a facility. The following quantities should be considered the minimum acceptable design standard:

  Evergreen trees: 3 per 1000 square feet, minimum height 6 feet; and

  Deciduous trees: 2 per 1000 square feet, minimum caliper 1 to 1-1/2-inch at 2feet above base; and

Shrubs: 30 per 1000 square feet, minimum container 1 gallon or equivalent.

Wetland plants: 1 per 2 square feet of pond emergent plant zone.

STATUS - Public Works Standards; Appendix B

- Use of fences should be avoided whenever possible. Alternatively, side slopes should be constructed at safe slopes (side slopes greater than 3H:1V) and vegetated buffers or 10-foot wide safety bench provided to maximize safety. Where fencing is required by safety or security considerations, the fencing shall be aesthetically designed and screened with vegetation and plantings that conform with the site design.

STATUS - Public Works Standards; Section 301.3 and Appendix D

- Access should be provided for the entire perimeter of the pond. At a minimum, at least one access shall be provided for maintenance and inspection. Access roads should have a minimum width of 15 feet and a maximum slope of 15%.

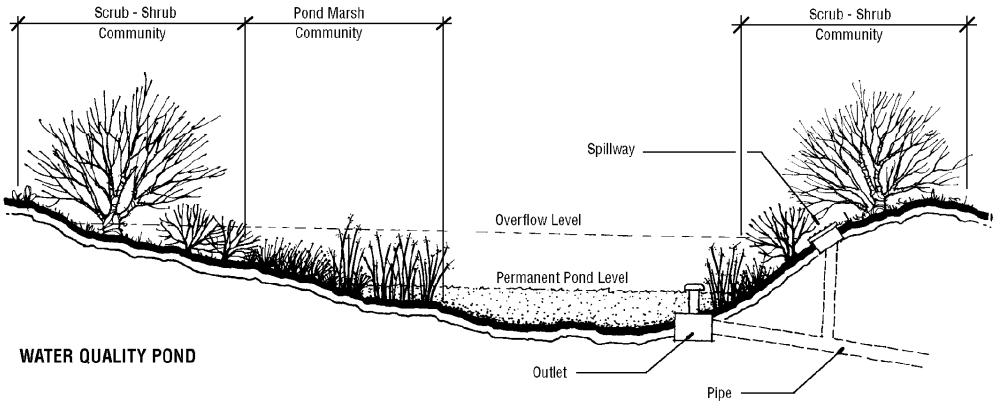
STATUS - Public Works Standards, Sections 301.4 and 301.6.

- Landscaping for new stormwater facilities shall be maintained by the owner or responsible party. For stormwater facilities that become property of the City, landscaping shall be maintained through a two year period prior to acceptance by the City.

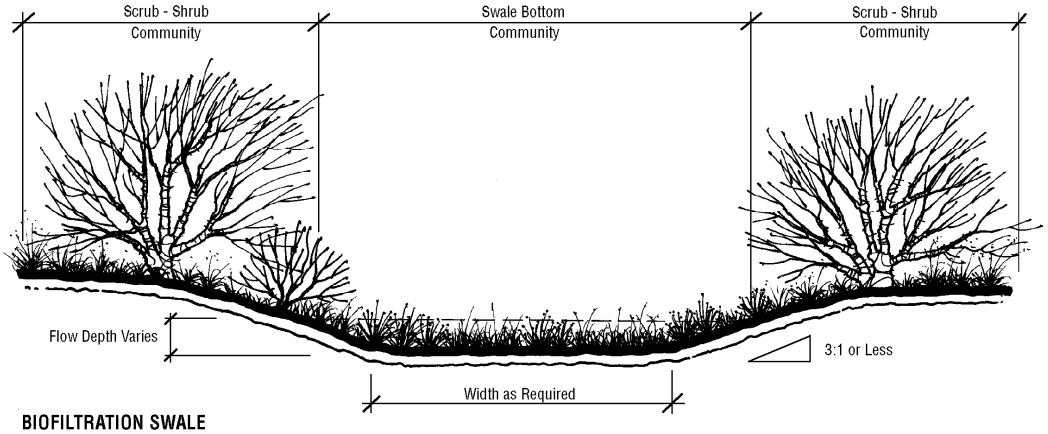
STATUS - Public Works Standards, Appendix B; and the City of Wilsonville's Maintenance Covenant and Access Easements.

Recommended Plant Communities

9.4.1.2 The following guidelines are intended to assist in determining appropriate plant materials for landscaping stormwater facilities. The following two cross sections illustrate the most common water quality facilities: the pond, and the biofiltration swale. Plant community types have been referenced in the cross-sections with typical species list shown below. These plant communities are native to the Wilsonville area and are suitable for the conditions typically encountered in these facility types.



WATER QUALITY POND



BIOFILTRATION SWALE

Pond Marsh / Swale Bottom Plant Community

Groundlayer

Alisma plantago-aquatica	Water Plantain
Beckmannia syzigachne	American Sloughgrass
Bromus Carinatus	California Bromegrass
Cammasia quamash	Common Camas
Carex obnupta	Slough Sedge
Deschampsia caespitosa	Tufted Hairgrass
Eleocharis ovata	Ovate Spike Rush
Eleocharis palustris	Common Spike Rush
Elymus glaucus	Blue Wildrye
Festuca rubra v. rubra	Native Red Fescue
Iris tenax	Oregon Iris
Juncus effusis	Soft Rush
Juncus ensifolius	Dagger Leaf Rush
Lysichitum americanum	Skunk Cabbage
Regreen	Wheat Cover Crop

Sagitaria latifolia	Wapato Duck Potato
Scirpus acutus	Hardstem Bulrush
Scirpus microcarpus	Small Fruited Bulrush

Understory

Spiraea douglasii	Douglas' Spirea

Scrub / Shrub Plant Community

Groundlayer

Deschampia caespitosa	Tufted Hairgrass
Festuca rubra v. rubra	Native Red Fescue

Understory

Cornus stolonifera	Redtwig Dogwood
Rosa nutkana	Nootka Rose
Salix lasiandra	Pacific Willow
Salix piperi	Piper Willow
Salix scouleriana	Scouler's Willow
Salix sitchensis	Sitka Willow
Spiraea douglasii	Douglas' Spirea

STATUS - Public Works Standards, Appendix B.

Landscape Maintenance

9.4.1.3. Weed eradication should include eradication by proper use of herbicide and non-herbicide methods of all plants found on the prohibited species list below. The purpose of this is to discourage invasive exotic plant species from infesting Wilsonville's natural drainage ways.

STATUS - Public Works Standards, Appendix B; and, Implemented through Stormwater Management Plan

9.4.1.4. The following plant materials shall not be used for landscaping stormwater facilities.

Prohibited Plant Species

Cirsium arvense	Canadian Thistle
Convolvulvus spp.	Morning Glory
Cytisus scoparus	Scotch Broom
Dipsacus sylvestris	Common Teasel
Festuca arundinaceae	Tall Fescue
Hedera helix	English Ivy
Holcus canatus	Velvet Grass
Lolium spp.	Rye Grasses
Lotus corniculatus	Bird's Foot Trefoil
Lythrium salicaria	Purple Loose Strife
Melilotus spp.	Sweet Clover

Myriophyllum spicatum	Erasian Milfoil
Phalaris arundinaceae	Reed Canary Grass
Rubus discolor	Himalayan Blackberry
Solanum spp.	Nightshade
Trifolium spp.	Clovers

STATUS - Public Works Standards; Appendix B.

Irrigation Guidelines

9.4.1.5 All water quality facilities must be assured of adequate irrigation for landscape survival. Permanent or temporary automatic irrigation systems may be required to ensure initial establishment.

STATUS - Public Works Standards; Appendix B.

9.5 STORMWATER QUANTITY POLICIES

Design Standards

Wilsonville's current hydrology and hydraulic design standards for stormwater facility construction are contained in the City's *Public Works Standards*. These standards provide construction details and design criteria for pipes and channels. Policy guidelines identify the appropriate design storm and allowable impacts on upstream and downstream properties. Unless changed in the future to enhance stormwater handling, the following standards shall continue to be applied:

- The design storm for conveyance facilities is the 25-year storm.
- Hydrology is to be based on the "rational method" for areas smaller than 400 acres.

  (This method is based on the rational equation, Q=CiA, where A = the area of the drainage area in acres; I = the rainfall intensity in inches per hour; C = the runoff coefficient, a function of the physical characteristics of the drainage area; and Q = the peak discharge, flow in cubic feet per second.)
- On-site facilities shall be constructed to accept flows from upstream areas based on developed conditions under current zoning and no detention facilities.
- Recorded agreements with downstream property owners are required to modify the location or concentrate flow discharged to downstream properties.
- Although stormwater detention is not required per se, the capacity of the downstream system is required to be taken into account with the design of the on-site improvements.

Policy 9.5.1. The City of Wilsonville shall continue to utilize Public Works Standards that provide a comprehensive set of requirements for surface water management facilities.

Implementation Measures:

9.5.1.1. More specific design and construction specifications and policy statements are to be adopted to ensure high quality, maintainable facilities that protect against flooding and meet water quality goals.

STATUS - Public Works Standards, Sections 301.4 and 301.5.

9.5.1.2 Revised design and construction standards may be identified by combining elements from multiple sources including the Unified Sewerage Agency, the City of Portland, Clackamas County Surface Water Management Agency, King County, Washington, or the City of Wilsonville. The revised standards shall include the recommended elements described below.

On-Site Stormwater Detention

The proposed regional stormwater facilities were limited by geographical and financial constraints and will not by themselves be able to maintain future-condition flows at existing levels. As streambank erosion is affected by both the frequency and magnitude of increased flows, runoff from both small and large storms must be controlled, managed on or as close as is practical to the development site in order to mitigate water quantity and water quality discharge impacts near the source. Consequently, on-site detention facilities for new development City-wide are recommended but financial participation in regional facilities will be considered as well as other creative alternatives to on-site detention facilities.

STATUS - Public Works Standards, Section 301.4 and 301.5.

Policy 9.5.2 The City of Wilsonville shall continue to require on-site detention facilities to serve new or expanding developments, subject to prescribed standards.

Implementation Measures:

9.5.2.1 On-site detention facilities shall be designed to maintain predevelopment runoff rates based on 2- through 25-year, 24-hour storms. For events more severe than the 25-year storm, means by which overflows can safely be directed to the downstream channel shall be provided.

STATUS: Public Works Standards; Section 301.4.

9.5.2.2. Exemptions to the on-site detention requirements could be considered for situations in which properties discharge directly to the Willamette River, properties discharge directly to open water bodies that have no capacity limitations, areas where detention in downstream reaches could increase peak

stormwater flow rates, and other areas or unique circumstances as identified by the City Engineer.

STATUS: Currently Public Works Standards to be revised per this document to meet this measure; City Ordinance 608.

9.6 PROPERTY ACQUISITION POLICIES

Policy 9.6.1 The City of Wilsonville shall continue to acquire property in fee or easement for stormwater facilities.

Implementation Measure:

9.6.1.1 The City will use any of the following methods as appropriate to secure property for public stormwater facilities:

- Require dedication AND full improvements. Where a proposed development necessitates the construction of a planned stormwater facility the City shall, as a condition of approval, require the dedication and full improvement of the facility to City standards.

STATUS: Public Works Standards, Section 301.13.

- Require dedication AND partial improvements. Where a proposed development warrants the construction of a planned stormwater facility, but sufficient findings cannot be made to require the developer to complete the entire facility, the City shall, as a condition of approval, require the dedication of property and partial improvement of the facility to City standards. The City may complete the remainder of the facility with other funds or may accept the partial, but functional, improvement.

STATUS: This measure not implemented.

- Require full dedication or require the property owner to offer a dedication. Where a proposed development would prevent the construction of a planned future facility, but the construction of that facility is not yet needed nor necessitated by the development, the City shall, as a condition of approval, require the dedication, an offer of dedication or any other appropriate means to acquire the needed property.

STATUS: This measure not implemented.

- Enforce setbacks to reserve space for future facilities. If the above findings cannot be made, the City shall at a minimum require that new developments maintain a setback from planned stormwater facilities and assure that the setback is sufficient to provide the required area for the

planned facility, as well as maintenance access to the facility and adequate space to initially construct the facility.

STATUS: Public Works Standards; Section 101.8.

- Developer's engineer may offer another solution that the City will review Developers shall have the option of providing engineering designs for alternative stormwater facilities that are equal to or better than current City standards. The City Engineer shall not accept any such design as an alternative to facilities shown in the adopted Stormwater Master Plan unless convinced that the proposed alternative facility can, and will, be built.

STATUS: Public Works Standards; Sections 301.1 and 301.5.

- City purchase. The City should also seek to purchase properties as early action items in implementing the Capital Improvement Program to ensure that adequate land requirements can be met.

STATUS: City implementing where feasible.

A.2 2001 Stormwater Master Plan Recommended CIP Status

Note: CIP numbers in **bold** match the 2001 Master Plan numbers; *italicized* numbers are the new numbers that are identified in this Master Plan update.

REGIONAL STORMWATER DETENTION:

Project CLC-5 – Regional Detention/Constructed Wetland

Regional detention aspect of project deleted. Stream and riparian enhancement project developed for this site identified as *CLC-5, Stream and Riparian Enhancement - I-5 to SW 95th Ave.*.

Project CLC-8 – Detention Storage/Wetland Enlargement on North Tributary to Basalt Creek

Project included in updated Stormwater Master Plan as *CLC-1, Detention/Wetland Enhancement near Tributary to Basalt Creek.*

Project CLC-9 – Regional Detention Ponds on Basalt Creek Upstream of Burlington Northern Railroad

Project deleted; instream detention no longer permitted.

Project CLC-10 – Detention Pond/Wetland Enlargement at Dammasch Basin Outfall/Arrowhead Creek

Project completed.

Project CLC-11 – Detention Pond/Wetland Enlargement East of Parkway Avenue on South Tributary to Coffee Lake Creek

Detention portion of project deleted; project wetland elements enhanced and included in updated Stormwater Master Plan as *CLC-6, Wetland Enlargement - East of SW Parkway Avenue*.

Project BC-4 – Regional Detention on Boeckman Creek Upstream of Boeckman Road

Project Completed.

Project BC-6 – Regional Detention/Wetland Enhancement

Project included in updated Stormwater Master Plan as *BC-1, Regional Stormwater Detention, Stream Enhancement - north of Wiedeman Road*.

Project BC-7 – Regional Detention/Wetland Enhancement

Project combined with **BC-6** above and included in updated Stormwater Master Plan as *BC-1, Regional Stormwater Detention, Stream Enhancement - north of Wiedeman Road.*

WETLAND ENHANCEMENT AND STREAMBANK RESTORATION PROJECTS:

Project CLC-1 – Wetland Enhancement Northwest of Burlington Northern Railroad/Wilsonville Road Crossing

Project deleted; area developed and project no longer feasible.

Project CLC-2 – Wetland Enhancement Adjacent to South Tributary to Coffee Lake Creek

Project is deleted; area is developed and project is no longer feasible.

Project CLC-3 – Wetland Enhancement Adjacent to Middle Tributary to Coffee Lake Creek

Project is deleted; area is developed.

Project CLC-6 – Water Quality/Spill Control Facility Middle Tributary to Basalt Creek

Project is included in the updated Stormwater Master Plan as *CLC-4, Wetland Restoration Project West of I-5; north of Ridder Road*.

Project BC-2 – Stream Restoration/Wetland Enhancement.

Project included in updated Stormwater Master Plan as *BC-10, Stream and Wetland Enhancement at Memorial Park.*

Project CLC-12 – Stream Restoration South Tributary to Coffee Lake Creek.

Project included in updated Stormwater Master Plan as *CLC-7, Stream Restoration - South Tributary to Coffee Lake Creek.*

CONVEYANCE AND EROSION IMPROVEMENTS:

Project BC-1 – Boeckman Creek Erosion Improvements.

Project completed.

Project BC-8 – Elligsen Road Outfall/Urban Reserve Area 35

Project deleted.

Project CLC-13 – Channel West of Commerce Circle

Project included in updated Stormwater Master Plan as *CLC-3, Channel Project - Commerce Circle.*

APPENDIX B

LOW IMPACT
DEVELOPMENT INFORMATION

SOURCE: NEVUE NGAN ASSOCIATES

Figure #: *The conventional approach to stormwater management is treating rainfall runoff as a waste rather than a resource.*

SOURCE: KEVIN ROBERT PERRY - CITY OF PORTLAND

Figure #: *Sustainable stormwater design strives for a more natural, cost effective, and visible approach to managing runoff.*

SOURCE: NEVUE NGAN ASSOCIATES

Figure #: *The Sustainable Stormwater Design Model. A balance of economy, ecology, and society.*

For much of the last century, drainage systems have been engineered to quickly collect runoff in underground pipes and carry it away using an "out of sight, out of mind" approach. This design philosophy treats rainfall runoff as a waste, and many people are unaware of the stormwater flowing in pipes underneath city streets when it rains.

Sustainable stormwater design treats rainfall runoff as a valuable resource. It is based on balancing urban development while preserving natural hydrological functions. Furthermore, sustainable stormwater design achieves the multiple goals of being cost effective, improving water quality, and addressing community concerns. Mimicking the natural hydrologic function of healthy ecosystems in street and parking lot landscapes can dramatically reduce pollution, decrease runoff volume, reduce runoff temperature, protect aquatic habitat, and create more interesting places to live.

The following pages illustrate how the natural environment functions prior to urban development, the overall effects of creating impervious area, and methods of redesigning urban landscapes to help bring healthy hydrological functions back into our neighborhoods.

SUSTAINABLE STORMWATER DESIGN PRINCIPLES

1. Manage stormwater at the source and on the surface. As soon as rainfall lands on a street or parking lot, allow it to infiltrate into the ground or provide surface flow to nearby landscaping.

2. Use plants and soil to absorb, slow, filter, and cleanse runoff. Let nature do its work.

3. Design stormwater facilities that are simple, cost-effective and enhance community aesthetics. Stormwater facilities can be beautiful!

Figure #: *A think layer of moss and groundcover absorbs water before it reaches soil surface or flows downstream*

Figure #: *_Floodplains, lakes and wetlands provide emergency storage areas.*

Figure #: *_Large bodies of water and raging rivers have developed over hundreds of years to handle the volume and velocity of the rainfall that typically reaches them.*

Figure #: *_healthy ecosystems evolve to balance erosion and sedimentation patterns with restorative processes*

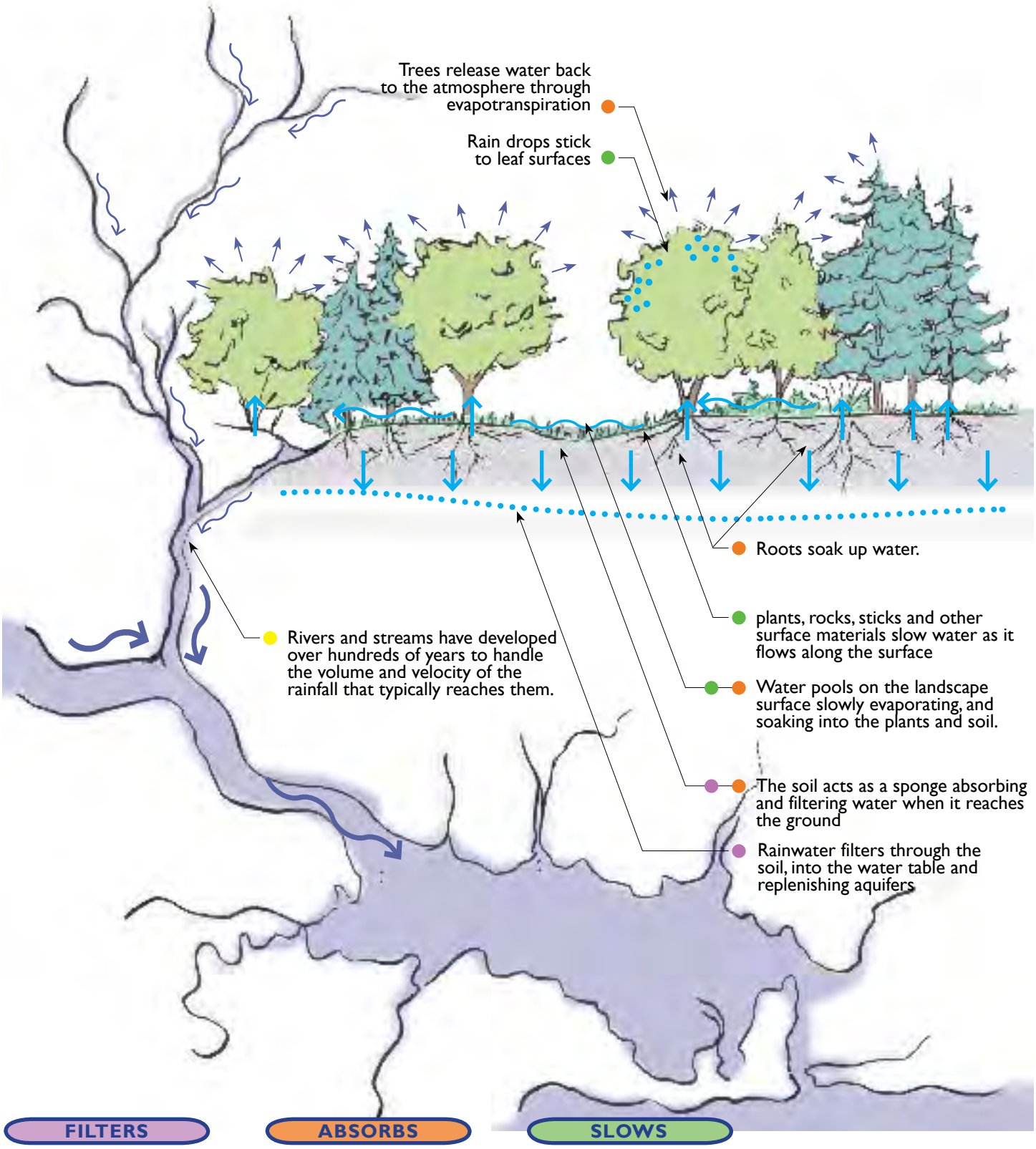
Pre-Settlement - A healthy Landscape
Slows, Filters, and Absorbs

A healthy, undisturbed landscape acts like a sponge, capturing, absorbing, and slowing the flow of water from the moment a raindrop falls. Only a small percentage of rainwater that falls reaches streams and rivers, and it takes a long time to get there. Raindrops are caught by leaves and needles on trees, and eventually drip to the landscape surface. Once they work their way through the grasses and groundcovers, they are **absorbed** into the soil. Water from the ground is soaked up by plant roots, or is **filtered** through soils to recharge aquifers. As soils become saturated, and water accumulates on the surface, it begins to meander along the ground, across rocks, fallen branches and logs, mosses, grasses and other plants. These obstacles physically **slow** the flow of small streams and delay the accumulation of water downstream. The slow movement of water minimizes the sediments that are washed downstream.

Balanced systems

Large bodies of water and rivers have developed over hundreds of years to handle the volume and velocity of the rainfall that typically reaches them. Floodplains, lakes and wetlands provide emergency storage areas. Over time, a system evolves that **balances** typical erosion and sedimentation patterns with restorative processes.

1" of rain on a 1000 sf surface is 623 gallons of water..... where does it go?



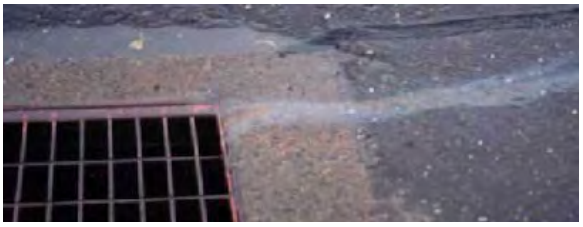


Figure #: *When it rains pollutants are washed directly into pipes and then rivers and bays*

Figure #: *_Stormwater gains speed as it flows through pipes designed to efficiently carry it away._*

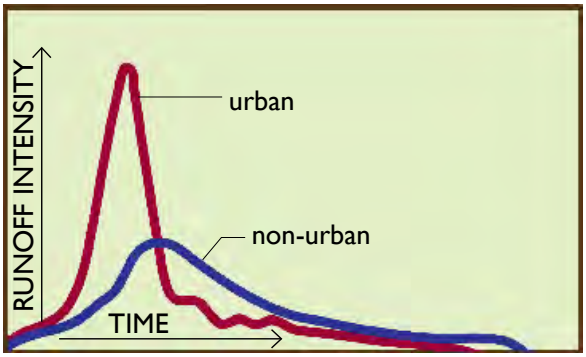


Figure #: *all the water drains at the same time, causing downstream volume to increase quickly.*

Figure #: *_Delicately balanced riparian systems cannot handle increased volumes and speeds*

No Absorption

Impervious surface prevents water from being absorbed at the source. Trees have been cut down, plants and top soil paved over. Natural storage areas, such as wetlands and floodplains, have been drained and paved. Instead of giving stormwater a place to go, they contribute to increased volumes of water rushing into overextended rivers and streams. In contrast to the natural landscape, where everything seems to slowly collect and hold water as much as possible, conventional stormwater management has done just the opposite – It has placed the emphasis on fast drainage.

No filtering

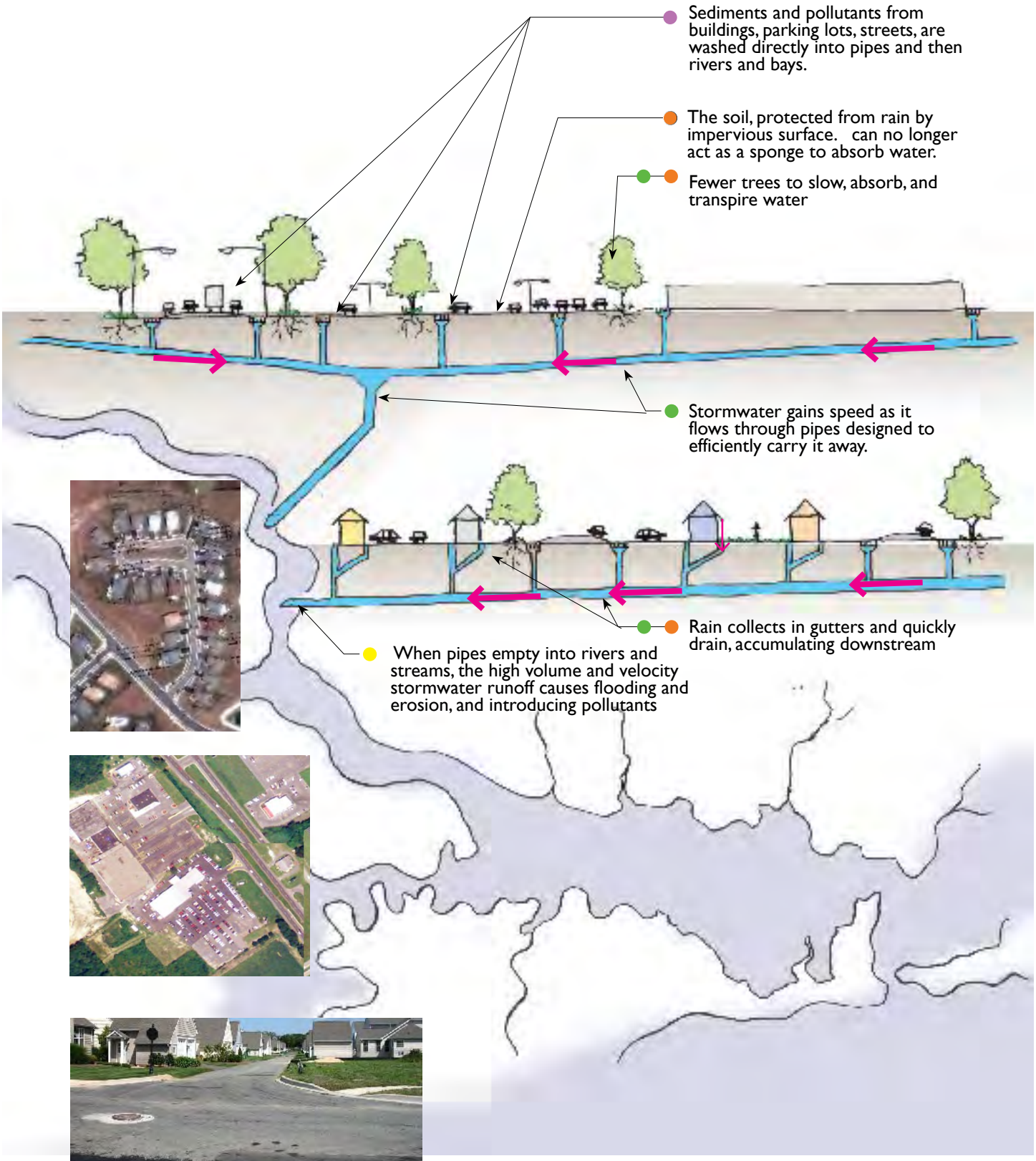
Sediments and pollutants from homes, yards, streets, manufacturing, and many other sources collect on the landscape surface. When it rains these pollutants are washed directly into pipes and then rivers and bays.

No Slowing

Raindrops fall onto slick rooftops, and smooth pavement. They collect in gutters and quickly drain, accumulating downstream. Stormwater gains speed as it flows through pipes designed to efficiently carry it away. Like rush hour in the city, all the water drains at the same time, causing downstream volume to increase quickly.

Imbalance

Delicately balanced riparian systems cannot handle increased volumes and speeds of runoff associated with the built environment. When pipes empty into rivers and streams, the high volume and velocity of stormwater runoff causes flooding and erosion, and destroys natural habitat. The landscape can't adapt as fast as we change it. When stormwater facilities are built at these downstream locations, they must rely on high levels of engineering to control large volumes of fast moving stormwater. There is a better approach.


Sediments and pollutants from buildings, parking lots, streets, are washed directly into pipes and then rivers and bays.
The soil, protected from rain by impervious surface. can no longer act as a sponge to absorb water.
Fewer trees to slow, absorb, and transpire water
Stormwater gains speed as it flows through pipes designed to efficiently carry it away.
Rain collects in gutters and quickly drain, accumulating downstream
When pipes empty into rivers and streams, the high volume and velocity stormwater runoff causes flooding and erosion, and introducing pollutants

- Landscape systems become **balanced** over centuries and millennia. Where rivers flood repeatedly, floodplains develop over time to give water a place to go. People change the landscape quickly in comparison. Landscapes can not adapt as fast as we can build streets, parking lots, and buildings. In order to maintain healthy and balanced rivers, infrastructure must be adapted to work within, and maintain the landscape systems they are built in. A healthy, undisturbed landscape acts like a sponge, capturing, absorbing, and slowing the flow of water from the moment a raindrop falls. Our infrastructure can help protect balanced rivers and streams by also capturing, slowing, and absorbing rain water, as well as filtering the pollutants that we introduce.

Figure #: *Infrastructure can help protect rivers and streams by capturing, slowing, and absorbing rain water, and filtering pollutants.*

Figure #: *Infrastructure can be beautiful too!*

- Designing building sites efficiently and decreasing overall impervious surface area on a site provides more landscape areas, enabling trees, plants and soil to **absorb** water. Collecting and reusing rainwater for irrigation allows water, that would otherwise flow downstream, to be absorbed by plants and soil. Rain gardens help collect water and allow it to infiltrate.

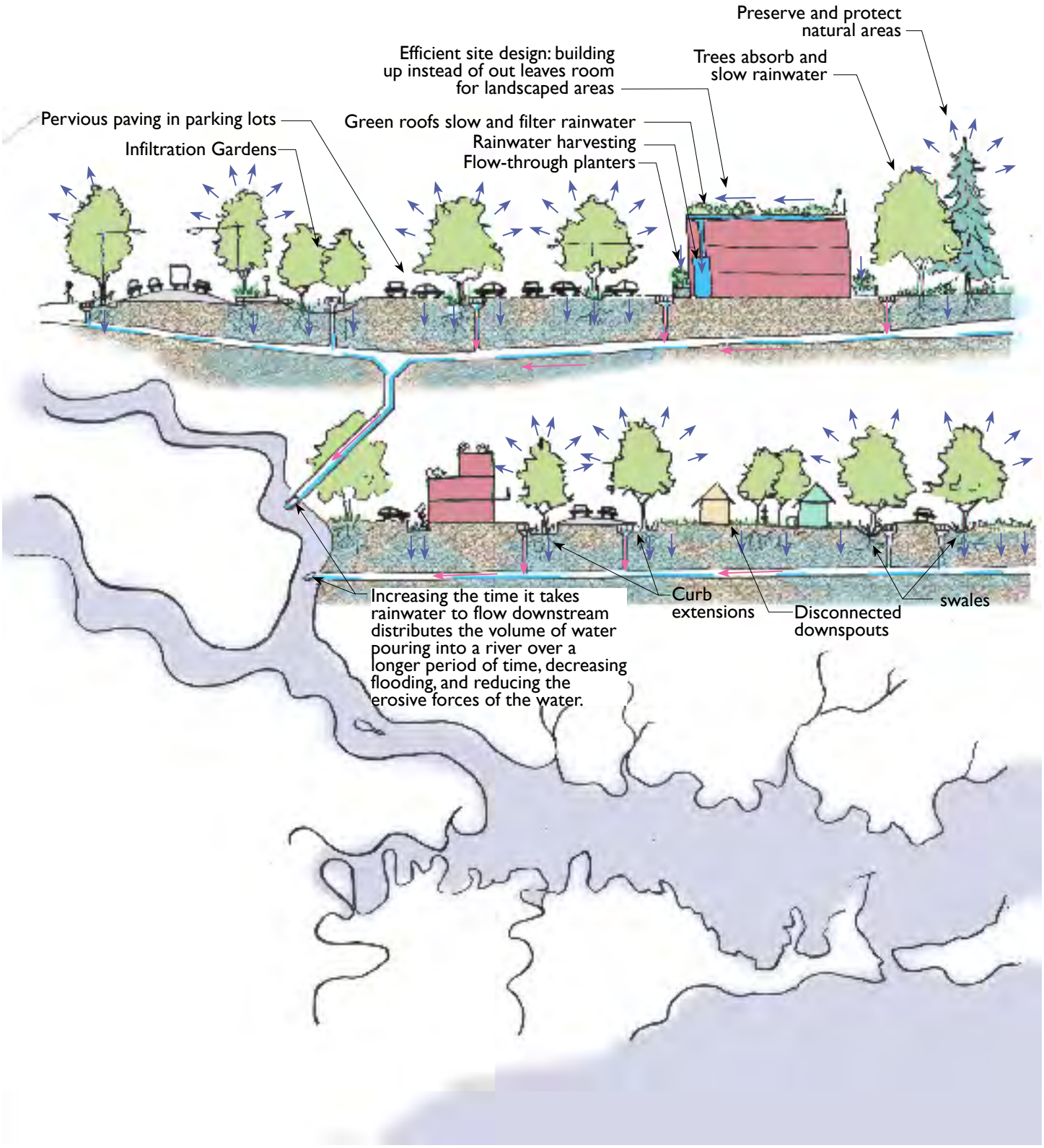
- **Slowing** the flow of rainwater can greatly reduce downstream erosion, flooding, and pollution. Increasing the time it takes rainwater to flow into rivers and streams distributes the volume of water that is conveyed into a river over a longer period of time. This not only decreases the potential for flooding, but also helps reduce erosive forces of the water. Increasing overall landscaped surface area slows water as it flows through landscaped areas. Trees "drink" water out of the ground, and help physically slow stormwater. Raindrops that are caught by leaves and needles on trees take longer to reach the ground. When infiltration is not a viable option because of poor soils or high water table, slowing the water as it flows downstream may be the best way to help maintain healthy rivers.

- Human development has introduced many pollutants into rivers and streams. Capturing and slowing water provides an opportunity for pollutants to **filter** out of runoff before it reaches sensitive areas. As the flow of water is slowed, pollutants are able to settle out. As water flows over landscaped areas, and percolates through green roofs and stormwater gardens, sediments are trapped by the rough surfaces and pollutants are broken down by plants and soil organisms.

FILTERS

ABSORBS

SLOWS


Preserve and protect natural areas
Trees absorb and slow rainwater
Efficient site design: building up instead of out leaves room for landscaped areas
Green roofs slow and filter rainwater
Rainwater harvesting
Flow-through planters
Pervious paving in parking lots
Infiltration Gardens
Increasing the time it takes rainwater to flow downstream distributes the volume of water pouring into a river over a longer period of time, decreasing flooding, and reducing the erosive forces of the water.
Curb extensions
Disconnected downspouts
swales

SOURCE: KEVIN ROBERT PERRY - CITY OF PORTLAND

Figure #: *Stormwater facilities filter sediments and other pollutants in runoff; which results in improved water quality.*

SOURCE: NEVUE NGAN ASSOCIATES

Figure #: *Stormwater facilities slow the flow of stormwater runoff through the interaction of the water with plants and soil.*

SOURCE: KEVIN ROBERT PERRY - CITY OF PORTLAND

Figure #: *Stormwater facilities collect and absorb stormwater to reduce the overall volume of runoff.*

The Three Stormwater Management Goals

Sustainable stormwater design should achieve the following three goals to the greatest extent possible:

Water Quality Goal

Stormwater facilities should filter and **remove** excess sediments and other pollutants from runoff. By allowing water to interact with plants and soil, water quality improvements are achieved through a variety of natural physical and chemical processes. Even if soils are not conducive to infiltration, or if there is a high water table, water quality is still enhanced through pollutant settling, absorption into the soil, and uptake by plants.

Flow Reduction Goal

Stormwater facilities should **slow** the velocity of runoff by detaining stormwater in the landscape. Flow rate reduction can often be achieved by integrating design strategies (such as pervious paving, planter boxes, swales, and rain gardens) that provide stormwater detention. By detaining and delaying runoff, peak flow rates are attenuated and downstream creeks are protected from erosive flows. Conveying runoff through a system of naturalized surface features mimics the natural hydrological cycle and minimizes the need for underground drainage infrastructure.

Volume Reduction Goal

Whenever possible, facilities should collect and **absorb** stormwater to reduce the overall volume of runoff. Retention facilities offer long-term stormwater collection and storage for reuse or groundwater recharge. Plants contribute to retention capacity by intercepting rainfall, taking up water from the soil, and assisting infiltration by maintaining soil porosity. Volume reduction does not require stormwater facilities to be extremely deep. In fact, it is usually best to employ a highly integrated and interconnected system of shallow stormwater facilities.

APPENDIX C

FLOW MONITORING PROJECT

Technical Memorandum

To: Kerry Rappold, City of Wilsonville

From: Steve Wesley, Ela Whelan, URS

Date: October 6, 2008

Subject: Stormwater Flow Monitoring Project Results and Summary, City of Wilsonville, Oregon

INTRODUCTION

The City of Wilsonville (City) contracted with URS on March 19, 2008 to conduct a three month stormwater flow monitoring program to provide flow data to the City for use in an effort to improve the accuracy of developing a hydrologic and hydraulic (H&H) model defining the existing storm drainage system. Increasing the accuracy of the model through calibration of the model with site specific flow data will optimize City resources by properly sizing Capital Improvement Projects (CIP). Properly sized CIPs assure the City provides a level of protection for the rainfall and runoff criteria established by the City. Undersized projects do not provide the level of protection the City wishes to provide for storm drainage in the City and oversized projects waste limited resources.

Acquisition of the flow data is being done in preparation for embarking on an update to the City's existing Stormwater Master Plan, June 2001. Hydragraphics, the computer model in current use, was developed for the 2001 master plan and was calibrated by using existing studies, including the Federal Emergency Management Agency (FEMA) study of Seely Ditch and a 1989 hydrology study of Boeckman Creek, and unit flows developed for flood insurance studies in Portland and adjacent areas. At this time, the City has not decided which model to proceed with for the master plan update. However, with specific flow data resulting from measured rainfall events, the selected H&H model will be calibrated to represent actual storm drainage system response to runoff within the City.

FLOW MONITORING LOCATIONS

Flow monitoring locations were based on identifying a number of different land uses, and corresponding degrees of impervious areas. Four locations were selected to be monitored. Although each site represents a variety of land use, attempts were made to include sites that drained mostly residential land use and sites that drained primarily commercial/industrial land use. The final locations of the sample sites were selected based on the following:

- Ease of access to allow for installation, inspection and frequent downloading of data,
- Minimize need for confined entry, and
- Overall safety and security of the equipment.

Three flow meters were installed in exposed pipe discharge points. Only one site required confined space entry for installation of the flow monitor. The four flow monitoring stations selected were as follows:

1. End of line manhole beyond Tauchman Road and Boones Ferry Road (Station ID: 81-11-001). The meter was installed in the 18-inch diameter upgradient concrete pipe and required a confined space entry procedure.

2. East pipe entering detention pond off Ridder Road (Station ID: 80-05-001). The meter was installed in the 48-inch diameter concrete pipe. The pipe discharges openly to a dry pond.
3. Discharge pipe downstream of the wastewater lift station off SW Belnap Court (Station ID: 96-02-001). The meter was installed in the 18-inch diameter HDPE storm pipe that has an open discharge to a natural drainage ditch.
4. Discharge pipe at detention pond near the Library (Station ID: 87-10-002). The meter was installed in the 48-inch diameter concrete pipe that discharges openly to a dry pond.

FLOW MONITORING METHODOLOGY

A flow monitor and datalogger unit were installed at each of the four monitoring stations. The Sigma 910 Area-Velocity (A/V) flow meter was the selected meter for the monitoring program based on cost considerations, availability, and local technical support.

The Sigma A/V meter uses an internal pressure transducer to measure the depth of water head on the instrument. An internal Doppler ultrasonic sensor provides the methodology to measure the stormwater flow velocity. The overall flow is calculated by multiplying the calculated area of depth of flow by the flow velocity. The datalogger records and logs the date, time, water depth, velocity, and flow. Readings were recorded and logged every 15 minutes.

The flow monitoring meters were initially installed directly in each stormwater pipe within the center of the flow. Each pipe was inspected at the time of installation to ensure the location was free of sediment and debris. The Ridder Road monitoring station had noticeable gravels accumulated within the pipe which were removed by the City prior to meter installation, however additional gravel deposits occurred after the meter was installed, as discussed later in the specific site description in this memo. The three other monitoring stations were clear of debris throughout the project. Each meter was setup and calibrated prior to being placed online. Level calibration was also performed at the end of the 3-month period to ensure the meters pressure transducers were responding properly. All four meters indicated accurate level readings.

The flow monitoring program was conducted from February 29 to May 29, 2008. The Library monitoring station was instrumented on February 29 and the meters at the other three monitoring stations, Tauchman Road, Ridder Road, and Belnap Court, were all installed on March 5. Due to scheduling challenges and installation details, not all meters were installed on the same day. A licensed subcontractor was hired for the meter installation at the Tauchman Road manhole monitoring station due to the confined space entry requirement.

The data from the four monitoring stations was uploaded to a notebook computer by either the City or URS on a weekly basis. This assured that no more than a week's data was lost at any time in the event of equipment failure or other issues that may interfere with the data collection (i.e. sediment buildup or blockage).

FLOW MONITORING DATA AND RESULTS

The data for the monitoring period was reviewed on a weekly basis after collection to ensure that the monitoring was progressing without interruption and the equipment was still secure and in tact.

The City provided the rainfall data that was measured at a recording station at the end of Boones Ferry Road near the Tauchman Road monitoring station. During the three month monitoring period, there were 57 days with measurable precipitation. The highest daily rainfall total occurred on March 13 with 0.59 inches of rain. Numerous days throughout all three months recorded a daily low rainfall of 0.02 inches. It should be noted that some of the daily rain totals, or a portion of, occurred in the form of heavy showers and thunderstorms whereas other events were spread out over the course of the 24-hr period. Specific rainfall totals and rates may have been different across the drainage areas of the four monitoring stations during periods of showers and thunderstorms. The rainfall used for this evaluation was based on the Tauchman Road monitoring station rainfall data. Table 1 shows the daily rainfall during the monitoring period.

Tauchman Road Monitoring Station

Upstream land use is mostly single family residential with some multi-family residential and commercial development.

Measured stormwater flows at the Tauchman Road monitoring station (Figure 2) showed fairly consistent response and correlation to the precipitation data. The majority of the flows measured were below 3 cubic feet per second (cfs). The three highest flows were recorded on March 8, April 22, and May 24, 2008 at measured flows of 8.4 cfs, 5.9 cfs, and 21.8 cfs, respectively. The peak reading of 21.8 cfs appears to be a bit of an anomaly and does not correlate well with the recorded daily rainfall, but could be reflective of an intense thunderstorm isolated over the Tauchman Road drainage area.

Ridder Road Monitoring Station

Land use is primarily industrial and commercial. A number of detention facilities and drainage ways/bioswales are located upstream of the discharge.

The peak recorded stormwater flows at the Ridder Road monitoring station (Figure 3) occurred on March 7, March 22, March 23, April 7, and April 22, 2008 with measured flows of 4.0 cfs, 3.1 cfs, 3.9 cfs, and 3.0 cfs, respectively.

During the March 17, 2008 data collection and inspection, the Ridder Road location had a noticeable buildup of gravel in the pipeline which buried the flow meter. The estimated six-inches of gravel interfered with the pressure transducer level and Doppler velocity readings. The meter was manually uncovered and exposed at the time of the data collection visit. URS contacted the City regarding the gravel issue and was told that an upgradient beaver dam had been breached and was causing gravel and other debris to enter the pipeline. URS spoke with the meter vendor regarding the issue, and the decision was made to move the meter off to the side slope of the pipe just above the level of the gravel at the current water line. Moving the meter over to the side alleviated the gravel impedance issue, but did not allow the meter to record any low pipe flows present in the pipe beneath the level of the meter. This low level

"baseline" flow of 0.21 cfs was recorded by the flow monitor prior to the relocation of the meter and was added to the flows recorded at the new higher meter location to calculate the cumulative flow.

The blue line on Figure 3 shows the 0.21 cfs baseline flow. There were no stormwater flows above the baseline flow during the month of May. Generally, the daily rainfall was very light during May, less than 0.10 inches, with the daily rainfall increasing towards the end of the month. The meter was functioning properly at the time of removal therefore there is no reason to believe that the flow data is not accurate. The lack of flow data above the baseline flow of 0.21 cfs may be related to upgradient stormwater storage and detention.

Belnap Court Monitoring Station
Land use is all single family residential with no upstream detention facilities.

The Belnap Court Monitoring Station incorporates the smallest drainage area of the four sites. Generally, the daily flows were less than 1.5 cfs. Peak flows occurred March 17, March 25, April 22, and May 27, 2008 with recorded flows of 2.7 cfs, 2.4 cfs, 2.9 cfs, and 3.05 cfs respectively (Figure 4). Overall, the recorded flows correlate relatively closely to the rainfall data.

Library Monitoring Station
This site drains primarily a mixture of commercial and residential land use. There are some upstream bioswales, particularly at the new City Hall, that may slow down some of the flow.

The Library outfall site includes the largest drainage area of the four locations monitored. As with the Belnap Court site, the Library outfall flow also correlates fairly closely to the associated rainfall data although a hydraulic lag does appear to exist. The peak stormwater flows occurred hours after the peak rainfall event on a consistent basis. As a result of draining the largest area of the four monitoring sites, this site had the highest flow rates recorded. The majority of recorded flow was under 15 cfs (Figure 5). The highest peak flows measured were reported on March 10, March 20, April 28, and May 26, 2008 at 23.2 cfs, 23.2 cfs, 22.3 cfs, and 27.4 cfs respectively.

CONCLUSIONS

Overall, the three months of monitoring at the four selected sites provided reasonably good data for calibration of the stormwater model. The flow data correlated fairly closely with the precipitation data in most cases. It should be noted that the data is strongly influenced by upgradient storage and detention of stormwater, including rainfall intensity.

Besides the Ridder Road location, and it's issues with accumulating gravels, there were also a few anomalous data gaps at the other three locations. These were most likely due to random debris on top of or near the meter causing interference with the level pressure transducer or Doppler readings. Other than the gravel issue at the Ridder Road monitoring station, no debris was observed at the other monitoring stations during the data collection events.

One limitation for this analysis is the use of daily rainfall totals. Hourly precipitation data would provide greater detailed information about the response of the storm system based on the

intensity of a storm, particularly during thunderstorms. Hourly data could identify the difference between gentle showers and brief but heavy rains, both of which could provide the same rainfall over a 24 hour period. URS will attempt to locate rain gages in the vicinity of Wilsonville that can provide hourly rainfall data to use during the model calibration process.


Ridder Road
SW Baker Rd
SW Tooze Rd
SW 110th Ave
SW Barber St
SW Brown Rd
SW Stafford Rd
SW Wilsonville Rd
Library
5
Tauchman Road
Pump Station
5910 ft
© 2009 Tele Atlas
Image © 2009 Metro, Portland Oregon
©2008 Google

Figure 2
Tachman Road Outfall Daily Flow and Rainfall

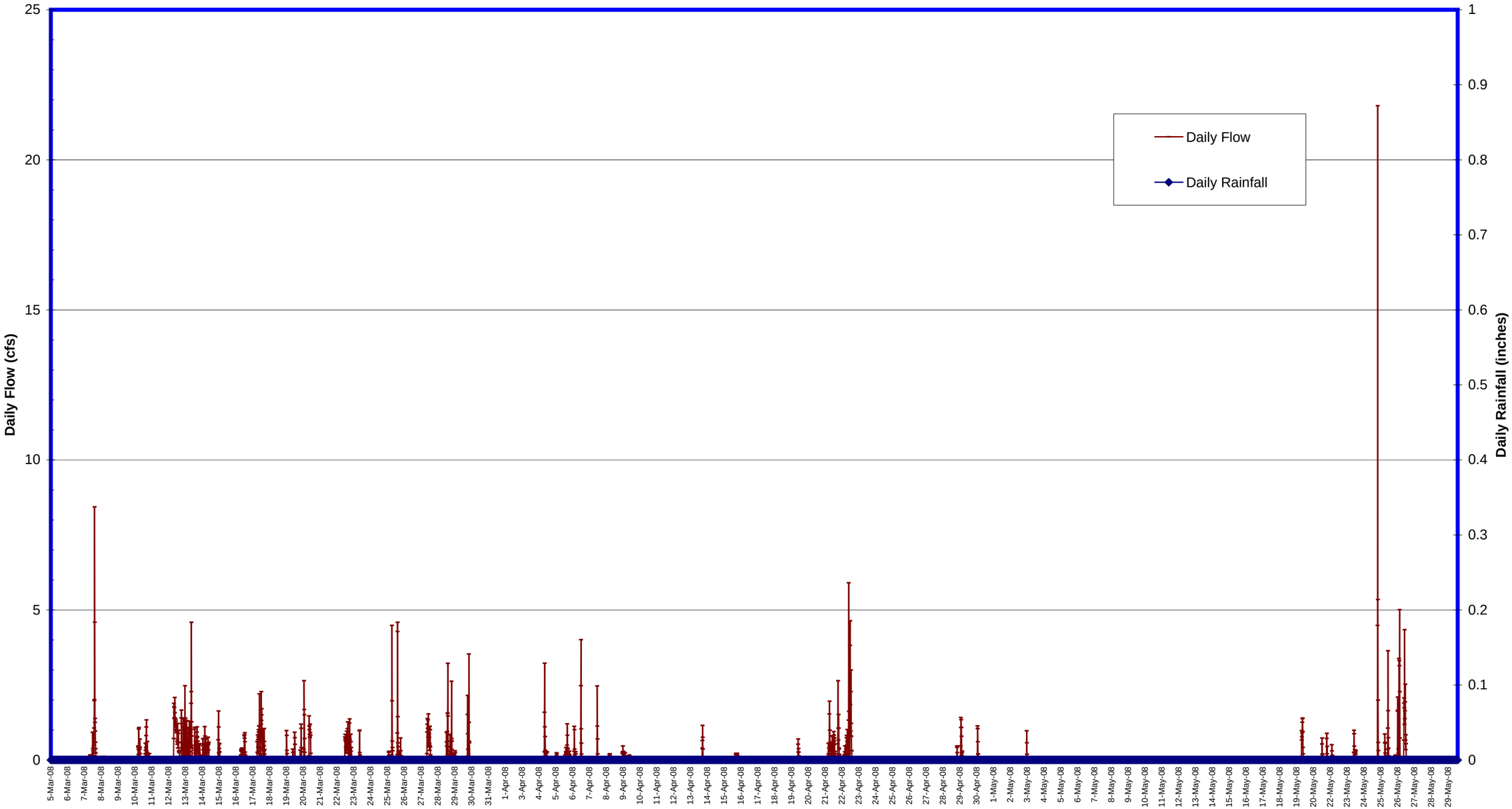


Figure 3
Ridder Road Outfall Daily Flow and Rainfall

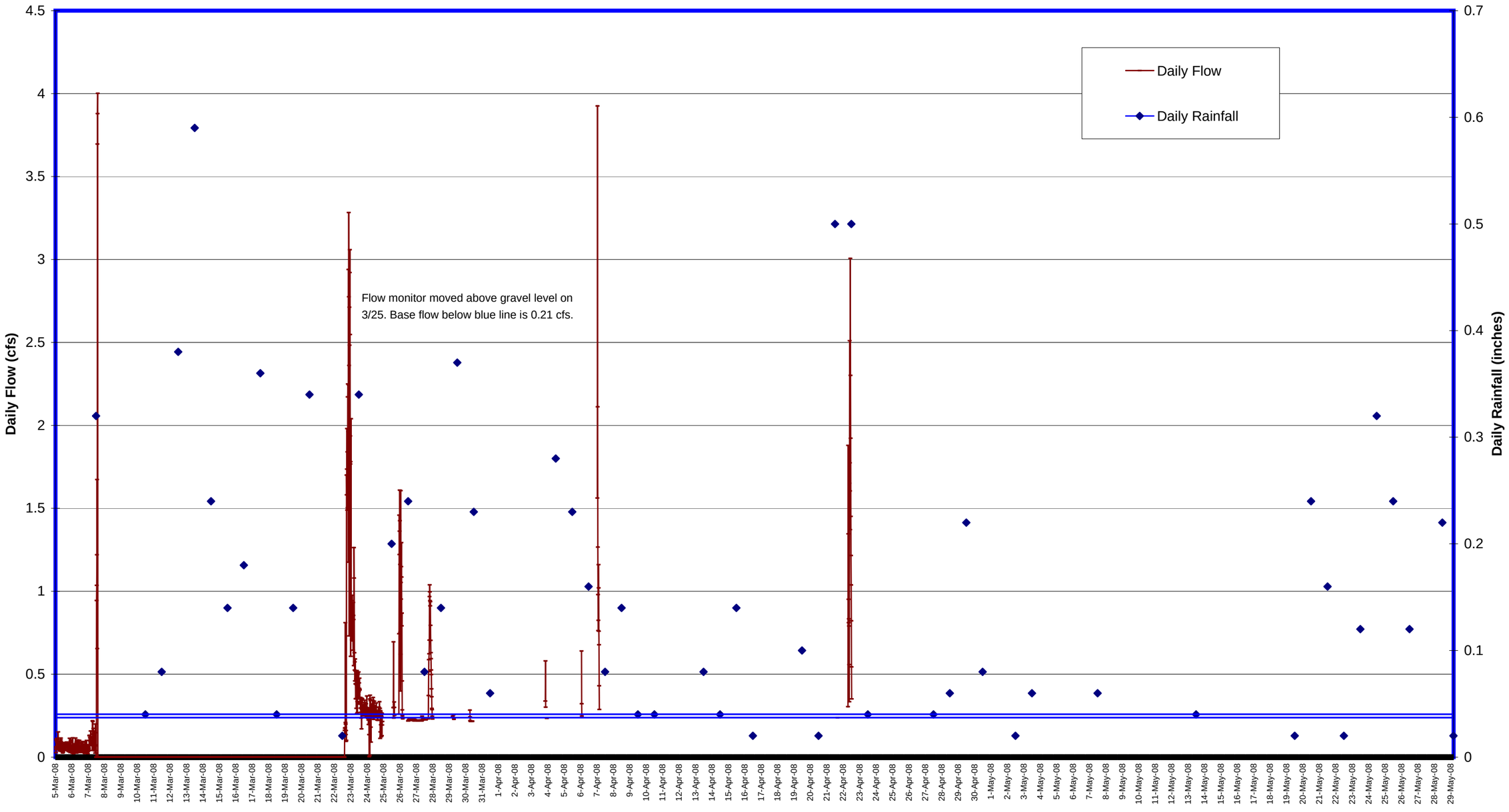


Figure 4
Pump Station Outfall Daily Flow and Rainfall

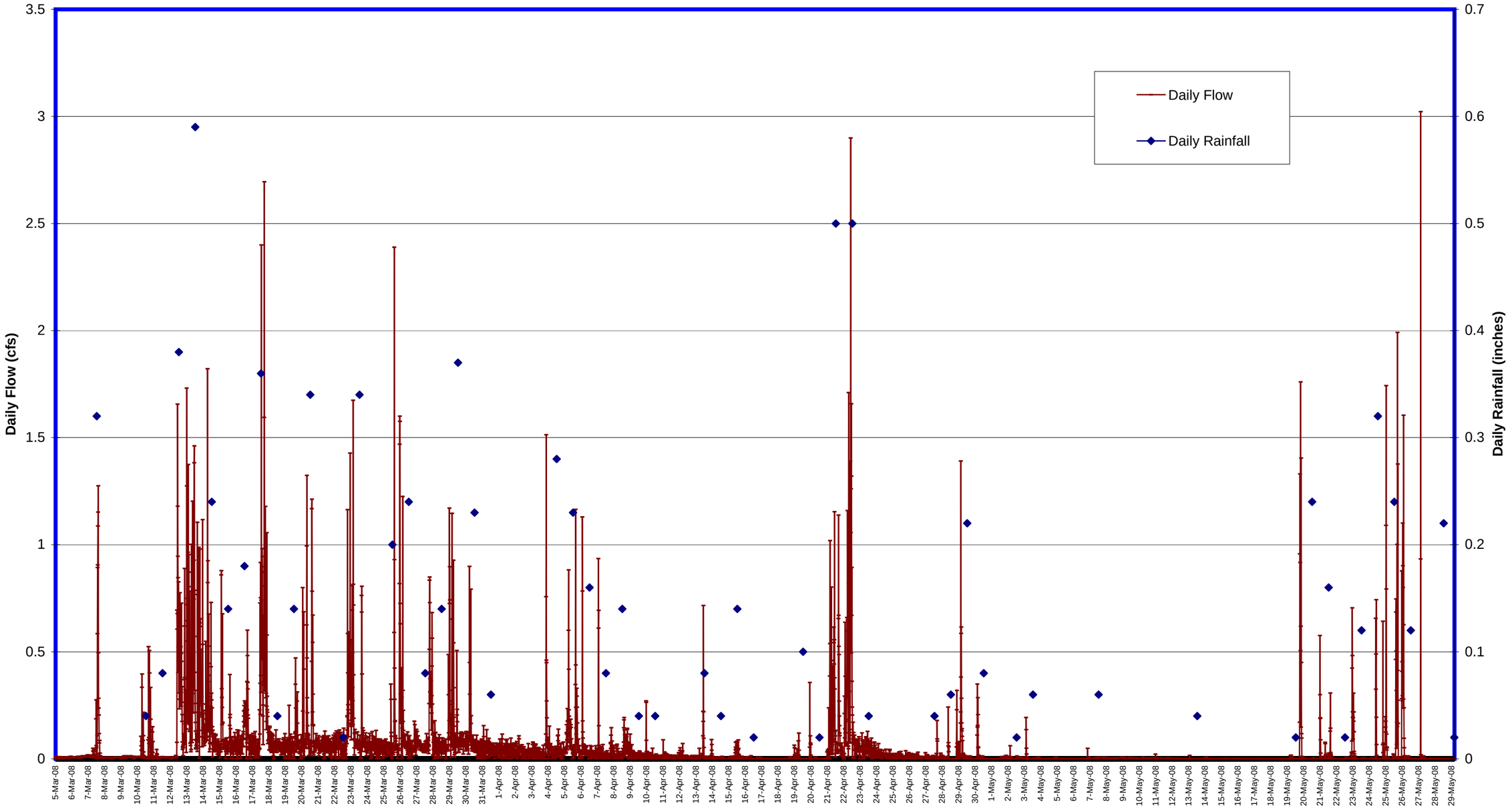


Figure 5
Library Outfall Daily Flow and Rainfall

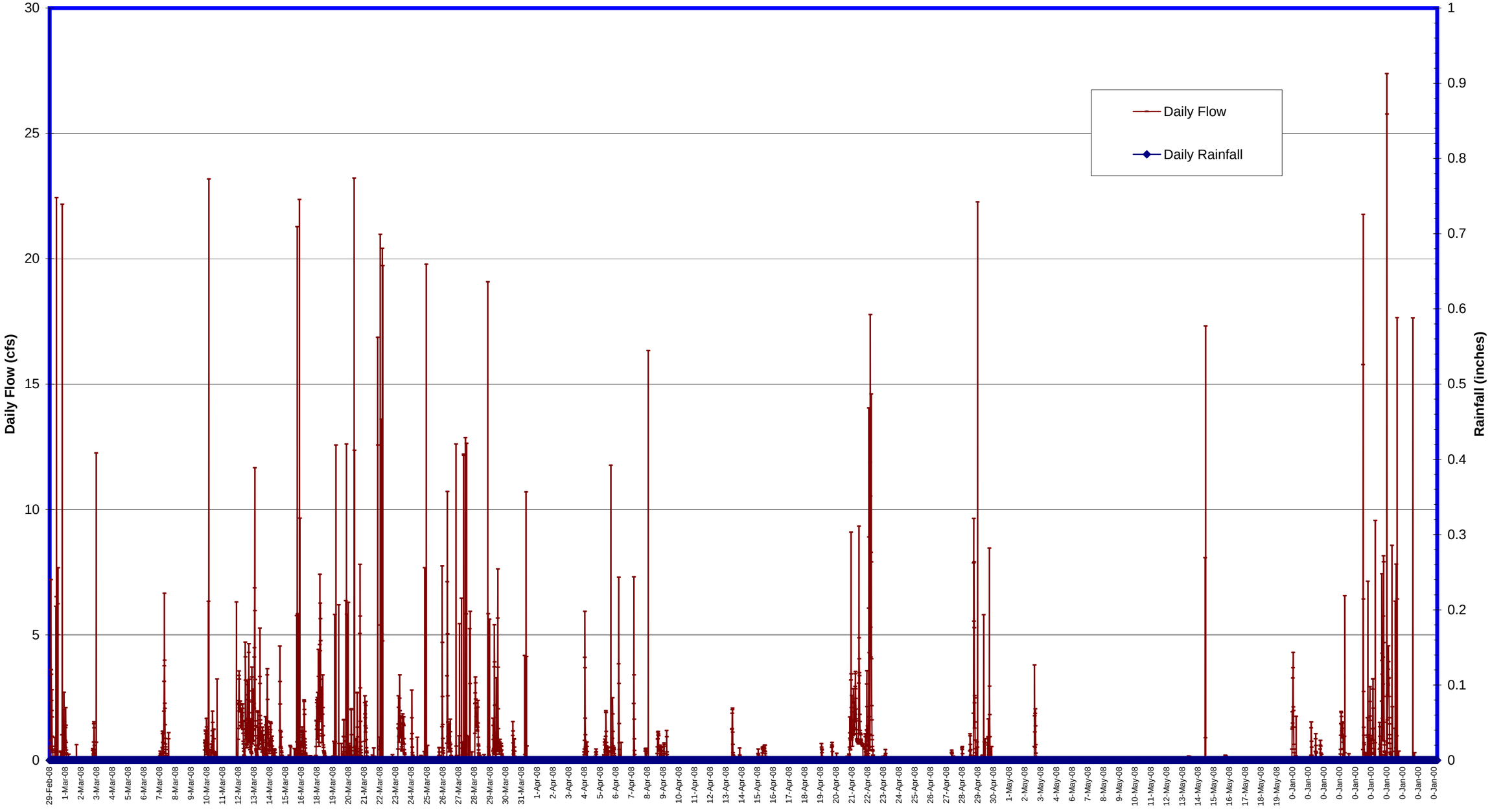


Table 1
Daily Rainfall Data Wilsonville, Oregon

Feb-08		Mar-08		April-08		May-08	
Inches	Day	Inches	Day	Inches	Day	Inches	Day
0.00	2/26/08	0.38	3/1/08	0.00	4/1/08	0.00	5/1/08
0.00	2/27/08	0.00	3/2/08	0.00	4/2/08	0.02	5/2/08
0.00	2/28/08	0.10	3/3/08	0.00	4/3/08	0.06	5/3/08
0.34	2/29/08	0.00	3/4/08	0.28	4/4/08	0.00	5/4/08
		0.00	3/5/08	0.23	4/5/08	0.00	5/5/08
		0.00	3/6/08	0.16	4/6/08	0.00	5/6/08
		0.32	3/7/08	0.08	4/7/08	0.06	5/7/08
		0.00	3/8/08	0.14	4/8/08	0.00	5/8/08
		0.00	3/9/08	0.04	4/9/08	0.00	5/9/08
		0.04	3/10/08	0.04	4/10/08	0.00	5/10/08
		0.08	3/11/08	0.00	4/11/08	0.00	5/11/08
		0.38	3/12/08	0.00	4/12/08	0.00	5/12/08
		0.59	3/13/08	0.08	4/13/08	0.04	5/13/08
		0.24	3/14/08	0.04	4/14/08	0.00	5/14/08
		0.14	3/15/08	0.14	4/15/08	0.00	5/15/08
		0.18	3/16/08	0.02	4/16/08	0.00	5/16/08
		0.36	3/17/08	0.00	4/17/08	0.00	5/17/08
		0.04	3/18/08	0.00	4/18/08	0.00	5/18/08
		0.14	3/19/08	0.10	4/19/08	0.02	5/19/08
		0.34	3/20/08	0.02	4/20/08	0.24	5/20/08
		0.00	3/21/08	0.50	4/21/08	0.16	5/21/08
		0.02	3/22/08	0.50	4/22/08	0.02	5/22/08
		0.34	3/23/08	0.04	4/23/08	0.12	5/23/08
		0.00	3/24/08	0.00	4/24/08	0.32	5/24/08
		0.20	3/25/08	0.00	4/25/08	0.24	5/25/08
		0.24	3/26/08	0.00	4/26/08	0.12	5/26/08
		0.08	3/27/08	0.04	4/27/08	0.00	5/27/08
		0.14	3/28/08	0.06	4/28/08	0.22	5/28/08
		0.37	3/29/08	0.22	4/29/08	0.02	5/29/08
		0.23	3/30/08	0.08	4/30/08	0.00	5/30/08
		0.06	3/31/08			0.02	5/31/08

Note:
Rainfall recording gauge is located at the end of Boones Ferry Road.

APPENDIX D

INFOSWMM MODEL
DETAILS AND CALIBRATION

Appendix D
InfoSWMM Model Details and Calibration

Model Selection

Wilsonville city staff selected the InfoSWMM model for use in the hydrologic and hydraulic modeling of the stormwater system. This decision was made after URS conducted research on a number of models and the City evaluated their overall needs. InfoSWMM has a strong interface with GIS and provides flexibility to allow the user to readily change scenarios and rerun the model with new assumptions. InfoSWMM also has the capability to incorporate Low Impact Development (LID) projects, which is an important component of this Stormwater Master Plan update.

Another major factor that influenced the City's decision was their need to develop new models for the drinking water and wastewater systems and the desire by the City to use a unified platform for all three analyses. InfoSWMM has separate modules for all three system types: potable water, wastewater, and stormwater. Using the same model (although different modules) for all three applications would provide efficiency in training and communication between staff and technical support.

Hydraulic Model Development

Due to limited resources including budget and schedule, only the major components of the stormwater system were modeled. Modeling included pipes that are, in general, 15-inches in diameter and greater, although there were a few exceptions. In addition, as with most public stormwater systems, the locations and functions of existing facilities are not well documented, particularly older systems installed prior to current documentation and stormwater management requirements. Thus, modeling was limited to major systems including interceptors that provide for the primary drainage for each basin. Simplification of the modeled drainage system minimized overall model run time. The existing modeled system was presented, adjusted based on City staff comments, and approved, by the staff stakeholder team.

Hydraulic Parameters

The hydraulic portion of the InfoSWMM Model is primarily comprised of conduits, junctions, and storage nodes. The majority of the hydraulic input data was taken from the GIS data provided by the City, with remaining data gathered from as-built drawings, project design reports, as well as limited field reconnaissance, and staff input in order to qualify and create an updated, comprehensive system directory. The previous HYDRA Model was used to fill in data gaps, and provided additional information related to open channel geometry. URS conducted field work to verify the locations and configurations of select outfalls, culverts under roadways, and detention facilities configuration for existing conditions. Major culverts were field inspected and sizes and shapes verified for inclusion in the model, such as the Coffee Lake Creek crossing at Wilsonville Road.

Surveying was not a part of the project. Input parameters required for each component of the hydraulic system are described below.

Conduits

Conduits connect all points within the hydraulic system (manholes, flow control devices, ponds, etc.) and transports water through the system. For the Wilsonville model, conduits were either pipes or open channels, and associated input parameters are as follows:

Conduit Length

Conduit length specifies the distance a conduit spans between two points.

Manning's roughness coefficient (n)

Manning's "n" values for conduits were based on pipe material, and taken from the GIS data supplied by the City. Typical values were used based on pipe materials:

n = 0.011 for PVC
n = 0.013 for RCP
n = 0.024 for CMP

Pipes with unknown materials were assigned the manning's "n" for concrete, 0.013. Open channels were assumed to have a Manning's "n" of 0.035, consistent with input from the previous HYDRA Model.

Upstream and Downstream Invert Elevations (feet)

Upstream and downstream invert elevations are inputted into the model, in order for the model to calculate the slope of the pipe.

Cross-Sectional Geometry (feet)

For round pipes, the pipe diameter is used. For arch-shaped conduits, both the width (feet) and height (feet) are specified. All open channels were assumed to be trapezoidal in shape with depths equal to the depth of upstream and downstream conduits, as was used in the existing HYDRA model.

Nodes

Nodes are used to describe points in the conveyance system. The three main types of nodes used in the InfoSWMM model are junctions, outfalls, and storage nodes. Junction nodes can receive runoff from a subbasin, or connect links in the system conveying flow. Outfall nodes can receive flow from a subbasin or a system link, and define the downstream boundary of the system. Storage nodes represent detention facilities, designed to collect runoff, store it, and release it at a slower rate. The discharge from the storage nodes is typically described by a stage-discharge curve provided by the City. In instances where this was not available, pipes and/or orifices were used to simulate the discharge at specific storm events. Input parameters associated with nodes are as follows:

Invert Elevation (feet)

Describes the inside bottom elevation of the node.

Rim Elevation (feet)
Describes the ground elevation at the node. Rim elevations were estimations based on 2-foot contours.

Ponded Area (square feet)
Describes the area around a node that is allowed to pond at the junction, and subsequently drain back into the junction. This parameter is only for junction nodes and was set at 20 square feet for all junctions.

Maximum Depth (feet)
Represents the distance from the ground surface to the invert elevation of a storage node. These values were derived from information provided by the City for the modeled storage nodes.

Storage Curves
Tabular storage curves, representing a depth vs. surface area relationship were used to define the available storage volume.

Hydrologic Model Development

For the hydrologic component of the modeling, subbasins were originally defined based on the City's 2001 Stormwater Master Plan. The subbasins were then checked against topography and updated in accordance with staff details and project as-built information. In some cases, storm system components installed for new development results in redirected drainage from natural or pre-developed runoff patterns and results in discharges into neighboring subbasins.

The model was initially developed using Curve Numbers as the method for modeling infiltration and runoff, similar to the method used by the former HYDRA model. A single curve number (CN) is assigned to each subbasin in accordance with a variety of subbasin characteristics including land use, and subsequent impervious area, soil types, and antecedent moisture conditions.

However, assigning a single value (a Curve Number) to account for a variety of runoff parameters resulted in broad generalizations and difficulties in calibrating the model. Model calibration was attempted by adjusting the CN, but in order to detect significant changes in flows and volumes, large increases to the CN value were required. The CN method did not appear to respond realistically to locally collected rainfall data during the initial calibration process. As a result, an alternative method, the Green Ampt method (described below), was used to estimate runoff and infiltration. This method appeared to produce more realistic results and was therefore used in lieu of the CN method for estimating infiltration of stormwater in the model. A 25-year storm event occurred on January 1, 2009, which provided a check on existing system conditions in comparison with anticipated modeling results. The rainfall event resulted in minor flooding in several low lying areas, such as Rose Lane and Montgomery Way, located near the Willamette River. Another area that flooded was near the Elligsen Road/I-5 interchange. Other than these localized issues, no significant flooding occurred in the City. Modeling results

using the Green Ampt method better followed the observed trends, and thus was determined to be the better method for simulating infiltration and runoff of stormwater for the City.

Hydrologic Parameters

The hydrologic input data for the InfoSWMM Model was taken from the GIS data provided by the City, and information from the previous HYDRA Model. The HYDRA Model provided drainage configurations for more recent developments (i.e. Villebois). The following user-defined hydrologic parameters were specified for each subbasin in the InfoSWMM model:

- Subbasin name or number
- Area of subbasin (acres)
- Width of subbasin (feet)
- Impervious percentage (percent)
- Average ground slope (%)
- Manning's roughness coefficient for impervious areas
- Manning's roughness coefficient for pervious areas
- Depression storage for impervious areas (inches)
- Depression storage for pervious areas (inches)
- Green-Ampt soil infiltration parameters: initial moisture deficit of soil, hydraulic conductivity of soil, and suction head at the wetting front.

A summary is provided below for each user-defined hydrologic parameter entered into the InfoSWMM model.

Subbasin Name/Number

Most subbasins were named in accordance with the Hydra Model. A few additional subbasins were created to simulate additional detention facilities provided by the City after meeting with the stakeholder team. These subbasins were name in accordance with the detention facility they drain to. Subbasins only simulated for the future conditions scenario have the prefix "Fut".

Subbasin Area (acres)

Subbasins and their areas were originally defined based on the City's 2001 Stormwater Master Plan. The subbasins were then checked against topography and updated in accordance with staff details and project as-built information. In some cases, storm system components installed for new development results in redirected drainage from natural or pre-developed runoff patterns and results in discharges into neighboring subbasins; however, overall flows remained in the major basin. Areas expected to become annexed to the City were included in the future conditions model, using areas provided by the City.

Subbasin Impervious Percentage (%)

The City assigns a percent impervious to each land use type (Table 1). Using GIS, a weighted average of the percent impervious was calculated for each subbasin, reflective of the subbasin's overall land use. Existing condition land use coverage and associated percent impervious values were determined using the City's zoning map (as documented in the Comprehensive Plan) and recent aerial photos (City of Wilsonville 2007) to document undeveloped areas. City zoning was consolidated and classified into the land use categories shown in Table 1. Areas (based on the aerial photos) that were undeveloped were categorized as vacant land use. Future condition land use coverage and associated permit impervious values were calculated assuming the City was fully built-out. All vacant land use areas were redefined in accordance with the associated zoning for that area as documented in the Comprehensive Plan.

Table 1

Land Use Category	**Impervious %**
Agriculture	5
Industrial	85
Open Space	5
Vacant	5
Commercial	80
Commercial - Villebois	85
Residential	35
Residential - Villebois	60
Multi Family Residential	55
Multi Family Residential - Villebois	85

Subbasin Slope

The subbasin slope is the average slope along the pathway of overland flow to the inlet of the drainage system. The subbasin slope was developed based on the digital topographic data contained in GIS, averaged over each basin.

Subbasin Width

The subbasin width describes the geometry of the subbasin, and influences the shape of the runoff hydrograph. Basin width estimates for the model were based on the square root of the basin area for simplification.

Manning's Roughness Coefficient for Impervious Area

Manning's roughness coefficient (n) provides a measure of the friction resistance to flow across a surface or channel. The Manning's roughness coefficient for impervious surfaces used in the previous HYDRA model were used for the InfoSWMM Model, and set at 0.011 for all impervious surfaces.

Manning's Roughness Coefficient for Pervious Area

The Manning's "n" for pervious areas from the previous HYDRA model were used for the InfoSWMM Model, and set at 0.13 for all pervious surfaces.

Depression Storage for Impervious Area

The depression storage is the maximum surface storage provided by ponding, surface wetting, etc. that is filled prior to runoff occurring. The values used for the previous HYDRA model were used for the InfoSWMM Model, and set at 0.05 for all impervious areas.

Depression Storage for Pervious Area

The values for depression storage for pervious areas were set at 0.1 for all pervious areas, consistent with what was used for the previous HYDRA Model.

Green-Ampt Infiltration Parameters (units vary)

The Green Ampt method, was used to estimate runoff and infiltration. The Green Ampt method calculates infiltration of stormwater into soils, by taking into account antecedent moisture conditions, suction head, and hydraulic conductivity of the soil. The values of these three parameters were based on soil types in the City of Wilsonville. Specific soils types and their associated distribution within each watershed were determined using GIS files from the Natural Resources Conservation Service (NRCS). Using GIS, the area-weighted averages were calculated on a subbasin basis, using information in Table 2, and entered into the InfoSWMM model for each subbasin.

Table 2: Green-Ampt Infiltration Parameters by Soil Type

Soil Texture Class	Hydraulic Conductivity (in/hr)	Suction Head (in)	Initial Moisture Deficit (fraction)
Sand	4.74	1.93	0.413
Loamy Sand	1.18	2.4	0.39
Sandy Loam	0.43	4.33	0.368
Loam	0.13	3.5	0.347
Silt Loam	0.26	6.69	0.366
Sandy Clay Loam	0.06	8.66	0.262
Clay Loam	0.04	8.27	0.277
Silty Clay Loam	0.04	10.63	0.261
Sandy Clay	0.02	9.45	0.209
Silty Clay	0.02	11.42	0.228
Clay	0.01	12.6	0.21

Model Runs

The calibrated model was run for existing and future development conditions for the following storm events and 24-hour cumulative rainfall with the following distributions:

Table 3: Cumulative Rainfall Depths and Distributions Used for Model

Hour	Percent Rainfall		Rainfall Depth (inches)					
			2-Year Storm	5-Year Storm	10-Year Storm	25-Year Storm	50-Year Storm	100-Year Storm
	Incremental	Cumulative	2.50	3.10	3.45	3.90	4.20	4.50
1	2.40	2.40	0.06	0.07	0.08	0.09	0.10	0.11
2	2.60	5.00	0.07	0.08	0.09	0.10	0.11	0.12
3	3.20	8.20	0.80	0.10	0.11	0.12	0.13	0.14
4	3.80	12.00	0.10	0.12	0.13	0.15	0.16	0.17
5	4.44	16.44	0.11	0.14	0.15	0.17	0.19	0.20
6	5.18	21.62	0.13	0.16	0.18	0.20	0.22	0.23
7	6.48	28.10	0.16	0.20	0.22	0.25	0.27	0.29
8	16.44	44.54	0.41	0.51	0.57	0.64	0.69	0.74
9	7.58	52.12	0.19	0.23	0.26	0.30	0.32	0.34
10	5.28	57.40	0.13	0.16	0.18	0.21	0.22	0.24
11	4.96	62.36	0.12	0.15	0.17	0.19	0.21	0.22
12	4.32	66.68	0.11	0.13	0.15	0.17	0.18	0.19
13	4.02	70.70	0.10	0.12	0.14	0.16	0.17	0.18
14	3.42	74.12	0.09	0.11	0.12	0.13	0.14	0.15
15	3.28	77.40	0.08	0.10	0.11	0.13	0.14	0.15
16	3.00	80.40	0.08	0.09	0.10	0.12	0.13	0.14
17	2.80	83.20	0.07	0.09	0.10	0.11	0.12	0.13
18	2.40	85.60	0.06	0.07	0.08	0.09	0.10	0.11
19	2.40	88.00	0.06	0.07	0.08	0.09	0.10	0.11
20	2.40	90.40	0.06	0.07	0.08	0.09	0.10	0.11
21	2.40	92.80	0.06	0.07	0.08	0.09	0.40	0.11
22	2.40	95.20	0.06	0.07	0.08	0.09	0.10	0.11
23	2.40	97.60	0.06	0.07	0.08	0.09	0.10	0.11
24	2.40	100.00	0.06	0.07	0.08	0.09	0.10	0.11

Calibration of InfoSWMM Model

Calibration efforts relied on the use of existing flow monitoring data collected by URS, through a contract with the City, and the comparison of modeled and observed flows for a specific storm event. Flow monitoring was conducted by the City during the months of March through May, 2008, on four outfalls: two outfalls adjacent to the Willamette River (one at SW Belknap Court and one at Tauchman Road); one outfall located at the Memorial Park detention pond on Memorial Drive; and one at Ridder Road, in the northern part of the City. During the flow monitoring period, the outfall at Ridder Road experienced continual build-up of gravel due to upstream beaver dam activity. Attempts were made to calibrate flows to adjust for this additional depth of gravel in the pipe. However, despite successful calibration of the flow meter, flow monitoring results provided significantly differing flow measurements from this site, compared with the other three sites, raising concerns over the accuracy of those flow measurements. Therefore, due to the uncertainty of data from the flow monitor at Ridder Road, data from that site was not used for calibration, and the model calibration was performed using data from the other three monitoring sites.

Data from the remaining three flow monitoring sites was used for the InfoSWMM model calibration, specifically: conduits SD5219 (Library), SD6000 (Tauchman), and SD6601 (Belknap Court). The storm events on March 13, 2008 and March 15, 2008 were used for the calibration of the model because they showed the highest peak flows that occurred during the flow monitoring project (see Figures 1-3). Calibration was conducted by comparing the model-simulated flows at conduits SD5219, SD6000, and SD6601 with the respective actual monitored flows for those storm events. Although the model provided peak flows and volume for these storm events, URS was not able to calibrate to both parameters. It was decided to calibrate to peak flows to assure adequate sizing of stormwater systems in the City, particularly for future conditions.

Calibration focused on matching the general shape of the modeled and observed runoff hydrographs, as well as matching peak measured flows of two storm events. These two storm events, on March 13 and March 15, 2008, were chosen for calibration because they were the most consistent storms across the three sampling sites. Results of the modeled and observed flow comparison, prior to calibration, showed that observed flows were often higher than simulated flows (see Figures 4-6).

In an effort to prevent the model from underestimating flows, hydrologic input parameters in the model were adjusted to simulate flows that met or slightly exceeded measured flows. Several model runs were conducted to evaluate the model's sensitivity to changes in certain hydrologic input parameters, specifically basin width and percent impervious. Modeled peak flows changed significantly with varying changes to the impervious percentages while varying basin widths provided very little changes to peak flows. The hydrologic model adjustment that resulted in the best match of peak modeled flow rates and peak observed flow rates was a 25% increase in the modeled impervious percentage value. This adjustment was applied to all modeled subbasins for both existing and future condition simulations conducted for this Master Plan Update. Model results

for the different combinations of calibration adjustments are shown on Table 1, and results for the 25% increase in impervious area (the best match) are shaded.

In summary, optimum calibration for the model resulted with a 25% increase in impervious area. This adjustment produced the minimum difference between modeled and observed flows for both storm events, while the other hydrologic input parameter adjustments evaluated tended to underpredict peak flows. To avoid oversizing CIPs, model results should be used for planning purposes only including planning level budgeting; a detailed hydrology and hydraulic study needs to be conducted during the design phase for the CIP(s).

Table 4 – Parameter Sensitivity Analysis and Calibration Results

Alternative Model Adjustments	Conduit	Simulated Flow (cfs)	Measured Flow (cfs)	Percent Difference
Storm Date: 3/13/2008				
No initial Changes	5219	9.909	11.663	-15%
	6000	3.875	4.586	-16%
	6601	1.333	1.461	-9%
25% increase Impervious %	5219	11.996	11.663	3%
	6000	4.75	4.586	4%
	6601	1.66	1.461	14%
25% Reduction Impervious %	5219	7.864	11.663	-33%
	6000	2.964	4.586	-35%
	6601	1.002	1.461	-31%
20% increase Impervious % & 50% Reduction Subbasin Width	5219	10.047	11.663	-14%
	6000	4.164	4.586	-9%
	6601	1.544	1.461	6%
25% increase Impervious % & 50% Reduction Subbasin Width	5219	10.369	11.663	-11%
	6000	4.311	4.586	-6%
	6601	1.603	1.461	10%
20% increase Impervious % & 25% Reduction Subbasin Width	5219	10.369	11.663	-11%
	6000	4.311	4.586	-6%
	6601	1.603	1.461	10%
25% increase Impervious % & 25% Increase Subbasin Width	5219	10.1	11.663	-13%
	6000	3.973	4.586	-13%
	6601	1.38	1.461	-6%
Storm Date: 3/15/2008				
No initial Changes	5219	3.869	4.53	-15%
	6000	1.827	1.636	12%
	6601	0.83	0.879	-6%

Alternative Model Adjustments	Conduit	Simulated Flow (cfs)	Measured Flow (cfs)	Percent Difference
25% increase Impervious %	5219	4.368	4.53	-4%
	6000	2.134	1.636	30%
	6601	0.999	0.879	14%
25% Reduction Impervious %	5219	3.301	4.53	-27%
	6000	1.469	1.636	-10%
	6601	0.642	0.879	-27%
20% increase Impervious % & 50% Reduction Subbasin Width	5219	3.14	4.53	-31%
	6000	1.489	1.636	-9%
	6601	0.795	0.879	-10%
25% increase Impervious % & 50% Reduction Subbasin Width	5219	3.203	4.53	-29%
	6000	1.523	1.636	-7%
	6601	0.816	0.879	-7%
20% increase Impervious % & 25% Reduction Subbasin Width	5219	3.203	4.53	-29%
	6000	1.523	1.636	-7%
	6601	0.816	0.879	-7%
25% increase Impervious % & 25% Increase Subbasin Width	5219	3.941	4.53	-13%
	6000	1.867	1.636	14%
	6601	0.828	0.879	-6%

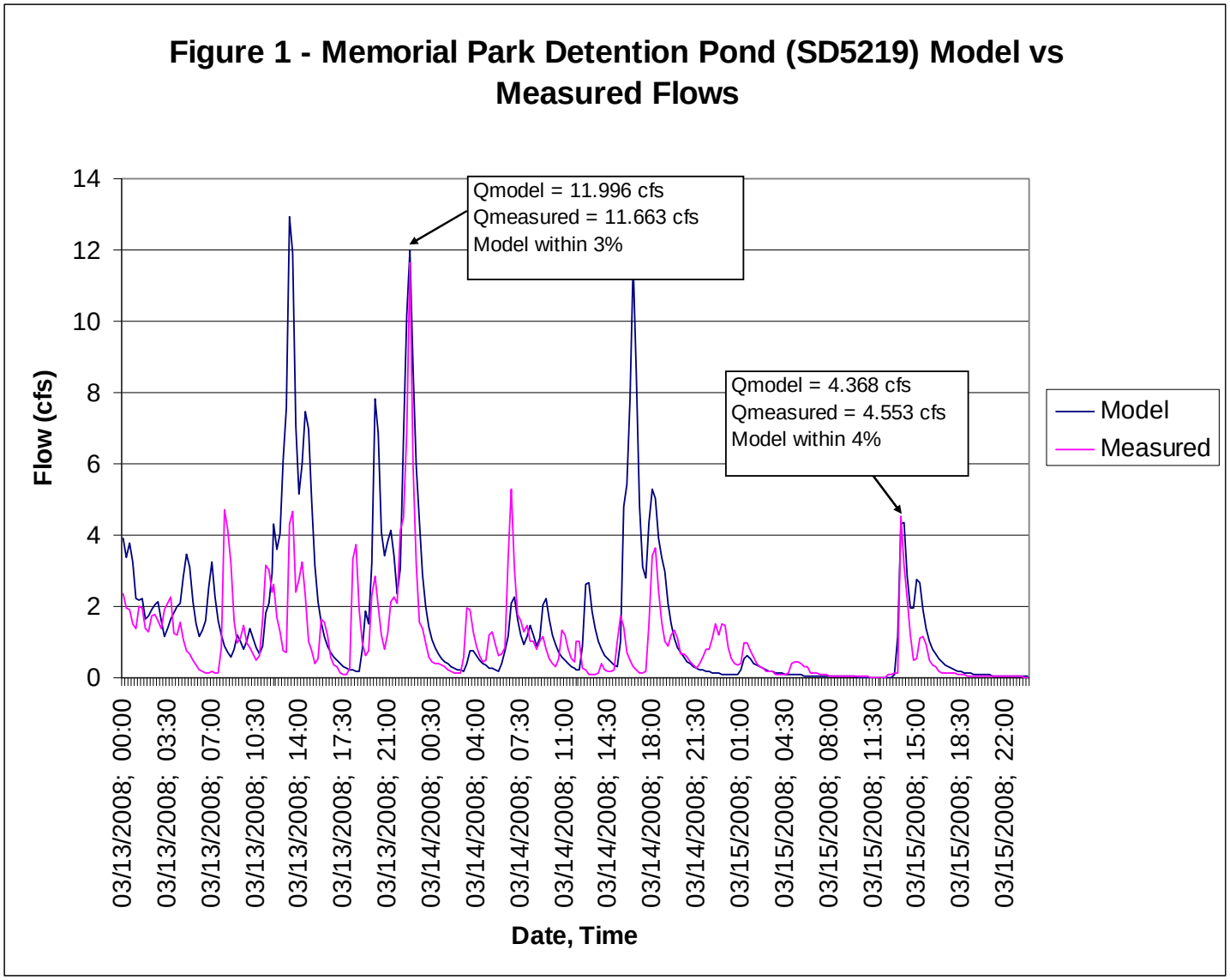


Figure 1 - Memorial Park Detention Pond (SD5219) Model vs Measured Flows
Qmodel = 11.996 cfs
Qmeasured = 11.663 cfs
Model within 3%
Qmodel = 4.368 cfs
Qmeasured = 4.553 cfs
Model within 4%
Model
Measured
Flow (cfs)
0
2
4
6
8
10
12
14
03/13/2008; 00:00
03/13/2008; 03:30
03/13/2008; 07:00
03/13/2008; 10:30
03/13/2008; 14:00
03/13/2008; 17:30
03/13/2008; 21:00
03/14/2008; 00:30
03/14/2008; 04:00
03/14/2008; 07:30
03/14/2008; 11:00
03/14/2008; 14:30
03/14/2008; 18:00
03/14/2008; 21:30
03/15/2008; 01:00
03/15/2008; 04:30
03/15/2008; 08:00
03/15/2008; 11:30
03/15/2008; 15:00
03/15/2008; 18:30
03/15/2008; 22:00
Date, Time

Figure 2 - Tauchman (SD6000) Model vs Measured Flows

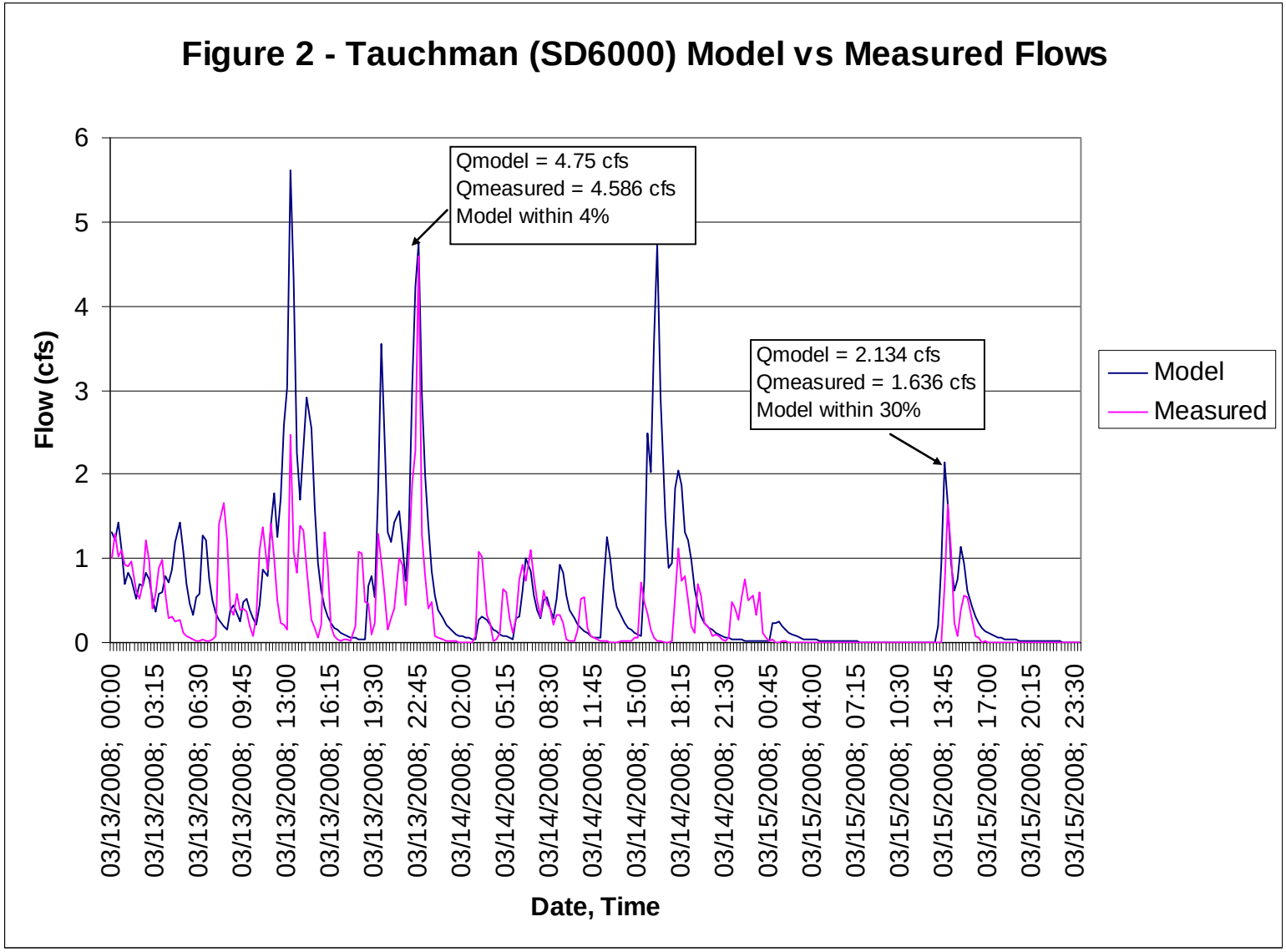
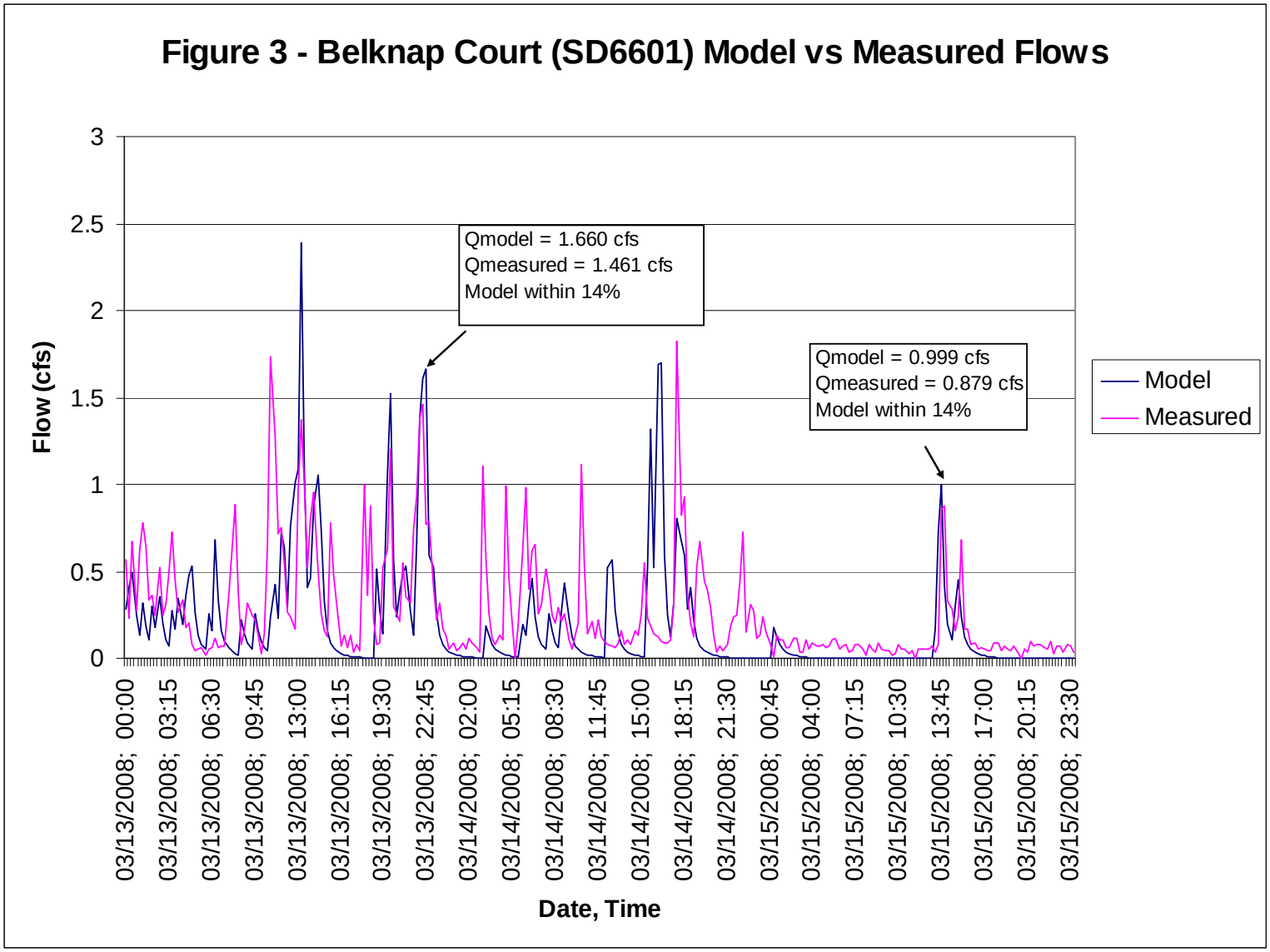


Figure 3 - Belknap Court (SD6601) Model vs Measured Flows



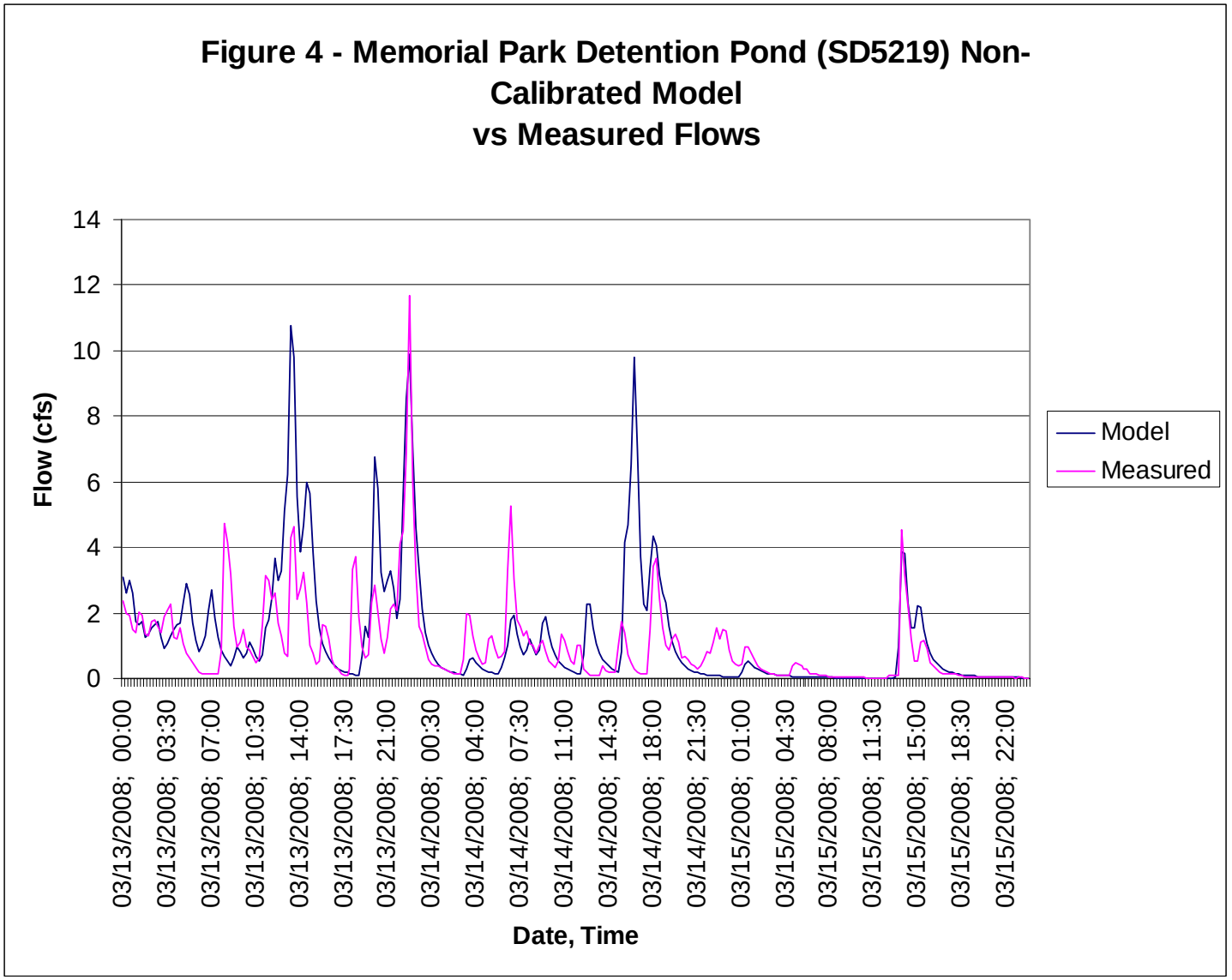


Figure 4 - Memorial Park Detention Pond (SD5219) Non-Calibrated Model vs Measured Flows
Flow (cfs)
14
12
10
8
6
4
2
0
03/13/2008; 00:00
03/13/2008; 03:30
03/13/2008; 07:00
03/13/2008; 10:30
03/13/2008; 14:00
03/13/2008; 17:30
03/13/2008; 21:00
03/14/2008; 00:30
03/14/2008; 04:00
03/14/2008; 07:30
03/14/2008; 11:00
03/14/2008; 14:30
03/14/2008; 18:00
03/14/2008; 21:30
03/15/2008; 01:00
03/15/2008; 04:30
03/15/2008; 08:00
03/15/2008; 11:30
03/15/2008; 15:00
03/15/2008; 18:30
03/15/2008; 22:00
Date, Time
Model
Measured

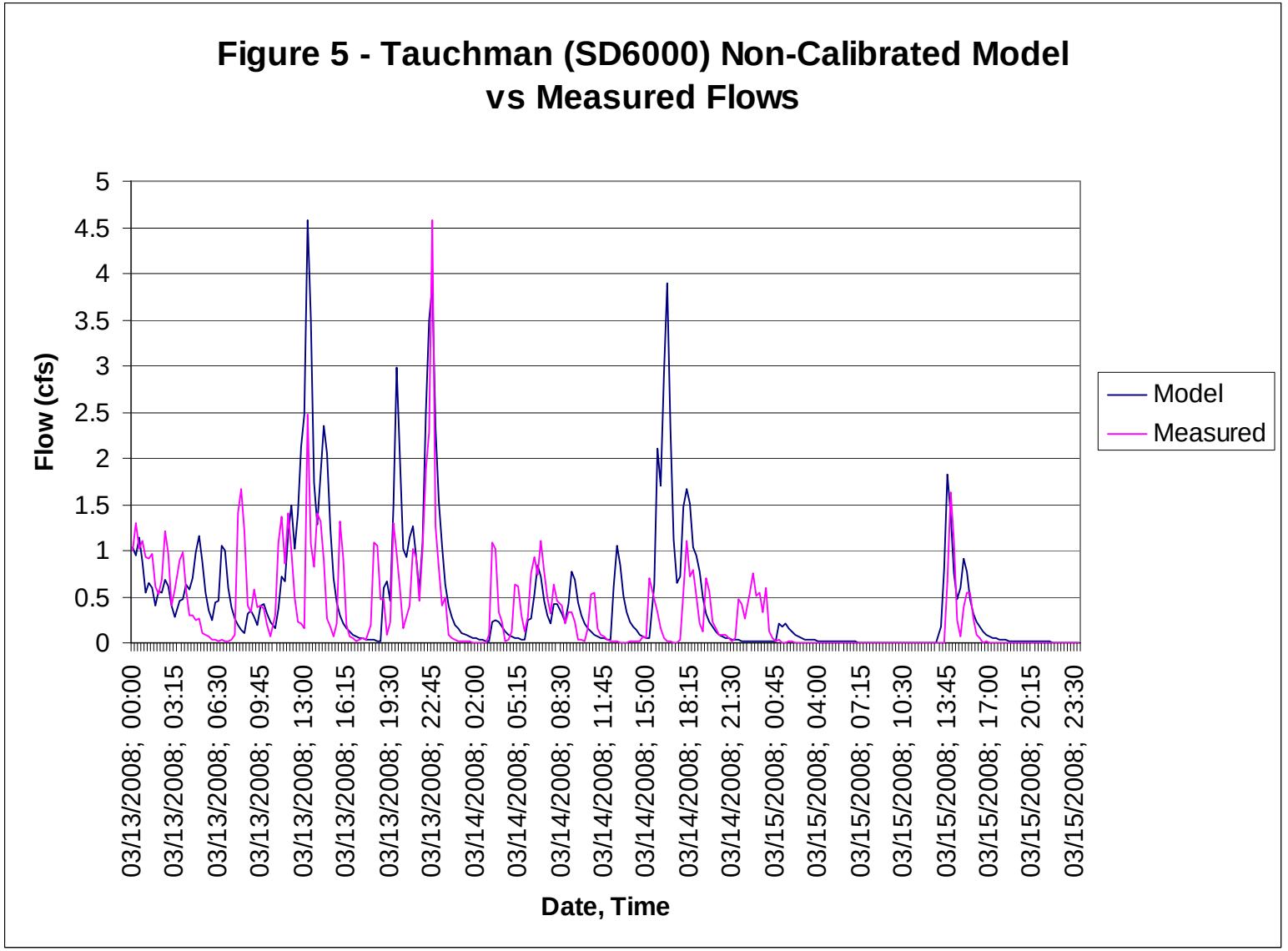


Figure 5 - Tauchman (SD6000) Non-Calibrated Model vs Measured Flows
Flow (cfs)
5
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
03/13/2008; 00:00
03/13/2008; 03:15
03/13/2008; 06:30
03/13/2008; 09:45
03/13/2008; 13:00
03/13/2008; 16:15
03/13/2008; 19:30
03/13/2008; 22:45
03/14/2008; 02:00
03/14/2008; 05:15
03/14/2008; 08:30
03/14/2008; 11:45
03/14/2008; 15:00
03/14/2008; 18:15
03/14/2008; 21:30
03/15/2008; 00:45
03/15/2008; 04:00
03/15/2008; 07:15
03/15/2008; 10:30
03/15/2008; 13:45
03/15/2008; 17:00
03/15/2008; 20:15
03/15/2008; 23:30
Date, Time
Model
Measured

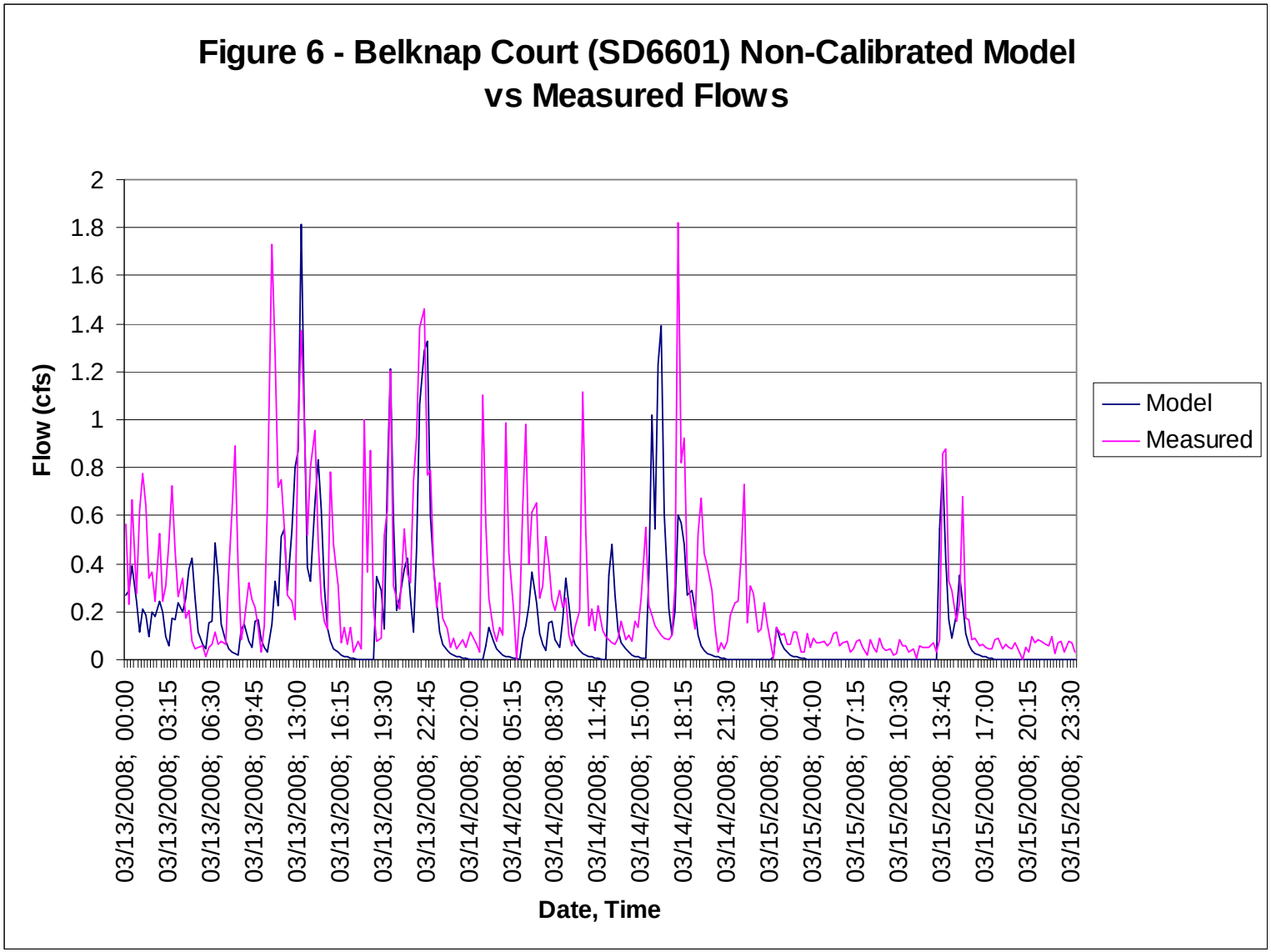


Figure 6 - Belknap Court (SD6601) Non-Calibrated Model vs Measured Flows
Flow (cfs)
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
03/13/2008; 00:00
03/13/2008; 03:15
03/13/2008; 06:30
03/13/2008; 09:45
03/13/2008; 13:00
03/13/2008; 16:15
03/13/2008; 19:30
03/13/2008; 22:45
03/14/2008; 02:00
03/14/2008; 05:15
03/14/2008; 08:30
03/14/2008; 11:45
03/14/2008; 15:00
03/14/2008; 18:15
03/14/2008; 21:30
03/15/2008; 00:45
03/15/2008; 04:00
03/15/2008; 07:15
03/15/2008; 10:30
03/15/2008; 13:45
03/15/2008; 17:00
03/15/2008; 20:15
03/15/2008; 23:30
Date, Time
Model
Measured

APPENDIX E

COST ESTIMATING DETAILS

Appendix E

Cost Estimating Details

Construction Cost Estimates

Estimates for pipe upgrades and improvements are shown in Table E-1. Assumptions are included in the table.

Unit costs for restoration projects are included with individual CIP cost summaries identified in Appendix F and Appendix I.

Maintenance Cost Estimates

The following guidelines were used in establishing maintenance costs for each CIP project. City staff adjusted maintenance cost estimates based on experience with similar projects.

Maintenance costs were established by assuming a crew of 2 would be $600/day for vactor staff and $570/day for utility staff. The cost of a vactor truck is assumed to be $1,250/day and the cost of other equipment was assumed at $250/day.

Maintenance of restoration projects and outfalls assumes a crew of 2 for a day with a frequency of 4 times per year for inspection and maintenance activities. Maintenance includes inspection, cleaning of debris, and vegetation management.

Detention facilities assume 2 crews of 2 for a day at four times per year. Maintenance includes inspection, cleaning of debris, and vegetation management.

Pipe maintenance assumes a crew of 2 for one day, with the use of a vactor for 4 hours. Activities include cleaning of catch basins, pipe as needed, and removal of material to appropriate facility.

Low Impact Development maintenance assumes a crew of 2 for one day once per month.

Low Impact Development cost estimates

$25/square foot for retrofits of paved areas to provide curb extensions and swales;
$40/square foot for planters.

Table E-1: Pipe Cost Estimating Details

Pipe Diameter	Cost/Lineal Foot[1]	Excavation[2]	Excavation Cost[3]	Backfill	Cost[3]	Paving	Cost[4]	Total Cost per Lineal Foot[5]
inch		CY/FT.	Cost/foot	CY/FT.	Cost/foot	SF/FT.		
15	$125	0.55	$11	0.47	$9	3.88	$39	$286
18	$130	0.69	$14	0.58	$12	4.42	$44	$309
24	$140	1.00	$20	0.82	$16	5.5	$55	$359
27	$150	1.17	$23	0.94	$19	6.04	$60	$392
30	$160	1.36	$27	1.08	$22	6.58	$66	$426
36	$180	1.77	$35	1.38	$28	7.67	$77	$496
42	$200	2.22	$44	1.69	$34	8.75	$88	$567
48	$210	2.73	$55	2.05	$41	9.83	$98	$626
60	$315	3.52	$70	2.47	$49	11	$110	$844
72	$420	4.41	$88	2.92	$58	12.17	$122	$1,067
6' X 4' Box Culvert	$245	3.50	$70	2.2	$44	12.0	$120	$742

Notes:

1 Reinforced concrete pipe, includes manholes, catch basins, or inlets, any work necessary for pipe installation
2 Assumes: 3 ft. of cover over pipe and removal of existing pipe and debris.
3 Estimated at $20/CY
4 Estimated at $10/SY
5 Includes 25% for traffic control, erosion control, contingency, engineering, etc. and 30% for construction contingency

Sources:

ODOT bid tab (2008) - excavation and backfill
City of Portland bid tab (2008) updated to 2009 - pipe costs
Means 2008 - paving
CPI - first half of 2008 for Portland - 3.4%
Hanson Precast - 6'x4' Box Culvert

APPENDIX F

CAPITAL IMPROVEMENT PROGRAM
PROJECTS – SUPPLEMENTAL INFORMATION

Note: This appendix includes additional, supplemental information that was prepared as part of the development of this Stormwater Master Plan. Therefore, only projects where additional information is available are included in this appendix.

CLC-1 – Detention /Wetland Enhancement near Tributary to Basalt Creek

Project Overview: The site is located to the northwest of Commerce Circle and south of Day Road in the northern portion of the City, where Basalt Creek crosses underneath Day Road. At this location, Basalt Creek receives flows from an area to the north, including a 645-acre area that was brought into the UGB, as well as a small portion of the City of Tualatin UGB, which is currently used as agricultural land. As described in Section 4.4.1, this area near Commerce Circle experiences flooding from moderate storm events. As the drainage area develops from agricultural land use to industrial (as it is currently zoned) more runoff will be produced. This will increase the flooding issues already experienced near Commerce Circle.

By constructing a wetland so that stormwater runoff can be detained there, flows to Basalt Creek will be decreased, flooding near Commerce Circle will be reduced, and erosion potential will be reduced in the creek because of reduced flows and velocities in the creek. Additional benefits to this project include water quality enhancement and habitat restoration.

Aerial view of CLC-1 Location

Map View of CLC-1 Location

Potential Constraints: A portion of the project may be located under BPA power lines (according to the 2001 Stormwater Master Plan). The City of Wilsonville will need to develop a plan for addressing the portion of the Tualatin UGB that will be drained by the facility.

Benefits: Water quality; habitat restoration; flooding mitigation; reduce erosion

Flow Comparison for CLC-1:

Storm Event	Existing Condition Flow Rate (cfs)	Future Condition Flow Rate (cfs)
2-year	46.5	240.7
10-year	64.9	328.1
25-year	74.3	378.1

CLC-2 – SW Parkway Avenue Stream Restoration

Project Location: Stream between SW Parkway Avenue and I-5, south of the intersection of SW Salish Lane and Parkway Avenue

Project Overview

The incised east/west stream flows west just north of the La Quinta Inn's swimming pool and just north of an office building at SW Sun Place. A short portion of the channel is culverted. There are wetlands on the north side of the stream. The site contains a mix of trees and shrubs, with significant areas of blackberry.

A low terrace can be excavated adjacent to the north side of the channel to create flood storage capacity. The riparian vegetation can be enhanced with trees and shrubs. In-channel vegetation will improve water quality.

Looking downstream along creek at CLC-2

Aerial view of project area

Conceptual Plan

- Remove invasive plants.
- Excavate to create a low terrace on the north side of the stream along the northerly Sun Place lots. The terrace elevation will be low enough to flood at frequent storm events and may become jurisdictional wetland in certain locations.
- Remove existing culvert and restore stream
- Install site-appropriate native trees, shrubs and herbs within the temperature TMDL buffer or to a minimum of 50 feet from the limits of the stream to enhance riparian habitat and to provide shade to the open water, thereby addressing temperature TMDL compliance targets.

Benefits: Water quality; temperature TMDL; habitat restoration; recreation (if trail access provided)

Maintenance/monitoring

- Visually inspect 2-4 times per year for buildup of sediment, trash, debris, floatables, invasive vegetation, clogged outlets, erosion or scour at outlets, and survival of new plants
- Maintain once per year (or as needed based on inspections), removing sediment and debris, invasive vegetation and replanting as needed.

Potential Constraints
The site is privately owned. Terraced excavation must be designed to prevent adverse impacts to nearby wetlands.


CLC-2 - STREAM RESTORATION AT SW PARKWAY AVE AND I-5
0
50
100
200
SCALE IN FEET
A~REMOVE EXISTING CULVERT
B~EXCAVATE TO CREATE A FLOODPLAIN TERRACE
C~REMOVE INVASIVES AND REPLANT TO LIMITS OF TMDL BUFFER OR TO A MINIMUM OF 50-FT. FROM STREAM/WETLANDS
A
B
C
C

CLC-3 – Channel Project - Commerce Circle

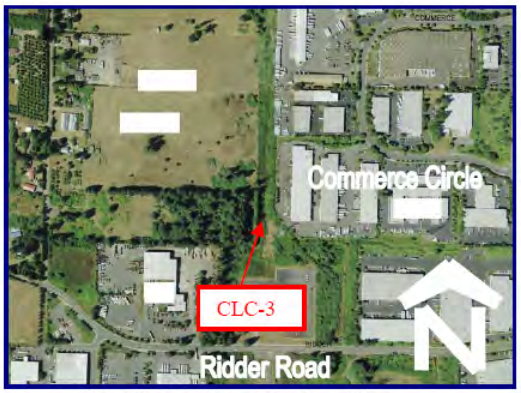
Project Location: Southwest of Commerce Circle and north of Ridder Road

Project Overview

The northern portion of Basalt Creek (a tributary to Coffee Lake Creek) is contained within a straightened, incised channel and flows due south on the western edge of the SW Commerce Circle industrial area. The stream turns to flow due east along the southern edge of the industrial area, still within a straightened, incised channel. Both portions of the stream offer enhancement opportunities.

Restoration and enhancement action will create a more naturalistic and ecologically valuable waterway. This will be accomplished by widening the channel, creating a meandering channel bank line, and laying back the stream bank on the west side of the north/south reach of the creek and on the south side of the east/west reach. Facing downstream, most of the bank excavation and re-contouring will occur on the right bank of the channel. The industrial development is too close to the stream to allow any significant re-contouring on the left bank of the channel.

Looking east along the east–west reach of Basalt Creek



Aerial view of project location

Conceptual Plan

<u>North/South Reach beginning at southwest corner of Tax Lot 600; industrial parking area west of SW Commerce Circle</u>**.**

- Excavate to create a 6-foot-wide bench on the west side of north/south channel. The elevation of the bench will be one foot above the ordinary high water level of the stream.

- Lay back the west bank above the new bench with a slope no steeper than 2:1.

- Remove two culverts: a 52-foot culvert located near the northwest corner of Tax Lot 400 and a 319-foot culvert located west of Tax Lot 600.

- Widen and/or re-grade the channel to improve storm flow where constrictions or grade changes contribute to flooding the industrial area.

- Remove invasive plants throughout the work area. Install site-appropriate native shrubs and herbs to improve wildlife habitat, and to provide shade to the open water, thereby addressing temperature TMDL compliance targets.

East/West Reach.

- Establish a meandering channel bank line by widening the south side of the east/west channel six to eight feet to create a more naturalistic and ecologically valuable waterway.

- Excavate to create an eight-to-ten-foot-wide terrace with an elevation one foot higher than the channel on the south side of the stream. Throughout, the terrace width will vary to create a more naturalistic contour than the current, straight alignment. The terrace elevations will be low enough to flood at frequent storm events and may become jurisdictional wetland in certain locations.

- Grade the slope south of the terrace no steeper than 2.5:1.

- Widen and/or re-grade the channel to improve storm flow where constrictions or grade changes contribute to flooding the industrial area.

Remove invasive plants throughout the work area. Install site-appropriate native trees, shrubs and herbs to improve wildlife habitat, and to provide shade to the open water, thereby addressing temperature TMDL compliance targets.

Benefits: Water quality; temperature TMDL; habitat restoration; flood control; improved high-flow conveyance

Maintenance/monitoring

- Visually inspect 2-4 times per year for buildup of sediment, trash, debris, floatables, invasive vegetation, clogged outlets, erosion or scour at outlets, and survival of new plants
- Maintain once per year (or as needed based on inspections), removing sediment and debris, invasive vegetation and replanting as needed.

Potential Constraints

The conceptual plan includes property that is under private ownership or that has set-back constraints. On the portion of the site located under high-voltage BPA power lines, shrubs but not trees will be allowed within the riparian buffer. Portions of the temperature TMDL buffer consist of parking lots and other impervious surfaces, and therefore, the temperature TMDL buffers can not be fully revegetated.

Flow Comparison at CLC-3:

Storm Event	Existing Condition Flow Rate (cfs)	Future Condition Flow Rate (cfs)
2-year	46.5	240.7
10-year	64.9	328.1
25-year	74.3	378.1


CLC-3 - CHANNEL PROJECT - COMMERCE CIRCLE
0
75
150
300
SCALE IN FEET
A~WIDEN CHANNEL AND CREATE A SINUOUS BANK ON THE WEST SIDE
B~2:1 SLOPE ABOVE THE CHANNEL
TMDL BUFFER, TYP.
A
B
C
D
E
C~WIDEN CHANNELTO CREATE A SINUOUS BANK ON THE SOUTH SIDE
D~8-10-FT. WIDE TERRACE 1-FT. ABOVE THE CHANNEL
E~2.5:1 SLOPE TO MEET GRADE ABOVE TERRACE

CLC-4 – Wetland Restoration Project West of I-5 - North of Ridder Road

Project Location: A reach of the North Tributary to Coffee Lake Creek that flows in a straightened channel for approximately 450 feet from a culvert under I-5 toward the southwest to a corridor between parking lots.

Project Overview

The portion of the stream targeted for enhancement is a reach that flows in a straightened channel for approximately 450 feet from a culvert under Interstate 5 toward the southwest to a corridor between parking lots. Currently, the channel area is approximately 12 to 15 feet wide and is mostly vegetated with reed canarygrass. Both north and south banks are approximately 2:1 slopes. On the south side, a grassy field is approximately 4 feet higher than the channel. On the north side, a grassy field is approximately eight feet higher than the channel. The primary waterway enhancement will be the creation of a new, floodplain terrace along the south side of the channel and the realignment of the channel for approximately 120 feet to create a meander north of the existing channel. Construct a water quality manhole at the outlet to function as a spill control facility.

Looking west at stream at CLC-4

Aerial view of CLC-4

Conceptual Plan

- Excavate to create a six-to-eight-foot-wide floodplain terrace on the south side of the stream. Throughout, the terrace width will vary to create a more naturalistic contour than the current, straight alignment. The new terrace will begin near the east end of the site and continue for approximately 300 feet. The elevation of the terrace will be approximately one foot above the existing channel. The terrace elevations will be low enough to flood at frequent storm events and may become jurisdictional wetland in certain locations.

- Grade the slope south of the terrace no steeper than 2:1.

- Realign the channel for approximately 120 feet beginning 120 feet west of the outfall culvert at I-5, ending 240 feet west of I-5. The new channel path will be a shallow curve that extends approximately 30 feet north of the existing channel at its widest point. Grade the north bank to a slope no steeper than 2:1.

- Install site-appropriate native trees, shrubs and herbs to improve wildlife habitat and to provide shade to the stream.

Benefits: Water quality; temperature TMDL; habitat restoration; more naturalistic channel path

Maintenance/monitoring

- Visually inspect 2-4 times per year for buildup of sediment, trash, debris, floatables, invasive vegetation, clogged outlets, erosion or scour at outlets, and survival of new plants
- Maintain once per year (or as needed based on inspections), removing sediment and debris, invasive vegetation and replanting as needed.

Potential Constraints

All or part of new terrace may interfere with the proposed spill containment feature within this reach of the creek.

Flow Comparison at CLC-4:

Storm Event	Existing Condition Flow Rate (cfs)	Future Condition Flow Rate (cfs)
2-year	39.7	40.9
10-year	53.0	54.6
25-year	59.6	61.4


CLC-4 - WEST OF I-5
NORTH OF RIDDER ROAD
0 50 100 200
SCALE IN FEET
A~50-FT. PLANTING AREA ON NORTH SIDE OF EXISTING CHANNEL AND AS SHOWN ON SOUTH SIDE
B~EXCAVATE A 6-8-FT. WIDE FLOOD PLAIN TERRACE 1-FT. ABOVE THE CHANNEL ON THE SOUTH SIDE
C~2:1 SLOPE ABOVE TERRACE ON SOUTH SIDE OF CHANNEL
A
C
A
B

CLC-5 – Stream and Riparian Enhancement – I-5 to SW 95th Avenue

Location: West of I-5, north of the Wilsonville Nissan dealership, and east of SW 95th Avenue.

Project Overview

The site is west of I-5, north of the Wilsonville Nissan dealership, and east of SW 95th Avenue. An unnamed tributary to Basalt Creek flows from a culvert under I-5 and storm line in Boones Ferry Road west through an incised, straightened channel on the northern edge of this narrow, rectangular property. The channel can be widened to create a meandering bank line, and the entire western half of the site can be excavated and re-contoured to create a low floodplain terrace south of the channel. A trail can be created for recreational activity. Shrubs on the terrace and the adjacent upland would provide wildlife habitat and provide summer shade for the stream. The site has the potential for a spill control facility.

Looking east along stream at CLC-5

Looking west along stream at CLC-5

Aerial view of project location

Conceptual Plan

- Widen the south side of the existing channel by four to eight feet to create a meandering bank line.

- Construct a new floodplain terrace on the south side of the channel beginning approximately 75 feet west of the power-line tower and continuing to the western end of the site. The terrace will range in width from 40 to 50 feet at an elevation approximately 0.8 feet above the existing channel. Throughout, the terrace width will vary to create a more naturalistic contour than the current, straight alignment. The terrace elevation will be low enough to flood at frequent storm events and may become jurisdictional wetland in certain locations.

- Grade the bank above the new terrace to a slope no steeper than 3:1.

- Install site-appropriate native shrubs and herbs to improve wildlife habitat and to provide shade to the open water, thereby addressing temperature TMDL compliance targets.

- Create a trail on the west end of the site.

- The site has the potential for a spill control facility.

Benefits: Water quality; temperature TMDL; increased flood storage; habitat restoration; recreation

Maintenance/monitoring

- Visually inspect 2-4 times per year for buildup of sediment, trash, debris, floatables, invasive vegetation, clogged outlets, erosion or scour at outlets, and survival of new plants
- Maintain once per year (or as needed based on inspections), removing sediment and debris, invasive vegetation and replanting as needed.

Potential Constraints

The site is privately owned. The plan will need BPA approval. No excavation can occur within 62.5 feet from the center point of the tower. Shrubs but no trees will be allowed in the BPA right-of-way.

Flow Comparison at CLC-5:

Storm Event	Existing Condition Flow Rate (cfs)	Future Condition Flow Rate (cfs)
2-year	22.3	25.7
10-year	27.9	32.5
25-year	29.3	35.2


CLC-5 - STREAM AND RIPARIAN ENHANCEMENT - 1-5 TO SW 95TH AVE
0
50
100
200
SCALE IN FEET
TMDL BUFFER, TYP
A
B
C
A~WIDEN CHANNEL TO CREATE SINUOUS BANK LINE ON SOUTH SIDE
B~EXCAVATE TO CREATE LOW FLOODPLAIN TERRACE (ELEVATION APPROXIMATELY 0.8-FT ABOVE THE EXISTING CHANNEL/TERRACE 40-50-FT WIDE)
C~SLOPE ABOVE TERRACE NO STEEPER THAN 3:1

BC-1 –Weideman Road Regional Stormwater Detention/Stream Enhancment

Location: Within and adjacent to the Wiedeman Road right-of-way west of Canyon Creek Road and east of Parkway Avenue, along the western side of the Sysco facility.

Project Overview

The site is within and adjacent to Wiedemann Rd right-of-way west of Canyon Creek Road north and south of Parkway Avenue, along the west side of the Sysco facility and adjacent to undeveloped land to the west. Two sets of BPA power lines run east-and-west along the southern edge of the site. Wiedemann Road could be constructed in conjunction with this project.

The northern portion of the stream is a straightened, incised channel that flows due south along the western side of the Sysco facility. Just north of the Wiedemann Road right-of-way, the stream flows into a culvert under the right-of-way, and the channel turns due east, still within a straightened, incised channel.

Throughout, the north/south channel will be widened and realigned to form a meander path and the banks will be sloped back within the existing channel easement. Trees, shrubs and herbaceous plants will be planted to improve water quality within the channel, to provide diverse habitat, and to create shade. Shrubs but no trees will be planted under the BPA power lines.

This site will include a regional stormwater detention facility. The exact size and location will be determined by the City.

Looking west at the potential site of a stormwater detention pond

Aerial view of project location

Conceptual Plan

- Create an off-channel detention basin near the southern edge of the site west of the north/south channel. A low-flow opening will discharge water from the basin into a pipe to a new bioswale on the north side of Wiedemann Road. The exact basin size can be determined later but, for example, a 3-acre-foot basin could fit within an acre of land if the ground elevation and slope will accommodate a basin that is three feet deep.

- Create a high-flow diversion structure within the north/south channel to reroute all flood flows into the detention basin. This bypass can divert storm flow into the detention basin via an open channel or a buried pipe located adjacent to the west side of the channel. The open channel is preferred as it can be planted to function as a bioswale. The location of the structure will be determined later.

- Within the existing, fence-enclosed channel easement, create a meandering channel bank line by widening the west side of the channel at variable widths to create a more naturalistic and ecologically valuable waterway.

- Remove invasive plants

- Install site-appropriate native trees, shrubs and herbs within the temperature TMDL buffer or to a minimum of 50 feet from the limits of the stream to enhance riparian habitat and to provide shade to the open water, thereby addressing temperature TMDL compliance targets. No trees can be planted under the BPA power lines.

- Create a bioswale instead of a conventional roadside ditch along the north side of the new Wiedemann Road. The 1350-foot-long bioswale will receive the water that is discharged from the detention basin during storms and will discharge through an under-street pipe into the existing stream channel on the south side of Wiedemann Road. The three-foot-deep channel will be uniformly sloped. The east end will be approximately 6 feet lower than the west end. Control structures with low-flow outlets can be installed in the bioswale to temporarily detain storm flow from the storm water detention basin. Depending upon their design and placement within the bioswale, these control structures may detain up to 1/3rd acre-feet of water. The bioswale will be vegetated with native plants.

Benefits: Water quality; temperature TMDL; habitat restoration; flood control

Maintenance/monitoring

- Visually inspect 2-4 times per year for buildup of sediment, trash, debris, floatables, invasive vegetation, clogged outlets, erosion or scour at outlets, and survival of new plants
- Maintain once per year (or as needed based on inspections), removing sediment and debris, invasive vegetation and replanting as needed.

Potential Constraints
The property on the west side of the north/south reach of the ditch is privately owned. Its availability is unknown. The area immediately east of the north/south reach is developed and offers limited space for expanding the waterway features. A portion of the project may be located under the BPA power lines.

The control structure to divert high flows from the stream into the storm water detention facility will require regulatory agency permits.

CLC-6 – Coffee Lake Creek South Tributary Wetland Enlargement

Location: East of SW Parkway Avenue and north of SW Maxine Lane on the South Tributary to Coffee Lake Creek.

Project Overview

The site is east of SW Parkway Ave and north of SW Maxine Lane on a tributary to Coffee Lake Creek. It can be enhanced by creating wetlands adjacent to the existing stream and wetlands. The site is large enough to allow a mix of wetland and upland plant communities which will enhance wildlife habitat. Depending on the hydrograph of the water entering the site, water quality features may be incorporated into the wetland design.

Looking north at existing wetland

Aerial view of proposed project area

Conceptual Plan

- Remove invasive plants.
- Excavate to create additional wetlands adjacent to the creek and to existing wetlands. Design the wetlands to stay saturated throughout much of the year but to not pond water except during storm events.
- Install site-appropriate native trees, shrubs and herbs within the temperature TMDL buffer or to a minimum of 50 feet from the limits of the stream to enhance riparian habitat and to provide shade to the open water, thereby addressing temperature TMDL compliance targets.

Benefits: Water quality; temperature TMDL; habitat restoration

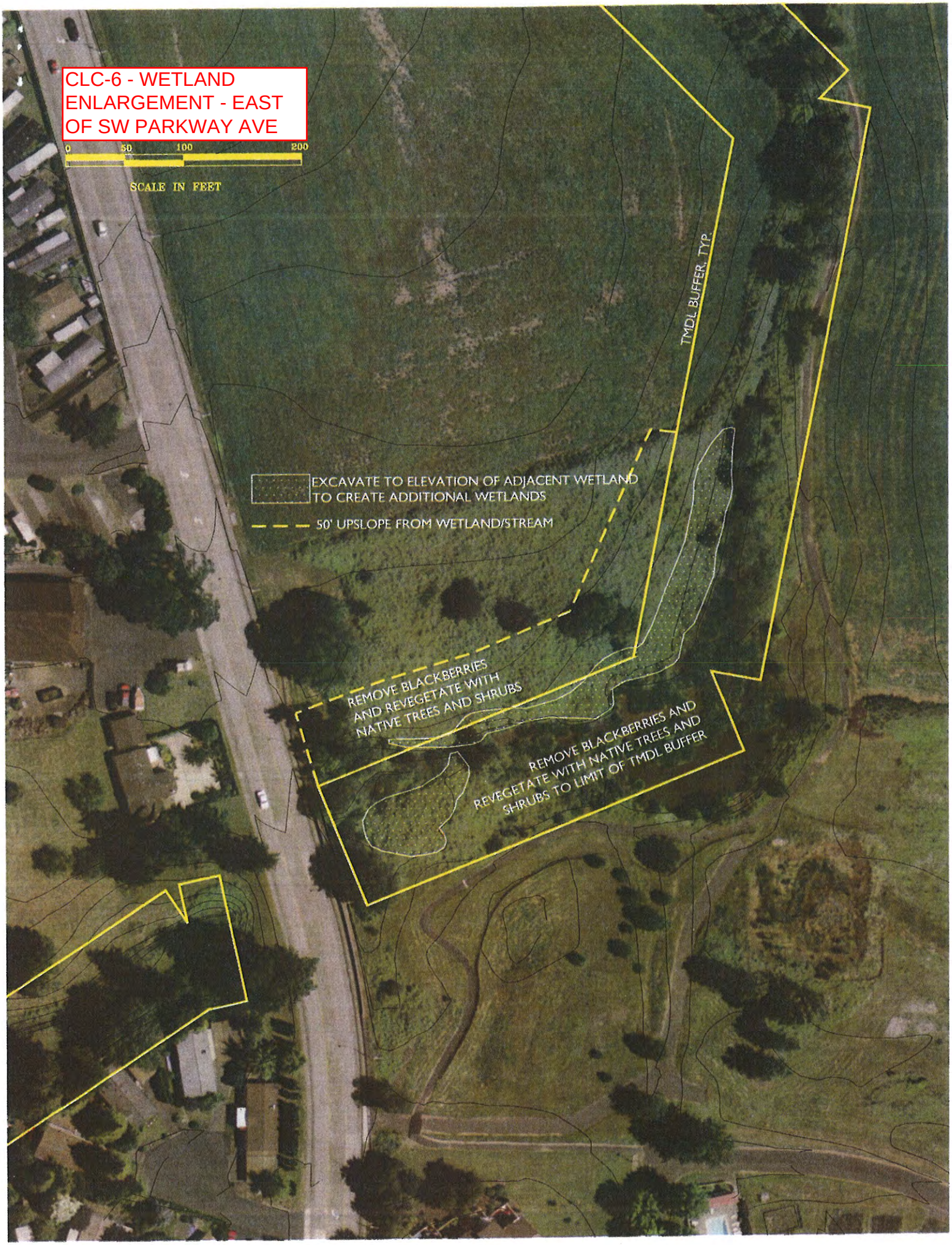
Maintenance/monitoring

- Visually inspect 2-4 times per year for buildup of sediment, trash, debris, floatables, invasive vegetation, clogged outlets, erosion or scour at outlets, and survival of new plants
- Maintain once per year (or as needed based on inspections), removing sediment and debris, invasive vegetation and replanting as needed.

Potential Constraints
The site is privately owned.

Flow Comparison:

Storm Event	Existing Condition Flow Rate (cfs)	Future Condition Flow Rate (cfs)
2-year	34.5	35.1
10-year	42.7	43.6
25-year	46.9	48.0


CLC-6 - WETLAND ENLARGEMENT - EAST OF SW PARKWAY AVE
0
50
100
200
SCALE IN FEET
TMDL BUFFER, TYP.
EXCAVATE TO ELEVATION OF ADJACENT WETLAND TO CREATE ADDITIONAL WETLANDS
50' UPSLOPE FROM WETLAND/STREAM
REMOVE BLACKBERRIES AND REVEGETATE WITH NATIVE TREES AND SHRUBS
REMOVE BLACKBERRIES AND REVEGETATE WITH NATIVE TREES AND SHRUBS TO LIMIT OF TMDL BUFFER

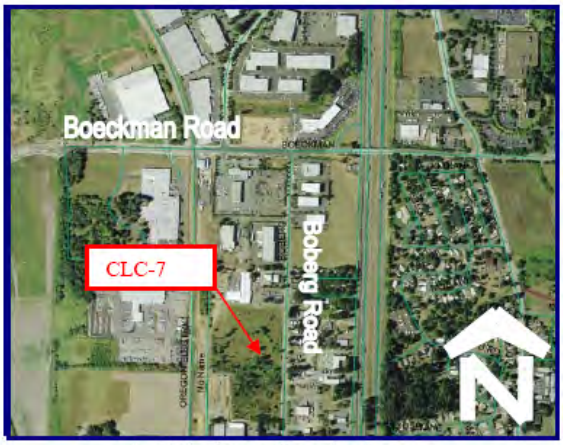
CLC-7 – Coffee Lake Creek South Tributary Stream Restoration

Location: South Tributary to Coffee Lake Creek, between Boberg Road and Coffee Lake Creek

Project Overview

This incised, straightened, east/west channel between Coffee Lake Creek and Boberg Road can be enhanced in several ways. The site slopes to the west and is covered with trees, shrubs and blackberries. The channel between Boberg Road and the railroad can be reshaped to create meanders and provide a more naturalistic flow path; the channel can be widened and the banks re-contoured to a shallower slope; large woody debris can be added for wildlife habitat improvement; through the entire east/west reach of the stream, invasive plants can be removed and the riparian area can be planted with native trees and shrubs. Different vegetation communities can be established to provide additional habitat diversity. The site has the potential for a spill control facility. The Master Plan recommends that the culverts crossing Boberg Road should be replaced with a box culvert with a concrete throat extending at least 3 feet to the east to eliminate future clogging by plant materials.

Looking west along stream at CLC-7



Aerial view of project area

Conceptual Plan

- Throughout the entire east/west reach of the creek, remove Himalayan blackberry and other invasive plants.

- Between Boberg Road and the railroad, re-align stream channel to the south of the existing channel to add meanders and restore more naturalistic flow path. Keep the new channel within 50 feet of the existing channel in order to stay within the existing Wilsonville Significant Resource Overlay Zone.

- Lay back the channel banks to a 4:1 slope.

- Install large wood and boulder check dams in the channel to reduce the likelihood of channel headcutting and bank erosion and to provide aquatic habitat diversity.

- Install site-appropriate native trees, shrubs and herbs within the temperature TMDL buffer or to a minimum of 50 feet from the limits of the stream to enhance riparian habitat and to provide shade to the open water, thereby addressing temperature TMDL compliance targets.

- The site has the potential for a spill control facility.

Benefits: Water quality; temperature TMDL; habitat restoration.

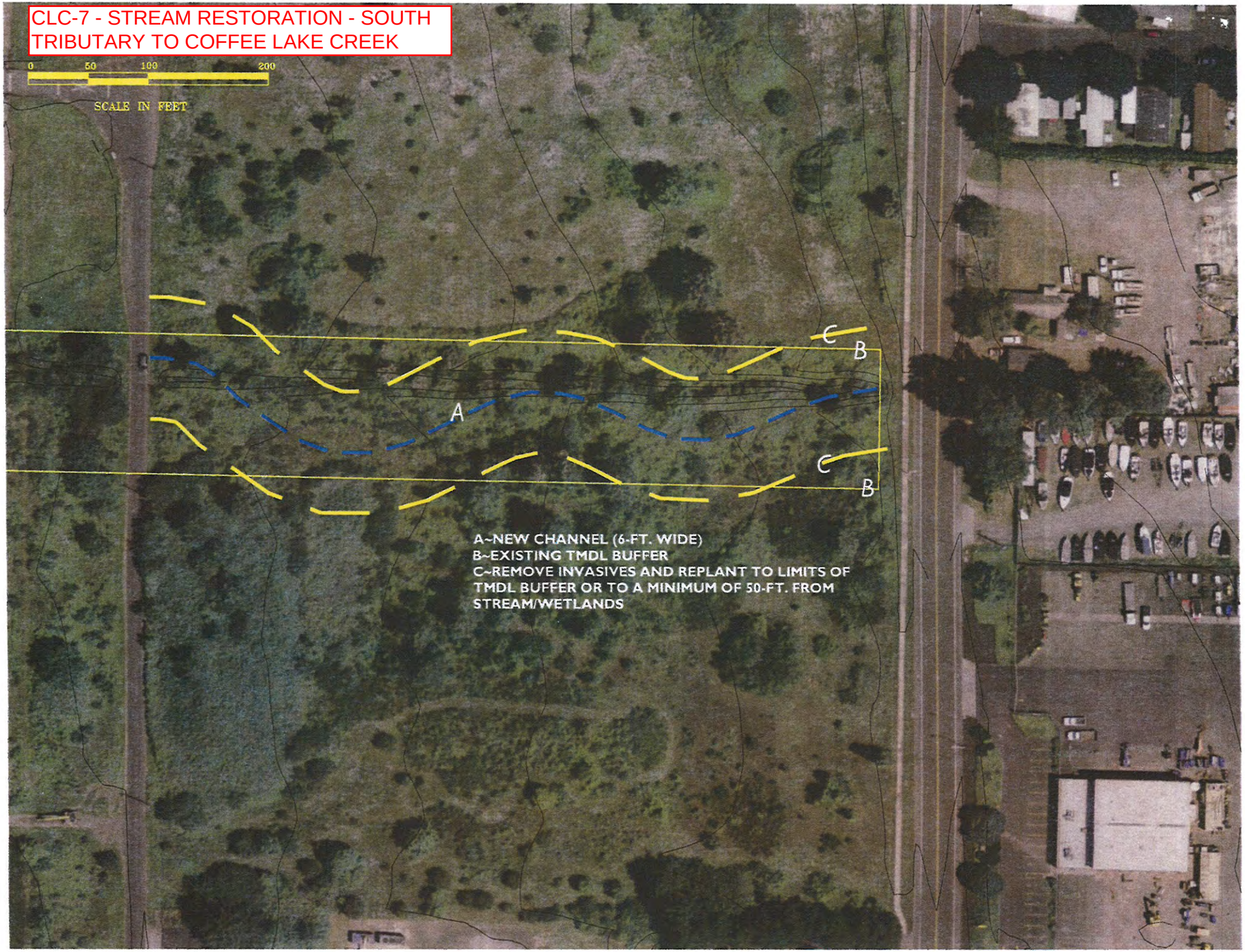
Maintenance/monitoring

- Visually inspect 2-4 times per year for buildup of sediment, trash, debris, floatables, invasive vegetation, clogged outlets, erosion or scour at outlets, and survival of new plants
- Maintain once per year (or as needed based on inspections), removing sediment and debris, invasive vegetation and replanting as needed.

Potential Constraints
Enhancement is limited to the area already within the Wilsonville Significant Resource Overlay Zone.

Flow Comparison at CLC-7:

Storm Event	Existing Condition Flow Rate (cfs)	Future Condition Flow Rate (cfs)
2-year	56.5	80.5
10-year	73.6	82.0
25-year	73.2	81.8


CLC-7 - STREAM RESTORATION - SOUTH TRIBUTARY TO COFFEE LAKE CREEK
0
50
100
200
SCALE IN FEET
A
B
C
C
B
A~NEW CHANNEL (6-FT. WIDE)
B~EXISTING TMDL BUFFER
C~REMOVE INVASIVES AND REPLANT TO LIMITS OF TMDL BUFFER OR TO A MINIMUM OF 50-FT. FROM STREAM/WETLANDS

CLC-8 – Coffee Lake Creek Restoration

Location: Coffee Lake Creek (along Industrial Way between Wilsonville Road and Ore Pac Avenue)

Project Overview

Coffee Lake Creek flows south from Wilsonville Road just east of Industrial Way. The project site is approximately 400 feet long, ending where the ditch flows under SW Ore Pac Avenue. The channel is incised, with bank elevations approximately 8 feet above the ordinary high water level. There are very few trees or shrubs of a size or density to provide shade to the stream. Invasive blackberries and reed canarygrass are found through the entire project reach. A field on the east side of the channel is slated for development. Industrial Way will become obsolete when Kinsman Road is extended within the area east and south of the channel. Most of this northern section of Industrial Way will be removed and the central portion of Coffee Lake Creek will be realigned into a new channel to the west between Wilsonville Road and the Kinsman Road extension. A 10-foot strip of Industrial Way would be retained as part of a pedestrian/bike trail beginning at Wilsonville Road and extending south. The area between the re-aligned stream channel and the trail will be excavated to create a floodplain for Coffee Lake Creek.

Looking south along Seely Ditch from Wilsonville Road

Aerial view of project area

Conceptual Plan

- Re-align the central portion of Seely Ditch to the west to add a meander and restore a more naturalistic flow path.
- Remove Himalayan blackberry, reed canarygrass, and other invasive plants.
- Create an excavated floodplain terrace between Seely Ditch and the location of the future pedestrian/bike trail to the west.

- Install site-appropriate native trees, shrubs and herbs on the newly excavated floodplain terrace to create a diverse riparian habitat area and address temperature TMDL compliance targets.

Benefits: Water quality; temperature TMDL; habitat restoration; floodplain expansion; recreation.

Maintenance/monitoring

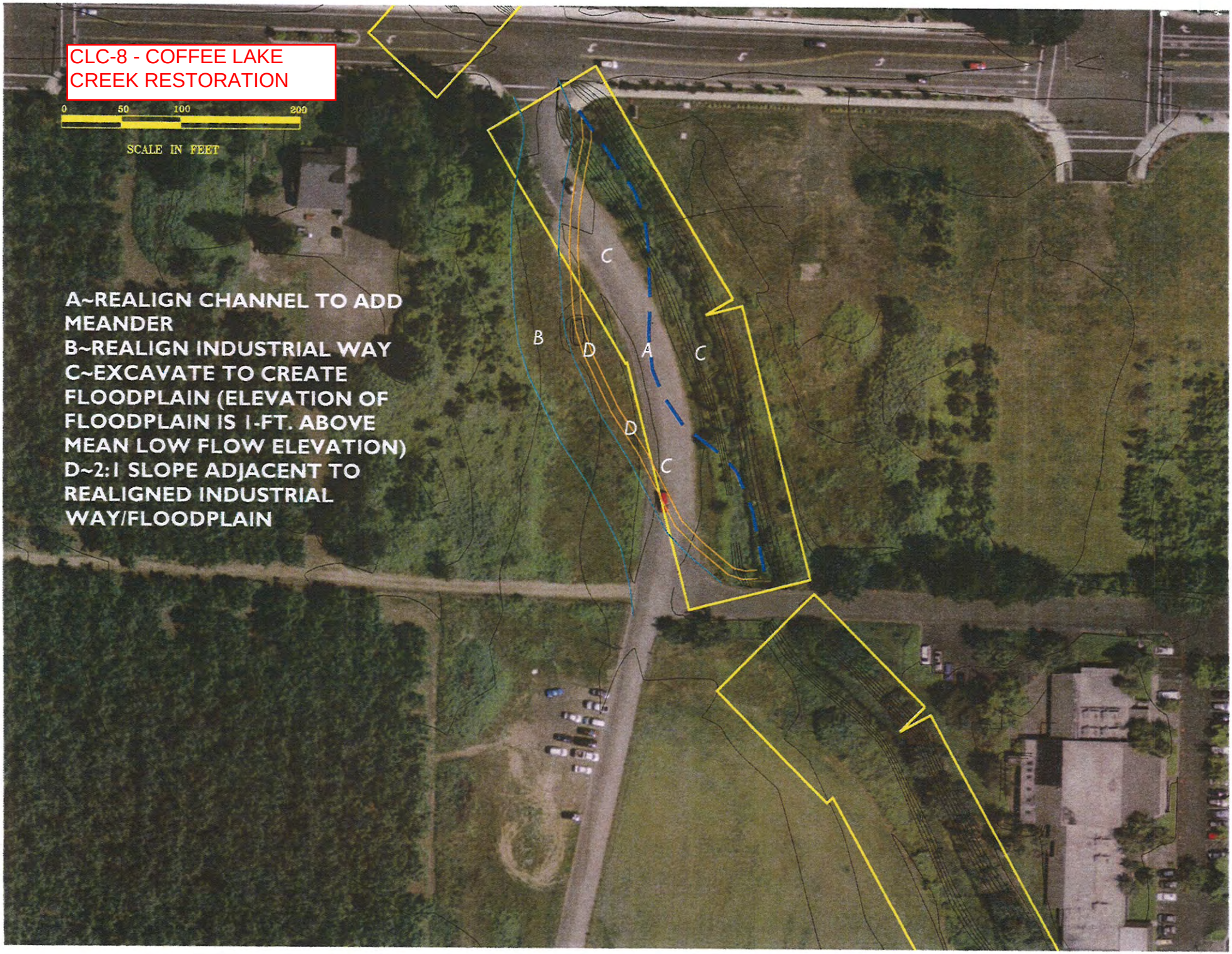
- Visually inspect 2-4 times per year for buildup of sediment, trash, debris, floatables, invasive vegetation, clogged outlets, erosion or scour at outlets, and survival of new plants
- Maintain once per year (or as needed based on inspections), removing sediment and debris, invasive vegetation and replanting as needed.

Potential Constraints

The floodplain on the west cannot be created until Industrial Way is abandoned. The area on the east side of Coffee Lake Creek is slated for development and is not available for expanding the floodplain. A portion of the project may be located under the BPA power lines.

Flow Comparison at CLC-8:

Storm Event	Existing Condition Flow Rate (cfs)	Future Condition Flow Rate (cfs)
2-year	577.1	600.4
10-year	593.0	602.9
25-year	649.4	687.2


CLC-8 - COFFEE LAKE CREEK RESTORATION
0
50
100
200
SCALE IN FEET
A~REALIGN CHANNEL TO ADD MEANDER
B~REALIGN INDUSTRIAL WAY
C~EXCAVATE TO CREATE FLOODPLAIN (ELEVATION OF FLOODPLAIN IS 1-FT. ABOVE MEAN LOW FLOW ELEVATION)
D~2:1 SLOPE ADJACENT TO REALIGNED INDUSTRIAL WAY/FLOODPLAIN
B
D
A
C
C
D
C

BC-4 – Gesellschaft Water Well Channel Restoration

Location: Boeckman Creek riparian area, south end of Cascade Loop

Project Overview

An existing drainage swale to Boeckman Creek is experiencing severe, on-going erosion. A channel has been cut into the slope for approximately 500 feet from the top of the slope to the level of the creek. A likely cause of this erosion is the weekly discharge of the Gesellschaft Water Well, which is done to keep the well water fresh as a backup for drinking water for the City. The shrink-swell character of clay soil may exacerbate the erosion. When wet, clay swells and becomes cohesive. When clay dries, it shrinks and forms open cracks, making the dry, textured soil highly erodible when subsequently subjected to flowing water.

The channel slope is too steep to hold enough moisture to contain aquatic or wetland habitat and without the weekly discharge from the well, the channel is most likely relatively stable.

The easiest solution to the erosion problem is to bypass the channel entirely by piping the weekly discharge from the well to the bottom of the slope. Other potential options include piping the well discharge into a poly tank with a flow control hole to allow a slow controlled release; and creating a small pond weir set back from the top of slope. Minimizing the pump run time (it currently runs for 30 minutes at a time) could also help reduce further erosion potential. The detention pipe proposed in Cascade Loop (project BC-3) described in the main text in Chapter 8 will also help to address the problem.

Bank erosion downstream from the Gessellschaft well

Aerial view of project location

Conceptual Plan

- Install coir log check dams at 30-40 foot intervals across the existing channel bed and woody debris to reduce the chances of additional bed erosion.
- Cover the bare soil in the bed with coir matting.
- Sow native grass seed over the coir matting.

- Plant shade-tolerant native trees and shrubs within the channel and along the banks.

Potential Constraints

The pipe outfall near the creek will need some form of energy dissipater to prevent erosion of the creek bank. This could be a bubbler and/or a boulder pad. The pipe will need to be sited to avoid disturbing the existing sanitary sewer line that runs near the creek.

The weekly well discharge is clean water but there is the possibility that the well may be treated with chlorine at some point. If the chlorinated water would ever need to be flushed from the well, an alternative discharge path may need to be used to avoid getting chlorine into the creek.

Benefits: Reduced erosion within the drainage channel; reduced sediment loading within Boeckman Creek; temperature TMDL; water quality.

Maintenance/monitoring

- Visually inspect 2-4 times per year for buildup of sediment, trash, debris, floatables, invasive vegetation, clogged outlets, erosion or scour at outlets, and survival of new plants
- Maintain once per year (or as needed based on inspections), removing sediment and debris, invasive vegetation and replanting as needed.
- Visually inspect 2-4 times per year for buildup of sediment, trash, debris, floatables, invasive vegetation, clogged outlets, erosion or scour at outlets, and survival of new plants
- Maintain once per year (or as needed based on inspections), removing sediment and debris, invasive vegetation and replanting as needed.

BC-7 – Boeckman Creek Realignment

Location: Boeckman Creek at Wilsonville Road Bridge

Project Overview

The site is a reach of Boeckman Creek and its floodplain beginning at the Wilsonville Road bridge, running beneath the bridge and crossing two sets of pile caps, and extending north (upstream) approximately 1000 feet. The site contains a mix of natural and man-made features such as off-channel ponded areas, berms created by side-cast spoils, and historic channels. The main channel is somewhat incised but it overflows regularly into its floodplain. A sewer line is located in the low, riparian area just west of the creek. Bank erosion has occurred in several locations where surface flows and drain pipes discharge into the creek's floodplain.

Currently, the channel beneath the bridge makes a westerly turn near the base of one of the concrete bridge pilings. The channel will be realigned in a location that doesn't jeopardize the stability of the pilings.

Throughout the reach, a portion of the pond will be filled and graded to become part of the regularly inundated floodplain. Berms will be removed to allow a more even spread of water onto the floodplain. Surface drainage discharge sites will be armored to reduce erosion.

Bank erosion near Wilsonville Road piling

Aerial view of project location

Conceptual Plan

Overview

To protect the bridge pilings, the channel under the bridge must be relocated or realigned. This can be accomplished in several ways. The existing channel could be straightened by excavating a new channel to move it away from the bridge pilings. The new channel would meet the existing channel approximately 100 feet south of where the channel now turns west near one of the bridge pilings. This would create approximately 100 feet of new, straight channel. Approximately 60 feet of the existing channel would be filled near the bridge piling. Approximately 150 feet of the existing, meandering channel would be

isolated. Embedded boulders can be used to armor the new channel banks to reduce the chance of having the new channel meander toward any of the bridge pilings.

An alternative design would create a new channel west of the existing channel beginning approximately 200 to 300 feet upstream of the bridge. As the new channel passes beneath the bridge, it would be centered between two sets of bridge pilings. It would join the existing channel approximately 25 feet south of the bridge. Upstream, this channel would go through the ponded area just north of the bridge and west of the existing channel.

Both design options would fill a section of the existing channel beneath the bridge where the channel is near a piling.

Project Components

- Realign or relocate the channel beneath the Wilsonville Road bridge
- Armor the south bank of the creek where the new channel meets the existing channel
- Fill a ponded area
- Remove the berms
- Armor the discharge points of the surface and the pipe drains
- Create off-channel habitat

Benefits: Bridge piling protection; erosion control; enhanced wildlife habitat; increased floodplain area; higher frequency of floodplain inundation; temperature TMDL; water quality.

Maintenance/monitoring

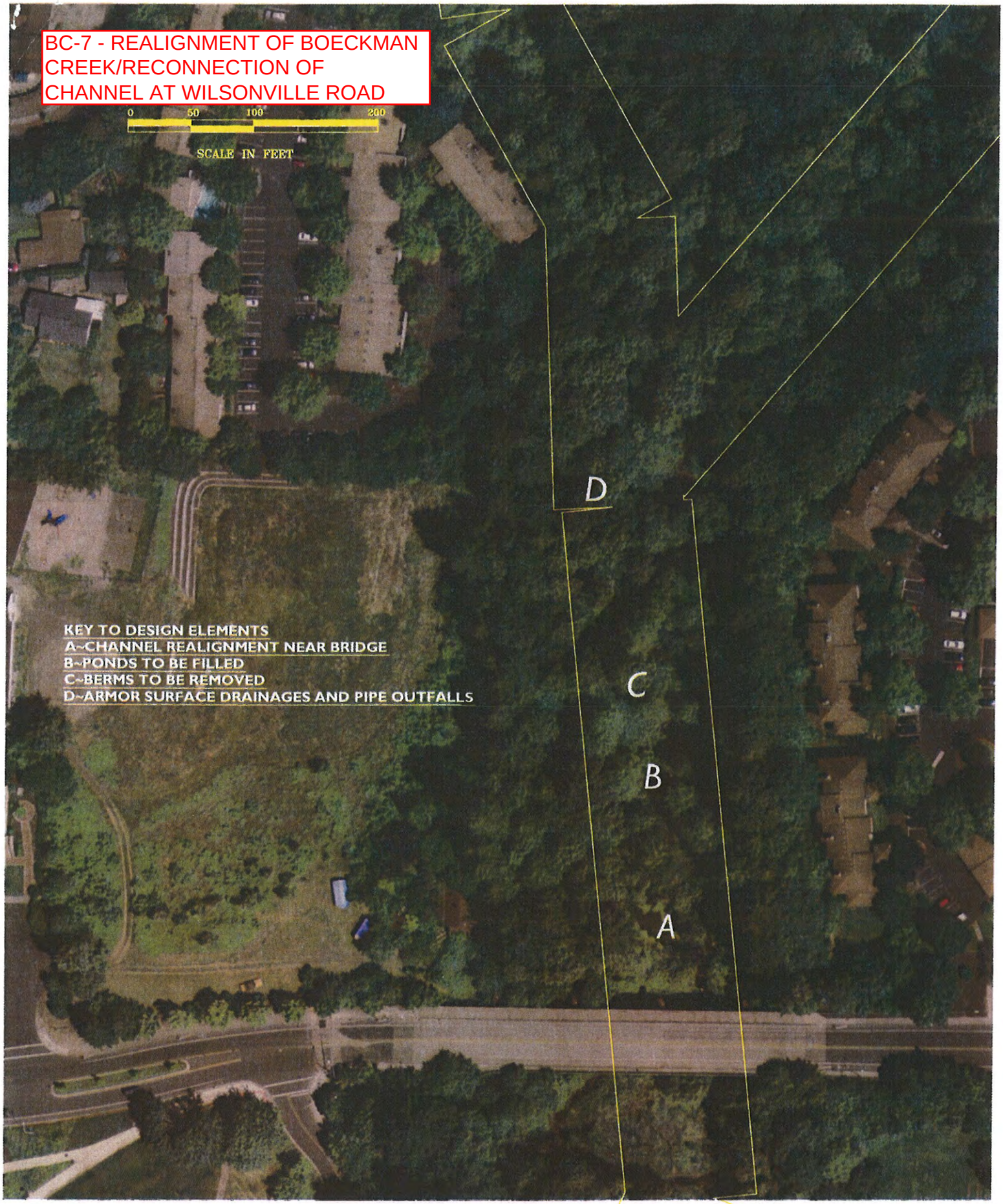
- Visually inspect main channel and high-flow channel near the Wilsonville Road bridge 2-4 times per year for channel migration, bank erosion, sedimentation or headcutting.
- Throughout, visually inspect 2-4 times per year for buildup of sediment, trash, debris, floatables, invasive vegetation, clogged outlets, erosion or scour at outlets, and survival of new plants
- Maintain once per year (or as needed based on inspections), removing sediment and debris, invasive vegetation and replanting as needed.

Potential Constraints

Protecting the pilings of the Wilsonville Road bridge will drive the design of the channel realignment and the creation of a new, high-flow channel. Regulatory permits will be needed.

Flow Comparison at BC-7:

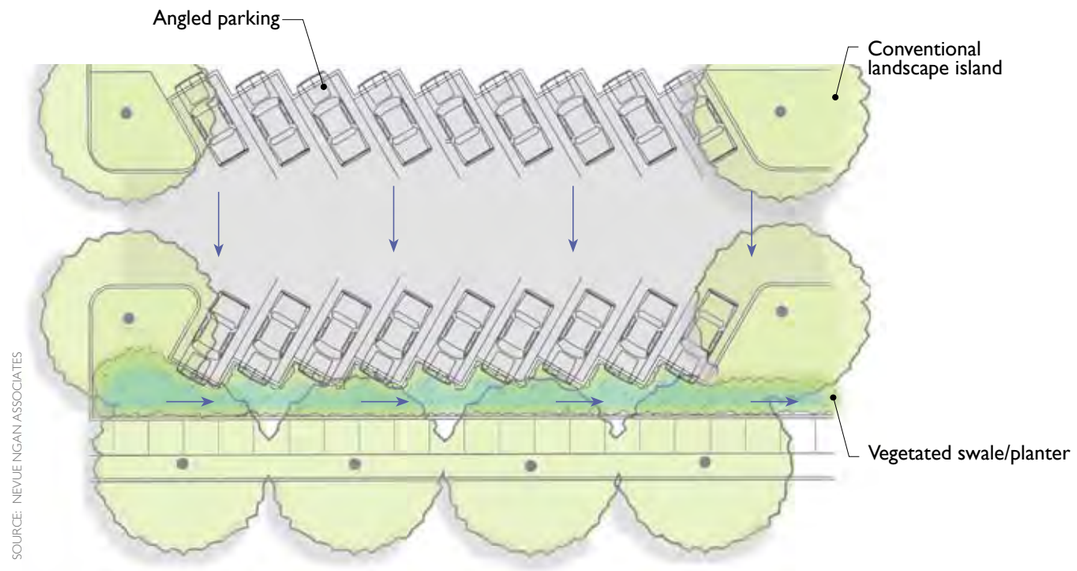
Storm Event	Existing Condition Flow Rate (cfs)	Future Condition Flow Rate (cfs)
2-year	138.5	150.4
10-year	182.9	190.9
25-year	200.6	207.6


BC-7 - REALIGNMENT OF BOECKMAN CREEK/RECONNECTION OF CHANNEL AT WILSONVILLE ROAD
0
50
100
200
SCALE IN FEET
KEY TO DESIGN ELEMENTS
A~CHANNEL REALIGNMENT NEAR BRIDGE
B~PONDS TO BE FILLED
C~BERMS TO BE REMOVED
D~ARMOR SURFACE DRAINAGES AND PIPE OUTFALLS
D
C
B
A

LID1: Memorial Park Parking Lot Vegetated Swales (3)

[nev-ū-non]
Nevue | Ngan | Associates

SOURCE: GOOGLE EARTH



SOURCE: NEVUE NGAN ASSOCIATES

Side Vegetated Swale with Angled Parking Plan View

Existing Conditions:

This is a public parking lot that currently has several oversized travel/back-up aisles as well as a general inefficient use of asphalt space.

Proposed Retrofit Opportunity:

Reduce travel/back-up aisles and tighten the efficiency of the site. The remaining space can be converted into stormwater swales. Depending on how much space is available, another design option is to convert the angled parking into 90 degree head in parking which may yield additional parking spaces along with the stormwater improvements.

Potential Constraints:

There are no constraints currently identified.

Stormwater Benefits:

Water quality, impervious area reduction, TMDL, flow reduction, volume reduction (depending on infiltration rates).

Maintenance:

Remove sediment, debris, and weedy plant species on a regular basis. Replace plant material as needed. Keep curb cuts, inlets, and overflow devices free of clogging.

Estimated Cost: $203,148 for 3 large parking lot swales.

SOURCE: NEVUE NGAN ASSOCIATES

Existing Parking Lot Conditions

SOURCE: NEVUE NGAN ASSOCIATES

Proposed Retrofit Condition Concept Sketch

LID2: SW Hillman Green Street Stormwater Curb Extensions

[nev-ū-non]
Nevue | Ngan | Associates

SOURCE: GOOGLE EARTH

Existing Conditions:

This is a relatively wide street with sporadic on-street parking use. The street currently drains towards the curbs, and stormwater is collected into the storm drain system. There is a curb tight sidewalk on the parking side of the street.

Proposed Retrofit Opportunity:

There are two options that can be considered. A series of stormwater curb extensions can be placed within the parking zone of the street to capture runoff. This option would allow some on-street parking to still exist. Another alternative would be to install stormwater curb extensions on the parking zone of the street and install continuous stormwater swale on the non-parking side of the street.

Potential Constraints:

Loss of parking and increased landscape maintenance.

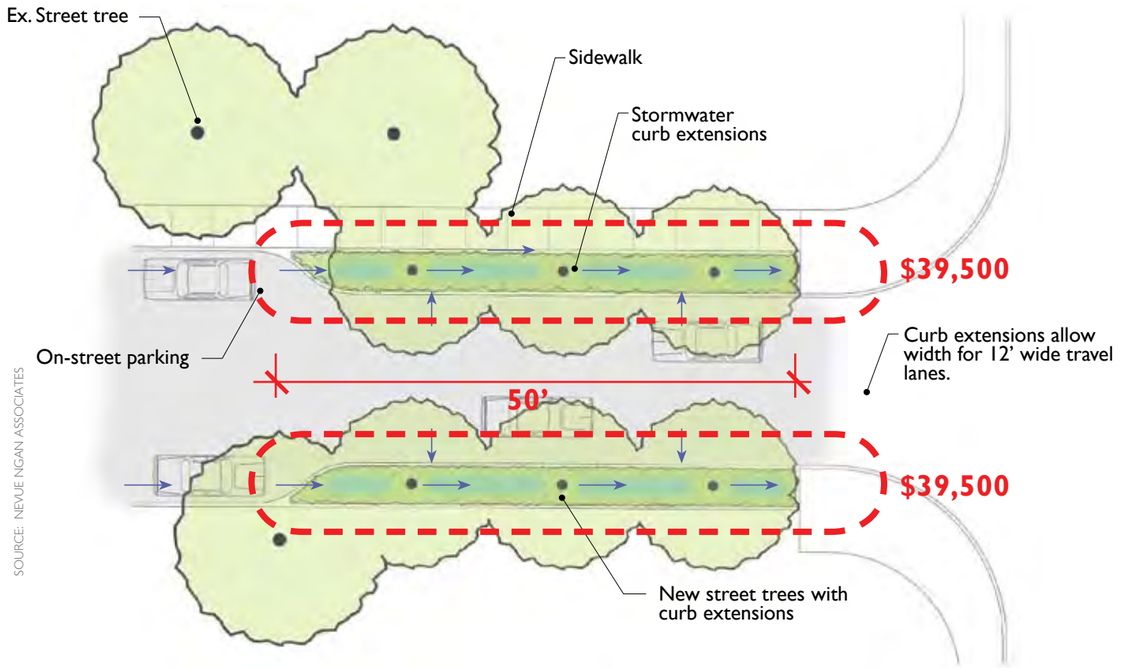
Stormwater Benefits:

Water quality, impervious area reduction, TMDL, flow reduction, volume reduction (depending on infiltration rates).

Maintenance:

Remove sediment, debris, and weedy plant species on a regular basis. Replace plant material as needed. Keep curb cuts, inlets, and overflow devices free of clogging.

Estimated Cost: $236,938 for 6 Stormwater Curb Extensions



SOURCE: NEVUE NGAN ASSOCIATES

Stormwater Curb Extensions At Intersection Plan View

SOURCE: NEVUE NGAN ASSOCIATES

Existing Street Conditions

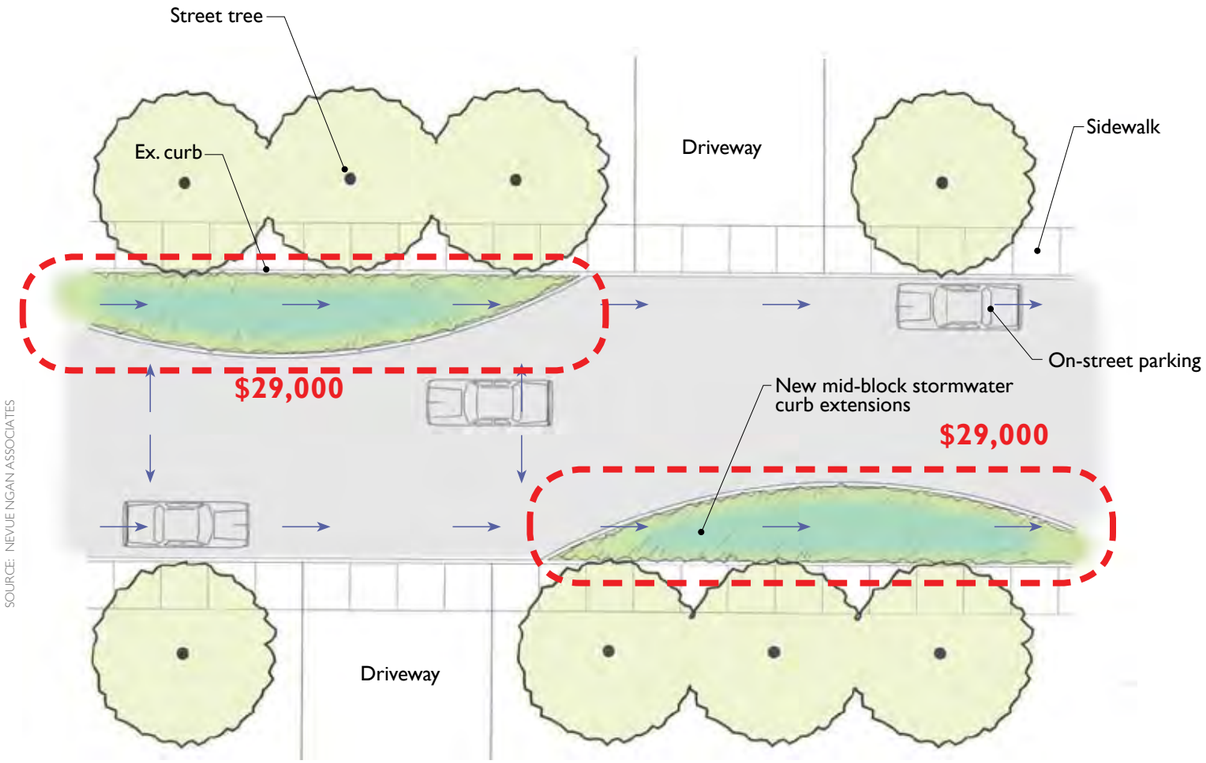
SOURCE: KEVIN ROBERT PERRY, CITY OF PORTLAND

Example: Stormwater Curb Extensions

LID3: SW Camelot Green Street Mid Block Curb Extensions (20 extensions)

[nev-ū-non]
Nevue | Ngan | Associates

SOURCE: GOOGLE EARTH



SOURCE: NEVUE NGAN ASSOCIATES

Mid-Block Stormwater Curb Extension Plan View (Asymmetrical Layout)

Existing Conditions:

This establihed neighborhood has relatively wide residential streets. The streets currently have on-street parking and curb-tight sidewalks on both sides of the street. The streets currently drain to storm drain inlets along the existing curbs of the street. Neighbors have also noted that people often speed along the streets.

Proposed Retrofit Opportunity:

Convert portions of the neighborhood streets' parking zone into stormwater curb extensions to capture stormwater runoff. These curb extensions could also be staggered along the street to help provide a traffic calming benefit.

Potential Constraints:

Loss of parking and increased landscape maintenance.

Stormwater Benefits:

Water quality, impervious area reduction, TMDL, flow reduction, volume reduction (depending on infiltration rates).

Maintenance:

Remove sediment, debris, and weedy plant species on a regular basis. Replace plant material as needed. Keep curb cuts, inlets, and overflow devices free of clogging.

Estimated Cost: $584,820 for 20 Stormwater Curb Extensions

SOURCE: NEVUE NGAN ASSOCIATES

Existing Street Conditions

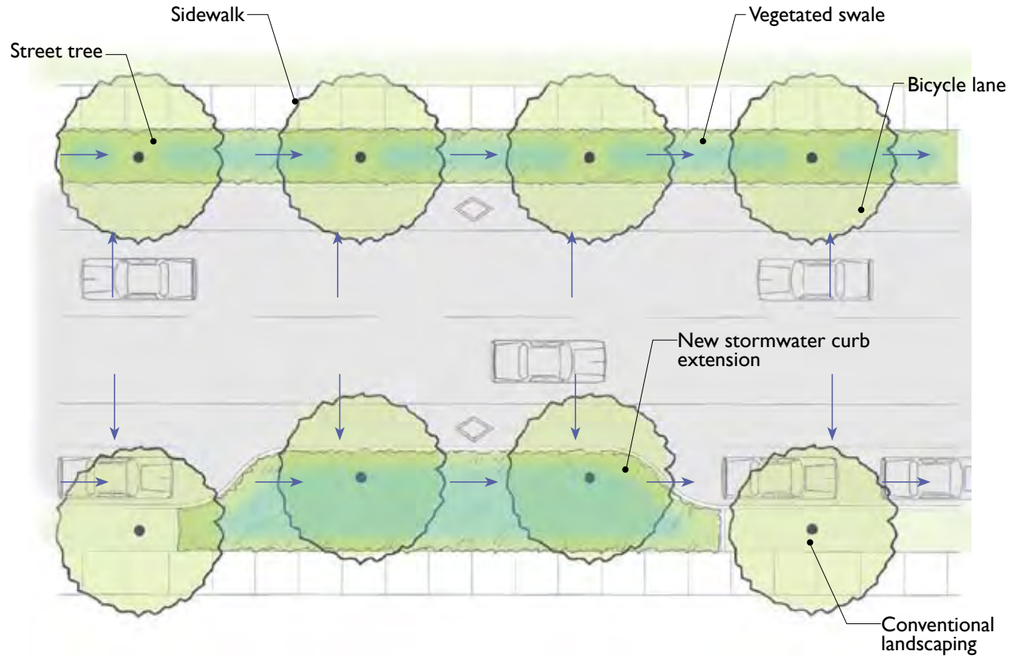
SOURCE: NEVUE NGAN ASSOCIATES

Proposed Retrofit Condition Concept Sketch

LID4: SW Costa Circle Vegetated Swale and Stormwater Curb Extension

[nev-ū-non]
Nevue | Ngan | Associates

SOURCE: GOOGLE EARTH



SOURCE: NEVUE NGAN ASSOCIATES

Vegetated Swale with Stormwater Curb Extension Plan View

Existing Conditions:

The existing 7'+ landscape strip to the south of SW Costa Circle is currently planted with lawn without any street trees. Stormwater drainage currently collected into storm drains located along the adjacent curb. The parking zone on the north side of the street is sparsely used.

Proposed Retrofit Opportunity:

On the south side, convert the lawn strip into a stormwater swale. Re-grade and re-plant the landscape strip with appropriate plant species and introduce several curb cuts to allow water to flow into the new stormwater swale. On the north side, strategically place one or more stormwater curb extensions to capture runoff.

Potential Constraints:

This is a newly built street and there may be little incentive to undertake a street retrofit. Loss of parking and increased landscape maintenance.

Stormwater Benefits:

Water quality, impervious area reduction, TMDL, flow reduction, volume reduction (depending on infiltration rates).

Maintenance:

Remove sediment, debris, and weedy plant species on a regular basis. Replace plant material as needed. Keep curb cuts, inlets, and overflow devices free of clogging.

Estimated Cost: $70,817

SOURCE: NEVUE NGAN ASSOCIATES

Existing Street Conditions

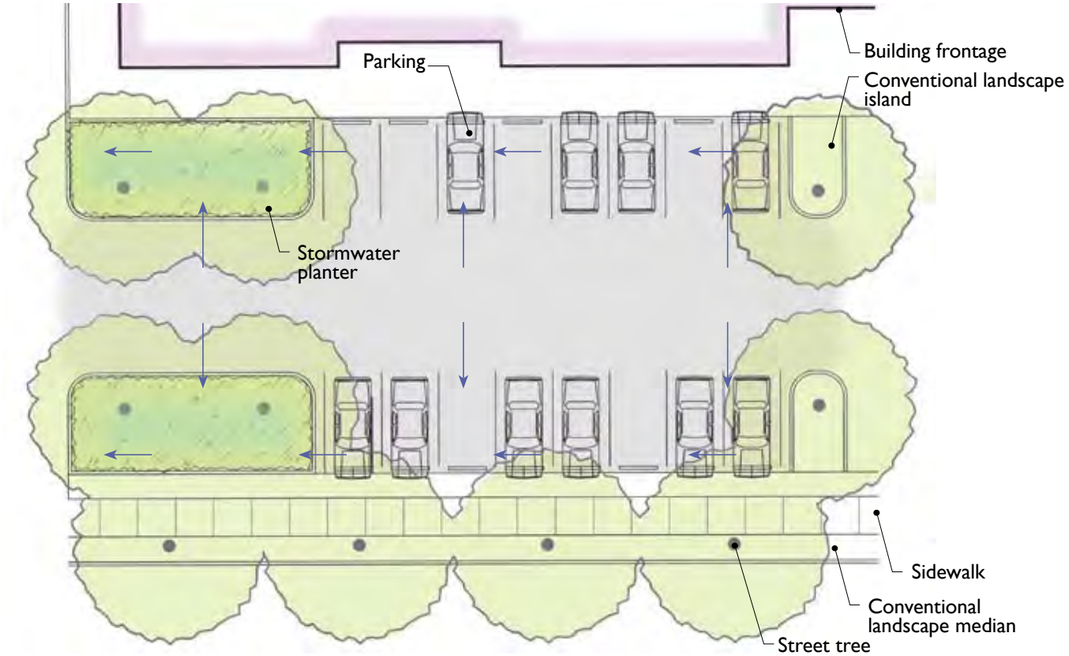
SOURCE: NEVUE NGAN ASSOCIATES

Example: Vegetated Swale

LID5: Wood Middle School Parking Lot Green Street

[nev-ū-non]
Nevue Ngan Associates

SOURCE: GOOGLE EARTH



SOURCE: NEVUE NGAN ASSOCIATES

Stormwater Planter with 90-Degree Head-In Parking Plan View

Existing Conditions:

Currently several of the parking lot's parking bays are inefficiently laid out with oversized (in length) head-in parking and travel/back-up aisles. Stormwater runoff currently drains to the center of the parking lot where it is collected into a series of storm drains.

Proposed Retrofit Opportunity:

There are multiple retrofit options available at this site. For both options the parking lot should reduce parking stall lengths to 15' long and travel aisles to 22' wide. One option is redesign the site so that new stormwater planters are placed at the low points of the parking lot. Another option is redesign the parking lot layout to include a long rain garden at the center of the parking lot.

Potential Constraints:

School District property condition is difficult to fund and assure quality of future maintenance. Need to provide for adequate pedestrian/school bus circulation and increased landscape maintenance.

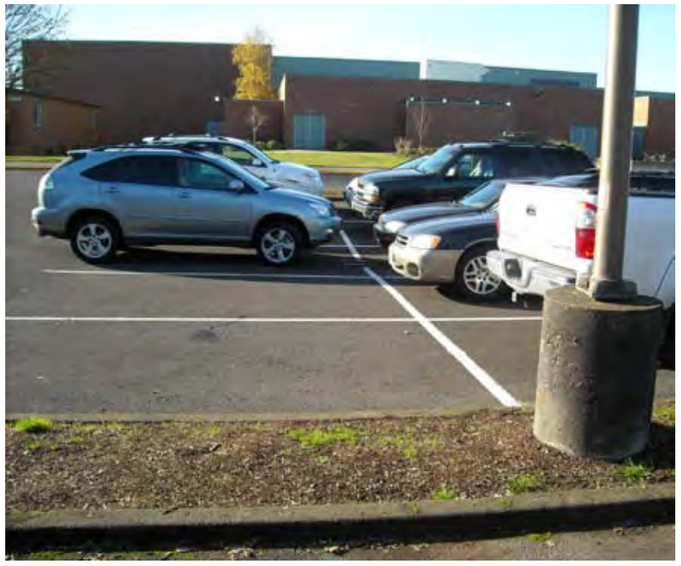
Stormwater Benefits:

Water quality, impervious area reduction, TMDL, flow reduction, volume reduction (depending on infiltration rates). Potential environmental education opportunity.

Maintenance:

Remove sediment, debris, and weedy plant species on a regular basis. Replace plant material as needed. Keep curb cuts, inlets, and overflow devices free of clogging.

Estimated Cost: $203,148



SOURCE: NEVUE NGAN ASSOCIATES

Existing Parking Lot Conditions

SOURCE: NEVUE NGAN ASSOCIATES

Example: Stormwater Planters

LID6: Boones Ferry Primary School Parking Lot Green Gutters and Pervious Paving

[nev-ū-non] Nevue Ngan Associates

SOURCE: GOOGLE EARTH

Existing Conditions:

Currently several of the parking lot's parking stalls are inefficiently laid out with oversized (in length) head-in parking. Stormwater runoff currently drains to edge of an existing landscaped area, however, the runoff is collected in storm drains along an existing curb edge.

Proposed Retrofit Opportunity:

Re-stripe some of the existing parking lot stalls so that they are 15' long. Allow the remainder of the space in the front of the parking stalls to be converted into a shallow 3'+ wide green gutter. Further stormwater management can be achieved by introducing pervious paving on the "uphill" side of the parking lot's stalls.

Potential Constraints:

School District property condition is difficult to fund and assure quality of future maintenance. Need to provide for increased landscape maintenance.

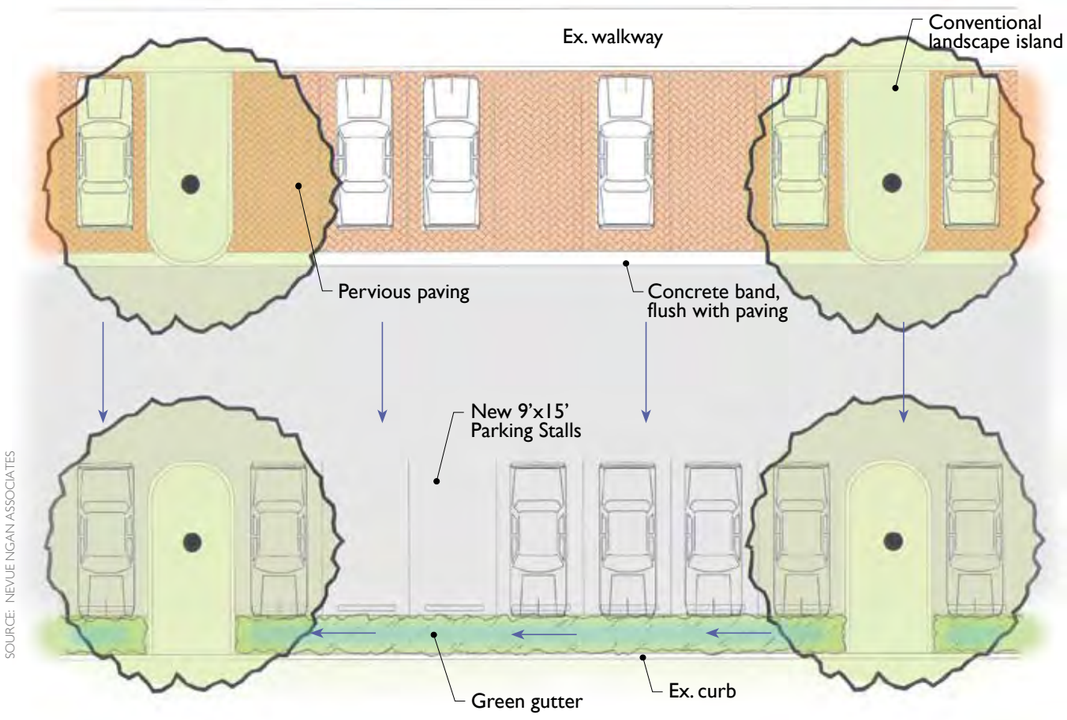
Stormwater Benefits:

Water quality, impervious area reduction, TMDL, flow reduction, volume reduction (depending on infiltration rates). Potential environmental education opportunity.

Maintenance:

Remove sediment, debris, and weedy plant species on a regular basis. Replace plant material as needed. Keep curb cuts, inlets, and overflow devices free of clogging. Vacuum sweep pervious paving on a regular basis to help minimize the potential for the paving system to clog with sediment.

Estimated Cost: $130,945



SOURCE: NEVUE NGAN ASSOCIATES

Green Gutter with Pervious Paving in Parking Zone Typical Plan View

SOURCE: NEVUE NGAN ASSOCIATES

Existing Parking Lot Conditions

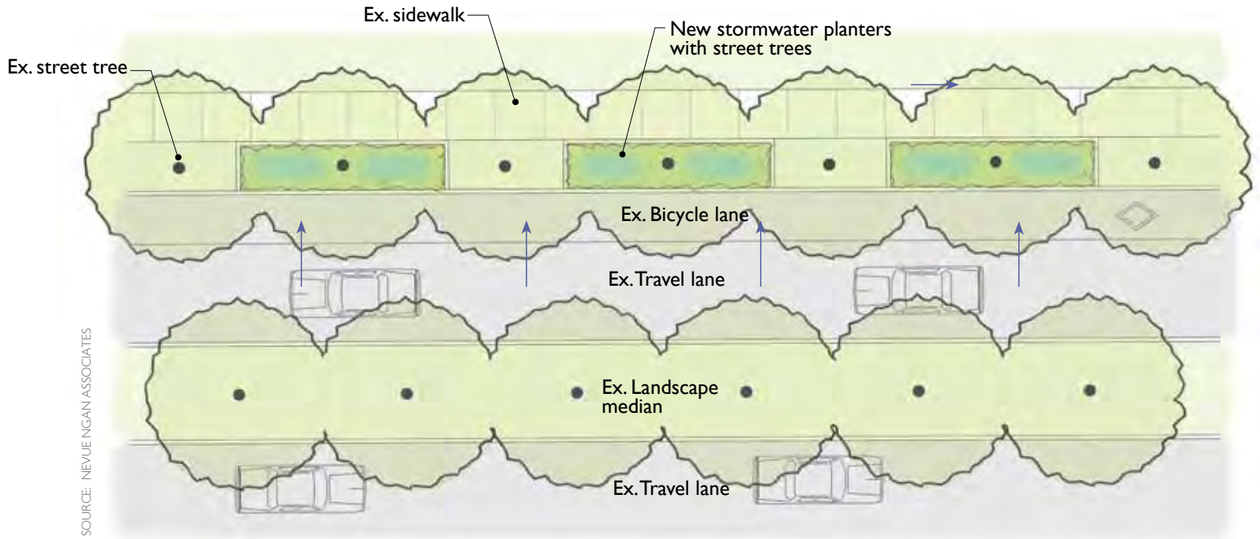
SOURCE: NEVUE NGAN ASSOCIATES

Example: A Green Gutter Within A Parking Lot

LID7: SW Wilsonville Road Stormwater Planters

[nev-ū-non]
Nevue Ngan Associates

SOURCE: GOOGLE EARTH



SOURCE: NEVUE NGAN ASSOCIATES

Stormwater Planters Plan View

Existing Conditions:

This arterial street is a two-lane road with a 6'+ wide landscape strip that separates the bike lanes and sidewalk zone. Existing street trees are placed at a regular spacing within the landscape strip. Stormwater runoff from the roadway is collected in a series of storm drains located along the street curb.

Proposed Retrofit Opportunity:

Introduce stormwater planers in-between the existing street trees to accept stormwater runoff from the roadway. Wide curb cuts would allow water to freely enter and exit the stormwater planters. The spacing and number of stormwater planters can vary depending on the overall stormwater goal.

Potential Constraints:

The root zones of existing trees will need to be protected and there may be increased landscape maintenance.

Stormwater Benefits:

Water quality, impervious area reduction, TMDL, flow reduction, volume reduction (depending on infiltration rates).

Maintenance:

Remove sediment, debris, and weedy plant species on a regular basis. Replace plant material as needed. Keep curb cuts, inlets, and overflow devices free of clogging.

Estimated Cost: $362,794 for 14 Stormwater Planters

SOURCE: NEVUE NGAN ASSOCIATES

Existing Street Conditions

SOURCE: NEVUE NGAN ASSOCIATES

Proposed Retrofit Condition Concept Sketch

APPENDIX G

MEMO ON ANALYSIS OF BARRIERS TO HABITAT-FRIENDLY DEVELOPMENT PRACTICES IN THE CITY OF WILSONVILLE

Memorandum

Date: November 24, 2008

To: Kerry Rappold, Natural Resources Program Manager, City of Wilsonville
Ela Whelan, URS

cc: File

From: Cathy Corliss

Re: Wilsonville Total Maximum Daily Load (TMDL) Implementation Plan and Stormwater Master Plan – Phase 1 Task 9 Memorandum

INTRODUCTION

Background

On September 29, 2005 the Metro Council voted to approve a regional Nature in Neighborhoods (Goal 5) program which became Title 13 of Metro's Urban Growth Management Functional Plan. Local governments are required to comply with Title 13 by January 5, 2009. An important feature of the Nature in Neighborhoods approach is the encouragement of local agencies to assess current codes for implementation barriers to land developers, builders, and property owners to incorporate habitat (nature)-friendly practices in their site design. Habitat-friendly development practices include a broad range of development techniques and activities that reduce the detrimental impact on fish and wildlife habitat relative to traditional development practices. As part of Title 13, Metro has identified a wide range of habitat-friendly development practices that represent best management practices. While the phrases are sometimes used interchangeably, for the purposes of this report low impact development (LID) practices, which are more specifically focused on minimizing hydrologic impacts, e.g., reducing effective impervious area (EIA) and improving water quality, are considered a subset of nature-friendly practices.

Key Findings

- Generally, the City of Wilsonville's development standards do not appear to present a barrier to habitat-friendly development.

- Most of the developable land in the City is subject to review as a Planned Development. This process offers considerable flexibility in terms of site design to avoid natural resource impacts. For the very few sites that wouldn't otherwise require a Planned Development, the City could consider code amendments that increase the flexibility in order to protect natural resources. However, because there are so few sites that would be affected, the benefit of these amendments would be limited.

- Additional code amendments that the City may wish to consider include:
  - Increasing the allowable distance to parking to encourage the use of shared parking facilities;
  - Reworking the definition of landscaping to encourage more green alternatives (e.g. a specified percentage of greenscape);
  - Establishing wildlife-friendly fencing criteria and standards; and,
  - Reducing the size of trees that can qualify for a landscaping tree credit.

- The City's existing Significant Resource Overlay Zone (SROZ) restricts most development from impacting locally significant natural resources. Typically, only minor encroachments have been approved, and only in cases where avoidance was not possible. Minimization of impacts and mitigation for these impacts are required for approved encroachments.

- The city has a tree protection ordinance, which protects trees greater than six inches in diameter. The tree protection ordinance compliments the SROZ by protecting individual trees and groups of trees, which provides important connectivity and habitat in the urban environment.

- The City recently adopted a "dark-sky friendly lighting ordinance" based on the International Dark Sky Association's model code.

Scope of the Memorandum

Task 9 of the Scope of Work for the Wilsonville TMDL Implementation Plan and Stormwater Master Plan project includes an evaluation of the City Development Code[1], in terms of its ability to meet the goal of having a single, clear, and concise requirement for addressing natural resources and storm water management and to encourage habitat-friendly development and LID practices as required by Metro's Title 13. This technical memorandum identifies those habitat-friendly development approaches and methods which potentially could be used within the City of Wilsonville to develop and encourage habitat friendly development practices and provides an outline of our preliminary findings regarding barriers to implementation and the potential need for conforming amendments.

The memorandum addresses the habitat-friendly development approaches and methods in three sections (A – C) as summarized below.

A. Planning and development. These habitat-friendly development approaches and methods include those that are typically associated with land use planning and development reviews such as site design, parking design and lighting design. These approaches are the primary focus of this review. Implementation of these approaches may necessitate modifications to the Planning and Land Use Development Ordinance. Some specific amendments to the City's Significant Resource Overlay Zone (SROZ)

[1] City of Wilsonville Planning and Land Development Ordinance (Wilsonville's Development Code). The Development Code Was Updated January 2007. Updated January 2008: Section 4.135 and Section 4.135.5 (of the Zoning Section) by Ordinance 631; and, Ordinance No.649, (dark-sky friendly lighting ordinance).

Ordinance that the City may wish to consider in implementing Title 13 and the TMDL Implementation Plan are included in **Appendix A**.

B. Engineering and design. These habitat-friendly development approaches and methods include those that typically require a more innovative approach to engineering and may require the adoption of new design specifications and public works standards. They may require detailed geotechnical analysis and design for on-site soil suitability and slope stability. Within public rights-of-way, how these approaches affect emergency response access, utility access, roadway structure, and road maintenance costs will require careful evaluation. Implementation of these approaches may necessitate modifications to the public works standards.

C. Building design. These habitat-friendly development approaches and methods include those that affect the building itself and may necessitate modifications to the building and/or plumbing code, for example eco-roofs. Implementation of these approaches may necessitate modifications to the building standards.

Applicability of the Habitat-Friendly Development Approaches and Methods

The recommended habitat-friendly development approaches and methods outlined in Title 13 vary in terms of their usefulness or suitability for different types of locations within the City. In general, the habitat-friendly development approaches and methods can be considered as follows.

- **Applicable (or Suitable) Adjacent to Resources.** These recommended approaches are only effective on sites within or immediately adjacent to resource areas. They are intended to convey an advantage to the developer in exchange for the use of habitat friendly development practices. They would not necessarily increase development restrictions. Use of these approaches would typically be at the option of the developer/property owner. However, the advantages should only be available to projects that provide real habitat benefits above and beyond what is otherwise required by current regulations.

- **Applicable (or Suitable) City-Wide**. These recommended approaches could be effective anywhere within the study area (including within or adjacent to habitat areas) as a mean of reducing effective impervious area (EIA) by providing tools designed to reduce environmental impacts of new development and removing barriers to their utilization.

Applicability of Habitat –Friendly Development Practices

● = Primary focus ○ = Secondary focus
NOTE: Areas within and adjacent to habitats are also included in the definition of "citywide"

Approaches and Methods	Applicable/Suitable	
	Adjacent to Resource	Citywide
Planning and development approaches		
1) Land Division Design		
o Clustering/lot size averaging, on-site density transfers	●	
2) Site Design		
o Increased flexibility for setbacks	●	
o Increased flexibility for lot coverage	●	
o Increased flexibility for building heights	●	
3) Parking Design		
o Reduced parking ratios	●	○
o Shared driveways and parking areas		●
o Flexibility in parking lot landscaping / Additional parking lot landscaping	●	
o Smaller car spaces and stall dimensions	●	○
o Increased use of pervious materials		●
4) Landscaping/Hardscape Design		
o Locating landscaping adjacent to habitat areas	●	
o Increased use of native plant	●	●
o Improved soil amendment		●
o Reduction of non-ADA sidewalks within a site	●	○
o Increased use of habitat-friendly fencing	●	
o Preservation of existing trees and maximize forest canopy	●	●
5) Lighting Design		
o Re-directed outdoor lighting, reducing light spill-off	●	
6) Density Reduction for Regionally Significant Habitat		
o Modified definition of net buildable areas	●	
o Reduced minimum buildable lot sizes	●	
Engineering and Design Approaches		
1) Street design		
o Minimize paving	●	○
o Use pervious paving materials		●
o Maximize street tree usage		●
o Use multi-functional open drainage systems / modify drainage practices		●
2) Stream crossing and street connectivity standards		
o Minimize the number of stream crossings/place crossings perpendicular	●	

Applicability of Habitat –Friendly Development Practices		
● = Primary focus ○ = Secondary focus NOTE: Areas within and adjacent to habitats are also included in the definition of "citywide"		
Approaches and Methods	**Applicable/Suitable**	
	Adjacent to Resource	**Citywide**
o Allow narrow paved widths through stream corridors	●	
o Use habitat sensitive bridge and culvert designs	●	
3) *Stormwater management facility design*		
o Use vegetated stormwater management facilities		●
o Use detention ponds		●
o Use of underground detention and/or treatment		●
Building Design Solutions		
o Encourage Green roofs (eco-roofs)		●
o Disconnect downspouts		●
o Use rain barrel or cistern system		●

A. PLANNING AND DEVELOPMENT APPROACHES

Planning and development approaches include those methods that can be implemented most easily at the time of land use approval, e.g., as part of a subdivision or development review. With the possible exception of the use of pervious materials within parking areas, these methods do not require any engineering innovations or new specifications.

1) Land Division Design: Clustering/lot size averaging, on-site density transfers

Zoning and land division ordinances can require, allow, or encourage lot size averaging at the land division stage to avoid or minimize impacts to significant riparian and other wildlife habitat areas. Lot size averaging is typically most relevant for residential land divisions, but the method could also be applicable in commercial and industrial zones that establish minimum lot sizes.

- **Section 4.118, 4.124 -4.131, 4.140 Planned Development Zones.** In Wilsonville, land division design flexibility appears to be primarily implemented through the City's Planned Development standards. As stated in Section 4.140.01 the purpose of the Planned Development Regulations is *"to permit flexibility of design in the placement and uses of buildings and open spaces, circulation facilities and off-street parking areas, and to more efficiently utilize potentials of sites characterized by special features of geography, topography, size or shape or characterized by problems of flood hazard, severe soil limitations, or other hazards."* Most of the land within the City of Wilsonville is within one of the Planned Development zones. All sites that are greater than two (2) acres in size, and designated in the Comprehensive Plan for commercial, residential, or industrial use must be developed as Planned Developments. Smaller sites may also be developed through the City's

PD procedures, provided that the location, size, lot configuration, topography, open space and natural vegetation of the site warrant such development.

The Planned Development standards allow considerable flexibility in terms of minimum lot area, lot width and frontage, and lot depth. The Planned Development zones also allow for the transfer of development densities from one portion of a proposed development site to another in order to protect significant open space or resource areas. The benefits of doing a Planned Development may be somewhat offset by the open space requirements. In addition, it is not clear how much flexibility is available to smaller lots (under two acres) and those that do not have a Planned Development designation. For example, the code language does not expressly allow flexible development standards in the case of a small site with some resource areas, where the property owner would prefer to do a partition. However, there are very few situations where these circumstances exist.

- **Section 4.139 Significant Resource Overlay Zone (SROZ) Ordinance** applies to resource areas throughout the City regardless of the base zone. As addressed in an earlier memorandum (Task 6, May 13, 2008), the SROZ includes nearly all of the lands designated as Habitat Conservation Areas in Title 13 as well as most of the draft TMDL temperature buffer. According to **Section 4.113. Standards Applying To Residential Developments In Any Zone,** protected open space must include at a minimum natural areas that are preserved under the City's SROZ regulations. While the code includes specific provisions to allow the transfer of residential density on lands which contain an SROZ, there are significant limitations. Limitations on residential density transfers are found in requirements addressing the number of dwelling units (only 50% of the maximum that are within the SROZ are allowed to be transferred to the buildable portion of the proposed development), the standards for outdoor living area, landscaping, building height and parking (all of which must still be met), and the requirement to demonstrate compatibility between adjacent properties (which leaves the application vulnerable to appeal by neighbors).

- **Sections 4.200 – 4.290 Land Division Standards** also establish lot design standards. In most cases, flexibility in these standards can be provided through the Planned Development process and by the decisions of the Development Review Board. However, there are a few instances in the code language where this flexibility is not clearly stated. For example, in the case of "through lots", **Section 4.237.07** requires a minimum average depth of one hundred (100) feet, but the code does not identify when the Development Review Board may reduce this requirement to allow for site constraints. In all cases it appears that the Development Review Board may authorize a variance from any of the land division standards (per **Section 4.270).** The criteria for the variance do not look overly onerous; however, requiring that a variance be obtained can represent a hurdle to habitat-friendly development. In addition, the waiver provisions of the Planned Development procedures of **Section 4.118** also allow flexibility from the land division standards for Planned Developments.

Finding #1: Wilsonville provides significant flexibility for land division design through its Planned Development process, and this process would be required for most development. For the limited number of other land divisions, some additional flexibility is provided through the

Land Division standards; however, Development Review Board approval and/or a variance may be required.

2) Site Design: Increased flexibility for setbacks, Increased flexibility for lot coverage, Increased flexibility for building heights

Typical of most zoning ordinance development standards, the City of Wilsonville's Development Code establishes specific setbacks, building heights, and maximum lot coverage for the various zoning districts. These standards are applied at the site plan or building permit phases of development. While these standards provide certainty within the development process, when applied too rigidly they can result in increased impacts on resource areas. Flexibility in applying standards can enable and encourage sensitive site designs and may be necessary to facilitate lot size averaging and/or on-site density transfer. In addition to avoiding development immediately within or adjacent to resource areas, sensitive site designs could take into account the preservation of mature trees, tree stands, and connectivity between habitat areas. If a site is adjacent to or near habitat areas, wildlife and migratory birds may use the site as a pathway. Whenever possible, these pathways should be preserved or enhanced to provide continued access and protection for wildlife.

In Wilsonville, these techniques are currently implemented through the following:

- **Section 4.118, 4.124 -4.131, 4.140 Planned Development Zones.** In Wilsonville, site design flexibility appears to be primarily implemented through the City's Planned Development standards. As noted above, most of the land within the City is within one of the Planned Development zones and PD's are required for sites that are greater than two (2) acres in size and designated on the Comprehensive Plan map for commercial, residential, or industrial use. Through the PD process the Development Review Board may waive height, yard, and lot coverage requirements.

- **Section 4.139 Significant Resource Overlay Zone (SROZ)** applies to resource areas throughout the City regardless of the base zone. This section of the code includes special provisions to reduce front, rear, and side yard setbacks for sites with SROZ; however, these reductions are discretionary and must be as approved by the Development Review Board.

- **Section 4.196 Variances** can provide flexibility to standards such as setbacks and maximum lot coverage. A change of up to 20 percent of one or more quantifiable provisions of yard, area, lot dimension, or parking requirements required of the base zone can be modified with a Class II - Administrative Approval procedure. All other variances require approval of the Development Review Board. In both cases, the variance process and the criteria in Section 4.196 may create a barrier to preserving habitat areas.

Finding #2: As noted in Finding #1, above, Wilsonville provides significant flexibility for land division design through its Planned Development process, and this process would be required for most development. For other types of development, some additional flexibility is provided through the SROZ standards; however, discretionary approval is required. The variance process provides some additional flexibility.

3) Parking Design

There are several methods related to parking lot design that contribute to the reduction of overall amount of impervious surface and cut down on stormwater runoff. Reducing the number of parking spaces required, allowing alternative parking spaces to count towards the minimum parking standard (such as shared parking), and minimizing the size of the parking spaces created are all techniques that reduce impervious surface. There are also a number of alternatives to conventional paving materials that can be used to reduce impervious surface area. Pervious concrete and asphalt both allow for more infiltration than traditional impervious pavement, and therefore have the effect of reducing the amount of runoff created by a parking lot. Brick, pavers, and natural stone or gravel provide similar benefits, although the amount of infiltration is not as high unless constructed with a permeable plastic grid system. These materials are not always appropriate for high use parking lots, but they can be used in combination with conventional paving materials to provide at least some benefit.

In Wilsonville, these techniques are currently implemented through the following:

- **Section 4.155 General Regulations - Parking, Loading and Bicycle Parking.** Wilsonville's Development Code does not include any specific provisions to reduce parking to minimize hydrologic impacts on downstream receiving waters and associated habitat areas. However, the City's parking requirements are not excessive and the established parking maximums are consistent with Metro standards. In addition to established parking maximums, other existing City standards also promote nature-friendly design. Shared parking between uses is encouraged in mixed-use developments (Section 4.155.02E). Smaller car spaces and stall dimensions are allowed, as long as these "compact" vehicle spaces do not exceed 40% percent of the total parking stalls required (Section 4.155.02N). The City could consider allowing more flexibility for off-site parking (e.g., shared parking structures). Currently Section 4.155.02(G) states that "the nearest portion of a parking area may be separated from the use or containing structure it serves by a distance not exceeding one hundred (100) feet." In addition, Section 4.155.02K specifically allows for the use of pervious materials such as "grasscrete" to be used in lightly-used parking areas. However, the use of pervious materials is at the discretion of the Natural Resource Director.

- **Section 4.125 V –** Village Zone allows further reductions in the off-street parking requirements for shared parking or for bicycle parking.

- **Section 4.118, 4.124 -4.131, 4.140 Planned Development Zones.** Through the PD process the Development Review Board may waive requirements for parking space configuration, minimum number of parking or loading spaces, and shade tree islands in parking lots, provided that alternative shading is provided.

- **Section 4.196 Variances** could provide additional flexibility from the parking standards. As noted previously, a change of up to 20 percent of one or more quantifiable provisions of yard, area, lot dimension, or parking requirements required of the base zone can be reviewed with the Class II - Administrative Approval procedures. All other variances require approval of the Development Review Board. In both cases, the variance process and the criteria in Section 4.196 may create a barrier to preserving habitat areas.

Finding #3: Wilsonville's code does a good job of allowing shared parking and a relatively high percentage of compact spaces. The City could consider allowing off-site parking to be further from the use in order to allow for more shared parking facilities. For example, the Model Development Code & User's Guide for Small Cities, 2nd Edition (Oregon Transportation and Growth Management Program) suggests the following language:

> ***Off-site parking. Except for single-family dwellings, the vehicle parking spaces required by this Chapter may be located on another parcel of land, provided the parcel is within [300-500] feet of the use it serves and the City has approved the off-site parking through Land Use Review. The distance from the parking area to the use shall be measured from the nearest parking space to a building entrance, following a sidewalk or other pedestrian route. The right to use the off-site parking must be evidenced by a recorded deed, lease, easement, or similar written instrument.***

In addition, Wilsonville's code specifically acknowledges the potential use of alternative paving materials, but could provide more clear and objective standards for when and how these materials will be allowed. As noted in Findings #1 and #2, Wilsonville provides significant flexibility through its Planned Development process.

4) Landscaping/Hardscape Design

Stormwater management is an ancillary benefit of landscaping requirements. Planting hardy native species can reduce the amount of pesticides and irrigation necessary to maintain landscaped areas and the use of soil amendments can improve the permeability of soils within landscaped areas. Landscaped areas can provide wildlife benefits too, even in very urban settings. Habitat-friendly development practices can be reflected in a code in terms of location of landscaping/protection of existing vegetation, encouraging the use of native plants, encouraging the use of soil amendments, reducing requirements for non-ADA sidewalks, encouraging nature-friendly fencing, and ensuring the preservation of existing trees and maximize forest canopy. Each of these six key areas is addressed below.

Location of Landscaping/Protection of Existing Vegetation: Allowing existing vegetation to serve as required landscaping can help protect habitat and allowing required landscaping to be located adjacent to habitat areas can increase the benefit these areas can have for wildlife.

- **Section 4.001.120. Definition of "Landscaping"** is very inclusive and lists a wide range of non-vegetative and impervious materials (e.g., paths, walkways, fountains, patios, decks, ornamental concrete or stonework areas, and exterior use of artificial turf or carpeting). However, as noted below, Section 4.176 requires the use of vegetative plant materials. Therefore, it would appear that non-vegetative or impervious materials could not be included in the required landscape areas. The city may wish to reword the definition of landscaping to more clearly relate to the landscape requirements of the code.

- **Section 4.176 Landscaping, Screening, and Buffering** requires that not less than fifteen percent (15%) of the total lot area be landscaped with vegetative plant materials.

However, the landscaping must be located in at least three separate and distinct areas of the lot, one of which must be in a contiguous frontage area. This requirement could preclude the use of a single existing stand of trees from serving as the required landscaping. Section 4.176.06 also establishes screening and buffering requirements. It allows the use of existing landscaping or native vegetation to meet these standards and offers a tree credit for existing trees that are in good health and are not disturbed during construction. However, the ratio for the tree credit (shown below) is somewhat low, with trees less than 19 inches in diameter not qualifying for any credit.

Existing trunk diameter	**Number of Tree Credits**
19 inches in diameter	3 tree credits
20 to 25 inches in diameter	4 tree credits
26 inches or greater	5 tree credits

- **Section 4.155.03B** specifies landscaping standards for parking lots. These standards are designed to screen and shade parking lots. Landscape tree planting areas can be aggregated which could potentially allow the use of existing natural resource areas.

- **Section 4.139.00 Significant Resource Overlay Zone (SROZ) Ordinance** provides additional protection for existing vegetation and trees within the SROZ. Unauthorized land clearing or grading of a site to alter site conditions is not allowed; however, agriculture is exempt and **Section 4.005** provides an exclusion from the requirements for a development permit for landscaping, provided that plant materials specifically prohibited by the Wilsonville Code are not installed.

Native Plants: Landscaping is required for most developments and the stated purpose of Wilsonville's landscaping standards includes the restoration of native plant communities and conservation of irrigation water through establishment, or re-establishment, of native, drought-tolerant plants and mitigation for loss of native vegetation. The code defines "native" as applied to any tree or plant, to mean indigenous to the northern Willamette Valley, but does not refer to a native plant list. As noted above, Section 4.176.06 allows the use of existing vegetation and provides for a tree credit. However, except in the case of mitigation and restoration plantings (Section 4.176.12), the use of native plants is not specifically required.

Soil Amendments: Except within the Village zone, the current code language does not specifically acknowledge the role soil amendments can play in improving the soil for greater retention and permeability, it does prohibit non-horticultural plastic sheeting or other impermeable surface from being placed under mulch. (Section 4.176.06A). At a minimum, the landscaping requirements should require the preservation and replacement of topsoil.

- **Section 4.125.18 Village Zone Development Permit Process** requires the submittal of a Rainwater Management Program including the use of compost-amended topsoil in all areas to be landscaped to help detain runoff, reduce irrigation and fertilizer needs, and create a sustainable, low-maintenance landscape.

Non-ADA Sidewalks: Metro's nature-friendly development practices that recommends eliminating redundant, non-ADA sidewalks within a site can result in a reduction of impervious surface. Public policy, which has been emphasizing pedestrian connectivity for a number of years, can be at odds with reducing the number of sidewalks. Wilsonville requires five-foot sidewalks on all streets (10-foot sidewalks on major arterials). Reducing these requirements may allow for reduction in effective impervious area if the "reserved" area is used for landscaping or other pervious uses. However, weighing the benefits of securing pedestrian access versus utilizing land in ways that potentially benefit habitat is a question of public policy.

- **Section 4.177 Street Improvement Standards** requires that all streets be developed with curbs, utility strips and sidewalks on both sides; or a sidewalk on one side and a bike path on the other side. However, within a Planned Development, the Development Review Board may approve a sidewalk on only one side. In addition, transportation standards in the Development Code allow for street design variations "approved by the Development Review Board". While not explicitly stated, circumstances such as avoiding natural features, such as a mature stand of trees, could qualify for a reduction of standards. However, the City's code does not anticipate potentially unnecessary sidewalk and walkways in industrial developments as Metro's model language does.

- **Section 4.178 Sidewalk and Pathway Standards** requires that bicycle and pedestrian paths be located to provide a reasonably direct connection between likely destinations. Sidewalks are required to be concrete and a minimum of five (5) feet in width, except where the walk is adjacent to commercial storefronts, where it must be a minimum of ten (10) feet in width. However, the code does allow the use of pervious materials under limited circumstances -- pedestrian and equestrian trails may have a gravel or sawdust surface if not intended for all weather use.

Nature-Friendly Fencing: Appropriate fencing can help guide animals toward animal crossings under, over, or around transportation corridors. However, if located inappropriately, fencing can disrupt animal travel patterns. **Sections 4.113.08, 4.125.05, and 4.176** addresses fencing and screening. The criteria and standards in these sections focus on the aesthetic and social role of fencing and do not directly acknowledge the impact of fencing on wildlife. Given this, the City may want to consider updating this section to acknowledge the importance of ensuring that fencing is designed in a nature-friendly manner[2].

Preservation of existing trees and maximize forest canopy: Trees and the canopy they provide are an important component of landscaping for water quality, quantity, and habitat. An intact tree canopy can reduce the amount of precipitation that results in runoff, thus reducing the amount of stormwater that needs to be treated. There are also habitat benefits to preserving resource areas with tree canopy and vegetative cover. Tree roots stabilize soil and reduce erosion, and the shade that trees provide acts

[2] (Potential resources: future Metro Wildlife Crossings Handbook & Corridor map; article in WDFW fall 2004 newsletter http://wdfw.wa.gov/wlm/crospath/fall2004.pdf
Napa Sustainable Winegrowing Group posting http://www.nswg.org/april05fencing.htm
Document from Jackson Hole Wildlife Foundation http://www.jhwildlife.org/pdf/createwff.pdf

as a shelter and cooling agent. Trees also purify the air, provide habitat for birds and wildlife, and add character and aesthetics to an area.

- **Section 4.171 General Regulations - Protection of Natural Features and Other Resources** requires that all developments be planned, designed, constructed and maintained with maximum regard to natural terrain features and topography, especially hillside areas, floodplains, and other significant landforms. In addition, developments are required to be planned, designed, constructed and maintained so as to avoid substantial probabilities of: (1) accelerated erosion; (2) pollution, contamination, or siltation of lakes, rivers, streams and wetlands; (3) damage to vegetation; (4) injury to wildlife and fish habitats, and to minimize the removal of trees and other native vegetation that stabilize hillsides, retain moisture, reduce erosion, siltation and nutrient runoff, and preserve the natural scenic character.

- **Chapter 4 – Sections 4.500 – 4.515 Willamette River Greenway** provides additional protection standards for the lands along the Willamette River. **Section 4.514** establishes Conditional Use Permit use management standards which include the preservation and enhancement of the vegetative fringe along the river bank and the requirement that all new development, except water dependent and water related uses, be set back a minimum of 75 feet upland from the top of bank.

- **Chapter 4 – Sections 4.600 – 4.640.20 Tree Preservation and Protection** recognizes the positive contribution trees make to water quality and water supply "by absorbing rainfall, controlling surface water run-off, and filtering and assisting in ground water recharge". A tree removal permit is required along with mitigation. The code also requires the protection of trees during construction. In the case of mitigation, the code requires that a diversity of species be maintained where essential to preserving a wooded area or habitat.

- **Section 4.001 Definitions** defines "trees" as "Any living, standing woody plant having a trunk six inches or more d.b.h. at four and one-half (4-1/2) feet above grade." The use of a six inch measurement at 4-1/2 feet above grade is common many jurisdictions in the region; although some jurisdictions, such as the City of Durham have moved to a more inclusive definition which protects smaller trees and those with multiple main stems[3].

- **Section 4.137 Solar Access For New Residential Development** establishes the standards for development within the Solar Access Overlay Zone. This overlay zone is intended to ensure that land is divided or developed so that structures can be oriented to maximize solar access and to minimize shade on adjoining properties from structures and trees. The zone is crafted to try to avoid the unintended consequence of creating a loop-

[3] City of Durham Ordinance Number 228-05. "This ordinance applies to all trees within the City, no matter where located, having a diameter of five (5) inches or greater diameter measured at 24" above grade; or, for species trees with multiple main stems (e.g. hazelnut, vine maple) the average diameter of all stems of the tree measured at a point no more than six inches above the surrounding grade or measured six (6) inches from the point where the stems digress from the trunk, whichever produces the larger measurement. If a tree has been removed and only the stump remains, diameter shall be measured as the diameter of the top of the stump."

hole which will allow a developer to clear-cut a site. There are a number of exemptions intended to protect trees, including those within the Significant Resource Overlay Zone.

Finding #4:

a) Provide additional flexibility to allow developers to substitute some of the required landscaping for existing habitat or by installing new native plantings adjacent to SROZs. Including code provisions requiring "functional" landscaping be located adjacent to habitat areas is also recommended.

b) Where the City's standards encourage the use of native plants to satisfy landscaping requirements add references to the adopted City of Portland Native Plant List (note Metro recommends the use of this list rather than the Metro list)

c) Add language to the general landscaping purpose statement that describes the role of soil amendments in retaining/infiltrating stormwater. Consider adding standards to this chapter that require the use of soil amendments to improve the permeability of soils within landscaped areas. At a minimum, the landscaping requirements should require the preservation and replacement of topsoil.

d) For sites with SROZs, Wilsonville should consider creating an exception in the pedestrian connectivity standards that allows a reduction in the width of required sidewalks and pedestrian accessway to the minimum necessary to comply with the Americans with Disabilities Act. To reduce unnecessary sidewalks within a site, pedestrian access and circulation standards could be modified to specify that non-ADA sidewalks within a site (e.g., sidewalks to non-primary or non-public entrances, or truck loading areas in industrial sites) are not required, especially for short streets that only access a small number of homes or expect a small number of walking trips.

e) Consider updating fencing criteria and standards to acknowledge the importance of ensuring that fencing is designed in a nature-friendly manner to ensure wildlife passage or to guide wildlife to corridors and away from roads.

5) Lighting Design: Re-directed outdoor lighting, reducing light spill-off

Outdoor lighting can have a deleterious effect on natural systems (flora and fauna and their associated life cycles and biological/behavioral activities) when it is not designed, installed, or managed properly. Some of the biological and behavioral activities of plants, animals (including birds and amphibians), insects, and microorganisms are either adversely affected by light or can only function effectively in darkness. Such activities include foraging, breeding, and social behavior in higher animals, amphibians and insects, all of which are affected in various ways when artificial light is introduced into their environment.

Artificial light at night can disrupt hunting, migrating, and reproductive patterns of invertebrates, mammals, and birds. Lighting used along river corridors, near woodland edges and near hedgerows can be particularly harmful to animals that hunt and live in these habitats. There is also evidence that

trees and plants can be impacted by lighting because of their sensitivity to day length and seasonality. Prolonged artificial light can alter their flowering and dormancy cycles.

In Wilsonville, lighting requirements are currently implemented through the following:

- **Ordinance 649** is the city's recently adopted a "dark-sky friendly lighting ordinance". Wilsonville is the first city in Oregon to have a modern lighting code under the International Dark Sky Association's model code. The lighting ordinance went into effect July 1, 2008 and has five lighting zones that regulate the amount of light depending on location. This Ordinance helps prevent most light pollution by limiting the wattage of lighting that can be used, by requiring most lighting to be shielded, and requiring lighting to be located thoughtfully with respect to mounting height, setback, and in some critical cases, additional shielding. The Ordinance specifically notes the impacts to circadian rhythms, when lighting causes unwanted changes in the circadian cycles of living organisms and other impacts to flora and fauna, particularly those causing changes in habitat or behavior.

- **Section 4.138.12 Old Town (O) Overlay Zone – Lighting** establishes minimum and maximum lighting level for commercial, industrial, or multi-family residential building entrances. The code states that "in no case is lighting to produce glare on neighboring properties or public rights of-way such that a nuisance or safety hazard results."

- **Section 4.155.02(L) General Regulations - Parking, Loading and Bicycle Parking** also addresses the impact of light off-site and requires that it be "so limited or deflected as not to shine into adjoining structures or into the eyes of passers-by".

- **Section 4.184.07(H) Conditional Use Permits – Service Stations** – Lighting requirements are similar to the above provisions. This section requires that "all outside lighting shall be so arranged and shielded so as not to shine into adjacent residential areas and to prevent any undue glare or reflection and any nuisance, inconvenience, and hazardous interference of any kind on adjoining streets or property.

Finding #5: In adopting the new dark-sky friendly lighting ordinance, the City has taken an important step in addressing the need for habitat-friendly lighting.

6) Density Reduction for Regionally Significant Habitat

Objectives to preserve regionally significant riparian and other wildlife habitat areas within the urban area may conflict with objectives to achieve minimum densities and avoid expansion of the Urban Growth Boundary (UGB). Minimum density requirements, along with other factors such as escalating land prices and development costs, have had an impact on shrinking residential lot sizes. Minimum density requirements may have also resulted in pressures and impacts on significant riparian and habitat areas inside the UGB. The impact of this issue may increase as many of the remaining developable areas within the UGB have constraints, and it can be a challenge to fit the required number of dwellings on these sites in a manner that is nature-friendly.

Metro's Functional Plan (Section 3.07.140) states that "a city or county shall not approve a subdivision or development application that will result in a density below the minimum density for the zoning district." The potential impact of this requirement is off-set by the fact that the Functional Plan (Section 3.07.1010) definition of a "net acre" excludes "... environmentally constrained areas, including any ... natural resource areas protected under statewide planning Goal 5 in the comprehensive plans of cities and counties in the region.... These excluded areas do not include lands for which the local zoning code provides a density bonus or other mechanism which allows the transfer of the allowable density or use to another area or to development elsewhere on the same site..." Similarly, most local ordinances already allow developers to subtract sensitive areas such as floodplains, Title 3 buffers, and steep slopes from gross acres before calculating required minimum densities.

Many local ordinances offer density bonuses to encourage protection of significant resource areas and to avoid regulatory takings, in some circumstances, however, a waiver from minimum density requirements may be just as attractive to the development community and could facilitate greater protection of resource areas. Minimum density requirements are most commonly an issue for residential development. However, minimum floor area requirements also apply to non-residential development in regional centers, town centers, and station areas. Expectations for minimum floor area ratios and more intensive mixed use development in these areas may be difficult to balance with resource protection and reductions in effective impervious area.

The Development Code does not define "net acre". The minimum and maximum densities established for each zone appear to be based on the gross site area; although, the transfer of density from the SROZ is optional. Considerable flexibility is provided in the Planned Development process. For example the Board can waive the minimum lot size; however, the code states that the Board will not waive the minimum density standards of residential zones unless there is substantial evidence in the whole record to support a finding that the intent and purpose of the standards will be met in alternative ways.

Finding #6: The density transfer provisions of Section 4.139.02 address the maximum density for residential development. However, the City should consider to clarifying that the area within an SROZ is not calculated as part of the minimum density requirement.

B. ENGINEERING AND DESIGN APPROACHES

The engineering and design approaches described in this section typically require a more innovative approach to engineering and may require the adoption of new design specifications and public works standards. Amendments to transportation system plans may also be needed.

As described below, specific nature-friendly methods and approaches can be applied to street design, stream crossings and stormwater facility design. The Development Code was reviewed to assess if such methods or standards are currently practiced in the city.

1) Street Design: Minimize paving, Use pervious paving materials, Maximize street tree usage, Use multi-functional open drainage systems / modify drainage practices

Nature-friendly methods related to street design include minimizing paving (reducing street width, length, cul-de-sac radii, using vegetated islands in center), using pervious paving materials, maximizing street tree coverage, using multi-functional open drainage systems in lieu of more conventional curb-and-gutter systems, modifying drainage practices (e.g., allowing sidewalks to drain into yards or adjoining landscape areas rather than to the street system). The Practice of Low Impact Development (published by the Partnership for Advancing Technology in Housing in July 2003) notes that besides rooftops and driveways, residential streets account for an enormous share of a community's impervious surfaces. Street designs that minimize the amount of paved area by reducing street width, cul-de-sac radii or length, can result in an overall reduction of effective impervious area provided the area saved is not made impervious by development.

Standards found in the City of Wilsonville's Transportation Systems Plan (TSP) dictate city street design (cross-section). However, the Development Code includes additional standards for street design.

- **Section 4.177 Street Improvement Standards** requires that all streets shall be developed with curbs, utility strips and sidewalks on both sides; or a sidewalk on one side and a bike path on the other side and specifies the dimensions and materials for sidewalks. The code does not include exceptions or situational modifications to the existing standards that would allow for multi-function open drainage systems (including curbless streets or streets with curb cuts draining to bioswale, rain garden, or other vegetated drainageway) or for a reduction in sidewalk width.

Finding #7: Consider amending the Development Code to include exceptions or situational modifications to the existing standards that would allow for multi-function open drainage systems (including curbless streets or streets with curb cuts draining to bioswale, rain garden, or other vegetated drainageway). Also, consider allowing for the reduction in sidewalk width especially to incorporate bioswale or other vegetative drainageway to avoid impacts to natural resource areas and allow grading to front yard or retention area.

2) Stream Crossing and Street Connectivity Standards*: *Minimize the number of stream crossings/place crossings perpendicular, Allow narrow paved widths through stream corridors, Use habitat sensitive bridge and culvert designs

Nature-friendly development methods include minimizing the number of stream crossings and placing crossings perpendicular to the stream channel, allowing narrow street right-of-ways through stream corridors, and using habitat sensitive bridge and culvert designs. Stream crossings can have a significant impact on in-stream water flow as well impacts on the adjacent riparian area They can also impede the travel patterns of fish and wildlife. Typically, bridges have fewer in-stream impacts than culverts. Stream crossing can also affect other wildlife by interrupting a pathway. When the crossing interrupts a terrestrial pathway, properly located fencing and natural landscaping can help guide animals around or through these areas. The Development Code does not include specific stream

crossing standards or bridge and culvert designs; however, there are elements which do affect stream crossings.

- **Section 4.124.06 Standards Applying To All Planned Development Residential Zones -** Block and access standards establish maximum block perimeter and spacing standards for new streets. While the code recognizes that SROZ or other barriers could preclude the maximum spacing standard from being met, similar language is not provided for the block perimeter standard. In addition, approval by the Development Review Board is necessary for a modification.

- **Section 4.139.04 Uses and Activities Exempt from These Regulations** exempts the construction of new roads, pedestrian or bike paths into the SROZ in order to provide access to the sensitive area or across the sensitive area, provided the location of the crossing is consistent with the intent of the Wilsonville Comprehensive Plan and the roads and paths are constructed so as to minimize and repair disturbance to existing vegetation and slope stability.

Finding #8: Consider amending 4.126.06 to ensure that it's clear that block perimeter standards can be adjusted as well as block spacing standards.

3) Stormwater Management Facility Design: Use vegetated stormwater management facilities, manage stormwater close to the source to minimize the use of detention ponds, infiltrate stormwater on site when feasible

Stormwater has been found to be a key factor in stream health and the management of stormwater quality and quantity influences the ability of a stream to absorb changes in water quality and hydrology. According to *The Practice of Low Impact Development*, in addition to protecting the environment, when correctly planned for and accommodated, stormwater management systems can satisfy regulatory requirements, act as desirable site design elements, and reduce infrastructure costs. Stormwater management methods that can have a positive impact on habitat include using vegetated stormwater management facilities, such as bioretention cells or rain gardens; detention ponds, underground detention, and detention criteria specific to the local stream needs; and water quality swales and constructed wetlands.. The goal of this approach is to mimic the hydrology on the site under natural conditions.

- **Section 4.001 Definitions** defines a "Rainwater Management Program" as the "Infrastructure and procedures for the collection, filtration, and conveyance of rainwater"

- **Section 4.125.18 Village Zone Development Permit Process** requires the submittal of a Rainwater Management Program. This innovative approach requires developers to address opportunities to integrate water quality, detention, and infiltration into the SAP's natural features and proposed development areas as well as mitigating the impacts of the impervious area

- **Section 4.155.03 Minimum and Maximum Off-Street Parking Requirements** requires that the landscape buffer shall integrate parking lot storm water treatment in bioswales

and related plantings. Use of berms or drainage swales are allowed provided that planting areas with lower grade are constructed so that they are protected from vehicle maneuvers, where topography and slope condition permit. This standard does a good job of requiring the use of bioswales within parking lots.

Finding #9: The City could consider expanding the use of its innovative Rainwater Management Program approach to other zones.

C. Building Design Solutions

Incorporating certain elements into the design of new buildings and retrofitting existing buildings can minimize the amount of stormwater runoff leaving a property or site. Elements that can be incorporated into building and landscaping designs that reduce or detain runoff include green roofs, disconnecting downspouts, and rain barrel detention. The nature-friendly approaches described below are most appropriately included in a municipality's building code. A review of Wilsonville's building code was not undertaken for this audit.

1) Green Roofs

Green roofs, also known as *vegetated roof covers* or *eco-roofs*, are thin layers of living vegetation installed on top of conventional flat or sloping roofs. Potential benefits associated with green roofs include controlling storm water runoff, improving water quality, mitigating urban heat-island effects, and creating wildlife habitat.

2) Disconnected Downspouts

Disconnecting downspouts from the stormwater system is another tool some jurisdictions use to help manage stormwater runoff. Reducing the volume of runoff being diverted directly into municipal storm systems is of primary importance to those jurisdictions with a combined sewer/stormwater system. Disconnecting downspouts from this system reduces pressure on combination sewer system and helps prevent overflows into streams and rivers. However, because the City of Wilsonville does not have a combined sewer/stormwater system and because soils within the City are generally not suitable, this approach may have limited value in Wilsonville.

3) Rain Barrel or Cistern Systems

This type of rainwater collection system stores rooftop runoff to be used later for activities such as lawn and garden watering, car washing, and window cleaning. A cistern functions similarly to a rain barrel, but has a much greater storage capacity and, in addition to rainwater collection, can be used to filter the water for a wider range of domestic uses. Over the rainy season, even a small roof has the potential to capture enormous amounts of water that otherwise flows down the drain. For example, a typical residence in Portland (36 inches of rain per year) with a 2,000 square foot roof collection area will result in around 35,000 gallons of water captured per year, an average of almost 100 gallons per day.

APPENDIX A. POTENTIAL UPDATES TO THE SROZ

As described in our previous memorandum, the SROZ includes nearly all of the lands designated as Habitat Conservation Areas in Title 13, as well as most of the draft TMDL temperature buffer. However, the text of Section 4.139.00 Significant Resource Overlay Zone (SROZ) Ordinance may need to be updated to reflect both Title 13 and the TMDL temperature buffers. Below are some key sections from the SROZ (shown in *italics*). Some preliminary suggestions of how the City might update the language in these sections are shown in double underline.

EXCERPTS FROM THE SIGNIFICANT RESOURCE OVERLAY ZONE
(proposed new text is in double-underline)

Section 4.139.00 Definitions:

1. Area of Limited Conflicting Uses: An Area of Limited Conflicting Uses is either:

A. An area located between the riparian corridor boundary, riparian impact area, TMDL temperature buffer or the Urban Growth Management Functional Plan (UGMFP) Metro Title 3 Water Quality Resource Area boundary, whichever is furthest away from the wetland or stream, and the outside edge of the SROZ; or

B. An isolated significant wildlife habitat (upland forest) resource site.

8. Significant Resource Overlay Zone (SROZ): The delineated outer boundary of a significant natural resource that includes: a significant Goal 5 natural resource, lands protected under Metro's Urban Growth Management Functional Plan Title 3 (Water Quality Resource Areas), TMDL temperature buffers, riparian corridors, and significant wildlife habitat.

Section 4.139.01 SROZ - Purpose

The Significant Resource Overlay Zone (SROZ) is intended to be used with any underlying base zone as shown on the City of Wilsonville Zoning Map. The purpose of the Significant Resource Overlay Zone is to implement the goals and policies of the Comprehensive Plan relating to natural resources, open space, environment, flood hazard, water quality, and the Willamette River Greenway as well as the recommendations of the TMDL Implementation Plan. In addition, the purposes of these regulations are to achieve compliance with the requirements of the Metro Urban Growth Management Functional Plan (UGMFP) relating to Title 3 Water Quality Resource Areas and Title 13 Habitat Conservation Areas, and that portion of Statewide Planning Goal 5 relating to significant natural resources. It is not the intent of this ordinance to prevent development where the impacts to significant resources can be minimized or mitigated.

Section 4.139.02 Where These Regulations Apply

…The SROZ represents the area within the outer boundary of all inventoried significant natural resources. The Significant Resource Overlay Zone includes all land identified and protected under Metro's UGMFP Title 3 Water Quality Resource Areas and Title 13 Habitat Conservation Areas, as currently configured, significant wetlands, riparian corridors, and significant wildlife habitat that is inventoried and mapped on the Wilsonville Significant Resource Overlay Zone Map, and the TMDL temperature buffers recommended by the TMDL Implementation Plan.

Section 4.139.03 Administration

(.01) Resources. The text provisions of this section shall be used to determine whether applications may be approved within the Significant Resource Overlay Zone. The following maps and documents may be used as references for identifying areas subject to the requirements of this Section:

A. Metro's UGMFP Title 3 Water Quality Resource Area maps.

B. The Federal Emergency Management Agency (FEMA) Flood Insurance Rate Maps (FIRM)

C. The Wilsonville Local Wetland Inventory (LWI) (1998)

D. The Wilsonville Riparian Corridor Inventory (RCI) (1998)

E. Locally adopted studies or maps

F. City of Wilsonville slope analysis maps

G. Clackamas and Washington County soils surveys

H. Metro's UGMFP Title 13 Habitat Conservation Area maps

I. The Wilsonville TMDL Implementation Plan

APPENDIX H

SUMMARY COST SHEETS

SUMMARY COST SHEETS:

Short-Term Projects

CIP WD-3 Rivergreen Project Repair				
Item	**Quantity**	**Unit**	**Unit Cost**	**Total Cost**
Mob/Traffic Control/Erosion Control (20%)	1	LS	$41,500	$41,500
Restoration/Enhancement	1	LS	$208,000	$208,000
Construction Subtotal, 2009				$250,000
Construction Contingencies (30%)				
Monitoring and Maintenance				
Design, Legal (min.)				
Right-of-Way				$0
Subtotal				$250,000
12% Engineering Overhead			12%	$30,000
2% Admin Overhead			2%	$5,000
Total Project Cost Estimate				**$285,000**

CIP BC-7 - Boeckman Creek Realignment				
Item	**Quantity**	**Unit**	**Unit Cost**	**Total Cost**
Mob/Traffic Control/Erosion Control (20%)	1	LS	$54,600	$54,600
Earthwork	1	LS	$30,490	$30,490
Restoration/Enhancement	1	LS	$42,510	$42,510
Stabilization of Footings	1	LS	$200,000	$200,000
Construction Subtotal, 2009				$327,600
Construction Contingencies (30%)				$98,280
Monitoring & Maintenance				$15,000
Design, Legal (20%)				$65,520
Right-of-Way				$0
Subtotal				$506,400
12% Engineering Overhead			12%	$60,768
2% Admin Overhead			2%	$10,128
Total Project Cost Estimate				**$577,296**

CIP BC-4 - Gesellschaft Water Well Channel Restoration				
Item	**Quantity**	**Unit**	**Unit Cost**	**Total Cost**
Mob/Traffic Control/Erosion Control (20%)	1	LS	$12,000	$12,000
Restoration/Enhancement	1	LS	$45,000	$45,000
Construction Subtotal, 2009				$57,000
Construction Contingencies (30%)				$17,100
Monitoring and Maintenance				$15,000
Design, Legal (min.)				$30,000
Right-of-Way				$0
Subtotal				$119,100
12% Engineering Overhead			12%	$14,292
2% Admin Overhead			2%	$2,382
Total Project Cost Estimate				**$135,774**

CIP LID1 - Memorial Park Parking Lot Vegetated Swales (3)				
Item	**Quantity**	**Unit**	**Unit Cost**	**Total Cost**
Mob/Traffic Control/Erosion Control (20%)	1	LS	$19,000	$19,000
Site Demo (Remove existing hardscape, excavate subgrade/soil)	1	LS	$20,000	$20,000
Site Grading (Soil prep, soil import, fine grading)	1	LS	$25,000	$25,000
Hardscape Installation (concrete curbs cuts, curbing, check dams)	1	LS	$20,000	$20,000
Landscape Installation (planting and mulch material)	1	LS	$30,000	$30,000
Construction Subtotal, 2009				$114,000
Construction Contingencies (30%)				$34,200
Design, Legal (min.)				$30,000
Right-of-Way				$0
Subtotal				$178,200
12% Engineering Overhead			12%	$21,384
2% Admin Overhead			2%	$3,564
Total Project Cost Estimate				**$203,148**

CIP BC-8 - Colvin Lane in Canyon Creek Estates Pipe Removal				
Item	**Quantity**	**Unit**	**Unit Cost**	**Total Cost**
Mob/Traffic Control/Erosion Control (20%)	1	LS	$12,000	$12,000
Pipe Removal	1	LS	$10,000	$10,000
Restoration/Enhancement	1	LS	$50,000	$50,000
Construction Subtotal, 2009				$72,000
Construction Contingencies (30%)				$21,600
Design, Legal (min.)				$20,000
Right-of-Way				$0
Subtotal				$113,600
12% Engineering Overhead			12%	$13,632
2% Admin Overhead			2%	$2,272
Total Project Cost Estimate				**$129,504**

CIP SD4208 - SD4209 Barber Street Pipe Replacement				
Item	**Quantity**	**Unit**	**Unit Cost**	**Total Cost**
Mob/Traffic Control/Erosion Control (20%)	1	LS	$20,130	$20,130
42-inch diameter pipe	275	LF	$366	$100,650
Construction Subtotal, 2009				$120,780
Construction Contingencies (30%)				$36,234
Design, Legal (min.)				$30,000
Right-of-Way				$0
Subtotal				$187,014
12% Engineering Overhead			12%	$22,442
2% Admin Overhead			2%	$3,740
Total Project Cost Estimate				**$213,196**

CIP LID3 - SW Camelot Green Street Mid-block Curb Extensions (20 extensions)				
Item	**Quantity**	**Unit**	**Unit Cost**	**Total Cost**
Mob/Traffic Control/Erosion Control (20%)	1	LS	$57,000	$57,000
Site Demo (Remove existing hardscape, excavate subgrade/soil)	1	LS	$45,000	$45,000
Site Grading (Soil prep, soil import, fine grading)	1	LS	$60,000	$60,000
Hardscape Installation (concrete curbs cuts, curbing, check dams)	1	LS	$105,000	$105,000
Landscape Installation (planting and mulch material)	1	LS	$75,000	$75,000
Construction Subtotal, 2009				$342,000
Construction Contingencies (30%)				$102,600
Design, Legal (20%)				$68,400
Right-of-Way				$0
Subtotal				$513,000
12% Engineering Overhead			12%	$61,560
2% Admin Overhead			2%	$10,260
Total Project Cost Estimate				**$584,820**

CIP CLC-3 - Commerce Circle Channel Restoration				
Item	**Quantity**	**Unit**	**Unit Cost**	**Total Cost**
Mob/Traffic Control/Erosion Control (20%)	1	LS	$53,311	$53,311
Earthwork	1	LS	$159,870	$159,870
Restoration/Enhancement	1	LS	$106,685	$106,685
Construction Subtotal, 2009				$319,866
Construction Contingencies (30%)				$95,960
Monitoring & Maintenance				$15,000
Design, Legal (20%)				$63,973
Right-of-Way				$0
Subtotal				$494,799
12% Engineering Overhead			12%	$59,376
2% Admin Overhead			2%	$9,896
Total Project Cost Estimate				**$564,071**

CIP FP - Future Projects				
Item	**Quantity**	**Unit**	**Unit Cost**	**Total Cost**
Mob/Traffic Control/Erosion Control (20%)	5	LS	$8,000	$40,000
Restoration/Enhancement	5	LS	$42,000	$210,000
Construction Subtotal, 2009				$250,000
Construction Contingencies (30%)				
Monitoring and Maintenance				
Design, Legal (min.)				
Right-of-Way				$0
Subtotal				$250,000
12% Engineering Overhead			12%	$30,000
2% Admin Overhead			2%	$5,000
Total Project Cost Estimate				**$285,000**

SUMMARY COST SHEETS:

Mid-Term Projects

CIP BC-2 - Boeckman Creek Outfall Rehabilitation				
Item	**Quantity**	**Unit**	**Unit Cost**	**Total Cost**
Mob/Traffic Control/Erosion Control (20%)	1	LS	$15,000	$15,000
Outfalls in Boeckman Creek	5	EACH	$15,000	$75,000
Construction Subtotal, 2009				$90,000
Construction Contingencies (30%)				$27,000
Design, Legal (min.)				$30,000
Right-of-Way				$0
Subtotal				$147,000
12% Engineering Overhead			12%	$17,640
2% Admin Overhead			2%	$2,940
Total Project Cost Estimate				**$167,580**

CIP BC-6 - Multiple Detention Pipe Installation				
Item	**Quantity**	**Unit**	**Unit Cost**	**Total Cost**
Mob/Traffic Control/Erosion Control (20%)	1	LS	$235,807	$235,807
72-inch diameter pipe	1105	LF	$1,067	$1,179,035
Construction Subtotal, 2009				$1,414,842
Construction Contingencies (30%)				$424,453
Design, Legal (20%)				$282,968
Right-of-Way				$0
Subtotal				$2,122,263
12% Engineering Overhead			12%	$254,672
2% Admin Overhead			2%	$42,445
Total Project Cost Estimate				**$2,419,380**

CIP BC-5 Boeckman Creek Outfall Realignment				
Item	**Quantity**	**Unit**	**Unit Cost**	**Total Cost**
Mob/Traffic Control/Erosion Control (20%)	1	LS	$2,400	$2,400
Restoration	1	LS	$12,000	$12,000
Construction Subtotal, 2009				$14,400
Construction Contingencies (30%)				$4,320
Design, Legal (min.)				$15,000
Right-of-Way				$0
Subtotal				$33,720
12% Engineering Overhead			12%	$4,046
2% Admin Overhead			2%	$674
Total Project Cost Estimate				**$38,441**

CIP BC-3 - Cascade Loop Detention Pipe Installation				
Item	**Quantity**	**Unit**	**Unit Cost**	**Total Cost**
Mob/Traffic Control/Erosion Control (20%)	1	LS	$78,958	$78,958
72-inch diameter pipe	370	LF	$1,067	$394,790
Construction Subtotal, 2009				$473,748
Construction Contingencies (30%)				$142,124
Design, Legal (20%)				$94,750
Right-of-Way				$0
Subtotal				$710,622
12% Engineering Overhead			12%	$85,275
2% Admin Overhead			2%	$14,212
Total Project Cost Estimate				**$810,109**

CIP BC-10 - Memorial Park Stream and Wetland Enhancement				
Item	**Quantity**	**Unit**	**Unit Cost**	**Total Cost**
Mob/Traffic Control/Erosion Control (20%)	1	LS	$5,000	$5,000
Restoration/Enhancement	1	LS	$25,000	$25,000
Construction Subtotal, 2009				$30,000
Construction Contingencies (30%)				$9,000
Monitoring and Maintenance				$15,000
Design, Legal (min.)				$20,000
Right-of-Way				$0
Subtotal				$74,000
12% Engineering Overhead			12%	$8,880
2% Admin Overhead			2%	$1,480
Total Project Cost Estimate				**$84,360**

CIP BC-9 Memorial Drive Pathway and Storm Drain Repair				
Item	**Quantity**	**Unit**	**Unit Cost**	**Total Cost**
Mob/Traffic Control/Erosion Control (20%)	1	LS	$10,000	$10,000
Install Wiers and retrofit outfall	1	LS	$50,000	$50,000
Construction Subtotal, 2009				$60,000
Construction Contingencies (30%)				$18,000
Design, Legal (min.)				$20,000
Right-of-Way				$0
Subtotal				$98,000
12% Engineering Overhead			12%	$11,760
2% Admin Overhead			2%	$1,960
Total Project Cost Estimate				**$111,720**

CIP LID7 - SW Wilsonville Road Stormwater Planters				
Item	**Quantity**	**Unit**	**Unit Cost**	**Total Cost**
Mob/Traffic Control/Erosion Control (20%)	1	LS	$35,360	$35,360
Site Demo (Remove existing hardscape, excavate subgrade/soil)	1	LS	$19,500	$19,500
Site Grading (Soil prep, soil import, fine grading)	1	LS	$39,000	$39,000
Hardscape Installation (concrete curbs cuts, curbing, check dams)	1	LS	$68,300	$68,300
Landscape Installation (planting and mulch material)	1	LS	$50,000	$50,000
Construction Subtotal, 2009				$212,160
Construction Contingencies (30%)				$63,648
Design, Legal (20%)				$42,432
Right-of-Way				$0
Subtotal				$318,240
12% Engineering Overhead			12%	$38,189
2% Admin Overhead			2%	$6,365
Total Project Cost Estimate				**$362,794**

CIP CLC-2 - SW Parkway Avenue Stream Restoration				
Item	**Quantity**	**Unit**	**Unit Cost**	**Total Cost**
Mob/Traffic Control/Erosion Control (20%)	1	LS	$8,860	$8,860
Earthwork	1	LS	$16,080	$16,080
Restoration/Enhancement	1	LS	$28,218	$28,218
Construction Subtotal, 2009				$53,158
Construction Contingencies (30%)				$15,947
Monitoring & Maintenance				$15,000
Design, Legal (min.)				$30,000
Right-of-Way				$131,000
Subtotal				$245,105
12% Engineering Overhead			12%	$29,413
2% Admin Overhead			2%	$4,902
Total Project Cost Estimate				**$279,420**

CIP CLC-9 - Jobsey Lane Culvert Replacement				
Item	**Quantity**	**Unit**	**Unit Cost**	**Total Cost**
Mob/Traffic Control/Erosion Control (20%)	1	LS	$9,090	$9,090
Culvert Replacement - 60-inch diameter	10	LF	$545	$5,450
Restoration/Enhancement	1	LS	$40,000	$40,000
Construction Subtotal, 2009				$54,540
Construction Contingencies (30%)				$16,362
Design, Legal (min.)				$30,000
Right-of-Way				$0
Subtotal				$100,902
12% Engineering Overhead			12%	$12,108
2% Admin Overhead			2%	$2,018
Total Project Cost Estimate				**$115,028**

CIP SD5707, SD5709, SD5714, SD5719 - SW Parkway Pipes				
Item	**Quantity**	**Unit**	**Unit Cost**	**Total Cost**
Mob/Traffic Control/Erosion Control (20%)	1	LS	$48,480	$48,480
48-inch diameter pipe	600	LF	$404	$242,400
Construction Subtotal, 2009				$290,880
Construction Contingencies (30%)				$87,264
Design, Legal (20%)				$58,176
Right-of-Way				$0
Subtotal				$436,320
12% Engineering Overhead			12%	$52,358
2% Admin Overhead			2%	$8,726
Total Project Cost Estimate				**$497,405**

CIP CLC-1 - Detention/Wetland Facility near Tributary to Basalt Creek				
Item	**Quantity**	**Unit**	**Unit Cost**	**Total Cost**
Mob/Traffic Control/Erosion Control (20%)	1	LS	$70,000	$70,000
Earthwork	1	LS	$250,000	$250,000
Restoration/Enhancement	1	LS	$100,000	$100,000
Construction Subtotal, 2009				$420,000
Construction Contingencies (30%)				$126,000
Monitoring				$15,000
Design, Legal (20%)				$84,000
Right-of-Way				$2,440,000
Subtotal				$3,085,000
12% Engineering Overhead			12%	$370,200
2% Admin Overhead			2%	$61,700
Total Project Cost Estimate				**$3,516,900**

CIP SD9038; SD9045-SD9046; SD9054-SD9058 - French Prairie Road in NW Charbonneau Pipe Replacement				
Item	**Quantity**	**Unit**	**Unit Cost**	**Total Cost**
Mob/Traffic Control/Erosion Control (20%)	1	LS	$84,544	$84,544
24-inch diameter pipe	1260.9	LF	$231	$291,268
30-inch diameter pipe	478.0	LF	$275	$131,450
Construction Subtotal, 2009				$507,261
Construction Contingencies (30%)				$152,178
Design, Legal (20%)				$101,452
Right-of-Way				$0
Subtotal				$760,892
12% Engineering Overhead			12%	$91,307
2% Admin Overhead			2%	$15,218
Total Project Cost Estimate				**$867,417**

CIP SD9052-SD9053; SD9059; SD9061-SD9069 - Curry Drive & French Prairie Rd in NW Charbonneau Pipe Replacement				
Item	**Quantity**	**Unit**	**Unit Cost**	**Total Cost**
Mob/Traffic Control/Erosion Control (20%)	1	LS	$101,706	$101,706
15-inch diamter pipe	412.9	LF	$184	$75,974
18-inch diameter pipe	1632.9	LF	$200	$326,580
30-inch diameter pipe	205.0	LF	$275	$56,375
36-inch diameter pipe	155.0	LF	$320	$49,600
Construction Subtotal, 2009				$610,234
Construction Contingencies (30%)				$183,070
Design, Legal (20%)				$122,047
Right-of-Way				$0
Subtotal				$915,351
12% Engineering Overhead			12%	$109,842
2% Admin Overhead			2%	$18,307
Total Project Cost Estimate				**$1,043,501**

CIP FP - Future Projects				
Item	**Quantity**	**Unit**	**Unit Cost**	**Total Cost**
Mob/Traffic Control/Erosion Control (20%)	5	LS	$8,000	$40,000
Restoration/Enhancement	5	LS	$42,000	$210,000
Construction Subtotal, 2009				$250,000
Construction Contingencies (30%)				
Monitoring and Maintenance				
Design, Legal (min.)				
Right-of-Way				$0
Subtotal				$250,000
12% Engineering Overhead			12%	$30,000
2% Admin Overhead			2%	$5,000
Total Project Cost Estimate				**$285,000**

SUMMARY COST SHEETS:

Long-Term Projects

CIP BC-1 - Wiedeman Road Regional Stormwater Detention/Stream Enhancement				
Item	**Quantity**	**Unit**	**Unit Cost**	**Total Cost**
Mob/Traffic Control/Erosion Control (20%)	1	LS	$122,500	$122,500
Earthwork	1	LS	$575,500	$575,500
Restoration/Enhancement	1	LS	$37,000	$37,000
Construction Subtotal, 2009				$735,000
Construction Contingencies (30%)				$220,500
Monitoring				$15,000
Design, Legal (20%)				$147,000
Right-of-Way				$3,660,000
Subtotal				$4,777,500
12% Engineering Overhead			12%	$573,300
2% Admin Overhead			2%	$95,550
Total Project Cost Estimate				**$5,446,350**

CIP CLC-4 - Ridder Road Wetland Restoration				
Item	**Quantity**	**Unit**	**Unit Cost**	**Total Cost**
Mob/Traffic Control/Erosion Control (20%)	1	LS	$11,401	$11,401
Earthwork	1	LS	$24,610	$24,610
Restoration/Enhancement	1	LS	$32,395	$32,395
Construction Subtotal, 2009				$68,406
Construction Contingencies (30)%				$20,522
Monitoring				$15,000
Design, Legal (min.)				$30,000
Right-of-Way				$115,000
Subtotal				$248,928
12% Engineering Overhead			12%	$29,871
2% Admin Overhead			2%	$4,979
Total Project Cost Estimate				**$283,778**

CIP LID2 - SW Hillman Green Street Stormwater Curb Extensions				
Item	**Quantity**	**Unit**	**Unit Cost**	**Total Cost**
Mob/Traffic Control/Erosion Control (20%)	1	LS	$22,800	$22,800
Site Demo (Remove existing hardscape, excavate subgrade/soil)	1	LS	$18,000	$18,000
Site Grading (Soil prep, soil import, fine grading)	1	LS	$24,000	$24,000
Hardscape Installation (concrete curbs cuts, curbing, check dams)	1	LS	$42,000	$42,000
Landscape Installation (planting and mulch material)	1	LS	$30,000	$30,000
Construction Subtotal, 2009				$136,800
Construction Contingencies (30%)				$41,040
Design, Legal (min.)				$30,000
Right-of-Way				$0
Subtotal				$207,840
12% Engineering Overhead			12%	$24,941
2% Admin Overhead			2%	$4,157
Total Project Cost Estimate				**$236,938**

CIP CLC-5 - Coffee Lake Creek Stream and Riparian Enhancement				
Item	**Quantity**	**Unit**	**Unit Cost**	**Total Cost**
Mob/Traffic Control/Erosion Control (20%)	1	LS	$17,706	$17,706
Earthwork	1	LS	$45,660	$45,660
Restoration/Enhancement	1	LS	$42,871	$42,871
Construction Subtotal, 2009				$106,237
Construction Contingencies (30%)				$31,871
Monitoring				$15,000
Design, Legal (Min.)				$30,000
Right-of-Way				$115,000
Subtotal				$298,108
12% Engineering Overhead			12%	$35,773
2% Admin Overhead			2%	$5,962
Total Project Cost Estimate				**$339,844**

CIP CLC-6 - Coffee Lake Creek South Tributary Wetland Enlargement				
Item	**Quantity**	**Unit**	**Unit Cost**	**Total Cost**
Mob/Traffic Control/Erosion Control (20%)	1	LS	$13,471	$13,471
Earthwork	1	LS	$29,960	$29,960
Restoration/Enhancement	1	LS	$37,396	$37,396
Construction Subtotal, 2009				$80,827
Construction Contingencies (30%)				$24,248
Monitoring				$15,000
Design, Legal (Min.)				$30,000
Right-of-Way				$280,000
Subtotal				$430,075
12% Engineering Overhead			12%	$51,609
2% Admin Overhead			2%	$8,602
Total Project Cost Estimate				**$490,286**

CIP CLC-7 - Coffee Lake Creek South Tributary Stream Restoration				
Item	**Quantity**	**Unit**	**Unit Cost**	**Total Cost**
Mob/Traffic Control/Erosion Control (20%)	1	LS	$33,132	$33,132
Earthwork	1	LS	$29,940	$29,940
Restoration/Enhancement	1	LS	$135,720	$135,720
Construction Subtotal, 2009				$198,792
Construction Contingencies (30%)				$59,638
Monitoring				$15,000
Design, Legal (20%)				$39,758
Right-of-Way				$122,000
Subtotal				$435,188
12% Engineering Overhead			12%	$52,223
2% Admin Overhead			2%	$8,704
Total Project Cost Estimate				**$496,114**

CIP SD4021 - SD4022 - Boberg Road Culvert Replacement				
Item	**Quantity**	**Unit**	**Unit Cost**	**Total Cost**
Mob/Traffic Control/Erosion Control (20%)	1	LS	$4,790	$4,790
6'x4' Box Culvert	50	LF	$479	$23,950
Construction Subtotal, 2009				$28,740
Construction Contingencies (30%)				$8,622
Design, Legal (Min.)				$20,000
Right-of-Way				$0
Subtotal				$57,362
12% Engineering Overhead			12%	$6,883
2% Admin Overhead			2%	$1,147
Total Project Cost Estimate				**$65,393**

CIP CLC-8 - Coffee Lake Creek Restoration				
Item	**Quantity**	**Unit**	**Unit Cost**	**Total Cost**
Mob/Traffic Control/Erosion Control (20%)	1	LS	$26,343	$26,343
Earthwork	1	LS	$98,136	$98,136
Restoration/Enhancement	1	LS	$33,578	$33,578
Construction Subtotal, 2009				$158,057
Construction Contingencies (30%)				$47,417
Monitoring				$15,000
Design, Legal (20%)				$31,611
Right-of-Way				$175,000
Subtotal				$427,085
12% Engineering Overhead			12%	$51,250
2% Admin Overhead			2%	$8,542
Total Project Cost Estimate				**$486,877**

CIP SD4025-SD4028 - Boberg Road Pipe Replacement				
Item	**Quantity**	**Unit**	**Unit Cost**	**Total Cost**
Mob/Traffic Control/Erosion Control (20%)	1	LS	$71,500	$71,500
18-inch diameter pipe	401.5	LF	$200	$80,300
24-inch diameter pipe	1200	LF	$231	$277,200
Construction Subtotal, 2009				$429,000
Construction Contingencies (30%)				$128,700
Design, Legal (20%)				$85,800
Right-of-Way				$0
Subtotal				$643,500
12% Engineering Overhead			12%	$77,220
2% Admin Overhead			2%	$12,870
Total Project Cost Estimate				**$733,590**

SUMMARY COST SHEETS:

Unfunded Projects

CIP SD9000 - SD9012 Miley Road in S Charbonneau Pipe Replacement				
Item	**Quantity**	**Unit**	**Unit Cost**	**Total Cost**
Mob/Traffic Control/Erosion Control (20%)	1	LS	$311,675	$311,905
36-inch diameter pipe	3,626.4	LF	$320	$1,160,448
42-inch diameter pipe	505	LF	$366	$184,830
60-inch diameter pipe	391	LF	$545	$213,095
Construction Subtotal, 2009				$1,870,278
Construction Contingencies (30%)				$561,083
Design, Legal (20%)				$374,056
Right-of-Way				$0
Subtotal				$2,805,417
12% Engineering Overhead			12%	$336,650
2% Admin Overhead			2%	$56,108
Total Project Cost Estimate				**$3,198,175**

CIP SD9013-SD9021; SD9060 - French Prairie Road in NE Charbonneau Pipe Replacement				
Item	**Quantity**	**Unit**	**Unit Cost**	**Total Cost**
Mob/Traffic Control/Erosion Control (20%)	1	LS	$163,798	$163,798
15-inch diameter pipe	1200	LS	$184	$220,708
18-inch diameter pipe	309	LF	$200	$61,800
36-inch diameter pipe	1677	LF	$320	$536,480
Construction Subtotal, 2009				$982,786
Construction Contingencies (30%)				$294,836
Design, Legal (20%)				$196,557
Right-of-Way				$0
Subtotal				$1,474,178
12% Engineering Overhead			12%	$176,901
2% Admin Overhead			2%	$29,484
Total Project Cost Estimate				**$1,680,563**

CIP SD9022-SD9029 - Old Farm Road in NE Charbonneau Pipe Replacement				
Item	**Quantity**	**Unit**	**Unit Cost**	**Total Cost**
Mob/Traffic Control/Erosion Control (20%)	1	LS	$98,930	$98,930
30-inch diameter pipe	1316	LF	$275	$361,818
36-inch diameter pipe	415	LF	$320	$132,832
Construction Subtotal, 2009				$593,579
Construction Contingencies (30%)				$178,074
Design, Legal (20%)				$118,716
Right-of-Way				$0
Subtotal				$890,369
12% Engineering Overhead			12%	$106,844
2% Admin Overhead			2%	$17,807
Total Project Cost Estimate				**$1,015,021**

CIP SD9030 - SD9037 - Edgewater Dr. E and French Praire Rd. in NE Charbonneau Pipe Replacement				
Item	**Quantity**	**Unit**	**Unit Cost**	**Total Cost**
Mob/Traffic Control/Erosion Control (20%)	1	LS	$97,101	$97,101
27-inch diameter pipe	1618	LF	$253	$409,329
30-inch diameter pipe	277	LF	$275	$76,175
Construction Subtotal, 2009				$582,604
Construction Contingencies (30%)				$174,781
Design, Legal (20%)				$116,521
Right-of-Way				$0
Subtotal				$873,907
12% Engineering Overhead			12%	$104,869
2% Admin Overhead			2%	$17,478
Total Project Cost Estimate				**$996,254**

CIP SD9039-SD9044; SD9047-SD9051 - Boones Bend Road in NW Charbonneau Pipe Replacement				
Item	**Quantity**	**Unit**	**Unit Cost**	**Total Cost**
Mob/Traffic Control/Erosion Control (20%)	1	LS	$83,372	$83,372
24-inch diameter pipe	1566.7	LF	$231	$361,908
27-inch diameter pipe	217.2	LF	$253	$54,952
Construction Subtotal, 2009				$500,231
Construction Contingencies (30%)				$150,069
Design, Legal (20%)				$100,046
Right-of-Way				$0
Subtotal				$750,347
12% Engineering Overhead			12%	$90,042
2% Admin Overhead			2%	$15,007
Total Project Cost Estimate				**$855,395**

CIP LID4 - SW Costa Circle Vegetated Swale and Stormwater Curb Extension				
Item	**Quantity**	**Unit**	**Unit Cost**	**Total Cost**
Mob/Traffic Control/Erosion Control (20%)	1	LS	$5,400	$5,400
Site Demo (Remove existing hardscape, excavate subgrade/soil)	1	LS	$4,500	$4,500
Site Grading (Soil prep, soil import, fine grading)	1	LS	$6,000	$6,000
Hardscape Installation (concrete curbs cuts, curbing, check dams)	1	LS	$9,000	$9,000
Landscape Installation (planting and mulch material)	1	LS	$7,500	$7,500
Construction Subtotal, 2009				$32,400
Construction Contingencies (30%)				$9,720
Design, Legal (Min.)				$20,000
Right-of-Way				$0
Subtotal				$62,120
12% Engineering Overhead			12%	$7,454
2% Admin Overhead			2%	$1,242
Total Project Cost Estimate				**$70,817**

CIP LID5 - Wood Middle School Parking Lot Green Street				
Item	**Quantity**	**Unit**	**Unit Cost**	**Total Cost**
Mob/Traffic Control/Erosion Control (20%)	1	LS	$19,000	$19,000
Site Demo (Remove existing hardscape, excavate subgrade/soil)	1	LS	$15,000	$15,000
Site Grading (Soil prep, soil import, fine grading)	1	LS	$20,000	$20,000
Hardscape Installation (concrete curbs cuts, curbing, check dams)	1	LS	$35,000	$35,000
Landscape Installation (planting and mulch material)	1	LS	$25,000	$25,000
Construction Subtotal, 2009				$114,000
Construction Contingencies (30%)				$34,200
Design, Legal (Min.)				$30,000
Right-of-Way				$0
Subtotal				$178,200
12% Engineering Overhead			12%	$21,384
2% Admin Overhead			2%	$3,564
Total Project Cost Estimate				**$203,148**

CIP LID6 - Boones Ferry Primary School Parking Lot Green Gutters and Pervious Paving				
Item	**Quantity**	**Unit**	**Unit Cost**	**Total Cost**
Mob/Traffic Control/Erosion Control (20%)	1	LS	$10,880	$10,880
Site Demo (Remove existing hardscape, excavate subgrade/soil)	1	LS	$6,300	$6,300
Site Grading (Soil prep, soil import, fine grading)	1	LS	$8,400	$8,400
Hardscape Installation (concrete curbs cuts, curbing, check dams)	1	LS	$14,700	$14,700
Landscape Installation (planting and mulch material)	1	LS	$25,000	$25,000
Construction Subtotal, 2009				$65,280
Construction Contingencies (30%)				$19,584
Design, Legal (Min.)				$30,000
Right-of-Way				$0
Subtotal				$114,864
12% Engineering Overhead			12%	$13,784
2% Admin Overhead			2%	$2,297
Total Project Cost Estimate				**$130,945**

CIP WD-1 - Montgomery Way Culvert Replacement				
Item	**Quantity**	**Unit**	**Unit Cost**	**Total Cost**
Mob/Traffic Control/Erosion Control (20%)	1	LS	$2,424	$2,424
48-inch diameter pipe	30	LF	$404	$12,120
Construction Subtotal, 2009				$14,544
Construction Contingencies (30%)				$4,363
Design, Legal (Min.)				$20,000
Right-of-Way				$0
Subtotal				$38,907
12% Engineering Overhead			12%	$4,669
2% Admin Overhead			2%	$778
Total Project Cost Estimate				**$44,354**

CIP WD-2 - Rose Lane Culvert Replacement				
Item	**Quantity**	**Unit**	**Unit Cost**	**Total Cost**
Mob/Traffic Control/Erosion Control (20%)	1	LS	$3,200	$3,200
36-inch diameter pipe	50	LF	$320	$16,000
Construction Subtotal, 2009				$19,200
Construction Contingencies (30%)				$5,760
Design, Legal (Min.)				$20,000
Right-of-Way				$0
Subtotal				$44,960
12% Engineering Overhead			12%	$5,395
2% Admin Overhead			2%	$899
Total Project Cost Estimate				**$51,254**