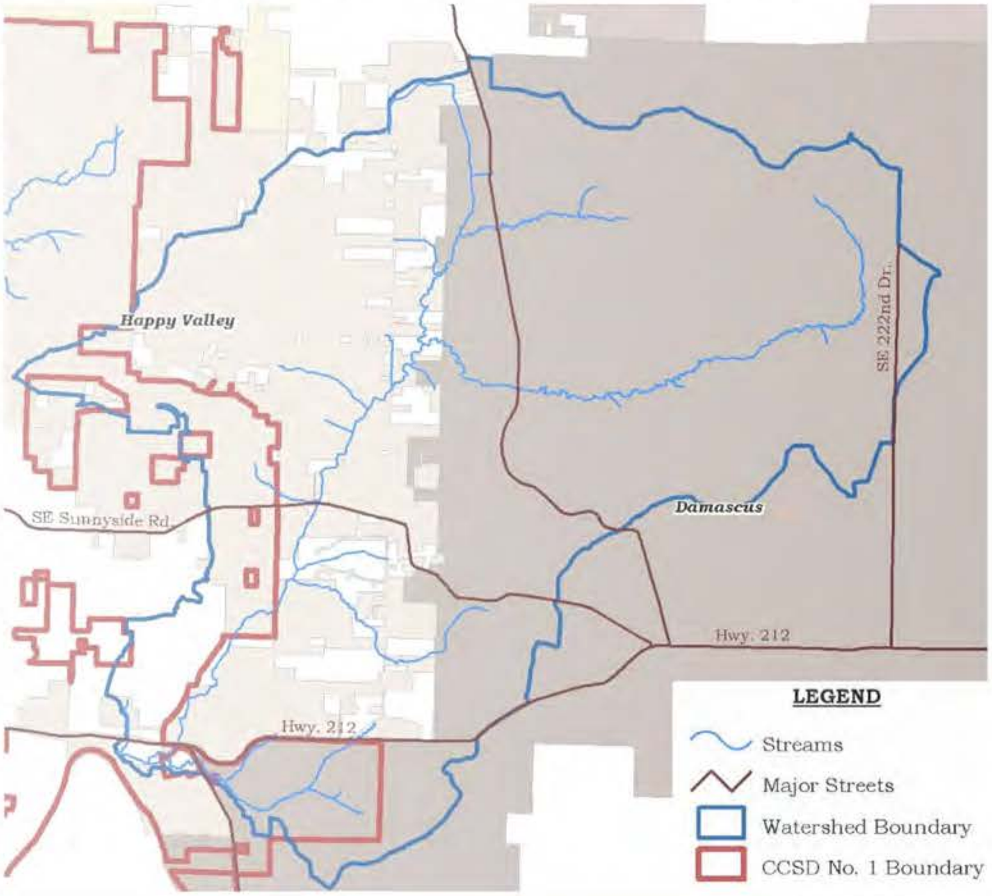
WATER
ENVIRONMENT
SERVICES
A Department of Clackamas County

Watershed Action Plan
Rock Creek Watershed
June 2009

Prepared by Brown and Caldwell, Ellis Ecological Services, and Waterways Consulting



BROWN AND
CALDWELL
Environmental Engineers & Consultants

WATERSHED ACTION PLAN
Rock Creek Watershed

Prepared for

Water Environment Services

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Brown and Caldwell Project Number 135774

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ACWA	Oregon Association of Clean Water Agencies
B-IBI	Benthic Index of Biological Integrity
BIUG	biological Iidex for urban gradient
BMP	Best Management Practices
BOD	biochemical oxygen demand
C	celsius
CCSD No. 1	Clackamas County Service District No. 1
CCSWCD	Clackams County Soil and Water Conservation District
CIP	Capital Improvement Program
CRBC	Clackamas River Basin Council
CWA	Clean Water Act
D	District wide
dbh	diameter at breast height
DEQ	Oregon Department of Environmental Quality
DFIRM	Digital Flood Insurance Rate Map
DO	dissolved oxygen
DTD	Clackamas County Department of Transportation and Development
E. Coli	*Escherichia coli*
EES	Ellis Ecological Services, Inc.
ERCO	Erosion Prevention and Sediment Control
ESU	Equivalent Service Unit
F	Fahrenheit
F-IBI	Fish Index of Biological Integrity
FEMA	Federal Emergency Management Agency
FIRM	Flood Insurance Rate Map
FIS	Flood Insurance Study
FTE	full-time equivalent
GIS	Geographic Information System
HEC	Hydrologic Engineering Center
HBI	Hilsenhoft biotic index
HMS	Hydrologic Modeling System
IGA	inter-governmental agreement
JCWC	Johnson Creek Watershed Council
KMS	Kellogg-Mt. Scott
LA	load allocation
LID	low impact development
LOS	Level of Service
LWD	large woody debris

μg/L	micrograms per liter
mg/L	millgrams per liter
m/L	milliliters
MPN	most probable number
MS4	Municipal Separate Storm Sewer System
NCCWC	North Clackamas County Water Commission
NPDES	National Pollutant Discharge Elimination System
NRCS	Natural Resources and Conservation Service
NWI	National Wetlands Inventory
ODFW	Oregon Department of Fish and Wildlife
ODOT	Oregon Department of Transportation
OWEB	Oregon Watershed Enhancement Board
OWQI	Oregon Water Quality Index
PIP	Project Implementation Planning
PWR	Pacific Water Resources
RC	Rock Creek
RCSI	Rock Creek Sustainability Initiative
RM	river mile
SDCs	system development charge
SFR	single family residential
SWM	Surface Water Management
SWMACC	Surface Water Management Agency of Clackamas County
SWMP	Stormwater Management Plan
SWMPMP	Surface Water Management Program Master Plan
TMDL	total maximum daily load
TP	total phosphorus
TSS	total suspended solids
UGB	urban growth boundary
UIC	underground injection controls
USEPA	U.S. Environmental Protection Agency
USGS	U.S. Geological Survey
WAP	Watershed Action Plan
WES	Water Environment Services
WHI	Watershed Health Index
WLA	waste load allocation
WPCF	Water Pollution Control Facility

EXECUTIVE SUMMARY

ROCK CREEK WATERSHED ACTION PLAN

Introduction

Water Environment Services (WES), a department of Clackamas County, conducts and manages surface water and wastewater management services in several districts including Clackamas County Service District No. 1 (CCSD No. 1, also known as the District). WES' surface water management program reviews development plans, maintains stormwater facility infrastructure, and conducts activities to protect and enhance the health and function of the watershed, including water quality, aquatic habitat, and hydrologic functions.

WES is completing the Rock Creek (RC) and Kellogg Mount Scott (KMS) Watershed Action Plans (Action Plans) in order to prioritize surface water management program activities and future investments for watershed management. The approach to the Action Plan process is illustrated in Figure ES-1. The key elements of the Action Plan include the following:

- **Characterization Report**. The Characterization Report includes an inventory of watershed conditions, an identification of key factors that limit watershed health, and a summary of WES activities that affect watershed health based on existing information. The Characterization Report is contained in Chapters 1 through 4 of the Action Plan.
- **Assessment Report**. The Assessment Report includes an assessment of watershed conditions based on the characterization report results and identifies specific WES surface water programs, projects, and activities that are appropriate to improve watershed health efficiently and effectively. The Assessment Report is contained in Chapter 5 of the Action Plan.
- **Action Plan Summary**. The Action Plan Summary includes an evaluation and prioritization of the programs, projects, and activities described in the Assessment Report using scientifically-based criteria and an asset management Level of Service (LOS)-based evaluation process. The Action Plan Summary provides a process for sequencing the actions for implementation. It is contained in Chapter 6 of the Action Plan.
- **Implementation and Adaptive Management**. WES will implement the Action Plan components over time, and monitor and adapt their components as needed to continually improve watershed health.

Figure ES-1. Watershed Action Planning Process

Chapter 1 includes an overview of the RC watershed, an overview of the approach used to evaluate and characterize the watershed, and a summary of WES policies and practices that affect watershed health. Chapters 2 through 4 summarize information related to hydrology, water quality, and aquatic habitat and biological communities, and include discussions of the data reviewed for the characterization, data gaps identified, and watershed conditions and limiting factors. Chapter 5 contains a synthesis of the data evaluated in Chapters 1 through 4, including a reach-by-reach analysis of the stream and contributing area conditions. Chapter 6 contains the recommended actions developed based on the Chapter 5 assessment to assist WES in achieving its LOS goals.

Watershed Action Plan Goals and Objectives

WES' over-arching surface water management program goals are to improve and protect water quality and reduce the impacts of urbanization on hydrology. The objective of the Watershed Action Plans is to develop basin-specific plans to prioritize District activities and future investments for watershed management.

WES is incorporating the principles of an asset management program into the Surface Water Management program. As a part of this process, WES developed Levels of Service in 2009 to guide its program management and activities. The Level of Service (LOS) goals for the surface water management program elements are shown below. Further information on the LOS goals and performance measures for the goals is described in Appendix D.

- Environmental Permit Program Management
  - Meet Permit Requirements
  - Reduce Pollutant Loads through Structural Best Management Practices (BMPs)
  - Reduce Pollutant Loads through Non-Structural BMPs
- Environmental Policy and Watershed Health
  - Support Functioning Aquatic Ecosystems
  - Improve Water Quality
  - Improve Aquatic Habitat and Biology
  - Improve Hydrology and Geomorpology
- Erosion Prevention and Sediment Control
  - Conduct Inspections Based on Priority
  - Reduce Water Quality Impacts of Construction
- Program Management
  - Engage in Effective Partnering
  - Ensure Staff Understand Roles; Skills and Resources Meet Needs
  - Collect Monitoring Data Used for Decision-Making
  - Program Evaluation and Effectiveness
- Development Plan Review and Permitting
  - Ensure Development Needs Are Met and Ecosystem Services Protected
- Asset Management
  - Maximize Cost/Benefit of Service
  - Fully Implement the Asset Management Program
  - Ensure the Storm System is Reliable
- Customer Service
  - Implement Sustainability Action Plan
  - Conduct Effective Public Outreach Program
  - Maintain Employee Health and Safety

- Business Management
  - Maximize Use of Alternative Funding Sources
  - Full Capital Improvement Program Implementation
  - Ensure Rate Adequacy
  - Budget Management Effectiveness
  - Maintain Appropriate Policies for WAPs
- Stormwater Maintenance
  - Regularly Scheduled Maintenance Addressed
  - Scheduled versus Non-Scheduled Maintenance Balanced
  - Request-Driven Maintenance Addressed

One of WES' main goals and outcomes of the Action Plan is to be able to prioritize what stormwater management actions and activities should be conducted in specific sub-basin areas, such as where to assist the operations and maintenance staff in targeting specific activities in various locations. Watershed Action Plans will be utilized to provide priorities and benefits including the following:

- Raise awareness of issues and constraints
- Identify key problems and opportunities
- Identify areas in which efforts should be focused both in terms of protection and restoration efforts and asset management activities
- Implement policies, programs, and standards in specific areas
- Build support for stewardship and implementation and serve as a tool for funding

WES Policies and Practices

WES is a department within Clackamas County that conducts and manages wastewater and stormwater management services in several districts including CCSD No. 1, the Surface Water Management Agency of Clackamas County (SWMACC), and the Tri-City Service District. CCSD No. 1 includes an agreement with and encompasses portions of Happy Valley.

WES has retooled its surface water management program and is transitioning from a utility-based, regulatory-driven program to an approach focused on watershed health and integrated watershed management. WES' vision is to improve watershed health by managing its surface water program efficiently and effectively, using financial resources to provide the most benefit through prioritized activities and investments.

Functional program elements within WES that relate to surface water management as shown in the current organizational chart are summarized below. It is important to note that as WES implements its vision to improve watershed health by managing its surface water program efficiently and effectively; changes may be made to the current organizational structure.

- Asset management
  - Development plan review and permitting
  - Erosion prevention and sediment control
- Water quality services
  - Stormwater system maintenance
  - Program management

- Environmental monitoring
  - Environmental permit program management
  - Laboratory operation
- Administration
  - Environmental policy and watershed health
  - Public information and outreach
- Business services
  - Customer service
- Financial services
  - Utility billing
  - Asset management reporting

Chapter 1 includes a summary of existing policies and practices implemented by WES that affect watershed conditions and identifies opportunities for potential improvements that will help WES to improve and protect watershed health more efficiently and effectively. These opportunities for potential improvements were evaluated further during the assessment phase of the project (Chapter 5) with WES staff input. Additional details on the existing policies and practices implemented by WES are provided in Appendix A, including work flows for several program elements.

Watershed Characterization and Assessment Process

The watershed characterization was used to develop the watershed assessment and the Action Plan. As illustrated in Figure ES-2, the watershed characterization and assessment process evaluates watershed health stressors, responses, and key indicators.

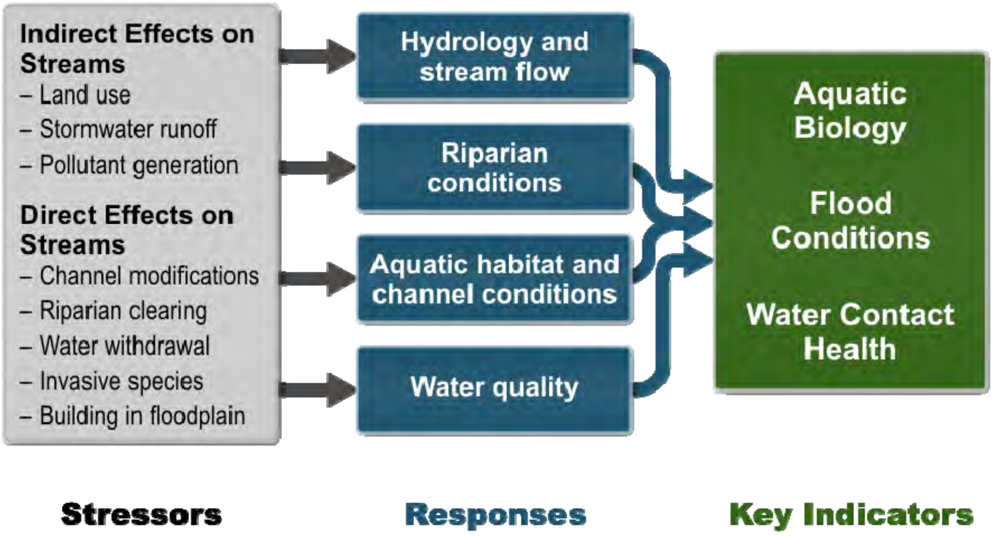

Figure ES-2. Watershed Characterization and Assessment Process (Modified from Booth et al., 2005 and Karr and Yoder, 2004)

The watershed characterization and watershed assessment will help WES to do the following:

- Identify features and processes important to hydrology, biological, habitat, and water quality resources
- Determine how natural processes influence those resources
- Understand if/how human activities and WES stormwater management practices are affecting resources and limiting watershed health conditions
- Evaluate the cumulative effects of land management and stormwater management practices over time

Chapters 2 through 5 contain the analysis of key indicators, responses, and stressors in the watershed. Watersheds respond differently to stressors in the environment depending on the extent of modification to the watershed (such as how much riparian clearing has occurred and how stormwater runoff is collected, treated, and conveyed) as well as the interaction between stressors (such as the combination of effects from water withdrawals and riparian clearing on water temperatures). Conditions such as soils, slopes, vegetation, and stream morphology also play an important role in how watersheds respond to stressors. Evaluating key indicators of watershed health helps to determine how a watershed is responding to the unique combination of stressors in the environment. The results of the watershed characterization will be used in the assessment to identify what management strategies and priority activities and actions are likely to improve functions and conditions.

In Chapters 2 through 5, key indicators are evaluated using available data that provide insight into how a combination of stressors and responses are affecting watershed health. Examples of key indicators evaluated include benthic macroinvertebrate and fish populations, flood conditions and channel erosion, and concentrations of water pollutants that could affect human health. Stressors such as land use, stormwater runoff, channel modifications, aquatic habitat conditions, and riparian clearing are evaluated and compared to available data on specific watershed responses as well as to key indicators in order to understand limiting factors for watershed health. Because several studies have been conducted that document watershed conditions extensively, in particular the 2006 Master Plan, Chapters 2 through 5 do not attempt to describe the watershed exhaustively. Instead, key aspects of available data are summarized and evaluated in the context of the goals for the Action Plans.

Chapters 2 through 4 summarize data on hydrology, water quality, and aquatic habitat and biological communities. These elements of watershed health often contain interrelated problems and integrated opportunities for improvement. Work in the watershed assessment phase of the project was completed to evaluate interrelated issues and to identify priority actions and management activities appropriate for WES to undertake to address factors that are limiting watershed health.

The watershed characterization and assessment were conducted with a focus on addressing the following questions that are of interest to WES.

Hydrology

- How can hydrologic goals or flow control objectives be achieved through design standards and retrofitting to improve watershed health?
- Where does regional detention and infiltration make the most hydrological and soil feasibility sense and where is land available to implement these projects?
- What specific stormwater infrastructure structures or areas require retrofits, what are state-of-the-art techniques that can be utilized, and what are the priorities?
- Where is flooding potentially a problem now or in the future?

Water Quality

- What are the most limiting water quality problems, what are the most important potential sources, and what are potential best management practices (BMPs) and solutions for these problems?
- What specific stormwater infrastructure structures or areas require retrofits, what are state-of-the-art techniques that can be utilized, and what are the priorities?
- Where and what parameters should WES monitor in the future to document watershed health and overall effectiveness of programs, policies, and actions and to address regulatory permits?

Aquatic Habitat and Biological Communities

- Where are the most sensitive and valuable habitats and functions to protect?
- Where are the highest priority and most degraded stream channel reaches to restore?
- What are the highest priority fish barriers to remove or retrofit?
- Where are the highest priority stream reaches for establishing native vegetation and canopy?

WES Policies and Programs

- How can ecosystem services be protected and enhanced through WES activities and policies?
- What traditional or innovative maintenance practices are most important and where should the focus be?
- Which management policies/programs/activities should be utilized to enhance, protect, restore or address the issues identified?
- What are the high priority areas for maintenance/retrofit/Capital Improvement Program (CIP) activities, what is the methodology, and what are the criteria for prioritizing these activities?
- What is the current maintenance process, what are the criteria for prioritizing maintenance activities, and who has the responsibility for implementing maintenance of the surface water drainage system?
- What are the recommended prioritized maintenance activities?
- What are the recommended actions for interdepartmental maintenance coordination including recommendations for coordination with the Clackamas County Department of Transportation and Development (DTD)?
- What are the recommended actions for the development review process, changes to development standards and development rules and regulations including low impact development?
- What is the recommended methodology and criteria for prioritizing erosion prevention and sediment control and establishing performance metrics?
- What are the gaps in customer service, including opportunities to enhance the Service Request database as a proactive tool for management activities and future CIP identification?
- What information is needed to inform decisions and track performance metrics in the future?

Following is a summary of the watershed characterization and assessment results.

Watershed Overview

The RC watershed, illustrated in Figure ES-3, encompasses approximately 6,280 acres in the northwestern portion of Clackamas County on the outskirts of the Portland metropolitan area. Photos ES-1 through ES-9 illustrate conditions in the RC watershed. Rock Creek begins in the hills east of Interstate 205 and flows southwest to its confluence with the Clackamas River. Elevations in the watershed range from more than 800 feet above sea level to approximately 70 feet above sea level. Trillium Creek is a major tributary that discharges to Rock Creek in the lowest reach. Major named sub-basins for tributaries have not been identified for the RC watershed, although the watershed has been divided into sub-basins for hydrologic and hydraulic modeling purposes.

The RC watershed has not yet been heavily developed for urban uses, although western drainages and its urban areas are growing and are expected to continue to grow significantly in the future within both the Cities of Happy Valley and Damascus. The RC watershed streams have been impacted by agriculture, roads, and other rural development since the early 1900s. Most of the land in the watershed is currently used for agriculture, nurseries, private forest land, open space, and rural residences. The watershed was estimated to be about 8 percent impervious in 2004.

Metro, the regional government and planning agency for the Portland metropolitan area, periodically analyzes land cover in the region using aerial photographs. The 2007 land cover analysis from Metro indicates that approximately 40 percent of the RC watershed is forested, 47 percent of the watershed is vegetated with grass, shrubs, or agricultural vegetation, and 13 percent of the watershed is comprised of built or “scarified” areas which includes buildings, pavement and some compacted or dry exposed soil areas. Due to the rapid growth in the area, the 2007 Metro built land classification is used as a current estimate of impervious area in the watershed in this report.

The land use in the watershed is currently classified as about 29 percent residential and rural residential, 19 percent farmland, 18 percent forestland, and 28 percent “tractland.” These classifications include both developed land uses and vacant land uses that fall into these categories. In addition, due to the large sizes of rural residential parcels and tractland in the watershed, these land uses are currently less densely developed than similar land use classifications may be in other more developed watersheds in CCSD No. 1.

Thirty-five percent of the watershed is within the City of Happy Valley. Twelve percent of the watershed is currently within CCSD No. 1. CCSD No. 1 includes portions of the City of Happy Valley. The eastern portion of the watershed is in the City of Damascus, which encompasses about 57 percent of the watershed. As development occurs in the Happy Valley and Damascus areas recently included in the urban growth boundary (UGB), there may be a transition of providers of stormwater management services from the Clackamas County Department of Transportation and Development (DTD) to the cities of Damascus and Happy Valley or to WES through intergovernmental agreements (IGAs) with the cities and/or through the expansion of CCSD No. 1 to include portions of the cities. Five percent of the watershed is currently in unincorporated areas outside of CCSD No. 1.

The RC watershed is currently on the edge of the Portland metropolitan area, which is generally distinguished by the UGB. The purpose of the UGB is to make a distinct separation between urban and rural lands. The UGB is expanded periodically by Metro to allow for new growth in residential, commercial, and industrial land uses. In 1979, when the UGB was first established, the RC watershed was outside the UGB. In 1998, approximately 670 acres of the RC watershed were added to the UGB and annexed to Happy Valley. In December 2002, Metro expanded the UGB significantly in Clackamas County, adding 12,200 acres in the Damascus/Boring area east of Happy Valley and south of Gresham. As a result, the entire RC watershed is now within the UGB and significant growth in the area is expected.

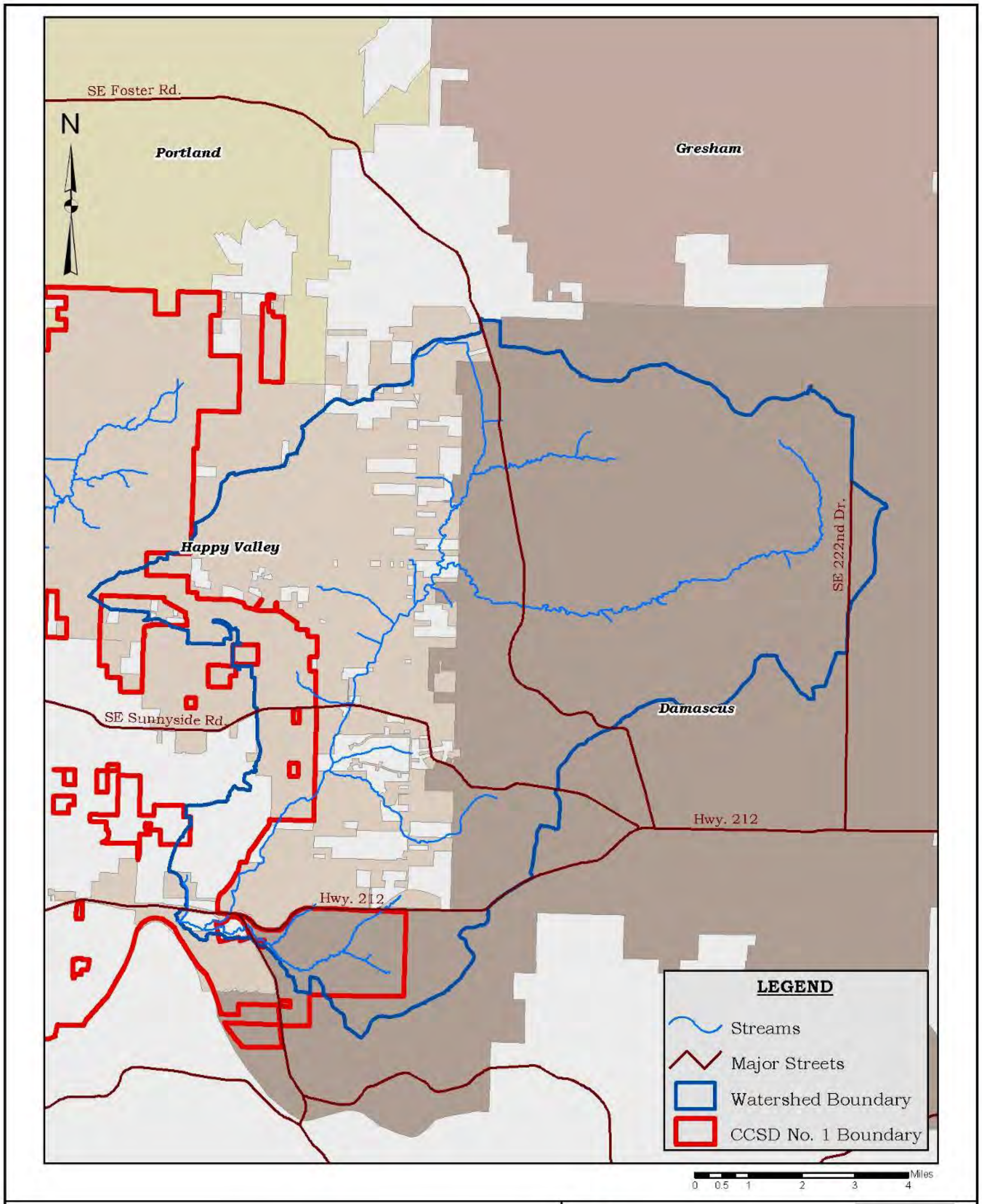

Figure ES-3
Rock Creek Watershed

Water Environment Services
Beyond clean water. www.clackamas.us/wes

Swanson Hydrology + Geomorphology

Ellis Ecological Services, Inc.

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Photo ES-1. Lower Rock Creek

Photo ES-2. Rock Creek at Highway 224 bridge

Photo ES-3. Rock Creek above Highway 224

Photo ES-4. Middle reach of Rock Creek

Photo ES-5. Middle reach of Rock Creek

Photo ES-6. Upper reach of Rock Creek at Troge Road

Photo ES-7. New development in the RC watershed

Photo ES-8. Road expansion in the RC watershed

Photo ES-9. Stormwater treatment in the RC watershed

Watershed Analysis

The RC watershed as a whole has not yet been heavily developed for urban uses, although it contains urbanized land in its western drainages and urbanized areas are expected to continue to grow significantly in the future within both the Cities of Happy Valley and Damascus. The watershed is depicted with an aerial photograph background in Chapter 5.

The land use in the watershed is currently classified as 29 percent residential and rural residential, 19 percent farmland, 18 percent forest land, and 30 percent tract land or undefined land use in the County Tax Assessor data. Tract land includes institutional land uses such as schools and parks as well as undeveloped parcels. All of the land use classifications in the RC watershed include both developed land uses and vacant land uses that fall into these categories. In addition, due to the large sizes of rural residential parcels and tract land in the watershed, these land uses are currently less densely developed than similar land use classifications may be in other more developed watersheds in Clackamas County Service District No. 1. As much as 60 percent of the watershed may still be available for further development based on the buildable lands assessment conducted by WES; however the estimate of buildable lands available may change in the future as land use planning in Damascus proceeds. Approximately 2 percent of watershed is currently treated with structural Best Management Practices (BMPs) such as detention ponds and swales.

Based on the results of the Characterization Report, key stressors in the watershed include the following:

- Loss of infiltration of rainwater and efficient delivery of runoff to streams due to removal of tree canopy and other native vegetation in areas with poor soils, tiling and ditching of agricultural fields, and addition of impervious surfaces
- Loss of tree canopy and other native vegetation in riparian corridors and uplands
- Untreated runoff from agricultural areas, older residential areas, and impervious surfaces such as roads

In addition to these key stressors identified in the Characterization Report, there may be other key stressors affecting watershed health that are not fully understood due to data gaps. Examples of other potential stressors include channel modifications, habitat conditions, water withdrawals, pollutant loadings, and loss of groundwater input to streams. Further data collection and analysis of these potential stressors would be valuable.

Key risks to future watershed health include additional hydrologic and water quality impacts from urbanization if development impacts are not properly mitigated, and erosion when steeper slopes or sensitive soils are altered or developed.

Key responses to these stressors in the watershed include the following:

- Increased flow volume and duration during storm events
- Channel instability including bank erosion and channel widening
- Flooding affecting infrastructure
- Lower flow during summer
- Streams exceeding water quality standards for temperature and bacteria as well as other pollutants
- Reduction in populations of sensitive aquatic species
- Increase in populations of aquatic species tolerant of poor water quality conditions and habitat
- Reduction in quality of aquatic habitat through fine sediment accumulation and loss of in-stream structure such as deep pool habitat and large woody debris (LWD)
- Increase in non-native invasive species

Watershed-wide and reach-specific opportunities to address these stressors and responses are summarized below and described further in Chapter 5. The opportunities were used to develop the Action Plan in Chapter 6.

Hydrology Issues and Opportunities

The hydrology of the RC watershed has been altered from pre-development conditions due to removal of forest canopy, conversion of wetland and floodplain areas to other land uses, ditching and tiling of fields for agriculture, the addition of roads and housing developments, and other rural development. As a result of these changes as well as the nature of the watershed conditions (including relatively poorly infiltrating soils and steep slopes in some areas), hydrologic modeling indicates that the RC streams already exhibit the "flashy" conditions of higher peak flows over longer durations during storm events which are typically characteristic of urbanized watersheds, despite the relatively low proportion of impervious surfaces in the watershed.

The effects of hydrologic changes on stream channels are known as hydromodification. Although changes in hydrology have occurred in the RC watershed, the hydrologic changes have occurred more gradually than in a fully developed urban watershed. Thus it is likely that existing channel change and incision has been driven more by direct modification of the stream channel and modification of the floodplain rather than through modifications to the hydrology. However, hydromodification impacts could increase dramatically in the future as the watershed is urbanized further unless mitigation of new impervious surfaces is effective at maintaining a hydrologic equilibrium with current conditions.

Currently, the RC watershed is approximately 7 to 13 percent impervious based on WES and Metro land cover analysis of 2007 aerial photos. Although the actual imperviousness of the watershed will likely increase in the future due to significant new development in the watershed, over time the directly connected, or "effective" imperviousness of the watershed can be reduced through retrofitting existing impervious areas and applying low impact development (LID) and sustainable development techniques to new development.

The City of Damascus is undertaking a Stormwater Master Planning effort that is focused on protecting and enhancing ecosystem services. Through this effort, Damascus is developing land use plans and policies that are intended to reduce the hydrologic impacts of future urbanization in a large portion of the RC watershed. The City of Happy Valley implements WES design standards to reduce the hydrologic impacts of urbanization.

Key issues related to hydrology in the RC watershed include the following:

- Mitigation of the hydrologic impacts of future urbanization will be required to minimize hydromodification, flooding, and erosion of stream beds and banks.

  Due to its location on the urban-rural boundary and the presence of easily developable land in the expanded urban growth boundary areas in Happy Valley and Damascus, the watershed will undergo increased urbanization pressures over the next several decades. Despite historic changes to hydrologic conditions in the watershed associated with conversion from forest to farm, the conversion to urban conditions is likely to have an even more profound effect on the hydrology, channel conditions, and watershed health unless proactive actions and sustainable measures are taken to protect the watershed and its functions.

  The results of hydrologic modeling suggest that future urbanization has the potential to result in a three-fold increase in stream flow during 2-year recurrence interval storm events along the mainstem channels of Rock Creek. Although flooding is currently not a major concern in most of the watershed, it could increasingly become an issue as development proceeds. Although current design standards for stormwater are intended to reduce the hydrologic impacts associated with new development, future development may modify the timing, volume, and duration of water delivered to stream channels.

As a result, it will be necessary to provide hydrologic controls to mimic current flow conditions for larger storms as well as smaller storms. The location of local and regional hydrologic control facilities (e.g., on-site and off-site LID features and detention basins) will be determined based on land use planning and stormwater master planning efforts in Damascus, existing land use plans for Happy Valley, and the implementation of design standards and regulations during the development process.

If the potential hydrologic changes in the watershed are not adequately minimized, there is risk associated with the corresponding potential morphologic responses of the stream channels. Geomorphically, it is difficult to evaluate how channels will respond to modifications of the hydrology. As described further in Chapter 2, a preliminary assessment of the Oregon Department of Fish and Wildlife (ODFW) dataset suggests that bank erosion could be the biggest concern under future conditions, specifically in the upper portion of the Rock Creek canyon, downstream of Southeast Sunnyside Road, and the portion of Rock Creek that runs adjacent to Troge Road.

- Limited hydrologic and geomorphic data are currently being collected.

Limited hydrologic and geomorphic data are available to assist in evaluating historical, current, and future watershed conditions and potential risks. Long-term stream gauge records are not available for the watershed and data vital to evaluating channel morphology, such as repeat cross-sections, bank erosion surveys, or bed substrate data, are not available. The existing stream gauge records have not been managed actively through a quality assurance/quality control process and an in-depth analysis of the records should be conducted in the future.

Relatively little is known about the conditions of the upper tributaries to the stream system and these areas may be prone to instability if future development does not adequately protect drainage areas and mitigate runoff. The 2008 ODFW habitat survey has a limited spatial extent in comparison to the extension network of channels that exist in the watershed. The ODFW survey focuses on channels in the watershed that have the potential to support salmonids, with a significant portion of the mainstem channel being omitted due to landowner permission access constraints. Unfortunately it is often the smaller, steeper headwater channels that are at the most risk when a watershed converts from rural to urban land uses. The lack of a comprehensive channel conditions assessment and dataset for these smaller headwater channels is a constraint for analysis of the watershed and limits the ability to track changing conditions over time.

- The hydrologic model of the watershed is a valuable tool that can be further enhanced and used for continued analysis.

As discussed in Chapter 2, it appears that the predicted flows under pre-development forested conditions may be underestimated significantly in the current hydrologic model. The model could be calibrated to better predict historic conditions in the RC watershed. To improve or increase the accuracy of the existing hydrologic modeling runoff rates for a pre-development, forested condition, reference data from a forested watershed could be used, constituting a reference condition. It may also be possible to locate peak flow data for a watershed of similar natural characteristics that is currently forested. Alternatively, the model could be calibrated using U.S. Geological Survey regional regression equations for forested conditions, similar to the process used by Pacific Water Resources for the existing conditions model.

Flow data from continuous gauges on Rock Creek have been collected for over 8 years and could be used for further calibration of the model to existing conditions. With these enhancements, the hydrologic model can continue to be used in the future to further evaluate the potential impacts associated with scenarios for development and stormwater management.

- Areas where the stream channel, riparian buffer, floodplain, and wetlands have been modified could be improved through active restoration with the cooperation of willing private landowners in partnership with other agencies and nonprofit watershed restoration and environmental groups.

There may be opportunities to work in collaboration with nonprofits, the Cities of Happy Valley and Damascus, ODFW, the Clackamas County Soil and Water Conservation District (CCSWCD), and other potential partners to undertake active restoration of degraded stream channels, buffer areas, floodplains, and wetlands on private lands with cooperating landowners. Restoration of these areas has the potential to improve hydrologic and geomorphic functions in the watershed while also improving water quality and habitat.

The City of Damascus is exploring the incorporation of policies and programs to protect and enhance ecosystem services through its Stormwater Master Planning process. These policies and programs could result in additional mechanisms and tools for working with private landowners to improve riparian and wetland conditions as development occurs in the watershed.

Summary of Recommended Actions

An active management strategy to maintain hydrologic conditions in the RC watershed is recommended for watershed health. Appropriate WES management activities to manage hydrology in the RC watershed include working collaboratively with the Cities of Happy Valley and Damascus as well as the Clackamas County Department of Transportation and Development (DTD) to implement enhanced design standards, regulations, land use policies, and sustainable practices that will maintain current hydrologic conditions matching both peaks and duration for small and large storms. This recommendation addresses risk factors proactively and is consistent with the 2006 Surface Water Management Program Master Plan. The 2006 Master Plan discussed the goal of sizing detention ponds using a flow duration design standard for storm events ranging from half the 2-year through a 10-year event.

Additional management activities appropriate for WES to undertake include working with Happy Valley, Damascus, CCSWCD, and DTD to fill data gaps on hydrologic and geomorphic conditions in the watershed, carefully minimizing construction-related erosion and buffer impacts during future development, and participating in targeted restoration activities with willing landowners and other partners.

The following potential actions will support this management strategy:

- Update stormwater design standards to promote LID techniques for new and re-development areas, and implement hydrologic control of runoff from small and large storm events for new development as well as re-development.
- Ensure that the replacement of structures (e.g., road culverts and bridges) at upstream locations does not change the high flow conditions downstream (or appropriately mitigate for such impacts) and address the potential for channel migration during structure replacement.
- Enhance the hydrologic model of the watershed through calibration to better predict historic conditions and match existing conditions; consider using the enhanced model to evaluate potential future development scenarios as planning in Damascus proceeds.
- Conduct an in-depth analysis and quality check of existing stream gauge data.
- Expand hydrologic and geomorphic data collection and analysis in the mainstem and upper tributaries. Conduct channel modification mapping, bank and channel stability and streambed analysis, and implement cross-section monitoring stations as described in Chapter 2.
- Implement strong Erosion Prevention and Sediment Control practices in areas at high risk for erosion based on steep slopes and erodible soils, including conducting frequent high priority site inspections and periodically reviewing site inspection data to continually improve process.
- Continue to track flood issues and complaints related to WES infrastructure. Evaluate opportunities to assist DTD in addressing other flooding issues as appropriate in support of overall watershed health.
- Maintain, and where possible improve, the riparian buffer conditions adjacent to stream channels.

- Maintain, and where possible increase, the upland tree canopy and native vegetation in the watershed.
- Where feasible, provide additional off-channel flood storage and enhanced wetlands with connections to streams.
- Where feasible, improve in-stream habitat using designs appropriate for the current flow regime.

Water Quality Issues and Opportunities

Water quality in the RC watershed has been affected by changes in land cover and hydrology as well as through the transmission of pollutants to the streams. The loss of riparian buffer vegetation, particularly in the upper portions of the watershed, has likely resulted in degraded water quality including increased stream temperatures. Untreated runoff from agricultural areas, roads, and older residential development may also contribute to degraded water quality.

As illustrated in Figure 5-1, although the new development in the Happy Valley area is treated with structural water quality BMPs, most of the watershed is not treated for water quality currently. Runoff from many of the roads in the watershed is currently conveyed to the streams through ditches. Although ditches may provide some water quality treatment of runoff, if the ditches are not maintained appropriately and lack the appropriate vegetation and slope characteristics of a water quality swale, pollutants from roadways may still reach streams. The City of Happy Valley began conducting street sweeping of all city streets approximately once per month in October 2008. Street sweeping outside Happy Valley is conducted by DTD. In the RC watershed, approximately 83 miles of streets were swept by DTD in 2007.

As the watershed develops further, it is expected that enhanced water quality treatment requirements for new development and re-development will be in place to protect water quality from degradation. It will be important for enhanced water quality treatment requirements to be applied to existing and new roads as well as to residential, institutional, commercial, and industrial development. In addition, it will be valuable for water quality treatment to be focused on protecting and enhancing ecosystem services (e.g., through buffer protection and enhancement) and to utilize LID techniques to integrate water quality treatment into landscaping and biologically-based treatment systems wherever possible.

Happy Valley, WES, Sunrise Water Authority, and Portland State University recently collaborated on the Rock Creek Sustainability Initiative (RCSI), which is a sustainable development test project for a 400-acre area in Happy Valley intended for commercial, institutional and industrial development. If implemented, application of the RCSI study results to planned future developments will assist in protecting watershed functions and natural resources in the watershed.

Key water quality issues in the RC watershed include the following:

- Stream temperatures exceed water quality criteria for summer conditions.

  Elevated water temperatures have been observed in mainstem Rock Creek and some tributaries during the summer. Riparian canopies and forests have been altered and removed in portions of the watershed, leaving the streams open to increased heat gain from solar radiation. The influx of cold spring water to the streams still occurs in some locations, but may have been reduced due to changes in land use and hydrology in the watershed from historical conditions. Modifications to the landscape including installation of impervious surfaces and drainage associated with agriculture has likely reduced infiltration and aquifer recharge. In addition, groundwater pumping in the area has resulted in portions of the watershed being identified as groundwater limited resources by the State of Oregon. These changes may have resulted in less groundwater discharge to streams during the summer. Less groundwater discharge can increase stream temperatures because groundwater tends to be cooler than surface runoff during the summer, and less total flow in the stream allows solar radiation to affect a greater proportion of the water column.

- Benthic macroinvertebrate and fish population surveys indicate that conditions in the streams in the watershed vary considerably.

  Sampling in the lower reach of Rock Creek generally indicates acceptable (unimpaired) and slightly impaired biological communities for fish and benthic macroinvertebrates, respectively, which is indicative of fair to moderately good water quality on average. The middle reach of Rock Creek and Upper Trillium Creek support moderately impaired benthic macroinvertebrate communities. The middle reaches of Rock Creek are more severely impaired for fish, and the upper reaches are marginally impaired for fish. Although there may be water quality issues affecting fish populations in the middle and upper reaches of Rock Creek (in particular water temperature), habitat conditions also likely play a role in supporting diverse and sustainable fish populations in these areas.

  Potential factors limiting biological potential of Rock Creek include landscape erosion and sedimentation in streams, increased water temperatures, and hydrologic regime disturbances. Water quality pollutants such as pesticides, dissolved metals, and other toxic materials could also be contributing to the reduced biological quality in the streams. Additional study of stream conditions and targeted water quality monitoring efforts may provide further insight into the contributing factors and help guide WES management activities intended to improve the biological index and overall watershed health results.
- Elevated levels of *E. coli* bacteria, a key indicator of water contact human health issues, have been found throughout the watershed.

  E. coli bacteria are associated with fecal matter, which can contain a wide range of pathogenic organisms. There are many potential sources of *E. coli* in streams including birds, wildlife, pets, livestock, and humans. The sources of *E. coli* in the RC watershed are not well understood at this time. Increased understanding of sources would be helpful to guide management activities to address this issue.
- Elevated levels of total phosphorus (TP) and pesticides have been observed in water quality samples collected in the watershed.

  Elevated nutrient levels and pesticides potentially could be due to use of fertilizers and pesticides in the residential area and/or poor land management practices associated with farm, nursery, and forest land areas.
- The expected future development in the watershed poses a high risk for in-stream sedimentation.

  The large amount of new development expected in the RC watershed in the coming years will require proactive inspections and careful management of construction site runoff to protect water quality.
- Inadequate water quality data are currently collected to adequately characterize the full watershed.

  Water quality data historically have been collected and are currently being collected at two locations in the watershed, Site #16 near the mouth of Rock Creek and Site #25 near Southeast Sunnyside Road. Collaboration with Happy Valley and Damascus to implement additional water quality monitoring sites on the tributaries and in the upper reaches of the watershed would provide valuable information to better characterize water quality throughout the watershed and to track changing conditions over time as further development occurs.

Summary of Recommended Actions

An active management strategy to improve and maintain water quality in the RC watershed is recommended for watershed health. Many of the potential actions described above for addressing hydrologic issues will also serve to improve water quality. Additional potential actions that will support the active management strategy to improve water quality include the following:

- Develop an integrated, comprehensive, and long-term monitoring plan that addresses key questions and provides a framework for organizing and analyzing data from all sources (water quality sampling, flow measurement, biological surveys, and special studies).

- In collaboration with Happy Valley and Damascus, expand water quality monitoring locations to more fully characterize water quality and geomorphic conditions throughout the watershed.
- In collaboration with Happy Valley and Damascus, expand benthic macroinvertebrate sampling locations and frequency to support the Watershed Health Index (WHI). A more extensive survey of benthic macroinvertebrates was conducted in 2003 for Metro when eight riffle habitats were sampled throughout the watershed. These sites possibly could be sampled again with landowner permission to compare changing conditions.
- Consider a Microbial Source Tracking project to increase understanding of *E. coli* bacteria sources.
- In collaboration with DTD, Happy Valley, and Damascus, develop a stormwater quality retrofit and prioritization program for existing roads.
- Continue implementing the private water quality facility inspection and maintenance program.
- In collaboration with Damascus and DTD, evaluate opportunities to enhance street sweeping effectiveness in reducing pollutant loads from high volume roads outside of Happy Valley through increased frequency and enhanced technology.
- Develop monitoring and evaluation processes to analyze the effectiveness and results associated with non-structural BMPs.

Aquatic Habitat and Biological Communities Issues and Opportunities

The RC watershed forms a patchwork of forested habitats and riparian corridors mixed with agricultural lands, roads, houses, and other development. The influences of development in the watershed have fragmented habitat connections and impacted the water and habitat quality of the riparian zones. However, there are still large patches of upland forest habitat and vegetated riparian corridors that provide dwelling, feeding, and nesting habitat and movement and migration for many of the region's resident wildlife species. If the current connections between large habitat patches are maintained and enhanced, and smaller patches are connected, the landscape in the watershed can likely continue to provide for the resident and migratory wildlife species that use the area. As further development occurs, preservation of forest canopy and wetlands will be important to maintaining biological communities.

The mainstem of Rock Creek supports a relatively diverse assemblage of native aquatic life. Recent sampling conducted by ODFW in 2008 indicates that Steelhead and Rainbow trout, Coho salmon, Chinook salmon and Cutthroat trout are present within the watershed. A naturally occurring, 23-foot waterfall located at approximately river mile (RM) 1.3 restricts anadromous salmonids (i.e., Coho, Chinook, Steelhead, Rainbow, and searun Cutthroat trout) to the lower reaches of the creek. These species also have access to the lower 0.4 mile of Trillium Creek, which joins Rock Creek near its mouth. Cutthroat trout is the only native salmonid species present in the watershed upstream of the falls at RM 1.3.

The mainstem of Rock Creek has been surveyed for aquatic habitat conditions through Reach RK7, shown in Figure 5-1. Above Reaches RK6 and RK7 the stream conditions have not been evaluated in detail. There are also several tributaries, including Trillium Creek and unnamed small drainages, that have not been surveyed in detail (a small portion of Trillium Creek near its confluence with Rock Creek has been surveyed).

Many of the issues related to hydrology and water quality also impact aquatic habitat and biological communities. Additional key aquatic habitat and biological communities issues in the RC watershed include the following:

- Native and sensitive fish populations are present, although limiting factors within and beyond the watershed affect population size, diversity, health, and sustainability.

  Historic sampling indicates that Chinook salmon, Coho salmon, and Cutthroat and Steelhead/Rainbow trout are present in Rock Creek year-round below the falls, but their numbers are highly variable. Resident Cutthroat trout and Rainbow trout are rare above the falls, but have been collected as far upstream as fish reach RK5-F. Trillium Creek (TR01) has been sampled only sporadically, but it appears to provide rearing habitat for juvenile Coho and Chinook salmon and Rainbow/Steelhead and Cutthroat trout (although Cutthroat trout have been identified less often). TR01 is accessible to anadromous salmonids up to the impassible barrier 0.4 mile upstream from the mouth. No salmonids have been collected above the impassible barrier. Limiting factors for fish populations likely include elevated summer stream temperatures and degraded aquatic habitat. Other water quality issues and fish passage impediments may also be limiting factors.

- Opportunities for improvements to aquatic habitat.

  In the analysis of aquatic habitat conditions in Chapter 4, there were many low and moderate scores on the habitat parameters. This suggests that there is opportunity for restoration and room for improvement in the physical components of fish habitat within the watershed. ODFW is developing detailed habitat improvement recommendations as a part of its 2008 survey of the watershed.

  The lower reaches of Rock Creek (RK1 to RK3) generally provide better habitat conditions than the middle and upper reaches. Lower Rock Creek habitat reaches RK1 to RK3 had high rankings on percent fines in riffles, percent pools, deep pools per kilometer, and percent slackwater pools; but scored poorly on the boulder metrics and to a lesser extent on the percent secondary channels and percent gravel in riffles. The middle reaches (RK4 through RK6) scored relatively high on percent pools but poorly on secondary channels, boulders, and the three LWD metrics. The upper reach (RK7), corresponding to fish reach (RK5-F), scored moderately on percent pools and percent fines (silt, organics, and sand particles smaller than 2 millimeters in diameter) and gravels in riffles, but scored poorly on the remainder of the metrics. Trillium Creek below the barrier at RM 0.4 scored high or moderate on all metrics but deep pools per kilometer, percent secondary channels, and percent fines in riffles.

- Opportunities to reduce fish passage barriers.

  In the ODFW habitat surveys, two significant artificial dams were identified in Reach RK4, one shortly above Southeast Sunnyside Road and the other at Pleasant Valley Golf Course. The nature of these dams and their degree of blockage is unknown at this time. Clackamas County lists nine culverts for replacement in the RC watershed. These culverts may present partial or full barriers to resident cutthroat trout, and may prevent them from fully utilizing habitat that otherwise may be suitable. One of the culverts is located on the Rock Creek mainstem at the Troge Road crossing, while the remainder are located on minor tributaries. Although Clackamas County does not currently list the long box culvert on Rock Creek at Southeast Sunnyside Road as a potential barrier, it should likely be listed as a partial barrier. DTD is expanding Southeast Sunnyside Road in this area and a new bridge crossing is planned, however the plans for the existing box culvert are not known at this time. Prioritization for replacement of these culverts will require additional site-specific information on the condition of the culverts, the species affected, available upstream habitat, and transportation risks and costs.

Summary of Recommended Actions

An active management strategy aimed at targeted investments in enhancing aquatic habitat and biological communities is recommended. Many of the potential actions described above for addressing hydrologic issues and water quality issues will also serve to improve or maintain aquatic habitat and biological communities. Additional potential actions that will support the targeted management strategy to enhance aquatic habitat and biological communities include the following:

- Continue partnering with agencies, nonprofits and volunteer groups to make strategic, targeted improvements in aquatic habitat and biological communities. As discussed above in the Hydrology section, there may be opportunities to partner to undertake active restoration of degraded stream channels, buffer areas, floodplains, and wetlands on private lands with cooperating landowners. Large development projects in particular may provide opportunities to work with landowners to implement significant stream restoration or wetland restoration activities.

- Engage in targeted outreach with private landowners and partner with other agencies and nonprofits to improve aquatic habitat and stream conditions through LWD placement, bank stabilization, and buffer enhancements.
- Evaluate areas lacking shade and engage in buffer enhancements on public land and private land (where feasible) to support aquatic habitat and temperature total maximum daily load (TMDL) implementation.
- Consider additional policies to support riparian buffer enhancement during development, similar to the Clean Water Services design standards that require invasive plant removal and revegetation of buffers when stream-side parcels are developed.
- Consider development policies and incentives to protect tree canopy and native vegetation communities during development.
- Consider incentives and policies to support habitat restoration and preservation on developable parcels.
- Collaborate with DTD and other applicable agencies to further evaluate fish barrier removal priorities.
- Integrate ODFW recommendations on habitat improvement opportunities into partnering efforts and Capital Improvement Program (CIP) planning as appropriate.

Watershed Action Plan

The Watershed Action Plan actions were developed based on the recommended management strategies and potential actions described in the Assessment Report, input provided by Stakeholders during Stakeholder Meetings, and input provided by WES staff. There are many potential actions that WES could undertake as a part of its surface water management program. The project team developed a list of actions that are most likely to assist WES in meeting its LOS goals in the near term. Additional potential actions that are not included in the current Action Plan may be incorporated by WES into longer term actions in the future. The Action Description Sheets in Chapter 6 provide details on the recommended actions.

Stakeholder Input

A stakeholder group was convened in the fall of 2008 to participate in the Watershed Action Planning process and provide feedback on the results of the study to the Clackamas County Citizens Advisory Committee (CAC). Stakeholders met in October and November of 2008 and in March, April and June of 2009. Stakeholders discussed areas of concern and opportunity in the watershed, possible watershed management actions, provided input on the importance of actions, and provided feedback on the Action Planning process. Further information on stakeholder involvement is included in Chapter 5.

Summary of Actions

The Watershed Action Plan contains recommended capital improvement projects, programmatic measures and capital improvement programs that address watershed issues and opportunities identified in the Assessment Report. The Watershed Action Plan includes recommendations for both the Kellogg-Mt. Scott and Rock Creek watersheds, because those watersheds were evaluated at the same time.

Capital Improvement Projects

Capital improvement projects recommended in this plan include stream channel and restoration work in Dean Creek, Mt. Scott Creek and Rock Creek as well as construction of a regional decant facility. These actions are listed as capital projects because they are primarily focused on implementation of specific construction activities.

Programmatic Measures

The Action Plan proposes a variety of programmatic (or operational) measures. Programmatic measures developed for this action plan include the continuation of current District programs and implementation of new programs, which are directed toward regulations, design standards, studies and monitoring, watershed enhancement, policy and practices, customer service, and coordination with other entities.

Capital Improvement and Programmatic Measures

The Action Plan proposes a variety of measures that include both capital improvements and programmatic elements within a larger program effort. The purpose of this approach is to provide the District with programs that will develop, implement, and monitor projects to improve basin hydrology, water quality, and aquatic habitat while also providing capital improvement funding for the implementation of those projects. There are many specific locations in the watersheds where capital projects could be implemented as a part of the combined capital improvement and programmatic measures, as described further in Chapter 5.

A summary table of the actions is provided below (Table ES-1). Actions that include elements related to specific Stakeholder Group recommendations are noted. A more detailed summary table is provided at the end of this chapter, along with Action Description Sheets that provide detailed information on each action.

Prioritization

Actions were prioritized based on the action's capacity to meet the District LOS goals in a workshop setting with WES staff, using a LOS prioritization tool. The LOS prioritization tool is a decision-support tool for WES. The prioritization score for actions that results from the LOS prioritization process is one of the key factors considered in the implementation sequencing of the Action Plan. Other important considerations included current District opportunities, needs, and planned projects. Table ES-1 below summarizes the high priority actions for 2009-2010 based on the LOS analysis and current District opportunities and needs.

The process for prioritizing the actions included the following steps:

1. Develop LOS goals and performance measures (described in Appendix D).
2. Evaluate current and anticipated future metrics for WES activities against LOS goals and performance measures. Determine the "LOS gap" for each performance measure (described in Appendix D).
3. Evaluate actions in terms of action's capacity to close the LOS gap for each performance measure using consistent LOS prioritization tool that provides scores for prioritization of each action.
4. Evaluate prioritization scores for each action as well as other factors such as current District opportunities, needs, and currently planned projects. Develop list of High Priority Actions for 2009-2010 implementation.
5. Adaptively manage Action Plan prioritization as needed to reflect changing priorities and opportunities.

Implementation

To implement the Action Plans, the WES Surface Water Management Steering Committee is organizing the work into program categories and developing a multi-year budgeting outlook under current funding and under proposed LOS funding. Implementation of the Action Plan will depend on the available resources. WES operates the Districts and provides wastewater and surface water management services using revenue from several sources. The Surface Water Management Program for CCSD No. 1 is funded through three primary sources: monthly SWM utility fees, systems development charges (SDCs), and permit fees. WES currently spends approximately $0.5 million annually on the existing programmatic elements of the Surface Water Management Program. These program elements are described in Appendix A. The amount of capital expenditures made by WES each year varies.

The recommended actions summarized in Table ES-1 describe programmatic activities and capital expenditures that will move WES toward meeting its LOS goals. It is anticipated that as part of implementing the WAPs, WES will evaluate resources and funding to support the Action Plans and to meet future LOS goals.

The estimated cost for implementing all recommended actions over a five-year period is approximately $22.4 million, an average of approximately $4.5 million per year. The estimated cost for implementing the Action Plans over a five-year period is presented in 2009 dollars. Of the approximately $4.5 million per year in expenditures recommended in the Action Plans, approximately $1.0 million (20 percent) is for programmatic elements and approximately $3.5 million (80 percent) is for capital expenditures.

Table ES-1. WES Watershed Action Plan Summary

Action Name[1]	5-Year cost (2009 dollars[2])	High Priority 2009-2010	Stakeholder Rec's[3]
D-19 Stakeholder Communication Plan	$200,000	X	X
D-7 Update Erosion Control Protocol	$72,000	X	
RC-2 Regional Detention Prop Ac	$3,540,000	X	
D-3 Integrated Monitoring Program	$354,000	X	X
D-10 Benthic Macro Surveys	$390,750	X	X
D-4 Channel Morph Monitoring	$315,000	X	
D-11 Microbial Source Study	$106,000	X	
D-1 Update SW Design Standards	$355,200	X	X
D-5 Improve Riparian Buffer	$600,000	X	X
D-2 SW Detention Retrofit	$412,000	X	X
KMS-1 Enhanced Street Sweeping	$572,000	X	X
RC-1 Wetlands Reach RK5	$1,434,238		X
RC-5 Pilot Graham Ck Basin	$500,000		X
D-13 WET Retrofit Program	$1,400,000		X
KMS-3 Dean Creek Wetlands	$741,000		X
D-8 Erosion Control Hotline	$33,800		X
KMS-4 Mount Scott in 3 Creeks	$253,692		X
D-20 Regional SW Task Force	$40,000		X
KMS-5 Flood-prone Culverts	$417,500		
KMS-6 Willing-seller Program	$2,048,000		X
D-12 Street Retrofit Program	$1,032,000		X
KMS-8 WQ Man-made Lakes	$43,375		X
D-14 Private WQ Inventory	$560,000		X
RC-4 Riparian Buffer Acq RC5	$270,000		X
RC-3 Riparian Buffer RK1 RK2	$76,000		X
KMS-9 Kellogg-for-Coho Init	$3,200		X
D-9 Track Flood Complaints	$20,000		
D-16 LWD w Partners	$133,750		X
KMS-2 Evaluate Low Summer Flow	$16,000		X

Table ES-1. WES Watershed Action Plan Summary

Action Name[1]	5-Year cost (2009 dollars[2])	High Priority 2009-2010	Stakeholder Rec's[3]
D-18 Improve fish passage	$1,667,000		X
D-17 Invasive Species Mgmt	$140,000		X
D-6 Upland Tree Canopy	$165,000		X
D-15 Riparian Buffer Analysis	$20,000		X
D-21 Regional Decant Facility	$2,000,000		
D-22 (AEX) Erosion Control	$330,145	X	
D-23 (AEX) Sampling/WQ	$170,960	X	
D-24 (AEX) Spills/Illicit Discharges	$68,435	X	
D-25 (AEX) Planning & Projects	$463,300	X	
D-26 (AEX) On-Site Maintenance	$885,165	X	
D-27 (AEX) Regulatory	$234,570	X	
D-28 (AEX) Customer Service Coordination	$102,035	X	
D-29 (AEX) Intergovernmental Coordination	$99,495	X	
D-30 (AEX) SWM Program Admin	$133,340	X	

[1] In the Action Names, "D" signifies a District-wide action, "KMS" signifies an action in the Kellogg-Mt. Scott watershed, "RC" signifies an action in the Rock Creek watershed, and "AEX" signifies an existing program element.

[2] Five-year cost estimates are in 2009 dollars and do not include inflation or the cost of capital.

[3] Denotes actions that include specific recommendations provided by Stakeholder Group.

CHAPTER 1 – WATERSHED OVERVIEW AND POLICIES AND PRACTICES

Overview

Water Environment Services (WES), a department of Clackamas County, conducts and manages surface water and wastewater management services in several districts including Clackamas County Service District No. 1 (CCSD No. 1). WES' surface water management program reviews development plans, maintains stormwater facility infrastructure, and conducts activities to protect and enhance the health and function of the watershed, including water quality, aquatic habitat, and hydrologic functions.

WES is completing the Rock Creek (RC) Watershed Action Plan (Action Plan) in order to prioritize surface water management program activities and future investments for watershed management. The approach to the Action Plan process is illustrated in Figure 1-1. The key elements of the Action Plan include the following:

- **Characterization Report**. The Characterization Report includes an inventory of watershed conditions, an identification of key factors limiting watershed health, and a summary of WES activities that affect watershed health based on existing information. The Characterization Report is contained in Chapters 1 through 4 of the Action Plan.
- **Assessment Report**. The Assessment Report includes an assessment of watershed conditions based on the characterization report results and identifies specific WES surface water programs, projects, and activities that are appropriate to efficiently and effectively improve watershed health. The Assessment Report is contained in Chapter 5 of the Action Plan.
- **Action Plan Summary**. The Action Plan Summary includes an evaluation and prioritization of the programs, projects, and activities described in the Assessment Report using scientifically-based criteria and an asset management Level of Service (LOS)-based evaluation process. The Action Plan Summary provides a process for sequencing the actions for implementation. The Action Plan Summary is contained in Chapter 6 of the Action Plan.
- **Implementation and Adaptive Management**. WES will implement the Action Plan components over time, and monitor and adapt the Action Plan components as needed to continually improve watershed health.

Figure 1-1. Watershed Action Planning Process

This chapter includes an overview of the RC watershed, an overview of the approach used to evaluate and characterize the watershed, and a summary of WES policies and practices that affect watershed health. Chapters 2 through 4 summarize information related to hydrology, water quality, and aquatic habitat and biological communities, and include discussions of the data reviewed for the characterization, data gaps identified, and watershed conditions and limiting factors. Chapter 5 contains a synthesis of the data evaluated in Chapters 1 through 4, including a reach-by-reach analysis of the stream and contributing area conditions.

Chapter 6 contains the recommended actions developed based on the Chapter 5 assessment to assist WES in achieving its LOS goals.

Watershed Overview

The RC watershed, illustrated in Figure 1-2, encompasses approximately 6,280 acres in the northwestern portion of Clackamas County on the outskirts of the Portland metropolitan area. Rock Creek begins in the hills east of Interstate 205 and flows southwest to its confluence with the Clackamas River. Elevations in the watershed range from more than 800 feet above sea level to approximately 70 feet above sea level. Trillium Creek is a major tributary that discharges to Rock Creek in the lowest reach. Major named sub-basins for tributaries have not been identified for the RC watershed, although the watershed has been divided into sub-basins for hydrologic and hydraulic modeling purposes.

The RC watershed has not yet been heavily developed for urban uses, although western drainages and its urban areas are growing and are expected to continue to grow significantly in the future within both the Cities of Happy Valley and Damascus. The RC watershed streams have been impacted by agriculture, roads, and other rural development since the early 1900s. Most of the land in the watershed is currently used for agriculture, nurseries, private forest land, open space, and rural residences. The watershed was estimated to be about 8 percent impervious in 2004.

Metro, the regional government and planning agency for the Portland metropolitan area, periodically analyzes land cover in the region using aerial photographs. The 2007 land cover analysis from Metro indicates that approximately 40 percent of the RC watershed is forested, 47 percent of the watershed is vegetated with grass, shrubs, or agricultural vegetation, and 13 percent of the watershed is comprised of built or “scarified” areas which includes buildings, pavement and some compacted or dry exposed soil areas. Due to the rapid growth in the area, the 2007 Metro built land classification is used as a current estimate of impervious area in the watershed in this report. Table 1-1 summarizes the characteristics of the RC watershed.

The land use in the watershed is currently classified as about 29 percent residential and rural residential, 19 percent farmland, 18 percent forestland, and 28 percent “tractland.” These classifications include both developed land uses and vacant land uses that fall into these categories. In addition, due to the large sizes of rural residential parcels and tractland in the watershed, these land uses are currently less densely developed than similar land use classifications may be in other more developed watersheds in CCSD No. 1.

Table 1-2 summarizes the jurisdictional areas in the RC watershed. Thirty-five percent of the watershed is within the City of Happy Valley. Twelve percent of the watershed is currently within CCSD No. 1. CCSD No. 1 includes portions of the City of Happy Valley, as shown in Figure 1-2. The eastern portion of the watershed is in the City of Damascus, which encompasses about 57 percent of the watershed. As development occurs in the Happy Valley and Damascus areas recently included in the urban growth boundary (UGB), there may be a transition of providers of stormwater management services from the Clackamas County Department of Transportation and Development (DTD) to the cities of Damascus and Happy Valley or to WES through intergovernmental agreements (IGAs) with the cities and/or through the expansion of CCSD No. 1 to include portions of the cities. Five percent of the watershed is currently in unincorporated areas outside of CCSD No. 1.

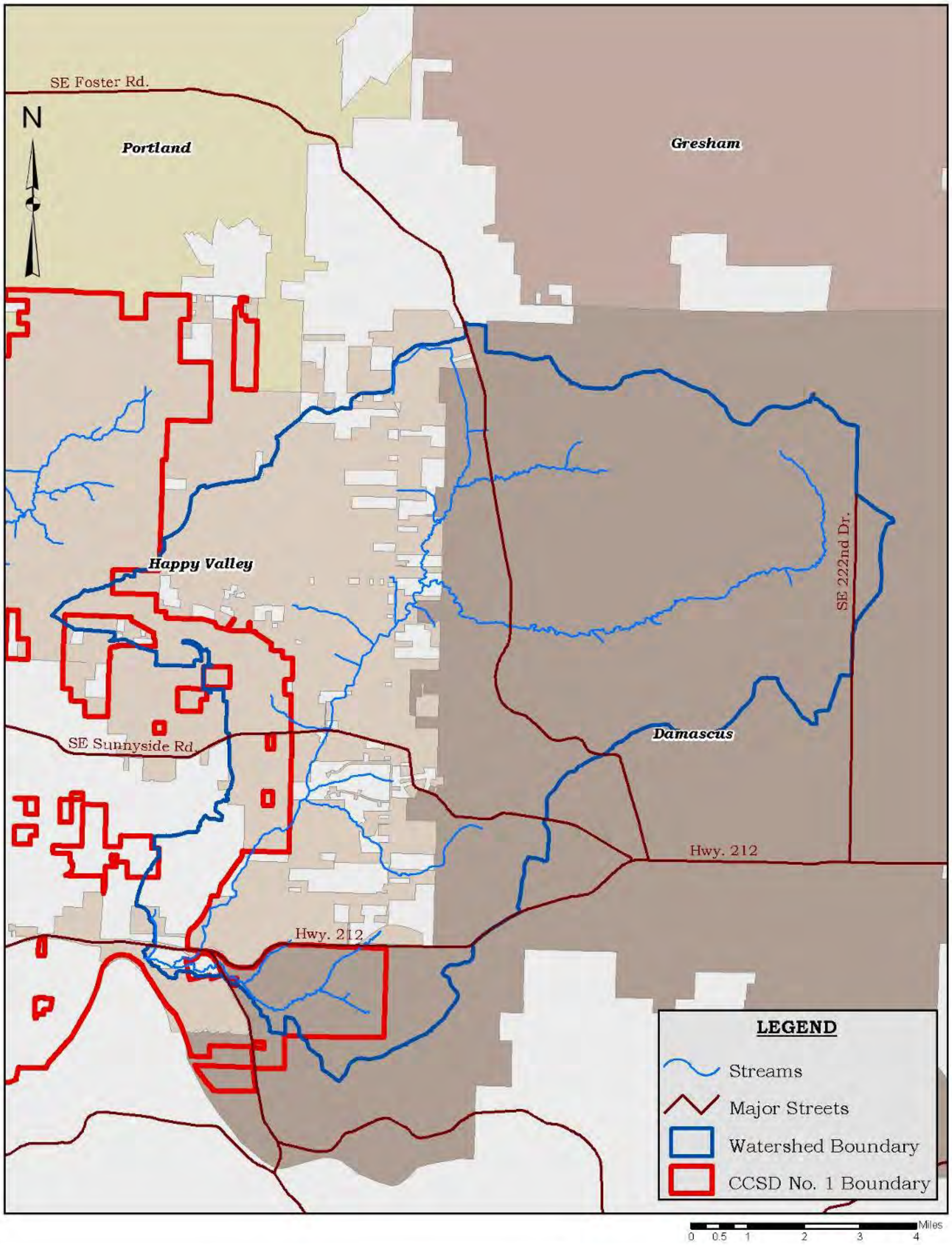

Figure 1-2

ROCK CREEK WATERSHED OVERVIEW

WES WATERSHED ACTION PLAN

WATER ENVIRONMENT SERVICES

Beyond clean water. www.clackamas.us/wes

SWANSON HYDROLOGY + GEOMORPHOLOGY

Ellis Ecological Services, Inc.

(BCTUC02)T:\Folder\Folder\GIS\ARCMAPS\FIGURES\Figure#

Table 1-1. RC Watershed Characteristics

Watershed	Area, square miles	Primary land use	2007 Total estimated impervious area, percent[1]	2007 estimated canopy in watershed, percent[2]	2004 Q100 Peak flow, cfs[3]	2004 Q100/ drainage area, cfs[4]/square mile
Rock Creek	9.67	Rural residential, agriculture, limited urban	13	40	923 (based on 8 percent impervious)	95 (based on 8 percent impervious)

[1] 2007 Metro land cover analysis from aerial photos.

[2] 2007 Metro land cover analysis.

[3] Peak flow in stream during 100-year recurrence-interval storm (1 percent probability of occurring each year) estimated from 2006 hydraulic model based on 2004 land cover data.

[4] cfs = cubic feet per second

Table 1-2. Jurisdictional Areas in the RC Watershed

	CCSD No. 1	Happy Valley[1]	Damascus	Unincorporated outside CCSD No. 1
Percent of land in RC watershed	12	35	57	5

[1] Portions of Happy Valley are contained within CCSD No. 1 as illustrated in Figure 1-2. The overlap in some jurisdictional areas results in this summary not totaling to 100 percent.

The RC watershed is currently on the edge of the Portland metropolitan area, which is generally distinguished by the UGB. The purpose of the UGB is to make a distinct separation between urban and rural lands. The UGB is expanded periodically by Metro to allow for new growth in residential, commercial, and industrial land uses. In 1979, when the UGB was first established, the RC watershed was outside the UGB. In 1998, approximately 670 acres of the RC watershed were added to the UGB and annexed to Happy Valley. In December 2002, Metro expanded the UGB significantly in Clackamas County, adding 12,200 acres in the Damascus/Boring area east of Happy Valley and south of Gresham. As a result, the entire RC watershed is now within the UGB and significant growth in the area is expected.

The City of Damascus was incorporated in 2004 and is in the process of developing municipal codes, zoning ordinances, policies, master plans for infrastructure, and an ecosystem services evaluation for natural resources. Until the comprehensive plan and zoning ordinance are adopted, Damascus will continue to operate under the provisions of the Clackamas County comprehensive plan and zoning and subdivision ordinance. Damascus currently contracts with Clackamas County Planning to administer the zoning ordinance. Happy Valley is also updating its comprehensive plan and zoning to address the expected growth from the expansion of the UGB and new areas recently annexed into Happy Valley. In 2006, Clackamas County, Metro, the Oregon Department of Transportation (ODOT), Happy Valley, Damascus, and other stakeholders collaborated to develop the Damascus/Boring Concept Plan. The Concept Plan identifies general patterns for future urban development and natural resources protection in the UGB expansion area.

In 2005-2008, Happy Valley, WES, and Sunrise Water Authority collaborated on the Rock Creek Sustainability Initiative (RCSI), which is a sustainable development test project for a 400-acre area in the lower RC watershed within Happy Valley intended for a variety of land uses, mainly commercial, institutional, and industrial development. The RCSI is focused on evaluating low impact development (LID) or sustainable development opportunities to reduce stormwater impacts and protect watershed functions during development of this portion of the RC watershed.

Damascus is currently using an Ecosystem Services Approach for its public facilities and infrastructure planning efforts in order to protect watershed functions and values and integrate the existing ecosystem into the built environment. In the near future, Damascus plans to apply the Ecosystem Services Approach in the development of a stormwater master plan for the Rock Creek area and other watersheds in Damascus. WES has been invited to participate as a partner along with other stakeholders in this planning process.

General concerns and challenges within the watershed include but are not limited to future development and associated impervious surfaces, steep slopes, flooding and erosion, poor streamside practices, removal of existing vegetation and a lack of riparian vegetation, invasive and non-native species, fish passage, limited groundwater resources, and water quality impairment including nutrient, sediment, and pesticide loadings.

The RC watershed is characterized by the Natural Resources and Conservation Service (NRCS) as having warm, dry summers and cool, moist winters. Temperatures, winds, and rainfall vary with elevation, slope aspect, and degree of vegetative cover. The average daily temperature is 41 degrees Fahrenheit (F) during the winter and 64 degrees F during the summer. Average annual rainfall ranges from 35 to 45 inches in the watershed. Seventy-five percent of precipitation usually falls from October through March. From November through January, monthly precipitation averages approximately 6 inches. Summers are usually dry.

Soils in the RC watershed are predominantly NRCS hydrologic group C with some group B soils present. Type C soils are characterized by the NRCS as somewhat poorly drained with slow to rapid runoff and low permeability. The existing drainage system has been modified in areas, primarily by agricultural activities, residential development in Happy Valley, and roads in the watershed. Efforts to improve drainage in agricultural areas have included the installation of drain tile and the excavation of ponds, ditches, and swales.

Hydrologic and hydraulic modeling of the watershed has indicated that the streams may experience flashier high peak flows than would generally be expected given the relatively low level of imperviousness in the watershed. This may be due to the soils in the watershed, the loss of forest cover in the watershed, and the modifications to the drainage system from agricultural land uses. A number of springs feed Rock Creek and its tributaries. The portion of the watershed in the Damascus area has been classified by the Oregon Water Resource Commission as being a Groundwater Limited Area. Hydrology and soils are discussed further in Chapter 2.

Current water quality issues in the watershed include elevated levels of *E. coli* bacteria, elevated summer water temperatures and elevated levels of sediment and pesticides found in Rock Creek. Available water quality data and the impacts of land use in the watershed on water quality are discussed in more detail in Chapter 3.

The lower reaches of both Rock and Trillium Creeks are sensitive areas with valuable aquatic habitat and relatively small but important salmonid populations. Coho and Chinook salmon are present in small numbers, along with larger populations of Rainbow/Steelhead trout, Cutthroat trout, redside shiner, reticulated sculpin, and speckled dace. There is a 22-foot-high impassable natural waterfall located approximately 1.2 miles upstream from the confluence with the Clackamas River that prevents anadromous fish usage of the upper reaches of the stream. There are multiple and diverse wetlands in the watershed and mature forests in both riparian and upland areas that provide important habitat, particularly in the northern and eastern portions of the watershed (Winterbrook, 2007). Additional aquatic habitat and biological community issues are discussed further in Chapter 4.

Photos 1-1 through 1-9 of the RC watershed follow.

Photo 1-1. Lower Rock Creek

Photo 1-2. Rock Creek at Highway 224 bridge

Photo 1-3. Rock Creek above Highway 224

Photo 1-4. Middle reach of Rock Creek

Photo 1-5. Middle reach of Rock Creek

Photo 1-6. Upper reach of Rock Creek at Troge Road

Photo 1-7. New development in the RC watershed

Photo 1-8. Road expansion in the RC watershed

Photo 1-9. Stormwater treatment in the RC watershed

Watershed Characterization and Assessment Process

The watershed characterization was used to develop the watershed assessment and the Action Plan. The watershed characterization and assessment process evaluates watershed health stressors, responses, and key indicators, as illustrated in Figure 1-3.

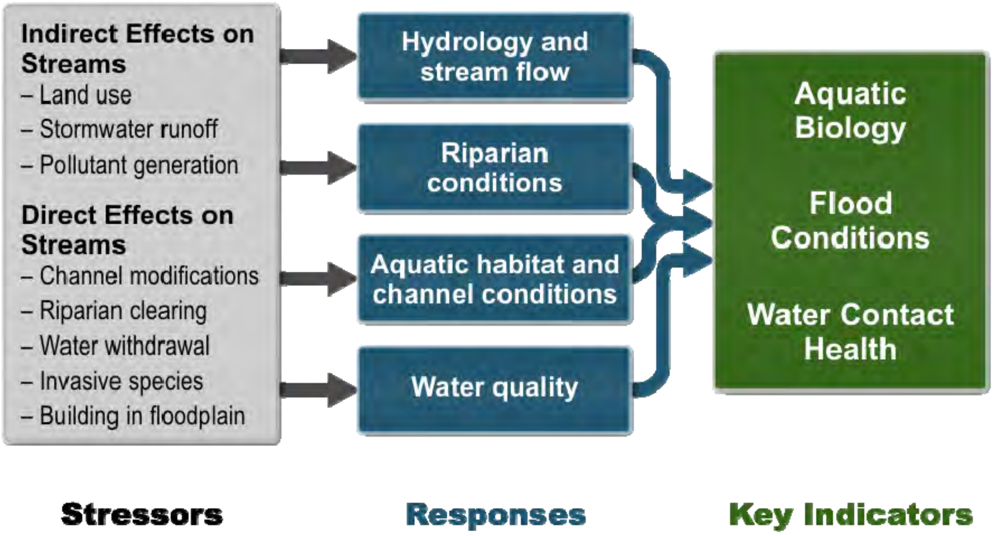

Figure 1-3. Watershed Characterization and Assessment Process (Modified from Booth et al., 2005 and Karr and Yoder, 2004)

The watershed characterization and watershed assessment will help WES do the following:

- Identify features and processes important to hydrology, biological, habitat, and water quality resources
- Determine how natural processes influence those resources
- Understand if/how human activities and WES stormwater management practices are affecting resources and limiting watershed health conditions
- Evaluate the cumulative effects of land management and stormwater management practices over time

The Characterization Report contains the initial analysis of key indicators, responses, and stressors in the watershed. Watersheds respond differently to stressors in the environment depending on the extent of modification to the watershed (such as how much riparian clearing has occurred and how stormwater runoff is collected, treated and conveyed) as well as the interaction between stressors (such as the combination of effects from water withdrawals and riparian clearing on water temperatures). Watershed conditions such as soils, slopes, vegetation, and stream morphology also play an important role in how watersheds respond to stressors. Evaluating key indicators of watershed health helps to determine how a watershed is responding to the unique combination of stressors in the environment. The results of the watershed characterization will be used in the watershed assessment to identify what management strategies and priority activities and actions are likely to improve functions and conditions.

In Chapters 2, 3, and 4 of this report, key indicators are evaluated using available data that provide insight into how a combination of stressors and responses are affecting watershed health. Examples of key indicators evaluated include benthic macroinvertebrate and fish populations, flood conditions and channel erosion, and concentrations of water pollutants that could affect human health. Stressors such as land use, stormwater runoff, channel modifications, aquatic habitat conditions, and riparian clearing are evaluated and compared to available data on specific watershed responses as well as key indicators in order to understand limiting factors for watershed health. Because several studies have been conducted that document watershed conditions extensively, in particular the 2006 Master Plan, Chapters 2 through 4 do not attempt to describe the watershed exhaustively. Instead, key aspects of available data are summarized and evaluated in the context of the goals for the Action Plan.

Chapters 2 through 4 summarize data on hydrology, water quality, and aquatic habitat and biological communities. These elements of watershed health often contain interrelated problems and integrated opportunities for improvement. Follow-on work in the watershed assessment phase of the project was completed to evaluate interrelated issues and to identify priority actions and management activities appropriate for WES to undertake to address factors that are limiting watershed health.

The watershed assessment was conducted using the information in the Characterization Report (Chapters 1 through 4) with a focus on addressing the following questions that are of interest to WES.

Hydrology

- How can hydrologic goals or flow control objectives be achieved through design standards and retrofitting to improve watershed health?
- Where does regional detention and infiltration make the most hydrological and soil feasibility sense and where is land available to implement these projects?
- What specific stormwater infrastructure structures or areas require retrofits, what are state-of-the-art techniques that can be utilized, and what are the priorities?
- Where is flooding now or in the future potentially a problem?

Water Quality

- What are the most limiting water quality problems, what are the most important potential sources, and what are potential Best Management Practices (BMPs) and solutions for these problems?
- What specific stormwater infrastructure structures or areas require retrofits, what are state-of-the-art techniques that can be utilized, and what are the priorities?
- Where and what parameters should WES monitor in the future to document watershed health and overall effectiveness of programs, policies, actions and to address regulatory permits?

Aquatic Habitat and Biological Communities

- Where are the most sensitive and valuable habitats and functions to protect?
- Where are the highest priority and most degraded stream channel reaches to restore?
- What are the highest priority fish barriers to remove or retrofit?
- Where are the highest priority stream reaches for establishing native vegetation and canopy?

WES Policies and Programs

- How can ecosystem services be protected and enhanced through WES activities and policies?
- What traditional or innovative maintenance practices are most important and where should the focus be?
- Which management policies/programs/activities should be utilized to enhance, protect, restore or address issues identified?
- What are the high priority areas for maintenance/retrofit/Capital Improvement Program (CIP) activities and what is the methodology and criteria for prioritizing these activities?
- What is the current maintenance process, what are the criteria for prioritizing maintenance activities, and who has the responsibility for implementing maintenance of the surface water drainage system?
- What are the recommended prioritized maintenance activities?

- What are the recommended actions for interdepartmental maintenance coordination including recommendations for coordination with DTD?
- What are the recommended actions for the development review process, changes to development standards and development rules and regulations including LID?
- What is the recommended methodology and what are the criteria for prioritizing erosion prevention and sediment control and establishing performance metrics?
- What are the gaps in customer service including opportunities to enhance the Service Request database as a proactive tool for management activities and future CIP identification?
- What information is needed to inform decisions and track performance metrics in the future?

Following completion of the watershed characterization and watershed assessment, the Action Plan will be developed to recommend site-specific and reach-oriented solutions and management programs for problems and opportunities related to flooding, erosion and deposition, water quality, habitat, and other watershed health issues.

WES is incorporating the principles of an Asset Management program into the Surface Water Management program by developing an LOS-based decision-matrix for prioritizing and evaluating the effectiveness of current and proposed projects and activities. The LOS-based decision-matrix and scientifically-based criteria will be used to evaluate, prioritize, and sequence the programs, projects, and activities that are included in the Action Plan.

One of WES' main goals and outcomes of the Action Plan is to be able to prioritize what stormwater management actions and activities should be conducted in specific sub-basin areas, such as where to assist the operations and maintenance program in targeting specific activities in various locales. The Action Plan will be utilized to establish priorities and to provide benefits including the following:

- Raise awareness of issues and constraints
- Identify key problems and opportunities
- Identify areas where efforts should be focused both in terms of protection and restoration efforts and asset management activities
- Implement policies, programs, and standards in specific areas
- Build support for stewardship and implementation, serving as a tool to identify funding needs

WES Policies and Practices

WES is a department within Clackamas County that conducts and manages wastewater and stormwater management services in several districts including CCSD No. 1, the Surface Water Management Agency of Clackamas County (SWMACC), and the Tri-City Service District (the Districts). CCSD No. 1 includes an agreement with and encompasses portions of the City of Happy Valley, as shown in Figure 1-2.

WES has retooled its surface water management program and is transitioning from a utility-based, regulatory driven program to an approach focused on watershed health and integrated watershed management. WES' vision is to improve watershed health by managing its surface water program efficiently and effectively, using financial resources to provide the most benefit through prioritized activities and investments. An organizational chart for WES is provided in Figure 1-4.

Functional program elements within WES that relate to surface water management as shown in the current organizational chart are summarized below. It is important to note that as WES implements its vision to improve watershed health by managing its surface water program efficiently and effectively, changes may be made to the current organizational structure described below.

- Asset management
  - Development plan review and permitting
  - Erosion prevention and sediment control
- Water quality services
  - Stormwater system maintenance
  - Program management
- Environmental monitoring
  - Environmental permit program management
  - Laboratory operation
- Administration
  - Environmental policy and watershed health
  - Public information and outreach
- Business services
  - Customer service
- Financial services
  - Utility billing
  - Asset management reporting

WES currently provides stormwater management and development review services in the western portions of the RC watershed including the CCSD No. 1 service area and the western portions of Happy Valley served through an IGA. DTD currently provides stormwater management and development review services in the less developed portions of east Happy Valley and Damascus that are currently outside the CCSD No. 1 service area.

As development occurs in the Happy Valley and Damascus areas recently included in the UGB, there may be a transition of providers of stormwater management services from DTD to the Cities of Damascus and Happy Valley, to WES, or to another provider such as the City of Gresham. Thus, the coordination of WES, Happy Valley, Damascus, and DTD activities, policies, and practices are important for watershed health in the RC watershed. The policies and practices implemented by WES are also likely to play an increasingly significant role in the protection and improvement of watershed functions.

As discussed above, the City of Damascus is in the process of developing municipal codes, zoning ordinances, policies, and master plans for infrastructure. Until the comprehensive plan and zoning ordinance are adopted, Damascus will continue to operate under the provisions of the Clackamas County comprehensive plan and zoning and subdivision ordinance and DTD will establish stormwater management requirements for development in the area. Damascus currently contracts with Clackamas County Planning (part of DTD) to administer the zoning ordinance. In the future, Damascus is expected to implement stormwater management policies intended to preserve and or enhance ecosystem services.

The purpose of the following section is to summarize existing policies and practices implemented by WES that affect watershed conditions and identify opportunities for potential improvements that will help WES to more efficiently and effectively improve and protect watershed health. These opportunities for potential improvements were evaluated further during the assessment phase of the project (Chapter 5) with WES staff input. Additional detail on the existing policies and practices implemented by WES are provided in Appendix A, including work flows for several program elements.

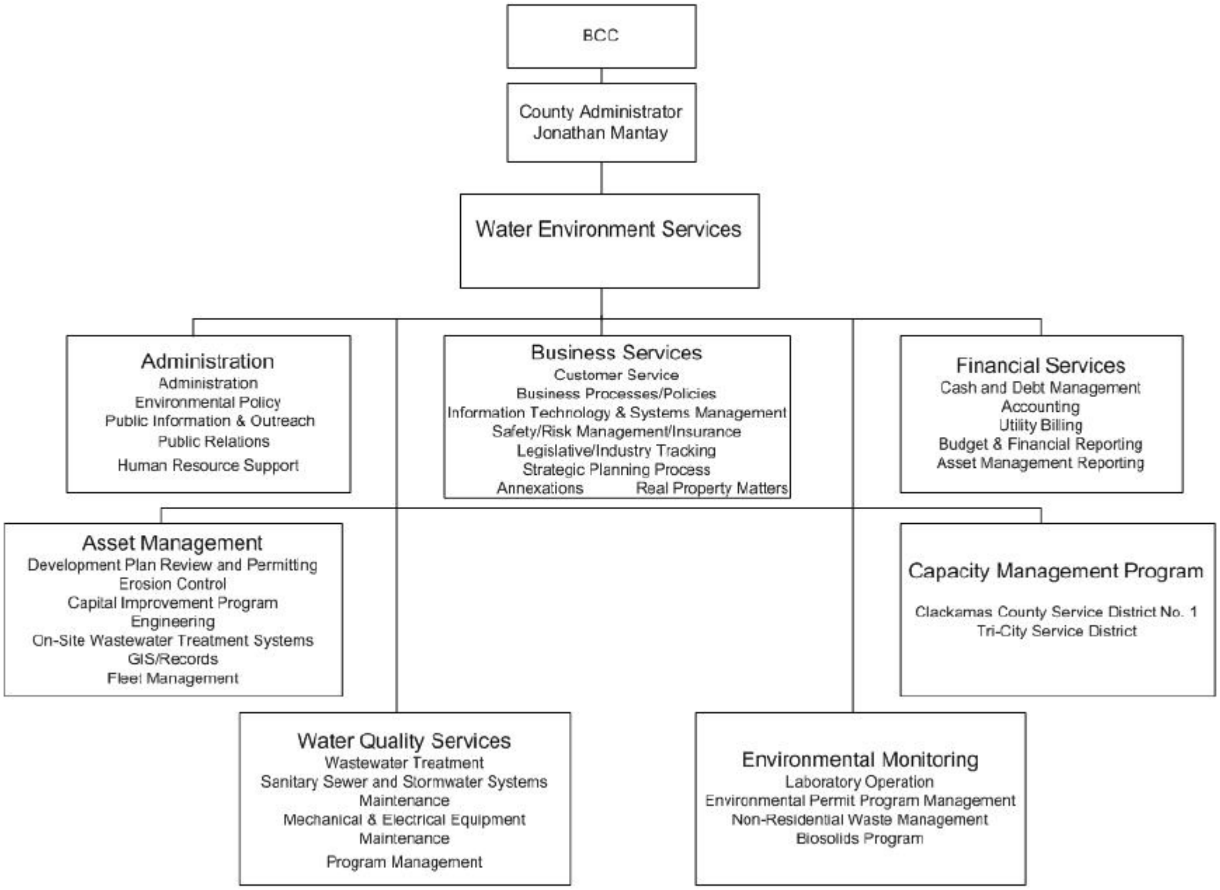

Figure 1-4. WES Organizational Chart

Asset Management

Asset management at WES includes the following program components: development plan review and permitting, erosion prevention and sediment control (ERCO), CIP, engineering, on-site wastewater treatment systems, Geographic Information System (GIS)/records, and fleet management.

The CIP plans, designs, and builds major capital facilities in the three area Districts, so that operating divisions can serve district customers' wastewater and surface water needs. Examples of CIP projects that affect watershed health include regional stormwater detention and treatment systems and public stormwater infrastructure projects, including pipes and bioswales.

The GIS/records program is also an important element of asset management for watershed health. GIS is a useful tool for tracking watershed health metrics and management activities as well as analyzing information about watershed conditions. The WESworks GIS is used by WES staff for data display and queries, such as to identify the location of stormwater assets. ArcGIS is used for data input, storage, and analysis. Opportunities are being identified to improve the efficiency and usefulness of the data collected by WES staff related to environmental monitoring, watershed health, development review, maintenance, and erosion control. The collection, storage, display, and analysis of this data potentially could be improved with assistance from the GIS staff using capabilities in WESworks and ArcGIS.

The asset management program element includes the following WES staffing levels expressed as employee full time equivalents (FTEs) engaged in development review, capital projects, planning, and erosion control.

- 0.2 FTE Program Manager
- 0.5 FTE Surface Water Coordinator
- 0.2 FTE Soils Program Supervisor
- 0.2 FTE Development Review Supervisor
- 1.0 FTE Administrative Support
- 0.5 FTE Senior Civil Engineer
- 0.5 FTE Civil Engineer
- 1.0 FTE Surface Water Technician
- 1.5 FTE Plan Reviewer
- 1.5 FTE Erosion Control Inspectors
- 0.5 FTE Single Family Plan Reviewer
- 2.5 FTE for WES-related GIS work
- Additional staff through DTD for floodplain and miscellaneous land use issues

Development review and ERCO are discussed in more detail below.

Development Plan Review and Permitting

WES reviews development plans for installation of public sewers and stormwater systems within CCSD No. 1. The development plan review and permitting process is performed by WES Development Review staff in conjunction with development review and permitting conducted by DTD and the Land Use Planning division (Planning) within DTD. The development review process includes subdivisions, partition plats, commercial and industrial development, single family residential (SFR), and other facilities that discharge into the public sanitary sewer or stormwater system. WES provides sewer and stormwater development review services for the City of Happy Valley areas within CCSD No. 1.

DTD currently performs development permit review and establishes stormwater management requirements for areas outside of CCSD No. 1 in the RC watershed. As the City of Happy Valley finalizes its Comprehensive Plan and Zoning Ordinance for the East Happy Valley Annexation area and it is developed, it is possible that this area may be incorporated into CCSD No. 1. However, it is not clear whether the CCSD No. 1 stormwater management requirements or the DTD requirements will be in place for this area as development takes place.

As discussed above, the City of Damascus is in the process of developing municipal codes, zoning ordinances, policies, and master plans for infrastructure. Until the comprehensive plan and zoning ordinance are adopted, Damascus will continue to operate under the provisions of the Clackamas County comprehensive plan and zoning and subdivision ordinance. Damascus currently contracts with Clackamas County Planning (part of Clackamas County DTD) to administer the zoning ordinance.

The development review process is a critical element of WES policies and practices that affects watershed health. The design standards and requirements for stormwater management applied by WES Development Review staff for the permitting of new development in the Districts have long-term consequences on water quality and hydrology in developed areas. These direct impacts also contribute to secondary impacts on aquatic habitat and biological communities.

The WES development review processes for subdivision/partition, commercial, and single family permit approval was discussed by WES staff during two workflow mapping workshops, held on October 30 and November 19, 2008. At the workshops, WES staff collaborated to revise the existing process map to reflect the actual processes for permit approval. The revised process maps are provided in Appendix A along with a detailed description of the current development review process. Appendix A also includes a summary of the current design standards for stormwater, which are used by developers, engineers, and contractors to guide the design of stormwater treatment systems included with new development.

Stormwater Design Standards

The design standards and requirements for stormwater management applied by WES Development Review staff for the permitting of new development in the Districts have long-term consequences on water quality, hydrology, aquatic habitat, and biological communities. The creation of impervious surfaces, removal of vegetation, and modification of topography during development alters hydrology and creates pathways for pollutants to enter waterbodies. The requirements for stormwater treatment, site design, and site construction in the design standards are a key aspect of WES' work to protect and improve watershed health.

This section summarizes the current design standards in the Districts, which are used by developers, engineers, and contractors to guide the design of sites and the stormwater treatment systems included with new development. This summary is focused on elements of the design standards that affect watershed health, and is not intended to be a complete documentation of the current standards. In the assessment phase of the project, potential improvements to these design standards will be evaluated and recommendations will be developed to include in the Action Plan.

Stormwater is managed by WES using two documents: the *Surface Water Management Agency of Clackamas County Rules and Regulations* (December 15, 2002), and the *Surface Water Management Rules and Regulations for Clackamas County Service District No. 1* (February 1, 2005).

The Standards for both Districts are largely the same. Key elements of the Standards include the following:

- Under 5.2.4 Onsite Detention Design Criteria, CCSD No. 1 requires detention of the 25-year 24-hour post development flow to the 2-year 24-hour flow in areas with limited downstream capacity in the storm sewer system.
- CCSD No. 1 Standards contains Section 5.3 Water Quality Standards that requires treatment of two-thirds of a 2-year, 24-hour post development storm. The SWMACC Standards contain a larger Section 6 on Permanent Onsite Water Quality Facilities.
- All development and redevelopment must include a system for controlling storm/surface water within the development without causing harm to the natural environment or to property or persons (Section 5.1.1.3). Some exemptions are provided for SFR development.
- Infiltration systems are required for all new development and redevelopment. Infiltration systems must be able to infiltrate runoff from storm events up to one-half inch of rainfall in 24 hours (Section 5.2.6). Treatment must be provided prior to or concurrent with the infiltration system; for example, infiltration can be incorporated into detention facilities. Exceptions to the infiltration requirement are allowed where soil conditions are not adequate for infiltration.
- Water quality treatment using vegetated treatment systems is required for all new development and redevelopment (Section 5.2.6). Acceptable vegetated treatment facilities include: swales, filter strips, wetlands, wet ponds, and extended detention basins. Design criteria for these facilities are provided in Appendix D of the CCSD No. 1 Standard Surface Water Specifications.
- Proprietary mechanical stormwater treatment systems may also be used with approval from the District. Currently approved proprietary systems include Stormceptor, CDS, Downstream Defender, Vortechnics, and Stormgate Separator.

Appendix A contains a more detailed summary of the Standards for both Districts and a discussion of current issues and opportunities for future improvements identified during the process mapping workshops.

Erosion Prevention and Sediment Control

ERCO is intended to prevent erosion and improve sediment control at construction sites and existing stormwater facilities within WES' jurisdiction, including CCSD No. 1, SWMACC, Boring, Hoodland, Gladstone, and all 1200C permit sites in Clackamas County. 1200C permit sites are sites where construction activities disturb one or more acres of land, including smaller sites that are less than 1 acre that are part of a larger common plan of development.

Erosion prevention and sediment control are very important to watershed health. Uncontrolled erosion at construction sites can contribute heavily to water quality problems including poor water clarity, high pollutant loads, damage to aquatic habitat, and maintenance problems in the storm drainage system from sediment deposition in pipes, catchbasins, culverts, outfalls, ponds, and swales.

Grading permits are also an element of the erosion control permitting process, in that erosion control inspections are completed as enforcement for grading permits. The grading permit process regulates and controls excavation, grading, and earthwork construction, including fills and embankments for issuance of permits. It also provides for approval of plans and inspection of grading construction. Whether or not a permit is required, all excavation and grading must conform to Clackamas County Code requirements, and must prevent erosion and control sediment as well as protect adjacent properties.

The WES process for erosion control permitting and inspecting for new construction sites was discussed by WES staff during two erosion control workflow mapping workshops, held on October 31 and November 19, 2008. At the workshops, WES staff collaborated to revise the existing process map to reflect the actual process for new construction permits. The revised process maps for ERCO and grading as well as a summary of the current process are included in Appendix A.

WES currently provides erosion control services for development in CCSD No. 1, SWMACC, Boring, Hoodland, Gladstone, and in and out of district 1200C permits. From July 2007 through June 2008, 817 erosion control permits were issued and 2,046 inspections were performed by CCSD No. 1 with 1.5 FTE. Happy Valley took over responsibility for administering the erosion control program within its city limits in 2005. Happy Valley performed 215 erosion control inspections from July 2007 to June 2008.

To maintain quality service to its customers, WES accepts call-in and over-the-counter complaints from the public with regard to erosion problems. Following receipt of a complaint, the receiver updates the WES maintenance management system. WES does not currently have an erosion control hotline phone number that is posted at construction sites to facilitate public reporting of erosion control problems, although such a hotline posting requirement is being considered for the future.

More information on the maintenance process is below. Appendix A contains a discussion of current issues and opportunities for future improvements identified during the process mapping workshops.

Stormwater System Maintenance

The WES Stormwater Maintenance program is responsible for the maintenance of all stormwater assets within the public right-of-way in the Districts, with the exception of assets that are the responsibility of the DTD or ODOT. The WES Stormwater Maintenance program is responsible for inspecting and maintaining detention ponds, pipes, vortex separators, pollution control systems, catch basins, manholes, open channels including natural drainage features, and public underground injection control (UIC) systems.

The stormwater maintenance crew primarily inspects sites and prescribes maintenance work. Most field maintenance is performed by the sanitary maintenance crew.

As of 2008, WES stormwater maintenance is currently responsible for the following:

- 304 miles of stormwater pipe
- 23,000 storm structures including catch basins and manholes
- 262 detention ponds
- 700 detention pipes
- 31 treatment facilities (swales and underground devices)

Maintenance Staff and Equipment Statistics:

- 0.2 FTE Program Manager
- 2.0 FTE Surface Water Technicians
- 3.3 FTE Collection System Technicians
- 1.2 FTE Seasonal Employees
- 1.0 FTE contracted with DTD
- Use of two fully equipped maintenance utility trucks
- Use of combination vacuum/hydrocleaner trucks (Vactor trucks)
- Use of regenerative air sweepers (for street sweeping)
- Use of pipe video equipment

Maintenance is performed primarily for cleaning and to ensure structural integrity. Catch basins, pollution control manholes and other debris capturing structures are cleaned periodically to remove sediment, pollutants, debris and other materials before they gain entrance into the storm system pipes and discharge to receiving waters. WES is directly responsible for maintenance in the maintenance agreement areas (generally all subdivisions constructed since 1998, including a large number in Happy Valley) and the storm sewer pipe network in the District. WES also began additional maintenance in the CCSD No. 1 road rights-of-way several years ago, although there is a lack of clarification of the responsibilities for stormwater infrastructure maintenance on Clackamas County roads.

In the maintenance agreement areas, which include over 240 subdivisions, WES collects a maintenance fee in addition to the standard surface water management fee from property owners. In other areas, the owners of stormwater treatment facilities and equipment are responsible for stormwater maintenance. However, WES has in the past stepped in and cleaned or serviced stormwater equipment or treatment systems in emergency cases even when they are not responsible for the asset.

Below is a summary of the maintenance activities conducted in CCSD No. 1 and Happy Valley as reported in the July 2007 to June 2008 Annual Report for the National Pollutant Discharge Elimination System (NPDES) Municipal Separate Storm Sewer System (MS4) permit.

- 1,206 structures 108 ponds, and 275 feet of storm line were inspected and/or cleaned
- 14.69 tons of material was removed from the non-pipe storm drainage components and 2.75 tons of material was removed from the storm drain pipes.
- 3,801 feet of storm drain ditches were maintained and 546.6 tons of material were removed.
- 83 miles of streets were swept in the RC watershed by DTD (1,292 miles of streets swept and 840 cubic yards of material removed in all of CCSD No.1).
- 105 miles of streets were swept and 50 cubic yards of material were removed by Happy Valley.

Currently, maintenance activity is generated in two ways: complaint or service request generated activity, and maintenance activity generated from the inspection of facilities. Other responsibilities of the maintenance staff included the inspection of facilities, the review of new development submittals for maintenance feasibility, and the acceptance of the facilities associated with new development.

WES is just beginning to develop its preventive maintenance program for stormwater assets. Data have been populated in the computerized maintenance management system for the past 14 months and an inspection system has been started. Currently, only 5 to 10 percent of the residential systems have been inspected through this program, although the stormwater ponds are inspected each spring. WES also has a 4-year-old cleaning program. Every maintenance agreement subdivision for which WES has responsibility has been cleaned at least once in this time-frame, and vortex separators are cleaned every 6 months.

WES stormwater maintenance is in the process of developing predictive maintenance programs for pond condition assessment and vortex cleaning. The maintenance staff also want to develop predictive methods for refurbishment and replacement of assets.

Street sweeping is contracted with DTD; and WES provides requests to DTD on occasion if it knows of a trouble area. Major arterial curbed streets are swept on a regular basis. The frequency varies depending on a variety of factors such as traffic volumes. Street sweeping within the City of Happy Valley is the responsibility of the City. In October 2008, Happy Valley began sweeping all city streets once per month. Areas where street sweeping is conducted by WES and Happy Valley are illustrated in Figure 1-5.

WES processes for existing work orders, reactive requests, and new system acceptance were discussed by WES staff during two maintenance workflow mapping workshops, held on October 30 and November 19, 2008. At the workshops, WES staff collaborated to revise the existing process map to reflect the actual maintenance processes. The revised process maps and a summary of the current process are in Appendix A. Appendix A also contains a discussion of current issues and opportunities for future improvements identified during the process mapping workshops.

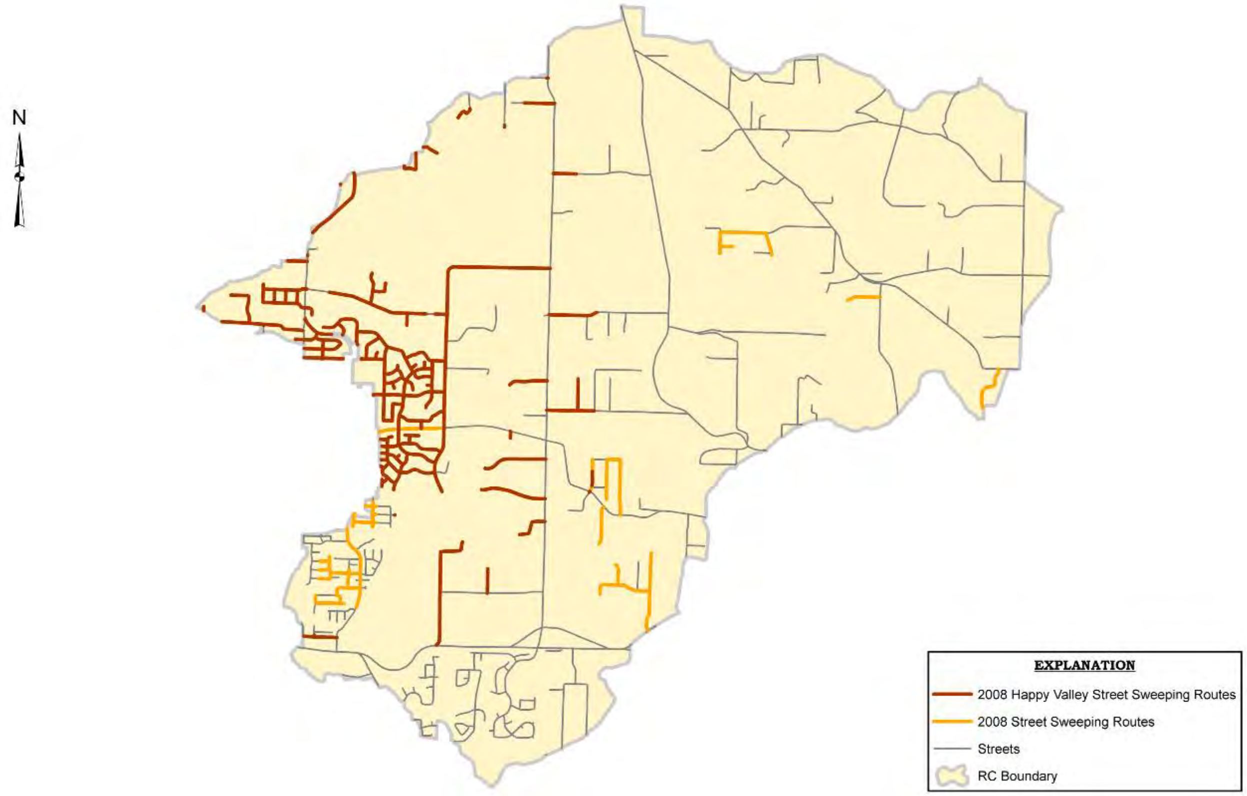

Figure 1-5. Street Sweeping Areas

Environmental Monitoring

The WES Environmental Monitoring program is responsible for tracking, reporting, and in some cases, managing environmental conditions associated with surface water, stormwater, and treated wastewater in order to meet regulations and permit requirements as well as WES program objectives. The Environmental Monitoring program includes environmental permit program management, laboratory operations, non-residential waste management, and a biosolids program. The Environmental Monitoring Program includes the following staff:

- 0.2 FTE Program Manager
- 0.6 FTE Water Quality Analyst
- 0.2 FTE Sample Collection (through Compliance Services)
- 0.2 FTE Additional staff performs spill response, laboratory analysis on samples and maintains continuous surface water monitoring equipment

The Environmental Monitoring program staff conducted internal workflow mapping exercises during 2008. These process maps are provided in Appendix A. The environmental permit program management element is an important part of WES' work to comply with the Clean Water Act (CWA), other regulations, and for the protection and improvement of watershed health. This element is summarized below and discussed in detail in Appendix A. Appendix A also contains a discussion of current issues and opportunities for future improvements identified during the characterization phase of the project.

Environmental Permit Program Management

The environmental permit program management element of WES is responsible for managing several permits, including the NPDES MS4 permit and the UIC requirements. The MS4 permit program is one of the key regulatory tools used to address the stormwater impacts from urban development. The UIC program regulates the discharge of stormwater below ground. Below is a summary of the MS4 permit program requirements and of the watershed management activities and monitoring implemented by WES as a part of the MS4 discharge permit program, as well as a summary of the UIC program. Additional details are provided in Appendix A. Currently, only a relatively small portion of the RC watershed is included in the MS4 permit area. As urban development in the watershed expands, the MS4 permit area will likely expand as well.

Most parts of the MS4-permitted surface-discharging storm sewer system are comprised of piped storm sewers, but some swales and open ditches are also present. Many privately-owned surface discharging storm sewer systems are present near the District's MS4-permitted systems. These privately-owned surface-discharging storm sewer systems are not regulated by the District's MS4 permit.

NPDES MS4 Permit Background. In the early 1990s, the CWA required municipalities in metropolitan areas with populations greater than 100,000 to apply for and obtain an NPDES permit for their stormwater discharges under Phase 1 of the MS4 permit program. CCSD No. 1 and SWMACC (the Districts), Oak Lodge Sanitary District, Clackamas County (including DTD), and the Cities of Happy Valley, Rivergrove, Gladstone, Johnson City, Lake Oswego, Milwaukie, Oregon City, West Linn, and Wilsonville are Phase 1 co-permittees on an NPDES MS4 permit that is referred to as the Clackamas County MS4 permit. The Clackamas County MS4 permit was first issued by the Oregon Department of Environmental Quality (DEQ) in 1995. In August 2008, WES submitted a permit renewal application to DEQ which included an updated Stormwater Management Plan (SWMP).

As a part of the initial MS4 permit application, a joint Stormwater Management Plan (SWMP) was developed in 1993 for CCSD No. 1 and SWMACC. As total maximum daily loads (TMDLs) are developed for streams that are in violation of water quality standards, the portion of TMDLs allocated for municipal stormwater are addressed through NPDES MS4 permits and the SWMPs.

The effectiveness of the SWMP is revisited annually. Each year, Clackamas County and co-permittees are required to submit an annual compliance report for their MS4 NPDES permit. The annual report is required to describe the status of implementing the components of the stormwater management program; proposed changes to the SWMP; and water quality monitoring results. The annual report provides an overall assessment of the permittees' actions to minimize pollutants in MS4-regulated stormwater systems. The annual reports contain a wealth of information about stormwater management activities undertaken in the Districts in the reporting year.

NPDES MS4 Program Implementation. According to the CWA, MS4 permittees must implement a program to reduce the discharge of pollutants to the maximum extent practicable, including management practices, control techniques and systems, and design and engineering methods. The program includes BMPs, monitoring, and other available and reasonable controls, which are then documented as requirements in the permit and the SWMP. SWMPs can be revised using adaptive management to improve overall program effectiveness.

WES' proposed 2008 SWMP is similar to the 2006 SWMP, which is the currently approved SWMP until the new permits are issued by DEQ. As a part of the 2008 permit renewal submittal, a comprehensive review of the SWMPs and an evaluation of program effectiveness, local applicability, and program resources was performed. As a result of this review, several changes were made to the 2008 SWMP including updating the monitoring plan to include a plan for sampling for selective pesticides and implementing a new BMP related to inspecting and maintaining private stormwater systems for new development. Further changes to the SWMP may be required during the permit negotiation process in 2009.

The proposed 2008 SWMP includes the following components with key BMPs listed beneath each component:

- Component #1: Structural and Source Control BMPs to Reduce Pollutants from Commercial and Residential Areas
  - Stormwater system maintenance
  - Planning procedures for new development
  - Street sweeping
  - Water quality and flood management projects
  - Public education to reduce the discharge of pesticides, herbicides, and fertilizers
- Component #2: A Program to Detect and Remove Illicit Discharges and Improper Disposal Into the Storm Sewer System
  - Conducting dry weather inspections
  - Implementing the spill response program
  - Facilitating public reporting of illicit discharges and spills
  - Controlling infiltration and cross connections to the storm sewer system
- Component #3: A Program to Monitor and Control Pollutants from Industrial Facilities
  - Addressing runoff from hazardous waste treatment, disposal and recovery facilities and other non-1200Z permitted industrial facilities
- Component #4: A Program to Reduce Pollutants in Stormwater Discharges from Construction Sites
  - Implementing requirements for structural and non-structural BMPs at construction sites
  - Identifying priorities for inspecting sites and conducting enforcement actions
  - Conducting training for construction site operators

Each BMP in the SWMP includes measurable goals and tracking measures appropriate for the BMP. Progress toward measurable goals and the results of tracking of the BMPs are reported in the annual reports.

The BMPs in the SWMP encompass most of the policy and practice areas described in this report. Several of the key BMPs have already been described in the earlier sections in this report on development review, ERCO, and maintenance. Following is a summary of the water quality monitoring and illicit discharge detection and elimination performed as a part of the MS4 permit program, and a discussion of the UIC program.

Water Quality Monitoring. As part of the MS4 permit requirements, WES, and other Clackamas County co-permittees are required to develop and implement a stormwater monitoring program. WES currently administers a routine and storm-event related water quality and flow monitoring program within CCSD No. 1. Parameters currently measured as a part of the MS4 permit monitoring include dissolved and total metals (copper, lead and zinc), hardness, *E. coli* bacteria, nutrients (nitrogen and phosphorus), solids (total, dissolved, and volatile), and field in situ measurements of conductivity, pH, temperature, flow, and dissolved oxygen.

In addition to monitoring conducted for the MS4 permit program, WES also conducts periodic monitoring of other environmental conditions that are related to water quality, including benthic macroinvertebrate sampling and fish sampling and associated habitat surveys. This monitoring is typically conducted under direction of the Environmental Policy Specialist as part of the Watershed Health functional program element of WES (described below) and is not performed by the WES Environmental Monitoring program. In the proposed 2008 Monitoring Plan, WES has proposed monitoring for selective pesticides as requested by

DEQ. It is likely that many of the other Clackamas County co-permittees will conduct this monitoring jointly in a single coordinated study. The monitoring program is discussed further in Chapter 3.

Illicit Discharge Detection and Elimination. Twenty-nine major outfalls are located in the portion of CCSD No. 1 regulated by the MS4 permit program (CCSD No. 1-UGB). Major outfalls are defined as and include pipes greater than 36-inch-diameter, conveyance from lands zoned for industrial activity, and conveyance from lands serving a drainage area of more than 50 acres. In an effort to identify and control illicit discharges of non-stormwater substances to the stormwater system, each major outfall receives at least one dry-weather inspection per year.

Underground Injection Control Devices. Discharges from injection-type storm sewer systems that discharge stormwater below ground are regulated by the federal Safe Drinking Water Act under a program called UIC. Due to the program name, injection-type storm sewer devices are often called UIC devices or UICs. Discharges from injection-type storm sewer systems are not regulated by any MS4 permit as they convey stormwater to the subsurface rather than through an MS4 conveyance system into surface water bodies. DTD and WES jointly manage about 150 injection-type storm sewer systems that are in or near CCSD No. 1. DTD and WES also jointly manage about 50 injection-type storm sewer systems near the SWMACC's MS4-permitted area. Nearly all of these stormwater injection devices are drywells, which are essentially perforated manhole shafts that discharge stormwater below the ground surface to infiltrate into the surrounding soil.

WES and DTD jointly applied for an area-wide Water Pollution Control Facility (WPCF) permit from DEQ for these devices on December 19, 2001. As of 2008, this WPCF permit had not been issued. A separate Stormwater Management Plan guides WES' and DTD's stormwater management programs in the geographic areas that drain to drywells. WES is involved in an ongoing water quality monitoring program in Oregon related to UIC devices.

Environmental Policy and Watershed Health

WES employs 1.0 FTE as an environmental policy specialist in the Environmental Policy and Watershed Health functional program element. This element is a part of WES Administration. The responsibilities of the environmental policy specialist are varied and include assessing watershed conditions in the Districts, assisting in developing management strategies to improve or protect environmental conditions, assisting in public information and outreach efforts, reviewing WES and other Clackamas County projects for permit compliance, and serving as a representative of WES on a wide variety of committees and advisory bodies addressing watershed health issues. The Environmental Policy and Watershed Health functional program element addresses numerous environmental regulatory programs including the Endangered Species Act. The Environmental Policy program element conducts periodic monitoring of environmental conditions that are related to water quality, including benthic macroinvertebrate sampling, fish sampling, and habitat surveys.

The Environmental Policy Specialist is responsible for all of WES' biological monitoring programs, developing and tracking watershed health performance metrics, and development of a Watershed Health Index. This staff person also is responsible for developing partnerships with other agencies and nonprofit groups in the implementation of watershed improvement projects.

Public Information and Outreach

WES administers a public outreach and education program which provides information that attempts to change behaviors and motivates residents and workers in Clackamas County to reduce stormwater pollution and improve watershed health. WES employs 1.0 FTE as a community relations specialist. This staff member is responsible for conducting public information and outreach related to both the sewer program and the surface water management program.

WES shares information with the public through newsletters, the WES website, brochures, and local public involvement campaigns including television and radio outreach. Additional information on public information and outreach activities conducted by WES as well as public survey results related to water resources in Clackamas County are provided in Appendix A.

Financial Services

WES operates the Districts and provides wastewater and surface water management services using revenue from several sources. The Surface Water Management (SWM) Program for CCSD No. 1 is funded through three primary sources: monthly SWM utility fees, system development charges (SDCs), and permit fees. SWM fees are used to fund the following:

- Maintenance of stormwater facilities
- Response to customer service enquiries
- Monitoring of water quality, hydrology, habitat conditions, and biological communities
- Planning and design of regional water quality and flood reduction projects
- Providing long-term watershed planning
- Providing public outreach and partnerships for pollution prevention and watershed enhancements
- Carrying out programs for compliance with State and Federal Regulatory Permits and Orders

The SWM fee is based on the amount of impervious surface on each site. The monthly surface water management fee is based on the Equivalent Service Unit (ESU). One ESU equals 2,500 square feet of impervious surface.

The current SWM rate is $6 per month per ESU in CCSD No. 1 and $4 per month per ESU in SWMACC. SFRs are charged for 2,500 square feet of impervious service area or 1 ESU (shown as 1.00 unit on your billing) per month, based on this average measurement. SFR customers who live in developments built since 1998 also pay a monthly maintenance agreement fee of $3 per ESU which is dedicated for maintenance of local subdivision stormwater conveyance, detention, treatment, and infiltration facilities.

Non-single family properties, including businesses, schools, governments and industrial areas, pay based on their measured impervious area. For example, a business with 10,000 square feet of impervious surface (4 ESUs) would be charged $16 per month ($4 x 10,000 square feet ÷ 2,500 square feet = $16). Through this approach, properties that generate more stormwater runoff and contribute more to the need for surface water management pay a greater proportion of the program costs.

SDCs are collected from new development and dedicated to planning, design, and construction of additional stormwater infrastructure capacity needed to accommodate growth. The current SDC rate is $205 per ESU.

Table 1-4 compares the number of ESUs in July 2005 and 2006 for residential and commercial/industrial land uses. Excluding roadways, the amount of impervious area in CCSD No. 1 increased by 44 acres (749 ESUs) during this period from 2005 to 2006. Based on aerial mapping, new roadways (not reflected in customer billing records) are estimated to account for an additional 22 acres of impervious surface added in CCSD No. 1 from 2005 to 2006.

Table 1-4. Equivalent Service Units in CCSD No. 1 2005-2006

ESUs	July 2005	July 2006	Change
Residential	14,213	14,972	759
Commercial/Industrial	29,112	29,112	0
Total	43,325	44,084	759

Based on the period from 2003 to 2007, the average annual growth rate for the ESUs was calculated to be 3 percent which is generally considered to be a reliable predictor of average future revenue, although current economic conditions could result in a slower growth rate in the near future. Table 1-5 summarizes WES' projected surface water rate revenues for CCSD No. 1. This estimate uses the current surface water rate of $6 per ESU for CCSD No. 1. The surface water rate is held constant for estimating future revenue. The estimate also does not include revenue from SDCs.

In the fiscal evaluation conducted as a part of the 2008 MS4 permit renewal, WES anticipates that the annual surface water budgets for CCSD#1 will continue to grow in order to meet regulatory requirements, system expansion, and to refurbish and enhance existing system facilities. In the permit renewal, it is noted that it is likely that future budgets may require rate increases and possibly additional staffing.

Table 1-5. CCSD No. 1 Surface Water Rate Revenue Forecast

Year	ESUs	Rate revenue, dollars
2008	45,504	3,432,372
2009	46870	3,535,343
2010	48,276	3,641,403
2011	49,724	3,750,646
2012	51,216	3,863,165
2013	52,752	3,979,060

Other Clackamas County Departments

The following Clackamas County departments, divisions, and districts also implement policies and practices that affect watershed health:

- DTD
- Sustainability
- Development Agency
- Engineering
- Planning
- Parks Department
- North Clackamas Parks and Recreation District

Further details on each of these departments and divisions is provided in Appendix A.

Cities

The RC watershed encompasses the Cities of Happy Valley and Damascus as described earlier. Thirty-five percent of the RC watershed is in Happy Valley and 57 percent of the watershed is in Damascus.

Happy Valley

Happy Valley is a small, rapidly growing city with a population of just under 10,000 in 2007. CCSD No. 1 has a service agreement with Happy Valley (through an IGA) to provide sewer and stormwater management services and development review for installation of public sewers and stormwater systems in developed portions of the city. DTD establishes stormwater management requirements for areas of the city that are currently outside the CCSD No. 1 boundary. Happy Valley is responsible for administering the erosion control program and for street sweeping within its city limits.

Damascus

The City of Damascus was incorporated in 2004 and is in the process of developing municipal codes, zoning ordinances, policies, and master plans for infrastructure. The city had a population of over 10,000 in 2006 and is expected to grow rapidly in the future. Until the comprehensive plan and zoning ordinance are adopted, Damascus will continue to operate under the provisions of the Clackamas County comprehensive plan and zoning and subdivision ordinance. As a result, Clackamas County DTD currently establishes stormwater management requirements for development in the city. Little development is expected to occur in the city until the comprehensive plan and zoning ordinance are adopted. Damascus currently contracts with Clackamas County Planning to administer the zoning ordinance.

Other Agencies and Organizations

There are a wide variety of other agencies and organizations that implement policies and practices that affect watershed health in the RC watershed, including state and federal agencies, Metro, local service providers, community groups, and others. Two key organizations are described briefly below.

Sunrise Water Authority

Sunrise Water Authority serves an area that covers approximately 22 square miles encompassing the communities of Happy Valley and Damascus, as well as unincorporated county areas. In 2006, Sunrise Water Authority delivered 1.55 billion gallons of drinking water to a population of about 40,000 through 12,000 service connections. Most of the water supplied to Sunrise Water Authority's customers is purchased from the North Clackamas County Water Commission (NCCWC). The NCCWC is a joint water supply partnership between Sunrise Water Authority, Oak Lodge Water District, and the City of Gladstone. The NCCWC owns and operates a treatment plant on the Clackamas River using both slow sand filtration and membrane filtration. The majority of water supplied to Sunrise Water Authority customers comes from the Clackamas River; however, Sunrise Water Authority also utilizes wells during the peak summer season.

Clackamas River Basin Council

The Clackamas River Basin Council (CRBC) is a watershed council founded in 1997 with volunteer representatives elected from 21 diverse member groups in the basin representing water providers, agriculture, forestry, environmental interests, streamside landowners, special districts, local governments and state and federal natural resource agencies and others. The CRBC meets monthly as a consensus-based forum to foster partnerships for clean water, healthy streams and abundant fisheries in the watershed. The CRBC works to protect and improve water quality and fish and wildlife habitat, and support the quality of life for those who live, work, and recreate in the Clackamas River basin.

The CRBC developed the Clackamas River Basin Action Plan in 2005. The Clackamas River Basin Action Plan identifies 16 key strategies to address challenges to watershed health including riparian, wetland and channel restoration, aquatic habitat improvement, fish passage, agricultural and urban management practices, and education and outreach initiatives. The Clackamas River Basin Action Plan addresses opportunities within the entire 900-square mile Clackamas River Basin. In 2007, and as result of strategic planning sessions, the CRBC formed a Project Implementation Planning (PIP) team. The PIP team is made up of members from both the CRBC and other key agency and watershed stakeholders. The purpose of the PIP team is to recommend implementation priority projects to the CRBC. A WES staff member currently serves on both the CRBC and PIP team.

Data Reviewed

WES has a wide variety of internal and external data sources available to characterize and assess the watershed. This report is based primarily on existing data available as of August 2008. Following is a partial listing of key materials that were reviewed for the Characterization Report (Chapters 1 through 4). A full list of all materials reviewed for the Characterization Report is available in the Summary of Existing Information in Appendix B. In the following chapters on hydrology, water quality, and aquatic habitat and biological communities, key data sources reviewed for each section are also described.

- Draft MS4 NPDES Permit Stormwater Management Plan for Clackamas County Service District No. 1 and the City of Happy Valley, Updated July 2008.
- Surface Water Management Rules and Regulations for Clackamas County Service District No. 1, February 1, 2005.
- Surface Water Management Administrative Procedures for Clackamas County Service District No. 1, January 3, 2003.
- Metro Goal 5 Resource Classification (Fish and Wildlife Habitat) and other various related maps.
- Technical Memorandum: Natural Resource Assessment of Rock and Richardson Creeks, URS Corporation, December 1999.
- Rock and Richardson Creeks Master Plan, WES/URS, 2000.
- Rock and Richardson Creek Watershed Assessment, Clackamas River Basin Council and EcoTrust, 2000.
- Distribution of Fish and Crayfish and Measurement of Available Habitat in Streams of the North Clackamas County, WES/ODFW, 1997-1999.
- Fish Species Distribution and Abundance and Habitat Assessment of Streams in Clackamas County Service District No. 1 (Draft Report), ODFW, October 15, 2008.
- Assessment of Macroinvertebrate Communities in Streams of North Clackamas County, Oregon, 2002 and 2007, ABR, Inc., 2003 and 2008.
- Baseline Assessment of Stream Habitat and Macroinvertebrate Communities in and Adjacent to the Damascus Area Urban Growth Boundary Expansion, Oregon, ABR, Inc. May, 2004.
- Stormwater Management Program Master Plan Update Project – Stream Reach Evaluation Tool for Assessing Potential Urbanization Effects of the Damascus Concept Plan on the Rock Creek Subwatershed, Clackamas County, Oregon; Prepared by Bob Storer and Carol Murdock (WES), and Lori Hennings (Metro), 2006.
- Clackamas County Service District No. 1 Surface Water Management Program Master Plan, Final Report, April 2006, (Prepared by Shaun Pigott Associates, LLC; Pacific Water Resources, Inc.; GeoSyntec Consultants; Donovan Enterprises, Inc.; and Norton Arnold & Company).
- Damascus Natural Features Inventory, Natural Resources Report and Natural Hazards Report, Winterbrook Planning, July 2007.
- Report on the Damascus/Boring Concept Plan, prepared by Clackamas County, Metro, City of Damascus, City of Happy Valley, ODOT, and OTAK, February 2006.
- Rock Creek Sustainability Initiative Research Findings, Portland State University Research Team, Urban Studies and Planning Department, December 2008.

CHAPTER 2 - HYDROLOGY

Overview

This chapter summarizes hydrologic conditions in the Rock Creek (RC) watershed based on an evaluation of existing data, modeling results, and reports of watershed conditions. Key sources of information regarding hydrology in the RC watershed include the following:

- Hydrologic and hydraulic models of the watershed
- Federal Emergency Management Agency (FEMA) flood maps
- Oregon Department of Fish and Wildlife (ODFW) Habitat Assessment Surveys
- Water Environment Services (WES) Geographic Information System (GIS) database
- Field visit to the watershed during a significant storm event
- Previous studies and master plans for the RC watershed

Key indicators of watershed health related to hydrology include flood conditions and channel erosion. These indicators are affected by watershed hydrology and stream channel hydraulics as well as by channel morphology. This chapter evaluates the current hydrologic conditions in the RC watershed, including the types of hydrologic impacts that have been observed in the watershed, the extent of flood impacts, and the future risks to stream channels as the watershed continues to develop. Hydrology, hydraulics, and channel morphology are evaluated to identify watershed stressors and responses.

Key issues related to hydrology in the RC watershed include the following:

- **Urbanization.** Urbanization pressures are increasing and are likely to affect hydrology. Land uses in the watershed are currently dominated by farm and rural residential land uses which have likely had an historic impact on stream channel conditions through direct channel modifications and reclamation of wetland and floodplain areas. Due to its location on the urban-rural boundary and the presence of easily developable land in the expanded Urban Growth Boundary (UGB) areas in Happy Valley and Damascus, the watershed will undergo increased urbanization pressures over the next several decades. Despite historic changes to hydrologic conditions in the watershed associated with conversion from forest to farm, the conversion to urban conditions is likely to have a profound effect on the hydrology, channel conditions, and watershed health unless proactive and sustainable measures are taken to protect the watershed.
- **Hydrologic and Geomorphic Data.** Limited hydrologic and geomorphic data are available to assist in evaluating historical, current, and future watershed conditions and potential risks. Long-term stream gauge records are not available for the watershed and data vital to evaluating channel in channel morphology, such as repeat cross-sections, bank erosion surveys, or bed substrate data are not available. Instead, this characterization relies primarily on existing information collected on channel conditions and makes inferences about potential future risks given expected changes in the hydrologic condition associated with future development. The primary data sources available to characterize existing conditions and conduct an analysis of future risk include hydrologic and hydraulic modeling prepared by Pacific Water Resources (PWR) and FEMA, and a channel conditions assessment recently prepared by ODFW as part of a comprehensive aquatic habitat and fish abundance survey. These data were used, in conjunction with a GIS database available from WES, to evaluate historic, existing, and future hydrologic and geomorphic conditions in the watershed.

- **Flooding Impacts.** The results of the analysis suggest that, hydrologically, urbanization has the potential to result in a three-fold increase in flows along the mainstem channels of Rock Creek. Although flooding is currently not a major concern in the watershed, it could increasingly become an issue as development proceeds. Although current design standards for stormwater are intended to reduce the hydrologic impacts associated with new development, future development may modify the timing and volume of water delivered to stream channels.
- **Channel Modification.** In addition to the potential hydrologic changes in the watershed, there is risk associated with the corresponding potential morphologic responses of the channels. Geomorphically, it is difficult to evaluate how channels will respond to modifications of the hydrology. A preliminary assessment of the ODFW dataset suggests that bank erosion could be the biggest concern, specifically in the upper portion of the Rock Creek canyon, downstream of Southeast Sunnyside Road, and the portion of Rock Creek that runs adjacent to Troge Road.

Further analysis of existing and potential future flooding issues and channel modification problems associated with altered hydrology were conducted during the assessment phase of the project, and appropriate management strategies for WES to undertake to address these issues are provided in Chapter 5.

Data Reviewed

The evaluation of the historic and existing hydrologic and geomorphic condition in the RC watershed relied primarily on existing data, reports, and modeling results provided by WES. Key data sources reviewed are summarized below.

Pacific Water Resources - Hydrologic Model

The HEC-HMS hydrologic computer model is a modeling tool developed by the U.S. Army Corps of Engineers Hydrologic Engineering Center (HEC) as a Hydrologic Modeling System (HMS). A HEC-HMS model prepared by PWR as part of the Clackamas County Service District No. 1 (CCSD No. 1), Surface Water Management Program Master Plan (SWMPMP), April 2006, was reviewed. The modeling simulated several hydrologic scenarios under the SWMPMP using input information such as rainfall, topography, land cover, drainage infrastructure, and soil hydrologic properties. The model variables were adjusted to assess pre-developed or 1930s forested, existing (as defined during the preparation of the SWMPMP), and future conditions to produce discharge estimates for the 1-, 2-, 5-, 10-, 25-, 50-, and 100-year return intervals. The PWR hydrologic modeling covers the entire RC watershed. The hydrologic reaches generated as part of the subwatershed and channel network delineation constitutes the reach delineation framework adopted for this study. Figure 2-1 summarizes the extent of the channel network used in this study.

Pacific Water Resources - Hydraulic Modeling

The available HEC-RAS (River Analysis System) hydraulic modeling for portions of the RC watershed was reviewed. The extent of the hydraulic modeling on Rock Creek is shown in Figure 2-1. The model was developed by PWR in support of a FEMA Flood Insurance Study (FIS), on behalf of Clackamas County, and was conducted outside of the SWMPMP process. The hydraulic model was prepared per current FEMA FIS standards and incorporates up-to-date channel geometry, survey data, and hydraulic structures. Peak discharge data used in the HEC-RAS model are consistent with the effective FEMA FIS, but are not consistent with the hydrology prepared by PWR for the SWMPMP. The discharge rates prepared as part of the SWMPMP are lower than those used for the effective FEMA FIS. Consequently, there is a slight disconnect between the discharge data output from the PWR hydrologic model and the discharge data used in the hydraulic modeling.

FEMA Flood Insurance Rate Maps

To evaluate areas in the watershed where flooding is likely to occur, GIS shapefiles representing the FEMA 100-year floodplain, dated June 17, 2008 were reviewed. The effective Flood Insurance Rate Maps (FIRMs) have recently been updated through the FEMA Digital FIRM (DFIRM) process. The DFIRM process updates the old paper maps to digital files in GIS. The floodplain boundaries on the DFIRMs are consistent with the old paper maps. The FIRMs illustrate the extents of flooding resulting from the 100-year or base flood event. The FIRMs also illustrate the floodway for each creek. The floodway is the channel of the creek and the adjacent land areas that must be protected in order to discharge the base flood without cumulatively increasing the water surface elevation more than 1 foot locally. PWR, under a separate contract from the SWMPMP, prepared an updated FIS for Rock Creek. In discussions with PWR and Clackamas County staff, it was indicated that the new PWR modeling and mapping have not yet been adopted by FEMA. The peak flow rates used for the new Rock Creek hydraulic modeling and mapping are consistent with the current FIS, so it is likely that the floodplain footprint may not vary greatly from that shown on the current FIRM.

Oregon Department of Fish and Wildlife Habitat Assessment Surveys

In 2008, ODFW fish biologists conducted a comprehensive assessment of habitat and channel conditions in and along the mainstem of Rock Creek. The extent of the surveys are shown in Figure 2-2 with a description of reach identifiers and overlap between the ODFW data and the PWR data presented in Table 2-1. The purpose of the assessment was to evaluate aquatic habitat conditions and fish populations and abundance within the WES service area. The habitat assessment was conducted using ODFW Aquatic Inventories basin-type protocols for fish habitat surveys (Moore et al., 2007). Geomorphic variables measured during the survey included an estimate of the percent of the delineated reach experiencing active erosion, channel geometry characteristics, active channel and floodplain widths, and substrate. Although the focus of the study was primarily biological, significant amounts of data are available describing channel morphology and dynamics. The data were provided to WES in a GIS database format, which was then linked to the reaches delineated for the watershed characterization. Portions of the Rock Creek mainstem were omitted from the study due to lack of access provided by landowners.

Water Environment Services Geographic Information System Database

WES maintains a comprehensive and up-to-date GIS database for its service area and surrounding region. Consequently, this database was available to the watershed assessment team for review and analysis. In most cases, WES staff members provided the necessary data evaluations and outputs and provided them to the watershed assessment team. GIS layers that are important for the hydrologic and geomorphic analysis include the FEMA floodplain mapping, 1996 flood maps, reach layers from the PWR studies, roads, land use, geology, soils, flooding complaints, and parcel boundaries, etc. In addition to the GIS database, the watershed assessment team incorporated data layers from other sources such as the U.S. Geological Survey (USGS).

Field Visit to Rock Creek during Significant Storm Event

On January 2, 2009, a significant storm event occurred in the RC watershed. The event produced localized flooding on several roads. A WES consultant conducted a field visit approximately 10 hours after the peak flows occurred to evaluate the stream conditions and identify areas where flooding may have occurred. Due to the timing of this event, the results of that visit were not evaluated extensively for this Characterization Report (Chapters 1 to 4). Further analysis of the 2009 field visit results were incorporated in the Assessment Report (Chapter 5), along with information collected by WES staff during other recent significant storm events.

Surface Water Master Plan for Rock and Richardson Creek Watersheds

URS conducted a study on behalf of WES entitled Surface Water Master Plan for Rock and Richardson Creek Watersheds (URS, 2000). The purpose of the Master Plan was to establish an overall strategy for surface water management that provides protection of property and public safety from flood hazards, protection and enhancement of riparian corridors for wildlife, anadromous and resident fish populations, and protection and improvement of water quality. As part of the study, an U.S. Environmental Protection Agency SWMM model was prepared to simulate the hydrology and hydraulics of the watershed. The report discusses several deficiencies in the drainage system, most of which occur under future build-out conditions. The authors recommend preserving the existing floodplain footprint from future development and encroachment to allow natural stream processes to continue to occur. The authors conclude that protecting this land not only helps mitigate for existing and future flooding impacts but enhances water quality and provides for aquatic and riparian habitat.

Rock and Richardson Creek Watershed Assessment

Ecotrust, in conjunction with the Clackamas River Basin Council, completed a comprehensive assessment of watershed conditions in the Rock and Richardson Creek watersheds. The purpose of the assessment was to evaluate conditions in the watersheds, identify restoration opportunities, and initiate a dialogue with the community to encourage creative approach and innovative alternatives to conventional urban development. The report addresses many of the same things being addressed in this study and was published in 2000. The report conclusions are limited by the lack of available data and an extensive list of identified data gaps is provided.

Data Gaps

The purpose of the data gaps analysis is three-fold:

- Identify gaps or deficiencies in existing information that limits our understanding of watershed conditions and potential project opportunities.
- Identify data gaps that limit the ability of WES to evaluate watershed conditions long-term.
- Identify gaps in monitoring data that, if these data were available, would provide WES with the opportunity to evaluate the success of any implemented action.

The following is a discussion of potential data gaps based on those criteria.

Hydrologic Modeling Data

In general, the hydrologic modeling is founded on quality information and was prepared relatively recently, making it more than adequate for use in the current study. Its limitations consist of those that are inherent in all hydrologic modeling such as limited calibration data, calibration at a single point in the watershed, and lack of model confidence at the site-specific scale.

The primary limitation identified during the investigation of the hydrologic modeling is the generation of discharge values for forested conditions. It is our understanding that flows for an historic, forested condition were generated using the existing conditions model with adjustments made to the model parameters that generate runoff to mimic a forested condition. Upon evaluating the results, many of the low order tributaries produce a 2-year and 10-year peak flow that is very small (0.1 cubic feet per second) or even zero in some cases. These values are in most cases tens to hundreds of times lower than the expected 2-year runoff event under existing conditions. Even with fully forested watersheds, one would expect some surface runoff to occur during a 2-year rainfall event.

When the forested condition modeling results are used to calculate a Flashiness Index, which is defined in a current WES project as the ratio between the current 2-year discharge and the 10-year forested discharge, the results are potentially misleading. Therefore, it is recommended that the forested peak flow results and the Flashiness Index should be used with caution.

The primary limitation of developing discharge events for a forested, pre-development condition is that it is difficult to predict the runoff values for a condition in which calibration or verification data are not available. In addition, the channel network and runoff processes may be quite different which is not reflected in the modeling effort. To achieve realistic results from the model, it is generally not as simple as only changing the hydrologic properties of the soil, modifying the land cover, and altering the area covered by impervious surfaces. Groundwater dynamics have most likely changed, affecting baseflow, return flow, and saturated overland flow. If these changes are not reflected in the model, the pre-development, forested condition may not be accurate. Without historic runoff gauge data for the watersheds to assist in evaluating these historic changes, it is difficult to have high confidence in the results of the pre-development, forested model scenarios.

The HEC-HMS model could be calibrated to better predict historic conditions in the RC watershed. To improve or increase the accuracy of the existing hydrologic modeling runoff rates for a pre-development, forested condition, reference data from a forested watershed could be used, constituting a reference condition. It may also be possible to locate peak flow data for a watershed of similar natural characteristics that is currently forested. Alternatively, the model could be calibrated using USGS regional regression equations for forested conditions, similar to the process used by PWR for the existing conditions model.

Geomorphic Data

The geomorphic analysis for this study is based primarily on the recent data collected during ODFW's habitat assessment surveys. Because the focus of the surveys was to evaluate fish populations and aquatic habitat conditions, and the primary surveyors were fisheries biologists, rigorous application of the data to evaluate channel morphology, channel geometry, and channel stability need to be placed in the context of the data collection effort. In addition, much of these data were collected at the habitat unit scale and have been compiled and averaged at the reach scale. For example, the ODFW *Manual for Stream Habitat Assessments* (1999) states:

> "**Percent Actively Eroding Bank:** Estimate the total percent of distance on both sides of the habitat unit (up to 100%) that is actively eroding at the active channel height. Active erosion is defined as currently eroding, recently eroding, or collapsing banks that may show exposed soils and rocks, evidence of tension cracks, active sloughing, or superficial vegetation that does not contribute to bank stability."

The ocular estimate is averaged at the habitat scale and does not consider the mechanism, severity of erosion, or type of material being eroded. All that is being considered is the unit length of erosion along a streambank which may or may not have consequences for biological integrity or watershed health. Although the data are valuable, and provide us with the ability to compare relative rates of bank erosion from one reach to the next, they should not be extended to other types of analysis such as an attempt to calculate sediment delivery from bank erosion or contribute to an overall sediment budget for the watershed.

Another limitation of the ODFW study for the purposes of the watershed assessment is the limited spatial extent of the survey in comparison to the extension network of channels that exist in the watershed (Figure 2-2). The ODFW survey focuses on channels in the watershed that have the potential to support salmonids with a significant portion of the mainstem channel being omitted due to access constraints. Unfortunately it is often the smaller, steeper headwater channels that are at the most risk when a watershed converts from rural to urban land uses. The lack of a comprehensive channel conditions dataset for these smaller headwater channels is a significant data gap in this study.

The frequency of overbank flow was evaluated in this characterization as a proxy for understanding channel and floodplain interactions and the potential for channel instability associated with high flows, and energy, being focused in the active channel during large events. The dataset used to evaluate overbank flow frequency was the cross-section data from the hydraulic model. Fortunately, the data for the RC watershed was surveyed relatively recently and is of much better quality than the data available for Kellogg-Mt. Scott. One valuable piece of information that is missing would be historic cross-sections at the same location to compare channel geometry. It is not likely that the data, or the exact location of the cross-sections that FEMA used in its previous modeling efforts, are readily available.

The missing pieces of geomorphic data that would be a valuable set of tools to understand channel morphology, stability, and long-term changes include the following:

- **Channel Modification Mapping.** Acquisition of historic aerial photos and change diction mapping to document channel modifications was beyond the scope of this study. In addition, many of the most significant channel changes, such as conversion of a natural stream to an agricultural ditch, relocation of a channel, or straightening, most likely occurred prior to the first aerial photo being available for the watershed (typically late 1930s). Nonetheless, a robust dataset using historic aerial photos would be a valuable tool for understanding how past impacts to channels has affected channel function, morphology, and physical habitat. This analysis could also be improved through a detailed documentation of current bank modifications, hard structures, in-channel structures, etc. If a repeat study by ODFW is completed in the future it would be valuable to add a team member to document and map existing channel conditions in addition to establishing historic channel conditions.
- **Bank and Channel Stability Analysis.** A comprehensive analysis of bank stability, especially in those areas where bank erosion risk is deemed to be of concern, should be commissioned. There are a variety of techniques available to evaluate bank and channel stability. This analysis would provide a credible tool to define at risk areas and allow WES to prioritize potential restoration and treatment areas.
- **Cross-section Monitoring Stations.** The data currently do not exist to evaluate long-term conditions of the channel such as widening or incision. Establishing a network of cross-section monitoring stations would be an effective way to monitor channel conditions long-term. In addition to cross-section monitoring, the sites could also be used to evaluate bed substrate conditions and possibly even extended longitudinally to evaluate pool-riffle ratios, benthic macroinvertebrates, embeddedness, and pool depths at key locations in the watershed.

In summary, the current dataset used to characterize the watershed is adequate in understanding reach-scale conditions and to prioritize at-risk areas in the watershed where data are available. What is currently limiting our ability to evaluate conditions throughout the watershed is the lack of data in the smaller tributary channels and headwaters. Consequently, we are unable to characterize these areas, except in the most general terms. Devising a field strategy to evaluate areas where survey information is not available will be an important gap to fill. Without that data we may be missing project sites that are an important component of the overall strategy to improve watershed health. Unfortunately, devising a strategy to collect data in these areas is limited by their inaccessibility, the number of channels that would need to be assessed, and the need to obtain land owner permission to conduct surveys.

Watershed Conditions

Watershed conditions evaluated in the Characterization Phase include watershed hydrology, stream hydraulics and channel morphology.

Hydrology and Hydraulics

Setting

The climate of the RC watershed is characterized by a wet season and a dry season. The wet season typically runs from October to May with the dry season running from June to September with most of the precipitation occurring as rainfall. Although snowfall occurs on occasion, it typically melts within a day or so and is not a significant component of the hydrologic cycle. Average annual rainfall ranges from 35 to 45 inches in the watershed with little orographic effect given the lack of significant relief across the watershed. The Happy Valley/Scouter's Mountain buttes create a mild rain shadow effect, with slightly lower rainfall east of the ridge on the leeward slopes and lowlands (Winterbrook, 2007). As mentioned earlier, the rainfall depth and duration of the 1996 and 2009 storm events were 6.95 inches over 4.3 days and 3.95 inches over 1.3 days, respectively. For comparison, the 24-hour design storm depths for CCSD No. 1 are 2.4, 3.0, 3.4, 4.0, 4.5, and 50 inches for the 2-year, 5-year, 10-year, 25-year, 50-year, and 100-year storms, respectively.

Streamflow

Given the location (mostly outside CCSD No. 1) and relatively small size of the watershed, there is a lack of long-term measured hydrologic data for the streams in the RC watershed. At least two continuously monitoring streamflow gauges have been established in the watershed, one located just above Southeast Sunnyside Road, and the other near the confluence with the Clackamas River. WES has not conducted an analysis of the streamflow gauge data recently. Both gauges have been operating for a limited time only, and are therefore not currently useful for understanding long-term changes in the magnitudes of peak flow events.

To generate peak discharge data for the hydraulic models, PWR built a hydrologic model using HEC-HMS for the watershed. A summary of the peak discharge rates predicted by the HEC-HMS hydrologic modeling for the SWMPMP are presented in Table 2-2. Values are presented at various locations in the watershed for the 2-, 10-, and 100-year return intervals for pre-developed or 1930s forested, existing (as defined during the preparation of the SWMPMP), and future conditions. The HEC-HMS hydrologic model was calibrated to a limited amount of historic gauge data. The calibration was performed using limited gauge data available from 2001 on Rock Creek. PWR performed a check of the predicted peak flow rates by comparing them to USGS Regional Regression Equations. Since that time, WES has collected additional data on streamflow during several large storm events.

As discussed in the data gaps discussion, the predicted flows under forested conditions may be underestimated. In most cases, existing flow conditions are estimated to be two orders of magnitude greater than estimated flows under pre-development conditions. Further evaluation of this issue in the future would be helpful for additional hydrologic and hydraulic analysis.

On January 3, 2007 and January 2, 2009, there were large storm events in the RC watershed that created significant stream flows in Rock Creek and its tributaries. Photos 2-1 through 2-7 from these events follow and show comparisons to lower flow conditions where possible.

Photos 2-1 and 2-2. Lower Rock Creek on January 3, 2007 and September 5, 2008

Photos 2-3 and 2-4. Lower Rock Creek near Trillium Creek on January 3, 2007 and September 5, 2008

Photo 2-5. Rock Creek at Troge Road and SE 172nd Avenue on January 2, 2009 approximately 10 hours after peak stream flow

Photos 2-6 and 2-7. Rock Creek adjacent to Troge Road on January 2, 2009 approximately 10 hours after peak stream flow and on September 5, 2008

Flashiness Index

In June 2008, PWR was retained by WES to conduct a study in which several different methods were researched for creating a watershed Flashiness Index. The Flashiness Index yields a numerical value that is used as a proxy to evaluate whether or not a channel is stable or unstable as a result of increased urbanization of a watershed. The purpose of a Flashiness Index is to characterize the magnitude of urban development in a given watershed by developing relationships between pre-developed or historic flow rates and those measured or modeled under today's land use condition.

Based upon the lack of availability of stream data to support other more complex methods, PWR chose to use an index developed by Booth and Jackson (1997). Booth and Jackson postulated that when the 2-year recurrence interval flow under current conditions (Q_2 current) is greater than the 10-year recurrence interval flow under forested conditions (Q_{10} forest), stream channels in the analysis area are potentially at risk to become unstable. The Flashiness Index is a measurement of the ratio of Q_{10} forest/Q_2 current. When the Flashiness Index is equal to or less than 1, then the stream channel is potentially considered to be at risk of becoming unstable.

As previously discussed, the HEC-HMS modeling results for the forested conditions runoff rates appear low. Low forested runoff rates yield low values in the Flashiness Index which potentially could lead to unreasonable assumptions about the degree of instability of stream channels in the RC watershed.

Given the level of uncertainty associated with the estimated pre-development flows, at best the Flashiness Index should be used to evaluate only the relative potential of channel instability between reaches in the watershed. If field investigations show that a specific reach is stable, then one could generally assume that another reach in the same watershed with a similar Flashiness Index value could also be stable, all other conditions being equal. Reaches with values below those of verified stable reaches could then potentially be considered unstable. The best approach would be to calibrate the Flashiness Index with field data by evaluating actual channel stability conditions at a range of index values. If a local relationship could be developed, that relationship could be applied to stream reaches that were not surveyed to estimate the potential for instability.

The results of the Flashiness Index calculations for the RC watershed are illustrated in Figure 2-3. The results suggest that the 10-year forested flow is in most cases one-fifth to one-third of the modeled 2-year existing conditions flows, especially along the lower to middle mainstem of Rock Creek. This is a profound result, given that much of the watershed is still undeveloped and primarily consists of land uses that can be characterized as either rural residential or farmland. Although some caution should be heeded to the actual values given the potential inaccuracies associated with the modeled forested flows, the results suggest that the soils in the watershed, the conversion of forested land to a farmland use and the presence of roads and drainage networks can have a significant hydrologic effect. In spite of the actual values, the portions of the RC watershed that are more developed have a lower index value resulting from the higher rates flow rates from these subwatersheds, per unit area, under existing conditions.

Hydraulic Modeling and Mapping

FEMA publishes a set of maps defining the 100-year floodplain. These maps identify the anticipated flooding areas associated with a 100-year recurrence interval storm event (which is the event with a 1.0 percent probability of occurring in any given year). The maps are referred to as FIRMs and dictate locally which parcel owners may purchase federal flood insurance. PWR, under a separate contract from the SWMPMP, prepared an updated FIS for Rock Creek. In discussions PWR and Clackamas County staff, it was indicated that the new PWR modeling and mapping have not yet been adopted by FEMA.

Since the more recent 100-year floodplain maps are still under review by FEMA and have not been certified, we relied primarily on the FIRMs currently published by FEMA to evaluate the extent of flooding on Rock Creek and the degree to which property and structures are affected by flooding. The 1996 flood mapping conducted by WES and Metro depicting the extent of flooding during the 1996 flood event was not available for the RC watershed. The results of the field visit to the RC watershed during the January 2, 2009 storm event are compared briefly with the hydraulic modeling and mapping results discussed below.

Figure 2-4 depicts anticipated flooding conditions on the mainstem and some tributaries of Rock Creek during the 100-year recurrence interval event. In Figure 2-4, the FEMA 100-year floodplain data is depicted along with the parcels that fall within the 100-year floodplain. Please note that some parcels are somewhat large and may have been highlighted through the analysis despite the fact that only a small portion of the parcel is potentially affected by flooding. In addition to depicting which parcels are affected by flooding, we have identified locations in the watershed where structures occur in the floodplain and also where flooding complaints have been logged by WES from property owners experiencing flooding.

What is apparent from the analysis is that most flooding that affects developed areas is anticipated to occur in the upper portion of the RC watershed in the vicinity of the Pleasant Valley Golf Course and along Southeast 172nd Avenue. Additional flooding issues were noted along Troge Road and Southeast 162nd Avenue during the January 2, 2009 storm event. These areas are predominantly rural residential and farmland, although they are in the process of rapid development and are projected to convert to residential lands over the next decade. Much of the flooding is most likely nuisance, impacting lawns, culvert crossings, backyards, and fields that are mostly fallow during the wet winter season. That notion is supported by the data presented in Figure 2-4 where only one parcel contained a structure that was within the mapped 100-year floodplain and only one complaint of flooding or drainage issues has been logged by WES. During the January 2, 2009 storm event, evidence of road flooding was observed on Troge Road, Southeast 162nd Avenue, and Southeast 172nd Avenue. Road flooding can be problematic because it can endanger drivers and damage roads. Although there are currently rules restricting the placement of new structures in the floodplain, nuisance flooding, potential road and property damage, and flooding complaints may increase as the watershed develops.

Using the cross-section data from the hydraulic model prepared by FEMA, a reach-level analysis was prepared to identify what return event is expected to cause the flow in the creek to begin to leave the main channel and flood the overbank or floodplain areas. Using the HEC-RAS models, the water surface elevations for several return intervals were calculated and examined within a given reach to determine when flood water overtopped the banks. A database for each reach was created for use in the GIS dataset.

Figure 2-5 illustrates the results of the channel-floodplain interaction analysis. Generally, the results suggest that, despite the fact that much of the watershed is not currently urbanized, the channels appear to be relatively incised. In the lower mainstem channel of Rock Creek, an incised condition is most likely associated with the fact that Rock Creek flows through an incised canyon just upstream of Highway 212/Highway 224 and the confluence with the Clackamas River where floodplain is limited by the morphology of the valley. Upstream in the middle and upper reaches, in Pleasant Valley, the channel was most likely ditched and confined to allow for agriculture to occur on the adjacent terraces and floodplains. It is also likely that historic floodplain channels and wetlands were filled or drained as part of an effort to reclaim land for farming.

Channel Morphology

This section includes a discussion of geologic setting, watershed processes, and channel conditions for Rock Creek.

Geologic Setting

The RC watershed is a relatively small watershed that drains southward, with a confluence with the Clackamas River just downstream of the town of Carver. Although the morphology of the watershed has been influenced significantly by the Boring Lava Domes, created more than 2 million years ago, and recent and persistent catastrophic flood events on the Columbia River known as the Missoula Floods, the surficial geology is relatively simple. The influence of the Missoula Floods, occurring as recently as 10,000 years ago, appears to have created the broad valley, known as Pleasant Valley, through the successive deposition of lag and backwater deposits when the Missoula flood backwaters resulted in significant ponding of the Clackamas River. Following these successive deposition events, which most likely mimicked the conditions in a lakebed, the Clackamas River reincised into the deposited materials and the steep, confined valley at the lower end of Rock Creek likely formed as a result. The surficial geology of the RC watershed is dominated by Quaternary deposits consisting of backwater deposits from the Missoula Floods, with several prominent peaks dominated by basalts from the Boring Lavas (Figure 2-6).

Watershed Processes

Channel morphology is affected by a variety of watershed processes. Stream channels function in a physical sense to transport watershed energy and products, including water, sediment, woody debris, and nutrients, to the lower end of the catchment. All of the fundamental characteristics of the channel, such as planform, capacity, and width-to-depth ratio, are reflective of the quantity and characteristics of watershed products supplied to the channel, and eventually transported through it. Changes in the quantity or characteristics of watershed products supplied to the channel are likely to result in changes in fundamental channel characteristics, although the link between the watershed and the channel is complex and specific channel response to watershed changes may be difficult to predict (Lisle, 1999).

There are a variety of erosional processes that contribute sediment to stream channels, including landsliding, slumping, rilling, debris flows, and bank failures. Each process differs by the quantity, timing, and grain size of sediment delivered to stream channels that may act as impairing sediment to salmonid production and rearing. Each process can also be classified into sources that are natural and those that are a result of human land use impacts. Erosion sources can also be classified into those that are episodic and those that are chronic.

Landsliding results from weak geologic formations, steep topography caused by tectonic uplift, and occurrence of intense periods of rainfall and seismic forces. Landslides often terminate at and impinge upon stream channels, sometimes feeding a seemingly endless supply of fine material directly into the channels. In the worst cases, chronic sediment loading from landslides can eliminate pools, riffles, and coarse substrate for hundreds of feet below the point of delivery. An important mechanism to store delivered sediment and attenuate sediment delivery downstream relates to the presence of large woody material and debris jams (Keller and Talley, 1979; Keller et al., 1981).

Steep slopes are an important factor in erosion in general and for landslides in particular. Weathered bedrock, soils, and colluvium are subject to saturation by rainfall. Saturated conditions can produce a nearly instantaneous and deadly failure of a rapidly moving landslide called a *debris flow*. Debris flows occur during intense periods of rainfall after hundreds of years of persistent slope wash and colluvium accumulation in swales. The swales are often underlain by bedrock, which has a lower permeability than the overlying colluvium. When the rate of rainfall exceeds the rate that the colluvium and soil can drain water off, the saturated zone or water table above the less permeable bedrock deepens. When the saturated mass overcomes the resistance holding it on the hillslope, the mass liquefies instantly and moves down the hillslope carrying trees, soil, and whatever else is in its path. In some cases, water separates from the debris flow mass as it reaches lower gradients and a debris torrent is unleashed—a wall of mud and debris that moves very fast and is extremely destructive.

Road building is a common and often dominant theme in land use disturbance. From farm road development to driveways and public thoroughfares, roads are required for access to nearly every land use. Roads are also generally the largest pollutant load generator in the urban environment and by far the most destructive element in the landscape as far as excessive fine sediment generation per unit area. Roads constructed along canyon floors and steep inner gorge slopes cause channel realignment resulting in direct delivery of sediment to streams. Erosion from road surfaces, ditches, shoulders, and other human-induced land clearing contribute mostly fine-grained sediment. Paved and unpaved roads modify local hillslope drainage patterns, concentrate flow, and increase runoff rates. Runoff on roads concentrates over soils exposed on the roadbed and shoulder, drainage ditches, road cuts, sidecasts, and fills. In terms of managing sediment loads to reduce aquatic habitat impairment, fine sediment source reduction from roads will often be the most effective treatment. Road crossings can also impact the channel erosion by constricting access to the floodplain and increasing velocities around bridges.

Bank erosion, reworking of old floodplain deposits, and drainage network expansion associated with gullying also contribute significantly to the amount of fine sediment in the channel. These sources contribute fine sediment directly to the channel and have a significant impact on aquatic habitat conditions. Reworking of old floodplain deposits that might have been delivered to the stream channel due to historic land uses may be especially important in watersheds where there is a history of logging and splash damming.

Several researchers have attempted to describe a predictable evolutionary sequence of channel response to urbanization (Simon, 1989; Arnold et al., 1982; Gregory et al., 1992; Park, 1997). One model, developed by Douglas (1985) describes a conceptual relationship between land use changes, relative sediment yield, and channel stability. At the onset of urban development, this model suggests the sediment yield would be very heavy due to increased runoff from impervious surfaces, resulting in increased gullying, undercutting, and bank erosion. The impact on channel stability would be rapid aggradation and some bank erosion. Assuming no net increase in urbanization, the Douglas model predicts that a watershed would proceed through a period of stabilization that would last on the order of 25 years. During this period, sediment yields would be moderate as channels adjusted to the new hydrologic condition and readily available sediment supplies were exhausted. Reduced sediment yields during this transitional period would result in channel degradation and severe bank erosion. Eventually, the channel is expected to reach a stable urban condition with low to moderate sediment yields and a relatively stable channel. This whole channel evolutionary process is expected to take 50 to 75 years due to lags in land use change and channel response. The timing would be highly dependent upon the size of the watershed, the rate of urbanization, and the time it takes for land use conditions to stabilize.

Urbanization in the RC watershed is a relatively recent process, with much of the change in channel morphology most likely a response to the conversion from forested lands to farmland and rural residential. Although changes in the hydrology have occurred, channel change and incision has most likely been more driven by direct modification of the stream channel, rather than through modifications to the hydrology. Changes in the hydrology in a landscape that is converting from forest to farm most likely occurs over a longer period of time than the hydrology in a conversion from farm to urban. There may be more of an opportunity for stream channels to adapt slowly to changes in the hydrology of a farm dominated land uses, absent the direct modifications of the channel.

Channel Conditions

Morphologically, stream channels in the Rock Creek basin can be divided into three distinct provinces consisting of the lower Rock Creek canyon, the broad alluvial plain represented where RC flows through Pleasant Valley, and the upper reaches of Rock Creek emanating from the Boring Lava Buttes. These morphologic provinces easily can be observed by evaluating channel slope (Figure 2-7) and the degree to which the channel is confined within a valley. Channel slope, though available from estimates provided as part of the ODFW habitat surveys, was derived, by reach, through the use of a 10-meter digital elevation model.

The underlying differences in the morphologic provinces are in part associated with differences in the surficial geologic units, but are primarily a result of landscape position. As mentioned previously, Pleasant Valley was formed by repeated sedimentation events within the backwater of the Missoula Flood and glacially derived flows coming out of the Clackamas watershed. Consequently, stream channels in Pleasant Valley are lower gradient than the stream channels that have incised into the terrace created from rapid incision in the Clackamas Valley.

In addition to channel slope, stream channels in the RC watershed can also be characterized by what material dominates the stream bed and how entrenched the stream channels are. The percentage of the bed that is represented by coarse substrate is depicted in Figure 2-8. Coarse substrate was defined as gravel, cobble, or boulder. A high percentage of coarse material in the bed most likely indicates a bed that is resistant to significant scour. The results suggest that, in general, the channel bed within the surveyed reaches of Rock Creek is relatively coarse and resistant to additional bed scour. All surveyed stream reaches have a bed where the percentage of coarse material exceeds 40 percent. The coarsest reaches are found in the lower canyon area.

To better characterize stream reaches in the project area based on morphologic conditions, and provide a common language to describe channel conditions, the Rosgen (1994) classification system was used. Since ODFW data were the primary data source available to classify stream channels, we used Rosgen's basic classification system rather than his more complex system. Additionally, the extent of our classification mapping was limited to the ODFW survey area. Consequently, we did not classify lower order tributary or headwater channels.

The key variables that Rosgen uses to classify streams are channel slope, degree of channel entrenchment, dominant substrate, width to depth ratios, and sinuosity to assign a reach identifier to the channel consisting of a letter from A to G and a number from 1 to 6. The letter represents the channel and valley form, from narrow to wide valley, and the number represents the dominant substrate, from bedrock to silt/clay. In most cases, the key variables that define the class assigned to a particular reach are the channel slope, degree of entrenchment, and the dominant substrate.

For the classification of Rock Creek, we used the channel slope derived from the Digital Elevation Model, and the degree of entrenchment and dominant substrate data included in the ODFW database. The degree of channel entrenchment, or entrenchment ratio (Figure 2-9), is calculated as the ratio of the flood-prone width and the active channel width. Flood-prone width is measured in the field as the width of the valley at two times the bankfull, or active channel, depth. Conceptually, entrenchment is meant to describe the level of channel and floodplain interaction that exists along a reach. Channels confined in narrow valleys or channels that are incised into historic floodplain will have a low value for the entrenchment ratio and consequently will be highly entrenched. Using these two variables, reaches within the ODFW study area were classified (Figure 2-10). Adjustments were made to the classes for each reach based on field observations of the channels. Reaches classified as A or B channels are typically better functioning than those classified as F or G channels since F and G classes represent incised conditions of B channels and are associated with low entrenchment ratios. Additional field work is required to verify the classification in many of these areas. Nonetheless, this represents an initial attempt to characterize the morphology of the mainstem reaches.

Another important parameter that was included in the ODFW assessment is an estimate of the degree to which bank erosion was occurring along each reach. As mentioned previously, this variable is recorded by the surveyors by estimating what percent of the stream banks are eroding within each surveyed habitat unit. WES staff then compiled this information by reach by taking a weighted average of habitat units along the reach. The results, presented in Figure 2-11, suggests that the reaches with the most unstable banks occur in the canyon area downstream of Southeast Sunnyside Road and in Pleasant Valley, upstream of the Southeast 172nd Street crossing along Southeast Troge Road. These areas were mapped as having high to moderate entrenchment with relatively coarse beds, suggesting that the energy which is confined to the channel due to the entrenchment is being forced to act on the banks due to the coarse bed.

Potential Future Risks and Further Analysis Recommended

The RC watershed currently exists at the edge of the Portland regional urban expansion. Although land use and land cover have changed from the historic forested condition to farm and rural residential, development pressure will most likely mean that large portions of the watershed will be urbanized in the next several decades. Changes in land use and vegetative cover along with subsequent impervious surfaces will almost certainly usher in significant changes to the hydrologic regime with the potential for unintended consequences on stream channels and watershed health. Water that historically was intercepted by vegetation, absorbed into the soil, and discharged slowly through natural runoff processes will more readily run off roads, roofs, sidewalks, and other impervious areas, to the creek through a direct and efficient flow path. Design standards, regulations, land use policies and sustainable practices will play a significant role in determining the impact that development has on the watershed.

The area expected to develop most rapidly over the next several decades includes the Happy Valley and Damascus areas included in the UGB expansion. Although the design standards for new development are intended to minimize changes to the hydrologic regime from future development, the timing and magnitude of peak discharge events will likely still be altered by the new development. To analyze expected future changes in flows under a future built-out conditions, PWR adjusted its hydrologic model to account for the expected increase in impervious areas. Figure 2-12 summarizes the expected changes that would occur at the 2-year recurrence discharge under full build-out condition. The data are presented as a ratio between the expected future 2-year discharge event and the current 2-year modeled discharge event. The results, therefore, depict the expected geometric increase in discharge. The results suggest that most of the modeled reaches could see flow increases of greater than 300 percent. These types of flow increases could have a severe and lasting affect on channel conditions as well as the potential for increased flooding in the lower gradient areas of the RC watershed. The most at-risk area is likely to be along the mainstem of Rock Creek between Southeast Sunnyside Road and Southeast Foster Road.

To evaluate how increased peak discharges would affect the potential for an increase in flooding, scenarios could be run using the HEC-RAS model to evaluate changes to the 100-year floodplain footprint. Since the model already has been built and the future flow hydrology already has been developed, running an expected future 100-year flood scenario would be a straightforward and useful exercise. This information could then be combined with the parcel and structure database to generate a figure similar to what we present in Figure 2-4 for expected future conditions.

As mentioned previously, hydromodification of the watershed has the potential to affect the morphologic character of stream channels that receive stormflows. The effect is often observed throughout the channel network since, functionally, the geometry of a stream channel (e.g., channel width, channel depth) is directly correlated with discharge. The dominant theory suggests that the geometry of the channel is dictated by a specific channel forming flow that typically falls in the range of the 1.5- to 2.33-year recurrence event. Since these frequent peak events occur often, averaged over time they typically perform the most work. Large floods obviously do a significant amount of work to the channel and floodplain and are responsible for events such as avulsions and debris flows, but when a new active channel is formed, it is typically responding to the more frequent and smaller discharge events.

When the hydrology of a watershed is modified, the observed changes vary spatially and temporally. Headwater channels often incise, widen, and experience headward migration. Erosion in these headwater channels result in aggradation and widening of higher order channels downstream. Eventually the headwater channels adjust and the process is typically transferred downstream. Mainstem channels often go through cycles of aggradation and downcutting in response to the processing occurring in the lower order channels upstream. Typically bank erosion is a significant issue in mainstem channels as they aggrade and downcut.

In addition to the risk to channels, changes in local runoff patterns associated with roads, an increase in impervious areas, and removal of vegetation have the potential to increase the risk of landslides and debris flows in zero order basins. Figure 2-13 depicts areas in the watershed that are at risk of mass failures, overlain onto a land use map of the watershed. High erosion risk areas are defined as slopes steeper than 30 percent underlain by highly erodible soils. The most at risk areas appear to be the lower canyon of Rock Creek and in the headwater areas of upper Rock Creek.

To evaluate the potential future risk of continued hydromodification on stream channels, we used existing data available from the ODFW assessment along with data layers provided by WES. One of the most significant concerns stemming from hydromodification is likely to be bank erosion. Channel incision most likely has been arrested in most locations due to road crossings and instream structures that act to hold grade. As the total amount of energy increases in a channel, due to an increase in peak flow, much of the additional work will be focused on stream banks as the channels attempt to widen, meander, and build floodplain that has been lost due to past incision. Eroding banks, though inherently a natural process, can be problematic when the erosion is excessive. Banks that are currently eroding are more likely to be at risk than banks that are currently stable because it implies something about the composition and condition of the existing bank and potentially the geomorphic setting. Figure 2-14 summarizes the ODFW bank erosion analysis. Reaches where 5 percent or more of the banks are currently eroding are presented as at-risk of eroding further in the future in response to changes in the hydrology. As mentioned previously, the areas of most concern are along the Rock Creek canyon downstream of Southeast Sunnyside Road and in the area of Rock Creek between Southeast 172nd and Southeast Foster Road.

Stream channels with roads directly adjacent to the channel also present a future risk. When roads are located close to the channel, it is likely that they have had an impact on the floodplain or even result in direct modification of the channel during construction. Channels modified by the impingement of roads are often less stable. As changes to the hydrology occur, these channels may be more at risk of bank erosion or downcutting. To assess the location of these roads, WES calculated the length of road within a 25-foot buffer on either side of the creeks for each reach. To better understand the results, we made the assumption that roads within 25 feet of the channel most likely run parallel to the channel and only along one side of the channel. That assumption allowed us to estimate the percent of channel length that was impacted by a road. The results are presented in Figure 2-15. The results suggest that many of the existing roads have stayed out of the riparian and stream corridor, except for a few of the smaller tributary channels in the upper Rock Creek area and along Highway 212. Future development should consider the location of smaller tributary channels before constructing roads that may impact the channel and result in future erosion and flooding issues.

In our final risk analysis, we attempted to overlay several variables included in the ODFW database to assess current and expected future risks to overall channel stability. After evaluating several variables, we decided to use the following criteria to identify channels where stability may be an issue:

- **Gradient.** Lower gradient channels are often inherently more unstable than higher gradient channels because they are primarily alluvial in nature, meaning they are underlain by mobile substrate and can therefore adjust spatially across the valley floor, the bed is often less coarse or armored, and they tend to occur lower in the watershed where sediment loads are delivered and deposited.
- **Entrenchment.** Entrenchment is often used as a proxy for understanding the potential energy acting on the channel bed and banks and the degree to which the floodplain is accessed. Highly entrenched channel will, by definition, have higher per unit shear stresses which can affect channel stability.
- **Bed Substrate.** Channels with coarse, armored beds are typically more stable over the long-term than channels with a bed, and presumably banks, composed of finer material. Although armored beds still have the potential to incise over time through selective coarsening, the magnitude of incision is much less than in beds composed of finer, more mobile material.

Using these variables, we selected reaches where the gradient is low (less than 2 percent), entrenchment is high (entrenchment ratio < 1.4), and coarse substrate composes less than 25 percent of the bed. The results are presented in Figure 2-16. Due to the fact that coarse substrate exceeds 25 percent in all of the surveyed Rock Creek reaches, no reaches were selected as having a high risk of channel instability under current conditions.

Further analysis of these issues and integration of the hydrologic data with the data on water quality, aquatic habitat, and biological resources was conducted in Chapter 5. Additional analysis of the continuous gauge data available for Rock Creek in comparison with modeled hydraulic flow is recommended for future assessment. In addition, further analysis of the proximity of current and planned future roads to stream buffers is recommended for future assessment.

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FIGURES 2-1 TO 2-16
TABLES 2-1 AND 2-2

Figure 2-1
Rock Creek - Hydraulic Modeling Extents
WES WATERSHED ACTION PLAN

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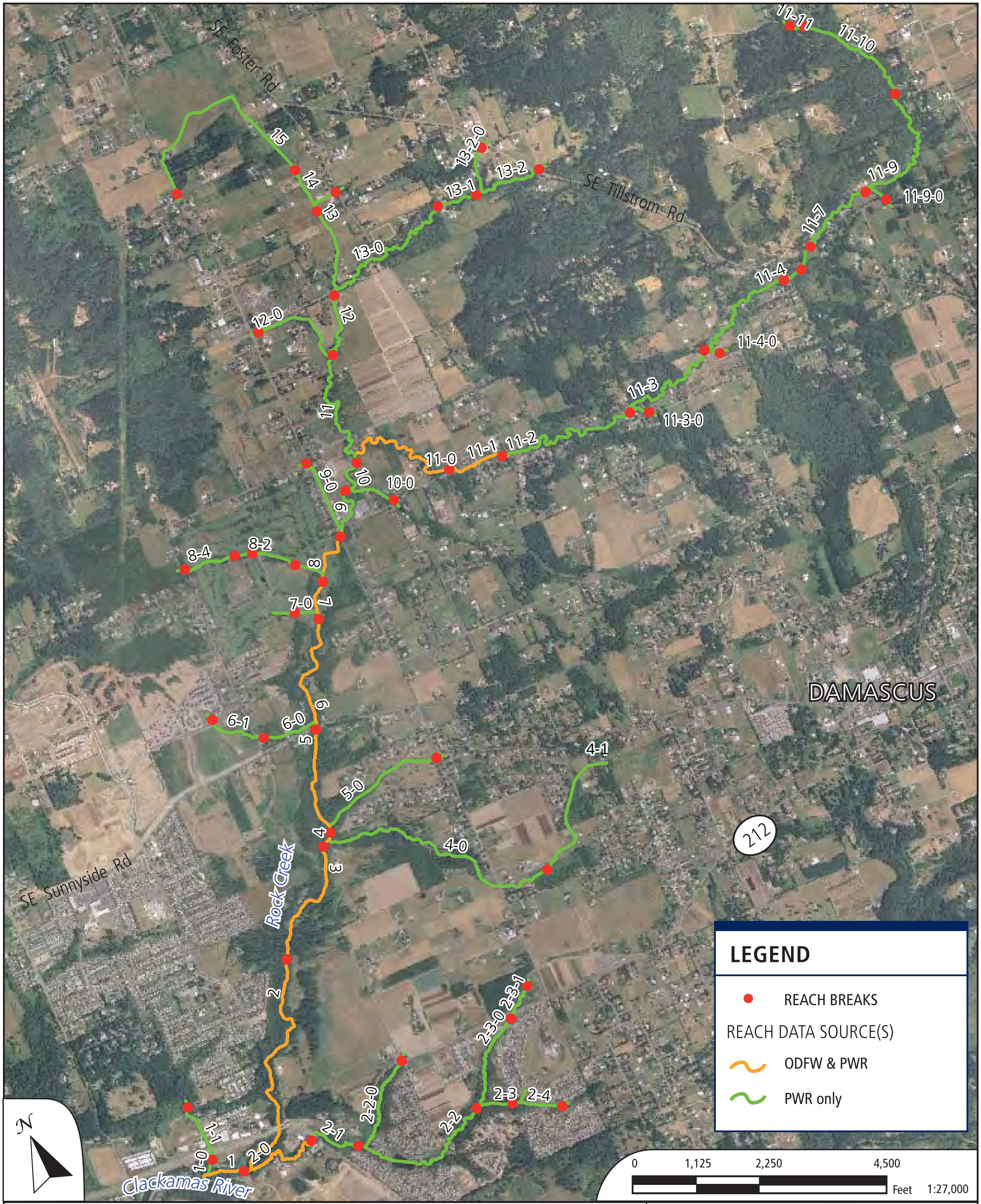

Figure 2-2
Rock Creek - Extent of Data Sources
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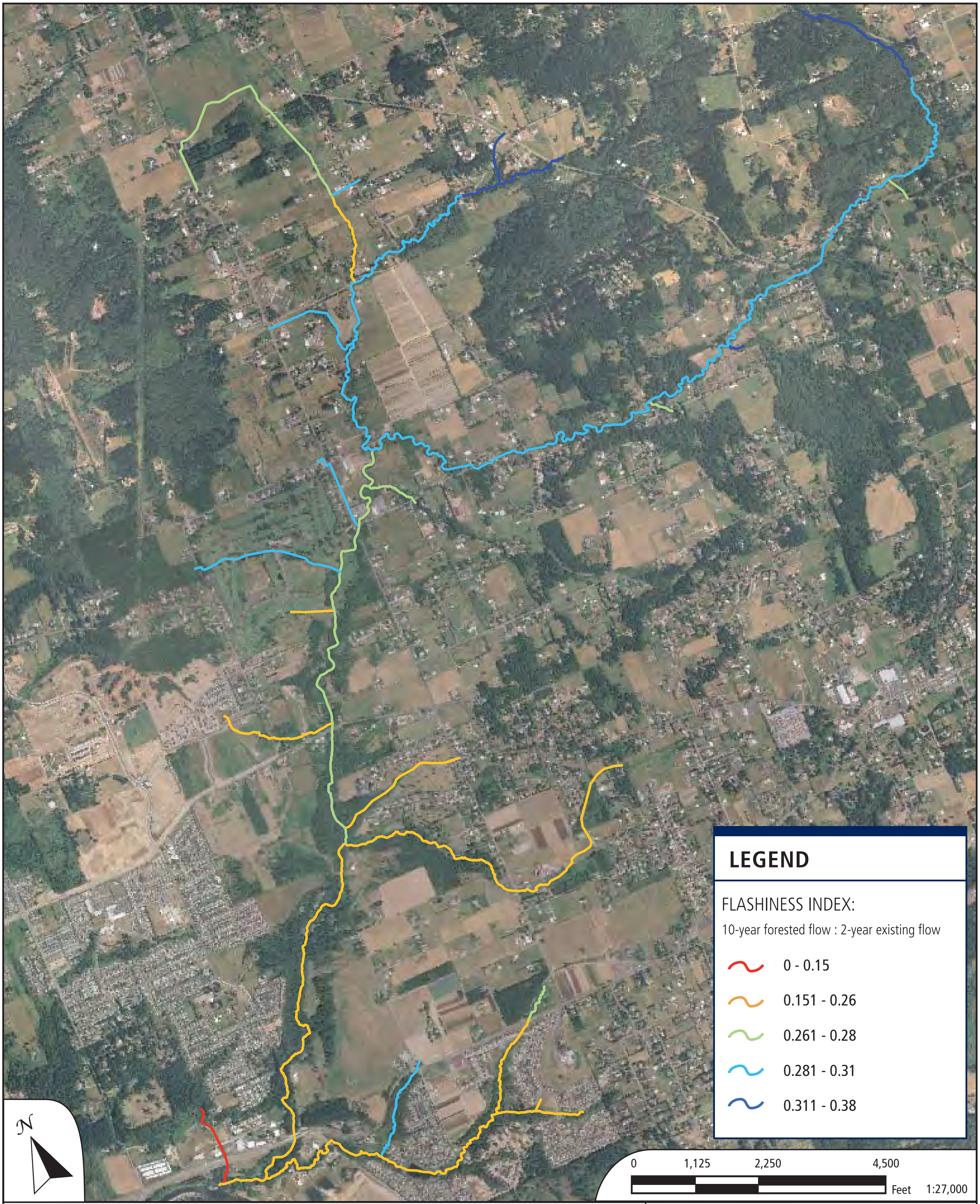

Figure 2-3
Rock Creek - Flashiness Index
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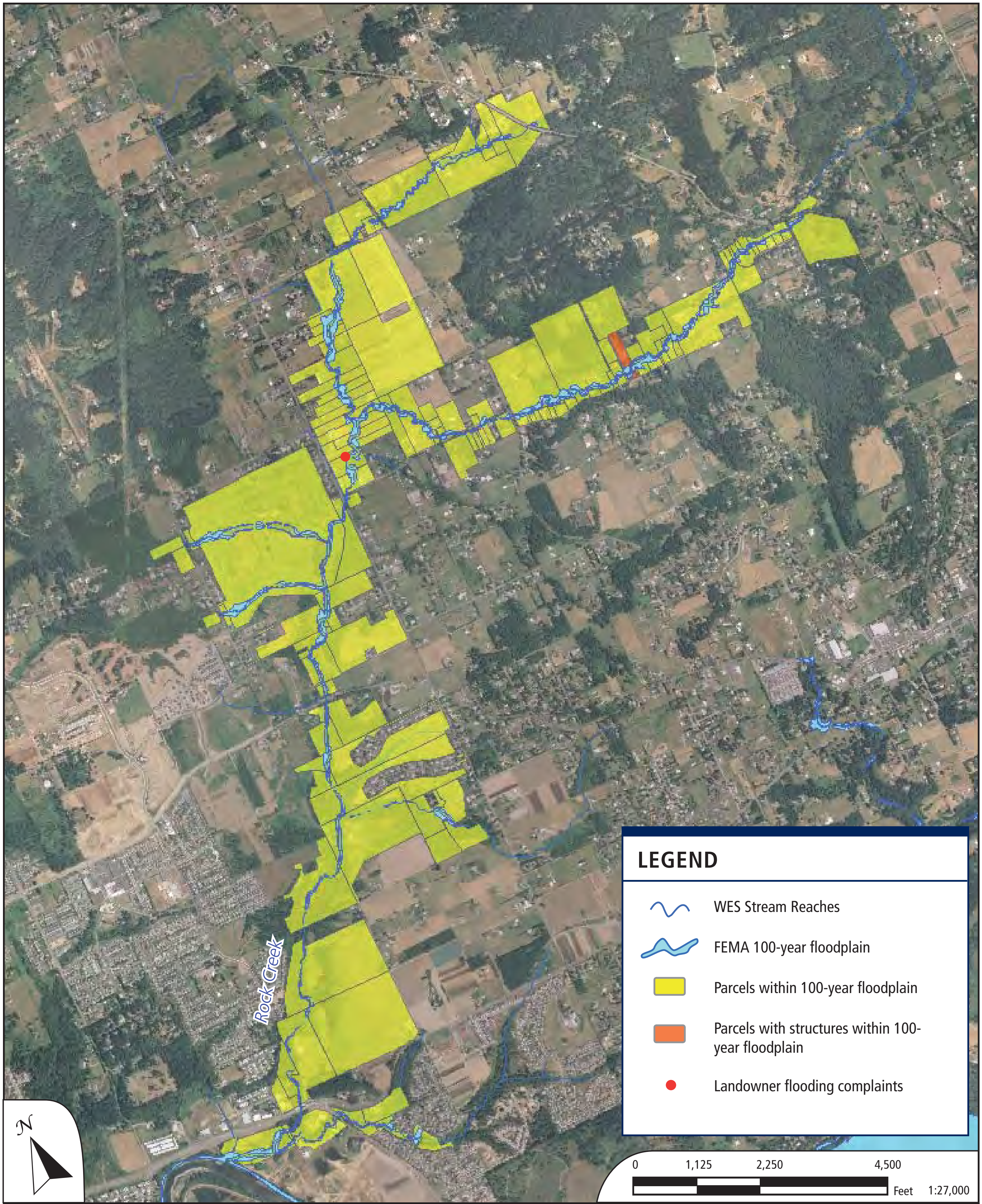

Figure 2-4
Rock Creek - Floodplain Conditions
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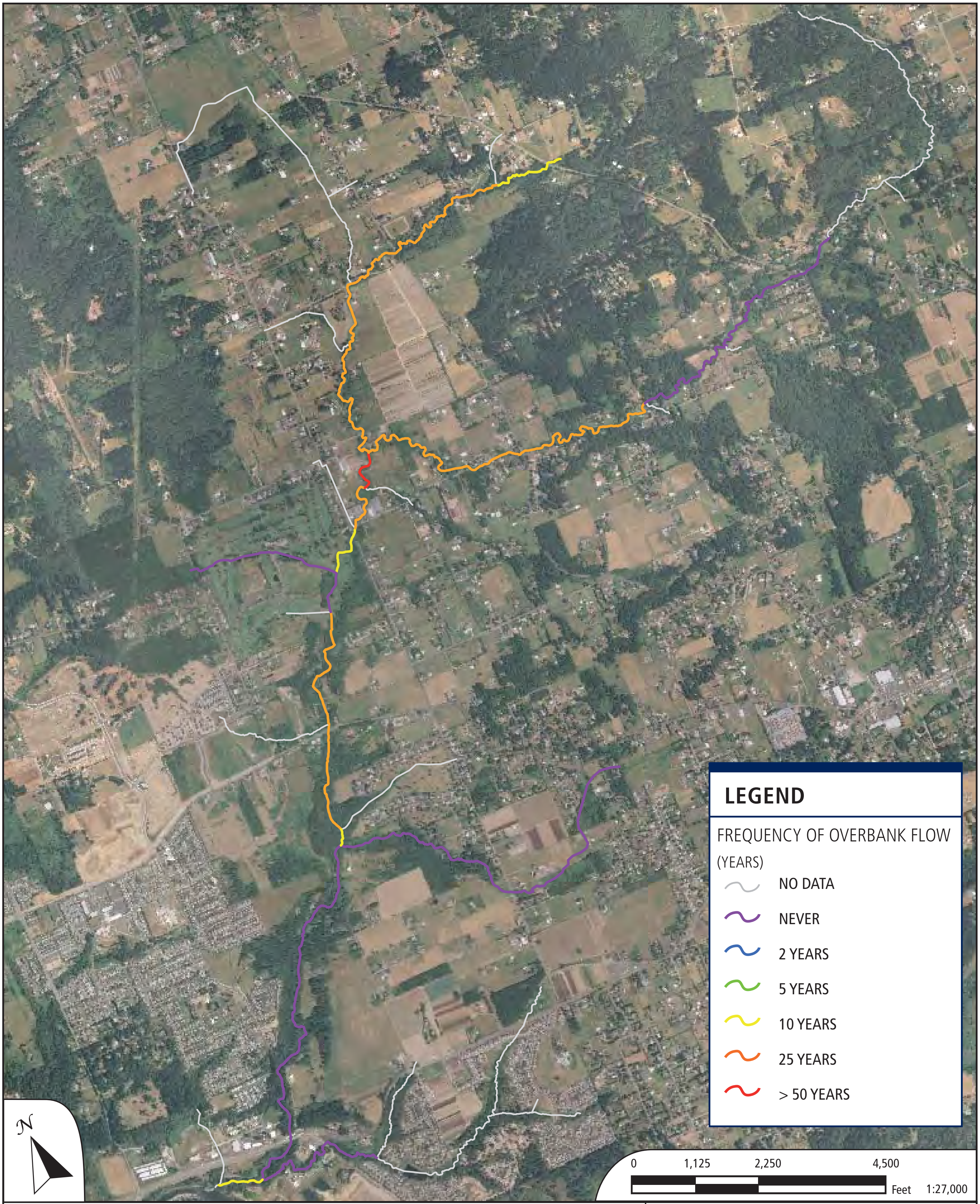

Figure 2-5

Rock Creek - Frequency of Overbank Flow

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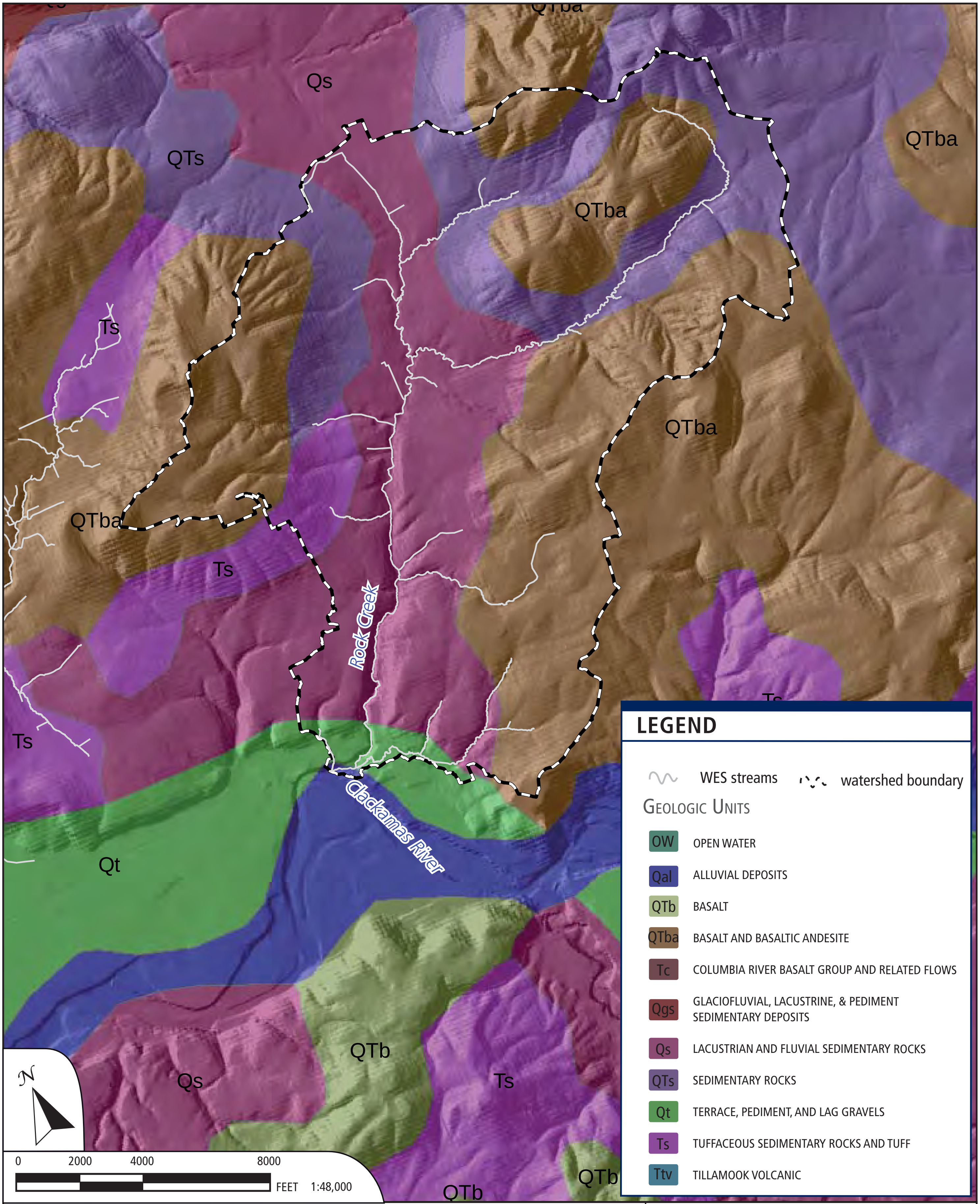

Figure 2-6
Rock Creek - Geologic Units
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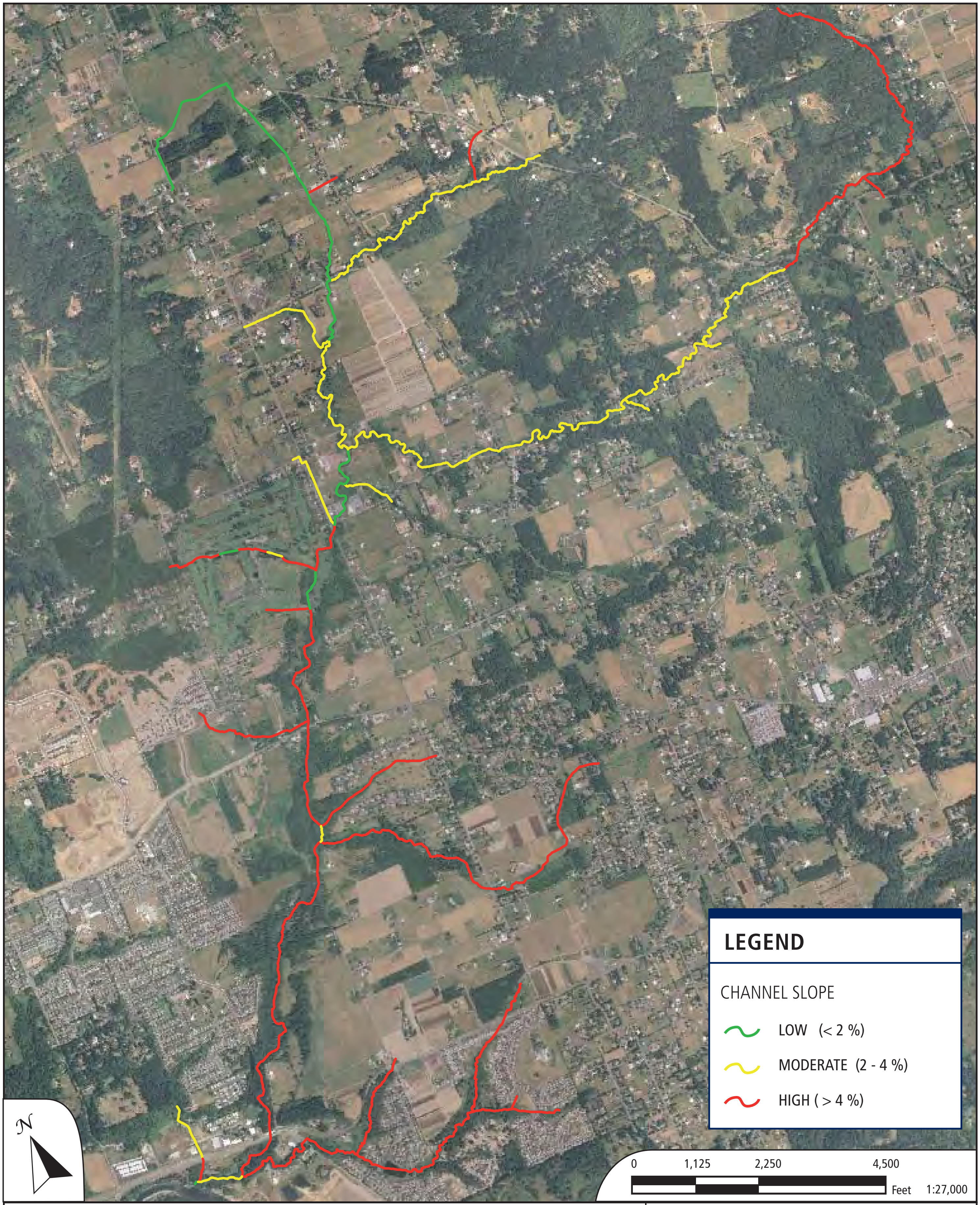

Figure 2-7
Rock Creek - Channel Slope
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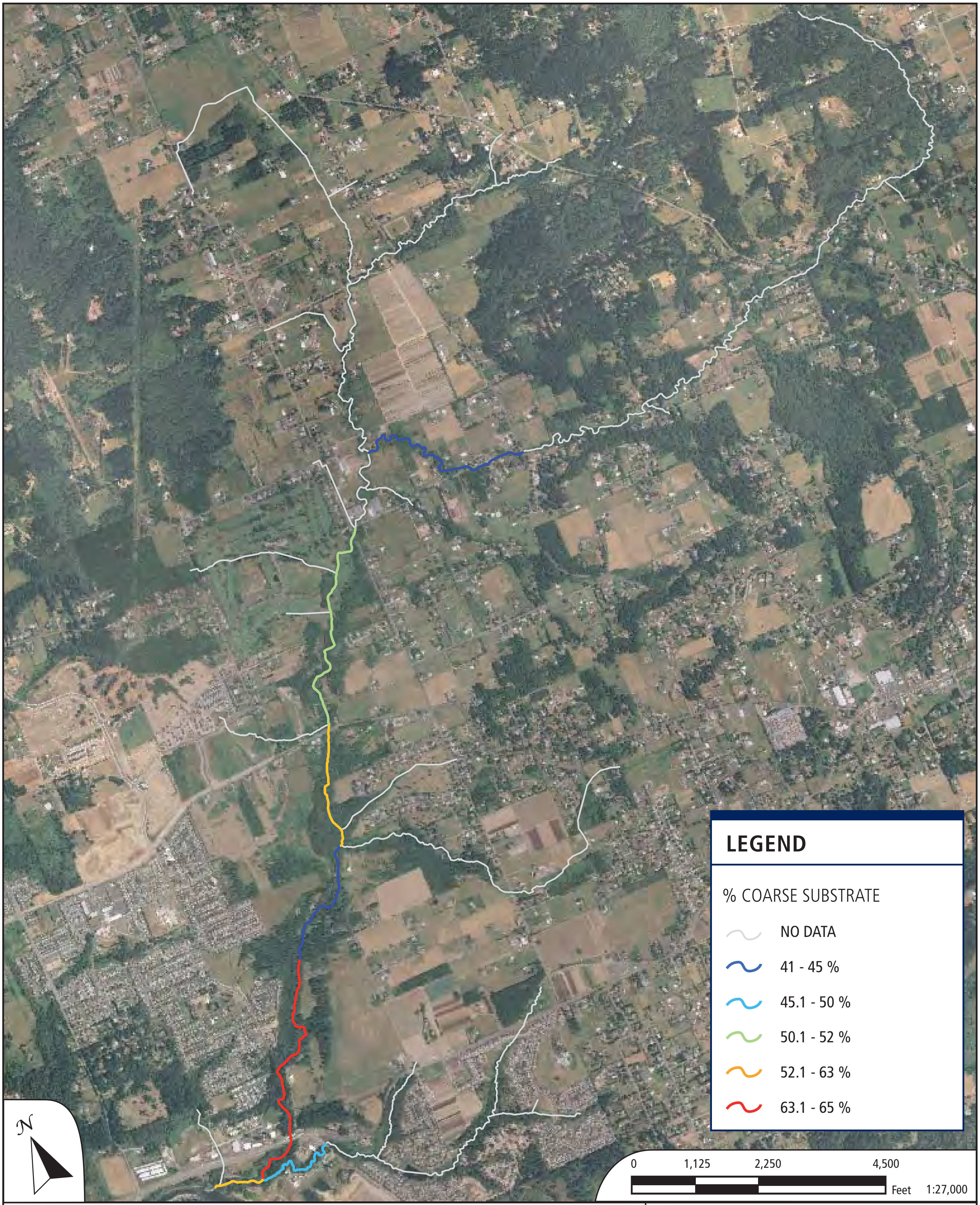

Figure 2-8

Rock Creek - Coarse Substrate by ReachWES

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Figure 2-9
Rock Creek - Entrenchment Ratio
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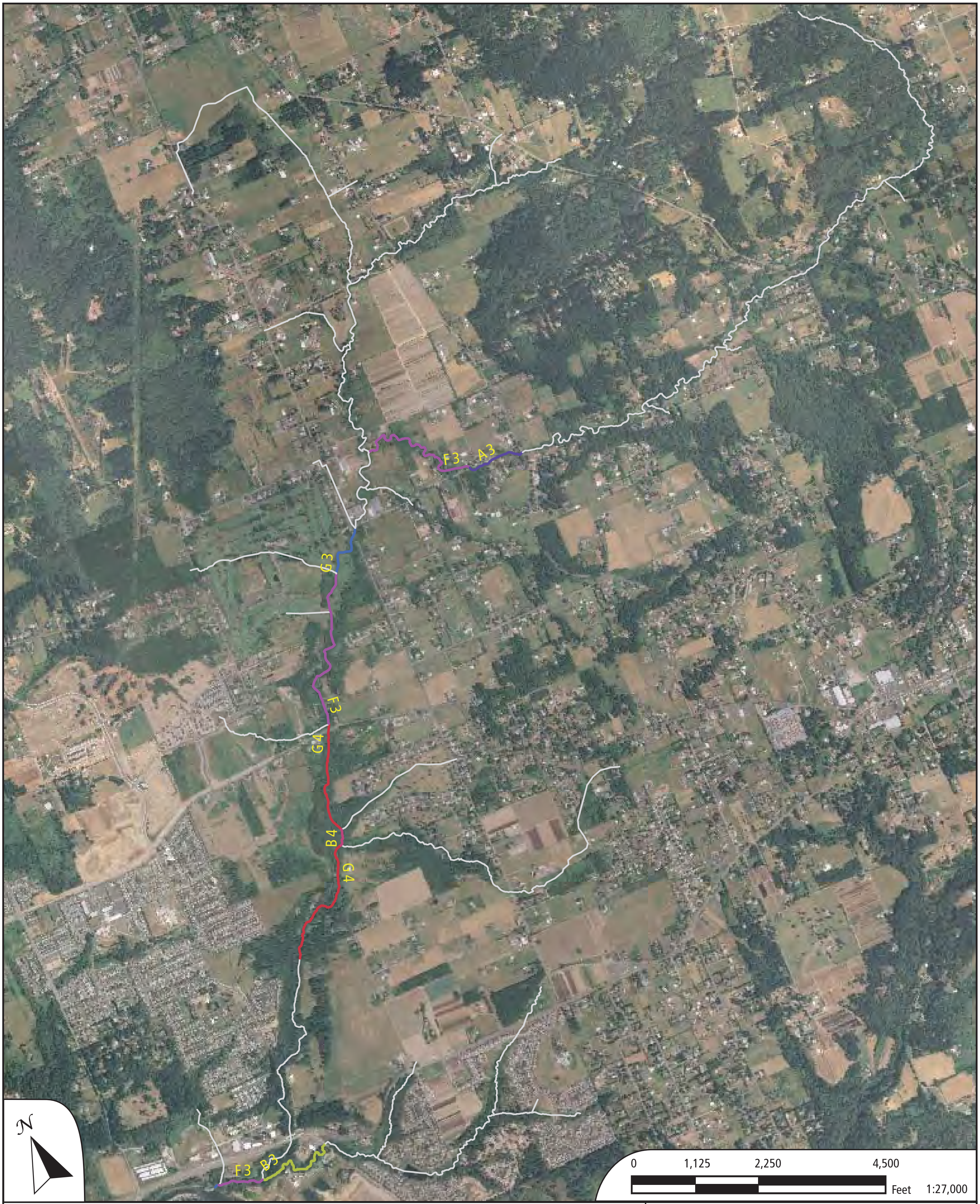

Figure 2-10
Rock Creek - Channel Classification (Rosgen)
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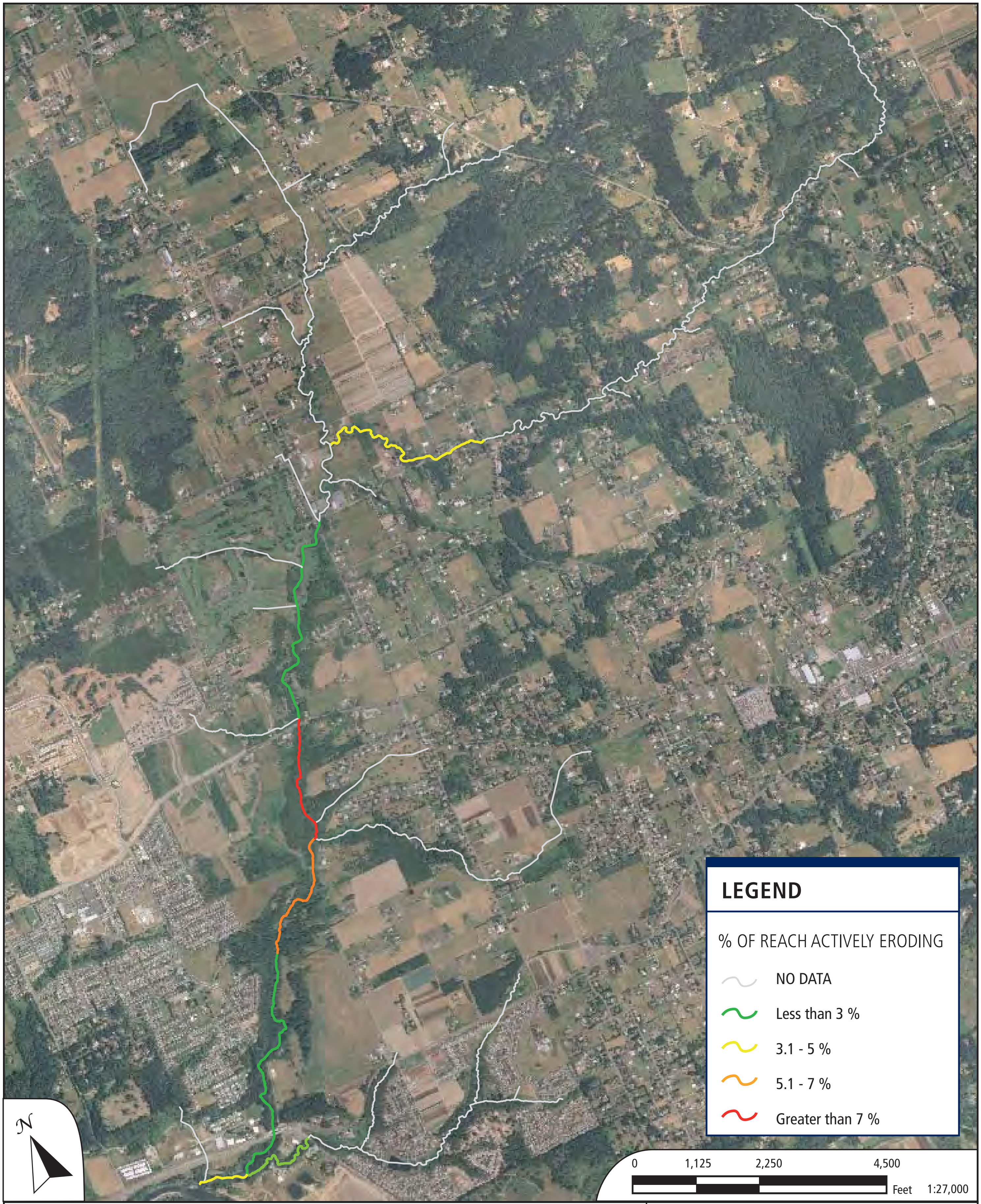

Figure 2-11
Rock Creek - Bank Erosion by Reach
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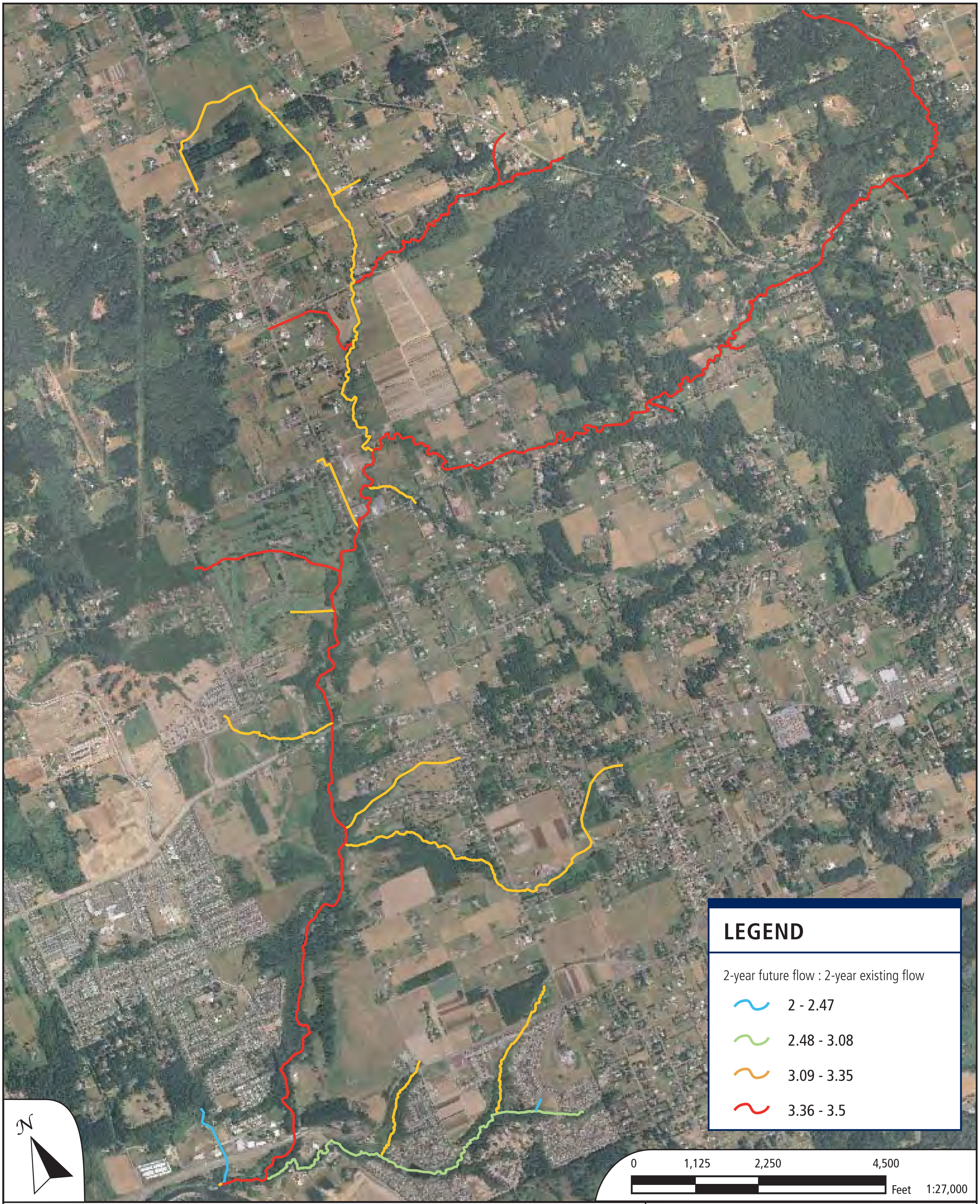

Figure 2-12
Rock Creek - Modeled Future Flow Conditions
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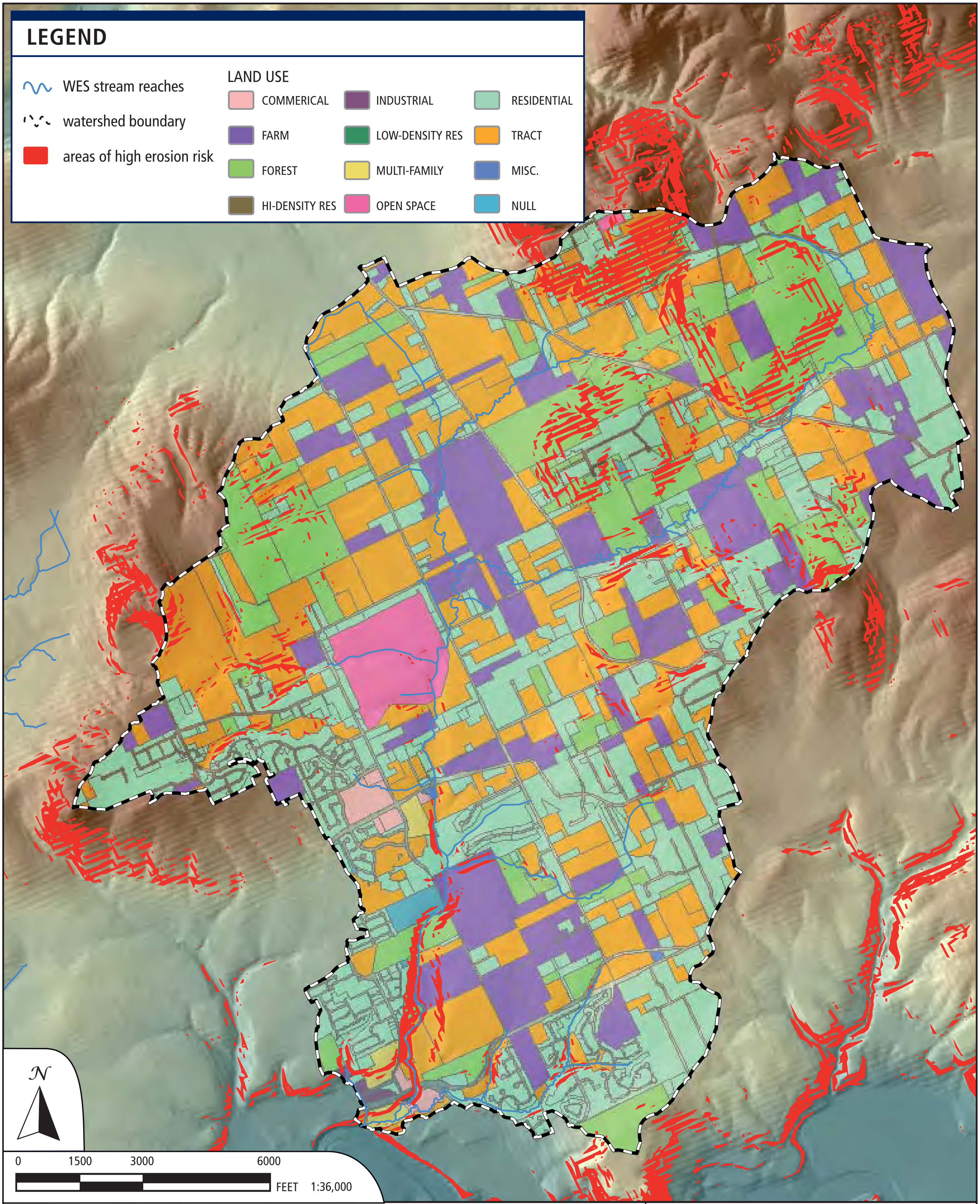

Figure 2-13
Rock Creek - Landslide and Erosion Risk
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Figure 2-14
Rock Creek - At Risk Channels due to Bank Erosion
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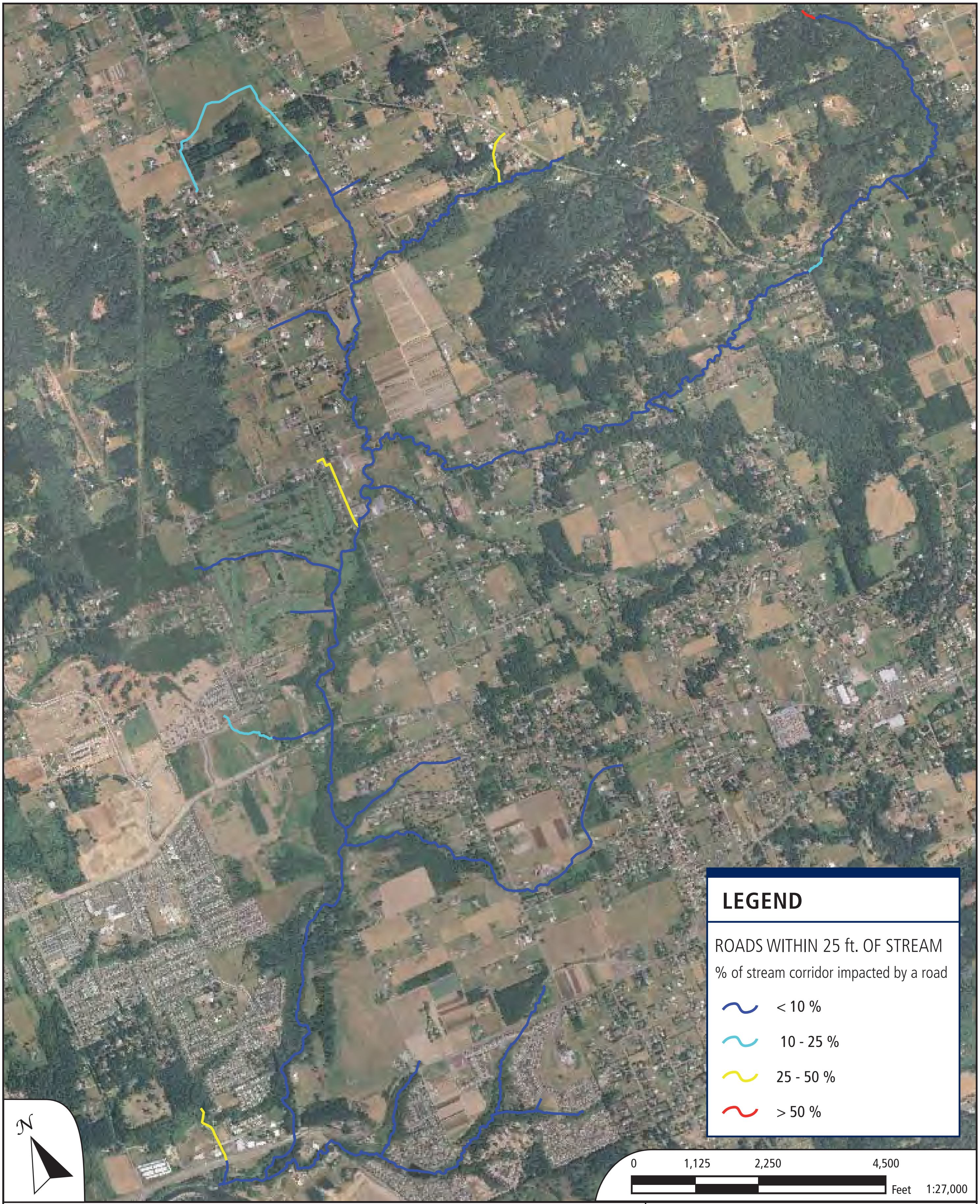

Figure 2-15
Rock Creek - Channel Impacts from Roads
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Figure 2-16

At Risk Channels due to Channel Stability

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Reaches with high risk of erosion due to a low gradient (<2%), high entrenchment (entrenchment ratio < 1.4), and low coarse substrate (< 25%).

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SUBBASIN	PWR ID	ODFW ID	SH+G ID					LENGTH (FT)
			Level 1	Level 2	Level 3	Level 4	Combined	
RC	RC009	RK1	0	--	--	--	0	74
RC	RC019	RK1	1	--	--	--	1	833
RC	RC029	RK2	2	--	--	--	2	4859
RC	RC039	RK3	3	--	--	--	3	2481
RC	RC049	RK4	4	--	--	--	4	299
RC	RC059	RK4	5	--	--	--	5	2031
RC	RC069	RK6	6	--	--	--	6	2371
RC	RC079	RK6	7	--	--	--	7	737
RC	RC089	RK6	8	--	--	--	8	1036
RC	RC110E09	RK7	11	0	--	--	11-0	2822
RC	RC110E19	RK7	11	1	--	--	11-1	1076
RC	RC020E09	TR1	2	0	--	--	2-0	1877

Table 2-1
REACH IDENTIFICATION TABLE
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Table 2-2. Peak Discharge Rates for Selected Points in the Rock Creek Watershed

Rock Creek	2-year Discharge Rates per Land Use Condition			10-year Discharge Rates per Land Use Condition			100-year Discharge Rates per Land Use Condition		
	Forested (cfs)	Existing (cfs)	Future (cfs)	Forested (cfs)	Existing (cfs)	Future (cfs)	Forested (cfs)	Existing (cfs)	Future (cfs)
Mouth of Creek	14.8	211.6	706.8	52.5	446.7	1004.8	458.4	927.4	1479.1
Orchard Lake/SE Goosehollow Drive	1.4	25.3	74.3	5.7	53.1	105.3	45.1	105.1	154.9
SE 172ND Avenue and SE Armstring Cir.	0.3	3.8	12.7	1	7.8	18	7.9	16.4	26.5
SE Sunnyside Road	11.3	156.4	532.8	41.2	328	757.7	349.9	689.1	1114.8
SE 172ND Avenue	8.4	115.3	391.1	31.4	240.9	554.3	260.6	505.3	815.5
SE Troge Road	3.8	53.8	184.1	15.2	114	260.9	123.3	239.7	383.8
SE Heuke Road	3.8	53	181	15	112.1	256.6	121.3	235.7	377.5
SE Hemrick Road	2.6	34.1	113.2	9.6	69.4	160.4	76	144.9	236
SE Foster Road	1.4	19.5	66.2	6	40.5	93.8	46.9	85.1	138
SE Tillstrom Road	1.8	25.6	87	7.4	53.9	123.3	58.3	113.3	181.4
SE Borges Road	0.6	8.2	28.3	2.7	17.6	40.1	20.6	37.1	59

Table 2-2
Rock Creek - PEAK DISCHARGE RATES
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[redacted]

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CHAPTER 3 - WATER QUALITY

Overview

This chapter summarizes water quality in the Rock Creek (RC) watershed based on an evaluation of existing environmental monitoring data and reports of watershed conditions. Key sources of information regarding water quality in the RC watershed include the following:

- Benthic macroinvertebrate surveys and Benthic Index of Biological Integrity (B-IBI) scores
- Fish surveys and Fish Index of Biological Integrity (F-IBI) scores
- Continuous flow and water quality monitoring data
- Grab sample data from in-stream locations
- Water quality pollutant loads model results
- Data from studies on specific water quality issues in the watershed area such as Best Management Practice (BMP) effectiveness

Figure 3-1 illustrates the water quality, continuous flow, benthic macroinvertebrate, and fish survey monitoring sites in the RC watershed.

Biological indicators such as benthic macroinvertebrate communities and fish populations can provide a long-term metric of water quality and insights on watershed health when sampled regularly over time. Since some of these species are long-lived, live in the water, and are sensitive to changes in water quality, studying the make-up of these communities provides clues about overall water quality conditions and levels of certain water quality constituents that can be limiting factors for aquatic organisms. Water Environment Services (WES) retained contractors to collect data on benthic macroinvertebrate communities in 2002 and 2007 (Lemke and Cole, 2008) and on fish populations in 1997-98, 2002-03, and 2008 (Oregon Department of Fish and Wildlife [ODFW], 2008). The results from these biological monitoring surveys are briefly summarized below and discussed in more detail in Chapter 4.

In addition to the biological indicators, WES has over 14 years of water quality monitoring data including grab samples and continuous monitoring. In the watershed conditions and limiting factors discussion below, key water quality parameters are evaluated against water quality criteria set by the Oregon Department of Environmental Quality (DEQ) as well as guidance levels from other sources where criteria have not been set by DEQ. An initial analysis of the results of water quality monitoring in comparison to the contributing watershed conditions is provided in this chapter; further analysis of the contributing areas and WES management activities in these areas will be performed during the watershed assessment.

The results of water quality modeling conducted as a part of the 2006 Clackamas County Service District No. 1 (CCSD No. 1) Master Plan and the results of other studies of specific water quality issues are evaluated in the watershed conditions and limiting factors discussion. The results of studies on specific water quality issues are also summarized, including the monitoring of stormwater detention ponds by Portland State University (PSU) and the pesticide studies in the lower Clackamas Basin by the U.S. Geological Survey (USGS).

Key water quality issues in the RC watershed include the following:

- Benthic macroinvertebrate and fish population surveys indicate that conditions in the streams in the watershed vary considerably. Sampling in the lower reach of Rock Creek generally indicates acceptable (unimpaired) and slightly impaired biological communities for fish and benthic macroinvertebrates, respectively, which is indicative of fair to moderately good water quality on average. The middle reach of Rock Creek and upper Trillium Creek support moderately impaired benthic macroinvertebrate communities. The middle reaches of Rock Creek are more severely impaired for fish, and the upper reaches are marginally impaired for fish. Although there may be water quality issues affecting fish populations in the middle and upper reaches of Rock Creek (in particular water temperature), habitat conditions also likely play a role in fish populations in these areas.
- Elevated water temperatures have been observed in mainstem Rock Creek and some tributaries during the summer. Riparian canopies and forests have been altered and removed in portions of the watershed, leaving the streams open to increased heat gain from solar radiation. The influx of cold spring water to the streams still occurs in some locations, but may have been reduced due to changes in land use and hydrology in the watershed from historical conditions. Modifications to the landscape including installation of impervious surfaces and drainage associated with agriculture have likely reduced infiltration and aquifer recharge. In addition, groundwater pumping in the area has resulted in portions of the watershed being identified as groundwater limited resources by the state. These changes may have resulted in less groundwater discharge to streams during the summer. Less groundwater discharge can increase stream temperatures because groundwater tends to be cooler than surface runoff during the summer, and less total flow in the stream allows solar radiation to affect a greater proportion of the water column.
- Elevated levels of *E. coli* bacteria, a key indicator of water contact human health issues, have been found throughout the watershed. *E. coli* is associated with fecal matter, which can contain a wide range of pathogenic organisms. There are many potential sources of *E. coli* in streams including birds and other wildlife, pets, livestock, and humans.
- Elevated levels of total phosphorus (TP) have been observed in water quality samples collected in the watershed. Elevated nutrient levels potentially could be due to use of fertilizers in the residential area and/or poor land management practices associated with farm, nursery, and forest land areas.
- A high proportion of water quality complaints in the WES complaint log are related to issues of construction site runoff. There is concern about the adequacy of required construction site BMPs for construction projects on steep slopes during the winter rainy season that contribute sediment loads. The large amount of new development expected in the RC watershed in the coming years will require proactive inspections and careful management of construction site runoff to protect water quality.
- WES has participated in pesticide monitoring studies (including herbicides, insecticides, and fungicides) with USGS in the Clackamas basin. Results from these studies indicate that several pesticides may exceed established or recommended criteria in the Clackamas basin and that sources may include runoff from urban and agricultural areas. Most of the samples containing the highest pesticide concentrations or the greatest number of compounds also had relatively high turbidity values.
- Limited sampling of dissolved metals (copper, lead, and zinc) was conducted in the watershed in 2007-2008. The samples collected have not exceeded the acute criteria for dissolved metals established by DEQ.

The potential causes of these water quality issues, risks and opportunities, and appropriate management strategies for WES to undertake to address these issues were evaluated and are presented in the watershed assessment Chapter 5.

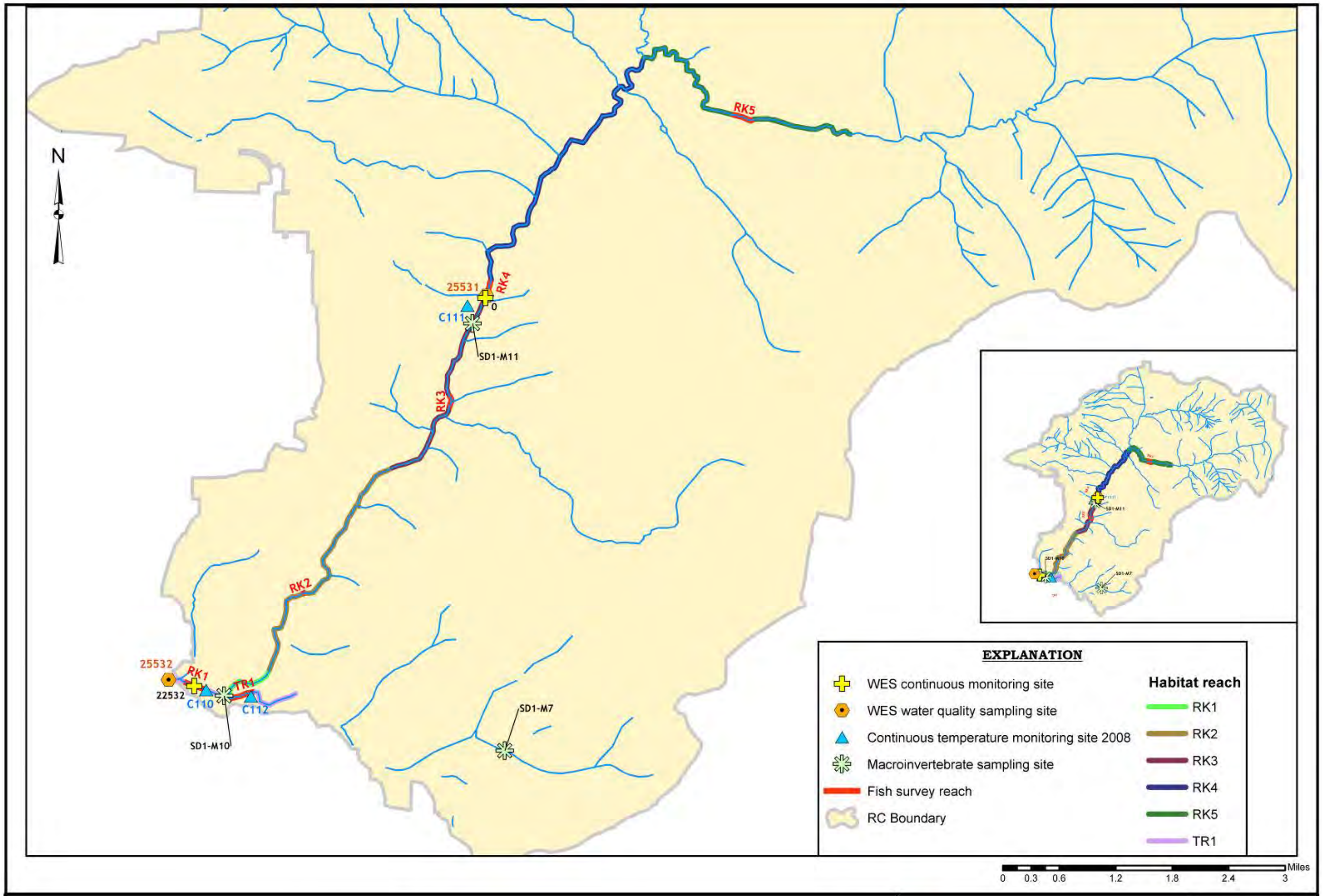

Figure 3-1
Environmental Monitoring Sites
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Data Reviewed

To characterize water quality in the RC watershed and evaluate limiting factors related to water quality, existing environmental monitoring data and reports of watershed conditions were reviewed. Key data sources evaluated include the following:

- WES Environmental Monitoring Data from 1994 to 2007 (WES, 2008a)
- WES Water Quality Annual Monitoring Reports (WES, 2006 and 2008b)
- National Pollutant Discharge Elimination System (NPDES) Municipal Separate Storm Sewer System (MS4) permit renewal submittal (WES, 2008c)
- WES Water Quality Trend Analysis (Brown and Caldwell, 2008)
- Benthic Macroinvertebrate Survey Results (Lemke and Cole, 2008)
- ODFW Draft Report of Fish Populations Assessment (ODFW, 2008)
- CCSD No. 1 Surface Water Management Program Master Plan (Shaun Piggott Associates et al., 2006)
- Surface Water Master Plans for Rock and Richardson Creek Watersheds (URS, 2000)
- Rock and Richardson Creek Watershed Assessment (CRBC, 2000)
- Pesticide Occurrence and Distribution in the Lower Clackamas River Basin, Oregon, 2000-2005 (USGS, 2008)

Data Gaps

The purpose of the data gaps analysis is three-fold:

- Identify gaps or deficiencies in existing information that limit our understanding of watershed conditions and potential project opportunities.
- Identify data gaps that limit the ability of WES to evaluate watershed conditions long-term.
- Identify gaps in monitoring data that, if these data were available, would provide WES with the opportunity to evaluate the success of any implemented action.

The following is a discussion of potential data gaps based on those criteria.

- The WES Geographic Information System (GIS) layer for the water quality monitoring sites does not have a consistent naming convention for the monitoring sites. There is a need to clarify the location, name, and associated data for each historic and current monitoring site in the WES GIS to improve future tracking of monitoring results.
- Additional water quality monitoring sites on upper tributaries and reaches are needed to fully characterize the watershed and monitor changes to water quality as development occurs. There are currently only two water quality monitoring sites in the RC watershed that are part of the WES monitoring program, two continuous flow monitoring sites, and three benthic macroinvertebrate monitoring sites, as shown in Figure 3-1. There are six fish monitoring sites. Due to the significant growth expected in the area, it would be helpful to add monitoring sites to serve as a baseline and to better characterize changes in water quality in specific upland and tributary areas and evaluate the water quality data in the context of the effectiveness of the WES surface water management program activities as well as activities conducted by Damascus and Happy Valley.

- Benthic macroinvertebrate sampling coverage for Rock Creek is presently insufficient to use benthic macroinvertebrate data to characterize water quality conditions throughout the basin and to allow reach-by-reach comparisons needed to evaluate stream habitat conditions. To allow comparisons between sites and with other studies in other streams, it is important that comparisons be made in riffle habitat. Additional benthic macroinvertebrate monitoring sites are needed.
- Much of the water quality data collected by WES is in the form of grab samples. Water quality data from grab samples represents conditions during a specific snapshot in time. Ambient water quality can vary considerably within short time intervals, especially during storm runoff events. Further sampling should be collected as composites.
- Summer low flow data are needed on Rock and Trillium Creeks. WES collects in-stream continuous flow monitoring data, however no analysis of these data have been conducted by WES recently.
- Continuous water temperature data were collected by ODFW under contract to WES at a number of locations in the RC watershed during spring, summer and early fall 2008. Some of the data were available and provided important insight into potential limiting factors.
- To support total maximum daily load (TMDL) compliance efforts, additional monitoring of TMDL constituents could be conducted. WES could consider conducting studies to identify the sources of *E. coli* in the watershed using Microbial Source Tracking methods (e.g., DNA ribotyping or Bacteroides).

Changes to the NPDES MS4 water quality monitoring program elements, including site locations, are possible through the adaptive management process for the Stormwater Management Plan but any changes to the MS4 permit monitoring must be coordinated with the other Clackamas County co-permittees that collaborate on the monitoring plan with WES and be approved by DEQ. However, there may also be opportunities to modify monitoring program elements that are not associated with the MS4 permit monitoring to better coordinate among these monitoring efforts.

Watershed Conditions

Several studies have been conducted recently that address water quality conditions in detail, including the 2006 Master Plan; therefore, this section does not attempt to exhaustively address all water quality conditions in the watershed. Key issues identified from existing data and reports as well as areas requiring further analysis are the focus of this section.

Watershed Processes

A wide variety of anthropogenic and natural factors in the watershed can have an impact on water quality. Watershed attributes that often affect water quality include development patterns and designs, effective impervious surface, land uses, age of development, structural and non-structural BMPs utilized, transportation systems, agricultural practices, forestry practices, air deposition of pollutants, soils, vegetation, and channel stability.

The RC watershed is expected to undergo significant conversion to urban land uses in the coming decades. As described in Chapter 2, conversion of natural and rural areas to urban land uses often alters the volume and delivery of surface water runoff, and associated water quality may become impaired. The volume of stormwater runoff increases due to the creation of impervious areas that prevent the interception and infiltration of rainfall into shallow soils. During dry weather, base flows may be altered and impacted by loss of groundwater recharge or by artificial flows from urban activities.

The water quality of surface flows can be impacted by the entrainment of pollutants in runoff. A variety of studies have been conducted to identify possible sources of pollutants in stormwater. Although the specific sources or factors contributing to the observed trends in water quality in Rock Creek are not fully known at this time, it is likely that some of the common contributors to water quality play a role in the watershed.

As described in the 2006 Master Plan (Piggott et al., 2006), there are a wide variety of potential sources of pollutants in urban watersheds including the following:

- Sediment from construction sites, roads, agriculture, and urban landscaping
- Nutrients from fertilizers applied to urban lawns or agricultural operations
- Metals from urban building materials, automobile use, and fluids from automobiles in disrepair
- Oil and grease from automobiles and commercial related activities
- Pesticides from agricultural and landscape areas
- Organic compounds from commercial and industrial areas
- Bacteria from animal wastes and failing septic systems
- Trash and debris from improper handling and disposal, including litter
- Temperature increases due to riparian vegetation clearing, reduced stream flow, and reduced groundwater inputs to streams

Water Quality Management Activities

A wide variety of management activities can be employed to lessen the hydrologic and water quality impacts associated with development. Examples include requirements for stormwater volume control and quality treatment systems and site design in new development (known as development and technical design standards), protection of natural features such as riparian buffers, enhancement of natural systems that are degraded, and non-structural BMPs such as street sweeping and public education.

Water quality management activities in the RC watershed are conducted primarily by WES, Clackamas County Department of Transportation and Development (DTD), Happy Valley, Damascus, Sunrise Water Authority, Clackamas River Basin Council and Clackamas County Soil and Water Conservation District along with a multitude of other partners. As described in Chapter 1, CCSD No. 1 currently includes only 12 percent of the RC watershed (including portions of the City of Happy Valley). The Cities of Happy Valley and Damascus encompass 35 and 57 percent of the RC watershed, respectively. Five percent of the watershed is outside the CCSD No. 1 and city boundaries (i.e., in unincorporated Clackamas County).

WES currently provides stormwater management and development review services in the western portions of Happy Valley through an inter-governmental agreement (IGA) and in the CCSD No. 1 service area, illustrated in Figure 1-1. DTD currently provides stormwater management and development review services in the less developed portions of east Happy Valley and Damascus that are currently outside the CCSD No. 1 service area. As development occurs in the Happy Valley and Damascus areas recently included in the urban growth boundary (UGB), there may be a transition of providers of stormwater management services from DTD to the cities of Damascus and Happy Valley or to WES or some other entity.

As described further in Chapter 1, WES and DTD require stormwater treatment systems for new residential subdivisions as well as commercial and industrial facilities in the watershed. The requirements for stormwater treatment for new Clackamas County roads and other DTD-reviewed projects are handled on a case-by-case basis, whereas the requirements for development in CCSD No. 1 and the portion of Happy Valley in the IGA with WES are based on the CCSD No. 1 rules and regulations, administrative procedures, and technical design standards. Much of the watershed is currently developed or characterized as rural residential and agricultural land without stormwater volume control or quality treatment systems. As a result, only a relatively small portion of the RC watershed is treated with stormwater volume control or quality treatment systems, as illustrated in Figure 3-2 from the 2006 Master Plan.

Figure 3-2 illustrates the areas draining to BMP categories of flood control basins, detention basins, treatment wetlands, water quality basins, and swales, as well as the location of features such as drywells. The BMP categories in Figure 3-2 reflect the design and primary intended function of the BMP structures. Flood control basins, for example, are detention ponds that are intended primarily to reduce downstream flooding. Flood control BMPs are often designed differently than water quality BMPs, although they may still provide water quality treatment.

WES currently maintains over 260 detention ponds that both detain and treat stormwater runoff. Many of these detention ponds are in Happy Valley. During the Early Action Item evaluation process, WES staff proposed retrofitting a number of existing stormwater treatment ponds to better treat runoff from smaller storms. Detention pond retrofit opportunities are detailed in Action D-2 of Chapter 6.

WES also allows developers to install proprietary stormwater treatment devices underground. Currently approved propriety systems include Stormceptor, CDS, Downstream Defender, Vortechnics, and Stormgate Separator. While these systems are usually effective at removing large-diameter sediment and litter from stormwater, they are often less effective at removing fine sediment and dissolved pollutants such as nutrients and metals from stormwater.

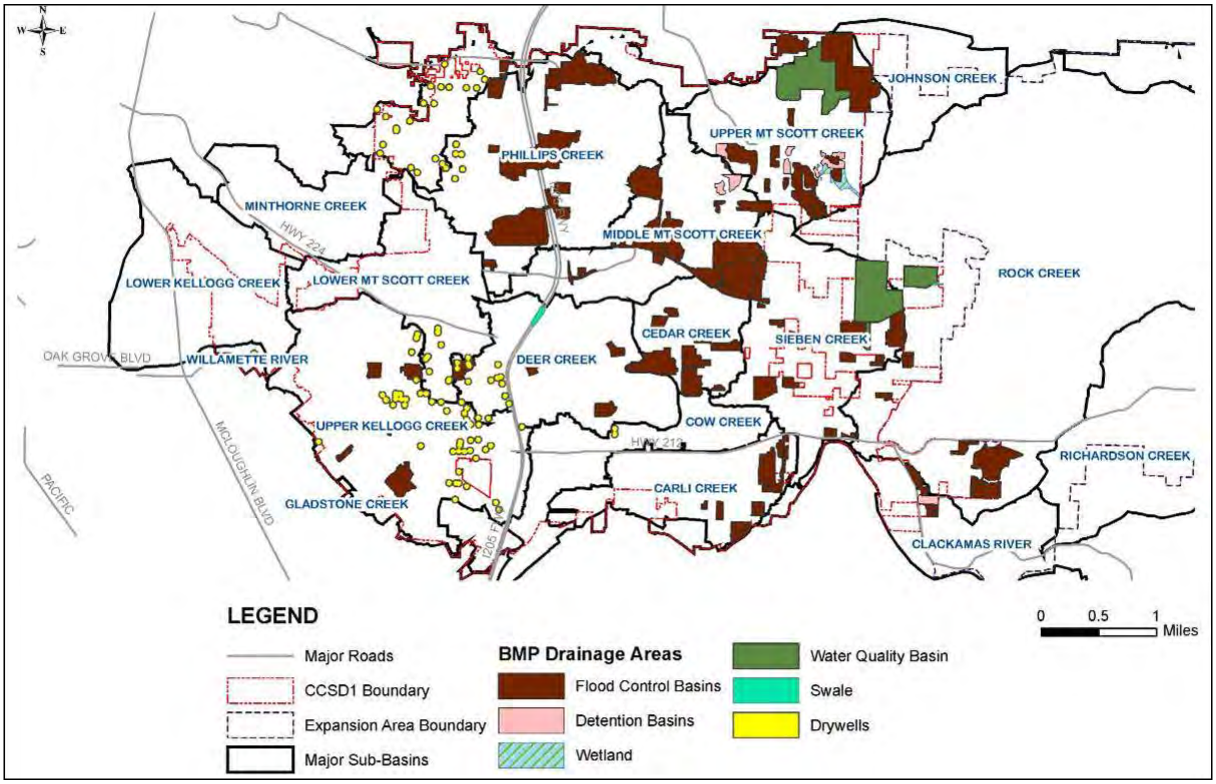

Figure 3-2. Drainage areas with stormwater treatment as of 2006

In addition to requiring structural treatment systems, WES, DTD, and Happy Valley also provide non-structural BMPs in the watershed to protect and improve water quality. These non-structural BMPs include activities like street sweeping and clean-up of spills of hazardous materials on roadways. Non-structural

BMPs also include public education and outreach efforts to encourage actions that promote stewardship and protect watershed health. WES summarizes its surface water management activities in its annual report for its NPDES MS4 permit.

The City of Damascus is currently conducting a pilot scale stormwater master planning project with an ecosystem services approach in the RC watershed. The project will expand the traditional stormwater master planning process to promote development approaches that protect and enhance ecosystems and use natural systems to provide stormwater management. The goal of the project is to eliminate water quality pollutant sources by preventing exposure to stormwater, infiltrating or reusing stormwater on-site, and protecting and restoring aquatic and riparian habitat. There are three main components being used for the ecosystem services approach for Damascus: net environmental benefits analysis; carbon sequestration analysis; and thermal reduction analysis. These three criteria are being used as indicators of ecosystem health to guide the development of certain aspects of a public facilities plan, stormwater BMPs, and natural resource policies, and codes/ordinances for Damascus. The project is a test case for the ecosystem services approach to evaluate the validity and utility of the approach.

Happy Valley, WES, and Sunrise Water Authority recently collaborated on the Rock Creek Sustainability Initiative (RCSI), which is a sustainable development test project for a 400-acre area in Happy Valley intended for commercial, institutional and industrial development. The RCSI is focused on evaluating low impact development (LID) or sustainable development opportunities to protect watershed functions and natural resources and values during development of the RC watershed.

Land Use and Impervious Surfaces

Uncontrolled runoff from impervious surfaces contributes to a variety of water quality problems and is therefore an important watershed stressor to evaluate. Figure 3-3 illustrates the expected changes in land use in the RC watershed as presented in the 2006 WES Master Plan. Overall, the RC watershed is currently approximately 13 percent impervious based on Metro land cover analysis of aerial photos. Although the actual imperviousness of the RC watershed will likely increase in the future due to significant new development in the watershed, over time the directly connected, or effective imperviousness of the watershed can be reduced through retrofitting existing impervious areas and applying LID techniques to new development.

LID or sustainable development techniques encompasses a variety of site design and stormwater management techniques intended to reduce the effective imperviousness of development by directing runoff from roofs and pavement to vegetated areas where it can be detained, treated, evapotranspired, and in some cases, infiltrated into the soil. These practices aim to mimic the natural hydrology of a site under post-development conditions. Four main principles of LID site design include the following: 1) reduce and soften the impervious footprint; 2) retain native vegetation and soils; 3) control runoff and pollutants at the source; and 4) increase infiltration.

LID techniques can be effective at reducing runoff and improving stormwater quality, particularly for smaller storms. Larger storms may still require the use of more traditional stormwater treatment and conveyance systems such as regional detention ponds and stormwater pipes, although the need for this varies based on individual site conditions such as soils and slopes as well as the amount of land used for LID techniques within a development. Retrofitting developed areas with LID techniques and regional stormwater treatment systems where feasible can help reduce the effective imperviousness of a watershed and improve watershed health.

Areas with high pollutant loads or high levels of imperviousness that lack stormwater treatment systems are areas to consider for prioritization to retrofit with regional stormwater treatment systems or site design modifications to allow more stormwater runoff to be stored, treated, and infiltrated in vegetated areas or other treatment systems. In the RC watershed, areas to consider for retrofitting with stormwater treatment systems include heavily traveled roads and parking areas that are currently untreated as well as other untreated urban development areas. However, ameliorating the impacts of previously developed urban areas can be challenging due to the magnitude and costs of retrofits that would be necessary to see a measurable difference in in-stream water quality as well as other issues such as private landowner owner willingness to participate in retrofitting projects. In addition, available land in areas with high levels of imperviousness may be difficult to find and expensive to use for stormwater treatment. Areas with moderate levels of imperviousness also provide opportunities to retrofit with stormwater treatment systems, and may offer more available land for this purpose.

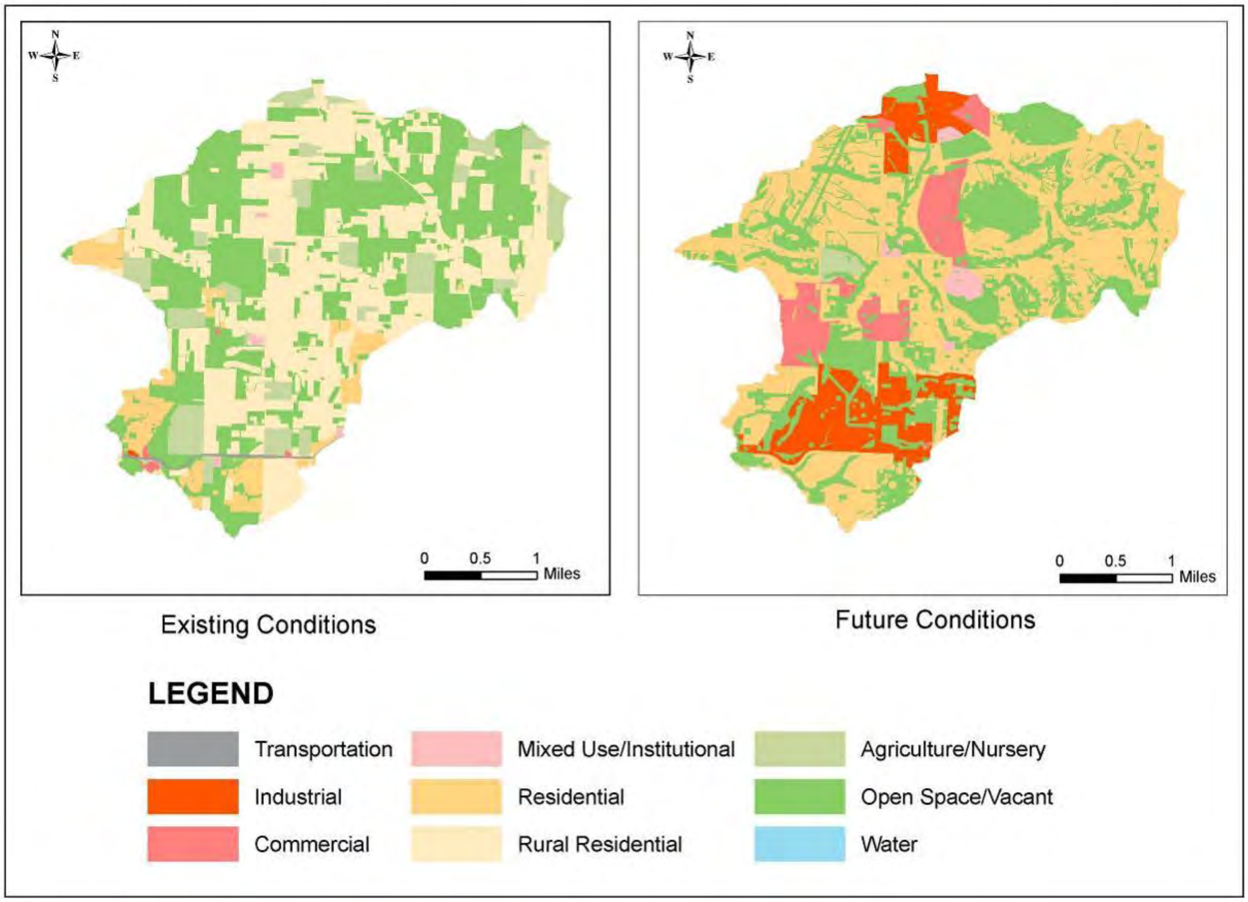

Figure 3-3. Existing and Planned Future Land Use in the RC watershed as of 2006

Water Environment Services Biological Indicator Monitoring

As discussed above, biological indicators such as benthic macroinvertebrate communities and fish populations can provide a long-term metric of water quality and insight into overall watershed health. Since some of these species are long-lived, live in the water, and are sensitive to changes in water quality, studying the make-up of these communities provides clues about overall water quality conditions and levels of water quality constituents that can be limiting factors for aquatic organisms.

However, it is also important to recognize that biological indicators can be affected by other limiting factors than water quality. Fish populations, in particular, can be affected significantly by habitat conditions as well as by a variety of other issues including competition with invasive species, passage and access to quality or suitable habitats, overfishing, ocean conditions (for anadromous fish), and other constraints. Therefore, low fish population scores (F-IBI) are not necessarily indicative of poor water quality. On the other hand, higher fish population scores generally indicate that minimal water quality requirements for sensitive species are being met or conditions are at least tolerable. Salmonids (e.g., trout and salmon) have similar basic requirements for reproduction, rearing, and migration including cool water temperatures; clean, well oxygenated water; and appropriate substrate with low levels of fines for spawning amongst other habitat requirements. The presence of these species in a given reach is indicative of water quality that is meeting fish population needs at some level, although the movement of fish through the stream can make it difficult to correlate specific fish population data with reach-scale water quality.

Benthic macroinvertebrate surveys may be a more reliable indicator of water quality than fish populations. Benthic macroinvertebrates are generally stationary, and thus are exposed to water quality conditions at a single location over time. The level of impairment in the benthic macroinvertebrate scores (B-IBI) indicates the proportion of organisms found in the surveys that are able to tolerate elevated sediment loads, increased water temperatures, periods of sustained high or low flows, and other characteristics of urbanized streams (Lemke and Cole, 2008). Benthic communities can become impaired due to temporary disturbance of the stream channel or other factors in addition to water quality issues.

WES retained contractors to collect data on benthic macroinvertebrate communities in 2002 and 2007 (Lemke and Cole, 2008) and on fish communities in 1997-98, 2002-03, and 2008 (ODFW, 2008). The results from these biological monitoring surveys are briefly summarized below and discussed in more detail in Chapter 4.

Benthic macroinvertebrate and fish population surveys indicate that conditions in the streams in the watershed vary considerably. Sampling in the lower reach of Rock Creek generally indicates acceptable (unimpaired) and slightly impaired biological communities for fish and benthic macroinvertebrates, respectively. Thus, the biological indicator monitoring indicates that the lower reach of Rock Creek on average exhibits fair to moderately good water quality. The middle reach of Rock Creek and upper Trillium Creek support moderately impaired benthic macroinvertebrate communities.

The fish population survey scores (F-IBI) varied more than the benthic macroinvertebrate community scores (B-IBI) in the streams. The middle reaches of Rock Creek are more severely impaired for fish, and the upper reaches are marginally impaired for fish. Although there may be water quality issues affecting fish populations in the middle and upper reaches of Rock Creek, in particular water temperature, and habitat conditions also likely play a role in these areas. The upper reaches and tributaries of Rock Creek have been characterized as degraded habitat due to highly simplified channel structure, minimal pool habitat, and little woody debris (URS, 2000).

Additional discussion of the biological indicators in the RC watershed, including a discussion of the B-IBI and F-IBI scores, is provided in Chapter 4.

Water Environment Services Water Quality Monitoring

WES has been collecting water quality monitoring data since 1994 as a part of its MS4 permit program. WES also operates continuous monitoring stations that collect in-stream flow data, rainfall data, and some limited water quality data such as stream temperature, pH, dissolved oxygen (DO), and conductivity. The environmental monitoring sites are illustrated in Figure 3-1. WES has a number of historic monitoring sites with varying data available as well as current monitoring sites.

Prior to 2006, WES primarily collected monthly grab samples at 14 in-stream sites and four outfall sites annually and performed continuous monitoring at one site in CCSD No. 1 for its MS4 permit monitoring. In-stream samples were collected once every 1 to 2 months and slightly less than 20 percent of samples were generally collected during storms. For some streams, only limited field parameters such as temperature, conductivity, total dissolved solids (TDS), pH, and DO are collected. At stormwater outfalls, WES collected grab samples one time per year during storm events.

In 2006, WES modified its stormwater sampling program for its MS4 permit. The number of sites where data are collected was reduced to nine in CCSD No. 1, but more composite samples are collected and more water quality parameters are measured at the remaining sites. Composite samples are multiple samples (usually three) collected at defined intervals from the same storm and combined (composited) prior to analysis for most parameters. Composite samples generally better represent the water quality impacts of a storm event than a single grab sample.

Sites currently included in the stormwater sampling program for the MS4 permit in the RC watershed include the following:

- CC-16: Rock Creek near Clackamas River and Highway 212/ Highway 224 (automated sampler and grab samples)
- CC-25: Rock Creek at Sunnyside (automated sampler)

The automated samplers collect limited data on stream gauge levels (used to estimate flow) and in some cases, other parameters such as temperature, conductivity, and pH. The parameters measured from grab samples at these sites since 2006 include the following:

- DO
- Conductivity
- Temperature
- pH
- Flow
- TDS
- Total Suspended Solids (TSS)
- Total Volatile Solids
- *E. coli* bacteria
- Nitrogen – Ammonia
- Nitrogen – Nitrate
- TP
- Phosphorus – Orthophosphate (Dissolved Phosphorus)
- Oil and grease
- Total metals: copper, lead, and zinc
- Dissolved metals: copper, lead, and zinc
- Total hardness

Water Quality Monitoring Results

Trend Analysis

As a part of the 2008 MS4 permit renewal, WES performed a trend analysis of its monitoring data to determine whether the monitoring results have exhibited statistically significant trends either upward or downward during the last 13 years of data collection (Brown and Caldwell, 2008). Only wet season datasets with an adequate number of detected results to perform a statistically valid analysis were evaluated. The results of the trend analysis for the Rock Creek sites are summarized in Table 3-1.

Table 3-1. Detailed Trend Analysis Results for Wet Season Datasets, Significance Level = 5 Percent

Site ID	Site	*E. coli* (MPN[1]/100 mL[2])	Hardness (mg/L[3])	Nitrate (mg/L)	Ortho-phosphate (mg/L)	Total Phosphorus (mg/L)	TSS (mg/L)	Zinc (µg/L)[4]
CC-16	Rock Creek near Clackamas River	No trend	No trend	No trend	Upward	No trend	No trend	No trend
CC-25	Rock Creek at SE Sunnyside Road	No trend		No trend	No trend	No trend	No trend	

[1] MNP = most probably number

[2] mL = milliliters

[3] mg/L = milligrams per liter

[4] µg/L = micrograms per liter

Oregon Water Quality Index

The Oregon Water Quality Index (OWQI) is a single-value measure of overall water quality developed by DEQ. The index was developed to provide a simple method for expressing the significance of regularly generated laboratory data, and was designed to aid in the assessment of water quality for general recreational uses. The OWQI integrates measurements of temperature, DO, biochemical oxygen demand (BOD), pH, ammonia+nitrate-nitrogen, TP, total solids, and fecal coliform bacteria into a score ranging between 10 (poor) and 100 (excellent). Although the integration of a variety of surface water parameters into a single value provides an interesting way of viewing data, the results of such an analysis often have limited value for assessing specific watershed conditions due to the combination of so many factors and the lack of detailed information on parameters, such as the time of the day the data were collected (which can be very important for both temperature and DO). The value of the OWQI is also limited because it does not address parameters, such as metals.

In the Rock and Richardson Creek Master Plans (URS, 2000), the OWQI was calculated for the lower reach of Rock Creek based on limited available water quality data. The OWQI was 65.2 for Lower Rock Creek in 2000, indicating moderate water quality.

WES also conducted analyses of monitoring data in CCSD No. 1 through a study conducted by EnviroData Solutions in 2000. As part of the analysis, EnviroData Solutions (2000) calculated a modified OWQI (modified due to lack of BOD and fecal coliform bacteria data). CCSD No. 1 monitoring stations with the poorest water quality in the OWQI analysis in 2000 were located at the manhole at La Jolla Street and Linwood Avenue (near the western boundary of the District), at two locations on Kellogg Creek (at Rust Road and at Clackamas Road), and at two locations on Cow Creek. Land uses in these areas are commercial, industrial and older residential development. The modified OWQI at these locations ranged from 23 to 42, indicating poor water quality.

CCSD No. 1 monitoring stations with the highest water quality are located on the Clackamas River (at Highway 99 and at Carver). The modified OWQI at these locations is 87 and 94, respectively, indicating good to excellent water quality. This is supported by findings in the annual Oregon Water Quality Index Summary Report (DEQ, 2005) which shows that stations on the Clackamas River have excellent water quality.

Boxplot Analysis of Water Quality Data

To further characterize water quality conditions in the watershed, as a part of this study, WES monitoring data on key water quality parameters were evaluated against water quality criteria set by DEQ as well as guidance levels from other sources where criteria have not been set by DEQ. Boxplots were used to display and analyze the data.

Boxplots are a method used for evaluating differences between groups of environmental data. They are also useful for examining data spread, central tendency, skewness, and the presence or absence of outliers. The type of boxplot used in this analysis is the standard boxplot. The box itself contains the center 50 percent of the data (i.e., the interquartile range), and the median is indicated as a horizontal line within the box. The top edge of the box is the 75th percentile and the bottom edge is the 25th percentile. Vertical lines, sometimes called whiskers, extend to the last observation within one step beyond either end of the box. A step is 1.5 times the height of the box. Data points that fall outside one step are considered to be outliers, and values that fall outside of two steps are labeled extreme. Outliers and extremes are plotted individually.

The following parameters were evaluated and the results are displayed in the accompanying figures:

- Temperature – continuous monitoring June 2008 – October 2008 (Figures 3-4 through 3-7)
- Temperature – grab samples (Figure 3-8)
- DO (Figure 3-9)
- pH (Figure 3-10)
- TP (Figure 3-11)
- Nitrogen – Nitrate (Figure 3-12)
- *E. coli* (Figure 3-13)
- TSS (Figure 3-14)
- Dissolved copper (Figure 3-15)
- Dissolved lead (Figure 3-16)
- Dissolved zinc (Figure 3-17)

Correlating data from in-stream and outfall water quality sampling with surface water management activities is a challenging task due to the myriad of other influences on water quality within the overall contributing drainage or watershed. An initial analysis of the results of water quality monitoring in comparison to the contributing watershed conditions is provided in this section; further analysis of the contributing areas and WES management activities in these areas will be performed during the watershed assessment. Results are summarized by monitoring site in tables 3-2 through 3-3 and illustrated in boxplots comparing multiple sites in Figures 3-7 through 3-17 and Tables 3-4 through 3-14.

The temperature data analysis was conducted using two different data sets. The first temperature data set, illustrated in Figures 3-4 to 3-6, is from continuous temperature monitoring completed by ODFW under contract to WES from June through October 2008. The 7-day moving average of the hourly maximum temperatures is compared to the summer 7-day average temperature standard (18 degrees Celsius[C]) in Figure 3-7. The continuous temperature monitoring sites are labeled C110 (near the confluence with the Clackamas River, near site CC-16), C111 (near Southeast Sunnyside Road, near site CC-25), and C112 (on Trillium Creek near the confluence with Rock Creek). The second temperature data set is from grab samples collected primarily during the fall, winter, and spring as a part of the MS4 monitoring effort at sites CC-16 and CC-25. This data is compared to the winter temperature standard (13 degrees C for October 15 to May 15).

CC-16 and C110

Sites CC-16 and C110 are located near the confluence of Rock Creek with the Clackamas River, near the Highway 212/Highway 224 crossing over the stream. The contributing area to CC-16 is thus nearly the entire RC watershed, approximately 6,200 acres. The contributing area to CC-16 is not heavily developed. The area was characterized as approximately 7 percent impervious in 2004. The 2007 Metro analysis of land cover found that the watershed contains approximately 13 percent built or scarified land cover. Thus, the imperviousness of the watershed is between 7 and 13 percent impervious currently. The land use in the contributing area includes 29 percent residential, 28 percent tractland (generally vacant parcels), 19 percent farmland, and 18 percent forestland.

Site CC-16 is close to the benthic macroinvertebrate monitoring site SD1-M10 and near the fish monitoring sites RK1 and TR1.

The results of the 2008 continuous temperature monitoring conducted at site C110 (near CC-16) are shown in Figure 3-4. The results of the boxplot analysis for site CC-16 are presented in Table 3-2 and Figures 3-7 through 3-17. Based on the results of the analysis, it appears that this site may exhibit limiting factors for summertime maximum stream temperatures, and nutrients (TP) and bacteria (*E. coli*) exceed indicator levels and criteria, respectively. The 7-day moving average of hourly maximum temperatures exceeded the summer 7-day temperature criteria of 18 degrees C 31 percent of the time during the period from June 2008 through October 2008.

The indicator level of 0.05 mg/L for TP was exceeded in 75 percent of samples collected during the last 12 years of sampling at this location. Although the DO criteria were met throughout the sampling period, elevated TP concentrations can cause eutrophication of the waterbody due to the increase in algae growth and subsequent decay die-off, and therefore limit the DO available in the stream. In the 2008 trend analysis, an increasing trend of orthophosphate was identified at CC-16. The elevated levels of TP and the trend in orthophosphate potentially could be due to use of fertilizers in the residential area and/or poor land management practices associated with the farm, nursery, and forest land areas.

Single day *E. coli* bacteria criteria were exceeded in 25 percent of samples. *E. coli* bacteria exceedances occurred equally in both the dry months (May through October) and wet months (November through April). Of the 29 times the criteria were exceeded, 14 times were during dry months and 15 times were during wet months. There are a wide variety of potential sources for *E. coli* bacteria in the contributing area to this site including wildlife and birds, domestic/farm animal keeping, pets, and improperly functioning septic systems.

The winter temperature (grab samples), DO, pH, nitrate, TSS and dissolved copper, lead, and zinc measurements at this site were all generally within required criteria or guidance levels. The data on temperature, DO, pH, and metals include only six to eight samples collected in the last 2 years and thus represent a limited monitoring time-frame.

Table 3-2. Constituents Analyzed for Water Quality Characterization at Site CC-16

Item	Date	Total samples	Number of exceedances	Percent exceedances	Criteria (DEQ) *or Indicator/guidance level (other sources)*
Temperature (continuous)	6/08-10/08	131	40	31	7-day average of hourly maximums not to exceed 18 degrees C
Temperature (grab samples)	2007-2008	8	0	0	Not to exceed 13 degrees C October 15 to May 15
DO	2007-2008	7	0	0	Not to be below 8 mg/L
pH	2007-2008	8	1	13	Between 6.5 and 8.5 units
TP	1996-2008	118	88	75	*Indicator: 0.05 mg/L (OWEB, 1999)*
Nitrate	1996-2008	122	1	1	*Guidance: 5 mg/L (1/2 of MCL, U.S. Environmental*

Table 3-2. Constituents Analyzed for Water Quality Characterization at Site CC-16

Item	Date	Total samples	Number of exceedances	Percent exceedances	Criteria (DEQ) *or Indicator/guidance level (other sources)*
					Protection Agency [USEPA], 2008)
E. coli	1997-2008	114	29	25	Single day: 406 *E. coli*/100 mL
TSS	1999-2008	106	2	2	*Guidance: 100 mg/L (not a published reference)*
Dissolved copper	2007-2008	6	0	0	Acute criteria based on hardness
Dissolved lead	2007-2008	6	0	0	Acute criteria based on hardness
Dissolved zinc	2007-2008	6	0	0	Acute criteria based on hardness

CC-25 and C-111

Sites CC-25 and C-111 are located on Rock Creek at Southeast Sunnyside Road. The contributing area to CC-25 is approximately 4,500 acres. Site CC-25 is upstream and close to the benthic macroinvertebrate monitoring site SD1-M11 and near the fish monitoring site RK4.

The contributing area to CC-25 is not heavily developed. The area is classified as approximately 10 percent built or scarified in the Metro land cover analysis, and thus the area is estimated to be approximately 7 to 10 percent impervious. The land use in the contributing area includes 25 percent residential, 32 percent tractland (generally vacant land), 18 percent farmland, and 20 percent forestland. These land use designations include both developed and undeveloped parcels. A WES analysis of the parcels in the contributing area indicates that approximately 63 percent of the area contains buildable lands.

The results of the 2008 continuous temperature monitoring conducted at site C111 (near CC-25) are shown in Figure 3-5. The results of the boxplot analysis for CC-25 are presented in Table 3-3, Figure 3-7, and Figures 3-11 through 3-14. Based on the results of the analysis, it appears that this site may exhibit limiting factors for summertime maximum stream temperatures, and nutrients (TP) and bacteria (*E. coli*) exceed indicator levels and criteria, respectively. The 7-day moving average of hourly maximum temperatures exceeded the summer 7-day temperature criteria of 18 degrees C 57 percent of the time during the period from June 2008 through October 2008.

The indicator level of 0.05 mg/L for TP was exceeded in 70 percent of samples collected during the 6 years of sampling at this location. Single day *E. coli* bacteria criteria were exceeded in 49 percent of samples. The TSS levels measured at this site are relatively low. The trend analysis indicated there was no trend for *E. coli*, nitrate, TP, or TSS at this location. The elevated levels of TP could potentially be due to use of fertilizers in the residential area and/or poor land management practices associated with the farm, nursery, golf course, and forest land areas. There are a wide variety of potential sources for *E. coli* bacteria in the contributing area to this site including wildlife and birds, domestic/farm animal keeping, pets, and improperly functioning septic systems.

Table 3-3. Constituents Analyzed for Water Quality Characterization at Site CC-25

Item	Date	Total samples	Number of Exceedances	Percent Exceedances	Criteria (DEQ) *or Indicator/guidance level (other sources)*
Temperature (continuous)	6/08-10/08	131	75	57	7-day moving average of hourly maximums not to exceed 18 degrees C
DO	2003	1	0	0	Not to be below 8 mg/L
TP	2001-2007	71	50	70	*Indicator: 0.05 mg/L (OWEB, 1999)*
Nitrate	2001-2007	71	0	0	*Guidance: 5 mg/L (1/2 of MCL, USEPA 2008)*

Table 3-3. Constituents Analyzed for Water Quality Characterization at Site CC-25

Item	Date	Total samples	Number of Exceedances	Percent Exceedances	Criteria (DEQ) or *Indicator/guidance level (other sources)*
E. coli	2001-2007	70	34	49	Single day: 406 *E. coli*/100 mL
TSS	2001-2007	71	3	4	*Guidance: 100 mg/L (not a published reference)*

C112

Site C112 is located on Trillium Creek near the confluence with Rock Creek. The contributing area to Site C112 is approximately 580 acres. Site C112 is near the fish monitoring site TR1 and downstream of the benthic macroinvertebrate monitoring Site SD1-M7.

The contributing area to Site C112 is more developed than the contributing areas to Sites CC-16 and CC-25. The area is classified as approximately 26 percent built or scarified in the Metro land cover analysis, and thus the area is estimated to be approximately 26 percent impervious. The land use in the contributing area includes 49 percent residential, 14 percent tractland (generally vacant land), 27 percent farmland, and 9 percent forest land. These land use designations include both developed and undeveloped parcels.

The results of the 2008 continuous temperature monitoring conducted at Site C112 are shown in Figure 3-6. The results of the boxplot analysis for Site C112 are presented in Figure 3-7. Based on the results of the analysis, it appears that this site may exhibit limiting factors for summertime maximum stream temperatures. The 7-day moving average of hourly maximum temperatures exceeded the summer 7-day temperature criteria of 18 degrees C 34 percent of the time during the period from June 2008 through October 2008.

Regional Water Quality Analysis Summary

The 2006 Master Plan contained a summary of regional data from the Oregon Association of Clean Water Agencies (ACWA) stormwater monitoring database compiled in the mid-1990s and limited stormwater grab sampling conducted as part of the Master Plan for targeted residential, agricultural, open space land uses (Shaun Piggott Associates et al., 2006). The regional water quality analysis summary findings in the Master Plan are generally consistent with the boxplot analysis of water quality data in the RC watershed and other findings from the watershed characterization. The Master Plan reported the following conclusions based on available data and literature:

- Commercial and industrial areas that lack effective stormwater treatment are likely to serve as urban sources of TSS and metal loadings.
- Stormwater runoff from older residential areas that lack effective stormwater treatment can have significant metal loadings due to road runoff and other sources. Due to very low hardness levels, the metal concentrations for zinc and copper may exceed acute water quality criteria.
- Stormwater quality is often better in runoff from undeveloped open spaces, newer low density residential areas, and low density rural residential areas. This is supported by very low pollutant concentrations for most water quality parameters that were measured in stormwater runoff from newer residential areas in the northeastern portion of the District, from open space runoff on Mt. Talbert, and from runoff of rural residential areas in the expansion study area. The main exception was measurement of *E. coli* bacteria concentrations. Nutrient levels can also be high in runoff from open spaces and residential areas, depending on land management practices and other watershed factors.
- Consistent with literature information, runoff from agricultural areas exhibits higher levels of nutrients (nitrogen and phosphorus) and total suspended solids in comparison to urban areas.

- The Oregon single sample criterion for *E. coli* is exceeded with varying frequency in runoff from nearly all land uses. The only exception was in runoff from undeveloped forested areas. Based on monitoring conducted, highest median *E. coli* concentrations are associated with runoff from agricultural and rural residential areas. Older residential areas in CCSD No. 1 appeared to have higher median *E. coli* concentrations than newer residential areas.
- A high proportion of water quality complaints in the District's complaint log are related to issues of sediment-laden construction site runoff. There is concern about the adequacy of required construction site BMPs for construction projects on steep slopes during the winter rainy season.
- Pesticides in surface runoff (including herbicides, insecticides, and fungicides) are not routinely measured. However, WES has participated in pesticide monitoring studies in the Clackamas basin and in the Johnson Creek watershed with USGS. The studies in the Clackamas basin included sampling in Rock Creek. In the USGS studies from 2000-2005, pesticide occurrence at relatively low levels was widespread in the tributaries that drain the northwestern area of the lower Clackamas River Basin including Rock, Deep, Richardson, Sieben, Carli, and Cow Creeks. Results indicate that several pesticides (carbaryl, chlorpyrifos, diazinon, malathion, and DDE) may exceed established or recommended criteria and that sources may include runoff from urban and agricultural areas. Most of the samples containing the highest pesticide concentrations or the greatest number of compounds also had relatively high turbidity values. Rock Creek pesticide concentrations were some of the highest reported in the tributaries that were sampled, although the concentrations in Rock Creek for glyphosate were still less than the USEPA aquatic life benchmark.

Pollutant Loads Modeling

WES conducted pollutant loads modeling of the CCSD No. 1 and Surface Water Management Agency of Clackamas County areas for the NPDES MS4 permit renewal in 2008 and for the Master Plan in 2006. For the MS4 permit renewal, the modeling included establishing new pollutant load reduction benchmarks and evaluating progress towards achieving already developed benchmarks for receiving waters with approved TMDLs. The following information is from the 2008 MS4 permit renewal (WES 2008).

Total Maximum Daily Loads

A TMDL is an estimate of the total load of pollutants from point, non-point, and natural sources that a water body may receive without exceeding applicable water quality standards (with a factor of safety included). TMDLs are generally developed as a way to project the maximum pollutant load capacity of a waterbody so as not to exceed water quality standards. They may be developed for pollutants with direct links to stormwater runoff (i.e., metals and nutrients) and also for pollutants for which loads of concern are not typically associated with urban stormwater runoff (temperature). To translate the TMDL into guidelines for municipalities, industries, and others responsible for TMDL implementation, waste load allocations (WLAs) and Load Allocations (LAs) are developed. WLAs and LAs allocate a proportion of the TMDL to contributing sources (industries, future growth, municipalities, groundwater, combined sewer overflow, wastewater treatment plants, etc). WLAs were developed originally as a means to regulate discharges from well-defined point sources (industries and wastewater treatment plants). But with the implementation of NPDES permits for industries, wastewater treatment plants, and MS4's; permits are now used to regulate WLAs from their point sources that are covered by the permits and LAs are used to address stormwater discharges outside the MS4 permit area.

A TMDL was established for the Willamette River in 2006. The WLAs described in the Willamette River TMDL apply to all of the current Phase 1 MS4 NPDES permittees and co-permittees in the State of Oregon. Basin-wide, the Willamette River TMDL is specific for mercury, bacteria, and temperature, although some tributaries have additional TMDL parameters. Temperature is not considered a stormwater pollutant in the Willamette River TMDL, and consequently is not addressed by the permittees' NPDES MS4 permits.

Temperature is considered to be a nonpoint source issue and is therefore addressed through jurisdictional TMDL Implementation Plans, which are focused on improving riparian tree canopy.

Mercury is a phased TMDL with monitoring requirements expected for the first phase to support DEQ's development of WLAs and LAs for the second phase. Although mercury can be associated with stormwater, permittees are not required to establish benchmarks for the pollutant at this time since WLAs and LAs have not yet been developed. *E. coli* bacteria is the only Willamette River TMDL parameter that requires a new benchmark to be established for permit renewal. *E. coli* generally signifies the presence of fecal bacteria in water. There are many potential sources of *E. coli* in streams including from a variety of wildlife, birds, domestic animals, pets, and humans.

MS4 Permit Renewal Pollutant Load Modeling

As a part of the 2008 permit renewal submittal, WES developed updated estimates of annual pollutant loads in urban runoff from the MS4 permit area. The pollutant load is the total mass of pollutant in runoff during a given period of time (e.g., pounds per year). Loading is the product of runoff volume and pollutant concentration.

The pollutant load estimates were developed using a spreadsheet model that estimates pollutant loads based on local land use together with stormwater quality data collected from all Oregon Phase 1 jurisdictions and were compiled by ACWA.

Establishing benchmarks relies on the use of a pollutant loadings model to calculate pollutant loads for select parameters, select scenarios, and under certain development conditions. Once loads are generated, both with and without BMP implementation, a comparison between the loads and the WLA identified in the TMDL can be used to show progress in how the District's current stormwater management program is attempting to achieve WLAs. A benchmark is defined as a pollutant load reduction estimate. Therefore, the differences between loads without BMPs and reduced loads associated with BMPs define the District's benchmarks.

To conduct the pollutant loading analysis, the Districts opted to use the pollutant load model developed as part of the 2006 Master Plan. The Clackamas County pollutant loads model is basically a spreadsheet model with a GIS interface that utilizes the USEPA Simple Method for pollutant load generation for each TMDL watershed.

Estimates of pollutant concentrations are based on land use. Using the USEPA Simple Method equations and GIS layers containing BMP drainage areas, watersheds, land use, and impervious information, loads are calculated automatically. The model was used to estimate current and future condition pollutant loads, assuming no structural BMPs in place and with structural BMPs in place. Estimates of the relative effectiveness of non-structural BMPs were based on best professional judgment. The model does not forecast stormwater characteristics for specific storms or monitoring periods.

The model uses the mean, the upper 95 percent confidence interval, and the lower 95 percent confidence interval to produce a range of associated pollutant loading. Revised mean and median land use concentrations and the associated upper and lower confidence intervals are provided in the NPDES MS4 permit renewal submittal.

For the Lower and Middle Willamette River and tributaries (e.g., the Clackamas River and its tributaries), the current condition (2008) model results with structural BMPs indicate that CCSD No. 1 may not be meeting its WLAs for bacteria. However, bacteria reduction associated with structural BMPs is limited and many bacteria sources are those that are not readily influenced as a result of BMP (structural and non-structural) implementation. Generally, bacteria reduction associated with structural BMPs is due to flow reduction that the structural BMP achieves.

Bacterial sources in urban environments typically have a very small human-derived component. The more predominant sources of bacteria include wildlife (avian and rodent), domestic farm animals, and/or domestic pets. It is difficult to develop a benchmark for this parameter because the WLA includes all sources of *E. coli* including those that CCSD No. 1 would not be responsible for reducing (i.e., the goal is generally not to reduce wildlife such as avians). Recent bacteria source tracking studies in the region found that bacterial sources in urban environments are not predominantly human, as a result the District's bacteria benchmark for the Lower Willamette River will be focused on continued educational activities to reduce human and pet sources of bacteria.

Master Plan Pollutant Load Modeling Results and Recommendations

The pollutant load model was used in the 2006 Master Plan to estimate stormwater pollutant loadings in the study area in order to do the following:

- Determine areas of highest existing loadings
- Estimate the changes in loadings with expected future development
- Help target recommended Capitol Improvement Program (CIP) and other pollutant reduction projects for water quality enhancement.

The pollutant loadings model was used to estimate changes in stormwater loadings and concentrations with land use conversion in the RC watershed. Results indicate that if proposed development occurs without the implementation of structural or site design BMPs to treat stormwater, development is expected to increase runoff volume and pollutant loadings of all constituents dramatically. Average concentrations would also increase for most constituents. Regional detention facilities or other BMPs would reduce loadings and concentrations substantially. However, if only regional detention facilities are used, annual loadings are estimated to increase with proposed development due to increased runoff and because the regional facilities do not treat all of the proposed development area. These results emphasize the need for progressive planning and site designs, in combination with low impact or sustainable development treatment controls, to counter potential impacts on water quality from future development in the RC watershed.

Additional key results reported in the Master Plan are as follows:

- In general, the highest estimated pollutant loads were associated with areas of concentrated urban development, which is to be expected because the pollutant loads model is based on land use. Increased impervious cover associated with urban development and generally higher pollutant concentrations both contribute to higher loading estimates for urban areas. Thus, there is a potential for substantial increases in pollutant loadings in areas where growth and development are anticipated. This emphasizes the need in developing areas for hydrologic controls to reduce runoff volume and low impact or sustainable development site design and treatment BMPs to reduce pollutant concentrations.
- TSS loads on a per-acre basis are predicted to be highest in areas that are dominated by commercial and industrial land use, again due to the land use basis of the model. Metal concentrations and loadings also are generally predicted to be greatest in areas that are dominated by commercial and industrial land uses.
- Highest nitrate-nitrogen concentrations are predicted to occur in the RC watershed, which has a high proportion of agricultural and nursery land uses. High nitrate loadings are also predicted in watersheds with residential land use, due to larger runoff volumes caused by higher impervious cover.
- Highest concentrations and loadings of phosphorus are predicted in areas that are dominated by industrial land use. CIP projects that help to reduce sediment loads in these watersheds would help to reduce phosphorus loadings.

- Highest predicted concentrations of *E. coli* bacteria are associated with industrial, commercial, and residential development. These areas generally coincide with the 303(d) listings and TMDLs for *E. coli*. They also coincide with areas predicted to be generally high in sediment and metals loadings. CIP projects to reduce sediment and metals loading through sedimentation could also provide some reduction in *E. coli* levels. Infiltration facilities, treatment wetlands within extended detention basins could help to improve *E. coli* reductions, and should be considered for potential CIP projects in these areas.

Specific Study Results

WES periodically participates in or cooperates with specialized water quality studies. The results of a study of three detention ponds and several pesticide monitoring studies conducted near the WES service area are described in this section.

Detention Pond Study Results

WES currently maintains over 260 detention ponds in suburban landscapes to detain and treat stormwater runoff. Many of these detention ponds are in Happy Valley. Prior to 2008, WES had no continuous, local monitoring data to evaluate whether the ponds reduce flows and/or significantly treat stormwater runoff with respect to TSS. Studies performed on ponds in the region in 2005 found that the standard set of sampling and monitoring techniques involving grab samples taken during storm events were insufficient to quantify pond performance.

The efficiency of wet detention ponds at removing TSS, organic matter, and the percentage of fine and sand-sized particles from stormwater runoff was investigated at three ponds in Clackamas County by a PSU graduate student (Rudolph, 2008).

Flow-weighted composite samples were collected by automatic samplers during storm events at the inlet and outlet of the ponds on Waldorf Lane, Valley Way and Taryn Court. Composite data collected between December 2007 and March 2008 showed that wet detention ponds can significantly reduce the mass of sediment contained in pond effluent. However, how well detention ponds slow flow and remove pollutants is limited by design and environmental elements that influence the hydrologic loading rate, such as the pond area to drainage area ratio and storm intensity.

The pond on Taryn Court with a pond area to drainage area ratio of 4.2 percent removed an average 94 percent of suspended solids, while the pond on Waldorf Lane with a pond area to drainage area ratio of 0.1 percent removed an average 62 percent of solids from incoming stormwater. Enough storms were captured at the pond on Waldorf Lane to also show a strong correlation ($r = -0.85$) between increasing storm intensity and a decreasing pond efficiency.

The ponds on Waldorf Lane and Taryn Court showed significant removal of TSS and organic matter, as well as attenuation of flow. However, the pond on Valley Way was ineffective at removing solids and attenuating flow due to an influx of groundwater into the pond. TSS effluent concentrations for all ponds were found to be composed primarily of fine material (< 63 μm) as the ponds removed 75 to 97 percent of the incoming coarse material (> 63 μm).

Pesticide Monitoring Studies

Pesticides (including herbicides, insecticides, and fungicides) in water and sediments of surface streams can cause toxicity to aquatic organisms. A wide variety of pesticides are associated with agricultural and nursery practices, but many are also used in urban areas for landscape maintenance and vegetation control along roadways. Legacy pesticides such as DDT and dieldrin, use of which have been banned, continue to persist in the environment and may also be found in surface streams.

In Oregon, over 11,000 pesticide products are registered for use (USGS, 2008). During the past 20 years, studies conducted by USGS have documented widespread occurrence of pesticides and degradates in streams and groundwater throughout the U.S. More than 90 percent of water samples from streams in agricultural, urban, or mixed-land-use settings in the U.S. have been found to contain two or more pesticide compounds, and 70 percent of samples contain five or more pesticide compounds.

Although the presence of pesticides in surface runoff and surface streams is not currently routinely monitored by WES, WES cooperated in studies of pesticides in the Lower Clackamas River published by the USGS between 2000 and 2005 (USGS, 2008). Five sites in Rock and Trillium Creeks were sampled along with 25 other sites on the Lower Clackamas River, its tributaries, and post-treatment drinking water from local water provider treatment plants on the Clackamas River.

Over the course of studies conducted from 2000 through 2005, 119 water samples were analyzed for a suite of 86 to 198 dissolved pesticides using ultra low detection level methods. In all, 63 pesticide compounds were detected, including 33 herbicides, 15 insecticides, 6 fungicides, and 9 pesticide degradation products. Atrazine and simazine were detected in about half of the samples. Other high-use herbicides such as glyphosate, triclopyr, 2,4-D, and metolachlor were also frequently detected. The significance of these mostly trace-level concentrations of pesticides is not yet known. USGS notes that conducting additional studies to both assess pesticide occurrence and levels in sediments and examine the potential effects on aquatic life and human health would be valuable (USGS, 2008).

In the USGS studies from 2000-2005, pesticide occurrence at relatively low levels was widespread in the tributaries that drain the northwestern area of the lower Clackamas River Basin including Rock, Deep, Richardson, Sieben, Carli, and Cow Creeks. Pesticides were detected in all 59 storm samples collected from these streams. Most of the samples containing the highest pesticide concentrations or the greatest number of compounds also had relatively high turbidity values. Some of the highest pesticide loads were found in Rock Creek at Southeast 172nd Avenue (for instance, glyphosate at 45.8 μg/L and benomyl at 5.7 μg/L) and in Deep Creek at several locations. Although the highest value of glyphosate in the study was observed in Rock Creek (45.8 μg/L), this concentration is still less than the USEPA aquatic life benchmark for vascular plants of 850 μg/L and the Canadian aquatic-life benchmark of 65 μg/L. Other sites with relatively high pesticide yields (loads per unit area) included Cow Creek, Carli Creek, middle Rock Creek, and upper Noyer Creek.

Some concentrations of insecticides exceeded USEPA aquatic-life benchmarks in Carli, Sieben, Rock, Noyer, Doane, and North Fork Deep Creeks. For example, the diazinon concentrations in storm samples collected from Carli, Sieben, and Rock Creeks exceeded the USEPA aquatic-life criterion for benthic invertebrates by as much as 2.5. However, the levels of dizainon measured in these streams was lower than the levels that have been found to impair Chinook salmon predator avoidance behavior and homing ability (which is in the range of 1 to 10 μg/L) (USGS, 2008). Diazinon sales for residential usage ended recently in December 2004.

WES also cooperated in studies investigating the presence of organochlorine compounds (legacy pesticides and PCBs) in the Johnson Creek watershed. A USGS study (USGS, 2004b) evaluated the levels of organochlorine compounds (with a focus on DDT and dieldrin during storm flows) in the middle and lower Johnson Creek watershed from 1988 to 2002. Organochlorine compounds were detected at most sites in 2002. The greatest concentrations were detected at the most upstream sites (mainly rural residential and agricultural and nursery land uses), and lowest concentrations at the downstream sites. The concentration of total DDT has decreased by an order of magnitude since 1989-90; however, the chronic freshwater criteria are still potentially exceeded for DDT, dieldrin, chlordane, and total PCBs. Concentrations of total DDT were found to correlate with TSS concentration. Regression functions indicate that total DDT exceeds chronic criteria when the TSS concentration exceeds 8 mg/L at the most upstream station (Palmblad Road site in Gresham) and 15 mg/L at the most downstream station in Milwaukie. The concentration of dieldrin did not correlate with TSS.

WES cooperated in a project to investigate levels of legacy pesticides in the upper reaches of the Johnson Creek watershed (Johnson Creek Watershed Council [JCWC], 2005). The study included monitoring stations on Sunshine Creek, which is in the northeast corner of the expansion area. The JCWC study found that concentrations of legacy pesticides in water samples collected in both urban and rural locations exceed acceptable water quality and health standards. The study also found that during storm events, there is a strong relationship between TSS in the water and concentrations of total DDT. No such relationship exists during dry weather, indicating that erosion from rainfall carries DDT contaminated soil into the stream. Dieldrin concentrations appear to be more closely linked to turbidity than TSS. The study also found that the concentrations of legacy pesticides are substantially lower in residential streams and stormwater outfalls than in the agricultural and nursery areas.

Potential Future Risks and Further Analysis Recommended

As described earlier, the RC watershed is located at the edge of the currently planned Portland regional urban expansion in the cities of Happy Valley and Damascus. Development pressures are likely to result in large portions of the watershed becoming urbanized in the next several decades, which poses potential future risks to water quality and other elements of watershed health. Many of the same issues addressed in Chapter 2 related to potential changes in hydrology could affect water quality. Design standards, regulations, land use policies and sustainable practices will play a significant role in determining the impact that development has on the watershed.

There are several key issues related to water quality that were analyzed further during the watershed assessment phase in Chapter 5, including contributing factors to elevated stream temperatures, opportunities to reduce pollutant loads from existing land uses, opportunities to reduce the impacts associated with changes in land use, and potential changes to the monitoring program to better meet WES objectives.

As discussed in Chapter 1, the elements of watershed health (hydrology, water quality, aquatic habitat, and biological communities) often contain interrelated problems and integrated opportunities for improvement. Further work in the watershed assessment phase of the project was conducted to evaluate interrelated issues and to identify priority actions and management activities appropriate for WES to undertake to address factors that are limiting watershed health. See Chapters 5 and 6 for detailed information.

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Tables 3-4 through 3-14
Figures 3-4 through 3-17

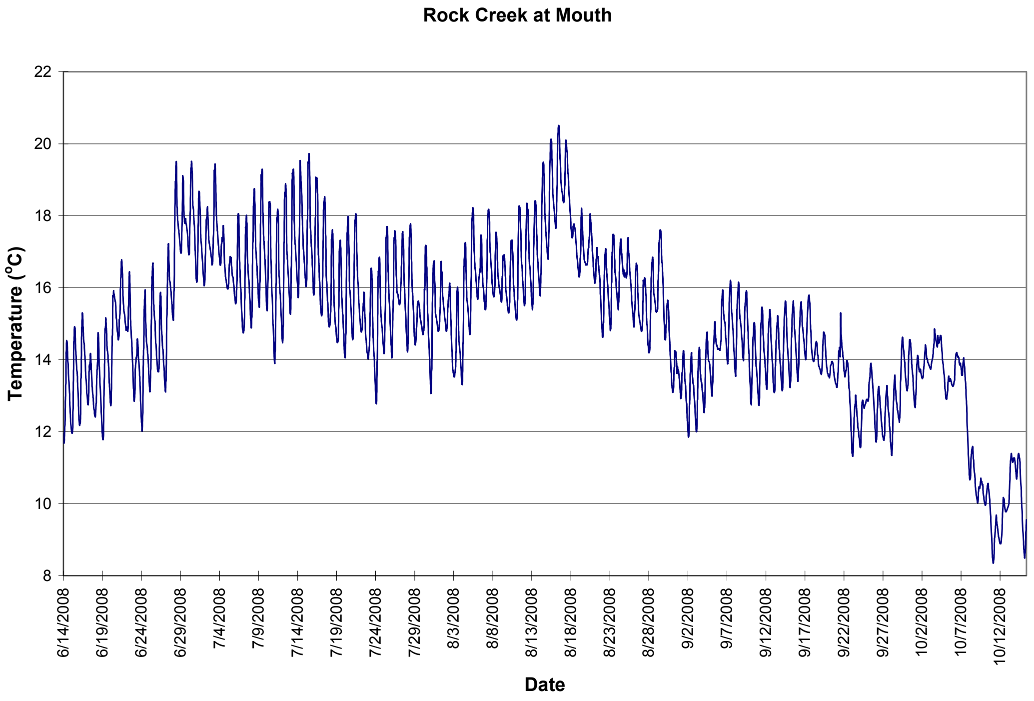

Figure 3-4. Site C110 (Rock Creek at mouth) continuous temperature monitoring 6/08 to 10/08

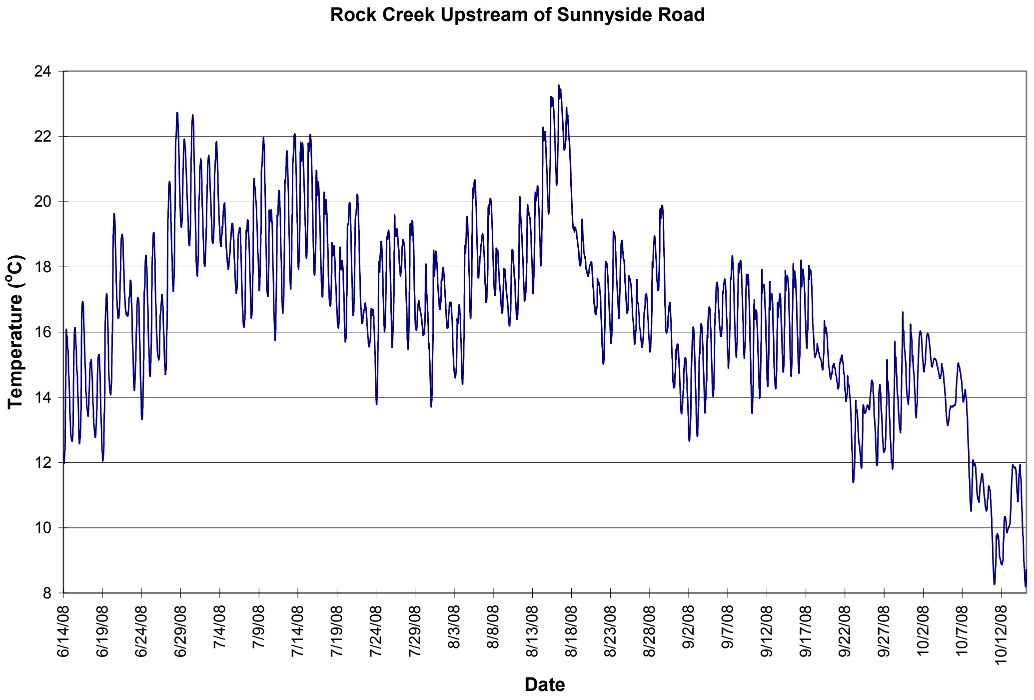

Figure 3-5. Site C111 (Rock Creek at Sunnyside Rd.) continuous temperature monitoring 6/08 to 10/08

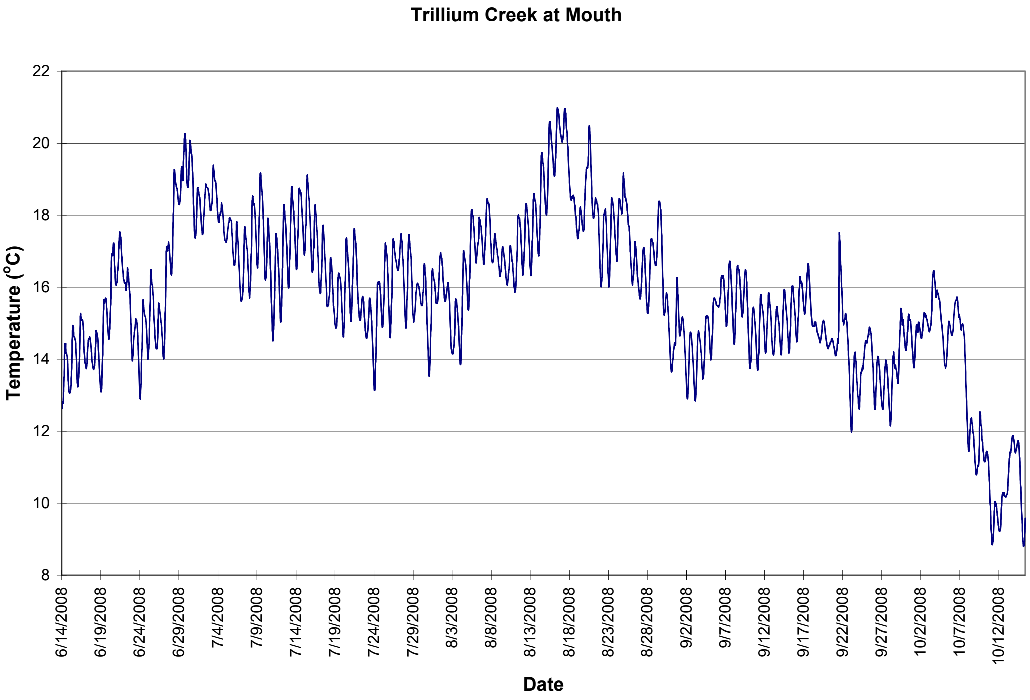

Figure 3-6. Site C112 (Trillium Creek at confluence with Rock Creek) continuous temperature monitoring 6/08 to 10/08

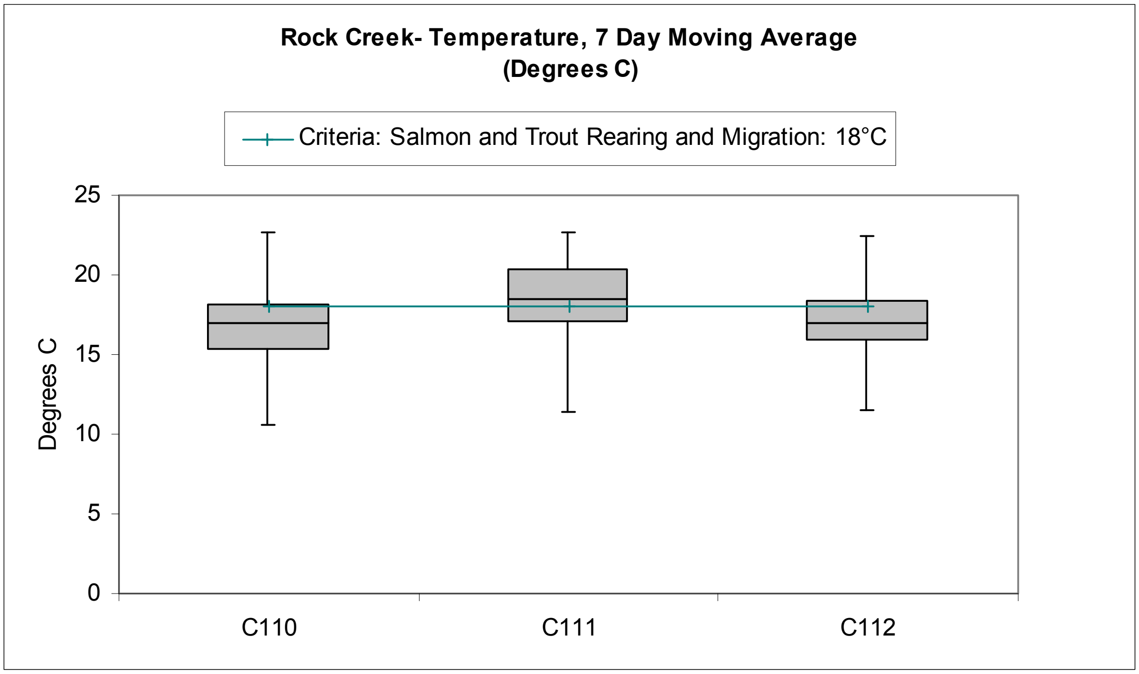

Figure 3-7. Continuous temperature monitoring 6/08 to 10/08, maximum temperature seven day moving average

Table 3-4. Boxplot Data for Rock Creek
Maximum Temperature, 7-Day Moving Average, Degrees C

	C110	C111	C112
Maximum	22.6	22.7	22.5
Upper quartile	18.2	20.4	18.3
Median	17.0	18.5	17.0
Lower quartile	15.3	17.1	15.9
Minimum	10.6	11.4	11.5
Count	131	131	131
Dates	6/08 – 10/08	6/08 – 10/08	6/08 – 10/08
Salmon and trout rearing and migration, degrees C	18	18	18

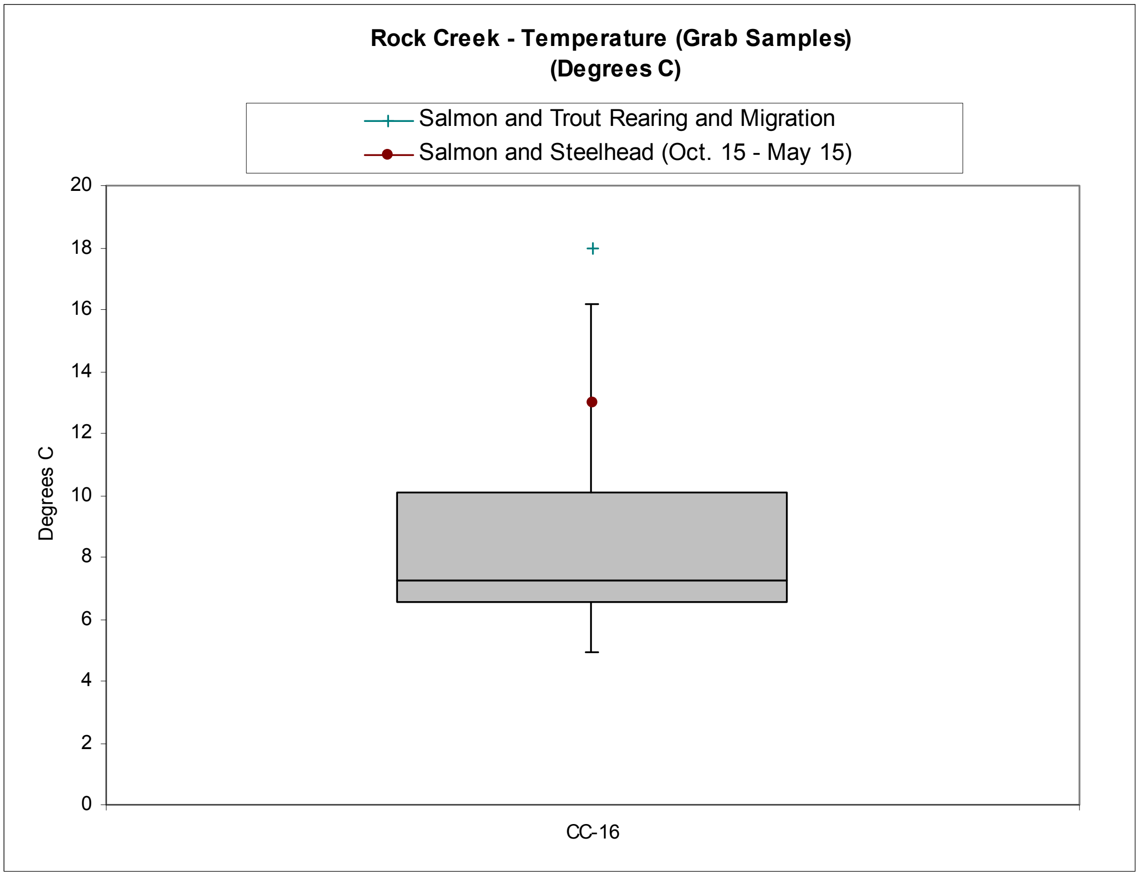

Figure 3-8. Temperature grab samples at Site CC-16

Table 3-5. Boxplot Data for Rock Creek Grab Sample Temperature, Degrees C

	CC-16
Maximum	16.2
Upper quartile	10.1
Median	7.3
Lower quartile	6.6
Minimum	4.9
Count	8
Dates	2007 to 2008
Salmon and steelhead (October 15 to May 15)	13
Salmon and trout rearing and migration	18

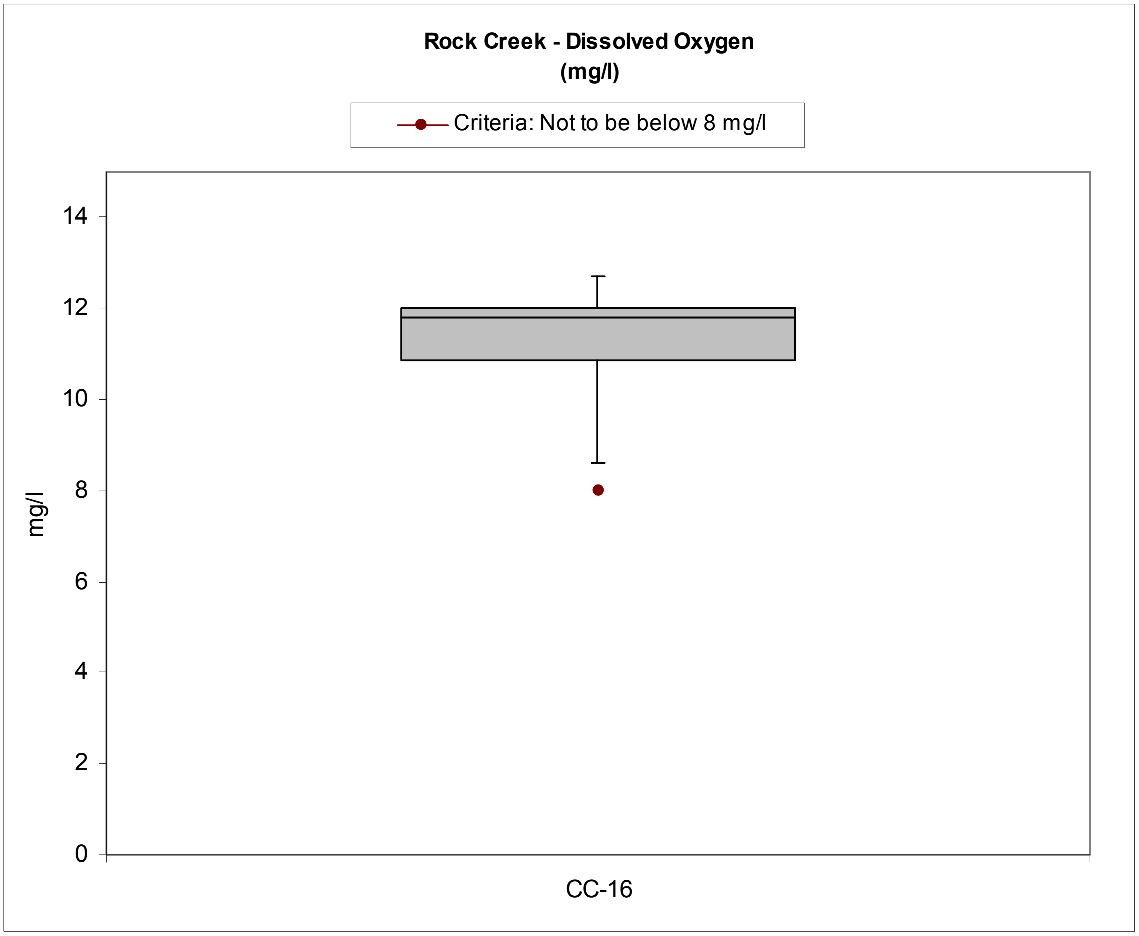

Figure 3-9. Dissolved Oxygen Data for Site CC-16

Table 3-6. Boxplot Data for Rock Creek DO, mg/L

	CC-16
Maximum	12.7
Upper quartile	12.0
Median	11.8
Lower quartile	10.9
Minimum	8.6
Count	7
Dates	2007 to 2008
Criteria: not to be below mg/L	8

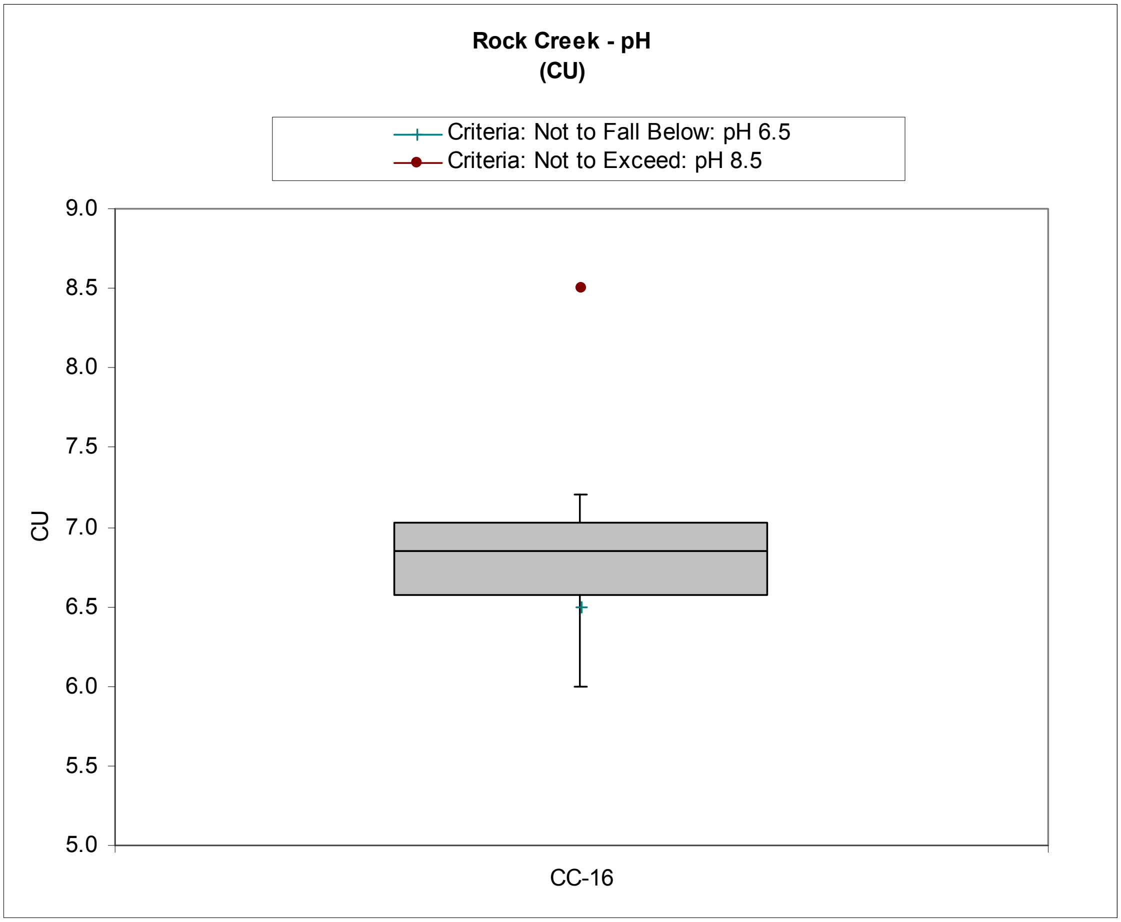

Figure 3-10. pH data for Site CC-16

Table 3-7. Boxplot Data for Rock Creek pH

	CC-16
Maximum	7.2
Upper quartile	7.0
Median	6.9
Lower quartile	6.6
Minimum	6.0
Count	8
Dates	2007 to 2008
Criterion: not to exceed	8.5
Criterion: not to fall below	6.5

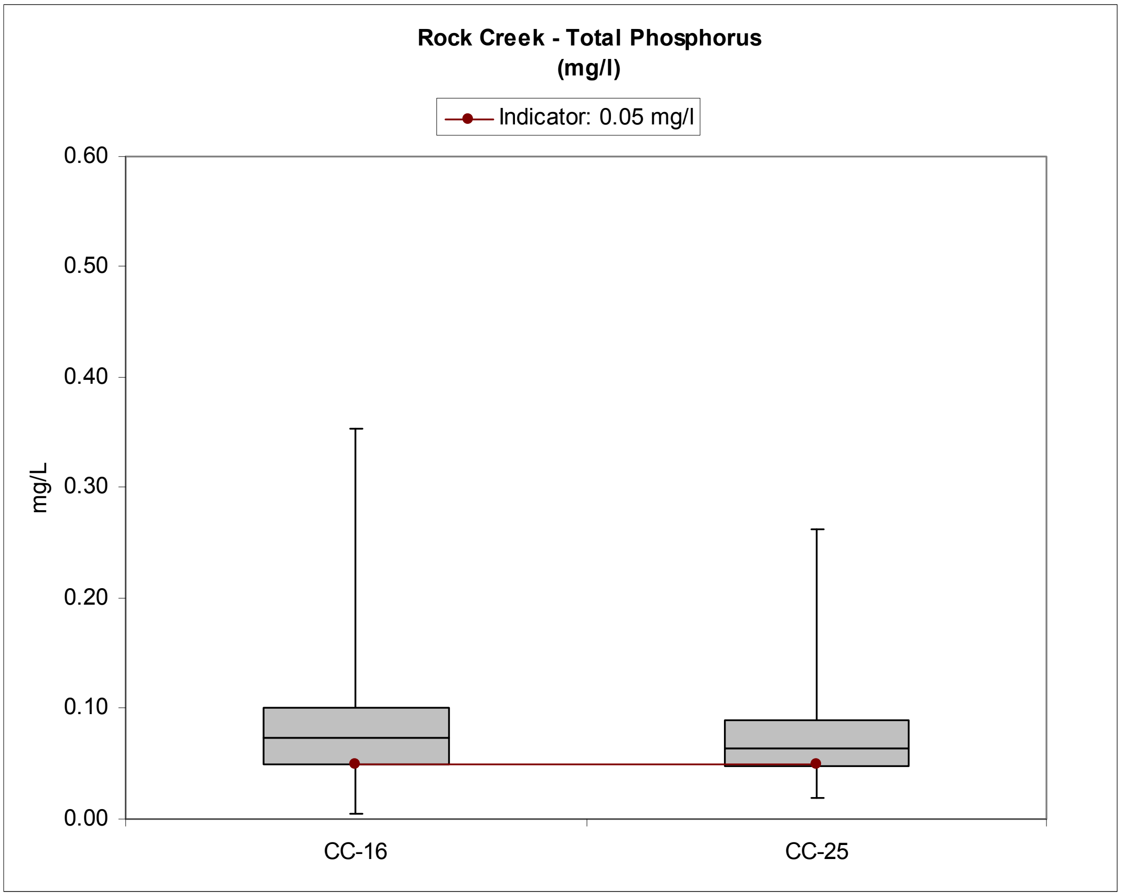

Figure 3-11. Total Phosphorus data for Sites CC-16 and CC-25

Table 3-8. Boxplot Data for Rock Creek Total Phosphorus, mg/L

	CC-16	CC-25
Maximum	0.354	0.262
Upper quartile	0.101	0.089
Median	0.074	0.064
Lower quartile	0.050	0.049
Minimum	0.005	0.020
Count	118	71
Dates	1996 to 2008	2001 to 2007
Indicator: mg/L	0.05	0.05

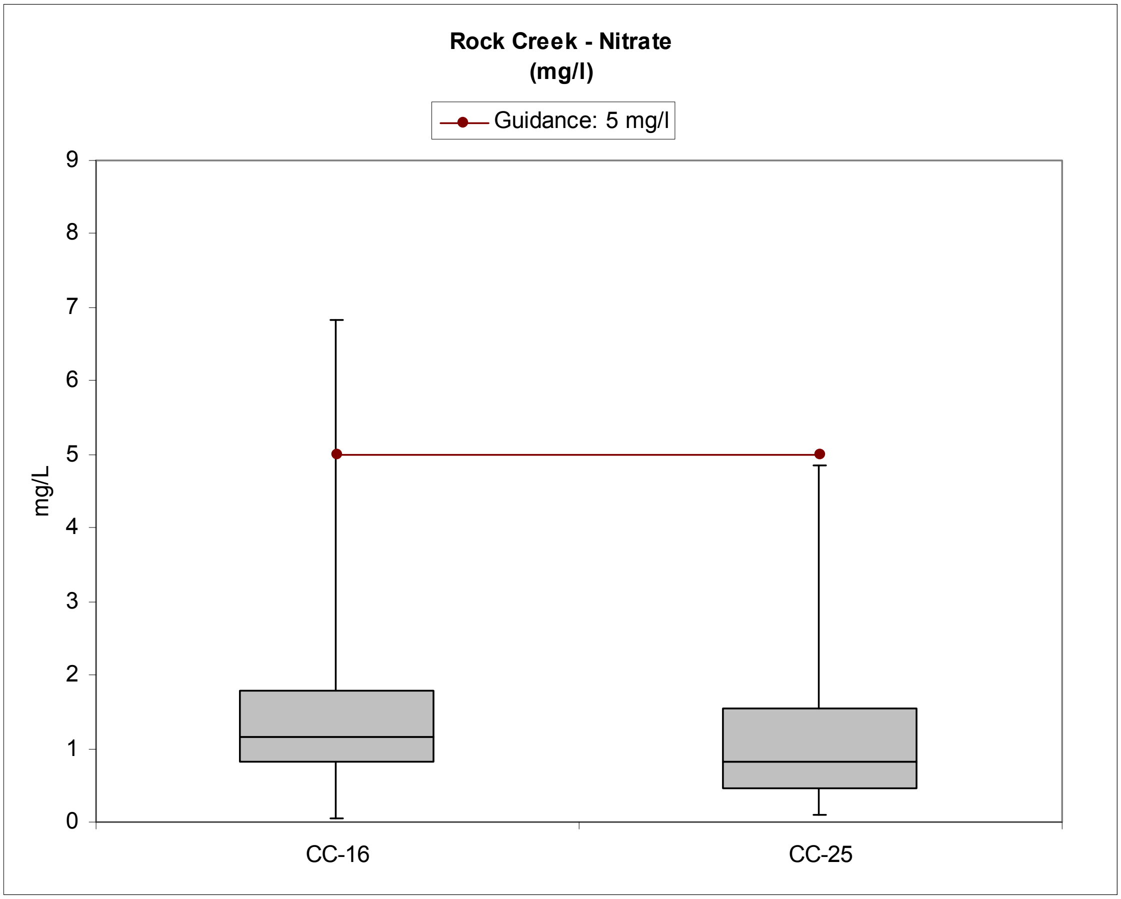

Figure 3-12. Nitrate data for Sites CC-16 and CC-25

Table 3-9. Boxplot Data for Rock Creek Nitrate, mg/L		
	CC-16	**CC-25**
Maximum	6.84	4.86
Upper quartile	1.79	1.55
Median	1.17	0.82
Lower quartile	0.81	0.47
Minimum	0.04	0.10
Count	122	71
Dates	1996 to 2008	2001 to 2007
Guidance: mg/L	5.00	5.00

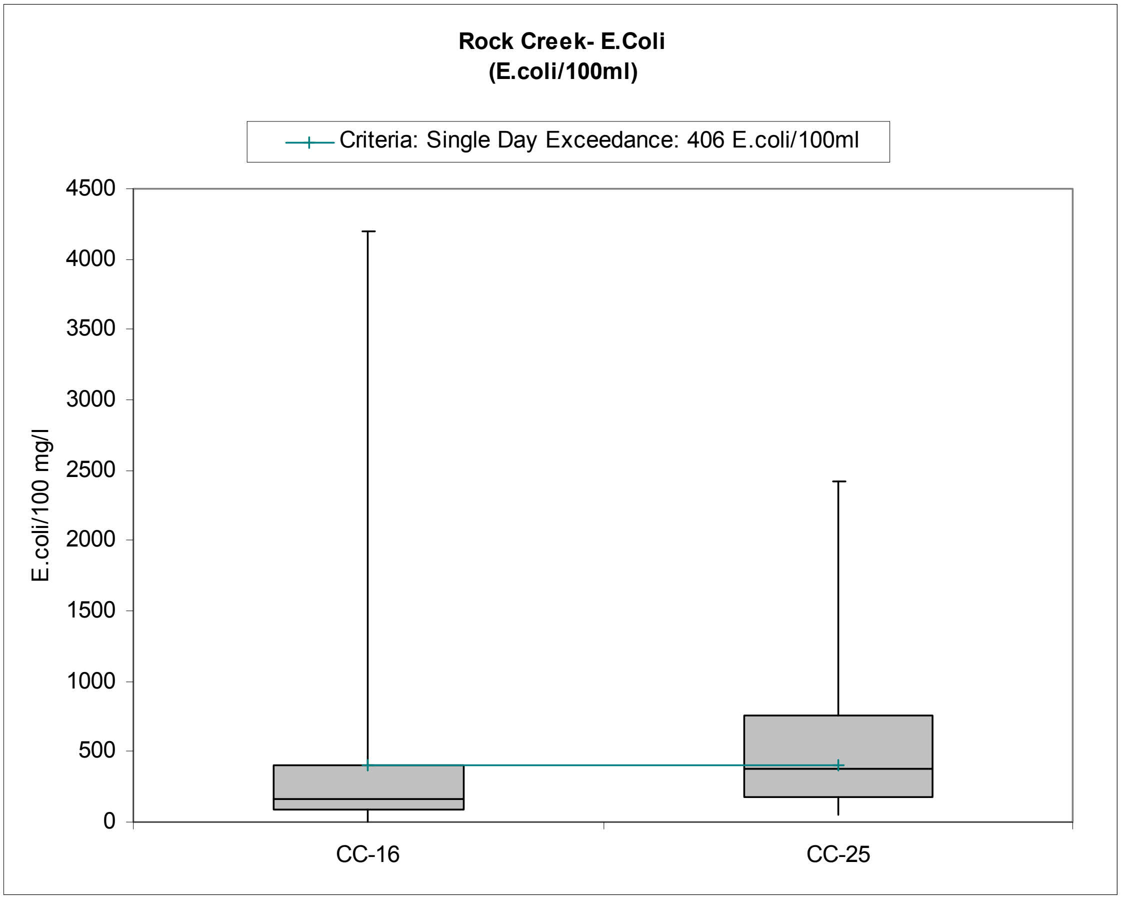

Figure 3-13. E. coli bacteria data for Sites CC-16 and CC-25

Table 3-10. Boxplot Data for Rock Creek *E. coli* bacteria, *E. coli*/100 mL)

	CC-16	CC-25
Maximum	4200	2419
Upper quartile	405	759
Median	167	376
Lower quartile	82	174
Minimum	1	55
Count	114	70
Dates	1997 to 2008	2001 to 2007
Criterion: *E. coli*/100 mL	406	406

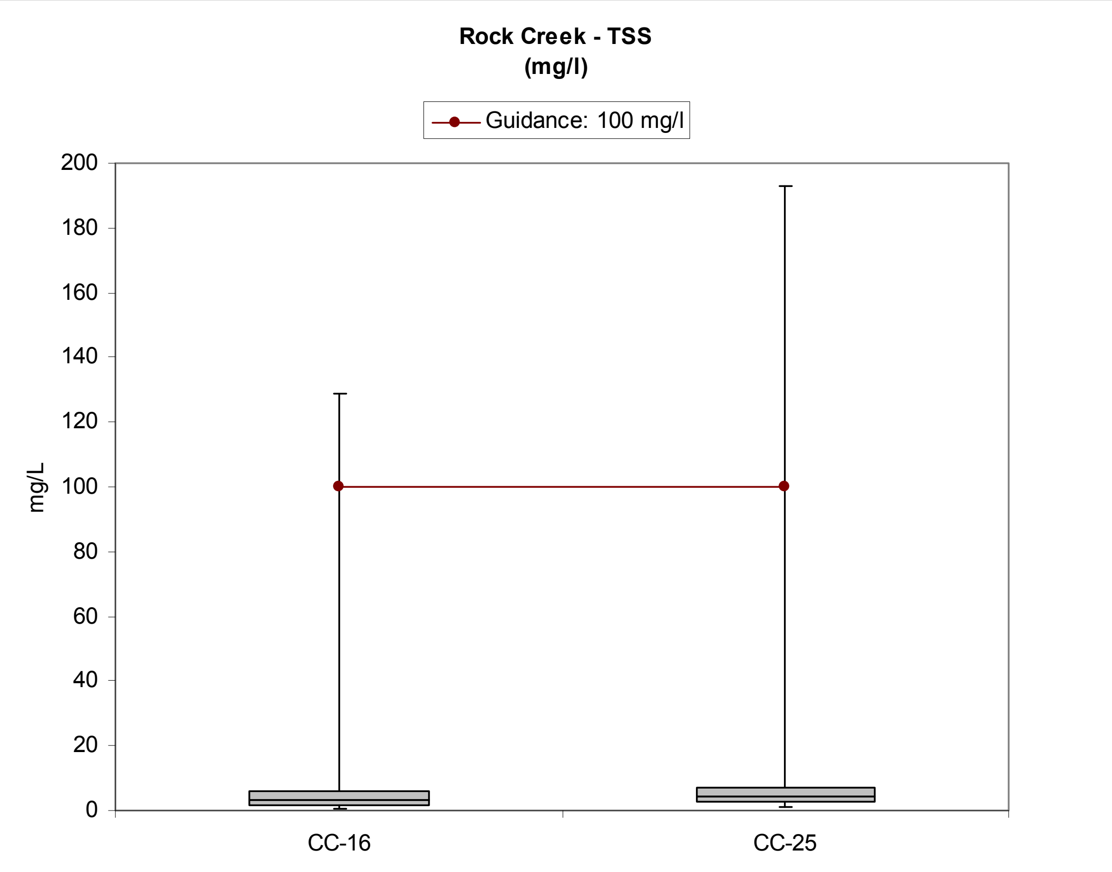

Figure 3-14. TSS data for Sites CC-16 and CC-25

Table 3-11. Boxplot Data for Rock Creek TSS, mg/L

	CC-16	CC-25
Maximum	129.0	193.0
Upper quartile	6.0	7.2
Median	3.0	4.6
Lower quartile	1.8	2.9
Minimum	0.5	1.2
Count	106	71
Dates	1999 to 2008	2001 to 2007
Guidance: mg/L	100	100

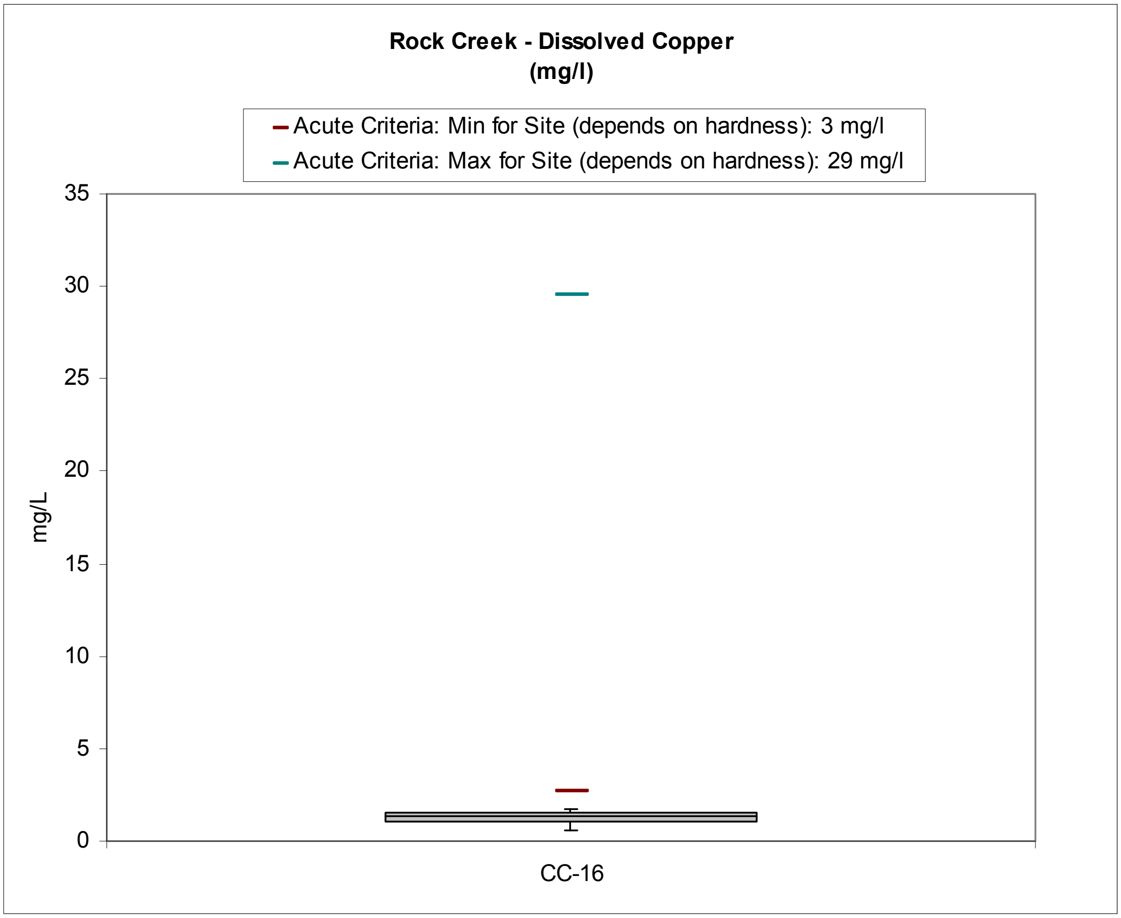

Figure 3-15. Dissolved Copper data at Site CC-16

Table 3-12. Boxplot Data for Rock Creek Dissolved Copper, mg/L

	CC-16
Maximum	0.6
Upper quartile	1.6
Median	1.3
Lower quartile	1.0
Minimum	0.6
Count	6
Dates	2007 to 2008
Acute criteria: mg/L	DNE[1]

[1] DNE: Did not exceed criteria at this sampling location during the sampling period.

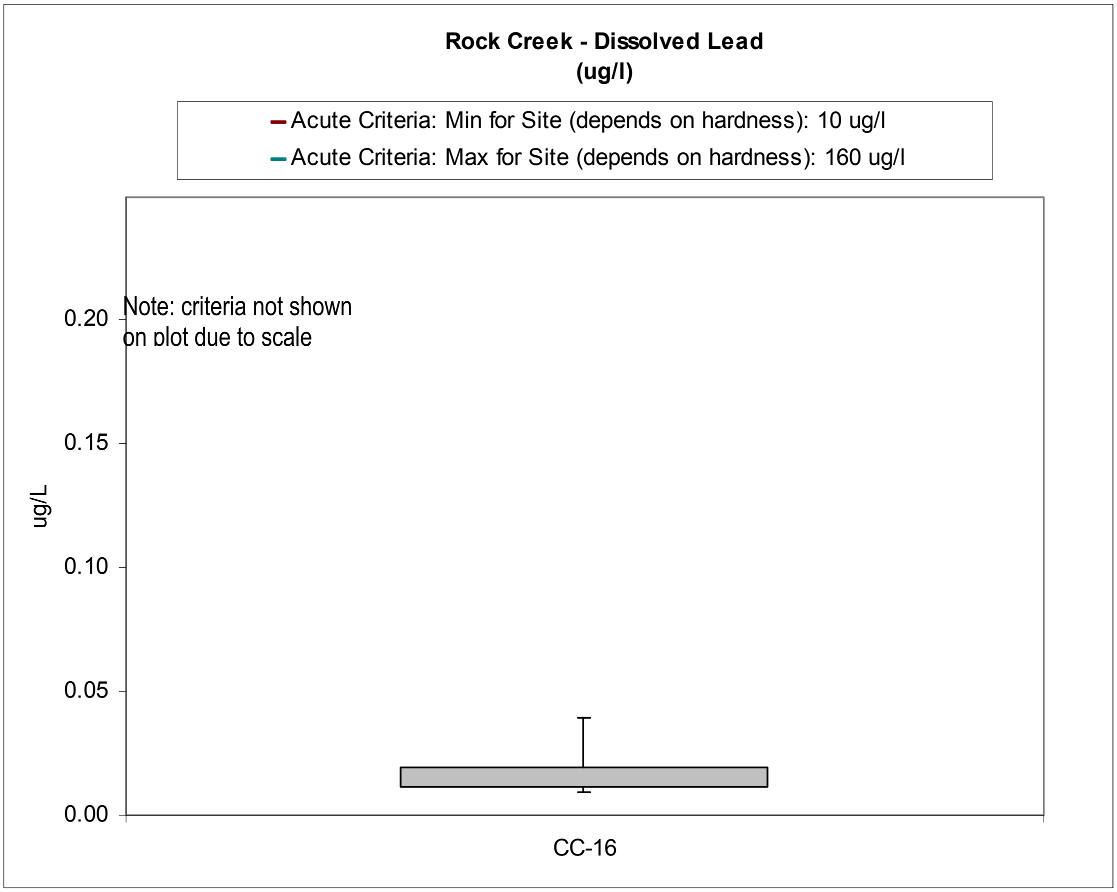

Figure 3-16. Dissolved Lead data at Site CC-16

Table 3-13. Boxplot Data for Rock Creek Dissolved Lead, µg/L

	CC-16
Maximum	0.04
Upper quartile	0.02
Median	0.02
Lower quartile	0.01
Minimum	0.01
Count	6
Dates	2007 to 2008
Acute criteria: µg/L	DNE[1]

[1] DNE: Did not exceed criteria at this sampling location during the sampling period.

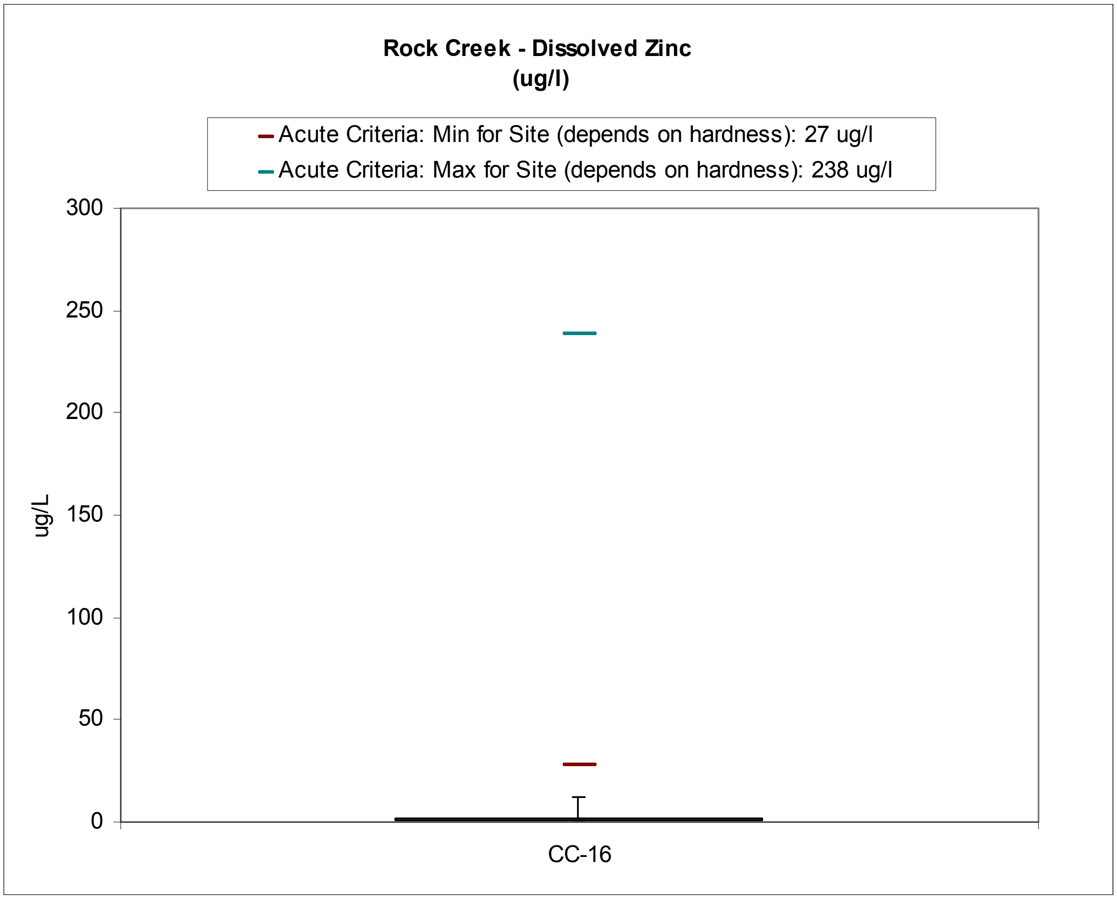

Figure 3-17. Dissolved Zinc data at Site CC-16

Table 3-14. Boxplot Data for Rock Creek Dissolved Zinc, µg/L

	CC-16
Maximum	12.4
Upper quartile	1.7
Median	1.4
Lower quartile	1.0
Minimum	0.7
Count	6
Dates	2007 to 2008
Acute criteria: µg/L	DNE[1]

[1] DNE: Did not exceed criteria at this sampling location during the sampling period.

CHAPTER 4 – AQUATIC HABITAT AND BIOLOGICAL COMMUNITIES

Overview

This chapter summarizes aquatic habitat and biological communities in the Rock Creek (RC) watershed based on an evaluation of existing environmental monitoring data and reports of watershed conditions. Key sources of information regarding aquatic habitat and biological communities in the RC watershed include the following:

- Benthic macroinvertebrate surveys and Benthic Index of Biological Integrity (B-IBI) scores
- Fish surveys, fish habitat assessments, and Fish Index of Biological Integrity (F-IBI) scores
- Continuous flow and water quality monitoring data
- Geographic Information System (GIS) data and studies describing forest canopy in the watershed
- Studies describing biological communities in the watershed

This chapter describes how key biological indicators are being used to characterize the present level of biological and aquatic habitat impairment in selected reaches of Rock and Trillium Creeks. This information was used in the assessment phase of the project to identify specific management activities appropriate for Water Environment Services (WES) to undertake (Chapter 5).

Available data on wetlands, riparian canopy, and other biological resources in the watershed were evaluated as key indicators to assess the biological communities' component of overall watershed health. Biological communities in the landscape are an important element of the ecosystem services provided by a watershed. WES is interested in identifying key ecosystem services and in exploring policies and practices that protect or enhance ecosystem services. The City of Damascus is also focusing its stormwater master planning efforts around the protection and enhancement of ecosystem services.

Fish and benthic macroinvertebrate bioassessment indices and information on the distribution and relative abundance of salmonids were selected as the key indicators to assess the aquatic habitat component of overall watershed health. It is important to recognize that biological indicators can be affected by a wide variety of limiting factors, many of which go beyond the scope of WES as a stormwater management service provider. Fish populations, in particular, can be affected significantly by a wide variety of habitat conditions, water quality conditions, competition with invasive species, access to streams, overfishing, ocean conditions (for anadromous fish), and other constraints. WES' efforts to improve watershed health are complemented by the actions of many other agencies and stakeholders to improve conditions for biological indicators.

Comparisons between reaches sampled by the Oregon Department of Fish and Wildlife (ODFW) (i.e., fish sampling reaches) are presented for the key aquatic habitat indicators. Stream reaches were also characterized with respect to an array of habitat parameters known to be important for maintenance of healthy salmonid populations in Western Oregon streams. Rating scores were established for each habitat parameter and scores were compared among ODFW's habitat sampling reaches and fish sampling reaches. Overall habitat scores indicated that all reaches of Rock Creek, but especially those above the falls at river mile (RM) 1.2, are below optimal conditions for the habitat parameters evaluated.

Limiting factors for salmonids in the watershed are discussed with respect to physical habitat. It is likely that other factors, especially temperature, may also be limiting. Additional factors that may be limiting watershed health and salmonid populations could include low summer flows, high peak flows, and water quality degradation from pollutants such as pesticides. Temperature monitoring has been conducted in the RC watershed, but the data are not evaluated in this chapter.

Riparian conditions are described with respect to riparian buffer intactness and structural differences (i.e., distribution of trees and shrubs) along the mainstems and tributaries to Rock and Trillium Creeks. Examples of how available GIS databases will be used to prioritize reaches for riparian restoration and protection actions are provided. A great amount of work was accomplished in assessing riparian conditions by Leferink (2007) for Metro. Maps showing the locations of high priority sites for riparian restoration were developed in Leferink's study and were used as appropriate in our recommendations.

Finally, fish passage issues within the watershed are identified and biological criteria for prioritizing which passage problems need to be resolved first, second, third, etc. are presented. Access of adult anadromous salmonids to upstream areas in Rock Creek is naturally blocked by the falls at RM 1.2. However, there are several culverts and partial barriers in upstream areas that may be impeding resident cutthroat trout. On Trillium Creek, access is blocked by a dam at stream mile 0.4, which does not have fish passage facilities. These obstacles in the watershed are described and steps required to prioritize these obstacles to migration are outlined.

Data Reviewed

To characterize aquatic habitat and biological communities in the RC watershed and evaluate factors limiting watershed health, existing environmental monitoring data and reports of watershed conditions were reviewed. Key data sources evaluated include the following:

- Benthic Macroinvertebrate Survey Results collected by ABR (Lemke and Cole, 2008 and Cole, 2004)
- ODFW Draft Report of Fish Populations Assessment (ODFW, 2008)
- ODFW Fish and Habitat Surveys (Tinus et al., 2003 and Freisen and Zimmerman, 1999)
- Damascus Natural Features Inventory, Natural Resources Report and Natural Hazards Report, (Winterbrook Planning, 2007)
- Report on the Damascus/Boring Concept Plan (Clackamas County et al., 2006)
- Surface Water Master Plans for Rock and Richardson Creek Watersheds (URS, 2000)
- Rock and Richardson Creek Watershed Assessment (Clackamas River Basin Council [CRBC], 2000)
- Rock and Richardson Creek Landscape and Natural Resources Assessment (Metro, 2000)

Data Gaps

The following data gaps were identified:

- Benthic macroinvertebrate sampling coverage for Rock Creek is presently insufficient to allow reach-by-reach comparisons needed to evaluate stream habitat conditions. To allow comparisons between sites and with other studies in other streams, it is important that comparisons be made in riffle habitat.
- Summer low flow data are needed for the Rock Creek Drainage.
- Continuous water temperature data were reportedly collected at a number of locations in the RC watershed during spring, summer, and early fall 2008. Some of the continuous temperature records are still at ODFW and will become available in the near future.

- Culvert and dam inspections will be required to determine the present status of those that have been identified as potential barriers. These inspections would evaluate the conditions of the culverts and dams as well as the potential use of the stream by salmonids and upstream available habitat.
- Fish survey reaches should be standardized so that the same areas are sampled year to year. F-IBI calculations should be based on either first-pass collections or multiple-pass collections and should not vary from year to year.
- Fish sampling should be expanded to include the major tributaries in the mid and upper watershed.
- Assessment of fine sediments in riffle habitat is an important indicator of spawning habitat quality. Present qualitative techniques are inadequate. A quantitative sampling approach (e.g., the grid method described by Bauer and Burton, 1993) should be employed on standard riffle sites within each ODFW habitat reach.

Watershed Conditions

The RC watershed encompasses approximately 6,280 acres. The RC watershed has not yet been heavily developed for urban uses, although its western drainages and urban areas are growing and are expected to continue growing significantly in the future within both the Cities of Happy Valley and Damascus. The RC watershed streams have been impacted by agriculture, roads, and other rural development since the early 1900s. Most of the land in the watershed is currently used for agriculture, nurseries, private forest land, open space, and rural residences.

Metro periodically analyzes land cover in the region using aerial photographs. The 2007 land cover analysis from Metro indicates that approximately 40 percent of the RC watershed is forested, 47 percent of the watershed is vegetated with grass, shrubs, or agricultural vegetation, and 13 percent of the watershed is comprised of built or scarified areas which include buildings, pavement, and some compacted or dry exposed soil areas.

The RC watershed forms a patchwork of forested habitats, riparian corridors, roads, houses, and other development. The influences of development in the watershed have fragmented habitat connections and have impacted the water and habitat quality of the riparian zones. However, there are still large patches of upland forest habitat and vegetated riparian corridors that provide dwelling, feeding, and nesting habitat for many of the region's resident wildlife species (Metro, 2000). If the current connections between large habitat patches are maintained and enhanced, the landscape in the watershed can likely continue to provide for the resident and migratory wildlife species that use the area (Metro, 2000). Additional detailed information on the biological communities in the RC watershed is available from Metro (2000) and Damascus (Winterbrook Planning, 2007).

Wetlands

The historic distribution of wetlands in the RC watershed is largely unknown due to the significant agricultural land clearing and urban development in the watershed. Wetlands in Rock Creek were most likely predominately forested with ash, alder, cottonwood, and red cedar (CRBC, 2000). Most of the existing wetlands are palustrine forested, palustrine shrub/scrub, and palustrine emergent. Riverine wetlands also exist in the lowlands near the mainstem of Rock Creek. Non-native plant species are prevalent in the existing wetlands.

Several documents provide valuable information about wetlands in the RC watershed (e.g., 2007 City of Happy Valley Local Wetland Inventory, Rock and Richardson Creek Watershed Assessment, etc.); however none of the documents summarize wetland status on a watershed-wide scale. The National Wetlands Inventory (NWI) data identify the size, type, and location of wetlands at the watershed scale based on aerial photo analysis. However, the data are often incomplete.

NWI data for Rock Creek watershed include the following:

- Number of wetlands: 17
- Average wetland size: 0.81 acres
- Total wetland acreage: 13.91 acres
- Types of wetlands: freshwater ponds, forested/shrub, riverine

Stream Reach Characterization

Historic Setting

Rock Creek historically supported cold-water fish and benthic macroinvertebrate communities. Anadromous Steelhead trout, Coho salmon, Chinook salmon, and sea-run Cutthroat trout have spawned and reared in the first 1.2 miles of Rock Creek. A naturally occurring, 23-foot (7-meter) waterfall at this location creates a natural barrier to salmonid migration, prohibiting upstream distribution of anadromous salmonids. Resident cutthroat trout however are thought to have utilized the entire length of Rock Creek as suitable stream gradient and substrate composition are present above the falls.

Rock Creek is a tributary to the Clackamas River, which, prior to 1899 was considered the most robust spring Chinook fishery in the Pacific Northwest (ODFW, 1992, as cited in Ecotrust, 2000). Hatchery introductions to the Lower Clackamas River began with spring Chinook salmon in the late 1800s and peaked in the 1950s and 1960s with the addition of large numbers of Coho salmon and Steelhead. It is likely that anadromous salmonids have always used the lower 1.2 miles of Rock Creek as rearing habitat, moving back and forth between the creek and the mainstem Clackamas River.

Biological Characterization Process

Essentially the same analytical process will be followed for identifying stream reaches that should be protected (Objective 1) and stream reaches that have a high priority for restoration as well as those that are the most severely degraded (Objective 2). In this report, the stream reaches will be characterized relative to their present condition but prioritization for restoration actions will require further analytical steps that will be conducted as part of the Watershed Assessment phase. The basic approach to characterization of the various reaches of Rock Creek and its tributary Trillium Creek is to use a combination of biological indicators to rank the reaches into the following three categories: 1) severely degraded; 2) moderately degraded; and 3) properly functioning. The spatial and temporal distribution of indicator fish species will be used in conjunction with indices of fish community and benthic macroinvertebrate community health indices to rank reaches.

Indicator Species. Recent sampling conducted by ODFW in 2008, indicate that Steelhead and Rainbow trout, Coho salmon, Chinook salmon and Cutthroat trout are present within the RC watershed (ODFW, 2008). Because of the falls at RM 1.2, anadromous salmonids (i.e., Coho, Chinook, Steelhead, Rainbow, and sea-run Cutthroat trout) are restricted to the lower 1.2 miles of the creek. These species also have access to the lower 0.4 mile of Trillium Creek, which joins Rock Creek near its mouth. Cutthroat trout is the only native salmonid species present in the watershed upstream of the falls at RM 1.2. The five species of salmonids have similar basic requirements for reproduction, rearing, and migration. They all require cool water temperatures; clean, well oxygenated water; appropriate substrate with low levels of fines for spawning; areas of refuge from high winter flow events; adequate cover (deep pools, root wads, undercut banks, etc.);

and adequate food production areas (e.g., shallow, clean riffle habitat). Therefore, the presence of expected life stages of these species in a given reach indicates that at least minimal requirements for these sensitive species are being met.

Seasonal fish sampling data were collected from six survey reaches (five on Rock Creek and one on Trillium Creek) by ODFW in 1997-98 (Friesen and Zimmerman, 1999), six reaches in 2002-03 (including three reaches on Trillium Creek)(Tinus et al., 2003) and six reaches (including one on Trillium Creek) in the spring of 2008 (Neerman and Vogt, 2008). Although surveys were conducted within the same general reaches, the start and end points of the surveys differed somewhat between surveys (Table 4-1). Note that in 2008, Rock Creek survey reach 2 extended above the natural barrier at RM 1.2. Fortunately, the raw data for the survey indicated which fish were collected from below and above the barrier. The most recent survey data probably provide the best indication of present conditions, but represent only one season. Previous survey data were collected in all four seasons and provide additional information on seasonal use of the various stream reaches.

The survey data were used to determine which reaches appear to provide the best conditions for the indicator salmonid species. Note that presence of salmonids does not necessarily indicate that the conditions are optimal. Fish survey and habitat reaches are depicted on Figure 4-1.

Biological Indices. The scientific literature contains a number of biological indices that have been developed for use with both fish and benthic macroinvertebrate sampling data. Each index is composed of a number of metrics calculated from sample data. The individual metrics are selected to provide information that describes specific aspects or sensitivities of the target community. Generally the upper limits of these biological indices are based on a reference condition in which water quality and habitat are considered to be unimpaired. Ranges in index values are typically established for categorizing impairment into three or more levels (e.g., severe impairment, moderate impairment and no impairment). The primary utility of biological indices is that they integrate a great deal of information about habitat conditions into a single value. It is important to evaluate the results of biological indices in the context of watershed conditions and management goals.

Table 4-1. Approximate Survey Reach Lengths

	Survey year								
	1997			2003			2008		
Study Reach	Start (RM)	End (RM)	Length (feet)	Start (RM)	End (RM)	Length (feet)	Start (RM)	End (RM)	Length (feet)
Reach 1	0.0	0.3	1,109	0	0.3	1,795	0.0	0.3	1,320
Reach 2	0.3	0.9	3,168	0.4	0.9	2,693	0.6	1.1	2,323
Reach 3	0.9	1.8	5,016	0.9	1.9	5,227	1.5	1.9	2,059
Reach 4	1.8	3.0	6,124	NA	NA	NA	1.9	2.5	3,274
Reach 5	3.0	4.7	9,187	NA	NA	NA	3.3	3.6	1,320

ODFW uses a fish index of biological integrity (F-IBI) and has routinely calculated index values for each of the fish samples they have collected in the RC watershed since 1997. The F-IBI combines the following 12 metrics:

Taxonomic richness

- Number of native families
- Number of native species

Habitat Guilds

- Number of native benthic species
- Number of native water column species
- Number of hider species
- Number of sensitive species
- Number of native non-guarding lithophil nester species (e.g., salmonids and lamprey)
- Percent tolerant individuals

Trophic guilds

- Percent filter-feeding individuals
- Percent omnivores

Individual health and abundance

- Percent of target species that include lunkers (i.e. relatively large individuals over specified lengths)
- Percent of individuals with anomalies

Each of the above metrics is given a score between 0 and 10 based on an established range of raw values for each metric. To distinguish between fish communities in small streams (stream order 1) and larger streams (orders 2 and 3) separate ranges for raw scores have been developed. The F-IBI is scaled to provide values between 0 and 120. However, the final F-IBI scores are given as a percentage of the maximum total of 120, yielding a final range between 0 and 100. Streams or reaches with and F-IBI ≤ 50 are considered severely impaired, those scoring 51 to 74 are marginally impaired, and those with a score ≤ 75 are considered acceptable. Note that the F-IBI focuses on conditions for native species rather than just salmonids. Therefore, a relatively high F-IBI score could be achieved without salmonids being present in the sample.

Benthic macroinvertebrate sampling was conducted at two locations in Rock Creek on behalf of WES in 2002 and 2007 (Cole, 2004 and Lemke and Cole, 2008). A more extensive survey of benthic macroinvertebrates was conducted in 2003 for Metro (Cole, 2004) when eight riffle habitats were sampled throughout the watershed. Macroinvertebrate taxonomic data were analyzed using Oregon Department of Environmental Quality's multimetric analysis for western Oregon streams, which hereafter is referred to as the B-IBI. This analysis employs a set of ten metrics, each of which describes an attribute of the benthic macroinvertebrate community that is known to be responsive to one or more types of pollution or habitat degradation. As with the F-IBI, each metric is converted to a standardized score; standardized scores of all metrics are summed to produce as single multimetric score that is a numeric measure of overall biotic integrity. The ten metrics and scoring criteria are listed in Table 4-2.

Table 4-2. Metric Set and Scoring Criteria Used to Assess Condition of Benthic Macroinvertebrate Communities from Riffles in the RC Watershed (from Lemke and Cole, 2008).

	Scoring Criteria		
Metric	**5 (good)**	**3 (fair)**	**1 (poor)**
Positive metrics			
Taxa richness	> 35	19 to 35	< 19
Mayfly richness	> 8	4 to 8	< 4
Stonefly richness	> 5	3 to 5	< 3
Caddisfly richness	> 8	4 to 8	< 4
Number of sensitive taxa	> 4	2 to 4	< 2
Number of sediment sensitive taxa	≥ 2	1	0

Table 4-2. Metric Set and Scoring Criteria Used to Assess Condition of Benthic Macroinvertebrate Communities from Riffles in the RC Watershed (from Lemke and Cole, 2008).

	Scoring Criteria		
Metric	**5 (good)**	**3 (fair)**	**1 (poor)**
Negative metrics			
Modified HBI[1]	< 4	4.0 to 5.0	> 5.0
Percent tolerant taxa	< 15	15 to 45	> 45
Percent sediment tolerant taxa	< 10	10 to 25	> 25
Percent dominant	< 20	20 to 40	> 40

[1] Modified HBI = Modified Hilsenhoff Biotic Index.

The multimetric benthic index is scaled to yield values between 10 and 50. Impairment levels are as follows: severe (< 20), moderate (20 to 30), slight (30 to 39) and unimpaired (> 39).

At the stream reach level, indices based on benthic macroinvertebrate community data may provide a somewhat better description of stream health than fish indices. This is because benthic organisms are relatively immobile and cannot move from reach to reach as can fish. Therefore, benthic indices are more likely to integrate responses to conditions that have occurred in the reach over a longer period of time.

The above indices will be used on a reach-by-reach basis to identify the level of impairment compared to an unimpaired reference condition. However, it should be recognized that urbanized and/or urbanizing catchments (i.e., watersheds) place limits on achievable biological conditions. Attainment goals for urban catchments must be considered with respect to largely unalterable effects associated with urbanization. These attainment goals can be expected to be higher for a catchment basin with low levels of urban development compared with one with high levels of urban development. In other words, the level of urbanization in a catchment basin sets limits on what can be achieved with regard to recovery from impaired conditions. Standard bioassessment indices do not take the level of urbanization into account.

This problem has been addressed in recent research conducted by Barbour et al. (2006). Their approach attempts to provide: a nationally applicable measure of urbanization, a process for developing urban-specific biological indicators, and empirically defined and realistic aquatic life use benchmarks for urban areas. Their paper describes a three-step process: 1) developing a primary urbanization gradient; 2) assembling an appropriate urban biological index; and 3) defining a biological potential that describes the highest biological condition currently achieved along the urban gradient. Their research was conducted across three distinct climatic regions with similar results found in each region. We believe that the approach described by Barbour et al. (2006) may be useful for prioritizing locations for protection and restoration efforts within the watershed.

Barbour et al.'s (2006) approach requires the calculation of an index of urbanization based on measures of land use, road density, and human population density and calculation of a biological index that is sensitive to different levels of urbanization. The biological index was selected after testing many combinations of benthic metrics against the urban gradient. The best fit was provided by averaging the number of Ephemeroptera (mayfly), Trichoptera (stonefly), and Plecotera (caddisfly) taxa (EPT index), filterer taxa richness and clinger numbers as a percent of total numbers. The index of urban biological condition developed by Barbour et al. (ibid) was found to have wide applicability across the U.S.

Data for calculation of the index of urbanization are available for each subbasin in the greater RC watershed but have not yet been assembled on a catchment by catchment basis. We used the available benthic sampling data to calculate the urban index of biological condition for each site sampled since 2002 and will present them below to show how they vary relative to the B-IBI scores. These index values should be viewed as preliminary in that not all of the details and assumptions used by Barbour et al. (2006) in their calculation of the urban gradient or biological index of urban effects were presented in their paper.

Existing Aquatic Biological Conditions

Indicator Fish Species. The most recent information on the distribution of fish within Rock Creek was sampling data collected in spring 2008 by ODFW in five reaches of Rock Creek (RC01-RC05) and one reach of Trillium Creek (Table 4-3). In spring 2008, only one cutthroat trout was collected (in RC02), which is a significant decrease over previous years. However, numerous unidentified salmonids were collected at sites RC01 and RC02, and these may have included some cutthroat trout. The report (ODFW, 2008) does not give a reason for the lack of salmonid identification, but presumably they were small, immature fish, which—in the case of Cutthroat trout—can be difficult to distinguish from immature Rainbow/Steelhead without careful inspection. Since listed fish species were involved, any extensive handling for identification could lead to a "take" situation. As indicated in Figure 4-2 and in Table 4-3, there were differences between stream reaches in the abundance of salmonids. By far the majority of salmonids were found below the falls in RC01 and RC02. It should be noted that the historic abundance data is not directly comparable year to year due to a difference in sampling methods. The 2002-03 and 2008 abundance data is from multiple-pass removal sampling, while the 1997-98 data is from the first electrofishing pass.

Sampling in upstream reaches in spring 2008 produced just one Steelhead/Rainbow trout at each of sites RC04 and RC05. The presence of these fish above the falls (and one Steelhead/Rainbow trout in RC05 in 1997/1998) indicates that they are not anadromous and are likely stocked fish – possibly escapees from a private pond. Steelhead/Rainbow trout were numerous below the falls, but only one Coho was collected, along with seven Chinook. In addition to the fish listed in Table 4-3, numerous salmonids were also collected during presence/absence surveys. Four of the sixteen Chinook salmon collected in RC01 and RC02 (during both presence/absence surveys and multi-pass removal sampling) and 12 of 17 Rainbow/Steelhead trout collected were hatchery (fin-clipped) fish. Since there is no stocking in Rock Creek, the presence of fin-clipped fish clearly demonstrates that at least some of the salmonids found in Lower Rock Creek had moved into the creek from the Clackamas River. It is possible that some spawning takes place in the lower 1.2 miles of Rock Creek, as there is some available gravel, but it is more likely that the majority of observed salmonids are migrants from the Clackamas River.

Table 4-3. Number of Fish Collected by Site in Rock and Trillium Creeks

Species	Year	Rock Creek					Trillium Creek	
		RC01	RC02	RC03	RC04	RC05	TR01	TR02
Summer								
Cutthroat	1997/1998	**1**	0	0	0	**3**	NS	NS
	2002/2003	**103**	**72**	**1**	N/S	N/S	**3**	0
Coho	1997/1998	0	0	0	0	0	NS	NS
	2002/2003	**10**	**7**	0	N/S	N/S	**15**	0
Rainbow/Steelhead	1997/1998	**18**	**15**	0	0	0	NS	NS
	2002/2003	**2**	**2**	0	N/S	N/S	0	0
Chinook salmon	1997/1998	0	0	0	0	0	NS	NS
	2002/2003	**1**	0	0	N/S	N/S	**1**	0

Table 4-3. Number of Fish Collected by Site in Rock and Trillium Creeks

Species	Year	Rock Creek					Trillium Creek	
		RC01	RC02	RC03	RC04	RC05	TR01	TR02
Fall								
Cutthroat	1997/1998	0	0	0	0	0	NS	NS
	2002/2003	**6**	**50**	**1**	N/S	N/S	0	0
Coho	1997/1998	0	**2**	0	0	0	NS	NS
	2002/2003	**19**	**4**	0	N/S	N/S	**5**	0
Rainbow/Steelhead	1997/1998	**7**	**20**	0	0	0	NS	NS
	2002/2003	**66**	0	0	N/S	N/S	**4**	0
Chinook salmon	1997/1998	**2**	0	0	0	0	NS	NS
	2002/2003	**5**	0	0	N/S	N/S	0	0
Unidentified salmonid	2002/2003	0	**2**	0	0	0	0	0
Winter								
Cutthroat	1997/1998	0	0	0	0	0	NS	NS
	2002/2003	**13**	0	0	N/S	N/S	0	0
Coho	1997/1998	0	0	0	0	0	NS	NS
	2002/2003	**5**	**2**	0	N/S	N/S	**27**	0
Winter								
Rainbow/Steelhead	1997/1998	**5**	**11**	0	0	0	N/S	N/S
	2002/2003	**1**	**9**	0	N/S	N/S	**14**	0
Chinook salmon	1997/1998	**1**	0	0	0	0	N/S	N/S
	2002/2003	0	**2**	0	N/S	N/S	0	0
Spring								
Cutthroat	1997/1998	0	0	0	0	0	N/S	N/S
	2002/2003	**6**	**50**	**1**	N/S	N/S	0	0
	2008	0	**1**	0	0	0	0	N/S
Coho	1997/1998	0	**2**	0	0	0	N/S	N/S
	2002/2003	**13**	0	0	N/S	N/S	**9**	0
	2008	0	**1**	0	0	0	**1**	N/S
Rainbow/Steelhead	1997/1998	**7**	**41**	0	0	**1**	N/S	N/S
	2002/2003	**2**	**11**	0	N/S	N/S	0	0
	2008	**19**	**10**	**1**	**1**	0	**1**	N/S
Chinook salmon	1997/1998	**1**	0	0	0	0	N/S	N/S
	2002/2003	**9**	0	0	N/S	N/S	0	0
	2008	**6**	**1**	0	0	0	**3**	0
Unidentified salmonid	2002/2003	**14**	0	0	0	0	0	0
	2008	**14**	**10**	0	0	0	0	N/S

N/S = Not sampled

Taken as a whole, the historic sampling indicates that Chinook salmon, Coho salmon, and Cutthroat and Steelhead/Rainbow trout are present in Rock Creek year-round below the falls, but their numbers are highly variable. Resident Cutthroat trout and Rainbow trout are rare above the falls, but have been collected as far upstream as RC05.

Trillium Creek (TR01) has been sampled only sporadically, but it appears to provide rearing habitat for juvenile Coho and Chinook salmon and Rainbow/Steelhead and Cutthroat trout (although Cutthroat have been identified less often). TR01 is accessible to anadromous salmonids up to the impassible barrier 0.4 mile upstream from the mouth. No salmonids have been collected above the impassible barrier.

Bioassessment Indices. F-IBI scores, based on spring fish collections in Rock and Trillium Creeks, are compared in Table 4-4 for the three survey years in which they have been calculated. In 2008, the F-IBI scores for Rock Creek varied widely, ranging from 44 to 92. These scores correspond to rankings of unimpaired (or acceptable) for RC01; marginally impaired for RC02 and RC05; and severely impaired for RC03 and RC04. It is clear from inspection of the list of species collected from the reaches that RC01 had the largest number of different species and families and much larger numbers of salmonids.

Table 4-4. Historic Spring F-IBI Scores

Site	Year		
	1998	2003	2008
Rock Creek			
RC01	58	67	92
RC02	59	32	62
RC03	30	30	50
RC04	40	N/S	44
RC05	59	N/S	56
Trillium Creek			
TR01	N/S	55	67
TR02	N/S	Not calculated	N/S

N/S = Not sampled

The F-IBI scores were calculated from multiple-pass removal surveys, rather than presence/absence surveys. However, the presence/absence surveys had rather significantly different results than the multiple-pass removal surveys. For instance, a total of 48 green sunfish, an exotic species, were collected at sites RC02-RC05 (with 23 collected at RC03 and 22 collected at RC05) during the presence/absence surveys, but no green sunfish were collected during the multiple-pass removal surveys. Conversely, 22 suckers were collected at RC01 during multiple-pass removal surveys, but only one was collected during presence/absence sampling. Therefore the accuracy and repeatability of the F-IBI scores is somewhat suspect. Comparing historic data is also complicated by the fact that the 1997/1998 scores were calculated on abundance and occurrence data from the first electrofishing pass, while the 2002/2003 and 2008 scores were calculated from multiple-pass removal surveys.

Spring F-IBI scores have shown an increasing trend in RC01, RC03 and RC04 from 1998 to 2008 and a slight decrease for RC05 (Table 4-4). Nonetheless, RC03 and RC04 consistently have been severely impaired, suggesting that the lowest quality fish habitat in Rock Creek is in the middle section. Reach RC02 decreased from moderately impaired to severely impaired between 1998 and 2003 and then regained its moderately impaired status in 2008. Neerman and Vogt (2008) caution against interpreting the high score at RC01 in spring 2008 as being indicative of actual significant improvement and state:

> "When comparing results for Rock Creek with those of the 2003 spring MPR surveys (Tinus et al, 2003), it appears that resident trout populations have significantly declined. In 2003, six cutthroat trout were observed in Reach 1 whereas none was observed in 2008. Similarly, 50 cutthroat trout were observed in the Rock Creek Reach 2 surveys of 2003, however none was observed in 2008. What is interesting is that this change is not reflected in IBI scores, which increased for the comparable reaches of Rock Creek in the 2008 surveys… Reach 1 had an IBI of 67 in 2003 and 92 in 2008. Reach 2 had a score of 32 in 2003 and 62 in 2008. The IBI score for Reach 1 in 2008 is higher due in part to the presence of a relatively high number of adult large-scale suckers. Adult suckers are counted in the "Lunkers" metric, which drives up the score. The IBI for Reach 1 would be 74 if the 11 adult suckers observed were not counted as Lunkers. Similarly, Rock Creek Reach 2 has a higher score in 2008 due to the observation of lamprey species and Chinook salmon which were not observed in that reach in 2003, despite the fact that 50 cutthroat were observed in 2003 compared to zero in 2008. This demonstrates the limitations in using IBI scores to quantify stream health and in this study's lack of temporal data."

The downstream Trillium Creek reach (TR01) scored in the moderately impaired category in 2008, which is consistent with earlier results.

For fish surveys conducted in 1997-98 and 2002-03, F-IBI scores were calculated for summer, fall, and winter as well as spring (Table 4-5). From inspection of the scores for Rock Creek it can be seen that in general, the lower reaches were moderately impaired (except for RC02 in winter 2002) and the upper reaches were more severely impaired. Aside from these generalities, there do not appear to be any seasonal patterns in F-IBI scores in these earlier surveys. The lower reach of Trillium Creek was moderately impaired regardless of season in 2002/2003, and an F-IBI has been calculated only once for the upper reach (in summer 2002, at which time it was very severely impaired), so seasonal and annual comparisons cannot be made.

Table 4-5. F-IBI Scores for Summer, Fall, and Winter Samples Collected in Rock and Trillium Creeks in 1997-98 and 2002-03 by ODFW

Site	F-IBI					
	1997-1998			2002-2003		
Rock Creek						
	Summer	Fall	Winter	Summer	Fall	Winter
RC01	63.9	71.5	69.1	59	65	62
RC02	50.0	72.5	59.5	59	60	47
RC03	30.2	30.2	42.9	36	51	30
RC04	40.8	30.2	30.2	N/S	N/S	N/S
RC05	53.5	30.2	30.2	N/S	N/S	N/S
Trillium Creek						
TR01	N/S			63	72	64
TR02				17	Not calculated	Not calculated

N/S = Not sampled

Benthic macroinvertebrate sampling was conducted in fall 2002 (Cole, 2003), 2003 (Cole, 2004), and 2007 (Lemke and Cole, 2008). In 2003, eight riffle samples were collected within the watershed and provide the most comprehensive of the available invertebrate datasets. Only two sites in Rock Creek were sampled in 2002 and 2007, one near the mouth (Fish Reach RC01) and one in the middle section (Fish Reach RC04).

The B-IBI sampling locations from 2002, 2003, and 2007 are depicted on Figure 4-3. The B-IBI scores for all of the benthic samples collected in riffle habitat are listed in Table 4-6 and are compared, where possible, with corresponding F-IBI values.

B-IBI scores for sampling sites on mainstem Rock Creek ranged from 20 in the middle section (Fish Reach RC04) in 2002 to 34 near the mouth (Fish Reach RC01) in 2003. The majority of the mainstem sampling sites fell within the moderate (20 to 30) to slight (30 to 39) impairment categories. Both the highest F-IBI and highest B-IBI scores occurred near the mouth of Rock Creek in RC01. However, RC01 had one of the lowest B-IBI scores in 2002. We know from discussions with WES staff that the lower end of Rock Creek has had periodic localized sediment deposition from a nearby construction site. This may account for the wide range in variability in B-IBI scores at this site. When we visited lower Rock Creek in August 2008, there was no evidence of excessive sediment loading.

Only two sites (SD1-M10 and SD1-M11) on mainstem Rock Creek were sampled at the same locations more than once between 2002 and 2007. In fall 2007, B-IBI scores for the lower (SD-M10) and middle (SD-M11) sections of the creek were 32 and 28, respectively. A score of 32 falls at the lower end of the slight impairment category (30 to 39) and a score of 28 is near the upper end of the moderate impairment category (20 to 29). In fall 2003, the two sites scored 22 and 20, respectively. Although these differences suggest that condition may have improved since 2002, a larger data set collected over a longer period of time would be needed to show definite trends in habitat condition. Note that unlike the F-IBI scores for these two sites, differences between the middle and lower section of Rock Creek in B-IBI scores were not very large in either 2002 or 2007.

Benthic macroinvertebrates were collected at one site in Trillium Creek, but the sampling site was significantly upstream of the fish sampling reach in Trillium Creek, and therefore no meaningful comparisons between F-IBI and B-IBI can be made. The Trillium Creek B-IBI score improved from 22 in 2002 to 26 in 2007, both of which are within the moderately impaired category.

The biological index for urban gradient (BIUG) was also calculated for each of the Rock Creek benthic macroinvertebrate sampling sites and the site on Trillium Creek from samples collected in 2002, 2003, and 2007 (Table 4-6). Substantial residential development has occurred around the western lower and mid-regions of Rock Creek since 2000. However, in general the level of urban development in the watershed is much lower than the Kellogg-Mt. Scott (KMS) watershed. Therefore, BIUG scores would be expected to be higher in the upper part of the watershed and generally higher throughout the watershed than found in the more urbanized KMS watershed. In general, the BIUG scores follow the expected pattern relative to our perceived gradient of urban development.

With a few exceptions, BIUG scores generally fell in the upper half of the potential range (i.e., between 60 and 80) as would be expected in a watershed with relatively low urban development. Also the higher scores occurred in the mid to upper regions of the watershed. The lowest BIUG score (26) occurred in 2002 at SD1-M10 near the creek mouth. As discussed above, the B-IBI score for the same sample was relatively low and may reflect effects of localized sediment deposition. The other relatively low BIUG scores occurred in samples collected in the Trillium Creek catchment basin in 2002 and 2003. At that time the Trillium Creek catchment was in the process of intensive residential development, and therefore would be expected to have received a lower BIUG score.

Note that in general there is little relationship between the B-IBI scores and the BIUG scores. If, as appears to be the case, the BIUG scores are responding to the upstream level of urban development, one would not expect to see much relationship between the two indices. More detailed analysis of the BIUG data will be possible once the information needed for calculation of the urban gradient index becomes available. This information could help in the determination of where efforts should be focused in restoration of impaired conditions.

In summary, the distribution and abundance data for salmonids in Rock Creek is reasonably clear. Upstream anadromous salmonid migration in Rock Creek is limited by falls at RM 1.2. As such, only the native resident cutthroat trout population is present upstream of the falls. Low abundance of cutthroat trout, particularly in the mid and upper regions of mainstem Rock Creek, indicates that conditions are severely impaired for maintenance of a healthy salmonid population in these areas. This was also reflected in low F-IBI scores (severe impairment) and relatively low B-IBI scores.

On the other hand, the relatively diverse assortment of salmonids found below the falls throughout the year indicates that this reach of the stream is in relatively good condition for at least the rearing of juvenile salmonids. Whether spawning is occurring in the stream below the falls is not known. This reach of the creek has consistently received relatively high F-IBI and B-IBI scores. Based on the B-IBI scores for the stream reach immediately upstream of the falls (Fish Reach RC03) it appears that habitat conditions for benthic macroinvertebrates is better than in areas further upstream. F-IBI scores for this reach have consistently been in the severely impaired range. Further analysis will be required to better understand the differences in results between these two biological indicators. As discussed previously, the BIUG index appears to be showing a relationship to urbanization but further analysis will be required before we can determine how valuable this index will be in categorizing reaches for protection, restoration or continued maintenance of existing conditions.

Table 4-6. F-IBI Scores Versus B-IBI Scores (Collected in Riffles) and BIUG[1] Scores

Creek	B-IBI and BIUG[1] Site #	F-IBI site which contains the B-IBI sampling location	F-IBI 2003 (spring)	F-IBI 2008 (spring)	B-IBI 2002[2] or 2003[3] (Fall)	BIUG[1] 2002[2] or 2003[3]	B-IBI 2007[4] (Fall)	2007 BIUG[1]	B-IBI trend	F-IBI trend
Rock	WES-SD1-M10	RC01	67	92	22[2]	26[2]	32	65	increasing	increasing
Rock	Metro-1				34[3]	60[3]	N/S	N/A	N/A	
Rock	Metro -2	RC03	30	30	32[3]	75[3]	N/S	N/A	N/A	unchanged
Rock	Metro -48				30[3]	73[3]	N/S	N/A	N/A	
Rock	Metro -3				26[3]	72[3]	N/S	N/A	N/A	
Rock	WES-SD1-M11	RC04	N/S	44	20[2]	52[2]	28	80	increasing	increasing
Rock	Metro -5	above RC05	N/A	N/A	24[3]	61[3]	NS	N/A	N/A	N/A
Trillium	WES-SD1-M7	N/A	N/A	N/A	22[2]	38[2]	26	59	increasing	N/A
Willow (tributary of Trillium)	Metro -17	N/A	N/A	N/A	16[3]	39[3]	NS	N/A	N/A	N/A
Unnamed tributary	Metro -13	enters RC03	N/A	N/A	28[3]	71[3]	NS	N/A	N/A	N/A
Unnamed tributary	Metro -10	enters RC04	N/A	N/A	32[3]	59[3]	NS	N/A	N/A	N/A

[1] Biological Index for Urban Gradient based on calculations described in Barbour et al. (2006)

[2] Data collected in 2002 and reported in Cole, 2003

[3] Data collected in 2003 and reported in Cole, 2004

[4] Data collected in 2007 and reported in Lemke and Cole, 2008

Physical Habitat Characterization Process

Only physical habitat data collected in association with the ODFW 2008 fish sampling (Neerman and Vogt, 2008) were used in the assessment of physical stream habitat characteristics. Lemke and Cole (2008) also collected habitat variables coincident with benthic macroinvertebrate sampling in fall 2007, but as described above, only two of their reaches were located within the fish habitat reaches. Furthermore, the habitat data that were collected by Lemke and Cole (ibid.) were significantly different than the data collected by Neeman and Vogt (2008), making direct comparisons impossible. A discussion of habitat variables as they relate to benthic macroinvertebrate and fish distribution and abundance is included in the Limiting Factors section below.

Descriptions of fish habitat require information on the physical characteristics of the streambed and channel, riparian community, water quality conditions (e.g., temperature, dissolved oxygen [DO], contaminant levels, etc.), hydrology (flow conditions) and biological conditions (e.g., food resources, competitors, and predators). In this section, we will describe and compare selected physical habitat features that have been identified in the scientific literature as being important for the maintenance of healthy populations of the salmonid species found in the RC watershed. Water quality, hydrology, and stream channel morphology are presented in other sections and were evaluated relative to fish habitat during the assessment phase of this project.

In its 2006 "Fish Habitat Assessment in the Oregon Department of Forestry North Cascade Study Area," (Kavanaugh et al., 2006) the ODFW identified 13 key habitat parameters for salmonids and discussed stream reaches in terms of these parameters as they related to selected reference reaches in relatively undisturbed areas. The ODFW parameters included the following:

- percent pools
- deep pools per kilometer
- percent slackwater pools
- percent secondary channels
- percent fines (silt, organics, and sand particles smaller than 2 millimeters in diameter) in riffles, percent gravel in riffles
- percent bedrock in stream
- pieces of large woody debris (LWD) per 100 meters of stream
- key pieces of LWD per 100 meters of stream
- volume of LWD per 100 meters of stream
- number of conifers > 50 centimeters diameter at breast height (dbh) within 30 meters on each side of the stream
- number of conifers > 50 centimeters dbh within 30 meters on each side of the stream
- percent shade

The 2008 ODFW habitat survey (ODFW, 2008) provided data on all of these parameters (except for percent bedrock in the stream) for each of the habitat survey reaches in the Rock Creek study area (five on Rock Creek and one on Trillium Creek). The fish survey and habitat survey reaches are shown on Figure 4-1. In an attempt to illuminate differences between the study reaches and thereby identify limiting factors, we created a ranking system for each of 11 important habitat parameters. The two conifer tree parameters identified by Kavanaugh et al. (2006) were eliminated from our analysis due to a lack of large conifers along any of the surveyed stream reaches in the study area. We also added a category ranking the number of large boulders per square meter of habitat.

The rankings were based on high and low values identified by ODFW for streams in the north and west Cascades (Kavanaugh et al., 2006); by desirable and undesirable benchmark values identified for Oregon streams in Foster et al. (2001); and/or by Habitat Suitability Indices for Coho salmon (McMahon, 1983).

Low, moderate, and high values were determined for each habitat parameter and a corresponding score of 1, 2, or 3 was assigned to each habitat survey reach on that parameter. All scores were then totaled for an overall combined habitat score. To allow a comparison of habitat within fish survey reaches, the values for the habitat survey reaches within each fish survey reach were summed and an average was calculated for each parameter. The parameters utilized are listed in Table 4-7 and the rationale for inclusion of each is presented in Appendix C. After compilation of the scores for each parameter (or metric), all scores were totaled for an overall combined habitat score.

Scores on individual metrics and overall combined scores are presented on Table 4-8. To allow a comparison of habitat within fish survey reaches, the values for the habitat survey reaches within each fish survey reach were summed and an average was calculated for each parameter. Mean habitat scores within fish survey reaches are presented in Table 4-9. It should also be noted that habitat reaches do not exist in isolation and all parameters should be viewed in that context. For example, a reach that was 100 percent riffle could provide important habitat if nearby reaches were more complex (including pools, glides, slackwater, etc.) but lacking in riffle habitat. The numbers represented by the habitat scores are useful primarily in comparing the habitat reaches to one another and do not represent absolute stand-alone habitat values outside of this context. It should also be noted that these habitat values are calculated only for data from spring 2008 and do not allow comparisons within habitat reaches over time.

Results of Habitat Characterization

In general there were many low and moderate scores on the habitat parameters. This suggests that there are significant opportunities for restoration and room for improvement in the physical components of fish habitat within the watershed. The maximum possible score on the habitat matrix is 33. Habitat survey reaches in Rock Creek ranged from 13 to 26, and the Trillium Creek reach scored a 22 (Table 4-8). There was a clear break in scores between the Lower Rock Creek reaches (habitat reaches RC01 – RC03, which correspond to fish reaches RC01 and RC02) and the middle and upper reaches. The habitat scores of the lower reaches ranged from 20 to 26 and the upper reaches ranged from 13 to 18.

Lower Rock Creek habitat reaches RC01 – RC03 had high rankings on percent fines in riffles, percent pools, deep pools per kilometer, and percent slackwater pools; but scored poorly on the boulder metrics and to a lesser extent on the percent secondary channels (two of the three sites receiving a score of 1) and percent gravel in riffles (two of the three sites receiving a score of one). The middle reaches (RC04 through RC06) scored relatively highly on percent pools but poorly on secondary channels, boulders, and the three LWD metrics. The upper reach (RC07, corresponding to fish reach RC05) scored moderately on percent pools, and percent fines and gravels in riffles, but scored poorly on the remainder of the metrics. Trillium Creek below the barrier at RM 0.4 scored high or moderate on all metrics but deep pools per kilometer, percent secondary channels, and percent fines (silt, organics, and sand particles smaller than 2 millimeters in diameter) in riffles.

To simplify the comparison among fish reaches, Table 4-9 presents the mean habitat scores by fish reach. As can be seen, fish reach RC02 has the highest mean combined score (25), followed by RC01 (23), RC03 (17), RC04 (15.5) and RC05 (14). This correlates well with the F-IBI scores, except that RC05 has generally received higher F-IBI scores that RC04, which was not the case with its habitat scores. Trillium Creek contained only one fish and one habitat reach and achieved a combined score of 22.

Physical habitat variables have been collected too infrequently to identify trends with any degree of certainty. Some habitat variables were collected in 1997, but only summaries (rather than detailed results) are available (ODFW, 2008). It should also be noted that any direct comparison of habitat variables that are collected subjectively (for instance, the percentage of substrate as silt is visually estimated) is suspect. Therefore, small changes year to year (approximately 5 percent or less) are likely well within the sampling error. Within Rock Creek the percentage of the substrate as silt (Table 4-10) did not show any clear pattern, increasing at some sites and decreasing at others, but in 2008 the percentage of substrate as silt in all reaches was on the lower end of moderate, with the maximum amount of silt in riffles at any reach being 15 percent.

Table 4-7. Fish Habitat Criteria

Parameter	Definition	Low score (1) criteria	Moderate score (2) criteria	High score (3) criteria
Percent pools	Percent of the primary channel area represented by pool habitat	< 7 or > 90	7 to 40 and 60 to 90	> 40 and ≤ 60
Deep pools per kilometer	Number of pools greater than 1 meter deep per kilometer of the primary channel	< 2	≥ 2 and < 4	≥ 4
Percent slackwater pools	Percent of the primary channel area in slackwater pool habitat. Slackwater pools include beaver ponds, backwaters, alcoves and isolated pools.	< 0.25 or > 30	> 0.25 and < 0.5	> 0.5 to 30
Percent secondary channels	Percent of the total channel area (primary and secondary channels combined) composed of secondary channels	< 2	≥ 2 and < 4	≥ 4
Percent fines in riffles	Percent of the substrate in riffles <2 millimeter in diameter	> 20	>10 and ≤ 20	≤ 10
Percent gravel in riffles	Percent of the substrate in riffles 2 to 64 millimeter in diameter	< 20	≥ 20 and < 49	≥ 49
Pieces of LWD/100 meters	Pieces of LWD > 0.15 meters in diameter by 3 meters in length per 100 meters of channel length	< 7	≥ 7 and < 21	≥ 21
Key pieces of LWD/100 meters	Pieces of LWD > 0.06 meters in diameter by 12 meters in length per 100 meters of channel length	< 1	≥ 1 and < 3	≥ 3
Volume of LWD/100 meters	Volume (cubic meters) of wood > 0.15 meters in diameter by 3 meters in length per 100 meters of channel length	≤ 20	20 to 30	≥ 30
Large boulders/square meter	Number of large boulders per square meter of channel area	< 0.10	0.10 to 0.25	≥ 0.25
Percent shade	Percent of the 180 degrees above the stream (the sky) visible. Includes topographic an tree shade.	< 60	≥ 60 and < 70	≥ 70

Table 4-8. Fish Habitat Scores

Creek	Fish sampling reach	Habitat reach	Percent pools	Deep pools/km	Percent slackwater pools	Percent secondary channels	Percent fines in riffles	Percent gravel in riffles	Pieces of LWD/100 m	Key pieces of LWD/100 m	Volume LWD/100m	Percent shade	Large boulders/m^2	Total score
Rock	RC01	RC01	3	3	3	1	3	1	2	1	1	1	1	20
		RC02	3	3	3	3	3	1	3	2	3	1	1	26
	RC02	RC03	2	3	3	1	3	3	2	1	3	3	1	25
	RC03	RC04	2	1	1	3	1	2	1	1	1	3	1	17
	RC04	RC05	3	1	3	1	2	1	1	1	1	3	1	18
		RC06	2	2	1	1	1	1	1	1	1	1	1	13
	RC05	RC07	2	1	1	1	2	2	1	1	1	1	1	14
Trillium	TR01	TR01	2	1	3	1	1	2	2	2	3	3	2	22

Table 4-9. Mean Habitat Scores by Fish Sampling Reach				
Creek	**Fish sampling reach**	**Habitat reach**	**Total score**	**Mean score per fish reach**
Rock	RC01	RC01	20	23
		RC02	26	
	RC02	RC03	25	25
	RC03	RC04	17	17
	RC04	RC05	18	15.5
		RC06	13	
	RC05	RC07	14	14
Trillium	TR01	TR01	22	22

Table 4-10. Selected Habitat Parameters, 1997 and 2008									
Creek	**Fish sampling site**	**Percent silt**		**Percent eroding banks**		**Percent pool**		**Percent fast water**	
		1997	**2008**	**1997**	**2008**	**1997**	**2008**	**1997**	**2008**
Rock	RC01	8	6	2	4	20	47	40	53
	RC02	1	9	11	7	24	45	45	48
	RC03	0	12	0	9	14	27	47	64
	RC04	35	15	24	7	12	69	37	29
	RC05	11	11	79	6	12	35	41	51

During the same time period, the percentage of banks that were eroding decreased in the upper reaches of Rock Creek and was generally stable in the lower reaches, and the percentage of pools and the percentage of fast water increased (except in reach RC04 where the percent of fast water decreased from 37 to 29). The percent pool and percent fast water scores should be interpreted with caution, as the increases may be an artifact of the amount of flow at the time that the surveys were conducted. Habitat conditions for 1997 and 2008 were not reported for Trillium Creek.

Identification of Limiting Factors

Fish and benthic macroinvertebrate sampling surveys have provided data on where species occur within the study area. Based on preliminary findings, it appears that there are likely a number of limiting factors responsible for the low densities of native fish in the streams. Understanding the interplay between limiting factors and determining what management activities will most efficiently address limiting factors is addressed in the assessment phase (Chapter 5). In the absence of one overriding factor (for instance a point source of pollution that by itself is limiting to salmonid abundance and distribution) the reasons for the observed distributions are almost certainly a combination of multiple factors that may or may not be currently occurring or being measured.

If one or a combination of the ten habitat variables discussed above are indeed limiting to salmonid abundance and distribution in the study area, those sites with the most salmonids should rank higher on either individual habitat variables or on the entire suit of variables combined. If salmonid distribution is not related to the habitat parameter rankings, then it is likely that some other factor (temperature, toxic releases, food resources) or an interplay of factors is limiting to salmonid distribution and abundance.

Because we are using salmonids as indicator species in the study area, the following is a discussion of potential limiting factors to salmonid distribution and abundance in the study area. Because of the small amount of benthic macroinvertebrate data, identification of limiting factors is more challenging.

Fish limiting factors were preliminarily identified using the habitat scoring approach described above and the results of numerous previous studies. The assessment phase of the project addresses, specific protection, restoration, or enhancement actions will be recommended for prioritization in the Action Plan (Chapter 6).

Rock Creek

Clearly, the most important limiting factor for anadromous salmonid use of the Rock Creek watershed is the impassible falls at RM 1.2. Below the falls (Fish Reaches RC01 and RC02), anadromous salmonids are present year-round, which indicates that conditions are at least being met for survival of juvenile salmonids. It is unlikely however that this section of the creek is providing optimal conditions since it appears that it ranks low on several important physical habitat indicators discussed previously. The assessment phase of this study looks at a wider variety of potential limiting factors including temperature, flow conditions (both winter and summer), potential for toxic contaminants (e.g., pesticides), predators, spawning substrate, etc. for this reach of the creek.

Perhaps the more challenging work for this project is in determining the key limiting factors for resident cutthroat trout in the reaches of stream above the impassible falls. As described above, fish surveys indicate very low numbers of resident cutthroat trout in all areas sampled upstream of the falls.

Based on preliminary findings, it appears that there are likely a number of factors responsible of the low densities of trout. In fish reach RC03, the stream is constrained in a narrow, steep-sided canyon that appears to have adequate shade conditions. However, LWD is lacking as are deep pools with complex habitat that could provide refuge habitat during the winter high flow events. In a number of places in this reach, the streambed has been scoured down to bedrock and it is likely that bedload movement during high flow events could preclude cutthroat trout from seeking winter shelter in the substrate as they have been shown to do in other creek systems.

Due to the steep-sided canyon, the opportunity for development of off-channel winter habitat in this reach is limited. Fish that enter this reach may simply be flushed out during winter high flow events. Other factors such as high summer water temperature, lack of suitable spawning habitat in both the mainstem and tributaries and contaminants such as pesticides for agricultural areas and residential uses may also be limiting cutthroat trout production is this reach. These potential limiting factors are addressed in more detail in the assessment phase of the project (Chapter 5).

In Fish Reach RC04, which is located in the mid-section of the watershed, the stream gradient is lower and the stream is fed by many small, mostly intermittent tributaries. This area has the poorest riparian cover and has relatively high fine sediment loads and content in the substrate. Poor riparian cover probably translates to poor water temperature conditions. Water temperature data for this reach have been collected but were not available for analysis at the time this report was prepared. Effects of water temperature will be examined during the assessment phase. Access to off-channel habitat should be adequate in this reach during the winter due to the many small tributaries feeding the reach. This reach also ranked very low on the presence of LWD and percent gravel in the substrate. These are also important habitat components that could limit the abundance of cutthroat trout.

Fish Reach RC05 has many of the same problems as RC04. The channel is smaller in this reach and the gradient is somewhat higher in the upper section above Southeast Foster Road. Poor substrate for spawning, summer water temperature, low summer flows and lack of adequate channel complexity are probably important limiting factors in this reach.

Trillium Creek

Trillium Creek F-IBI scores and B-IBI scores show moderate impairment, and the habitat rankings indicate that moderately favorable habitat is present in lower Trillium Creek. It scores high on percent shade, percent slackwater pools, and the volume of LWD, and moderately on many of the other habitat variables, which indicate that the habitat is fairly complex and cover may be adequate. Trillium Creek lacks deep pools (which may limit cold water refugia) and secondary channels (which reduces habitat complexity but may be offset by the availability of slackwater pools), and sedimentation may be a problem, as it received a low score on the percent of fines in riffles metric. Taken as a whole, the data suggest that while there is room for improvement in Trillium Creek, it may be a lower priority than other reaches in the watershed for restoration, due to these current conditions and the low system barrier. However, it may be a higher priority for protection to maintain existing conditions. Temperature data on Trillium Creek is lacking.

Previous Findings

Previous investigators have made initial attempts to identify limiting factors, and have made some recommendations. In regard to Rock Creek (and other streams as noted), Neerman and Vogt (2008), stated the following:

> “Actions taken to protect native fish communities should focus on a continued mix of restoration and protection on urban stream reaches. Lower reaches directly connected to the Clackamas River are of particular importance for salmonid spawning and rearing in that basin. Cow, Carli, Sieben, and Rock Creeks all contained some degree of juvenile salmonid use in the lower reaches entering the Clackamas River. Upper sections of Cow, Sieben, and Rock Creek are at various stages of degradation due to conflicting management practices, development, and land-use.”

These findings were based on general observations rather than any rigorous analysis.

Lemke and Cole (2008) conducted multiple correlation analyses between physical habitat variables and B-IBI scores. Among water quality variables, they found statistically significant correlations between riffle B-IBI scores and water temperature, conductivity, specific conductance (all negatively correlated) and DO (positively correlated). Among the habitat variables, there were statistically significant correlations between riffle B-IBI scores and reach gradient, riparian buffer width, percent coarse substrate (all positively correlated) and percent of the sample reach as glide, percent eroding banks, percent undercut banks, and percent fine substrate (all negatively correlated). Based on their analysis, they stated the following:

> “Results of the correlation analyses suggest that temperature and substrate may be playing an important role in mediating macroinvertebrate community condition in area streams. In addition to focused riparian zone improvements, any land use or infrastructural improvements (Structural and Non-structural Source Controls, Low Impact Development and other Best Management Practices (BMPs) to preserve native soils and vegetation, reduce impervious footprint, stormwater retention ponds with enhanced water quality treatment attributes, and using pervious surfaces, etc.) that can be implemented to reduce stormwater surface runoff and improve low-flow conditions. These hydrologic improvements would certainly benefit the physical instream environment to which benthic communities respond.”

Riparian Vegetation

Riparian vegetation plays important roles in the maintenance of salmonid habitat in streams. It helps maintain water temperatures by providing shade during summer and early fall, it provides a source of LWD to the stream channel that promotes channel complexity and it acts as a filter to remove contaminants and absorb runoff from surrounding areas. As stated above, it is likely that Rock Creek suffers from elevated summer temperatures. High summer water temperatures in streams are typically related to low summer flows, aspect of the stream channel to incident solar radiation and amount of canopy cover (shade).

Data for characterization of the riparian cover along stream channels in the RC watershed are available in a 2007 Metro land cover data base as well as site-specific information for habitat reaches surveyed by ODFW during spring 2008 (Neerman and Vogt, 2008). Additional data sources include stream surveys conducted by Ellis Ecological Services, Inc. (EES) in summer 2007 and a riparian shade analysis conducted by Leferink (2007). Each of these studies is described below.

The Metro data categorize land cover based on the structure of the vegetation into percent high (trees) and low (brush and grass) vegetation, percent scarified (urbanized) and percent waterbodies. These data can be manipulated in numerous ways to examine the existing condition of the riparian vegetation. WES performed analysis in GIS to determine the percentage of the riparian corridor within 25 and 100 feet of either side of the stream channel that is in each land cover classification. Areas with high structure vegetation (trees) are considered to be intact buffers.

Figure 4-4 shows the location of mainstem and tributary reaches with 0 to 33 percent, 34 to 66 percent and 67 to 100 percent intact buffers within 25 feet on either side of the stream channels. A similar figure could be generated for the 100-foot buffer width. Note that areas with low intactness are primarily located in small tributary and headwater areas although there are a few sections on the upper mainstem of Rock Creek with moderate intactness.

Figure 4-5 provides an example of how the Metro structure data can be used to show the percent of trees (high structure vegetation) within the intact buffer zones. Note that much of the buffer along the Rock and Trillium Creek mainstems has a relatively high percentage of trees. Where trees are present along small streams such as Rock and Trillium Creeks, shading would be expected to be relatively good. Rock Creek has a low percentage of channels with poor riparian buffers. Figure 4-6 depicts the 25-foot buffers that are less than 33 percent intact and shows the percentage of low structure (shrub) vegetation in those areas. This provides an indication of the lowest quality riparian buffers in the watershed. These areas are widely scattered, generally on smaller tributaries, but any of these tributaries that flow during the summer would likely be adding warm water the mainstem reaches.

In the summer of 2007, EES completed 45 survey transects on Rock Creek and its tributaries. Stream surveys of individual locations included measurements of average bankfull width, bankfull depth, floodplain width and likely fish presence. Notation was made of tree size, density, shade, and canopy height. Substrate type, the general setting of the stream, and the riparian recruitment situation were also noted. Invasive plants, areas of severe bank erosion, and areas that should be protected or have the potential for restoration were identified and described.

In addition to the Metro and EES data, Leferink (2007) completed a detailed analysis of riparian shade in the RC watershed and ranked restoration priority areas. In completing the analysis, riparian shade levels were characterized using remotely sensed data. The data were then ground-truthed and corrections were made. Highly shaded areas and areas that were piped or had intermittent flow were excluded from the prioritization analysis because they would not be contributing high-temperature water during summer low flow conditions. A total of 60.5 kilometers of stream were assessed in the watershed, of which 48 percent (29 kilometers) were greater than 70 percent shaded. An additional 6.8 kilometers were excluded from further analysis because they were intermittent or piped. The remaining 24.7 kilometers of stream were prioritized for restoration based on their degree of shading combined with their aspect (direction of flow as a measure of the potential thermal loading).

We have included two figures from the Leferink (2007) report. Figure 4-7 depicts the shade priority rank from I to V (highest to lowest priority). Figure 4-8 depicts high priority restoration areas based on their current degree of shading and their aspect. A total of 4.1 stream kilometers were assigned the highest priority rank for restoration, but the author states, "the ultimate selection of restoration sites will need to incorporate additional factors including wildlife habitat needs, land use plans and landowner cooperation." The methods utilized and analyses conducted by Leferink are reasonable and thorough. However, some of the identified locations may have been restored since the Leferink report, or other areas may have been degraded. Therefore, additional investigation of shading, fish presence, and temperature data is required before final conclusions regarding riparian condition and restoration priorities can be reached.

Fish Passage Barriers

Adults of both anadromous and resident salmonids in the RC watershed require barrier-free access to suitable spawning and rearing habitat. Although poorly studied, it is also likely that unobstructed access to tributaries may be important in allowing access to refuge habitat during winter high flow events.

Data on the presence of human-made and natural barriers to fish passage were found in StreamNet data files, lists of culverts in Clackamas County identified as partial or complete barriers, and ODFW's lists of partial and complete barriers.

The Rock Creek falls at RM 1.2 represent a complete natural barrier to upstream migration. These falls preclude the use of upper Rock Creek by anadromous salmonids. A second complete barrier, Haberlach Dam, is present on Trillium Creek at approximately RM 0.4. A large impoundment is present in a housing development behind the dam and may contribute to high summer temperatures. Streamnet identifies three unnamed culverts on the mainstem of Rock Creek (see Figure 4-9) as fish barriers, but these culverts are significantly upstream of the farthest upstream fish sampling reach.

Neerman and Vogt (2008) state, "Rock Creek Reach 4 has two significant artificial dams, one shortly above Sunnyside Road and the other at Pleasant Valley Golf Course." The nature of these dams and their degree of blockage is unknown at this time. During the 2007 site surveys, EES made note of culverts and other potential fish barriers, and this information too is still needed.

Clackamas County lists nine culverts for replacement in the RC watershed (Figure 4-9). These culverts may present partial or full barriers to resident cutthroat trout, and may prevent them from fully utilizing habitat that otherwise may be suitable. One of the culverts is located on the Rock Creek mainstem at the Troge Road crossing, while the remainder are located on minor tributaries. Although Figure 4-9 does not show the long box culvert on Rock Creek at Sunnyside Road, this should likely be listed as a partial barrier. Clackamas County Department of Transportation and Development (DTD) is expanding Sunnyside Road in this area and a new bridge crossing is planned, however the plans for the existing box culvert are not known at this time.

Prioritization for replacement of these culverts will require additional site-specific information on the condition of the culverts and the species and life stages affected, if any. In some cases, Clackamas County's list of culverts for replacement provides a priority rating of low or high. Of the nine culverts, eight were rated as low priority and the remaining culvert was unrated. The county's rating system takes into account both the potential biological benefits and the cost and logistics of replacement. ODFW also has a list of culverts identified for replacement and provides priority ratings for those identified. None of the culverts in the RC watershed are identified as high priority for removal.

Potential Future Risks

As described earlier, the RC watershed is located at the edge of the currently planned Portland regional urban expansion in the Cities of Happy Valley and Damascus. Development pressures are likely to result in large portions of the watershed becoming urbanized in the next several decades, which poses potential future risks to aquatic habitat, biological communities, and other elements of watershed health. Many of the same issues addressed in Chapters 2 and 3 related to potential changes in hydrology and water quality could affect aquatic habitat and biological communities. Design standards, regulations, land use policies and sustainable practices will play a significant role in determining the impact that development has on the watershed.

As discussed in Chapter 1, the elements of watershed health (hydrology, water quality, aquatic habitat, and biological communities) often contain interrelated problems and integrated opportunities for improvement. Further work in the watershed assessment phase of the project was completed to evaluate interrelated issues and to identify priority actions and management activities appropriate for WES to undertake to address factors that are limiting watershed health. The identification of specific stream reaches for protection measures on a reach by reach basis required a synthesis of all the available information in the watershed assessment phase, and is available in Chapters 5 and 6.

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Figures 4-1 to 4-9

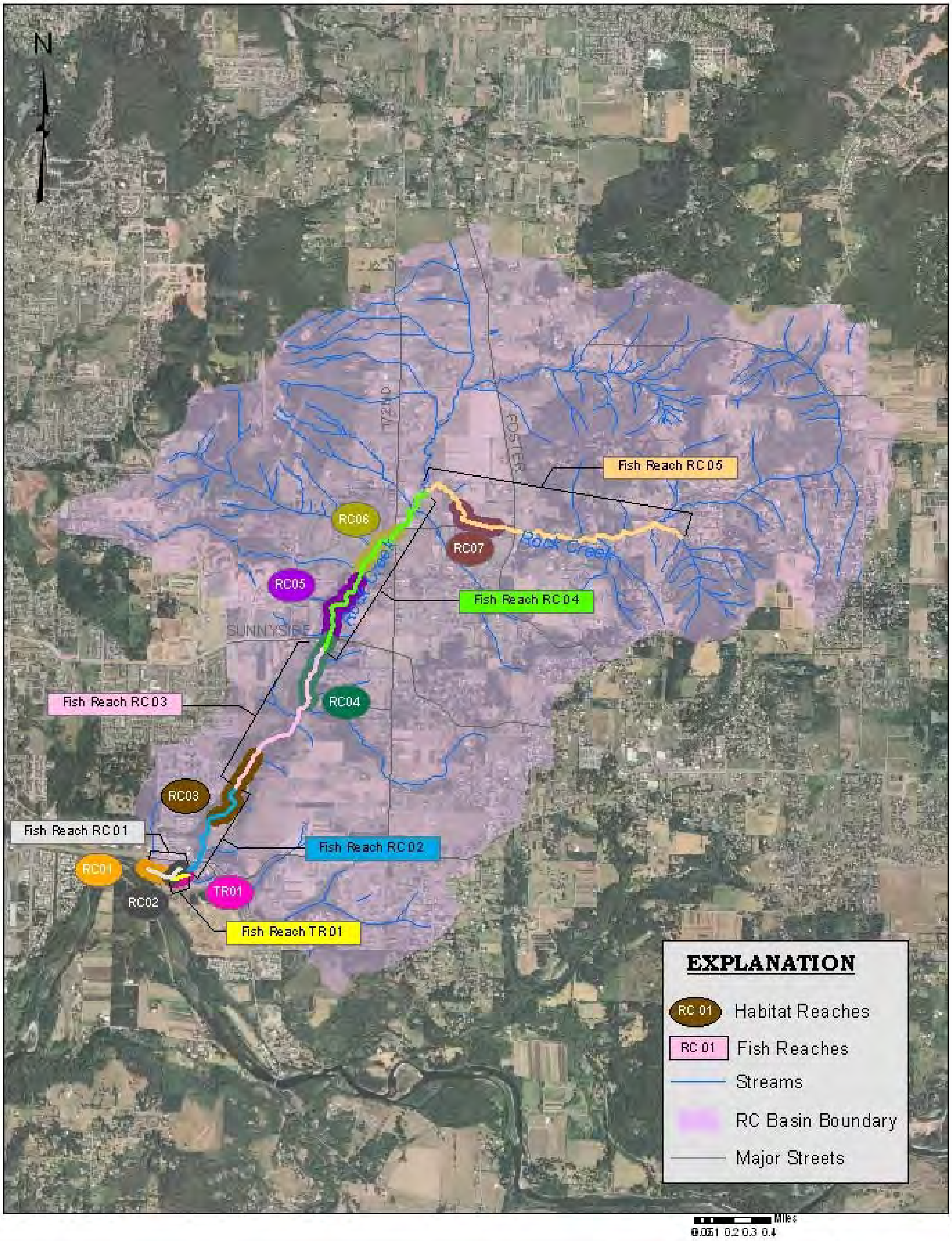

Figure 4-1
Rock Creek Habitat and Fish Study Reaches
WES WATERSHED ACTION PLAN

Water Environment Services

Brown and Caldwell

Swanson Hydrology + Geomorphology

Ellis Ecological Services, Inc.

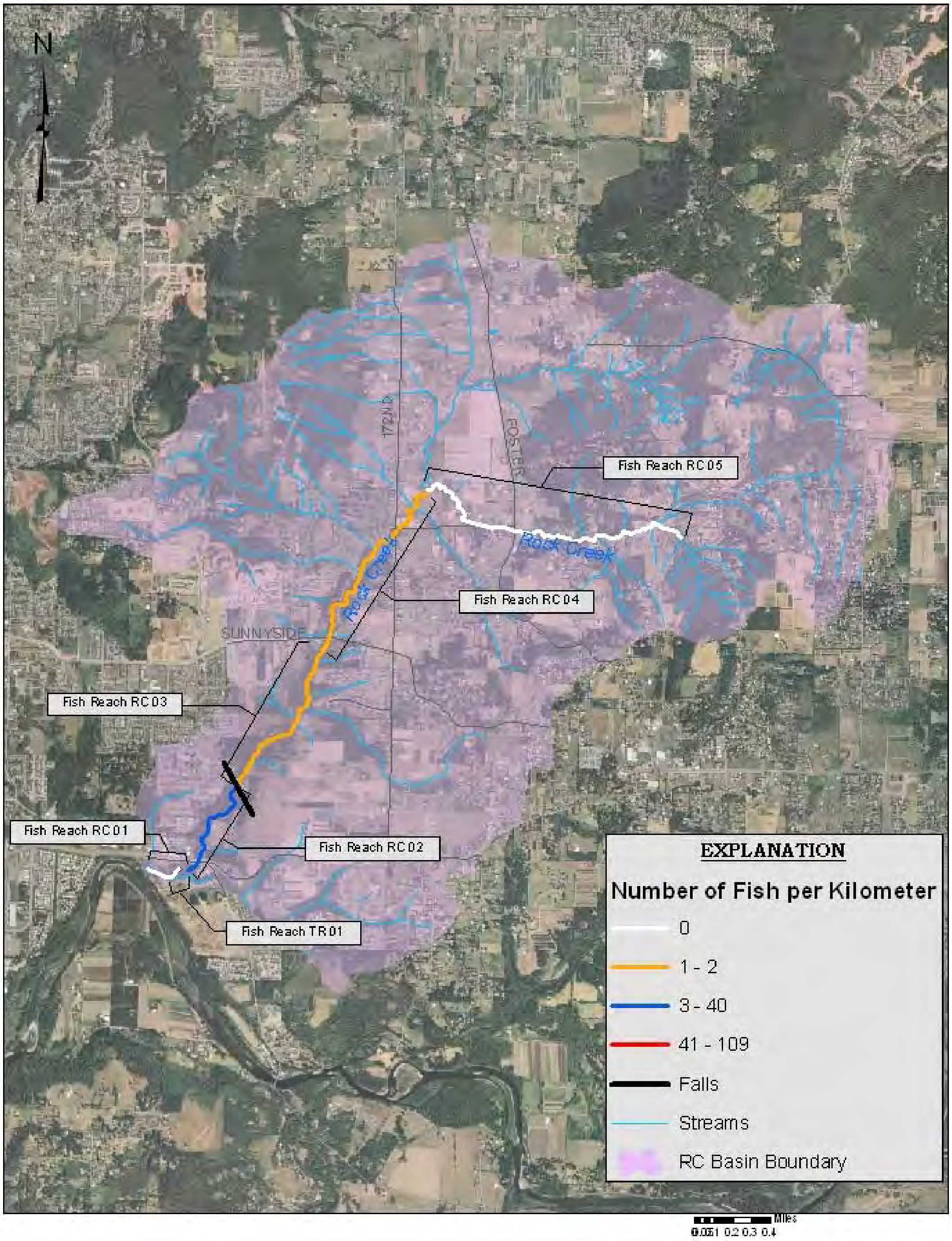

Figure 4-2
Relative Salmonid Abundance
WES WATERSHED ACTION PLAN

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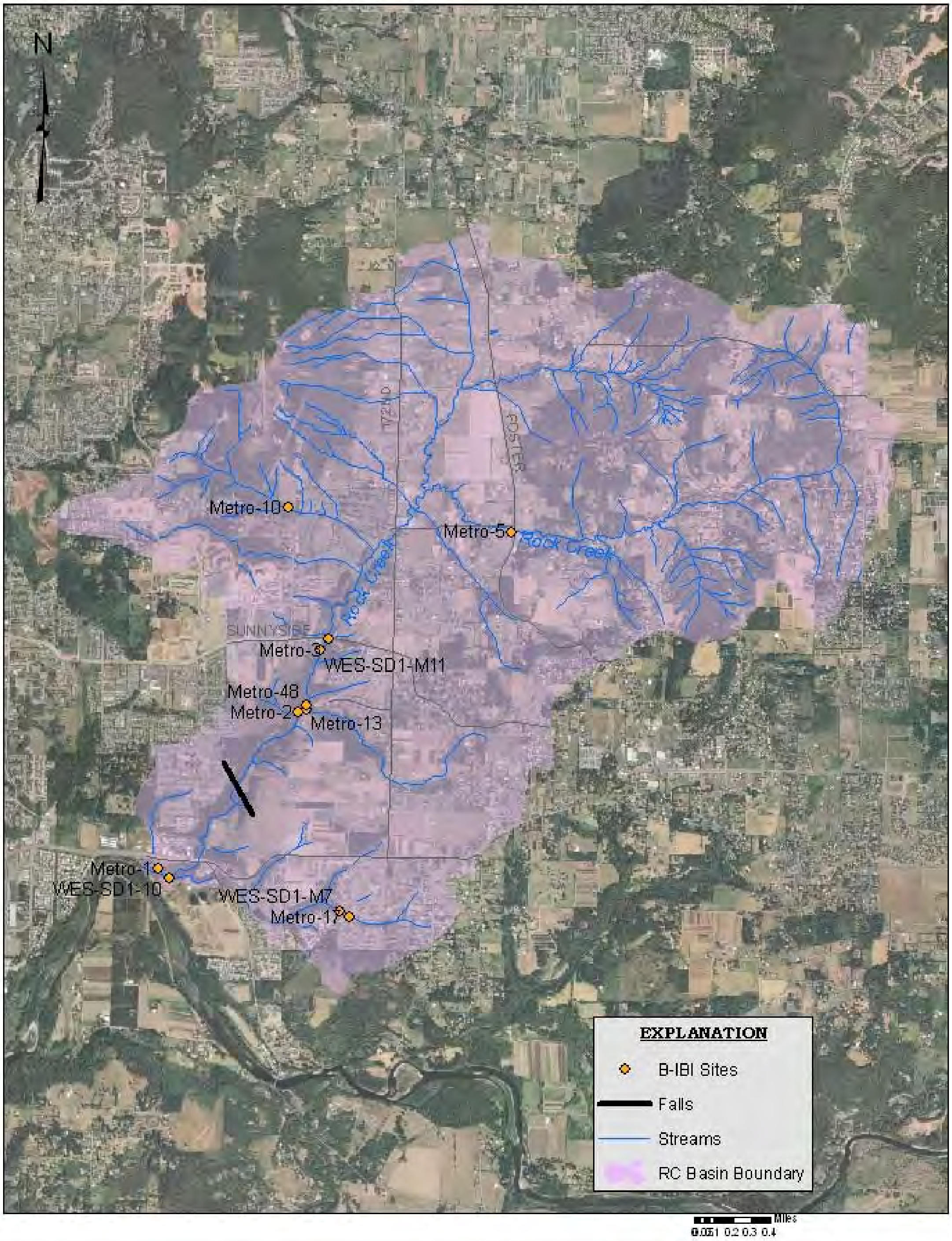

Figure 4-3
Macroinvertebrate Survey Sites Within Riffle Habitats
WES WATERSHED ACTION PLAN

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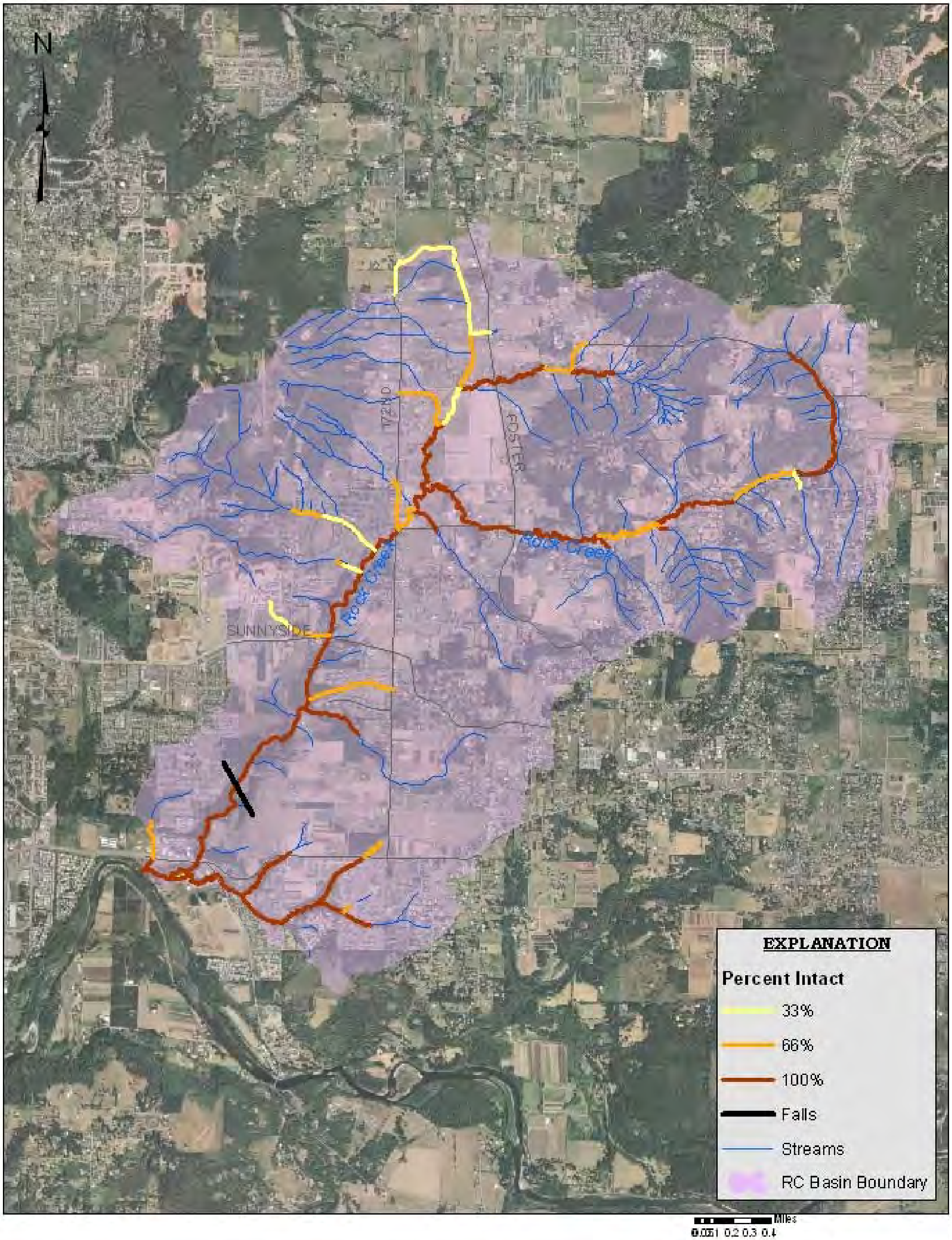

Figure 4-4
Relative Integrity of 25 ft Riparian Buffers
WES WATERSHED ACTION PLAN

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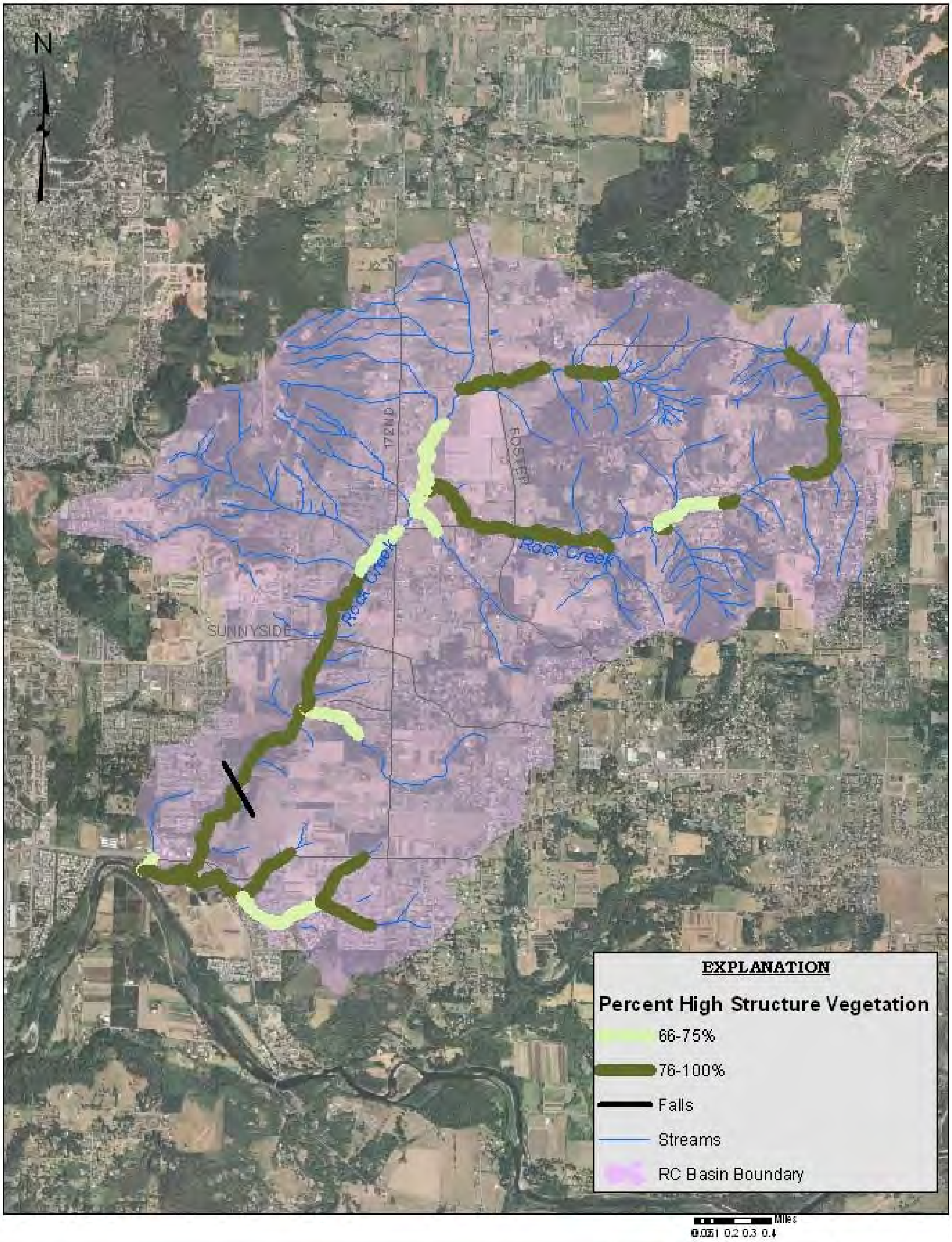

Figure 4-5
Composition of the 100 Percent Intact 25ft Riparian Buffers
WES WATERSHED ACTION PLAN

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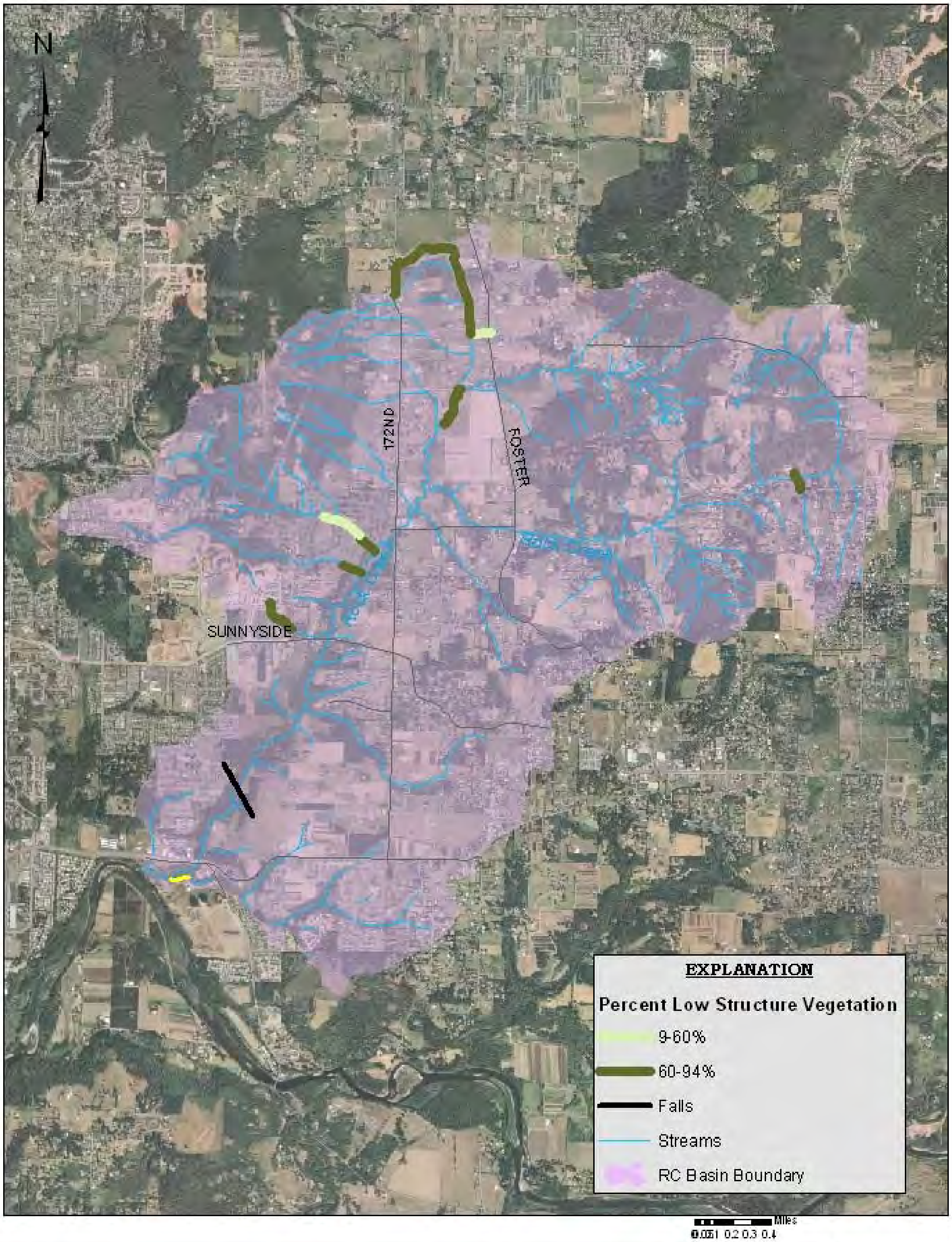

Figure 4-6
Composition of the 33 Percent Intact 25ft Riparian Buffers
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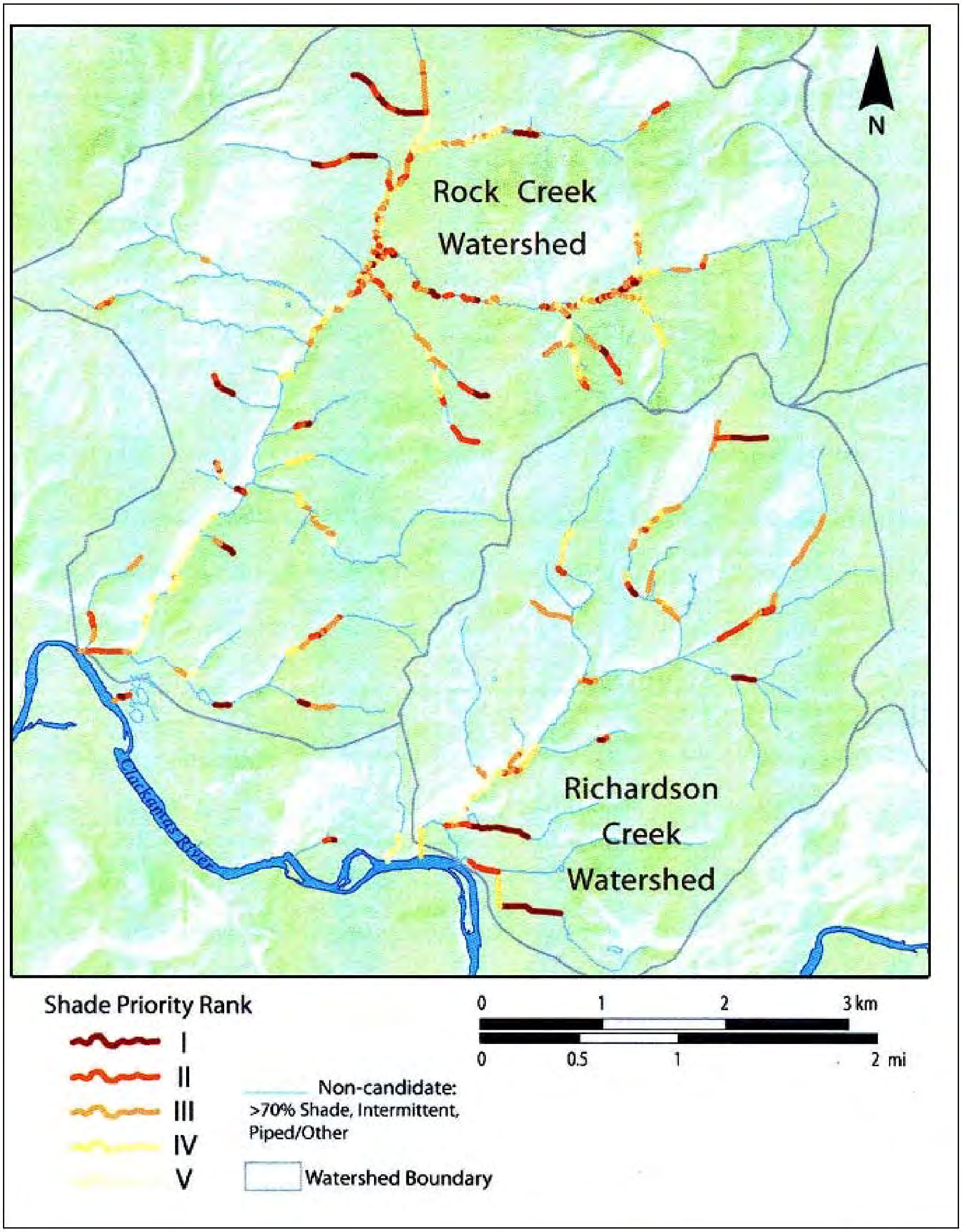

Figure 4-7
Shade Restoration Priority Classification (Leferink 2007)
WES WATERSHED ACTION PLAN

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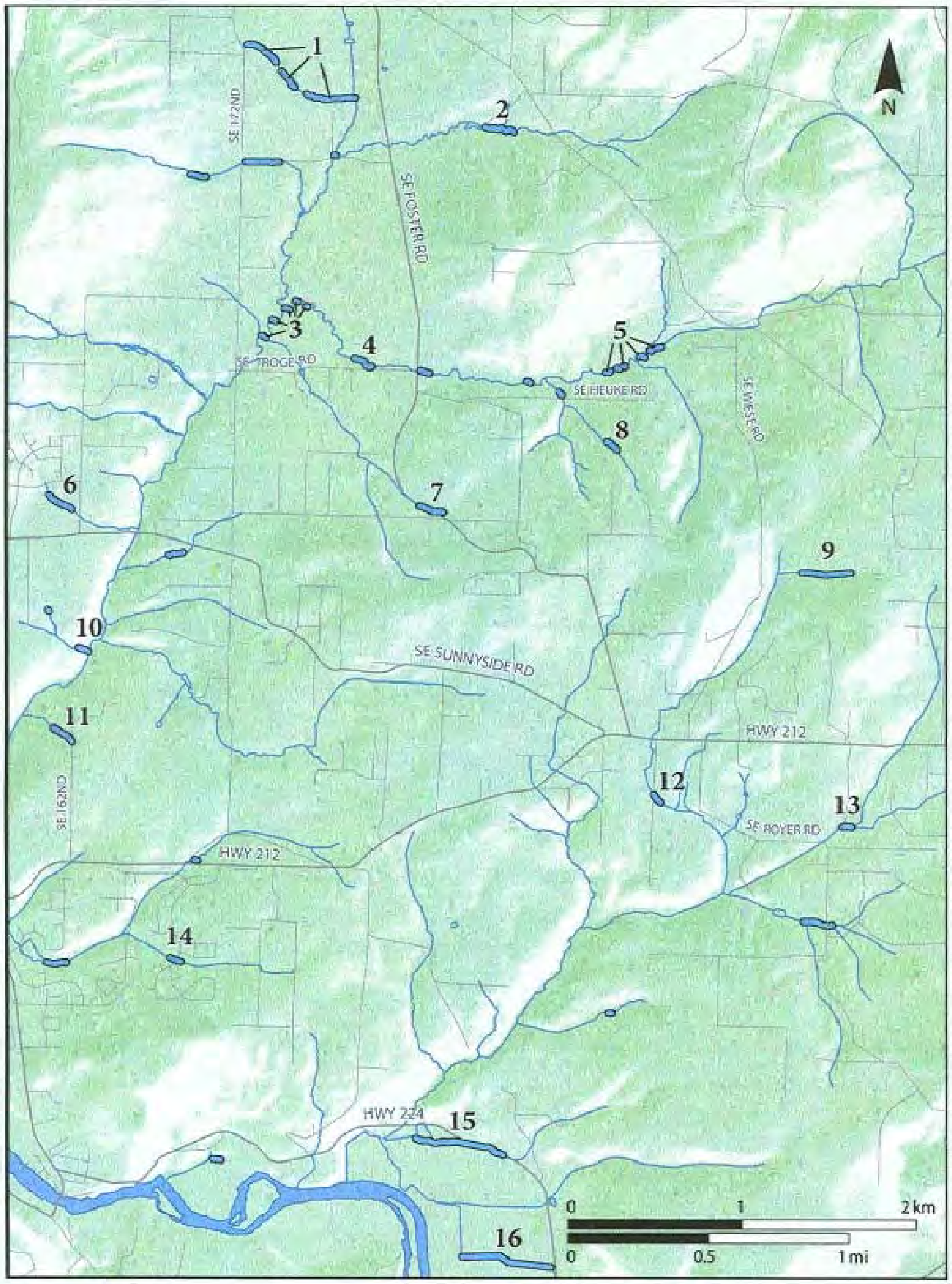

Figure 4-8
Priority Shade Restoration Areas (Leferink 2007)
WES WATERSHED ACTION PLAN

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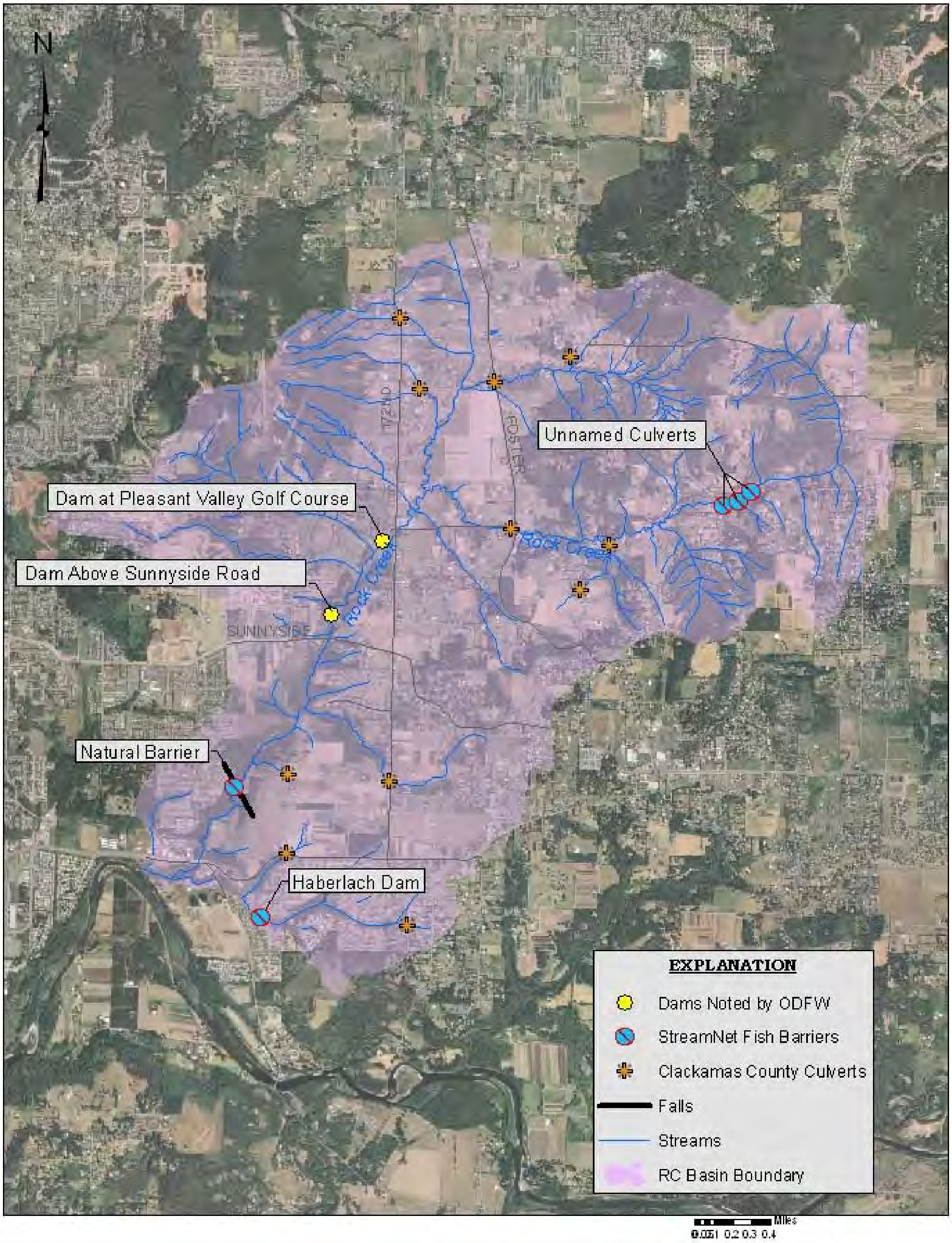


Figure 4-9
Potential Fish Barriers
WES WATERSHED ACTION PLAN

Water Environment Services

BROWN AND CALDWELL

Swanson Hydrology + Geomorphology

Ellis Ecological Services, Inc.

CHAPTER 5 – WATERSHED ASSESSMENT AND RECOMMENDED MANAGEMENT STRATEGIES

Overview

As discussed in Chapter 1, the Rock Creek (RC) Watershed Action Plan (Action Plan) includes a Characterization Report, Assessment Report, and an Action Plan summary. Chapters 1 to 4 comprise the Characterization Report, an inventory of existing information about the watershed conditions and Water Environment Services (WES) activities. This chapter is the Assessment Report. Chapter 6 summarizes the Action Plan.

The Assessment Report includes an assessment of watershed conditions based on the Characterization Report results and identifies WES surface water programs, projects, and activities that could efficiently and effectively improve watershed health. The Assessment Report begins with a summary of watershed-wide issues and opportunities to enhance watershed health. Input provided by the Stakeholder Group on watershed enhancement actions is then summarized. Following this, the Assessment Report includes a reach-by-reach analysis of factors limiting watershed health. Within the reach analysis, recommended management strategies and potential actions to enhance watershed conditions in specific stream reaches and contributing areas to reaches are described. Recommended early action projects to pursue to enhance watershed health during early 2010 are summarized at the end of the chapter.

In Chapter 6, the potential actions described in the Assessment Report are analyzed further and organized into near-term actions and longer-term actions based on feasibility, expected impact, urgency, and other factors. Near-term actions will be described in greater detail to identify implementation steps and planning-level cost estimates, then prioritized using an asset management Level of Service (LOS)-based evaluation process. Specific programs, projects, and activities will then be sequenced for implementation.

Watershed Analysis

The RC watershed as a whole has not yet been heavily developed for urban uses, although it contains urbanized land in its western drainages and urbanized areas are expected to continue to grow significantly in the future within both the Cities of Happy Valley and Damascus. The watershed is depicted in Figure 5-1 with aerial photographs as the background.

The 2007 Metro aerial photography land cover analysis indicates that approximately 40 percent of the watershed contains tree canopy, 47 percent of the watershed is vegetated with grass, shrubs, or agricultural vegetation, and 13 percent of the watershed is comprised of built or scarified areas which includes buildings, pavement, and some compacted or dry exposed soil areas.

The land use in the watershed is currently classified as 29 percent residential and rural residential, 19 percent farmland, 18 percent forest land, and 30 percent tract land or undefined land use in the County Tax Assessor data. Tract land includes institutional land uses such as schools and parks as well as undeveloped parcels. All of the land use classifications in the RC watershed include both developed land uses and vacant land uses that fall into these categories. In addition, due to the large sizes of rural residential parcels and tract land in the watershed, these land uses are currently less densely developed than similar land use classifications may be in other more developed watersheds in Clackamas County Service District No. 1. As much as 60 percent of the watershed may still be available for further development based on the buildable lands assessment conducted by WES; however the estimate of buildable lands available may change in the future as land use planning in Damascus proceeds. Approximately 2 percent of watershed is currently treated with structural Best Management Practices (BMPs) such as detention ponds and swales.

Based on the results of the Characterization Report, key stressors in the watershed include the following:

- Loss of infiltration of rainwater and efficient delivery of runoff to streams due to removal of tree canopy and other native vegetation in areas with poor soils, tiling and ditching of agricultural fields, and addition of impervious surfaces
- Loss of tree canopy and other native vegetation in riparian corridors and uplands
- Untreated runoff from agricultural areas, older residential areas, and impervious surfaces such as roads

In addition to these key stressors identified in the Characterization Report, there may be other key stressors affecting watershed health that are not fully understood due to data gaps. Examples of other potential stressors include channel modifications, habitat conditions, water withdrawals, pollutant loadings, and loss of groundwater input to streams. Further data collection and analysis of these potential stressors would be valuable.

Key risks to future watershed health include additional hydrologic and water quality impacts from urbanization if development impacts are not properly mitigated, and erosion when steeper slopes or sensitive soils are altered or developed.

Key responses to these stressors in the watershed include the following:

- Increased flow volume and duration during storm events
- Channel instability including bank erosion and channel widening
- Flooding affecting infrastructure
- Lower flow during summer
- Streams exceeding water quality standards for temperature and bacteria as well as other pollutants
- Reduction in populations of sensitive aquatic species
- Increase in populations of aquatic species tolerant of poor water quality conditions and habitat
- Reduction in quality of aquatic habitat through fine sediment accumulation and loss of in-stream structure such as deep pool habitat and large woody debris (LWD)
- Increase in non-native invasive species

Watershed-wide opportunities to address these stressors and responses are described below, along with opportunities to fill data gaps to better understand watershed health and guide future management activities. The Reach Assessment section further describes locations of reach-specific issues and opportunities to address those issues. Early Action Items recommended to address watershed-wide opportunities and reach-specific opportunities are summarized following the Reach Assessment.

Hydrology Issues and Opportunities

The hydrology of the RC watershed has been altered from pre-development conditions due to removal of forest canopy, conversion of wetland and floodplain areas to other land uses, ditching and tiling of fields for agriculture, the addition of roads and housing developments, and other rural development. As a result of these changes as well as the nature of the watershed conditions (including relatively poorly infiltrating soils and steep slopes in some areas), hydrologic modeling indicates that the RC streams already exhibit the "flashy" conditions of higher peak flows over longer durations during storm events which are typically characteristic of urbanized watersheds, despite the relatively low proportion of impervious surfaces in the watershed.

The effects of hydrologic changes on stream channels are known as hydromodification. Although changes in hydrology have occurred in the RC watershed, the hydrologic changes have occurred more gradually than in a fully developed urban watershed. Thus it is likely that existing channel change and incision has been driven more by direct modification of the stream channel and modification of the floodplain rather than through modifications to the hydrology. However, hydromodification impacts could increase dramatically in the future as the watershed is urbanized further unless mitigation of new impervious surfaces is effective at maintaining a hydrologic equilibrium with current conditions.

Currently, the RC watershed is approximately 7 to 13 percent impervious based on WES and Metro land cover analysis of 2007 aerial photos. Although the actual imperviousness of the watershed will likely increase in the future due to significant new development in the watershed, over time the directly connected, or "effective" imperviousness of the watershed can be reduced through retrofitting existing impervious areas and applying low impact development (LID) and sustainable development techniques to new development.

The City of Damascus is undertaking a Stormwater Master Planning effort that is focused on protecting and enhancing ecosystem services. Through this effort, Damascus is developing land use plans and policies that are intended to reduce the hydrologic impacts of future urbanization in a large portion of the RC watershed. The City of Happy Valley implements WES design standards to reduce the hydrologic impacts of urbanization.

Key issues related to hydrology in the RC watershed include the following:

- Mitigation of the hydrologic impacts of future urbanization will be required to minimize hydromodification, flooding, and erosion of stream beds and banks.

  Due to its location on the urban-rural boundary and the presence of easily developable land in the expanded urban growth boundary areas in Happy Valley and Damascus, the watershed will undergo increased urbanization pressures over the next several decades. Despite historic changes to hydrologic conditions in the watershed associated with conversion from forest to farm, the conversion to urban conditions is likely to have an even more profound effect on the hydrology, channel conditions, and watershed health unless proactive actions and sustainable measures are taken to protect the watershed and its functions.

  The results of hydrologic modeling suggest that future urbanization has the potential to result in a three-fold increase in stream flow during 2-year recurrence interval storm events along the mainstem channels of Rock Creek. Although flooding is currently not a major concern in most of the watershed, it could increasingly become an issue as development proceeds. Although current design standards for stormwater are intended to reduce the hydrologic impacts associated with new development, future development may modify the timing, volume, and duration of water delivered to stream channels.

  As a result, it will be necessary to provide hydrologic controls to mimic current flow conditions for larger storms as well as smaller storms. The location of local and regional hydrologic control facilities (e.g., on-site and off-site LID features and detention basins) will be determined based on land use planning and stormwater master planning efforts in Damascus, existing land use plans for Happy Valley, and the implementation of design standards and regulations during the development process.

  If the potential hydrologic changes in the watershed are not adequately minimized, there is risk associated with the corresponding potential morphologic responses of the stream channels. Geomorphically, it is difficult to evaluate how channels will respond to modifications of the hydrology. As described further in Chapter 2, a preliminary assessment of the Oregon Department of Fish and Wildlife (ODFW) dataset suggests that bank erosion could be the biggest concern under future conditions, specifically in the upper portion of the Rock Creek canyon, downstream of Southeast Sunnyside Road, and the portion of Rock Creek that runs adjacent to Troge Road.

- Limited hydrologic and geomorphic data are currently being collected.

  Limited hydrologic and geomorphic data are available to assist in evaluating historical, current, and future watershed conditions and potential risks. Long-term stream gauge records are not available for the watershed and data vital to evaluating channel morphology, such as repeat cross-sections, bank erosion surveys, or bed substrate data, are not available. The existing stream gauge records have not been managed actively through a quality assurance/quality control process and an in-depth analysis of the records should be conducted in the future.

  Relatively little is known about the conditions of the upper tributaries to the stream system and these areas may be prone to instability if future development does not adequately protect drainage areas and mitigate runoff. The 2008 ODFW habitat survey has a limited spatial extent in comparison to the extension network of channels that exist in the watershed. The ODFW survey focuses on channels in the watershed that have the potential to support salmonids, with a significant portion of the mainstem channel being omitted due to landowner permission access constraints. Unfortunately it is often the smaller, steeper headwater channels that are at the most risk when a watershed converts from rural to urban land uses. The lack of a comprehensive channel conditions assessment and dataset for these smaller headwater channels is a constraint for analysis of the watershed and limits the ability to track changing conditions over time.

- The hydrologic model of the watershed is a valuable tool that can be further enhanced and used for continued analysis.

  As discussed in Chapter 2, it appears that the predicted flows under pre-development forested conditions may be underestimated significantly in the current hydrologic model. The model could be calibrated to better predict historic conditions in the RC watershed. To improve or increase the accuracy of the existing hydrologic modeling runoff rates for a pre-development, forested condition, reference data from a forested watershed could be used, constituting a reference condition. It may also be possible to locate peak flow data for a watershed of similar natural characteristics that is currently forested. Alternatively, the model could be calibrated using U.S. Geological Survey regional regression equations for forested conditions, similar to the process used by Pacific Water Resources for the existing conditions model.

  Flow data from continuous gauges on Rock Creek have been collected for over 8 years and could be used for further calibration of the model to existing conditions. With these enhancements, the hydrologic model can continue to be used in the future to further evaluate the potential impacts associated with scenarios for development and stormwater management.

- Areas where the stream channel, riparian buffer, floodplain, and wetlands have been modified could be improved through active restoration with the cooperation of willing private landowners in partnership with other agencies and nonprofit watershed restoration and environmental groups.

  There may be opportunities to work in collaboration with nonprofits, the Cities of Happy Valley and Damascus, ODFW, the Clackamas County Soil and Water Conservation District (CCSWCD), and other potential partners to undertake active restoration of degraded stream channels, buffer areas, floodplains, and wetlands on private lands with cooperating landowners. Restoration of these areas has the potential to improve hydrologic and geomorphic functions in the watershed while also improving water quality and habitat.

  The City of Damascus is exploring the incorporation of policies and programs to protect and enhance ecosystem services through its Stormwater Master Planning process. These policies and programs could result in additional mechanisms and tools for working with private landowners to improve riparian and wetland conditions as development occurs in the watershed.

Potential Actions

An active management strategy to maintain hydrologic conditions in the RC watershed is recommended for watershed health. Appropriate WES management activities to manage hydrology in the RC watershed include working collaboratively with the Cities of Happy Valley and Damascus as well as the Clackamas County Department of Transportation and Development (DTD) to implement enhanced design standards, regulations, land use policies, and sustainable practices that will maintain current hydrologic conditions matching both peaks and duration for small and large storms. This recommendation addresses risk factors proactively and is consistent with the 2006 Surface Water Management Program Master Plan. The 2006 Master Plan discussed the goal of sizing detention ponds using a flow duration design standard for storm events ranging from half the 2-year through a 10-year event.

Additional management activities appropriate for WES to undertake include working with Happy Valley, Damascus, CCSWCD, and DTD to fill data gaps on hydrologic and geomorphic conditions in the watershed, carefully minimizing construction-related erosion and buffer impacts during future development, and participating in targeted restoration activities with willing landowners and other partners.

The following potential actions will support this management strategy:

- Update stormwater design standards to promote LID techniques for new and re-development areas, and implement hydrologic control of runoff from small and large storm events for new development as well as re-development.
- Ensure that the replacement of structures (e.g., road culverts and bridges) at upstream locations does not change the high flow conditions downstream (or appropriately mitigate for such impacts) and address the potential for channel migration during structure replacement.
- Enhance the hydrologic model of the watershed through calibration to better predict historic conditions and match existing conditions; consider using the enhanced model to evaluate potential future development scenarios as planning in Damascus proceeds.
- Conduct an in-depth analysis and quality check of existing stream gauge data.
- Expand hydrologic and geomorphic data collection and analysis in the mainstem and upper tributaries. Conduct channel modification mapping, bank and channel stability and streambed analysis, and implement cross-section monitoring stations as described in Chapter 2.
- Implement strong Erosion Prevention and Sediment Control practices in areas at high risk for erosion based on steep slopes and erodible soils, including conducting frequent high priority site inspections and periodically reviewing site inspection data to continually improve process.
- Continue to track flood issues and complaints related to WES infrastructure. Evaluate opportunities to assist DTD in addressing other flooding issues as appropriate in support of overall watershed health.
- Maintain, and where possible improve, the riparian buffer conditions adjacent to stream channels.
- Maintain, and where possible increase, the upland tree canopy and native vegetation in the watershed.
- Where feasible, provide additional off-channel flood storage and enhanced wetlands with connections to streams.
- Where feasible, improve in-stream habitat using designs appropriate for the current flow regime.

Water Quality Issues and Opportunities

Water quality in the RC watershed has been affected by changes in land cover and hydrology as well as through the transmission of pollutants to the streams. The loss of riparian buffer vegetation, particularly in the upper portions of the watershed, has likely resulted in degraded water quality including increased stream temperatures. Untreated runoff from agricultural areas, roads, and older residential development may also contribute to degraded water quality.

As illustrated in Figure 5-1, although the new development in the Happy Valley area is treated with structural water quality BMPs, most of the watershed is not treated for water quality currently. Runoff from many of the roads in the watershed is currently conveyed to the streams through ditches. Although ditches may provide some water quality treatment of runoff, if the ditches are not maintained appropriately and lack the appropriate vegetation and slope characteristics of a water quality swale, pollutants from roadways may still reach streams. The City of Happy Valley began conducting street sweeping of all city streets approximately once per month in October 2008. Street sweeping outside Happy Valley is conducted by DTD. In the RC watershed, approximately 83 miles of streets were swept by DTD in 2007.

As the watershed develops further, it is expected that enhanced water quality treatment requirements for new development and re-development will be in place to protect water quality from degradation. It will be important for enhanced water quality treatment requirements to be applied to existing and new roads as well as to residential, institutional, commercial, and industrial development. In addition, it will be valuable for water quality treatment to be focused on protecting and enhancing ecosystem services (e.g., through buffer protection and enhancement) and to utilize LID techniques to integrate water quality treatment into landscaping and biologically-based treatment systems wherever possible.

Happy Valley, WES, Sunrise Water Authority, and Portland State University recently collaborated on the Rock Creek Sustainability Initiative (RCSI), which is a sustainable development test project for a 400-acre area in Happy Valley intended for commercial, institutional and industrial development. If implemented, application of the RCSI study results to planned future developments will assist in protecting watershed functions and natural resources in the watershed.

Key water quality issues in the RC watershed include the following:

- Stream temperatures exceed water quality criteria for summer conditions.

  Elevated water temperatures have been observed in mainstem Rock Creek and some tributaries during the summer. Riparian canopies and forests have been altered and removed in portions of the watershed, leaving the streams open to increased heat gain from solar radiation. The influx of cold spring water to the streams still occurs in some locations, but may have been reduced due to changes in land use and hydrology in the watershed from historical conditions. Modifications to the landscape including installation of impervious surfaces and drainage associated with agriculture has likely reduced infiltration and aquifer recharge. In addition, groundwater pumping in the area has resulted in portions of the watershed being identified as groundwater limited resources by the State of Oregon. These changes may have resulted in less groundwater discharge to streams during the summer. Less groundwater discharge can increase stream temperatures because groundwater tends to be cooler than surface runoff during the summer, and less total flow in the stream allows solar radiation to affect a greater proportion of the water column.
- Benthic macroinvertebrate and fish population surveys indicate that conditions in the streams in the watershed vary considerably.

  Sampling in the lower reach of Rock Creek generally indicates acceptable (unimpaired) and slightly impaired biological communities for fish and benthic macroinvertebrates, respectively, which is indicative of fair to moderately good water quality on average. The middle reach of Rock Creek and Upper Trillium Creek support moderately impaired benthic macroinvertebrate communities. The middle reaches of Rock Creek are more severely impaired for fish, and the upper reaches are marginally impaired for fish. Although there may be water quality issues affecting fish populations in the middle and upper reaches of Rock Creek (in particular water temperature), habitat conditions also likely play a role in supporting diverse and sustainable fish populations in these areas.

According to the WES Watershed Health Index assessment of benthic macroinvertebrate communities as a biological index, the RC stream system in the locations where benthic macroinvertebrate surveys are conducted is below its biological potential given the level of development in the watershed. Table 5-1 compares the biological index for two sites in the RC watershed with the predicted biological potential for those sites based on the level of urbanization in the contributing area. Site SD1-M10, near the mouth of Rock Creek, is at 50 percent of its biological potential. Site SD1-M11, located on Rock Creek near Southeast Sunnyside Road, is at 54 percent of its biological potential.

Potential factors limiting biological potential of Rock Creek include landscape erosion and sedimentation in streams, increased water temperatures, and hydrologic regime disturbances. Water quality pollutants such as pesticides, dissolved metals, and other toxic materials could also be contributing to the reduced biological quality in the streams. Additional study of stream conditions and targeted water quality monitoring efforts may provide further insight into the contributing factors and help guide WES management activities intended to improve the biological index and overall watershed health results.

Table 5-1. Watershed Health Index – Biological Index Results

Creek	Site number	Biological index	Biological potential (90th quantile)	Percent of biological potential
Rock	SD1-M10	33	66	50
Rock	SD1-M11	35	65	54

- Elevated levels of *E. coli* bacteria, a key indicator of water contact human health issues, have been found throughout the watershed.

E. coli bacteria are associated with fecal matter, which can contain a wide range of pathogenic organisms. There are many potential sources of *E. coli* in streams including birds, wildlife, pets, livestock, and humans. The sources of *E. coli* in the RC watershed are not well understood at this time. Increased understanding of sources would be helpful to guide management activities to address this issue.

- Elevated levels of total phosphorus (TP) and pesticides have been observed in water quality samples collected in the watershed.

Elevated nutrient levels and pesticides potentially could be due to use of fertilizers and pesticides in the residential area and/or poor land management practices associated with farm, nursery, and forest land areas.

- The expected future development in the watershed poses a high risk for in-stream sedimentation.

The large amount of new development expected in the RC watershed in the coming years will require proactive inspections and careful management of construction site runoff to protect water quality.

- Inadequate water quality data are currently collected to adequately characterize the full watershed.

Water quality data historically have been collected and are currently being collected at two locations in the watershed, Site #16 near the mouth of Rock Creek and Site #25 near Southeast Sunnyside Road. Collaboration with Happy Valley and Damascus to implement additional water quality monitoring sites on the tributaries and in the upper reaches of the watershed would provide valuable information to better characterize water quality throughout the watershed and to track changing conditions over time as further development occurs.

Potential Actions

An active management strategy to improve and maintain water quality in the RC watershed is recommended for watershed health. Many of the potential actions described above for addressing hydrologic issues will also serve to improve water quality. Additional potential actions that will support the active management strategy to improve water quality include the following:

- Develop an integrated, comprehensive, and long-term monitoring plan that addresses key questions and provides a framework for organizing and analyzing data from all sources (water quality sampling, flow measurement, biological surveys, and special studies).
- In collaboration with Happy Valley and Damascus, expand water quality monitoring locations to more fully characterize water quality and geomorphic conditions throughout the watershed.
- In collaboration with Happy Valley and Damascus, expand benthic macroinvertebrate sampling locations and frequency to support the Watershed Health Index (WHI). A more extensive survey of benthic macroinvertebrates was conducted in 2003 for Metro when eight riffle habitats were sampled throughout the watershed. These sites possibly could be sampled again with landowner permission to compare changing conditions.
- Consider a Microbial Source Tracking project to increase understanding of *E. coli* bacteria sources.
- In collaboration with DTD, Happy Valley, and Damascus, develop a stormwater quality retrofit and prioritization program for existing roads.
- Continue implementing the private water quality facility inspection and maintenance program.
- In collaboration with Damascus and DTD, evaluate opportunities to enhance street sweeping effectiveness in reducing pollutant loads from high volume roads outside of Happy Valley through increased frequency and enhanced technology.
- Develop monitoring and evaluation processes to analyze the effectiveness and results associated with non-structural BMPs.

Aquatic Habitat and Biological Communities Issues and Opportunities

The RC watershed forms a patchwork of forested habitats and riparian corridors mixed with agricultural lands, roads, houses, and other development. The influences of development in the watershed have fragmented habitat connections and impacted the water and habitat quality of the riparian zones. However, there are still large patches of upland forest habitat and vegetated riparian corridors that provide dwelling, feeding, and nesting habitat and movement and migration for many of the region's resident wildlife species. If the current connections between large habitat patches are maintained and enhanced, and smaller patches are connected, the landscape in the watershed can likely continue to provide for the resident and migratory wildlife species that use the area. As further development occurs, preservation of forest canopy and wetlands will be important to maintaining biological communities.

The mainstem of Rock Creek supports a relatively diverse assemblage of native aquatic life. Recent sampling conducted by ODFW in 2008 indicates that steelhead and rainbow trout, Coho salmon, Chinook salmon and cutthroat trout are present within the watershed. A naturally occurring, 23-foot waterfall located at approximately river mile (RM) 1.3 restricts anadromous salmonids (i.e., Coho, Chinook, Steelhead, Rainbow, and searun Cutthroat trout) to the lower reaches of the creek. These species also have access to the lower 0.4 mile of Trillium Creek, which joins Rock Creek near its mouth. Cutthroat trout is the only native salmonid species present in the watershed upstream of the falls at RM 1.3.

The mainstem of Rock Creek has been surveyed for aquatic habitat conditions through Reach RK7, shown in Figure 5-1. Above Reaches RK6 and RK7 the stream conditions have not been evaluated in detail. There are also several tributaries, including Trillium Creek and unnamed small drainages, that have not been surveyed in detail (a small portion of Trillium Creek near its confluence with Rock Creek has been surveyed).

Many of the issues related to hydrology and water quality also impact aquatic habitat and biological communities. Additional key aquatic habitat and biological communities issues in the RC watershed include the following:

- Native and sensitive fish populations are present, although limiting factors within and beyond the watershed affect population size, diversity, health, and sustainability.

  Historic sampling indicates that Chinook salmon, Coho salmon, and Cutthroat and Steelhead/Rainbow trout are present in Rock Creek year-round below the falls, but their numbers are highly variable. Resident Cutthroat trout and Rainbow trout are rare above the falls, but have been collected as far upstream as fish reach RK5-F. Trillium Creek (TR01) has been sampled only sporadically, but it appears to provide rearing habitat for juvenile Coho and Chinook salmon and Rainbow/Steelhead and Cutthroat trout (although cutthroat trout have been identified less often). TR01 is accessible to anadromous salmonids up to the impassible barrier 0.4 mile upstream from the mouth. No salmonids have been collected above the impassible barrier. Limiting factors for fish populations likely include elevated summer stream temperatures and degraded aquatic habitat. Other water quality issues and fish passage impediments may also be limiting factors.

- Opportunities for improvements to aquatic habitat.

  In the analysis of aquatic habitat conditions in Chapter 4, there were many low and moderate scores on the habitat parameters. This suggests that there is opportunity for restoration and room for improvement in the physical components of fish habitat within the watershed. ODFW is developing detailed habitat improvement recommendations as a part of its 2008 survey of the watershed.

  The lower reaches of Rock Creek (RK1 to RK3) generally provide better habitat conditions than the middle and upper reaches. Lower Rock Creek habitat reaches RK1 to RK3 had high rankings on percent fines in riffles, percent pools, deep pools per kilometer, and percent slackwater pools; but scored poorly on the boulder metrics and to a lesser extent on the percent secondary channels and percent gravel in riffles. The middle reaches (RK4 through RK6) scored relatively high on percent pools but poorly on secondary channels, boulders, and the three LWD metrics. The upper reach (RK7), corresponding to fish reach (RK5-F), scored moderately on percent pools and percent fines (silt, organics, and sand particles smaller than 2 millimeters in diameter) and gravels in riffles, but scored poorly on the remainder of the metrics. Trillium Creek below the barrier at RM 0.4 scored high or moderate on all metrics but deep pools per kilometer, percent secondary channels, and percent fines in riffles.

- Opportunities to reduce fish passage barriers.

  In the ODFW habitat surveys, two significant artificial dams were identified in Reach RK4, one shortly above Southeast Sunnyside Road and the other at Pleasant Valley Golf Course. The nature of these dams and their degree of blockage is unknown at this time. Clackamas County lists nine culverts for replacement in the RC watershed. These culverts may present partial or full barriers to resident cutthroat trout, and may prevent them from fully utilizing habitat that otherwise may be suitable. One of the culverts is located on the Rock Creek mainstem at the Troge Road crossing, while the remainder are located on minor tributaries. Although Clackamas County does not currently list the long box culvert on Rock Creek at Southeast Sunnyside Road as a potential barrier, it should likely be listed as a partial barrier. DTD is expanding Southeast Sunnyside Road in this area and a new bridge crossing is planned, however the plans for the existing box culvert are not known at this time. Prioritization for replacement of these culverts will require additional site-specific information on the condition of the culverts, the species affected, available upstream habitat, and transportation risks and costs.

Potential Actions

An active management strategy aimed at targeted investments in enhancing aquatic habitat and biological communities is recommended. Many of the potential actions described above for addressing hydrologic issues and water quality issues will also serve to improve or maintain aquatic habitat and biological communities. Additional potential actions that will support the targeted management strategy to enhance aquatic habitat and biological communities include the following:

- Continue partnering with agencies, nonprofits and volunteer groups to make strategic, targeted improvements in aquatic habitat and biological communities. As discussed above in the Hydrology section, there may be opportunities to partner to undertake active restoration of degraded stream channels, buffer areas, floodplains, and wetlands on private lands with cooperating landowners. Large development projects in particular may provide opportunities to work with landowners to implement significant stream restoration or wetland restoration activities.
- Engage in targeted outreach with private landowners and partner with other agencies and nonprofits to improve aquatic habitat and stream conditions through LWD placement, bank stabilization, and buffer enhancements.
- Evaluate areas lacking shade and engage in buffer enhancements on public land and private land (where feasible) to support aquatic habitat and temperature total maximum daily load (TMDL) implementation.
- Consider additional policies to support riparian buffer enhancement during development, similar to the Clean Water Services design standards that require invasive plant removal and revegetation of buffers when stream-side parcels are developed.
- Consider development policies and incentives to protect tree canopy and native vegetation communities during development.
- Consider incentives and policies to support habitat restoration and preservation on developable parcels.
- Collaborate with DTD and other applicable agencies to further evaluate fish barrier removal priorities.
- Integrate ODFW recommendations on habitat improvement opportunities into partnering efforts and Capital Improvement Program (CIP) planning as appropriate.

Stakeholder Input

A stakeholder group was convened in the fall of 2008 to participate in the Watershed Action Planning process and provide feedback on the results of the study to the Clackamas County Citizens Advisory Committee. Stakeholders met in October and November 2008 and in March 2009. Additional stakeholder meetings are planned for April and June 2009. The stakeholder group includes local residents of the watershed and representatives of the City of Damascus, the City of Happy Valley, Sunrise Water Authority, the Clackamas River Basin Council, ODFW, the Oregon Department of Environmental Quality (DEQ), DTD, private land owners, and the Homebuilders Association. At the March 2009 stakeholder meeting, stakeholders discussed a list of possible watershed management actions. The list was developed using previous stakeholder input from the November 2008 meeting and supplemented by the project team. Potential actions were divided into policy-oriented and project-oriented actions. Each stakeholder received eight dots for priority voting. They were asked to identify the most important strategies to emphasize in the next 3 to 5 years in the RC watershed given what they now know about RC issues. Stakeholders then placed their dots on their action preferences among a list of 22 possible actions. The results are as follows:

Policy-Oriented Actions

Highest Ranking

- Protection of buffers and wetlands with zoning and density trading
- Design standards updated
- Explore and develop a variety of funding sources for watershed management

Medium Ranking

- Water quality monitoring, site specific, tracking LID results
- Integrated water resources approach to drinking water, stormwater, and wastewater
- Inter-agency cooperation and coordination between WES, Clackamas County, cities, and Metro
- Private property awareness and private land owner incentives

Low Ranking

- Tree protection ordinance for uplands
- Develop near-term and longer-term management strategies
- Water quality trading and credits

Project-Oriented Actions

Highest Ranking

- Stormwater treatment systems
- Maintenance of public storm system
- Provide outreach and/or fund projects for improved agricultural practices
- Require maintenance of private storm systems

Medium Ranking

- Slope stabilization with native plants
- Restoration of wetlands
- In-stream restoration of habitat
- Plant trees
- Septic systems – address water quality issues as needed
- Street sweeping

Low Ranking

- Metro habitat areas expanded and connected

Stakeholders emphasized that just because something did not get a dot does not mean it is not important or that it is not perceived to be a problem. The priority above is based on selecting actions that seem most important to focus on early in Watershed Action Plan (WAP) implementation because they address key stressors and supplement what WES is already doing. Stakeholders did not mean to imply by their priorities that WES should stop actions already underway. If it became known that an existing management activity was not effective enough, then priorities would likely change.

Reach Analysis

The reach analysis included the following three components:

- Rating of reach conditions using assessment criteria
- Identification of threats and opportunities based on reach ratings and contributing area conditions
- Development of management strategies and potential actions for reaches and contributing areas to address threats and opportunities

The process used for each component of the reach analysis is described below, followed by the results of the reach analysis. The management strategies and potential actions for reaches and contributing areas described below are identified as potential opportunities to supplement the watershed-wide strategies identified earlier in the Assessment Report.

Assessment Criteria

Assessment criteria were developed to evaluate the range of stressors, responses, and key indicators in the watershed at the reach level. The assessment criteria are summarized in Table 5-2. Thresholds for the assessment criteria were developed to rate stream reaches in a Good (3), Fair (2), and Poor (1) rating system.

The assessment ratings provide an overview of reach conditions based on available data. As new data are collected, the reach ratings can be updated and compared to ratings from prior years to evaluate changing conditions in the watershed. Changes in reach ratings can be evaluated in conjunction with WHI results and other watershed data to track in-stream responses to the implementation of new management activities. The reach ratings can also be used to track in-stream conditions as a part of the evaluation of LOS and goals for the watersheds.

Threats and Opportunities

The results of the assessment rating as well as other available information on stream conditions and contributing area conditions were used to evaluate threats and opportunities in the watershed. Threats to watershed health were identified based on areas rated poor in the assessment ratings as well as additional information about stressors in the contributing areas. Opportunities to improve or protect watershed health were identified based on locations where management strategies and potential actions could be undertaken by WES to address the causes of poor conditions or preserve and enhance good conditions in the watershed. Constraints were also considered in the evaluation of opportunities, such as available undeveloped land and land ownership.

Stressors, responses, and indicators that were evaluated to identify threats include the following:

- Current land use
  - High volume roads and parking areas lacking structural BMP treatment for water quality
  - Industrial areas lacking structural BMP treatment for water quality
  - Areas lacking structural BMPs for flow control
  - Areas lacking upland forest canopy
- Projected future land use
  - Areas likely to develop significantly in the future
  - Areas at risk for hydromodification

- Riparian conditions
    - Areas lacking riparian forest and shade
    - Areas with invasive vegetation
- In-stream conditions
    - Areas lacking LWD, pools, and other characteristics of good habitat
    - Areas subject to bank erosion
    - Fish passage barriers
    - Poor water quality conditions

Opportunities and constraints evaluated include the following:

- Type of property ownership adjacent to streams (public and private)
- Available undeveloped land in the contributing area
- WES management responsibility
- Partnering organizations
- Level of investment

Table 5-2. Assessment Criteria Developed for RC Action Plan

Reach assessment criteria	Assessment category (factors limiting watershed health)	Assessment criteria	Poor	Fair	Good	References for criteria
Hydrology and channel morphology						
Hydrology	Flood risk	Number of structures in 100-year floodplain	> 2	1	0	Professional judgment
		Flooding complaints	> 5	1 to 5	0	Professional judgment
	Hydromodification	2-year future to 2-year existing	> 3	1.5 to 3	< 1.5	Professional judgment
	Hydromodification	Ratio of 10-year future to 10-year existing	> 2	1.5 to 2	< 1.5	Professional judgment
Channel morphology	Access to and quality of floodplain	Entrenchment ratio	< 1.5	1.5 to 2.2	> 2.2	Professional judgment
		Roads in 25-foot buffer area (percent of buffer area)	> 25	10 to 25	< 10	Professional judgment
		Frequency of overbank flow, years	> 10	2 to 10	2	Professional judgment
	Channel and bank stability	Percent banks eroding	> 25	5 to 25	< 5	Professional judgment
		Percent coarse substrate	< 15	15 to 30	> 30	Professional judgment

Table 5-2. Assessment Criteria Developed for RC Action Plan

Reach assessment criteria	Assessment category (factors limiting watershed health)	Assessment criteria	Poor	Fair	Good	References for criteria
Water Quality						
	Biological indicators of water quality	Benthic macroinvertebrate bioassessment score (percent of biological potential)	< 30	30-75	> 75	Water Environment Research Foundation bioassessment study, professional judgment
	BMP treatment	Percent contributing area treated by structural BMPs	< 30	30 to 75	> 75	Professional judgment
	Water temperature	7-day running average maximum temperature during summer and/or during spawning/incubation period	Frequently exceeds DEQ guidelines for cold water streams (> 20 percent)	Occasionally exceeds DEQ guidelines for cold water streams (10 to 20 percent of time)	Generally meets DEQ guidelines for cold water streams (exceeds criteria < 10 percent of time)	DEQ
	Dissolved metal contaminants	Percent dissolved metals exceeding acute DEQ criteria	> 10	0 to 10	0	DEQ
	Nutrients	Percent TP and nitrate samples exceeding guidance levels	> 20	10 to 20	< 10	Oregon Watershed Enhancement Board (OWEB) and U.S. Environmental Protection Agency (USEPA) MCL
	Suspended solids	Percent total suspended solids (TSS) exceeding guidance levels	> 20	10 to 20	< 10	Professional judgment
	Water contact human health indicator (*E. coli* bacteria)	Percent *E. coli* bacteria exceedances of DEQ standards at monitoring sites within reach	> 50	10 to 50	< 10	DEQ
	Risks to water quality from land use	Dominant land uses in areas lacking BMPs	High-volume roads, industrial, large-parking area commercial, poorly managed agriculture	Roads, commercial, residential, agricultural	Low-density residential	Professional judgment
	Forested cover in contributing area	Percent forested land cover in contributing area	< 20	20 to 50	> 50	Professional judgment

Table 5-2. Assessment Criteria Developed for RC Action Plan						
Reach assessment criteria	**Assessment category (factors limiting watershed health)**	**Assessment criteria**	**Poor**	**Fair**	**Good**	**References for criteria**
Aquatic habitat and biological communities						
	Percent pools	Percent of the primary channel area represented by pool habitat	< 7 or > 90	7 to 40 and 60 to 90	>40 and <60	ODFW
	Deep pools per kilometer	Number of pools greater than 1 meter deep per kilometer of the primary channel	< 2	> 2 and < 4	> 4	ODFW
	Winter refuge habitat	Percent of the total channel area including alcoves and side channels that provides refuge habitat during winter high flow events	< 2	> 2 and < 4	> 4	ODFW
	Percent fines in riffles	Percent of the substrate in riffles < 2 millimeters in diameter	> 20	> 10 and < 20	< 10	ODFW
	Percent gravel in riffles	Percent of the substrate in riffles 2 to 64 millimeters in diameter	< 20	> 20 and < 49	> 49	ODFW
	Pieces of LWD per 100 meters	Pieces of LWD > 0.15 meter in diameter by 3 meters in length per 100 meters of channel length	< 7	> 7 and < 21	> 21	ODFW
	Percent shade	Percent shade from ODFW				ODFW
	Riparian buffer and shade	Percent riparian extent - 25-foot buffer area based on Metro land classification	< 33	33 to 66	> 67%	Professional judgment and DEQ TMDL to increase shade
	Riparian buffer and shade	Percent riparian extent - 100-foot buffer area based on Metro land classification	< 33	33 to 66	> 67	Professional judgment and DEQ TMDL to increase shade
	Low summer flow	Flow conditions during the late summer and early fall	Cessation of flow between riffles, runs and pools	Very small flow between riffle, runs and pools (i.e., does not cover low flow channel)	Sufficient flow to cover low flow channel throughout the stream reach	Professional judgment
	Fish diversity and abundance	Fish Index of Biological Integrity (F-IBI) scores	Severely Impaired	Moderately Impaired	Not impaired	Professional judgment
	Migration access	Upstream access for both adult and juvenile salmonids	Total blockage of upstream migration for adult or juvenile salmonids	Partial obstruction of migration for adult or juvenile salmonids	No obstructions	Professional judgment

Management Strategies

Agencies involved in watershed management have long recognized that the impacts of urbanization are not easily reversed and realistic management strategies are necessary to guide investments to improve watershed conditions. The USEPA and the OWEB have proposed management strategy frameworks that address the level of disturbance in a watershed and appropriate near-term and long-term management strategies to enhance and protect watershed health. The OWEB framework recommends management strategies depending on watershed conditions and opportunities that include protective management (e.g., buffer requirements), active management (e.g., building stormwater treatment systems, in-stream restoration), and passive management (e.g., design standards changes, policy changes).

The project team evaluated a range of management strategy frameworks and developed a framework that addresses existing WES activities and opportunities for future actions to further improve watershed health. The recommended approach is to organize stream reaches into areas suited for moderate, intermediate, and high levels of management. Table 5-3 provides examples of typical actions that may be associated with the recommended management strategy descriptions for the RC Action Plan.

Recommended management strategies and potential actions for each reach were developed based on the assessment of threats and opportunities. Further analysis of the potential actions was conducted for the Action Plan phase of the project (Chapter 6) to identify near-term and longer-term actions based on feasibility, expected impact, urgency, and other criteria.

Table 5-3. Management Strategies and Examples of Potential Action Opportunities

Management strategy	Upland management opportunities	In-stream restoration opportunities	Riparian corridor opportunities	Programmatic activity opportunities
High	• Targeted larger-scale stormwater BMP retrofits • Enhanced street sweeping	• Larger scale restoration on public land • Targeted restoration with private landowners • Wetland enhancement or creation • Channel modifications	• Projects on existing public land • Targeted riparian plantings • Targeted invasive plant management • Willing-seller land acquisition or conservation easement	• Targeted work with private landowners through outreach • Significant new studies
Intermediate	Non-targeted smaller-scale stormwater BMP retrofits	LWD placement and bank erosion prevention	Riparian plantings and invasive removal (smaller scale on private land)	• New monitoring • New protection measures • General outreach to private landowners
Moderate	Continued application of existing non-structural and structural BMPs	Continued monitoring of in-stream conditions	Continued protection of existing riparian corridor	• Existing monitoring • Existing protection measures

Assessment Results

The following section describes the reach-level assessment findings, including a synthesis of available data related to hydrology and channel morphology, water quality, and aquatic habitat and biological communities. Key data sources for the reach-level assessment include monitoring site data, aerial photography, and GIS analysis results. Visual observations are also included to provide qualitative information on watershed conditions. Findings are presented on a reach level followed by potential actions that could improve reach hydrology, water quality, aquatic habitat, and biological communities.

The reach-level assessment is limited by the lack of data in portions of the watershed. Hydrologic and geomorphic data, water quality data, and habitat data are all lacking in certain reaches, in particular the smaller tributary channels and upper reaches of the stream. Data on land use characteristics are limited to analysis conducted at two points, at the downstream end of Reach RK1 and at the downstream end of Reach RK5. Land use is expected to change significantly in the future in the watershed.

Reaches were developed using existing habitat reach designations provided by the ODFW survey. Where stream segments were not surveyed by ODFW and lacked reach names, reach names were created. Unsurveyed mainstem channel reaches were identified as A reaches, reflecting the location upstream of a named reach. For example, Reach RK3A is an unsurveyed reach upstream of the surveyed Reach RK3. Side channel tributary reaches were identified as B reaches. For example, Reach RK3B is an unsurveyed reach that is a tributary to reach RK3.

Table 5-4 provides a summary of the assessment rankings on the reach level, which supplement the following text. The thresholds for the good, fair, and poor ratings are described in Table 5-2. Table 5-5 provides a summary of the recommended management strategies and potential actions for each reach and contributing area.

The Rock Creek Basin encompasses approximately 6,280 acres surrounding Rock Creek reaches RK1 through RK7B and Trillium Creek reaches TR1 through TR1A. Cities within the basin include Damascus and Happy Valley. Main thoroughfares intersecting the basin include Highway 212 and Southeast Sunnyside Road, which run east-west in the southern portion of the basin and Southeast Foster Road which runs north-south through the center of the basin.

The majority of the riparian buffer is intact in the basin although there are opportunities to improve buffer width and quality, particularly in the middle and upper reaches. In a 25-foot buffer zone on either side of Rock Creek in the basin, approximately 67 percent of the buffer area is forested, 26 percent is grass and shrubs, and 5 percent is urbanized. In a 100-foot buffer zone on either side of Rock Creek, approximately 56 percent is forested, 36 percent is grass and shrubs, and 7 percent is urbanized. A significant portion of the riparian buffer along Rock Creek contains invasive plant species such as Japanese knotweed and blackberry. Invasive species were not quantified in the assessment, but the existence of these species has been visually observed and noted throughout the watershed.

Reach RK1

Reach RK1 begins at the confluence of Rock Creek and the Clackamas River and continues upstream to the confluence of Trillium and Rock Creeks. This reach is bordered by industrial and residential development to the north and land that is currently being developed to the south. The contributing area to reach RK1 is approximately 6,200 acres.

The land use in the contributing area is currently classified as 29 percent residential and rural residential, 19 percent farmland, 18 percent forest land, and 30 percent tract land or undefined land use in the County Tax Assessor data. Tract land includes institutional land uses such as schools and parks as well as undeveloped parcels. All of the land use classifications in the RC watershed include both developed land uses and vacant land uses that fall into these categories. As much as 60 percent of the watershed may still be available for further development based on the buildable lands assessment conducted by WES, however the estimate of buildable lands available may change in the future as land use planning in Damascus proceeds. Approximately two percent of the contributing area is currently treated with structural BMPs such as detention ponds and swales.

The 2007 Metro aerial photography land cover analysis indicates that approximately 40 percent of the contributing area contains tree canopy, 47 percent of the contributing area is vegetated with grass, shrubs, or agricultural vegetation, and 13 percent of the contributing area is comprised of built or scarified areas which includes buildings, pavement, and some compacted or dry exposed soil areas.

Reach RK1 includes a water quality sampling site (Site #16) and an ODFW fish sampling reach (RK1-F). Hydrologic analysis of this reach indicates good to fair conditions, with the exception of poor ratings for hydromodification risk for the 2- and 10-year storm events. Water quality analysis indicates elevated summer water temperatures and low proportion of developed land currently treated by structural stormwater BMPs. The water quality rating for nutrients is also poor and the rating for *E. coli* bacteria is fair.

Aquatic habitat and biological communities in this reach are largely good, however percent gravel in riffles and percent overhead shade from the ODFW analysis are poor.

There is an area of unstable soil on a slope near the upper end of reach RK1. The slope failure at this site has been attributed to poor land development practices on an adjacent parcel. Although some in-stream mitigation has been performed at this site to address the slope failure, it did not appear during an August 2008 site visit that the slope had been stabilized adequately and replanted with native vegetation. A large sheet of plastic still covers part of the slope.

The buffer riparian area associated with the parcel between Rock Creek and Highway 212 has recently been acquired by WES and other partners as a natural area. There are opportunities to remove invasive species (Himalayan blackberry and other invasive plants) and improve the riparian canopy in this reach. These activities could improve aquatic habitat and water quality as well as upland biological habitat.

Potential Actions

The recommended management strategy for this reach is a high level of management focused on addressing riparian buffer restoration on land co-owned by WES, upland habitat restoration, and addressing the need for slope stabilization at the landslide with the state and developer. Strategic placement of LWD and an increase in the amount of LWD in RK1 could improve in-stream structure and provide benefits to rearing juvenile salmonids from Rock Creek and the Clackamas River.

Reach RK2

Reach RK2 begins at the confluence of Rock and Trillium Creeks and extends upstream approximately 200 meters to reach RK2A. Beyond the riparian buffer, RK2 is bordered by Highway 212 to the north and land that is currently being developed to the south. The contributing area to reach RK2 is approximately 6,020 acres. The contributing area land use and land cover is similar to that of reach RK1.

Hydrologic analysis indicates good conditions, with the exception of poor hydromodification risk ratings for the 2- and 10-year storm events. Water quality data have not been collected for this reach, however, it is known that only a portion of the developed contributing area is treated by structural stormwater BMPs, resulting in a poor rating for BMP treatment.

Aquatic habitat is generally rated in good condition in RK2, with the exception of percent gravel in riffles and percent overhead shade from the ODFW survey. Benthic macroinvertebrate monitoring site SD1-M10 is located in reach RK2. According to the results of the WHI evaluation, the biological index for the site is 50 percent of the estimated biological potential based on the urbanization level of the contributing area.

Potential Actions

The recommended management strategy for this reach is a moderate level of management. Most of the current hydrologic, water quality, and aquatic habitat parameters rank as good. A programmatic approach to protective management throughout the contributing area could help prevent future degradation of this reach.

Reach TR1

Reach TR1 is a tributary reach to the mainstem of Rock Creek. Reach TR1 begins at RK2 where Trillium Creek enters Rock Creek and extends upstream a short distance. Reach TR1 includes fish reach TR1-F. The contributing area to reach TR1 is approximately 580 acres. The aerial photograph analysis indicates that approximately 25 percent of the contributing area to TR1 is forest canopy, 49 percent is shrubs and grass, and 26 percent is urbanized. Land use in the contributing area includes 49 percent residential, 27 percent farm land, 9 percent forest land, and 14 percent tract land.

Hydrologic analysis indicates good conditions, with the exception of a fair rating for hydromodification risk for the 2- and 10-year storm events and a fair rating for bank erosion. Water temperature may be affected by the large pond upstream of reach TR1A, although the pond does not appear to significantly affect summertime flow. Aquatic habitat data are generally good or fair, although there are poor conditions for deep pools and percent fines in riffles. Riparian buffer conditions and percent overhead shade are rated good. The control structure for the large pond is likely a barrier to migratory salmonids.

Potential Actions

The recommended management strategy for this reach is a moderate level of management. Most of the current hydrologic, water quality and aquatic habitat parameters rank as fair or good. A programmatic approach to protective management could help prevent future degradation of this reach.

Reach TR1A

Reach TR1A begins at the end of reach TR1 and extends upstream to the headwaters of Trillium Creek. Reach TR1 includes benthic macroinvertebrate monitoring site SD1-M7. The contributing area land use and land cover is similar to reach TR1.

Hydrologic analysis indicates a poor rating for hydromodification risk for the 2- and 10-year storm events. Water temperature is not known; however as noted above, the pond in reach TR1A could be a temperature source. Riparian buffer conditions are rated good in the 25-foot buffer area and fair in the 100-foot buffer area.

Potential Actions

The recommended management strategy for this reach is an intermediate level of management. A programmatic approach to protective management could help prevent future degradation of this reach. Active management to remove invasive Japanese knotweed and blackberry and prevent re-establishment through ongoing treatment and revegetation with native plant species could improve the riparian corridor.

Benthic site SD1-M7 is located relatively far upstream and may not provide highly valuable information unless land use is expected to change further in the contributing area to the site. This benthic site could be moved to downstream of the pond to better characterize the lower stretch of Trillium Creek where salmonids have been recorded or within reach RK2 or RK2A so that there is a benthic macroinvertebrate monitoring site upstream and downstream of the confluence of Trillium Creek with Rock Creek.

Reach RK2A

Reach RK2A begins at RK2 and extends upstream to reach RK3. A low density residential and commercial development exists beyond the riparian buffer on the west side of the reach and farms are located on the east side of the reach. Highway 212 also runs perpendicular to this reach.

Hydrologic analysis indicates good conditions, with the exception of a poor rating for hydromodification risk for the 2- and 10-year storm events. There are no water quality monitoring sites in RK2A. Aquatic habitat data available includes riparian buffer shade and migration access, which are good for this reach.

Potential Actions

The recommended management strategy for this reach is a moderate level of management. Most of the current hydrologic, water quality and aquatic habitat parameters rank as good. A programmatic approach to protective management could help prevent future degradation of this reach.

Reach RK3

Reach RK3 begins at reach RK2A, and extends upstream approximately 800 meters to reach RK3A. Low density residential developments comprise the majority of the immediate contributing area to the west of RK3 and farmland comprises the contributing area to the east of the reach. Most of the development to the west of this reach appears to have occurred in the last decade and many of the currently undeveloped lots are slated for future residential development. The contributing area to reach RK3 is approximately 5,440 acres. The contributing area land use and land cover is similar to reach RK1.

Hydrologic analysis results for reach RK3 show good to fair conditions, with the exception of hydromodification risk and entrenchment ratio, which rank as poor. WES GIS analysis indicates that a small proportion of the developed contributing area to this reach is treated with structural stormwater BMPs, resulting in a poor rating for BMP treatment. Since there are no water quality monitoring sites in RK3, no additional water quality data is available for this reach.

Aquatic habitat and biological community data was obtained from the ODFW habitat survey and from fish sampling reach, RK2-F. Conditions for this reach were good to fair.

Potential Actions

The recommended management strategy for this reach is an intermediate level of management. Most of the current hydrologic, water quality and aquatic habitat parameters rank as good. However, invasive species such as Japanese knotweed are prevalent in this reach. Removal of invasive Japanese knotweed and prevention of re-establishment through ongoing treatment and re-vegetation with native species could enhance the riparian corridor in RK3. A programmatic approach to protective management could help prevent future degradation of this reach.

Reach RK3A

Reach RK3A begins at reach RK3 and extends approximately 650 meters upstream to RK4, just north of the confluence with RK3B. According to the 2007 aerial photographs, low density residential development is in progress to the west of this reach. To the east are mostly farmed and some forested lands. The contributing area to Reach RK3A is approximately 5,280 acres. The contributing area land use and land cover is similar to reach RK1. The natural waterfall that forms an impassable barrier to anadromous fish is located in Reach RK3A.

Hydrologic analysis indicates poor hydromodification risk for the 2-year and 10-year storm events and a poor entrenchment ratio. Water quality data has not been collected in this reach. Aquatic habitat and biological community data is also sparse, but aerial photography analysis indicates good riparian buffer shade in the 25- and 100-foot buffer areas and good migration access. Overall, RK3A appears to have a fairly intact riparian corridor.

Potential Actions

The recommended management strategy for this reach is an intermediate level of management. Most of the current hydrologic, water quality and aquatic habitat parameters rank as good. However, invasive species such as Japanese knotweed are prevalent in this reach. Removal of invasive Japanese knotweed and prevention of re-establishment through ongoing treatment and re-vegetation with native species could enhance the riparian corridor in RK3. A programmatic approach to protective management could help prevent future degradation of this reach.

Reach RK3B

Reach RK3B is a tributary that flows through farms and low density residential land to the east of Rock Creek. The upper portion of the stream is most likely ditched, as shown by the relatively straight flow line on Figure 5-1. Portions of reach RK3B are lacking a riparian corridor as it flows through fields.

Little data are available for this reach, because it contains no monitoring sites. Hydrologic analysis indicates a poor rating for hydromodification risk.

Potential Actions

The recommended management strategy for this reach is an intermediate level of management. Collaboration with nonprofits and the Clackamas County Soil and Water Conservation District (CCSWCD) to implement targeted riparian buffer enhancements in this reach could improve stream temperature in Rock Creek over time.

Reach RK4

Reach RK4 extends from reach RK3A upstream to Southeast Sunnyside Road. The contributing area to reach RK4 is approximately 5,180 acres. The contributing area land use and land cover is similar to reach RK1. There is extensive new development occurring immediately to the west of RK4. The area to the east of RK4 is a mixture of forest and farmland.

Hydrologic analysis results for reach RK4 indicate poor conditions for hydromodification risk, entrenchment ratio, and floodplain access and frequency of overbank flow.

Aquatic habitat and biological community data was obtained from the ODFW habitat survey and from fish sampling reach, RK3-F. Conditions for this reach were good to fair. Benthic macroinvertebrate monitoring site SD1-M11 is located in reach RK4. According to the results of the WHI evaluation, the biological index for the site is 54 percent of the estimated biological potential based on the urbanization level of the contributing area.

Potential Actions

The recommended management strategy for this reach is a high level of management. Most of the current hydrologic, water quality and aquatic habitat parameters rank as good with the exception of some hydrologic analysis results. Stabilization of actively eroding banks using bio-engineering techniques and by enhancing riparian function could improve hydrologic conditions.

Invasive species such as Japanese knotweed are prevalent in this reach. Removal of invasive Japanese knotweed and prevention of its re-establishment through ongoing treatment and re-vegetation with native species could enhance the riparian corridor in RK3. Increasing conifer loading by planting western red cedar could also enhance the riparian corridor. A programmatic approach to protective management could help prevent future degradation of this reach.

Reach RK5

Reach RK5 extends from Southeast Sunnyside Road upstream to reach RK6. The contributing area to reach RK5 is approximately 4,500 acres. The land use in the contributing area is currently classified as 25 percent residential and rural residential, 18 percent farmland, 21 percent forestland, and 32 percent tract land or undefined land use in the County Tax Assessor data. Over 60 percent of the contributing area may still be available for further development based on the buildable lands assessment conducted by WES, however the estimate of buildable lands available may change in the future as land use planning in Damascus proceeds. Approximately one percent of contributing is currently treated with structural BMPs such as detention ponds and swales.

The 2007 Metro aerial photography land cover analysis indicates that approximately 43 percent of the contributing area contains tree canopy, 47 percent of the contributing area is vegetated with grass, shrubs, or agricultural vegetation, and 10 percent of the contributing area is comprised of built or scarified areas which includes buildings, pavement and some compacted or dry exposed soil areas.

Reach RK5 includes a water quality sampling site (Site #25), a continuous temperature monitoring site from summer 2008 (C111) and a continuous water level gauge (RC-C2). Hydrologic analysis results for reach RK5 indicate poor conditions for hydromodification risk, entrenchment ratio, and floodplain access and frequency of overbank flow. Water temperature exceeds summertime criteria at this site and is rated poor. The water quality rating for nutrients is also poor and the rating for *E. coli* bacteria is fair.

Aquatic habitat and biological community data indicate the conditions for this reach range from good to poor. The ratings for deep pools, percent gravel in riffles, and LWD are poor. The channel in this reach is rectangular and incised, resulting in poor habitat conditions.

Potential Actions

The recommended management strategy for this reach is an intermediate level of management. In collaboration with nonprofits and the CCSWCD or other interested agencies, enhancement of the channel (e.g., LWD placement) could be undertaken in this reach with participation by private land owners. The potential fish passage barrier identified by ODFW above Southeast Sunnyside Road and the golf course should be evaluated further. A programmatic approach to protective management could help prevent future degradation of this reach.

Reach RK6

Reach RK6 extends from reach RK5 upstream to Southeast 172nd Avenue. The contributing area to reach RK6 is approximately 4,120 acres. The contributing area land use and land cover is similar to reach RK5. There is a golf course immediately to the west of Rock Creek in this reach which is proposed to be developed into residential land use in the future. The area to the east of RK4 is a mixture of forest and farmland.

Hydrologic analysis results for reach RK6 indicate poor conditions for hydromodification risk, entrenchment ratio, and floodplain access and frequency of overbank flow.

Aquatic habitat and biological community data was obtained from the ODFW habitat survey. Conditions for this reach are generally fair to poor. Parameters that are rated poor include percent fines in riffles, percent gravel in riffles, pieces of LWD, and percent shade overhead. Although temperature data is not available for this reach, it is expected that it may be a limiting factor for aquatic life. The riparian buffer could be enhanced.

Potential Actions

The recommended management strategy for this reach is a high level of management. There may be opportunities to work collaboratively with nonprofits, ODFW, the City of Happy Valley, and the developer of the golf course to implement a restoration project in this reach. The restoration project could include in-stream channel and habitat enhancements, riparian plantings, dam removal or retrofit, as well as the creation of off-channel floodplain storage and wetland habitat connectivity. Grant funding from OWEB or other sources could be pursued for buffer enhancements and in-stream restoration.

There are small tributaries and groundwater seeps that contribute to Rock Creek from the area to the west of this reach. Preserving flow from these tributaries and their riparian canopy and native vegetation during development of the contributing area will be important for watershed health.

Reach RK6A

Reach RK6A extends from reach RK6 at Southeast 172nd Avenue upstream to reach RK7, north of Troge Road. The area surrounding RK6 is primarily agricultural and rural residential. There is a plant nursery adjacent to reach RK6 at Troge Road and Southeast 172nd Avenue.

Hydrologic analysis results for reach RKBA indicate poor conditions for hydromodification risk as well as floodplain access and frequency of overbank flow. Riparian buffer conditions in this reach are poor to fair in the 100-foot buffer area and fair to good in the 25-foot buffer area.

Although temperature data are not available for this reach, it is expected that it may be a limiting factor for aquatic life. Poor land management practices have been observed adjacent to Rock Creek in this reach (e.g., buffer areas lacking vegetation and heavy use by domestic animals resulting in ground compaction and erosion). The riparian buffer could be enhanced and outreach with landowners to improve streamside land practices could be conducted including voluntary farm plans and other sustainable practices in association with the CCSWCD.

Potential Actions

The recommended management strategy for this reach is an intermediate level of management. There may be opportunities to work collaboratively with nonprofits, the CCSWCD, and private landowners to improve riparian buffer conditions and in-stream habitat conditions in this reach. There are small tributaries and groundwater seeps that contribute to Rock Creek from the area to the south of this reach. Preserving flow from these tributaries as well as their riparian canopies and native vegetative communities during development of the contributing area will be important for watershed health.

Reach RK6B

Reach RK6B extends from reach RK6A north to the headwaters of Rock Creek. This reach has not been surveyed, therefore data on the reach are limited. The area surrounding RK6 is primarily agricultural and rural residential.

Hydrologic analysis results for reach RK6B indicate poor conditions for hydromodification risk as well as floodplain access and frequency of overbank flow. Riparian buffer conditions in this reach are poor in the 100-foot buffer area and poor to good in the 25-foot buffer area.

Although temperature data are not available for this reach, it is expected that it may be a limiting factor for aquatic life. The riparian buffer condition is poor overall and likely contributes to temperature problems downstream in Rock Creek. The riparian buffer could be enhanced and outreach with landowners to improve streamside land practices could be conducted.

Potential Actions

The recommended management strategy for this reach is a high level of management. This reach would benefit from additional temperature and benthic macroinvertebrate monitoring upstream of the confluence between RK6B and RK6A to track changing conditions in the upper watershed as it develops further. There may be opportunities to work collaboratively with nonprofits, the CCSWCD, and private landowners to improve riparian buffer conditions, in-stream habitat conditions, wetland areas, and off-channel floodplain storage in this reach. There may also be opportunities to form conservation easements or acquire land from willing sellers in this contributing area to enhance wetlands or implement a regional stormwater detention and infiltration site, however it will be important to evaluate soil characteristics before pursuing land purchases or easements. Hard pan clay soil is common in this area.

Reach RK7

Reach RK7 is a short reach that extends from reach RK6A to reach RK7A near the second crossing of the creek with Troge Road. The contributing area to this reach is 1,580 acres. The land cover in the contributing area includes 44 percent forested cover, 47 percent shrub and grass cover, and 9 percent urbanized cover. The area surrounding RK7 is primarily agricultural and rural residential.

Hydrologic analysis results for reach RK7 indicate poor conditions for hydromodification risk as well as floodplain access and frequency of overbank flow. Bank erosion, roads in the 25-foot buffer area, and entrenchment ratio rated fair in this reach. Riparian buffer conditions in this reach are fair in the 100-foot buffer area and good in the 25-foot buffer area. Habitat parameters rated poor in this reach include deep pools, percent fines in riffles, LWD pieces, and shade overhead.

Potential Actions

The recommended management strategy for this reach is an intermediate to high level of management. This reach would benefit from additional temperature and benthic macroinvertebrate monitoring to track changing conditions in the upper watershed as it develops further. There may be opportunities to work collaboratively with nonprofits, the CCSWCD, and private land owners to improve riparian buffer conditions and in-stream habitat conditions in this reach. If private land owners are willing to participate, the channel areas could be re-graded to provide more complexity and access to the floodplain. However, this active restoration could be expensive and/or difficult to permit and the overall benefit is not fully known at this time. Further evaluation of channel restoration opportunities and constraints in this reach is recommended.

Reach RK7A

Reach RK7A extends from reach RK7 past Southeast Foster Road to the eastern headwaters of Rock Creek. This reach has not been surveyed, therefore data on the reach are limited. The area surrounding RK7A is primarily forested and rural residential, with some agricultural areas.

Hydrologic analysis results for reach RK7A indicate poor conditions for hydromodification risk as well as floodplain access and frequency of overbank flow. Riparian buffer conditions in this reach are fair in the 100-foot buffer area and fair to good in the 25-foot buffer area.

Potential Actions

The recommended management strategy for this reach is an intermediate level of management. The contributing area to this reach may be developed significantly further in the future. Protecting existing high quality areas in this contributing area and tracking changing conditions over time will protect watershed health and help inform management decisions. A programmatic approach to protective management could help prevent future degradation of this reach.

Early Action Projects

As a part of the watershed assessment, the project team identified opportunities for early action projects. Early action projects may include both capital projects and programmatic measures. Criteria for potential early action projects include the following:

- Projects that are a high priority for improving watershed conditions.
- Projects that are a high priority to initiate or implement prior to July 2010.
- Projects that could be initiated or implemented prior to completion of the WAPs.

Based on the initial assessment of existing data and field visits to the watersheds, the project team developed a draft list of 13 potential early action projects. Feedback from WES staff was obtained to screen the list of potential early action projects down to the top projects for early implementation. These projects are summarized below. These projects include actions in the RC watershed as well as in the Kellogg-Mt. Scott (KMS) watershed.

1. Involvement in the City of Milwaukie's Kellogg-for-Coho initiative

The City of Milwaukie is leading the "Kellogg-for-Coho" initiative, which seeks to replace the Kellogg Lake Bridge, remove the Kellogg Lake dam, and restore the Kellogg Creek stream channel in the City of Milwaukie. The purpose of the project is to enhance Kellogg Creek for native Coho salmon and other threatened fish species while supporting bicycle and pedestrian travel and revitalizing the City of Milwaukie's South Downtown area. Removing Kellogg Lake dam would improve fish access to seven miles of riparian habitat in the KMS watershed.

As a part of the Kellogg-for-Coho initiative, the City of Milwaukie began hosting meetings with stakeholders in the watershed in September 2008 and is planning a lake drawdown study for the summer of 2009. This programmatic measure will include involvement of WES staff with the Kellogg-for-Coho initiative, including attending meetings, reviewing plans for the lake drawdown study, and coordinating information between the WAPs and the Kellogg-for-Coho initiative. It is anticipated that the WES Environmental Policy will contribute 2 to 4 hours per month to this programmatic measure from September 2008 through September 2009.

2. Update stormwater design standards

The Stormwater Design Standards for the Districts are outdated and do not appear to be serving the stormwater management needs of the Districts as well as they could be. Updating the Stormwater Design Standards could significantly improve or maintain water quality, in the short-term in areas where there will be extensive new development and in the long-term as areas are redeveloped. The Stormwater Design Standards are used within the Districts and by the City of Happy Valley. DTD has also begun applying the Stormwater Design Standards to some development outside the Districts. With the expected growth and development in the East Happy Valley Expansion Area and Damascus, it will be valuable for watershed health to update the Stormwater Design Standards as soon as possible.

It is anticipated that this programmatic measure could require up to 20 to 40 hours per month of combined time for several WES staff members over a period of 6 to 8 months to implement a design standard review and update with the assistance of a consultant. The fee for the consultant would depend on the scope of the project.

3. Temperature TMDL shade analysis

As a part of compliance with the water temperature TMDL for the Clackamas and Willamette Basins, Clackamas County is responsible for identifying areas lacking riparian shade and developing plans to increase riparian shade where feasible. WES is performing a riparian buffer analysis for the KMS and Rock Creek (RC) watersheds as a part of the WAPs. Additional riparian buffer analyses could be performed for other watersheds inside the Districts and outside the Districts in Clackamas County to establish baseline conditions throughout the County. Following this work, a programmatic measure could be developed through the WAPs to develop and implement plans to increase riparian shade where feasible. It is anticipated this measure could require 40 to 60 hours of time by an existing WES GIS staff member.

4. Perform additional benthic invertebrate surveys

WES has contracted with a consultant to perform benthic macroinvertebrate surveys at 12 locations throughout the KMS and RC watersheds. These surveys provide extremely valuable information about long-term aquatic habitat conditions, water quality, and watershed health. In order to expand the areas where the

Watershed Health Index (WHI) can be calculated and to expand the data available to use in setting management goals and tracking the effect of WES activities, it would be useful to expand the benthic monitoring program to include additional sites and greater frequency of sampling.

5. Add an erosion control hotline number and signs for construction sites

The Erosion Control group in WES has been working on establishing an erosion control hotline phone number for citizens to report poor erosion control practices at construction sites. Due to the significant sediment impacts and damage to watershed health that can occur from construction site erosion, it is a high priority to improve the effectiveness of erosion control. Establishing the erosion control hotline number and creating signs with the number for construction sites would benefit water quality.

6. Annual Stormwater Treatment Pond Retrofit Fund

WES is currently responsible for maintaining over 260 stormwater treatment ponds in the Districts and Happy Valley. Over 30 ponds in the Districts have been identified by WES staff as potential retrofit opportunities to improve performance. This early action project includes creating a stormwater treatment pond retrofit plan that would allocate annual CIP funds for the retrofit of several ponds each year. Costs will vary depending on the size of the pond and scope of the project at the pond.

The ponds that WES maintains were originally designed and constructed with various functions in mind (e.g., differing levels of flood control and water quality treatment) and at different stages of understanding of stormwater treatment opportunities to improve watershed health. There are opportunities to retrofit existing ponds to improve their function to better meet WES' watershed health goals and improve maintenance. Examples of pond retrofits include adding berms and weirs to slow flow progress through the treatment area and increase treatment detention time, adding native vegetation to improve water quality treatment, making modifications to ensure ponds operate properly to avoid causing stream temperatures to increase, and making modifications to the outflow structures to provide detention for smaller storm events.

Table 5-4. Rock Creek Reach Assessment Results

Hydrology		**RK1**	**RK2**	**TR1**	**TR1.a**	**RK2.a**	**RK3**	**RK3.a**	**RK3.b**	**RK4**	**RK5**	**RK6**	**RK6.a**	**RK6.b**	**RK7**	**RK7.a**
Flood risk	Number of structures in 100-year floodplain	Good	Good	Good		Good	Good	Good		Good	Good	Good	Good	Good	Good	
	Flooding complaints	Good	Good	Good	Good	Good	Good	Good	Good	Good	Good	Good	Fair	Good	Good	Good
Hydromodification	Ratio of 2-year future to 2-year existing	Poor	Poor	Fair	Poor	Poor	Poor	Poor	Poor	Poor	Poor	Poor	Poor	Poor	Poor	Poor
	Ratio of 10-year future to 10-year existing	Poor	Poor	Fair	Poor	Poor	Poor	Poor	Poor	Poor	Poor	Poor	Poor	Poor	Poor	Poor
Access to a quality of floodplain	Entrenchment ratio	Fair		Good			Poor	Poor		Poor	Poor	Poor			Fair	Fair
	Roads in 25-foot buffer	Good	Good	Good	Good	Good	Good	Good	Good	Good	Good	Good	Good	Fair	Fair	Good
	Frequency of overbank flow	Fair						Fair		Poor	Poor	Poor	Poor	Poor	Poor	Poor
Channel and bank stability	Percent banks eroding	Fair	Good	Fair		Good	Fair	Fair		Fair	Good	Good			Fair	
	Percent coarse substrate	Good	Good	Good		Good	Good	Good		Good	Good	Good			Good	
Water quality		**RK1**	**RK2**	**TR1**	**TR1.a**	**RK2.a**	**RK3**	**RK3.a**	**RK3.b**	**RK4**	**RK5**	**RK6**	**RK6.a**	**RK6.b**	**RK7**	**RK7.a**
Biological indicators of water quality	Benthic macroinvertebrate bioassessment score			Good						Good						
BMP treatment	Percent contributing area treated by structural BMPs	Poor	Poor	Poor			Poor			Poor	Poor					
Water temperature	7-day running average maximum temperature during summer and/or during spawning/ incubation period	Poor		Poor							Poor					
Dissolved metal contaminates	Dissolved metals exceeding acute DEQ criteria	Good														
Nutrients	TP and nitrate samples exceeding guidance levels	Poor									Poor					
Suspended solids	TSS exceeding guidance levels	Good									Good					
Water contact human health imitator (*E. coli* bacteria)	*E. coli* bacteria exceedance of DEQ standards at monitoring sites within reach	Fair									Fair					
Forested cover in contributing area	Percent forested land cover in contributing area	Fair	Fair	Fair			Fair			Fair	Fair	Fair			Fair	

Table 5-4. Rock Creek Reach Assessment Results

Aquatic habitat and biological communities		RK1	RK2	TR1	TR1.a	RK2.a	RK3	RK3.a	RK3.b	RK4	RK5	RK6	RK6.a	RK6.b	RK7	RK7.a
Percent pools	Percent of the primary channel area represented by pool habitat	Good	Good	Fair			Fair			Fair	Good	Fair			Fair	
Deep pools	Number of pools greater than 1 meter deep per kilometer of the primary channel	Good	Good	Poor			Good			Poor	Poor	Fair			Poor	
Winter refuge habitat	Percent of total channel area including alcoves and side channels that provide refuge habitat during winter high flow events															
Percent fines in riffles	Percent of substrate in riffles < 2 millimeters in diameter	Good	Good	Poor			Good			Poor	Fair	Poor			Poor	
Percent gravel in riffles	Percent substrate in riffles 2 to 64 millimeters in diameter	Poor	Poor	Fair			Good			Fair	Poor	Poor			Fair	
Pieces of LWD/100m	Pieces of LWD > 0.15 meter in diameter by 3 meters in length per 100 meters of channel length	Fair	Good	Fair			Fair			Poor	Poor	Poor			Poor	
Percent shade	Percent shade from ODFW	Poor	Poor	Good			Good			Good	Good	Poor			Poor	
Riparian buffer and shade	Riparian extent - 25-foot buffer area based on Metro land classification	Good	Good	Good	Good	Good	Good	Good	Good	Good	Good	Good	Good	Good to Poor	Good	Good to Fair
Riparian buffer and shade	Riparian extent - 100-foot buffer area based on Metro land classification	Good	Good	Good	Fair	Good	Good	Good	Fair	Good	Good	Fair	Fair to Poor	Poor	Fair	Fair
Low summer flow	Flow conditions during the late summer and early fall															
Fish diversity abundance	F-IBI scores															
Migration access	Upstream access for both adult and juvenile salmonids	Good	Good	Good	Fair	Good	Fair	Fair	Fair	Fair	Fair to Poor	Fair to Poor	Fair to Poor	Fair	Good	Fair

Table 5-5. Rock Creek Reach Analysis Recommended Management Strategies and Potential Actions

Reach	Recommended management strategy	Upland management opportunities	In-stream restoration opportunities	Riparian corridor opportunities	Programmatic activity opportunities
RK1	High	Upland habitat restoration	• Targeted stream enhancement on public land. • Add LWD with private landowners and partners.		Address stabilization needed for slope failure on the south side of RK1 with the state and the developer.
RK2	Moderate				Protective management to maintain existing conditions.
RK2a	Moderate				Protective management to maintain existing conditions.
TR1	Moderate				Protective management to maintain existing conditions.
TR1A	Intermediate			• Targeted invasive species removal and prevention of re-establishment through ongoing treatment and revegetation with native species. • Increase conifer loading by inter-planting western red cedar.	• Consider removing benthic macroinvertebrate site SD1-M7 because it is too far upstream and may not provide valuable information. • Protective management to protect existing conditions.
RK3	Intermediate			Targeted invasive species removal and prevention of re-establishment through ongoing treatment and revegetation with native species.	Protective management to maintain existing conditions.
RK3A	Intermediate			Targeted invasive species removal and prevention of re-establishment through ongoing treatment and revegetation with native species.	Protective management to maintain existing conditions.
RK3B	Intermediate			Improve riparian shade with private landowners and partners.	
RK4	High		Utilize bio-engineering techniques and enhance riparian function to stabilize actively eroding banks.	• Targeted invasive species removal and prevention of re-establishment through ongoing treatment and revegetation with native species. • Increase conifer loading by inter-planting western red cedar.	Protective management to maintain existing conditions.
RK5	Intermediate			Improve riparian shade with private landowners and partners.	Evaluate fish passage barrier identified by ODFW, near Sunnyside Road and the golf course.

Table 5-5. Rock Creek Reach Analysis Recommended Management Strategies and Potential Actions

Reach	Recommended management strategy	Upland management opportunities	In-stream restoration opportunities	Riparian corridor opportunities	Programmatic activity opportunities
RK6	High	Preserve small tributary and groundwater seep flow and riparian vegetation during development.	Targeted stream enhancement with the developer of the golf course, while the reach is still owned by one entity.	Target improved riparian shade with private landowners and partners.	• Evaluate potential grant funding for buffer restoration and active channel restoration. • Preserve small tributary and groundwater seep flow and riparian vegetation during development.
RK6A	Intermediate	Preserve small tributary and groundwater seep flow and riparian vegetation during development.	Add LWD with private landowners and partners	Improve riparian shade with private landowners and partners	Preserve small tributary and groundwater seep flow and riparian vegetation during development.
RK6B	High	Establish a willing sellers program for wetland restoration to accomplish upper watershed infiltration or install a regional stormwater detention site.		Target improved riparian shade with private landowners and partners.	New monitoring of benthic macroinvertebrates. Divide reach into smaller sections. Evaluate soil characteristics prior to upland management activities to improve infiltration.
RK7	High		Target stream enhancement with private landowners and partners.	Actively manage with private landowners and partners to increase setbacks and target improved riparian shade.	New monitoring of benthic macroinvertebrates and temperature.
RK7A	High		Target stream enhancement, including channel grading, with private landowners and partners.	Actively manage with private landowners and partners to increase setbacks and target improved riparian shade.	New monitoring of benthic macroinvertebrates and temperature.

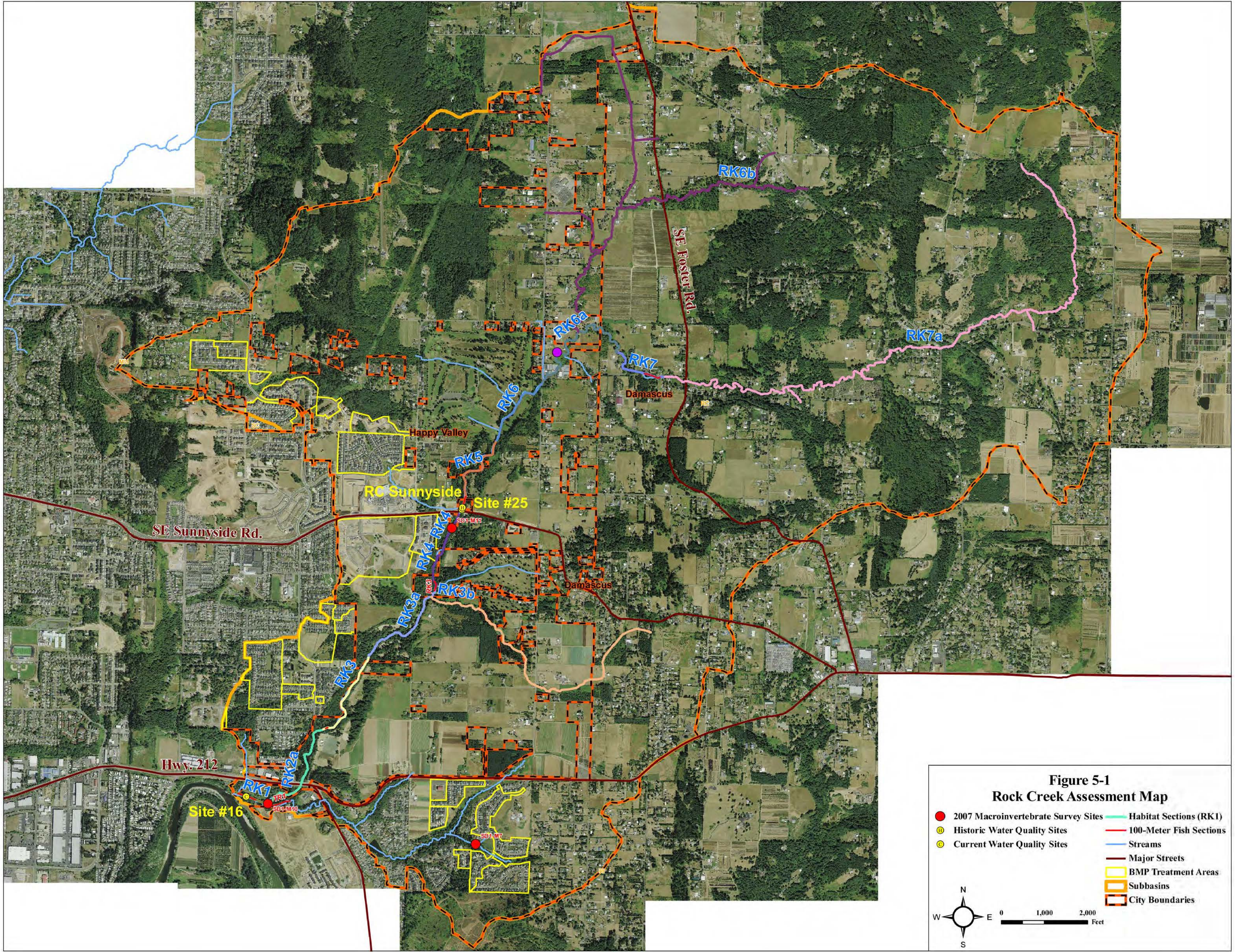


Figure 5-1
Rock Creek Assessment Map

CHAPTER 6 – ACTION PLAN SUMMARY

Overview

As discussed in Chapter 1, the Rock Creek (RC) Watershed Action Plan (Action Plan) includes a Characterization Report, Assessment Report, and an Action Plan Summary. Chapters 1 to 4 comprise the Characterization Report and Chapter 5 contains the Assessment Report. The Action Plan Summary is contained within this chapter.

This chapter builds upon information presented in previous reports and develops potential actions to address issues and opportunities that were described in the Assessment Report. The actions developed include programs, projects, and activities intended to protect or improve watershed health and assist Water Environment Services (WES) in meeting its Level of Service (LOS) goals.

The actions are described in the Action Description Sheets attached to this chapter. The Action Description Sheets identify implementation steps and planning-level cost estimates. The actions have been analyzed and prioritized using scientifically-based criteria and an asset management LOS-based evaluation process. In the future, WES will develop an implementation approach for the actions based on feasibility, expected impact, urgency, and other criteria. The implementation approach will sequence the actions for implementation and identify near-term actions and longer-term actions.

Action Plan Goals and Objectives

WES' over-arching surface water management program goals are to improve and protect water quality and reduce the impacts of urbanization on hydrology. The objective of the Watershed Action Plans (WAP) is to develop basin-specific plans to prioritize District activities and future investments for watershed management.

WES developed LOS in 2009 to guide its program management and activities. The LOS goals for the surface water management program elements are listed below. Further information on the LOS goals and performance measures for the goals is described in Appendix D.

- Environmental Permit Program Management
    - Meet Permit Requirements
    - Reduce Pollutant Loads through Structural Best Management Practices (BMPs)
    - Reduce Pollutant Loads through Non-Structural BMPs
- Environmental Policy and Watershed Health
    - Support Functioning Aquatic Ecosystems
    - Improve Water Quality
    - Improve Aquatic Habitat and Biology
    - Improve Hydrology and Geomorpology
- Erosion Prevention and Sediment Control
    - Conduct Inspections Based on Priority
    - Reduce Water Quality Impacts of Construction

- Program Management
  - Engage in Effective Partnering
  - Ensure Staff Understand Roles; Skills and Resources Meet Needs
  - Collect Monitoring Data Used for Decision-Making
  - Program Evaluation and Effectiveness
- Development Plan Review and Permitting
  - Ensure Development Needs Are Met and Ecosystem Services Protected
- Asset Management
  - Maximize Cost/Benefit of Service
  - Fully Implement the Asset Management Program
  - Ensure the Storm System is Reliable
- Customer Service
  - Implement Sustainability Action Plan
  - Conduct Effective Public Outreach Program
  - Maintain Employee Health and Safety
- Business Management
  - Maximize Use of Alternative Funding Sources
  - Full Capital Improvement Program (CIP) Implementation
  - Ensure Rate Adequacy
  - Budget Management Effectiveness
  - Maintain Appropriate Policies for Watershed Action Plans
- Stormwater Maintenance
  - Regularly Scheduled Maintenance Addressed
  - Scheduled versus Non-Scheduled Maintenance Balanced
  - Request-Driven Maintenance Addressed

Plan Approach

The WAP actions were developed based on the recommended management strategies and potential actions described in the Assessment Report, input provided by Stakeholders during Stakeholder Meetings, and input provided by WES staff. There are many potential actions that WES could undertake as a part of its surface water management program. The project team developed a list of actions that are most likely to assist WES in meeting its LOS goals in the near term. Additional potential actions that are not included in the current Action Plan may be incorporated by WES into longer term actions in the future.

The attached Action Description Sheets provide details on the actions. The Action Description Sheets include the following information:

- **Action Extent and Location.** Actions are categorized by action extent. Action extents include District wide (D), Kellogg-Mt. Scott (KMS), and RC. These abbreviations are the first part of each action number, which is followed by a number. The final combination gives a unique identifier to each action.

- **Potential Lead and Partner Entities.** WES may lead some actions, whereas other actions may be led by the Clackamas County Department of Transportation and Development (DTD) or other agencies.
- **District Lead Group and Supporting Groups.** Within WES, there will be functional work groups that lead each action, and other groups that support the action implementation.
- **Potential Funding Sources.** The potential funding sources listed are anticipated to provide the majority of funding for implementation of an action; additional funding sources may also be used for the actions.
- **Action Description.** The description includes a statement of need, a description of the proposed action and implementation steps, and a summary of the benefits of the action.
- **Planning Level Cost Estimate.** The planning level cost estimate assumptions are described and the initial year costs and ongoing costs are summarized. Costs include full time equivalent staff time as programmatic costs and other implementation costs as capital costs.

Summary of Actions

The WAP contains recommended capital improvement projects, programmatic measures and CIPs that address watershed issues and opportunities identified in the Assessment Report. The WAP includes recommendations for both the KMS and RC watersheds, because they were evaluated at the same time.

Capital Improvement Projects

Capital improvement projects recommended in this plan include stream channel and restoration work in Dean, Mt. Scott, and Rock Creeks as well as construction of a regional decant facility. These actions are listed as capital projects because they are focused primarily on implementation of specific construction activities.

Programmatic Measures

The Action Plan proposes a variety of programmatic measures. Programmatic measures developed for this action plan include the continuation of current District programs and implementation of new programs, which are directed toward regulations, design standards, studies and monitoring, watershed enhancement, policy and practices, customer service, and coordination with other entities.

Capital Improvement and Programmatic Measures

The Action Plan proposes a variety of measures that include both capital improvements and programmatic elements within a larger program effort. The purpose of this approach is to provide the District with programs that will develop, implement, and monitor projects to improve basin hydrology, water quality, and aquatic habitat while also providing capital improvement funding for the implementation of those projects. There are many specific locations in the watersheds where capital projects could be implemented as a part of the combined capital improvement and programmatic measures, as described further in Chapter 5.

A summary table of the actions is provided in Table 6-1. Actions that include elements related to specific Stakeholder Group recommendations are noted. A more detailed summary table is provided at the end of this chapter, along with Action Description Sheets that provide detailed information on each action.

Prioritization

Actions were prioritized based on their capacity to meet the District's LOS goals in a workshop setting with WES staff, using a LOS prioritization tool. The LOS prioritization tool is a decision-support tool for WES. The prioritization score for actions that results from the LOS prioritization process is one of the key factors considered in the implementation sequencing of the Action Plan. Other important considerations included current District opportunities, needs, and planned projects. Table 6-1 below summarizes the high priority actions for 2009-2010 based on the LOS analysis and current District opportunities and needs.

The process for prioritizing the actions included the following steps:

1. Develop LOS goals and performance measures (described in Appendix D)
2. Evaluate current and anticipated future metrics for WES activities against LOS goals and performance measures. Determine the LOS gap for each performance measure (described in Appendix D).
3. Evaluate actions in terms of action's capacity to close the LOS gap for each performance measure using consistent LOS prioritization tool that provides scores for prioritization of each action.
4. Evaluate prioritization scores for each action as well as other factors such as current District opportunities, needs, and currently planned projects. Develop list of High Priority Actions for 2009-2010 implementation.
5. Adaptively manage Action Plan prioritization as needed to reflect changing priorities and opportunities.

Implementation

To implement the Action Plans, the WES Surface Water Management Steering Committee is conducting the following activities:

- Organizing work into Program Categories
- Developing multi-year budgeting outlook
  - Under current funding
  - Under proposed LOS funding

Implementation of the Action Plan will depend on the available resources. WES operates the Districts and provides wastewater and surface water management services using revenue from several sources. The Surface Water Management Program for Clackamas County Service District No. 1 is funded through three primary sources: monthly surface water management utility fees, system development charges, and permit fees. WES currently spends approximately $0.5 million annually on the existing programmatic elements of the Surface Water Management Program. These program elements are described in Appendix A. The amount of capital expenditures made by WES each year varies.

The recommended actions summarized in Table 6-1 describe programmatic activities and capital expenditures that will move WES toward meeting its LOS goals. It is anticipated that as part of implementing the WAPs, WES will evaluate resources and funding to support the Action Plans and to meet future LOS goals.

The estimated cost for implementing all recommended actions over a 5-year period is approximately $22.4 million, an average of approximately $4.5 million per year. The estimated cost for implementing the Action Plans over a 5-year period is presented in 2009 dollars. Of the approximately $4.5 million per year in expenditures recommended in the Action Plans, approximately $1.0 million (20 percent) is for programmatic elements and approximately $3.5 million (80 percent) is for capital expenditures.

Table 6-1. WES Watershed Action Plan Summary

Action Name[1]	5-Year Cost (2009 dollars[2])	High Priority 2009-2010	Stakeholder Recommendations[3]
D-19 Stakeholder Communication Plan	$200,000	X	X
D-7 Update Erosion Control Protocol	$72,000	X	
RC-2 Regional Detention Prop Ac	$3,540,000	X	
D-3 Integrated Monitoring Program	$354,000	X	X
D-10 Benthic Macro Surveys	$390,750	X	X
D-4 Channel Morph Monitoring	$315,000	X	
D-11 Microbial Source Study	$106,000	X	
D-1 Update SW Design Standards	$355,200	X	X
D-5 Improve Riparian Buffer	$600,000	X	X
D-2 SW Detention Retrofit	$412,000	X	X
KMS-1 Enhanced Street Sweeping	$572,000	X	X
RC-1 Wetlands Reach RK5	$1,434,238		X
RC-5 Pilot Graham Creek Basin	$500,000		X
D-13 WET Retrofit Program	$1,400,000		X
KMS-3 Dean Creek Wetlands	$741,000		X
D-8 Erosion Control Hotline	$33,800		X
KMS-4 Mt. Scott in 3 Creeks	$253,692		X
D-20 Regional SW Task Force	$40,000		X
KMS-5 Flood-prone Culverts	$417,500		
KMS-6 Willing-seller Program	$2,048,000		X
D-12 Street Retrofit Program	$1,032,000		X
KMS-8 WQ Man-made Lakes	$43,375		X
D-14 Private WQ Inventory	$560,000		X
RC-4 Riparian Buffer Acq RC5	$270,000		X
RC-3 Riparian Buffer RK1 RK2	$76,000		X
KMS-9 Kellogg-for-Coho Initiative	$3,200		X
D-9 Track Flood Complaints	$20,000		
D-16 LWD with Partners	$133,750		X
KMS-2 Evaluate Low Summer Flow	$16,000		X
D-18 Improve fish passage	$1,667,000		X
D-17 Invasive Species Management	$140,000		X
D-6 Upland Tree Canopy	$165,000		X
D-15 Riparian Buffer Analysis	$20,000		X
D-21 Regional Decant Facility	$2,000,000		
D-22 (AEX) Erosion Control	$330,145	X	
D-23 (AEX) Sampling/WQ	$170,960	X	
D-24 (AEX) Spills/Illicit Discharges	$68,435	X	
D-25 (AEX) Planning and Projects	$463,300	X	
D-26 (AEX) On-Site Maintenance	$885,165	X	
D-27 (AEX) Regulatory	$234,570	X	

Table 6-1. WES Watershed Action Plan Summary

Action Name[1]	5-Year Cost (2009 dollars[2])	High Priority 2009-2010	Stakeholder Recommendations[3]
D-28 (AEX) Customer Service Coordination	$102,035	X	
D-29 (AEX) Intergovernmental Coordination	$99,495	X	
D-30 (AEX) SWM Program Administration	$133,340	X	

[1] In the Action Names, D signifies a District-wide action, KMS signifies an action in the Kellogg-Mt. Scott watershed, RC signifies an action in the Rock Creek watershed, and AEX signifies an existing program element.

[2] Five-year cost estimates are in 2009 dollars and do not include inflation or the cost of capital.

[3] Denotes actions that include specific recommendations provided by Stakeholder Group.

ACTION PLAN SUMMARY
ACTION PLAN DESCRIPTION SHEETS

WES Watershed Action Plan - Summary of Actions
6-26-09

Action Number	Action Name	Action Type	Total Years Implemented (1-5)	Total Cost Unadjusted (2009 dollars)	Total Cost with combined Cost of Capital and Inflation of 3.2% (2009 dollars)
D-1 (EAP)	Update stormwater design standards	Programmatic	3	$ 355,200	$ 373,082
D-2 (EAP)	Evaluate and prioritize retrofit of stormwater detention facilities	Programmatic	5	$ 412,000	$ 459,827
D-3	Develop Integrated Monitoring Program	Programmatic	5	$ 354,000	$ 392,606
D-4	Channel Morphology monitoring	Programmatic	5	$ 315,000	$ 346,971
D-5	Improve riparian buffer with private landowners and partners	Programmatic and Capital	5	$ 600,000	$ 660,117
D-6	Improve upland tree canopy with private landowners and partners	Programmatic and Capital	5	$ 165,000	$ 181,532
D-7	Update Erosion Prevention and Sediment Control protocol	Programmatic	5	$ 72,000	$ 79,760
D-8 (EAP)	Add an erosion control hotline number and signs for construction sites	Programmatic	5	$ 33,800	$ 36,859
D-9	Track flooding complaints with DTD	Programmatic	5	$ 20,000	$ 22,004
D-10 (EAP)	Perform additional benthic macro-invertebrate surveys	Programmatic	5	$ 390,750	$ 429,901
D-11	Microbial Source Tracking study	Programmatic and Capital	1	$ 106,000	$ 109,392
D-12	Stormwater quality retrofit program for streets and street-related drainage	Programmatic and Capital	5	$ 1,302,000	$ 1,431,636
D-13	Stormwater quality retrofit program for institutional, commercial, and residential landowners	Programmatic and Capital	5	$ 1,400,000	$ 1,540,274
D-14	Private Water Quality facility inventory and inspections	Programmatic	5	$ 560,000	$ 618,837
D-15 (EAP)	Riparian buffer analysis and prioritization for enhancement	Programmatic	1	$ 20,000	$ 20,900
D-16	Add LWD with private landowners and partners	Programmatic and Capital	5	$ 133,750	$ 147,151
D-17	Targeted invasive species management	Programmatic and Capital	5	$ 140,000	$ 154,027
D-18	Improve Fish Passage	Programmatic	5	$ 1,667,000	$ 1,859,463
D-19	Stakeholder Involvement and Communications Plan Implementation	Programmatic	5	$ 200,000	$ 220,039
D-20	Regional Stormwater Task Force	Programmatic	5	$ 40,000	$ 44,008
D-21	Regional Decant Facility	Capital	1	$ 2,000,000	$ 2,064,000

WES Watershed Action Plan - Summary of Actions

6-26-09

Action Number	Action Name	Action Type	Total Years Implemented (1-5)	Total Cost Unadjusted (2009 dollars)	Total Cost with combined Cost of Capital and Inflation of 3.2% (2009 dollars)
KMS-1	Enhanced street sweeping	Programmatic	5	$ 572,000	$ 607,489
KMS-2	Investigate water rights and water withdrawals	Programmatic	1	$ 16,000	$ 16,512
KMS-3	Enhance Dean Creek wetlands and stream channel	Capital	3	$ 741,250	$ 787,608
KMS-4	Enhance Mount Scott Creek channel in Three Creeks Area	Capital	3	$ 253,692	$ 261,995
KMS-5	Evaluate flood-prone culverts and options for reducing impacts	Programmatic	2	$ 417,500	$ 442,881
KMS-6	Willing-seller property acquisition program	Programmatic and Capital	5	$ 2,048,000	$ 2,286,753
KMS-8 (EAP)	Evaluate water quality impacts of human-made lakes	Programmatic	1	$ 43,375	$ 44,763
KMS-9 (EAP)	Involvement in City of Milwaukie's Kellogg-for-Coho initiative	Programmatic	2	$ 3,200	$ 3,355
RC-1	Enhance Rock Creek wetlands in Reach RK5	Capital	3	$ 1,167,307	$ 1,240,504
RC-2	Evaluate regional detention needs and opportunities	Programmatic	5	$ 3,540,000	$ 3,894,692
RC-3	Enhance riparian buffer in reach RC1 and RC2	Programmatic and Capital	5	$ 76,000	$ 84,570
RC-4	Riparian buffer acquisition or conservation easements in reach RC5	Programmatic	5	$ 270,000	$ 297,053
RC-5	Pilot improvement basin in Graham Creek basin	Programmatic	5	$ 500,000	$ 550,098
D-22 (AEX)	Erosion Control - Existing Program Elements	Programmatic	5	$ 330,145	$ 363,224
D-23 (AEX)	Sampling/WQ - Existing Program Elements	Programmatic	5	$ 170,960	$ 188,089
D-24 (AEX)	Spills/Illicit Discharges - Existing Program Elements	Programmatic	5	$ 68,435	$ 75,292
D-25 (AEX)	Planning & Projects - Existing Program Elements	Programmatic	5	$ 463,300	$ 509,721
D-26 (AEX)	On-Site Maintenance - Existing Program Elements	Programmatic	5	$ 885,165	$ 973,855
D-27 (AEX)	Regulatory - Existing Program Elements	Programmatic	5	$ 234,570	$ 258,073
D-28 (AEX)	Customer Service Coordination - Existing Program Elements	Programmatic	5	$ 102,035	$ 112,258
D-29 (AEX)	Intergovernment Coordination - Existing Program Elements	Programmatic	5	$ 99,495	$ 109,464
D-30 (AEX)	SWM Program Admin - Existing Program Elements	Programmatic	5	$ 133,340	$ 146,700
	Total			$ 22,422,300	$ 24,447,300

Action Name: Update Stormwater Design Standards
Action # D-1 (EAP)
Action Type: Programmatic
Action Extent: District-wide
Priority Ranking: -

	Watershed	Basin	Lat	Long	Modeling Subbasin	Reach(es)				
Action Location:	Multiple	-	-	-	-	-	-	-	-	-

Potential lead entity:	WES			**WES Lead:**	Asset Management	**Potential funding sources:**	WES (Rates)
Partner entities:	DTD Clackamas Co.	**Partner entities:**		**WES Support:**	Development Review	**Potential funding sources:**	
Partner entities:	City of Happy Valley	**Partner entities:**		**WES Support:**	Env. Policy & Watershed Health	**Potential funding sources:**	
Partner entities:	City of Damascus	**Partner entities:**		**WES Support:**		**Potential funding sources:**	

Action Description (see backside of sheet for more details)

Statement of Need: Stormwater Design Standards for the Districts are used within the Districts and by the City of Happy Valley. DTD has also begun applying the Stormwater Design Standards to some development outside the Districts. The Stormwater Design Standards for the Districts are not serving the stormwater management needs of the Districts. To address the Districts interest in the application of Low Impact Development (LID), sustainable stormwater management techniques, and other enhancements to development practices to further protect water quality and ecosystem services the Stormwater Design Standards should be updated.

Proposed Action - Implementation Steps: Updating the Stormwater Design Standards would include developing updated guidance on stormwater technologies and design criteria to serve the needs of the Districts. Components of the revision typically include revising documents, revising standard detail drawings, stakeholder involvement, updating rules, regulations and ordinances, developing a sizing tool, and workshops for WES staff and developer design engineers. Other options include developing a graphically-focused handbook on LID specific to Clackamas County conditions to increase successful application of LID techniques by developers in the County.

Items to address during the update include:

1) Design storms - Determine if Districts will continue to use existing design storms or evaluate new design storms for water quality and quantity volume management
2) Volume requirements - Evaluate the benefits and costs of requiring control for a) small water quality storms and b) larger flood control storms
3) LID - Develop standard details and guidance for implementing on-site vegetated SW facilities in a variety of soil and slope conditions
4) Thresholds for new development - Determine if threshold for requiring SW treatment will be reduced from current requirements to increase re-developed areas adding SW treatment
5) Design guidance - Enhance standard details and design guidance to include additional guidance for attractive and functional pond design, process for creating SW facilities as neighborhood amenities, and providing adequate maintenance access
6) Buffer enhancement - Evaluate the benefits and costs of requiring riparian buffer enhancement during development linked to Title 13 requirements (similar to CWS requirements), and inspection and enforcement of buffers during infrastructure acceptance inspections
7) Design standards use and exemptions - Evaluate process for exemptions/exceptions, work with DTD to implement policy requiring use of design standards for all public and private projects, evaluate in-lieu-of fee options for regional flood detention.

Benefits of Action: Updating the Stormwater Design Standards could significantly improve or maintain water quality, reduce development-related flooding, and reduce hydromodification, in the short term in areas where there will be extensive new development and in the long term as areas are re-developed. The Happy Valley area and Damascus are two areas that could see short term results if anticipated development in these areas occurs.

Action Cost Summary (see backside for detailed cost estimate)

						Subtotal
Initial Programmatic FTE estimate:	0.3	**Initial Programmatic FTE Cost:**	$ 24,000	**Initial Capital Cost Summary:**	$150,000	*$ 174,000*
Ongoing Programmatic FTE estimate:	0.20	**Ongoing Programmatic FTE Cost:**	$ 15,600	**Annual Ongoing Capital Cost (year 2 only)**	$150,000	*$ 165,600*
		(Programmatic Cost Summary is the FTE estimate translated into dollars)		**Years of Ongoing Cost Past Yr 1 included**		*2*
				Total Estimated 5-year Programmatic and Capital Cost		*$ 355,200*

Action Name: Update Stormwater Design Standards

Action # D-1 (EAP)

Action Type: Programmatic

Action Extent: District-wide

Priority Ranking: -

	Watershed	Basin	Lat	Long	Modeling Subbasin	Reach(es)				
Action Location:	Multiple	-	-	-	-	-	-	-	-	-

Proposed Action - Implementation Steps (continued):

Attachments to describe Implementation Steps further? No

Pathway for attachment(s):

Proposed Action - Implementation Steps (continued): Implementation includes the following steps:
1) Select WES project manager and project team, develop RFP for consultants
2) Review consultant proposals, select consultant team
3) Conduct meetings and workshops with consultant team and project team to address items listed on page 1 of action description
4) Develop new standards and design guidance
5) Conduct internal and external workshops to explain new standards and address questions

Detailed Cost Breakdown

Initial Implementation Cost Assumptions: The estimated cost for this project will depend on the scope of the project including the level of modifications the Districts decide to make to the existing design standards, the complexity of the sizing tool, and the tasks the Districts decide to perform in-house. A high range cost estimate is provided below to reflect the upper end of the scope of the project. Assumes WES Project Manager - 1 staff 20 hours/month, 12 months; WES Project Review Team - 6 staff meet 24 times for 2 hours; Workshops - 12 staff meet 4 times for 2 hours;

Ongoing Cost Assumptions: Ongoing staff training - 6 staff meet 12 times for 2 hours per year during years 2 and 3 to review submitted/completed projects and evaluate benefits and drawbacks of design alternatives, discuss opportunities for improvements and lessons learned. Ongoing developer training - 3 staff meet with developers and development engineers 12 times per year for 3 hours during years 2 and 3 to educate developers on changes in the design standards and discuss opportunities for improvements and lessons learned. Preparation and materials for the developer trainings include 152 hours for staff to develop training program. An additional $150,000 was added for a consultant to continue more detailed work on the SW Design Standards in year 2, which could include development of a sizing tool.

Initial Implementation Cost Estimate:

Item	Quantity	Unit	Unit Cost	Estimated Cost
FTE summary	0.3	FTE	$ 80,000	$ 24,000
Consultant	1	each	$ 150,000	$ 150,000
				$ -
				$ -
				$ -
				$ -
Raw Cost				$ 174,000
Engineering, Administration, Contingency*			35%	$ -
Sub-total				$ 174,000
Land Costs		acre	$ 100,000	$ -
Total Estimated Initial Implementation Costs (2009 dollars) *				$ 174,000

Ongoing Cost Estimate: Project Life Past Yr 1 (yrs) 2

Item	Quantity	Unit	Unit Cost	Estimated Cost
FTE summary	0.07	FTE	$ 80,000	$ 5,600
Developer Training	0.125	FTE	$ 80,000	$ 10,000
Additional Consultant Work	1	each	$150,000	$ 150,000
				$ -
				$ -
Raw Cost				$ 165,600
Engineering, Administration, Contingency*			35%	$ -
Sub-total				$ 165,600
Land Costs		acre	$100,000	$ -
Annual Ongoing Costs (2009 dollars)				$ 165,600
Total Ongoing Cost Over Project Life (2009 dollars)				$ 181,200

* Contingency and engineering mark-ups for capital projects only. Mark-ups linked to action type in cell C2

Action Name:	Evaluate and Prioritize Retrofit of SW Detention Facilities						**Action #**	D-2 (EAP)		
Action Type:	Programmatic			**Action Extent:**	District-wide		**Priority Ranking:**			-
	Watershed	**Basin**	**Lat**	**Long**	**Modeling Subbasin**	**Reach(es)**				
Action Location:	Multiple	-	-	-	-	-	-	-	-	-

Potential lead entity:	WES			**WES Lead:**	Asset Management	**Potential funding sources:**	WES (Rates)
Partner entities:	City of Happy Valley	**Partner entities:**		**WES Support:**	Stormwater Maintenance	**Potential funding sources:**	City of Happy Valley
Partner entities:	City of Damascus	**Partner entities:**		**WES Support:**		**Potential funding sources:**	City of Damascus
Partner entities:		**Partner entities:**		**WES Support:**		**Potential funding sources:**	Grants

Action Description (see backside of sheet for more details)

Statement of Need: WES is currently responsible for maintaining over 260 stormwater treatment ponds in the Districts and Happy Valley. Over 30 ponds in the Districts have been identified by WES staff as potential opportunities to retrofit to function better. The ponds that WES maintains were originally designed and constructed with various functions in mind (e.g., differing levels of flood control and water quality treatment), and at different stages of understanding of stormwater treatment opportunities to improve watershed health. There are opportunities to retrofit existing ponds to improve their function to better meet WES' watershed health goals and improve maintenance.

Proposed Action - Implementation Steps: Create a stormwater treatment pond retrofit plan that would allocate annual CIP funds for the retrofit of several ponds each year. The estimated cost for retrofitting ponds ranges from $10,000 to $50,000 or more per pond for smaller scale projects. The recommended budget of $100,000 per year would provide funds to retrofit approximately 1-5 ponds per year, depending on the scope of the projects.

1. Identify employees with knowledge of SW dention retrofit needs and select WES project manager
2. Set project goals - goals should include amount of money to be spent annually on SW detention retrofit and detention pond performance
3. Prioritize detention pond retrofit projects
3. Identify partners and funding sources
4. Develop design and detailed cost estimate for projects - includes modeling to determine impacts on flooding
5. Secure project funding
6. Annually implement CIPs
7. Develop effectiveness monitoring element

See attached for a list of detention ponds in need of retrofit that was compiled by WES staff.

Benefits of Action:

Improvement of detention ponds could significantly improve stormwater quality and riparian conditions in the Districts

Action Cost Summary (see backside for detailed cost estimate)

						Subtotal
Initial Programmatic FTE estimate:	0.07	**Initial Programmatic FTE Cost:**	$ 5,600	**Initial Capital Cost Summary:**	$ -	*$ 5,600*
Ongoing Programmatic FTE estimate:	0.02	**Ongoing Programmatic FTE Cost:**	$ 1,600	**Annual Ongoing Capital Cost**	$100,000	*$ 101,600*
		(Programmatic Cost Summary is the FTE estimate translated into dollars)		**Years of Ongoing Cost Past Yr 1 included**		*4*
				Total Estimated 5-year Programmatic and Capital Cost		*$ 412,000*

Action Name: Evaluate and Prioritize Retrofit of SW Detention Facilities

Action # D-2 (EAP)

Action Type: Programmatic

Action Extent: District-wide

Priority Ranking: -

	Watershed	Basin	Lat	Long	Modeling Subbasin	Reach(es)				
Action Location:	Multiple	-	-	-	-	-	-	-	-	-

Proposed Action - Implementation Steps (continued):

Attachments to describe Implementation Steps further? Yes

Pathway for attachment(s): See attached figures and retrofit write up

Proposed Action - Implementation Steps (continued):

Examples of pond retrofits include adding berms and weirs to slow flow progress and create a low flow channel through the treatment area and increase treatment detention time, adding native vegetation to improve water quality treatment, making modifications to ensure ponds operate properly to avoid causing stream temperatures to increase, and making modifications to the outflow structures to provide detention for smaller storm events.

Detailed Cost Breakdown

Initial Implementation Cost Assumptions:

The first year cost includes design and prioritization of detention pond retrofits, capital improvements will follow in years 2-5

Ongoing Cost Assumptions:

1-5 detention ponds are retrofitted per year at an average annual cost of $100,000/year. Ongoing costs are annualized

Initial Implementation Cost Estimate:

Item	Quantity	Unit	Unit Cost	Estimated Cost
FTE Summary	0.07	FTE	$ 80,000	$ 5,600
				$ -
				$ -
				$ -
				$ -
				$ -
				$ -
				$ -
Raw Cost				$ 5,600
Engineering, Administration, Contingency*			35%	$ -
Sub-total				$ 5,600
Land Costs		acre	$ 100,000	$ -
Total Estimated Initial Implementation Costs (2009 dollars) *				$ 5,600

Ongoing Cost Estimate:

Project Lifetime (yrs) 4

Item	Quantity	Unit	Unit Cost	Estimated Cost
FTE Summary	0.02	FTE	$ 80,000	$ 1,600
Annual Retrofit Budget	1	yr	$ 100,000	$ 100,000
				$ -
				$ -
				$ -
				$ -
				$ -
Raw Cost				$ 101,600
Engineering, Administration, Contingency*			35%	$ -
Sub-total				$ 101,600
Land Costs		acre	$ 100,000	$ -
Annual Ongoing Costs (2009 dollars)				$ 101,600
Total Ongoing Cost Over Project Life (2009 dollars)				$ 406,400

* Contingency and engineering mark-ups for capital projects only. Mark-ups linked to action type in cell C2

Action Name:	Develop and Implement Integrated Monitoring Program						**Action #**	D-3	
Action Type:	Programmatic		**Action Extent:**	District-wide			**Priority Ranking:**		-
	Watershed	**Basin**	**Lat**	**Long**	**Modeling Subbasin**	**Reach(es)**			
Action Location:	Multiple	-	-	-	-	-	-	-	- -

Potential lead entity:	WES			**WES Lead:**	Env. Monitoring & Regulatory	**Potential funding sources:**	WES (Rates)
Partner entities:	City of Happy Valley	**Partner entities:**		**WES Support:**	Env. Policy & Watershed Health	**Potential funding sources:**	
Partner entities:	City of Damascus	**Partner entities:**		**WES Support:**	Asset Management	**Potential funding sources:**	
Partner entities:	Nonprofit Groups	**Partner entities:**		**WES Support:**	Public Information	**Potential funding sources:**	

Action Description (see backside of sheet for more details)

Statement of Need: WES conducts a variety of environmental monitoring activities including water quality (in-stream, outfall, special studies), continuous flow, benthic macroinvertebrate, fish monitoring, in-stream habitat, and erosion control program monitoring at locations throughout the KMS and RC watersheds as well as other watersheds in the Districts. Figure 3-1 in both Characterization Reports illustrates the current monitoring sites in the KMS and RC watersheds. There is an opportunity to enhance the effectiveness and usefulness of monitoring activities and analysis of monitoring data and studies to target questions regarding progress toward meeting level of service goals, environmental conditions, trends, and the proposed Watershed Health Index (WHI) metrics, and program effectiveness.

Proposed Action - Implementation Steps:

The WES Stormwater Steering Committee began evaluating the monitoring program in 2009. This action includes recommended steps for the Steering Committee monitoring program development as well as implementation cost estimates to use for planning purposes until a more detailed plan is developed.

1) Determine objectives and questions to be answered through monitoring program
2) Evaluate monitoring options for meeting objectives - on-going monitoring (hand sampling vs. automated sampling, wireless data collection), special studies, literature reviews, etc.
3) Prioritize monitoring program elements and develop schedule for program implementation
4) Identify staffing needs and consultant budgets for in-house and external monitoring implementation, sampling protocols, and data analysis
5) Implement integrated monitoring program, track results and annually evaluate effectiveness and potential improvements

Benefits of Action: Developing an integrated monitoring program will support informed stormwater management decision-making and meeting LOS service, as well as NPDES MS4 permit compliance.

Action Cost Summary (see backside for detailed cost estimate)

						Subtotal
Initial Programmatic FTE estimate:	0.05	**Initial Programmatic FTE Cost:**	$ 4,000	**Initial Capital Capital Cost Summary:**	$ 30,000	*$ 34,000*
Ongoing Programmatic FTE estimate:	0.5	**Ongoing Programmatic FTE Cost:**	$ 40,000	**Annual Ongoing Capital Cost**	$ 40,000	*$ 80,000*
		(Programmatic Cost Summary is the FTE estimate translated into dollars)		**Years of Ongoing Cost Past Yr 1 included**		*4*
				Total Estimated 5-year Programmatic and Capital Cost		*$ 354,000*

Action Name: Develop and Implement Integrated Monitoring Program

Action # D-3

Action Type: Programmatic

Action Extent: District-wide

Priority Ranking: -

	Watershed	Basin	Lat	Long	Modeling Subbasin	Reach(es)				
Action Location:	Multiple	-	-	-	-	-	-	-	-	-

Proposed Action - Implementation Steps (continued):

Attachments to describe Implementation Steps further? No

Pathway for attachment(s):

Proposed Action - Implementation Steps (continued):

Detailed Cost Breakdown

Initial Implementation Cost Assumptions: Assume WES Steering Sub-Committee forms and meets weekly to address monitoring questions and develop integrated monitoring program. Assume additional WES staff time of 18 hours per month for 6 months to assist in detailed program development. Assume consultant hired to assist in development of integrated monitoring program following completion of Watershed Action Plans.

Ongoing Cost Assumptions: Assume additional 0.5 FTE WES staff required to oversee monitoring program and analyze results. Assume lump sum for additional budget required to implement additional water quality monitoring. This action does not include cost to implement additional benthic macroinvertebrate, channel morphology, and microbial source tracking studies - those costs are addressed in actions D-4, D-10, and D-11, respectively.

Initial Implementation Cost Estimate:

Item	Quantity	Unit	Unit Cost	Estimated Cost
FTE summary	0.05	FTE	$ 80,000	$ 4,000
Consultant	200	hrs	$ 150	$ 30,000
				$ -
				$ -
				$ -
				$ -
				$ -
				$ -
Raw Cost				$ 34,000
Engineering, Administration, Contingency*			35%	$ -
Sub-total				$ 34,000
Land Costs		acre	$ 100,000	$ -
Total Estimated Initial Implementation Costs (2009 dollars) *				$ 34,000

Ongoing Cost Estimate: Project Life Past Yr 1 (yrs) 4

Item	Quantity	Unit	Unit Cost	Estimated Cost
FTE summary	0.5	FTE	$ 80,000	$ 40,000
Water quality monitoring	1	LS	$ 40,000	$ 40,000
				$ -
				$ -
				$ -
				$ -
				$ -
Raw Cost				$ 80,000
Engineering, Administration, Contingency*			35%	$ -
Sub-total				$ 80,000
Land Costs		acre	$100,000	$ -
Annual Ongoing Costs (2009 dollars)				$ 80,000
Total Ongoing Cost Over Project Life (2009 dollars)				$ 320,000

* Contingency and engineering mark-ups for capital projects only. Mark-ups linked to action type in cell C2

Action Name:	Channel Morphology Monitoring			**Action #**	D-4
Action Type:	Programmatic	**Action Extent:**	District-wide	**Priority Ranking:**	-

	Watershed	**Basin**	**Lat**	**Long**	**Modeling Subbasin**	**Reach(es)**				
Action Location:	Multiple	-	-	-	-	-	-	-	-	-

Potential lead entity:	WES			**WES Lead:**	Env. Policy & Watershed Health	**Potential funding sources:**	WES (Rates)
Partner entities:	City of Happy Valley	**Partner entities:**		**WES Support:**	Env. Monitoring & Regulatory	**Potential funding sources:**	
Partner entities:	City of Damascus	**Partner entities:**		**WES Support:**	GIS	**Potential funding sources:**	
Partner entities:		**Partner entities:**		**WES Support:**		**Potential funding sources:**	

Action Description (see backside of sheet for more details)

Statement of Need: Stormwater runoff affects watershed hydrology and stream hydraulics. Conducting channel cross-section monitoring to evaluate changing channel morphology conditions in a variety of locations throughout the watersheds will provide valuable information to WES about hydromodification impacts and channel stability. The ODFW surveys of streams has included some qualitative assessment of channel stability, however more detailed and quantitative data is needed.

Proposed Action - Implementation Steps:

Implementing a channel morphology monitoring program will include the following steps.
1) Select WES Project Manager, develop RFP for consultants, select consultant
2) Select monitoring sites (sections of channel 10-20 bankfull widths [500-1000 feet]); obtain landowner permission for access; Monument sites for permanent monitoring identification
4) Conduct monitoring • Longitudinal profile: Measurement of thalweg profile. Start and end locations should be identified clearly and photo points established.
• Cross sections: 3-5 per monitoring site. Cross-sections end points should be monumented out of the 100-year floodplain and photo points established.
• Pool depths: Maximum pool depth and residual pool depth should be measured in each pool throughout the monitoring reach. Repeat measurements, averaged will give you a sense of sedimentation within the reach.
• Pebble Counts: Surficial substrate conditions (Wolman, 1954) should be measured at a pool tail and within a riffle for each reach. Used to calculate D16, D50, and D84.
• Bulk sample: A bulk sample of bed conditions in a representative pool tail out should be taken according to McNeil and Ahnell (1964).
• Bank erosion: Bank conditions within the project reach should be assessed for active erosion. Changes in bank conditions is an important metric for understanding the impacts of geomorphic instability (e.g. – observed downcutting, etc).
5) Analyze monitoring results and develop recommended actions to address problems identified
6) Repeat monitoring at sites at every year and more frequently if significant development activity is occurring upstream.

Benefits of Action: Understanding hydromodification impacts and channel stability will assist in informed stormwater management decision-making, in assessing and meeting LOS, and potentially in compliance with future NPDES MS4 permit requirements.

Action Cost Summary (see backside for detailed cost estimate)

						Subtotal
Initial Programmatic FTE estimate:	0.04	**Initial Programmatic FTE Cost:**	$ 3,200	**Initial Capital Cost Summary:**	$ 55,000	*$ 58,200*
Ongoing Programmatic FTE estimate:	0.04	**Ongoing Programmatic FTE Cost:**	$ 3,200	**Annual Ongoing Capital Cost**	$ 61,000	*$ 64,200*
		(Programmatic Cost Summary is the FTE estimate translated into dollars)		**Years of Ongoing Cost Past Yr 1 included**		*4*
				Total Estimated 5-year Programmatic and Capital Cost		*$ 315,000*

Action Name: Channel Morphology Monitoring

Action # D-4

Action Type: Programmatic

Action Extent: District-wide

Priority Ranking: -

	Watershed	Basin	Lat	Long	Modeling Subbasin	Reach(es)				
Action Location:	Multiple	-	-	-	-	-	-	-	-	-

Proposed Action - Implementation Steps (continued):

Attachments to describe Implementation Steps further? No

Pathway for attachment(s):

Proposed Action - Implementation Steps (continued): Monitoring Site Recommendations:

Kellogg – Mt Scott: Lower Kellogg (confined reach) (KG1), Upper Kellogg (above Thiessen Road) (KG3a), Three Creeks Area (MS3), Mt. Scott (downstream of Sunnyside) (MS8.a), Mt Scott (steep reach) (MS10), Upper Mt. Scott (MS12.a), 2 Tributaries to compare to mainstem (MS11.b and PH1)

Rock Creek: Lower Rock Creek (below 224/212) (RK1), Middle Rock (below Sunnyside)(RK4), Middle Rock (between Sunnyside & Foster) (RK7), Tributary in Golf Course above Sunnyside (Unnamed trib of RK6), Upper Rock (RK7.a), Northern Branch of Rock Creek (RK6.b), 2 Tributaries to compare to mainstem (RK3.b and unnamed trib to east of RK6.a)

Detailed Cost Breakdown

Initial Implementation Cost Assumptions: Assume WES project manager provides 80 hours for project oversight and analysis. Assume consultant performs surveys and analysis for 20 sites (16 in KMS and RC, 4 in other watersheds), estimated cost of $2,000 per site which includes 2-person field crew and $250 lab fee to analyze bulk sample of soil. Assume consultant provides assistance with analysis and reporting for 20 sites, estimated cost of 100 hours.

Ongoing Cost Assumptions: Assumes monitoring performed every year, for four additional surveys during 5-year period after initial survey. Assume consultant provides assistance with analysis and reporting for 20 sites, with additional effort to compare results to prior surveys, estimated cost of 140 hours.

Initial Implementation Cost Estimate:

Item	Quantity	Unit	Unit Cost	Estimated Cost
FTE summary	0.04	FTE	$ 80,000	$ 3,200
Consultant - surveys	20	sites	$ 2,000	$ 40,000
Consultant - reporting	100	hours	$ 150	$ 15,000
				$ -
				$ -
				$ -
				$ -
				$ -
Raw Cost				$ 58,200
Engineering, Administration, Contingency*			35%	$ -
Sub-total				$ 58,200
Land Costs		acre	$ 100,000	$ -
Total Estimated Initial Implementation Costs (2009 dollars) *				$ 58,200

Ongoing Cost Estimate: Project Life Past Yr 1 (yrs) 4

Item	Quantity	Unit	Unit Cost	Estimated Cost
FTE summary	0.04	FTE	$ 80,000	$ 3,200
Consultant - surveys	20	sites	$ 2,000	$ 40,000
Consultant - reporting	140	hours	$ 150	$ 21,000
				$ -
				$ -
				$ -
				$ -
Raw Cost				$ 64,200
Engineering, Administration, Contingency*			35%	$ -
Sub-total				$ 64,200
Land Costs		acre	$100,000	$ -
Annual Ongoing Costs (2009 dollars)				$ 64,200
Total Ongoing Cost Over Project Life (2009 dollars)				$ 256,800

* Contingency and engineering mark-ups for capital projects only. Mark-ups linked to action type in cell C2

Action Name:	Improve Riparian Buffer with Private Landowners and Partners			**Action #**	D-5
Action Type:	Programmatic & Capital	**Action Extent:**	District-wide	**Priority Ranking:**	-

	Watershed	**Basin**	**Lat**	**Long**	**Modeling Subbasin**	**Reach(es)**				
Action Location:	Multiple	-	-	-	-	-	-	-	-	-

Potential lead entity:	WES			**WES Lead:**	Env. Policy & Watershed Health	**Potential funding sources:**	Grants
Partner entities:	DTD Clackamas Co.	**Partner entities:**	City of Happy Valley	**WES Support:**	Env. Monitoring & Regulatory	**Potential funding sources:**	WES (Devel. Fees)
Partner entities:	Parks Clackamas Co.	**Partner entities:**	City of Damascus	**WES Support:**	GIS	**Potential funding sources:**	
Partner entities:	City of Milwaukie	**Partner entities:**	PGE	**WES Support:**		**Potential funding sources:**	

Action Description (see backside of sheet for more details)

Statement of Need: Riparian canopies and upland forests have been altered and removed in portions of the watershed, leaving the streams open to increased heat gain from solar radiation. Increasing riparian buffer is recommended in reaches that have poor temperature, percent shade, and/or riparian buffer shade. Preservation and enhancement of streams generate ongoing, appreciating benefits to water quality, water quantity, and aquatic habitat. Increasing riparian buffer will support the TMDL implementation plan. The District has existing partnerships with Friends of Trees, Portland Revegetation Program, SOLV, Clackamas County CCSWCD, Clackamas River Basin Council, Tsunami Crew and others.

Proposed Action - Implementation Steps: Improving riparian buffer shade will require a coordinated effort between the District and private landowners and partners. This action will include continuation of existing partnerships for riparian planting targeted in reaches identified in the Assessment Report. The programmatic portion of this project will include prioritization of reaches where riparian buffer shade is to be added on an annual basis, measured in linear feet of riparian corridor. Planning this program will likely include coordination with one or more volunteer organization that would provide volunteer hours for implementation. The capital expense will include the purchase of trees, vegetation, revegetation supplies, permitting costs (if applicable) and staff's hours for supervison of planting and long-term maintenance work. Main responsibilities include:

(1) Identify willing landowners by working with non-profit watershed groups and Public Outreach staff. Target highest priority areas first but realize that it's important to take advantage of willing partners and landowners. Develop agreements for long-term access for maintenance.

(2) Prioritize reaches identified in Assessment Report based on physical factors such as temperature, fish habitat, and willing landowners. RK3B, RK5-7A, KG1-2, KG3A, KG4, MS1, MS5, MS7, MS9-11, MS12A are reaches identified in the Assessment Report. Also see Figures 2-11, 2-14, and 2-16 in the Rock Creek Assessment.

(3) Identify resources to help in the restoration, e.g., recruit volunteers, hire contractors, order supplies, and publicize planting events or completed projects.

(4) Develop restoration plans using Oregon Watershed Enhancement Board guidance or similar resources; coordinate with staff in the Parks Department for oversight and guidance, as appropriate.

(5) Plant new sites and manage existing sites, e.g., remove non-native plants and replace plants that didn't survive.

(6) Track planting locations in GIS.

Benefits of Action: The project provides the following benefits: helps meet permit requirements, reduce pollutant loads with structural BMPs, supports functioning aquatic ecosystems, improves water quality, improves aquatic habitat and biological communities, and builds effective partnering.

Action Cost Summary (see backside for detailed cost estimate)

						Subtotal
Initial Programmatic FTE estimate:	0.25	**Initial Programmatic FTE Cost:**	$ 20,000	**Initial Capital Cost Summary:**	$ 100,000	*$ 120,000*
Ongoing Programmatic FTE estimate:	0.25	**Ongoing Programmatic FTE Cost:**	$ 20,000	**Annual Ongoing Capital Cost**	$ 100,000	*$ 120,000*
		(Programmatic Cost Summary is the FTE estimate translated into dollars)		**Years of Ongoing Cost Past Yr 1 included**		*4*
				Total Estimated 5-year Programmatic and Capital Cost		*$ 600,000*

Action Name: Improve Riparian Buffer with Private Landowners and Partners **Action #** D-5

Action Type: Programmatic & Capital **Action Extent:** District-wide **Priority Ranking:** -

	Watershed	Basin	Lat	Long	Modeling Subbasin	Reach(es)				
Action Location:	Multiple	-	-	-	-	-	-	-	-	-

Proposed Action - Implementation Steps (continued):

Attachments to describe Implementation Steps further? No

Pathway for attachment(s):

Support of the Watershed Enhancement Technical Assisstance (WET) program would include funding of riparian enhancement projects. In addition, the District would form partnerships with volunteer groups and other organizations such as SOLV, Friends of Trees, Soil and Water Conservation District, Clackamas River Basin Council, streamside homeowners, Friends of Kellogg and Mt. Scott Creek Watersheds, and Tsunami Crew to implement planting projects. The District would also maintain its Inter-governmental agreement with City of Portland BES Revegetation Program for technical assistance. This program would be conducted in coordination with Actions D6-Improve upland tree canopy with private landowners and partners, D16-Add LWD with private landowners and partners, and D17-Targeted invasive species management.

Detailed Cost Breakdown

Initial Implementation Cost Assumptions: 0.25 FTE per year to establish and run the program including maintaining GIS records of completed projects. $100,000 per year to fund riparian planting through WET and continue agreements with up to 12 existing groups including Friends of Trees, SOLV, SWCD, BES Reveg Program Intergovernmental Agreement.

Ongoing Cost Assumptions: 0.5 FTE and $100,000 per year to continue Initial Year approach.

Initial Implementation Cost Estimate:

Item	Quantity	Unit	Unit Cost	Estimated Cost
FTE summary	0.25	FTE	$ 80,000	$ 20,000
WET Funding	1	LS	$ 25,000	$ 25,000
PSA's with non-profits	1	LS	$ 75,000	$ 75,000
				$ -
				$ -
				$ -
				$ -
				$ -
Raw Cost				$ 120,000
Engineering, Administration, Contingency*			35%	$ -
Sub-total				$ 120,000
Land Costs		acre	$ 100,000	$ -
Total Estimated Initial Implementation Costs (2009 dollars) *				$ 120,000

Ongoing Cost Estimate: Project Lifetime (yrs) 4

Item	Quantity	Unit	Unit Cost	Estimated Cost
FTE summary	0.25	FTE	$ 80,000	$ 20,000
WET Funding	1	LS	$ 25,000	$ 25,000
PSA's with non-profits	1	LS	$ 75,000	$ 75,000
				$ -
				$ -
				$ -
				$ -
Raw Cost				$ 120,000
Engineering, Administration, Contingency*			35%	$ -
Sub-total				$ 120,000
Land Costs		acre	$ 100,000	$ -
Annual Ongoing Costs (2009 dollars)				$ 120,000
Total Ongoing Cost Over Project Life (2009 dollars)				$ 480,000

* Contingency and engineering mark-ups for capital projects only. Mark-ups linked to action type in cell C2

Action Name:	Improve Upland Tree Canopy with Private Landowners and Partners			**Action #**	D-6
Action Type:	Programmatic & Capital	**Action Extent:**	District-wide	**Priority Ranking:**	-

	Watershed	**Basin**	**Lat**	**Long**	**Modeling Subbasin**	**Reach(es)**				
Action Location:	Multiple	-	-	-	-	-	-	-	-	-

Potential lead entity:	WES			**WES Lead:**	Env. Policy & Watershed Health	**Potential funding sources:**	Grants
Partner entities:	Parks Clackamas Co.	**Partner entities:**		**WES Support:**	Env. Monitoring & Regulatory	**Potential funding sources:**	Other
Partner entities:	Nonprofit Groups	**Partner entities:**		**WES Support:**	GIS	**Potential funding sources:**	WES (Rates)
Partner entities:	CCSWCD	**Partner entities:**		**WES Support:**		**Potential funding sources:**	

Action Description (see backside of sheet for more details)

Statement of Need: Conversion of land to impervious surfaces has resulted in hydrologic changes including reduced evapotranspiration, increased stormwater runoff, and changes to stream channels, also known as hydromodification. Maintaining, and where possible increasing, upland tree canopy in the watershed will likely decrease stormwater runoff and associated hydromodification impacts and may also improve upland habitat quality and connectivity. There is an opportunity to develop a Tree Protection Ordinance to preserve existing trees and provide mitigation for tree removal. There is also an opportunity to increase upland tree canopy by providing assistance the public to plant trees on private property.

Proposed Action - Implementation Steps: This action will inlcude work with the County on developing a Tree Protection Ordinance and work with willing landowners on planting additional trees. Recommended steps include:

(1) Set project goals - how many trees in how many years and where. For example, focus on a targeted area such as Upper Kellogg Subbasin, Lower Mt. Scott Subbasin, Phillips Subbasin or the Cedar Subbasin every two years.

(2) Recommend type of plants to be used. For example, use bare-root and 1-gallon and larger (1-inch caliper) native trees and shrubs provided through the District, and plant the densities and composition outlined in the District's stormwater standards (or another source), as appropriate.

(3) Determine how to implement. For example, use non-proft groups, contractors or work crews provided through or approved by the District to conduct site preparation and maintenance. Have the District coordinate technical aspects of site preparation, revegetation, and maintenance and monitoring activities.

(4) Conduct outreach. For example, coordinate neighborhood and community involvement and media for event-based streamside projects on public land.
Assist private landowners with technical and material assistance from the District.

(5) Financial considerations. For example, collaborate with cities and Metro to provide financial, community awareness, and pre-event mobilization support. Individual cities may choose to participate in additional project elements as appropriate.

(6) Track planting locations in GIS.

The professional services agreement with Friends of Trees (FOT) currently in place for riparian plantings should be expanded to include upland areas. This program would be conducted in coordination with D5-Improve riparian buffer with private landowners and partners, D16-Add LWD with private landowners and partners, and D17-Targeted invasive species management.

Benefits of Action: This action will benefit watershed health by improving hydrology and geomorphology.

Action Cost Summary (see backside for detailed cost estimate)

						Subtotal
Initial Programmatic FTE estimate:	0.1	**Initial Programmatic FTE Cost:**	$ 8,000	**Initial Capital Cost Summary:**	$ 25,000	*$ 33,000*
Ongoing Programmatic FTE estimate:	0.1	**Ongoing Programmatic FTE Cost:**	$ 8,000	**Annual Ongoing Capital Cost**	$ 25,000	*$ 33,000*
		(Programmatic Cost Summary is the FTE estimate translated into dollars)		**Years of Ongoing Cost Past Yr 1 included**		*4*
				Total Estimated 5-year Programmatic and Capital Cost		*$ 165,000*

Action Name: Improve Upland Tree Canopy with Private Landowners and Partners **Action #** D-6

Action Type: Programmatic & Capital **Action Extent:** District-wide **Priority Ranking:** -

	Watershed	Basin	Lat	Long	Modeling Subbasin	Reach(es)				
Action Location:	Multiple	-	-	-	-	-	-	-	-	-

Proposed Action - Implementation Steps (continued):

Attachments to describe Implementation Steps further? No

Pathway for attachment(s):

Proposed Action - Implementation Steps (continued):

Detailed Cost Breakdown

Initial Implementation Cost Assumptions: 0.10 FTE in first year to develop goals and program and track progress in GIS; 0.10 FTE in later years to maintain program. Expand professional services agreemen (PSA) with Friends of Trees (FOT) currently in place for riparian plantings to include upland areas. Public outreach costs. One large volunteer event coordinated by Friends of Trees is approximately $6,500 and includes coordination, public outreach, plants, and supplies.

Ongoing Cost Assumptions: Assumed costs are the same in subsequent years.

Initial Implementation Cost Estimate:

Item	Quantity	Unit	Unit Cost	Estimated Cost
FTE summary	0.1	FTE	$ 80,000	$ 8,000
FOT PSA	1	year	$ 25,000	$ 25,000
				$ -
				$ -
				$ -
				$ -
				$ -
				$ -
Raw Cost				$ 33,000
Engineering, Administration, Contingency*			35%	$ -
Sub-total				$ 33,000
Land Costs		acre	$ 100,000	$ -
Total Estimated Initial Implementation Costs (2009 dollars) *				$ 33,000

Ongoing Cost Estimate: Project Lifetime (yrs) 4

Item	Quantity	Unit	Unit Cost	Estimated Cost
FTE summary	0.1	FTE	$ 80,000	$ 8,000
FOT PSA	1	years	$ 25,000	$ 25,000
				$ -
				$ -
				$ -
				$ -
				$ -
Raw Cost				$ 33,000
Engineering, Administration, Contingency*			35%	$ -
Sub-total				$ 33,000
Land Costs		acre	$100,000	$ -
Annual Ongoing Costs (2009 dollars)				$ 33,000
Total Ongoing Cost Over Project Life (2009 dollars)				$ 132,000

* Contingency and engineering mark-ups for capital projects only. Mark-ups linked to action type in cell C2

Action Name: Update Erosion Prevention and Sediment Control (ERCO) protocol

Action # D-7

Action Type: Programmatic **Action Extent:** District-wide

Priority Ranking: -

Action Location:

	Watershed	Basin	Lat	Long	Modeling Subbasin	Reach(es)				
Action Location:	Multiple	-	-	-	-	-	-	-	-	-

Potential lead entity:	WES			**WES Lead:**	Erosion Prevention & Control	**Potential funding sources:**	WES (Devel. Fees)
Partner entities:	DEQ	**Partner entities:**		**WES Support:**	Env. Monitoring & Regulatory	**Potential funding sources:**	
Partner entities:		**Partner entities:**		**WES Support:**	WES GIS	**Potential funding sources:**	
Partner entities:		**Partner entities:**		**WES Support:**	Development Review	**Potential funding sources:**	

Action Description (see backside of sheet for more details)

Statement of Need: ERCO improves water quality and habitat by reducing sediment loading; minimizes maintenance problems in the storm drainage system from sediment deposition in pipes, and reduces land loss from erosion. In addition, ERCO is part of the County's compliance efforts with their stormwater NPDES permit. Updating the ERCO protocol will prioritize inspections on projects with the highest potential for erosion problems.

Proposed Action - Implementation Steps: This project will explore the following steps to enhance the ERCO protocol:

- Keep erosion control in permit preconsultation process and prioritize inspections by rating sites when permit application is submitted. This includes identifying areas at high risk for erosion based on steep slopes and erodible soils (slopes > 30% *or* soils with a soil erodibility k-factor of 0.25 or greater) using GIS and considering time of year, developer history, seasonal impact, watershed, complaints, site severity, and phase.
- Consider requiring an erosion control permit be issued before other permits are issued and complete a field check prior to permit issuance. Require Owners Rep call District to schedule field visit.
- Develop inspection frequency schedule based on site priority rating. For example, sites with slopes > 30% have inspections conducted pre-construction to discuss BMPs, at the start of construction to check BMPs, during or after major rainfall events, and post-construction.
- Document inspections. For example, develop a report card with a checklist for BMPs that can be provided to the contractor and kept by the District for reference. Track information in Permits 2008 or IVR.
- Implement enforcement actions. For example, consider a fine or stop work order for Owners who start construction without erosion control inspection. Establish ongoing fees if the erosion control permit is not closed.
- Review site inspection data to continually improve process. For example, monitor whether or not site visits improve BMP performance.
- Establish level of service for erosion and grading control.

Benefits of Action: This action will provide the following watershed benefits: reduce pollutant loads with structural BMPs, improve water quality, reduce water quality impacts of construction, monitor data used for decision-making, meet development needs, and protect ecosystem services.

Action Cost Summary (see backside for detailed cost estimate)

						Subtotal
Initial Programmatic FTE estimate:	0.1	**Initial Programmatic FTE Cost:**	$ 8,000	**Initial Capital Cost Summary:**	$ -	*$ 8,000*
Ongoing Programmatic FTE estimate:	0.2	**Ongoing Programmatic FTE Cost:**	$ 16,000	**Annual Ongoing Capital Cost**	$ -	*$ 16,000*
		(Programmatic Cost Summary is the FTE estimate translated into dollars)		**Years of Ongoing Cost Past Yr 1 included**		*4*
				Total Estimated 5-year Programmatic and Capital Cost		*$ 72,000*

Action Name: Update Erosion Prevention and Sediment Control (ERCO) protocol

Action # D-7

Action Type: Programmatic

Action Extent: District-wide

Priority Ranking: -

	Watershed	Basin	Lat	Long	Modeling Subbasin	Reach(es)				
Action Location:	Multiple	-	-	-	-	-	-	-	-	-

Proposed Action - Implementation Steps (continued):

Attachments to describe Implementation Steps further? No

Pathway for attachment(s):

Proposed Action - Implementation Steps (continued):

Detailed Cost Breakdown

Initial Implementation Cost Assumptions: During the first year of implementation, the project will need to complete GIS analysis, develop new protocol, and train staff. Estimated effort of 200 hours or 0.10 FTE From July 2007 through June 2008 there were 817 erosion control permits issued. If there is an average of 1 more inspection per site, at 2 hours per inspection, and another 20 minutes for additional documentation, the additional inspections and documentation come to 1,904 hours or 0.92 FTE. However, due to the recent lag in development activity, the estimated FTE estimate is 0.1 for year one and 0.2 for the following years. This cost will need adjustment when development activitiy increases.

Ongoing Cost Assumptions: Assume 0.2 additional FTE per year needed for additional site inspections.

Initial Implementation Cost Estimate:

Item	Quantity	Unit	Unit Cost	Estimated Cost
FTE summary	0.1	FTE	$ 80,000	$ 8,000
				$ -
				$ -
				$ -
				$ -
				$ -
				$ -
				$ -
Raw Cost				$ 8,000
Engineering, Administration, Contingency*			35%	$ -
Sub-total				$ 8,000
Land Costs		acre	$ 100,000	$ -
Total Estimated Initial Implementation Costs (2009 dollars) *				$ 8,000

Ongoing Cost Estimate:

Project Lifetime (yrs) 4

Item	Quantity	Unit	Unit Cost	Estimated Cost
FTE summary	0.2	FTE	$ 80,000	$ 16,000
				$ -
				$ -
				$ -
				$ -
				$ -
				$ -
Raw Cost				$ 16,000
Engineering, Administration, Contingency*			35%	$ -
Sub-total				$ 16,000
Land Costs		acre	$100,000	$ -
Annual Ongoing Costs (2009 dollars)				$ 16,000
Total Ongoing Cost Over Project Life (2009 dollars)				$ 64,000

* Contingency and engineering mark-ups for capital projects only. Mark-ups linked to action type in cell C2

Action Name: Erosion Control Hotline and Signs for Construction Sites

Action # D-8 (EAP)

Action Type: Programmatic

Action Extent: District-wide

Priority Ranking: -

	Watershed	Basin	Lat	Long	Modeling Subbasin	Reach(es)				
Action Location:	Multiple	-	-	-	-	-	-	-	-	-

Potential lead entity:	WES			**WES Lead:**	Erosion Prevention & Control	**Potential funding sources:**	WES (Devel. Fees)
Partner entities:		**Partner entities:**		**WES Support:**	Public Information	**Potential funding sources:**	
Partner entities:		**Partner entities:**		**WES Support:**		**Potential funding sources:**	
Partner entities:		**Partner entities:**		**WES Support:**		**Potential funding sources:**	

Action Description (see backside of sheet for more details)

Statement of Need: A hotline phone number for citizens to report poor erosion control practices at construction sites will make contractors accountable to the public. It will encourage contractors to install and maintain erosion control best management practices which reduce sediment load to stormwater stystems and local waterways. Due to the significant cost in maintaining stormwater systems and the sediment impacts and damage to watershed health that can occur from construction site erosion, it is a high priority to improve the effectiveness of erosion control.

Proposed Action - Implementation Steps: This project requires WES staff time to implement and additional funds to create signs for construction sites. Steps include the following:

- Communicate with other jurisdictions that have an erosion control hotline to review signs and hear lessons learned.
- Research costs related to a 1-800 number by calling the local phone company and researching potential providers. Costs range from less than a nickel to more than a quarter per minute.
- Determine if hotline will use new 1-800 number, existing WES number, or new WES number.
- Create a template for the District.
- Update Stormwater Standards and Erosion Control Manual to require sign placement on construction sites that are visible by the public.
- Develop plan for receiving calls (recorded system, live receptionist with after-hours recorded system) and a response plan to phone calls. For example, develop process for determining if it is a priority site and whether it warrants a site visit, enforcement action, etc.
- Develop database to log calls that can be cross-referenced with Grading Permits.
- Educate Erosion Control Inspectors and administration staff about new system.

Benefits of Action: This action will reduce pollutant loads, improves water quality, reduce water quality impacts of construction, provide data for decision making, and assist with effective public outreach.

Action Cost Summary (see backside for detailed cost estimate)

						Subtotal
Initial Programmatic FTE estimate:	0.07	**Initial Programmatic FTE Cost:**	$ 5,600	**Initial Capital Cost Summary:**	$ 5,000	*$ 10,600*
Ongoing Programmatic FTE estimate:	0.06	**Ongoing Programmatic FTE Cost:**	$ 4,800	**Annual Ongoing Capital Cost**	$ 1,000	*$ 5,800*
		(Programmatic Cost Summary is the FTE estimate translated into dollars)		**Years of Ongoing Cost Past Yr 1 included**		*4*
				Total Estimated 5-year Programmatic and Capital Cost		*$ 33,800*

Action Name: Erosion Control Hotline and Signs for Construction Sites

Action # D-8 (EAP)

Action Type: Programmatic

Action Extent: District-wide

Priority Ranking: -

	Watershed	Basin	Lat	Long	Modeling Subbasin	Reach(es)				
Action Location:	Multiple	-	-	-	-	-	-	-	-	-

Proposed Action - Implementation Steps (continued):

Attachments to describe Implementation Steps further? No

Pathway for attachment(s):

Proposed Action - Implementation Steps (continued):

Detailed Cost Breakdown

Initial Implementation Cost Assumptions: Includes one-time cost for staff or consultants to develop the sign format and create 1,000 waterproof signs for distribution. In the first year this is assumed at 0.02 FTE, and 0.01 FTE in subsequent years. The existing WES service request phone number could be used as an erosion control hotline number and costs are not included for an additional phone number. An additional 0.05 FTE will be needed on an ongoing basis for response to phone calls.

Ongoing Cost Assumptions: Replace 200 signs per year for wear and tear.

Initial Implementation Cost Estimate:

Item	Quantity	Unit	Unit Cost	Estimated Cost
FTE summary	0.07	FTE	$ 80,000	$ 5,600
Signs	1000	sign	$ 5	$ 5,000
				$ -
				$ -
				$ -
				$ -
				$ -
				$ -
Raw Cost				$ 10,600
Engineering, Administration, Contingency*			35%	$ -
Sub-total				$ 10,600
Land Costs		acre	$ 100,000	$ -
Total Estimated Initial Implementation Costs (2009 dollars) *				$ 10,600

Ongoing Cost Estimate:

Project Lifetime (yrs) 4

Item	Quantity	Unit	Unit Cost	Estimated Cost
FTE summary	0.06	FTE	$ 80,000	$ 4,800
Signs	200	signs	$ 5.00	$ 1,000
				$ -
				$ -
				$ -
				$ -
				$ -
Raw Cost				$ 5,800
Engineering, Administration, Contingency*			35%	$ -
Sub-total				$ 5,800
Land Costs		acre	$ 100,000	$ -
Annual Ongoing Costs (2009 dollars)				$ 5,800
Total Ongoing Cost Over Project Life (2009 dollars)				$ 23,200

* Contingency and engineering mark-ups for capital projects only. Mark-ups linked to action type in cell C2

Action Name:	Track Flooding Compliants with DTD			**Action #**	D-9
Action Type:	Programmatic	**Action Extent:**	District-wide	**Priority Ranking:**	-

	Watershed	Basin	Lat	Long	Modeling Subbasin	Reach(es)				
Action Location:	Multiple	-	-	-	-	-	-	-	-	-

Potential lead entity:	WES			**WES Lead:**	Asset Management	**Potential funding sources:**	WES (Rates)
Partner entities:	DTD Clackamas Co.	**Partner entities:**	Co. Emergency Mangmer	**WES Support:**	Customer Service	**Potential funding sources:**	
Partner entities:	City of Happy Valley	**Partner entities:**		**WES Support:**	Stormwater Maintenance	**Potential funding sources:**	
Partner entities:	City of Damascus	**Partner entities:**		**WES Support:**	Public Information	**Potential funding sources:**	

Action Description (see backside of sheet for more details)

Statement of Need: Localized and regional flooding occurs periodically in flood-prone areas of the KMS and RC watersheds. Flooding has been observed in the past associated with culverts and bridges at road crossings of the streams, in developed areas adjacent to or near streams, and in areas where stormwater infrastructure requires emergency maintenance. DTD responds to roadway flooding in some areas. Some customer complaints about flooding are reported to the WES Customer Service phone number, where they are logged and maintenance crews respond as appropriate. However, during large storm events in January 2009, many areas experienced flooding and there were very few customer flooding complaints reported to WES. With limited customer complaint information, it is difficult to evaluate flooding issues that WES and DTD may have opportunities to address. There is an opportunity for WES and DTD to track flooding complaints in a coordinated effort to identify flood-prone areas and potential solutions for implementation.

Proposed Action - Implementation Steps:

Implementation of this action includes the following steps:

1) WES and DTD meeting to discuss known flood-prone areas, current methods of receiving flooding complaints, and potential enhancements to coordinate tracking of flooding complaints

2) WES and DTD assign flooding-response coordination team (including maintenance, engineering, and asset management staff) to track flooding problems and meet periodically to review problems and identify potential solutions for implementation

3) WES and DTD develop Captial and Programmatic projects as appropriate to implement feasible solutions

Benefits of Action: Identifying and tracking flooding complaints provides useful information about flood-prone areas and flooding frequencies and severity.

Action Cost Summary (see backside for detailed cost estimate)

						Subtotal
Initial Programmatic FTE estimate:	0.05	**Initial Programmatic FTE Cost:**	$ 4,000	**Initial Capital Cost Summary:**	$ -	*$ 4,000*
Ongoing Programmatic FTE estimate:	0.05	**Ongoing Programmatic FTE Cost:**	$ 4,000	**Annual Ongoing Capital Cost**	$ -	*$ 4,000*
		(Programmatic Cost Summary is the FTE estimate translated into dollars)		**Years of Ongoing Cost Past Yr 1 included**		*4*
				Total Estimated 5-year Programmatic and Capital Cost		*$ 20,000*

Action Name: Track Flooding Compliants with DTD **Action #** D-9

Action Type: Programmatic **Action Extent:** District-wide **Priority Ranking:** -

	Watershed	Basin	Lat	Long	Modeling Subbasin	Reach(es)				
Action Location:	Multiple	-	-	-	-	-	-	-	-	-

Proposed Action - Implementation Steps (continued):

Attachments to describe Implementation Steps further? No

Pathway for attachment(s):

Proposed Action - Implementation Steps (continued):

Detailed Cost Breakdown

Initial Implementation Cost Assumptions: Assume combined WES staff time of 18 hours per month for 6 months per year for flooding-response coordination team to track and review information on flooding complaints, meet periodically, and develop potential solutions with DTD. DTD staff time will be additional. Implementation of solutions will require additional staff time and capital and/or programmatic budget.

Ongoing Cost Assumptions:

Initial Implementation Cost Estimate:

Item	Quantity	Unit	Unit Cost	Estimated Cost
FTE summary	0.05	FTE	$ 80,000	$ 4,000
				$ -
				$ -
				$ -
				$ -
				$ -
				$ -
				$ -
Raw Cost				$ 4,000
Engineering, Administration, Contingency*			35%	$ -
Sub-total				$ 4,000
Land Costs		acre	$ 100,000	$ -
Total Estimated Initial Implementation Costs (2009 dollars) *				$ 4,000

Ongoing Cost Estimate: Project Life Past Yr 1 (yrs) 4

Item	Quantity	Unit	Unit Cost	Estimated Cost
FTE summary	0.05	FTE	$ 80,000	$ 4,000
				$ -
				$ -
				$ -
				$ -
				$ -
				$ -
Raw Cost				$ 4,000
Engineering, Administration, Contingency*			35%	$ -
Sub-total				$ 4,000
Land Costs		acre	$100,000	$ -
Annual Ongoing Costs (2009 dollars)				$ 4,000
Total Ongoing Cost Over Project Life (2009 dollars)				$ 16,000

* Contingency and engineering mark-ups for capital projects only. Mark-ups linked to action type in cell C2

Action Name:	Additional Benthic Macroinvertebrate Surveys			**Action #**	D-10 (EAP)
Action Type:	Programmatic	**Action Extent:**	District-wide	**Priority Ranking:**	-

	Watershed	**Basin**	**Lat**	**Long**	**Modeling Subbasin**	**Reach(es)**				
Action Location:	Multiple	-	-	-	-	-	-	-	-	-

Potential lead entity:	WES			**WES Lead:**	Env. Policy & Watershed Health	**Potential funding sources:**	WES (Rates)
Partner entities:	City of Milwaukie	**Partner entities:**		**WES Support:**	Env. Monitoring & Regulatory	**Potential funding sources:**	
Partner entities:	City of Happy Valley	**Partner entities:**		**WES Support:**		**Potential funding sources:**	
Partner entities:	City of Damascus	**Partner entities:**		**WES Support:**		**Potential funding sources:**	

Action Description (see backside of sheet for more details)

Statement of Need: Benthic macroinvertebrate surveys provide extremely valuable information about long-term aquatic habitat conditions, water quality, and watershed health. WES contracted with a consultant to perform benthic macroinvertebrate surveys at 24 locations in the SWACC and CCSD No. 1 Districts in 2008. Seven (7) of these sites are located in the KMS watershed and three (3) are in the RC watershed. Of these sites, only five sites are in riffles and were appropriate to use for the Watershed Health Index (WHI). In order to expand the areas where the WHI can be calculated and to expand the data available to use in setting management goals and tracking the effect of WES activities, it would be useful to expand the benthic macroinvertebrate monitoring program to include additional sites and greater frequency of sampling.

Proposed Action - Implementation Steps:
Implementation of this action includes the following steps:
1) Contract with a consultant to perform benthic macroinvertebrate surveys at 35 riffle sites in the Districts, including 11 sites in the KMS watershed, 7 sites in the RC watershed, and 17 sites in additional watersheds.
See attached map for recommended survey locations in KMS and RC watershed *(Map to be provided by Ellis)*
Consultant to provide taxonomic analysis of macroinvertebrates, including chironomidae to subfamily level. Consultant to assist WES with development of WHI based on benthic macroinvertebrate sampling results.
2) Conduct benthic macroinvertebrate surveys at same locations every year (5 times total in 5-year period).

Benefits of Action: Performing additional benthic macroinvertebrate surveys will support the evaluation of watershed health through the Watershed Health Index (WHI) and support informed stormwater management decision-making and meeting LOS service.

Action Cost Summary (see backside for detailed cost estimate)

						Subtotal
Initial Programmatic FTE estimate:	0.08	**Initial Programmatic FTE Cost:**	$ 6,400	**Initial Capital Cost Summary:**	$ 71,750	***$ 78,150***
Ongoing Programmatic FTE estimate:	0.08	**Ongoing Programmatic FTE Cost:**	$ 6,400	**Annual Ongoing Capital Cost**	$ 71,750	***$ 78,150***
		(Programmatic Cost Summary is the FTE estimate translated into dollars)		**Years of Ongoing Cost Past Yr 1 included**		***4***
				Total Estimated 5-year Programmatic and Capital Cost		***$ 390,750***

Action Name: Additional Benthic Macroinvertebrate Surveys

Action # D-10 (EAP)

Action Type: Programmatic

Action Extent: District-wide

Priority Ranking: -

	Watershed	Basin	Lat	Long	Modeling Subbasin	Reach(es)				
Action Location:	Multiple	-	-	-	-	-	-	-	-	-

Proposed Action - Implementation Steps (continued):

Attachments to describe Implementation Steps further? Yes

Pathway for attachment(s): *Map to be provided by Ellis with recommended locations*

Proposed Action - Implementation Steps (continued):

Detailed Cost Breakdown

Initial Implementation Cost Assumptions: Assume WES project manager provides 160 hours for project oversight and analysis. Assume consultant performs surveys and analysis for 35 sites, estimated cost of $1,750 per site. Assume consultant provides assistance with WHI calculation for 35 sites, estimated cost of 70 hours.

Ongoing Cost Assumptions: Assume surveys, analysis, and WHI calculations performed annually for four years after year 1.

Initial Implementation Cost Estimate:

Item	Quantity	Unit	Unit Cost	Estimated Cost
FTE summary	0.08	FTE	$ 80,000	$ 6,400
Consultant - surveys	35	sites	$ 1,750	$ 61,250
Consultant - WHI assista	70	hours	$ 150	$ 10,500
				$ -
				$ -
				$ -
				$ -
				$ -
Raw Cost				$ 78,150
Engineering, Administration, Contingency*			35%	$ -
Sub-total				$ 78,150
Land Costs		acre	$ 100,000	$ -
Total Estimated Initial Implementation Costs (2009 dollars) *				$ 78,150

Ongoing Cost Estimate: Project Life Past Yr 1 (yrs) 4

Item	Quantity	Unit	Unit Cost	Estimated Cost
FTE summary	0.08	FTE	$ 80,000	$ 6,400
Consultant - surveys	35	sites	$ 1,750	$ 61,250
Consultant - WHI assistance	70	hours	$ 150	$ 10,500
				$ -
				$ -
				$ -
				$ -
Raw Cost				$ 78,150
Engineering, Administration, Contingency*			35%	$ -
Sub-total				$ 78,150
Land Costs		acre	$100,000	$ -
Annual Ongoing Costs (2009 dollars)				$ 78,150
Total Ongoing Cost Over Project Life (2009 dollars)				$ 312,600

* Contingency and engineering mark-ups for capital projects only. Mark-ups linked to action type in cell C2

Action Name: Microbial Source Tracking Study **Action #** D-11

Action Type: Programmatic & Capital **Action Extent:** District-wide **Priority Ranking:** -

	Watershed	Basin	Lat	Long	Modeling Subbasin	Reach(es)				
Action Location:	Multiple	-	-	-	-	-	-	-	-	-

Potential lead entity:	WES			**WES Lead:**	Env. Monitoring & Regulatory	**Potential funding sources:**	WES (Rates)
Partner entities:	City of Milwaukie	**Partner entities:**	CCSWCD	**WES Support:**	Env. Policy & Watershed Health	**Potential funding sources:**	City of Milwaukie
Partner entities:	City of Happy Valley	**Partner entities:**	OSU	**WES Support:**		**Potential funding sources:**	City of Happy Valley
Partner entities:	City of Damascus	**Partner entities:**		**WES Support:**		**Potential funding sources:**	City of Damascus

Action Description (see backside of sheet for more details)

Statement of Need: Elevated levels of E. coli bacteria, a key indicator of water contact human health issues, have been found throughout the RC and KMS watersheds. Additionally, a TMDL has been established in the watersheds which requires in-stream reductions of E. coli. Although there are many potential sources of E. coli in streams, including wildlife, pets, livestock, and humans, the actual sources of E. coli in the watersheds are not well understood at this time. WES currently collects E. coli samples at 8 sites in the KMS and RC watersheds.

Proposed Action - Implementation Steps: Use microbial source tracking (MST) methods for source identification and BMP targeting. MST methods can help identify the sources of fecal contamination in surface waters, such as humans, wildlife, pets, or livestock. Action plan includes the following steps:

1. Select site and sampling plan based on contributing area land use and known E. coli exceedances within the watersheds. The watershed assessment reports found high concentrations of E. coli bacteria in the Mt. Scott, Phillips, and Kellogg Creek subbasins. For example, high E. coli levels were found in reaches KG2, KG4 and KG4A of the Upper Kellogg Subbasin.
2. Select type of MST analysis method. MST methods can be grouped into library dependent methods (LDMs) and library independent methods (LIMs). LDMs require databases of genotypic or phenotypic fingerprints for bacterial strains isolated from suspected fecal sources, i.e., cows, birds, dogs, cats and humans. LIMs do not depend on the isolation of a targeted source identifier but instead depend on identifying the bacteria and viruses grown in collected water samples in a lab environment, which are traced to specific hosts or sources of fecal contamination.

Typically, taking a multi-tiered approach, moving from general to specific and from less to more expensive testing is most efficient and economical. After each step, progress can be assessed before deciding to move to the next one. For example, the first step could simply involve visual inspection followed by sampling and analysis of E. coli upstream and downstream of a potential source. If the results are inconclusive, additional MST analysis could be performed.

3. Implement sampling plan, review results and identity potential E. coli sources.
4. Target BMPs and develop outreach program to identified sources.

Benefits of Action: With a better understanding of E. coli sources, BMP can be targeted to reducing E. coli contamination from specific sources. Reduction in E. coli assists Districts in TMDL implementation, in meeting District's benchmark for the Lower Willamette River and improves stream water quality.

Action Cost Summary (see backside for detailed cost estimate)

						Subtotal
Initial Programmatic FTE estimate:	0.1	**Initial Programmatic FTE Cost:**	$ 8,000	**Initial Capital Cost Summary:**	$ 98,000	*$ 106,000*
Ongoing Programmatic FTE estimate:	0	**Ongoing Programmatic FTE Cost:**	$ -	**Annual Ongoing Capital Cost**	$ -	*$ -*
		(Programmatic Cost Summary is the FTE estimate translated into dollars)		**Years of Ongoing Cost Past Yr 1 included**		*0*
				Total Estimated 5-year Programmatic and Capital Cost		*$ 106,000*

Action Name: Microbial Source Tracking Study **Action #** D-11

Action Type: Programmatic & Capital **Action Extent:** District-wide **Priority Ranking:** -

	Watershed	Basin	Lat	Long	Modeling Subbasin	Reach(es)				
Action Location:	Multiple	-	-	-	-	-	-	-	-	-

Proposed Action - Implementation Steps (continued): Attachments to describe Implementation Steps further? No

Pathway for attachment(s):

Proposed Action - Implementation Steps (continued):

Detailed Cost Breakdown

Initial Implementation Cost Assumptions:

Assume project is conducted by consultant with WES project management. Assume WES project manager will spend 20 hours per month on project for 8 months. Assume consultant will spend 40 hours per month on project for 8 months. Assume 500 samples collected for MST analysis in accordance to selected sampling plan.

Ongoing Cost Assumptions: Assume project is completed in one year and no ongoing costs.

Initial Implementation Cost Estimate:

Item	Quantity	Unit	Unit Cost	Estimated Cost
FTE summary	0.1	FTE	$ 80,000	$ 8,000
MST Method Samples	500	Sample	$ 100	$ 50,000
Consultant	320	Hour	$ 150	$ 48,000
				$ -
				$ -
				$ -
				$ -
				$ -
Raw Cost				$ 106,000
Engineering, Administration, Contingency*			35%	
Sub-total				$ 106,000
Land Costs		acre	$ 100,000	$ -
Total Estimated Initial Implementation Costs (2009 dollars) *				$ 106,000

Ongoing Cost Estimate: Project Lifetime (yrs) 0

Item	Quantity	Unit	Unit Cost	Estimated Cost
				$ -
				$ -
				$ -
				$ -
				$ -
				$ -
				$ -
Raw Cost				$ -
Engineering, Administration, Contingency*			35%	$ -
Sub-total				$ -
Land Costs		acre	$ 100,000	$ -
Annual Ongoing Costs (2009 dollars)				$ -
Total Ongoing Cost Over Project Life (2009 dollars)				$ -

* Contingency and engineering mark-ups for capital projects only. Mark-ups linked to action type in cell C2

Action Name: Stormwater Quality Retrofit Program for Streets and Street-Related Drainage

Action # D-12

Action Type: Programmatic & Capital

Action Extent: District-wide

Priority Ranking: -

	Watershed	Basin	Lat	Long	Modeling Subbasin	Reach(es)				
Action Location:	Multiple	-	-	-	-	-	-	-	-	-

Potential lead entity:	DTD Clackamas Co.			**WES Lead:**	Asset Management	**Potential funding sources:**	WES (Devel. Fees)
Partner entities:	WES	**Partner entities:**		**WES Support:**		**Potential funding sources:**	
Partner entities:	Private	**Partner entities:**		**WES Support:**		**Potential funding sources:**	
Partner entities:		**Partner entities:**		**WES Support:**		**Potential funding sources:**	

Action Description (see backside of sheet for more details)

Statement of Need: Although stormwater treatment is required for new development, many existing roads lack adequate structural stormwater treatment facilities. Uncontrolled runoff from imperious surfaces contributes to a variety of water quality problems and is therefore an important watershed stressor to evaluate.

Proposed Action - Implementation Steps: In collaboration with DTD and WES, this action will develop a stormwater quality BMPs retrofit and prioritization program for existing roads within the watersheds. Action includes the following steps:

1. Identify areas within known impaired watersheds where retrofits would improve water quality. For example, assessment reports suggested retrofits in the contributing areas to reaches KG3, KG3A, MN1, and CD1 would improve water quality. Action would focus primarily on streets with adequate space for BMP retrofits, higher traffic volumes, and opportunities for improvements during planned repair or other construction.
2. DTD staff and WES staff meet to periodically to coordinate stormwater retrofits into future road repair projects in previously identified areas. Retrofits can coincide with scheduled road repairs. In addition to the retrofit of structural treatment systems, non-structural BMPs in the watershed can also be implemented.
3. Each identified area will have a unique stormwater retrofit to match the conditions of the site and water quality issues. For example, ditches can be converted into water treatment swales that meet the current infiltration requirements and adjacent drainage can be directed into the new swales to improve water quality from a greater area. Curb cuts and planter boxes can also be installed during street improvements.

Benefits of Action: Stormwater treatment from imperious surfaces, such as highly traveled roads, can decrease pollutant transport into the streams, improving water quality and stream health.

Action Cost Summary (see backside for detailed cost estimate)

						Subtotal
Initial Programmatic FTE estimate:	0.25	**Initial Programmatic FTE Cost:**	$ 20,000	**Initial Capital Cost Summary:**	$250,000	*$ 270,000*
Ongoing Programmatic FTE estimate:	0.1	**Ongoing Programmatic FTE Cost:**	$ 8,000	**Annual Ongoing Capital Cost**	$250,000	*$ 258,000*
		(Programmatic Cost Summary is the FTE estimate translated into dollars)		**Years of Ongoing Cost Past Yr 1 included**		*4*
				Total Estimated 5-year Programmatic and Capital Cost		*$ 1,302,000*

Action Name: Stormwater Quality Retrofit Program for Streets and Street-Related Drainage

Action # D-12

Action Type: Programmatic & Capital

Action Extent: District-wide

Priority Ranking: -

	Watershed	Basin	Lat	Long	Modeling Subbasin	Reach(es)				
Action Location:	Multiple	-	-	-	-	-	-	-	-	-

Proposed Action - Implementation Steps (continued):

Attachments to describe Implementation Steps further? No

Pathway for attachment(s):

Proposed Action - Implementation Steps (continued):

Detailed Cost Breakdown

Initial Implementation Cost Assumptions: Assume WES 0.25 FTE includes coordination with DTD staff in assisting in site selection, project design, implementation, and evaluation of effectiveness. Assume WES to provide up to $250,000 per year in capital funding to assist DTD in implementation, funding 2-10 projects per year (implementation assistance). This assumes implementation will support construction costs as well as engineering and administration. Cost estimation assumes DTD to provide staff for project coordination, engineering design and construction management.

Ongoing Cost Assumptions:

Initial Implementation Cost Estimate:

Item	Quantity	Unit	Unit Cost	Estimated Cost
FTE summary	0.25	FTE	$ 80,000	$ 20,000
Implementation Assistar	1	yr	$ 250,000	$ 250,000
				$ -
				$ -
				$ -
				$ -
				$ -
				$ -
Raw Cost				$ 270,000
Engineering, Administration, Contingency*			35%	
Sub-total				$ 270,000
Land Costs		acre	$ 100,000	$ -
Total Estimated Initial Implementation Costs (2009 dollars) *				$ 270,000

Ongoing Cost Estimate: Project Lifetime (yrs) 4

Item	Quantity	Unit	Unit Cost	Estimated Cost
FTE summary	0.1	FTE	$ 80,000	$ 8,000
Implementation Assistance	1	yrs	$ 250,000	$ 250,000
				$ -
				$ -
				$ -
				$ -
				$ -
Raw Cost				$ 258,000
Engineering, Administration, Contingency*			35%	$ -
Sub-total				$ 258,000
Land Costs		acre	$ 100,000	$ -
Annual Ongoing Costs (2009 dollars)				$ 258,000
Total Ongoing Cost Over Project Life (2009 dollars)				$ 1,032,000

* Contingency and engineering mark-ups for capital projects only. Mark-ups linked to action type in cell C2

Action Name:	Stormwater Quality Retrofit Program for Institutional, Commercial, and Residential Landowners			**Action #**	D-13
Action Type:	Programmatic & Capital	**Action Extent:**	District-wide	**Priority Ranking:**	-

	Watershed	**Basin**	**Lat**	**Long**	**Modeling Subbasin**	**Reach(es)**				
Action Location:	Multiple	-	-	-	-	-	-	-	-	-

Potential lead entity:	WES			**WES Lead:**	Asset Management	**Potential funding sources:**	WES (Devel. Fees)
Partner entities:	City of Happy Valley	**Partner entities:**	Nonprofit Groups	**WES Support:**	Stormwater Maintenance	**Potential funding sources:**	City of Milwaukie
Partner entities:	City of Milwaukie	**Partner entities:**	Private	**WES Support:**	WES GIS	**Potential funding sources:**	City of Happy Valley
Partner entities:	City of Damascus	**Partner entities:**	CCSWCD	**WES Support:**	Public Information	**Potential funding sources:**	City of Damascus

Action Description (see backside of sheet for more details)

Statement of Need: Untreated runoff from impervious surfaces contributes to a variety of water quality problems. In general, older developments in the KMS and RC lack structural stormwater BMPs. This results in only small portions of the watersheds which currently treat stormwater runoff from residential, commercial or institutional land. The existing Watershed Stewardship Program recently ended due to lack of public participation and interest as well as limited WES staff availability to promote the program. There is a need to develop a new technical assistance program to help private landowners identify and implement stormwater retrofit projects as well as other watershed enhancement projects. This new program should work in the conjunction with the CCSWCD Low Impact Development Program.

Proposed Action - Implementation Steps: This action includes a recommendation to develop a new technical assistance program for watershed improvement called the Watershed Enhancement Technical Assistance Program (WET). This program would include technical assistance and capital funding to support stormwater retrofits. Other program elements of the proposed WET program are described in Action D-5. This action would also include collaborating with nonprofit groups and engaging private landowners to participate the WET program. Action includes the following steps:

1. Define and prioritize areas to focus WET program efforts. Areas with high levels of imperviousness, which lack stormwater treatment systems, are areas to consider for high prioritization. These areas would be retrofitted with site design modifications to allow more stormwater runoff to be stored, treated, and infiltrated within vegetated areas or other treatment systems. For example, churches, schools, and commercial areas could install swales and vegetated stormwater treatment facilities in parking lots. Residential landowners could install swales or other vegetated stormwater facilities near their homes or adjacent to roads.
2. Develop an outreach program to target locations based on prioritization, as well as seek out participants which would be able to assist in implementation. For example, members of HOAs, schools, churches, and rotary clubs may desire to help improve water quality in their local watersheds. Watershed councils and nonprofit groups could also assist in promoting the WET program and help engage the surrounding communities.
3. Develop technical materials, ‘how to’ manuals, and guidelines to help assist participants. For example, materials could include explanations and examples of techniques to reduce runoff and improve water quality from impervious surfaces, such as how to implement low impact development (LID) techniques.
4. Review WET program applications, select participants, assist in implementation of projects and monitor effectiveness.

Benefits of Action: Improve watershed water quality by localized stormwater treatment. Retrofitting developed areas with LID techniques and regional stormwater treatment systems where feasible can help reduce the effective imperviousness of a watershed and improve watershed health.

Action Cost Summary (see backside for detailed cost estimate)

						Subtotal
Initial Programmatic FTE estimate:	1	**Initial Programmatic FTE Cost:**	$ 80,000	**Initial Capital Cost Summary:**	$ 200,000	*$ 280,000*
Ongoing Programmatic FTE estimate:	1	**Ongoing Programmatic FTE Cost:**	$ 80,000	**Annual Ongoing Capital Cost**	$ 200,000	*$ 280,000*
		(Programmatic Cost Summary is the FTE estimate translated into dollars)		**Years of Ongoing Cost Past Yr 1 included**		*4*
				Total Estimated 5-year Programmatic and Capital Cost		*$ 1,400,000*

Action Name: Stormwater Quality Retrofit Program for Institutional, Commercial, and Residential Landowners

Action # D-13

Action Type: Programmatic & Capital

Action Extent: District-wide

Priority Ranking: -

	Watershed	Basin	Lat	Long	Modeling Subbasin	Reach(es)				
Action Location:	Multiple	-	-	-	-	-	-	-	-	-

Proposed Action - Implementation Steps (continued):

Attachments to describe Implementation Steps further? No

Pathway for attachment(s):

Proposed Action - Implementation Steps (continued):

Detailed Cost Breakdown

Initial Implementation Cost Assumptions: Assume WET program will sponsor up to 10 stormwater retrofit projects per year at a cost of approximately $20,000 per project. Assume 1.0 FTE WES staff coordination, planning, outreach, technical assistance, and implementation. Assume watershed council and other nonprofits provide volunteers support for outreach and implementation.

Ongoing Cost Assumptions: Assume WET will sponsor up to 10 stormwater retrofit projects per year at a cost of approximately $20,000 per project. Assume 1.0 FTE WES staff coordination, planning, outreach, technical assistance, and implementation. Assume watershed council and other nonprofits provide volunteers support for outreach and implementation.

Initial Implementation Cost Estimate:

Item	Quantity	Unit	Unit Cost	Estimated Cost
FTE summary	1	FTE	$ 80,000	$ 80,000
Implementation	10	each	$ 20,000	$ 200,000
				$ -
				$ -
				$ -
				$ -
				$ -
				$ -
Raw Cost				$ 280,000
Engineering, Administration, Contingency*			35%	
Sub-total				$ 280,000
Land Costs		acre	$ 100,000	$ -
Total Estimated Initial Implementation Costs (2009 dollars) *				$ 280,000

Ongoing Cost Estimate:

Project Life Past Yr 1 (yrs) 4

Item	Quantity	Unit	Unit Cost	Estimated Cost
FTE summary	1	FTE	$ 80,000	$ 80,000
Implementation	10	each	$ 20,000	$ 200,000
				$ -
				$ -
				$ -
				$ -
				$ -
Raw Cost				$ 280,000
Engineering, Administration, Contingency*			35%	
Sub-total				$ 280,000
Land Costs		acre	$ 100,000	$ -
Annual Ongoing Costs (2009 dollars)				$ 280,000
Total Ongoing Cost Over Project Life (2009 dollars)				$ 1,120,000

* Contingency and engineering mark-ups for capital projects only. Mark-ups linked to action type in cell C2

Action Name:	Private Water Quality Facility Inventory and Inspections					**Action #**	D-14
Action Type:	Programmatic		**Action Extent:**	District-wide		**Priority Ranking:**	-

	Watershed	**Basin**	**Lat**	**Long**	**Modeling Subbasin**	**Reach(es)**				
Action Location:	Multiple	-	-	-	-	-	-	-	-	-

Potential lead entity:	WES			**WES Lead:**	Stormwater Maintenance	**Potential funding sources:**	WES (Rates)
Partner entities:	Private	**Partner entities:**		**WES Support:**	Customer Service	**Potential funding sources:**	
Partner entities:	DTD Clackamas Co.	**Partner entities:**		**WES Support:**	WES GIS	**Potential funding sources:**	
Partner entities:		**Partner entities:**		**WES Support:**		**Potential funding sources:**	

Action Description (see backside of sheet for more details)

Statement of Need: Maintenance for private water quality facilities varies based on type of ownership. Private residential water quality facilities are maintained by either private homeowners or by WES staff through maintenance agreements. Private commercial water quality facilities are required to maintain their facilities, however, few of these accounts actively maintain their facilities. WES has maintenance agreements for approximately 260 private stormwater facilities, mostly in residential areas. Currently, only 5 to 10 percent of the residential systems have been inspected through the preventative maintenance program for stormwater assets. WES is developing a maintenance management system to increase regular maintenance inspection. Currently, more time is often spent in response to emergency maintenance activities than with scheduled or routine maintenance efforts. Private water quality treatment facilities without a maintenance agreement are not inspected and there is no assurance to WES that they are properly functioning or maintained. Poorly maintained facilities may not provide adequate treatment.

Proposed Action - Implementation Steps:

1. Continue with preventative maintenance program for stormwater assets for residential customers and with the Storm Drain Cleaning Assistance Program for commercial and industrial customers. Residential program to continue to transfer maintenance from residential customers to WES and commercial/industrial program to transfer maintenance to private companies. WES may be requiring a letter from each potential landowner that proves that the required maintenance was performed by an outside contractor. WES maintenance staff involvement could be minimized for these facilities.
2. Improve inspection and tracking of residential stormwater assets with the computerized maintenance management system (CMMS) and integrate GIS tools to help better manage and link water quality facilities to watershed health. Refine database of applicable properties.
3. Investigate enforcement of non-compliance residential and commercial customers.
4. Revaluate both residential and commercial/industrial programs in 5 years.

Benefits of Action: Maintaining and tracking private water quality systems can assist in ensuring facilities are functioning properly and treating localized runoff.

Action Cost Summary (see backside for detailed cost estimate)

						Subtotal
Initial Programmatic FTE estimate:	1	**Initial Programmatic FTE Cost:**	$ 80,000	**Initial Capital Cost Summary:**	$ -	*$ 80,000*
Ongoing Programmatic FTE estimate:	1.5	**Ongoing Programmatic FTE Cost:**	$ 120,000	**Initial Capital Capital Cost Summary:**	$ -	*$ 120,000*
		(Programmatic Cost Summary is the FTE estimate translated into dollars)		**Years of Ongoing Cost Past Yr 1 included**		*4*
				Total Estimated 5-year Programmatic and Capital Cost		*$ 560,000*

Private Water Quality Facility Inventory and Inspections

Action # D-14

Action Type: Programmatic **Action Extent:** District-wide **Priority Ranking:** -

	Watershed	Basin	Lat	Long	Modeling Subbasin	Reach(es)				
Action Location:	Multiple	-	-	-	-	-	-	-	-	-

Proposed Action - Implementation Steps (continued):

Attachments to describe Implementation Steps further? No

Pathway for attachment(s):

Proposed Action - Implementation Steps (continued):

Detailed Cost Breakdown

Initial Implementation Cost Assumptions: Assume existing effort level includes 1 FTE Surface Water Technician, a portion of Maintenance Manager staff time and WES maintenance staff time for coordination and tracking. Action assumes additional WES maintenance staff time for inspection of facilities brought under new maintenance agreements and to perform more inspections through preventative maintenance program of existing facilities. Assuming approximatly 10 hours per facility to inspect and perform minor maintenance. Assume additional 1.0 FTE required to perform 200 residential structures per year and assume additional 0.5 FTE required in years 2-5 for inspecting and maintaining up to 100 additional residential structures.

Cost assumes at least 200 residential structures will be inspected over a one year time period by WES staff and a minimum charge of $3/month/home, based on existing rates, to include inspection, repair and maintenance of residential stormwater systems would be added to each stormwater bill. Cost also assumes WES will continue to bid cleaning contracts with private contractors and commercial/industrial customers will continue to coordinate directly with the contractors to pay for cleaning services. Additionally, cost assumes coordination with DTD to continue street sweeping in targeted areas within the watersheds.

Ongoing Cost Assumptions: Cost assumes program will continue similar to year one structure with the addition of 0.5 FTE as maintenance agreements increase.

Initial Implementation Cost Estimate:

Item	Quantity	Unit	Unit Cost	Estimated Cost
FTE summary	1	FTE	$ 80,000	$ 80,000
				$ -
				$ -
				$ -
				$ -
				$ -
				$ -
Raw Cost				$ 80,000
Engineering, Administration, Contingency*			35%	$ -
Sub-total				$ 80,000
Land Costs		acre	$ 100,000	$ -
Total Estimated Initial Implementation Costs (2009 dollars) *				$ 80,000

Ongoing Cost Estimate: Project Lifetime (yrs) 4

Item	Quantity	Unit	Unit Cost	Estimated Cost
FTE summary	1.5	FTE	$ 80,000	$ 120,000
				$ -
				$ -
				$ -
				$ -
				$ -
Raw Cost				$ 120,000
Engineering, Administration, Contingency*			35%	$ -
Sub-total				$ 120,000
Land Costs		acre	$ 100,000	$ -
Annual Ongoing Costs (2009 dollars)				$ 120,000
Total Ongoing Cost Over Project Life (2009 dollars)				$ 480,000

* Contingency and engineering mark-ups for capital projects only. Mark-ups linked to action type in cell C2

Action Name:	Riparian Buffer Analysis and Prioritization for Enhancement			**Action #**	D-15 (EAP)
Action Type:	Programmatic	**Action Extent:**	District-wide	**Priority Ranking:**	-

	Watershed	**Basin**	**Lat**	**Long**	**Modeling Subbasin**	**Reach(es)**				
Action Location:	Multiple	-	-	-	-	-	-	-	-	-

Potential lead entity:	WES			**WES Lead:**	Env. Monitoring & Regulatory	**Potential funding sources:**	DTD
Partner entities:	DTD Clackamas Co.	**Partner entities:**		**WES Support:**	Env. Policy & Watershed Health	**Potential funding sources:**	Grants
Partner entities:	Parks Clackamas Co.	**Partner entities:**		**WES Support:**	WES GIS	**Potential funding sources:**	
Partner entities:		**Partner entities:**		**WES Support:**		**Potential funding sources:**	

Action Description (see backside of sheet for more details)

Statement of Need: There are water temperature TMDLs (Total Maximum Daily Load) for the Clackamas and Willamette Basins. As designated management agencies (DMAs), Clackamas County and the Districts are responsible for identifying possible sources of increased water temperature in the watershed and potential management strategies that can be undertaken to reduce stream temperatures to meet water quality criteria. This includes identifying areas lacking riparian shade and developing prioritized implementation plans to increase riparian shade where feasible. Additional riparian buffer analyses is needed.

Proposed Action - Implementation Steps: WES is performing a riparian buffer analysis for the KMS and RC watersheds as a part of the Watershed Action Plans. Additional riparian buffer analyses for other portions of Clackamas County are needed.

Conduct riparian buffer analysis inside the Districts (by WES) and outside the Districts in Clackamas County (by DTD) to establish baseline conditions in the watersheds throughout the County that are under a TMDL order. In addition to GIS analysis, ground-truth conditions in the field using WES, DTD, and CCSWCD staff. Utilize consultant assistance to analyze results. Following analysis, implement a programmatic measure through the WAPs to develop and implement plans to increase riparian shade.
Once areas lacking riparian buffer are identified, Action D-5 should be updated and implemented to increase planting of trees in riparian buffer areas on both public land and private land with willing landowners.
Grants from Metro or other sources could be sought to assist in implementation of this Action.

Benefits of Action: Performing riparian buffer analysis will assist in supporting the evaluation of watershed health and support informed watershed management decision-making and meeting LOS levels; identify areas with opportunities to increase riparian buffer shading of streams to address stream temperatures; and contribute to fulfilling responsibilities as DMAs.

Action Cost Summary (see backside for detailed cost estimate)

						Subtotal
Initial Programmatic FTE estimate:	0.1	**Initial Programmatic FTE Cost:**	$ 8,000	**Initial Capital Cost Summary:**	$ 12,000	*$ 20,000*
Ongoing Programmatic FTE estimate:	0	**Ongoing Programmatic FTE Cost:**	$ -	**Annual Ongoing Capital Cost**	$ -	*$ -*
		(Programmatic Cost Summary is the FTE estimate translated into dollars)		**Years of Ongoing Cost Past Yr 1 included**		*0*
				Total Estimated 5-year Programmatic and Capital Cost		*$ 20,000*

Action Name: Riparian Buffer Analysis and Prioritization for Enhancement

Action # D-15 (EAP)

Action Type: Programmatic

Action Extent: District-wide

Priority Ranking: -

	Watershed	Basin	Lat	Long	Modeling Subbasin	Reach(es)				
Action Location:	Multiple	-	-	-	-	-	-	-	-	-

Proposed Action - Implementation Steps (continued):

Attachments to describe Implementation Steps further? No

Pathway for attachment(s):

Proposed Action - Implementation Steps (continued):

Detailed Cost Breakdown

Initial Implementation Cost Assumptions: It is estimated to require approximately 200 hours of time for a WES staff member and 200 hours of time for a DTD staff member (with GIS skills and riparian analysis field skills) to perform the riparian buffer analyses and up to 80 hours of consultant time to assist in analyzing the results. Development and implementation of plans to increase riparian shade to address opportunities identified in the analysis will require additional time of WES staff or a consultant working with WES staff; this additional cost is not included in this Action.

Ongoing Cost Assumptions:

Initial Implementation Cost Estimate:

Item	Quantity	Unit	Unit Cost	Estimated Cost
FTE summary	0.1	FTE	$ 80,000	$ 8,000
Consultant	80	hours	$ 150	$ 12,000
				$ -
				$ -
				$ -
				$ -
				$ -
				$ -
Raw Cost				$ 20,000
Engineering, Administration, Contingency*			35%	$ -
Sub-total				$ 20,000
Land Costs		acre	$ 100,000	$ -
Total Estimated Initial Implementation Costs (2009 dollars) *				$ 20,000

Ongoing Cost Estimate: Project Life Past Yr 1 (yrs) 0

Item	Quantity	Unit	Unit Cost	Estimated Cost
FTE summary - WES		FTE	$ 80,000	$ -
				$ -
				$ -
				$ -
				$ -
				$ -
				$ -
Raw Cost				$ -
Engineering, Administration, Contingency*			35%	$ -
Sub-total				$ -
Land Costs		acre	$100,000	$ -
Annual Ongoing Costs (2009 dollars)				$ -
Total Ongoing Cost Over Project Life (2009 dollars)				$ -

* Contingency and engineering mark-ups for capital projects only. Mark-ups linked to action type in cell C2

Action Name:	Add LWD with Private Landowners and Partners							**Action #**	D-16	
Action Type:	Programmatic & Capital			**Action Extent:**	District-wide			**Priority Ranking:**		-
	Watershed	**Basin**	**Lat**	**Long**	**Modeling Subbasin**	**Reach(es)**				
Action Location:	Multiple	-	-	-	-	RK4	RK5	RK6	RK7	see below

Potential lead entity:	ODFW			**WES Lead:**	Env. Policy & Watershed Health	**Potential funding sources:**	Grants
Partner entities:	CRBC	**Partner entities:**		**WES Support:**	Env. Monitoring & Regulatory	**Potential funding sources:**	WES (Rates)
Partner entities:	Nonprofit Groups	**Partner entities:**		**WES Support:**		**Potential funding sources:**	
Partner entities:	Private	**Partner entities:**		**WES Support:**		**Potential funding sources:**	

Action Description (see backside of sheet for more details)

Statement of Need: Most streams in the KMS watershed are lacking LWD, as shown in Table 5-4 of the Kellogg-Mt. Scott and Rock Creek reach assessment results. Large woody debris is important for aquatic habitat, improves the system hydraulics, and also provides refuge habitat during winter high flow events. This project will support efforts by Oregon Department of Fish and Wildlife, Columbia River Basin Council, and others.

Proposed Action - Implementation Steps:

The goal of this project is to support other entities efforts to add LWD to streams, primarily for fish habitat in partnership with ODFW, USDA-NRCS, Columbia River Basin Council, landowners, non-profits, such as the local watershed council, and others to implement LWD placement projects.

This project should also involve coordination and prioritization of project sites. Work will need to be conducted in coordination with willing landowners and effort should be made to select easily accessible sites that provide the greatest benefit to aquatic habitat. Initial efforts should consider focusing on reaches RK4 through RK6, and RK7 which scored poor on LWD metrics. In addition, KG1, KG2, MS1, MS6, and MS8 through MS12A could benefit from LWD placement. Also see Figures 2-11, 2-14, and 2-16 in the Rock Creek Assessment.

This project should work with DTD and co-develop a LWD reclamation program. This would involve working with developers to reclaim LWD from project sites and transporting LWD to a County storage facility. This project would need to secure a site for LWD storage, develop a program to provide the wood to project applicants working on stream restoration, and monitor whether or not project goals are achieved.

The following components are part of projects, but not necessarily within WES' purview. WES would need to determine their contribution on a project-by-project basis. These components include: outreach to landowners adjacent to the reaches identified as high priority; prioritizing areas for LWD placement based on assessment results and opportunities with willing landowners; partnering with non-profits and applying for grant funding; permitting; design of project; locating materials, e.g. LWD; construction; and monitoring the project for desired objectives.

Benefits of Action: This action will support functioning aquatic ecosystems, improve aqautic habitat and biological communities, and improve hydrology and geomorphology.

Action Cost Summary (see backside for detailed cost estimate)

						Subtotal
Initial Programmatic FTE estimate:	0.25	**Initial Programmatic FTE Cost:**	$ 20,000	**Initial Capital Cost Summary:**	$ 6,750	*$ 26,750*
Ongoing Programmatic FTE estimate:	0.25	**Ongoing Programmatic FTE Cost:**	$ 20,000	**Annual Ongoing Capital Cost**	$ 6,750	*$ 26,750*
		(Programmatic Cost Summary is the FTE estimate translated into dollars)		**Years of Ongoing Cost Past Yr 1 included**		*4*
				Total Estimated 5-year Programmatic and Capital Cost		*$ 133,750*

Action Name: Add LWD with Private Landowners and Partners **Action #** D-16

Action Type: Programmatic & Capital **Action Extent:** District-wide **Priority Ranking:** -

	Watershed	Basin	Lat	Long	Modeling Subbasin	Reach(es)				
Action Location:	Multiple	-	-	-	-	RK4	RK5	RK6	RK7	see below

Proposed Action - Implementation Steps (continued):

Attachments to describe Implementation Steps further? No

Pathway for attachment(s):

Proposed Action - Implementation Steps (continued): This program would be conducted in coordination with D5-Improve riparian buffer with private landowners and partners, D6-Improve upland tree canopy with private landowners and partners, and D17-Targeted invasive species management.

Detailed Cost Breakdown

Initial Implementation Cost Assumptions: Assumes partnering with other agencies and groups to support them in LWD placement projects. Capital costs are for acquiring and transporting LWD. Assumes existing County property can be used for LWD storage.

Ongoing Cost Assumptions: Same as above.

Initial Implementation Cost Estimate:

Item	Quantity	Unit	Unit Cost	Estimated Cost
FTE summary	0.25	FTE	$ 80,000	$ 20,000
Transporting LWD	10	tree	$ 500	$ 5,000
				$ -
				$ -
				$ -
				$ -
				$ -
				$ -
Raw Cost				$ 25,000
Engineering, Administration, Contingency*			35%	$ 1,750
Sub-total				$ 26,750
Land Costs		acre	$ 100,000	$ -
Total Estimated Initial Implementation Costs (2009 dollars) *				$ 26,750

Ongoing Cost Estimate: Project Lifetime (yrs) 4

Item	Quantity	Unit	Unit Cost	Estimated Cost
FTE summary	0.25	FTE	$ 80,000	$ 20,000
Transporting LWD	10	tree	$ 500	$ 5,000
				$ -
				$ -
				$ -
				$ -
				$ -
Raw Cost				$ 25,000
Engineering, Administration, Contingency*			35%	$ 1,750
Sub-total				$ 26,750
Land Costs		acre	$ 100,000	$ -
Annual Ongoing Costs (2009 dollars)				$ 26,750
Total Ongoing Cost Over Project Life (2009 dollars)				$ 107,000

* Contingency and engineering mark-ups for capital projects only. Mark-ups linked to action type in cell C2

Action Name:	Targeted Invasive Species Management							**Action #**	D-17	
Action Type:	Programmatic & Capital			**Action Extent:**	District-wide			**Priority Ranking:**		-
	Watershed	**Basin**	**Lat**	**Long**	**Modeling Subbasin**	**Reach(es)**				
Action Location:	Multiple	-	-	-	-	-	-	-	-	-

Potential lead entity:	CCSWCD			**WES Lead:**	Env. Policy & Watershed Health	**Potential funding sources:**	WES (Rates)
Partner entities:	WES	**Partner entities:**		**WES Support:**		**Potential funding sources:**	Grants
Partner entities:	Parks Clackamas Co.	**Partner entities:**		**WES Support:**		**Potential funding sources:**	
Partner entities:	Nonprofit Groups	**Partner entities:**		**WES Support:**		**Potential funding sources:**	

Action Description (see backside of sheet for more details)

Statement of Need: Invasive and non-native plants decrease habitat quality, reduce recreational and aesthetic qualities of rivers and streams, and sometimes increase erosion potential. This action would involve continued invasive species identification and removal in areas identified in the Assessment Report. The District has been working with a multitude of watershed and environmental groups to remove invasives and this project would continue to build on that work. The Clackamas County Soil and Water Conservation District has recently initiated a County Weed Board. This program will be coordinated and implemented with assistance from the District's WeedWise Program Manager.

Proposed Action - Implementation Steps: This project will prioritize areas for invasive plant removal, provide baseline information on invasive plants in the Rock Creek and Kellogg-Mt.Scott watersheds, develop a plan for removal (hand pulling, mechanical harvesting, and herbicides as appropriate), and work with contractors and non-profits to remove the invasive species. Targeted invasive species in the KMS watershed include Japanese Knotweed, Himalayan blackberry, bamboo, reed canary grass, Canada thistle, and others. In KMS, the invasive species management program could first target reach MS1, which is located in North Clackamas Park where one bank within a selected reach is dominated by invasive bamboo and Japanese Knotweed. After removal, the invasive species management program will purchase and plant native vegetation and monitor native vegetation to prevent reoccurrence of invasive species. Coordination with private landowners and volunteer organizations will significantly reduce the expense of this program. RC1 and 2 are also high priority reaches to start in.

This program would be conducted in coordination with D5-Improve riparian buffer with private landowners and partners, D6-Improve upland tree canopy with private landowners and partners, and D16-Add LWD with private landowners and partners.

Benefits of Action: Projects that preserve stream health or enhance stream condition generate ongoing, appreciating benefits to water quality, water quantity, and aquatic habitat.

Action Cost Summary (see backside for detailed cost estimate)

						Subtotal
Initial Programmatic FTE estimate:	0.1	**Initial Programmatic FTE Cost:**	$ 8,000	**Initial Capital Cost Summary:**	$ 20,000	*$ 28,000*
Ongoing Programmatic FTE estimate:	0.1	**Ongoing Programmatic FTE Cost:**	$ 8,000	**Annual Ongoing Capital Cost**	$ 20,000	*$ 28,000*
		(Programmatic Cost Summary is the FTE estimate translated into dollars)		**Years of Ongoing Cost Past Yr 1 included**		*4*
				Total Estimated 5-year Programmatic and Capital Cost		*$ 140,000*

Action Name: Targeted Invasive Species Management

Action # D-17

Action Type: Programmatic & Capital

Action Extent: District-wide

Priority Ranking: -

Action Location:

	Watershed	**Basin**	**Lat**	**Long**	**Modeling Subbasin**	**Reach(es)**				
Action Location:	Multiple	-	-	-	-	-	-	-	-	-

Proposed Action - Implementation Steps (continued):

Attachments to describe Implementation Steps further? No

Pathway for attachment(s):

Proposed Action - Implementation Steps (continued):

Detailed Cost Breakdown

Initial Implementation Cost Assumptions: 0.1 FTE per year for ongoing volunteer organization and implementation. This action assumes partnering with other agencies and use of volunteer hours to complete projects.

Ongoing Cost Assumptions: 0.1 FTE per year as discussed above.

Initial Implementation Cost Estimate:

Item	**Quantity**	**Unit**	**Unit Cost**	**Estimated Cost**
FTE summary	0.1	FTE	$ 80,000	$ 8,000
Supplies	1	year	$ 20,000	$ 20,000
				$ -
				$ -
				$ -
				$ -
				$ -
				$ -
Raw Cost				$ 28,000
Engineering, Administration, Contingency*			35%	$ -
Sub-total				$ 28,000
Land Costs		acre	$ 100,000	$ -
Total Estimated Initial Implementation Costs (2009 dollars) *				$ 28,000

Ongoing Cost Estimate: Project Lifetime (yrs) 4

Item	**Quantity**	**Unit**	**Unit Cost**	**Estimated Cost**
FTE summary	0.1	FTE	$ 80,000	$ 8,000
Supplies	1	year	$ 20,000	$ 20,000
				$ -
				$ -
				$ -
				$ -
				$ -
Raw Cost				$ 28,000
Engineering, Administration, Contingency*			35%	$ -
Sub-total				$ 28,000
Land Costs		acre	$ 100,000	$ -
Annual Ongoing Costs (2009 dollars)				$ 28,000
Total Ongoing Cost Over Project Life (2009 dollars)				$ 112,000

* Contingency and engineering mark-ups for capital projects only. Mark-ups linked to action type in cell C2

Action Name: Improve Fish Passage **Action #** D-18

Action Type: Programmatic **Action Extent:** District-wide **Priority Ranking:** -

	Watershed	Basin	Lat	Long	Modeling Subbasin	Reach(es)				
Action Location:	Multiple	-	-	-	-	-	-	-	-	-

Potential lead entity:	DTD Clackamas Co.			**WES Lead:**	Asset Management	**Potential funding sources:**	WES (Devel. Fees)
Partner entities:	WES	**Partner entities:**	City of Happy Valley	**WES Support:**	Env. Policy & Watershed Health	**Potential funding sources:**	Grants
Partner entities:	ODFW	**Partner entities:**	City of Damascus	**WES Support:**	Stormwater Maintenance	**Potential funding sources:**	
Partner entities:	City of Milwaukie	**Partner entities:**	Nonprofit Groups	**WES Support:**		**Potential funding sources:**	

Action Description (see backside of sheet for more details)

Statement of Need: Adults of both anadromous and resident salmonids in the KMS and RC watersheds require barrier free access to suitable spawning habitat. Although poorly studied, it is also likely that unobstructed access to tributaries may be important in allowing access to refuge habitat during winter high flow events. Data on the presence of human-made and natural fish passage barriers was collected and compiled from ODFW, the County, and the project team biologist for the characterization reports, and is illustrated on Figure 4-8 of the KMS Characterization Report and Figure 4-9 of the Rock Creek Characterization Report. However, further evaluation is needed to create a priority ranking of fish passage barrier replacement/retrofit.

Proposed Action - Implementation Steps: The replacement/retrofit of fish passage barriers should be prioritized following the collection and analysis of additional site-specific information on the condition of the barriers, species and life stages affected, quality and availability of upstream habitat and flooding potential. The steps outlined below begin with goal setting and follow the project through implementation. See attachment for more detailed implementation steps.

1. Select WES project manager
2. Set Goals
3. Collect Data
4. Evaluate extent of barrier using collected data, KMS and RC Characterization and Assessment Reports, ODFW Culvert Assessment, Clackamas County culvert inventory.
5. Identify preferred retrofit/replacement method and lower cost alternatives. Hydraulic modeling should be completed in this stage to identify impacts of design on surrounding hydraulics, especially when flood conditions exist in the area.
6. Develop a fish passage barrier retrofit prioritization and rank projects
7. Develop an implementation program to improve a number of fish passage barriers annually, working from downstream to upstream
8. Design of fish passage improvements. The design phase will coordinate funding, partnering agencies, engineering, permitting, construction, and monitoring.

Benefits of Action: The replacement/retrofit of fish passage barriers in KMS and RC would improve habitat for anadromous and resident salmonids in the watershed. Barrier replacement/retrofit in some instances also has potential to reduce flooding and improve water quality.

Action Cost Summary (see backside for detailed cost estimate)

						Subtotal
Initial Programmatic FTE estimate:	0.25	**Initial Programmatic FTE Cost:**	$ 20,000	**Initial Capital Cost Summary:**	$ 15,000	*$ 35,000*
Ongoing Programmatic FTE estimate:	0.1	**Ongoing Programmatic FTE Cost:**	$ 8,000	**Annual Ongoing Capital Cost**	$400,000	*$ 408,000*
		(Programmatic Cost Summary is the FTE estimate translated into dollars)		**Years of Ongoing Cost Past Yr 1 included**		*4*
				Total Estimated 5-year Programmatic and Capital Cost		*$ 1,667,000*

Action Name: Improve Fish Passage **Action #** D-18

Action Type: Programmatic **Action Extent:** District-wide **Priority Ranking:** -

	Watershed	Basin	Lat	Long	Modeling Subbasin	Reach(es)				
Action Location:	Multiple	-	-	-	-	-	-	-	-	-

Proposed Action - Implementation Steps (continued):

Attachments to describe Implementation Steps further? Yes

Pathway for attachment(s): Fish passage barrier locations, Implementation steps, ODFW 1999 Culvert Assessment Summary

Proposed Action - Implementation Steps (continued):

The ODFW data resources website contains links to GIS information on fish passage barriers: http://rainbow.dfw.state.or.us/nrimp/default.aspx?p=259. Data presented from this website was use to create Figure 4-8 of the KMS Characterization Report and Figure

DTD is listed at a lead entity for this project, however since they are a transportation department, they may not take the lead on projects that do not involve roadway culvert crossings, WES could parter with DTD to facilitate these other barriers. DTD has a list of passage barriers to address that should be evaluated and integrated with this effort.

Detailed Cost Breakdown

Initial Implementation Cost Assumptions:

Initial implementation includes WES staff time to complete the evaluation of potential fish passage barriers and a contracted consultant to conduct hydraulic modeling associated with the project. Evaluation coul be completed in one year.

Ongoing Cost Assumptions:

Ongoing costs cover implementation step 8. Assume 2 passage barriers are retrofitted/replaced every year for year 2-5 of this project. Costs are for replacement of culverts with 3-sided concrete box culverts, assuming existing culverts are 24" in diameter on average.

Initial Implementation Cost Estimate:

Item	Quantity	Unit	Unit Cost	Estimated Cost
FTE summary	0.25	FTE	$ 80,000	$ 20,000
Hydraulic Modeling	100	hrs	$ 150	$ 15,000
				$ -
				$ -
				$ -
				$ -
				$ -
				$ -
Raw Cost				$ 35,000
Engineering, Administration, Contingency*			35%	
Sub-total				$ 35,000
Land Costs		acre	$ 100,000	$ -
Total Estimated Initial Implementation Costs (2009 dollars) *				$ 35,000

Ongoing Cost Estimate: Project Lifetime (yrs) 4

Item	Quantity	Unit	Unit Cost	Estimated Cost
FTE summary	0.1	FTE	$ 80,000	$ 8,000
Culvert replacement	2	each	$ 200,000	$ 400,000
				$ -
				$ -
				$ -
				$ -
				$ -
Raw Cost				$ 408,000
Engineering, Administration, Contingency*			35%	$ -
Sub-total				$ 408,000
Land Costs		acre	$ 100,000	$ -
Annual Ongoing Costs (2009 dollars)				$ 408,000
Total Ongoing Cost Over Project Life (2009 dollars)				$ 1,632,000

* Contingency and engineering mark-ups for capital projects only. Mark-ups linked to action type in cell C2

Action Name: Stakeholder Involvement and Communications Plan Implementation **Action #** D-19

Action Type: Programmatic **Action Extent:** District-wide **Priority Ranking:** -

	Watershed	Basin	Lat	Long	Modeling Subbasin	Reach(es)				
Action Location:	Multiple	-	-	-	-	-	-	-	-	-

Potential lead entity:	WES			**WES Lead:**	Public Information	**Potential funding sources:**	WES (Rates)
Partner entities:	Nonprofit Groups	**Partner entities:**	City of Damascus	**WES Support:**	Env. Policy & Watershed Health	**Potential funding sources:**	Other
Partner entities:	City of Happy Valley	**Partner entities:**	DTD Clackamas Co.	**WES Support:**	Asset Management	**Potential funding sources:**	
Partner entities:	City of Milwaukie	**Partner entities:**		**WES Support:**		**Potential funding sources:**	

Action Description (see backside of sheet for more details)

Statement of Need: WES is developing a communications plan that will include opportunities for further stakeholder involvement in implementation of the Watershed Action Plans. The purpose of the communications plan is to provide watershed-specific information to stakeholders, to re-orient the WES SWM program, and to build a constituency to champion the integrated watershed health SWM approach.

Proposed Action - Implementation Steps:

It is recommended that WES develop an intneral outreach and communications task force comprised of WES staff. The WES task force will identify activities to implement for each of the following categories as a baseline annual program and for unique additional program elements as needed to meet level of service goals and implement the WAPs:

- Informational materials – print and web pieces, interpretative signage, press releases
- Education and citizen contact– seminars, brown bags, workshops, tours, presentations, booths and events tabling, call tracking
- Volunteer campaign – watershed enhancement, stewardship, clean-up, planting, inventory and monitoring activities
- Recognition and incentive – awards, certifications, fee and tax reductions, grants
- Meetings and communication - ongoing stakeholder meetings and outreach

Benefits of Action: Effective stakeholder outreach will affirm and/or initiate working partnerships between key stakeholders and WES; deepen and broaden understanding of the social value of watershed health; address challenges and threats generated by the new direction; assure that a broad range of perspectives are included in the action planning process; provide a stakeholder-based reality check for watershed health recommendations; develop support for watershed action plan implementation and SWM program re-orientation; and provide stakeholders with tools to improve watershed health through their actions.

Action Cost Summary (see backside for detailed cost estimate)

						Subtotal
Initial Programmatic FTE estimate:	0.5	**Initial Programmatic FTE Cost:**	$ 40,000	**Initial Capital Cost Summary:**	$ -	*$ 40,000*
Ongoing Programmatic FTE estimate:	0.5	**Ongoing Programmatic FTE Cost:**	$ 40,000	**Annual Ongoing Capital Cost**	$ -	*$ 40,000*
		(Programmatic Cost Summary is the FTE estimate translated into dollars)		**Years of Ongoing Cost Past Yr 1 included**		*4*
				Total Estimated 5-year Programmatic and Capital Cost		*$ 200,000*

Action Name: Stakeholder Involvement and Communications Plan Implementation **Action #** D-19

Action Type: Programmatic **Action Extent:** District-wide **Priority Ranking:** -

	Watershed	Basin	Lat	Long	Modeling Subbasin	Reach(es)				
Action Location:	Multiple	-	-	-	-	-	-	-	-	-

Proposed Action - Implementation Steps (continued):

Attachments to describe Implementation Steps further? No

Pathway for attachment(s):

Proposed Action - Implementation Steps (continued):

Detailed Cost Breakdown

Initial Implementation Cost Assumptions:

Assume 0.5 FTE required to implement Communications Plan. More detail to be included later as WES fully develops Communications Plan implementation process.

Ongoing Cost Assumptions: Assume 0.5 FTE required to implement Communications Plan.

Initial Implementation Cost Estimate:

Item	Quantity	Unit	Unit Cost	Estimated Cost
FTE summary	0.5	FTE	$ 80,000	$ 40,000
				$ -
				$ -
				$ -
				$ -
				$ -
				$ -
				$ -
Raw Cost				$ 40,000
Engineering, Administration, Contingency*			35%	$ -
Sub-total				$ 40,000
Land Costs		acre	$ 100,000	$ -
Total Estimated Initial Implementation Costs (2009 dollars) *				$ 40,000

Ongoing Cost Estimate:

Project Life Past Yr 1 (yrs) 4

Item	Quantity	Unit	Unit Cost	Estimated Cost
FTE summary	0.5	FTE	$ 80,000	$ 40,000
				$ -
				$ -
				$ -
				$ -
				$ -
				$ -
Raw Cost				$ 40,000
Engineering, Administration, Contingency*			35%	$ -
Sub-total				$ 40,000
Land Costs		acre	$ 100,000	$ -
Annual Ongoing Costs (2009 dollars)				$ 40,000
Total Ongoing Cost Over Project Life (2009 dollars)				$ 160,000

* Contingency and engineering mark-ups for capital projects only. Mark-ups linked to action type in cell C2

Action Name:	Regional Stormwater Task Force				**Action #**	D-20
Action Type:	Programmatic	**Action Extent:**	District-wide		**Priority Ranking:**	-

	Watershed	**Basin**	**Lat**	**Long**	**Modeling Subbasin**	**Reach(es)**				
Action Location:	Multiple	-	-	-	-	-	-	-	-	-

Potential lead entity:	WES			**WES Lead:**	Asset Management	**Potential funding sources:**	WES (Rates)
Partner entities:	City of Damascus	**Partner entities:**	DTD Clackamas Co.	**WES Support:**	Env. Policy & Watershed Health	**Potential funding sources:**	City of Damascus
Partner entities:	City of Happy Valley	**Partner entities:**		**WES Support:**	Development Review	**Potential funding sources:**	City of Happy Valley
Partner entities:	City of Milwaukie	**Partner entities:**		**WES Support:**		**Potential funding sources:**	City of Milwaukie

Action Description (see backside of sheet for more details)

Statement of Need: There is an opportunity for continued coordination between the Cities in and around the Districts and WES in implementation of the Watershed Action Plans and development of regional stormwater management strategies. The ACWA Stormwater Committee and Phase 1 MS4 Permittee Subcommittee provide excellent coordination opportunities on state-wide stormwater issues, however there are some issues that would be helpful to address with a regional group comprised of the Cities in and around the WES service area, DTD, and WES.

Proposed Action - Implementation Steps:

Developing and implementing the Clackamas Regional Stormwater Task Force will include the following steps:
1) Identify WES staff members to be involved in Task Force.
2) Identify Cities and City staff members as well as DTD staff members to be involved in Task Force (e.g., Damasucs, Happy Valley, Milwaukie, etc.).
3) Set regular meeting time and place for Task Force meetings, starting with quarterly meetings and adjusting the meeting schedule as needed to address issues.
4) Identify items to address on a regular basis (updates/coordination) and items to address with specific project timeframes. Agenda items will generally be limited to specific stormwater and watershed coordination issues in the WES service area and adjacent cities. The Clackamas Regional Stormwater Task Force is intended to supplement other regional coordination efforts such as the ACWA Stormwater Committee meetings, and not replace the content of those meetings.
5) Meet, distribute notes from meetings to all participants, regularly update agenda items as needed.

Benefits of Action: Continued coordination between the Cities in and around the Districts and WES will improve the implementation of the Watershed Action Plans and assist in development of regional stormwater management strategies, which will benefit the watershed health elements of water quality, water quantity control, and habitat.

Action Cost Summary (see backside for detailed cost estimate)

						Subtotal
Initial Programmatic FTE estimate:	0.1	**Initial Programmatic FTE Cost:**	$ 8,000	**Initial Capital Cost Summary:**	$ -	*$ 8,000*
Ongoing Programmatic FTE estimate:	0.1	**Ongoing Programmatic FTE Cost:**	$ 8,000	**Annual Ongoing Capital Cost**	$ -	*$ 8,000*
		(Programmatic Cost Summary is the FTE estimate translated into dollars)		**Years of Ongoing Cost Past Yr 1 included**		*4*
				Total Estimated 5-year Programmatic and Capital Cost		*$ 40,000*

Action Name:	Regional Stormwater Task Force						**Action #**	D-20		
Action Type:	Programmatic			**Action Extent:**	District-wide		**Priority Ranking:**		-	
	Watershed	**Basin**	**Lat**	**Long**	**Modeling Subbasin**	**Reach(es)**				
Action Location:	Multiple	-	-	-	-	-	-	-	-	-

Proposed Action - Implementation Steps (continued):

Attachments to describe Implementation Steps further? No

Pathway for attachment(s):

Proposed Action - Implementation Steps (continued):

Detailed Cost Breakdown

Initial Implementation Cost Assumptions:

Assume WES staff provide coordination and implementation for Clackamas Regional Stormwater Task Force, at an effort level of 200 hours per year (0.1 FTE).

Ongoing Cost Assumptions:

Initial Implementation Cost Estimate:

Item	Quantity	Unit	Unit Cost	Estimated Cost
FTE summary	0.1	FTE	$ 80,000	$ 8,000
				$ -
				$ -
				$ -
				$ -
				$ -
				$ -
				$ -
Raw Cost				$ 8,000
Engineering, Administration, Contingency*			35%	$ -
Sub-total				$ 8,000
Land Costs		acre	$ 100,000	$ -
Total Estimated Initial Implementation Costs (2009 dollars) *				$ 8,000

Ongoing Cost Estimate: Project Life Past Yr 1 (yrs) 4

Item	Quantity	Unit	Unit Cost	Estimated Cost
FTE summary	0.1	FTE	$ 80,000	$ 8,000
				$ -
				$ -
				$ -
				$ -
				$ -
				$ -
Raw Cost				$ 8,000
Engineering, Administration, Contingency*			35%	$ -
Sub-total				$ 8,000
Land Costs		acre	$100,000	$ -
Annual Ongoing Costs (2009 dollars)				$ 8,000
Total Ongoing Cost Over Project Life (2009 dollars)				$ 32,000

* Contingency and engineering mark-ups for capital projects only. Mark-ups linked to action type in cell C2

Action Name:	Regional Decant Facility				**Action #**	D-21
Action Type:	Capital	**Action Extent:**	District-wide		**Priority Ranking:**	-

	Watershed	**Basin**	**Lat**	**Long**	**Modeling Subbasin**	**Reach(es)**				
Action Location:	Multiple	-	-	-	-	-	-	-	-	-

Potential lead entity:	WES			**WES Lead:**	Asset Management	**Potential funding sources:**	WES (Rates)
Partner entities:	DTD Clackamas Co.	**Partner entities:**	City of Damascus	**WES Support:**	Stormwater Maintenance	**Potential funding sources:**	City of Milwaukie
Partner entities:	City of Milwaukie	**Partner entities:**	Other	**WES Support:**		**Potential funding sources:**	City of Happy Valley
Partner entities:	City of Happy Valley	**Partner entities:**		**WES Support:**		**Potential funding sources:**	City of Damascus

Action Description (see backside of sheet for more details)

Statement of Need:

The District and DTD currently use a decant facility to collect catch basin waste. The facility is currently undersized and does not meet the needs of the District and DTD.

Proposed Action - Implementation Steps:

1. Select WES project manager.
2. Conduct a cost/benefit analysis to determine benefits of decant facility.
3. Contact other jurisdictions (DTD, ODOT, Gresham, Portland, Milwaukie, Happy Valley, Oregon City, etc.) to identify potential interested partners in the facility siting study and facility operation.
4. Complete a siting study to determine decant facility location. Develop partnership agreements with parters.
5. Design and construct decant facility.
6. Designate a manager and staff for the decant facility.

Benefits of Action:

A strategically located decant facility could provide the County with a cost effective method for disposing of wastes collected from catch basins. The facillity could also serve sanitary sewer pump stations.

Action Cost Summary (see backside for detailed cost estimate)

						Subtotal
Initial Programmatic FTE estimate:	0	**Initial Programmatic FTE Cost:**	$ -	**Initial Capital Cost Summary:**	$ 2,000,000	*$ 2,000,000*
Ongoing Programmatic FTE estimate:	0	**Ongoing Programmatic FTE Cost:**	$ -	**Annual Ongoing Capital Cost**	$ -	*$ -*
		(Programmatic Cost Summary is the FTE estimate translated into dollars)		**Years of Ongoing Cost Past Yr 1 included**		*0*
				Total Estimated 5-year Programmatic and Capital Cost		*$ 2,000,000*

Action Name: Regional Decant Facility

Action # D-21

Action Type: Capital

Action Extent: District-wide

Priority Ranking: -

	Watershed	**Basin**	**Lat**	**Long**	**Modeling Subbasin**	**Reach(es)**				
Action Location:	Multiple	-	-	-	-	-	-	-	-	-

Proposed Action - Implementation Steps (continued):

Attachments to describe Implementation Steps further? No

Pathway for attachment(s):

Proposed Action - Implementation Steps (continued):

Detailed Cost Breakdown

Initial Implementation Cost Assumptions:

An estimated $2 million dollars for siting study, land, building and materials.

Ongoing Cost Assumptions:

Initial Implementation Cost Estimate:

Item	**Quantity**	**Unit**	**Unit Cost**	**Estimated Cost**
FTE summary		FTE	$ 80,000	$ -
Decant Facility	1	LS	$ 2,000,000	$ 2,000,000
				$ -
				$ -
				$ -
				$ -
				$ -
				$ -
Raw Cost				$ 2,000,000
Engineering, Administration, Contingency*			35%	
Sub-total				$ 2,000,000
Land Costs		acre	$ 100,000	$ -
Total Estimated Initial Implementation Costs (2009 dollars) *				$ 2,000,000

Ongoing Cost Estimate: Project Lifetime (yrs) 0

Item	**Quantity**	**Unit**	**Unit Cost**	**Estimated Cost**
FTE summary		FTE	$ 80,000	$ -
				$ -
				$ -
				$ -
				$ -
				$ -
				$ -
Raw Cost				$ -
Engineering, Administration, Contingency*			35%	$ -
Sub-total				$ -
Land Costs		acre	$ 100,000	$ -
Annual Ongoing Costs (2009 dollars)				$ -
Total Ongoing Cost Over Project Life (2009 dollars)				$ -

* Contingency and engineering mark-ups for capital projects only. Mark-ups linked to action type in cell C2

Action Name: Enhanced Street Sweeping
Action # KMS-1
Action Type: Programmatic
Action Extent: Multiple reaches
Priority Ranking: -

	Watershed	Basin	Lat	Long	Modeling Subbasin	Reach(es)				
Action Location:	KMS	Cedar	-	-	-	PH1	PH1A	-	-	-

Potential lead entity:	DTD Clackamas Co.			**WES Lead:**	Asset Management	**Potential funding sources:**	DTD
Partner entities:	WES	**Partner entities:**		**WES Support:**	Stormwater Maintenance	**Potential funding sources:**	WES (Rates)
Partner entities:		**Partner entities:**		**WES Support:**	Public Information	**Potential funding sources:**	
Partner entities:		**Partner entities:**		**WES Support:**	WES GIS	**Potential funding sources:**	

Action Description (see backside of sheet for more details)

Statement of Need: Increased frequency and effectiveness of street sweeping is needed on targeted high volume streets such as SE 82nd, along Sunnyside Road (Cedar and Phillips subbasin), other major arterials with average daily traffic over 1,000 vehicles, and in high traffic commercial parking areas. Street sweeping is one of the most cost-effective ways to remove the sediments and associated pollutants, such as metals and petroleum products, that accumulate on streets before they wash into streams in areas lacking structural stormwater quality facilities. Erosion, sedimentation, pesticides, dissolved metals, and other toxic materials contribute to reduced biological quality in streams. Increased street sweeping would assist DTD and WES in meeting NPDES MS4 permit requirements.

Proposed Action - Implementation Steps:

The goal of this project is to enhance street sweeping effectiveness in reducing pollutant loads from high volume roads by coordinating with DTD. Tasks include the following:

- Coordinate with DTD to increase the frequency of street sweeping on SE 82nd, Sunnyside Road, and in high traffic areas (Cedar subbasin and reaches PH1 and PH1A). Using the regenerative air sweeper on a monthly basis has shown to reduce total solids (TS) by 22%, total phosphorus (TP) by 4%, and total nitrogen (TN) by 4%. Weekly use of the regenerative air sweeper has shown a pollutant removal efficiency of 31% for TS, 8% for TP, and 7% for TN (see reference on next page).
- Consider additional areas for enhanced street sweeping by using GIS to map high pollutant accumulation and washoff areas (commercial, industrial, multi-family, highways, and major arterials with average daily traffic greater than 1,000 vehicles) and areas lacking pre-treatment facilities.
- Track frequency of sweeping by street locations in GIS.
- Track volume of pollutants removed per street to assess sweeping effectiveness.
- Assess the costs of increased sweeping relative to the benefits observed.

Benefits of Action: This action will assist in meeting permit requirements, reduce pollutant loads through use of structural BMPs, and improve water quality.

Action Cost Summary (see backside for detailed cost estimate)

						Subtotal
Initial Programmatic FTE estimate:	0	**Initial Programmatic FTE Cost:**	$ -	**Initial Capital Cost Summary:**	$370,400	*$ 370,400*
Ongoing Programmatic FTE estimate:	0	**Ongoing Programmatic FTE Cost:**	$ -	**Annual Ongoing Capital Cost**	$ 50,400	*$ 50,400*
		(Programmatic Cost Summary is the FTE estimate translated into dollars)		**Years of Ongoing Cost Past Yr 1 included**		*4*
				Total Estimated 5-year Programmatic and Capital Cost		*$ 572,000*

Action Name: Enhanced Street Sweeping

Action # KMS-1

Action Type: Programmatic

Action Extent: Multiple reaches

Priority Ranking: -

	Watershed	Basin	Lat	Long	Modeling Subbasin	Reach(es)				
Action Location:	KMS	Cedar	-	-	-	PH1	PH1A	-	-	-

Proposed Action - Implementation Steps (continued):

Attachments to describe Implementation Steps further? No

Pathway for attachment(s):

Proposed Action - Implementation Steps (continued):

Reference for street sweeping study: N.L. Law, K. DiBlasi, and U. Ghosh., Center for Watershed Protection, September 2008, "Deriving Reliable Pollutant Removal Rates for Municial Street Sweeping and Storm Drain Cleanout Programs in the Chesapeake Bay Basin" U.S. EPA Chesapeake Bay Program grant CB-973222-01

Detailed Cost Breakdown

Initial Implementation Cost Assumptions: Assumes puchase of 1 regenerative air street sweeper. Assumed currently sweeping 1x per year. Increased to bi-weekly sweeping. Dispoal and vehicle maintenance costs and the driver time are included in the cost per mile sweeping costs from DTD. Since FTE costs are included in the cost per mile, no additional FTE costs are included.

Initial Implementation Cost Estimate:

Item	Quantity	Unit	Unit Cost	Estimated Cost
FTE summary	0	FTE	$ 80,000	$ -
Regenerative air sweeper	1	truck	$ 320,000	$ 320,000
Sweep SE 82nd Ave	150	mile	$ 84	$ 12,600
Sweep Sunnyside Rd	75	mile	$ 84	$ 6,300
Other areas TBD	375	mile	$ 84	$ 31,500
				$ -
				$ -
Raw Cost				$ 370,400
Engineering, Administration, Contingency*			35%	$ -
Sub-total				$ 370,400
Land Costs		acre	$ 100,000	$ -
Total Estimated Initial Implementation Costs (2009 dollars) *				$ 370,400

Ongoing Cost Estimate:

Project Lifetime (yrs) 4

Item	Quantity	Unit	Unit Cost	Estimated Cost
FTE summary	0	FTE	$ 80,000	$ -
Sweep SE 82nd Ave	150	mile	$ 84	$ 12,600
Sweep Sunnyside Rd	75	mile	$ 84	$ 6,300
Other areas TBD	375	mile	$ 84	$ 31,500
				$ -
				$ -
Raw Cost				$ 50,400
Engineering, Administration, Contingency*			35%	$ -
Sub-total				$ 50,400
Land Costs		acre	$ 100,000	$ -
Annual Ongoing Costs (2009 dollars)				$ 50,400
Total Ongoing Cost Over Project Life (2009 dollars)				$ 201,600

* Contingency and engineering mark-ups for capital projects only. Mark-ups linked to action type in cell C2

Action Name:	Investigate Water Rights and Water Withdrawls Where Low Summer Flow is a Concern			**Action #**	KMS-2
Action Type:	Programmatic	**Action Extent:**	Multiple reaches	**Priority Ranking:**	-

	Watershed	**Basin**	**Lat**	**Long**	**Modeling Subbasin**	**Reach(es)**				
Action Location:	KMS	-	-	-	-	-	-	-	-	-

Potential lead entity:	WES			**WES Lead:**	Public Information	**Potential funding sources:**	WES (Rates)
Partner entities:	Nonprofit Groups	**Partner entities:**	OWRD	**WES Support:**	Asset Management	**Potential funding sources:**	
Partner entities:	Private	**Partner entities:**		**WES Support:**		**Potential funding sources:**	
Partner entities:		**Partner entities:**		**WES Support:**		**Potential funding sources:**	

Action Description (see backside of sheet for more details)

Statement of Need: Low flow in summer months in the upper Kellogg subbasin could be a result of possible withdrawals from private stream withdrawals or private wells that lower groundwater tables. However, little information is known about the capacity or current use of these withdrawals and if they are linked to private owners with water rights.

Proposed Action - Implementation Steps:

1. Conduct a record search of state water rights within basin.
2. Partner with local watershed councils, Friends of Kellogg-Mt. Scott Watershed and other outreach groups to gather information about water withdrawals from watershed. Use group contacts to educate private owners about impacts of water withdrawals on overall watershed and stream health.
3. Develop outreach programs to address withdrawals and potential purchase of waterights with focus on private owners.

Benefits of Action: Identifying potential causes of lower summer flow could assist in development actions to improve water quality.

Action Cost Summary (see backside for detailed cost estimate)

						Subtotal
Initial Programmatic FTE estimate:	0.2	**Initial Programmatic FTE Cost:**	$ 16,000	**Initial Capital Cost Summary:**	$ -	*$ 16,000*
Ongoing Programmatic FTE estimate:	0	**Ongoing Programmatic FTE Cost:**	$ -	**Annual Ongoing Capital Cost**	$ -	*$ -*
		(Programmatic Cost Summary is the FTE estimate translated into dollars)		**Years of Ongoing Cost Past Yr 1 included**		*0*
				Total Estimated 5-year Programmatic and Capital Cost		*$ 16,000*

Action Name: Investigate Water Rights and Water Withdrawls Where Low Summer Flow is a Concern

Action # KMS-2

Action Type: Programmatic

Action Extent: Multiple reaches

Priority Ranking: -

	Watershed	Basin	Lat	Long	Modeling Subbasin	Reach(es)				
Action Location:	KMS	-	-	-	-	-	-	-	-	-

Proposed Action - Implementation Steps (continued):

Attachments to describe Implementation Steps further? No

Pathway for attachment(s):

Proposed Action - Implementation Steps (continued):

Detailed Cost Breakdown

Initial Implementation Cost Assumptions: Assume one-year project. Assume partnership with local watershed groups for promotion of program. Assume 0.2 FTE WES staff effort to organize and create database of known water rights.

Ongoing Cost Assumptions: Ongoing Cost Assumptions: Assume project is completed in one year and no ongoing costs.

Initial Implementation Cost Estimate:

Item	Quantity	Unit	Unit Cost	Estimated Cost
FTE summary	0.2	FTE	$ 80,000	$ 16,000
				$ -
				$ -
				$ -
				$ -
				$ -
				$ -
				$ -
Raw Cost				$ 16,000
Engineering, Administration, Contingency*			35%	$ -
Sub-total				$ 16,000
Land Costs		acre	$ 100,000	$ -
Total Estimated Initial Implementation Costs (2009 dollars) *				$ 16,000

Ongoing Cost Estimate: Project Lifetime (yrs) 0

Item	Quantity	Unit	Unit Cost	Estimated Cost
				$ -
				$ -
				$ -
				$ -
				$ -
				$ -
				$ -
Raw Cost				$ -
Engineering, Administration, Contingency*			35%	$ -
Sub-total				$ -
Land Costs		acre	$ 100,000	$ -
Annual Ongoing Costs (2009 dollars)				$ -
Total Ongoing Cost Over Project Life (2009 dollars)				$ -

* Contingency and engineering mark-ups for capital projects only. Mark-ups linked to action type in cell C2

Action Name: Enhance Dean Creek Wetlands and Stream Channel

Action # KMS-3

Action Type: Capital

Action Extent: Single reach

Priority Ranking: -

	Watershed	Basin	Lat	Long	Modeling Subbasin	Reach(es)				
Action Location:	KMS	DN	-	-	-	DN1	-	-	-	-

Potential lead entity:	WES			**WES Lead:**	Env. Policy & Watershed Health	**Potential funding sources:**	Grants
Partner entities:	ODOT	**Partner entities:**		**WES Support:**		**Potential funding sources:**	WES (Rates)
Partner entities:		**Partner entities:**		**WES Support:**		**Potential funding sources:**	
Partner entities:		**Partner entities:**		**WES Support:**		**Potential funding sources:**	

Action Description (see backside of sheet for more details)

Statement of Need: The Dean Creek Subbasin lacks hydrologic, water quality and aquatic habitat data. Aerial photo analysis indicates that Dean Creek is largely piped or ditched and lacks a riparian buffer. Dean Creek currently flows through undeveloped area to the west of Mt. Talbert, which presents opportunity for wetlands and focused stream channel enhancement projects.

Proposed Action - Implementation Steps:

1. Select WES project manager
2. Set project goals and determine if project will be completed in-house or contracted out
3. Identify areas for wetlands restoration and for stream channel restoration, coordinate with the Sunrise Corridor Project and other development projects.
4. Survey project site and complete hydraulic modeling to determine project impacts on flooding and analyze capacity of project to meet project goals
5. Perform a cost/benefit analysis based on preliminary design information
6. Develop conceptual design and a more detailed cost estimate. Conceptual design includes flow management strategy.
7. Identify partners and funding sources for CIP
8. Secure project funding
9. Coordinate engineering, permitting and project schedule based on the in-stream work window
10. Develop monitoring plan to determine project success
11. Implement CIP
12. Monitor results according to specifications in monitoring plan

Benefits of Action: Wetlands and stream channel improvements could improve the hydrologic conditions, water quality and/or aquatic habitat in the creek. Dean Creek contributes to Mt. Scott Creek at Three Creeks; improvements made to Dean Creek will positively affect Mt. Scott Creek.

Action Cost Summary (see backside for detailed cost estimate)

						Subtotal
Initial Programmatic FTE estimate:	0.2	**Initial Programmatic FTE Cost:**	$ 16,000	**Initial Capital Cost Summary:**	$ 48,000	*$ 64,000*
Ongoing Programmatic FTE estimate:	0.1	**Ongoing Programmatic FTE Cost:**	$ 8,000	**Annual Ongoing Capital Cost**	$661,250	*$ 669,250*
		(Programmatic Cost Summary is the FTE estimate translated into dollars)		**Years of Ongoing Cost Past Yr 1 included**		2
				Total Estimated 5-year Programmatic and Capital Cost		*$ 741,250*

Action Name: Enhance Dean Creek Wetlands and Stream Channel

Action # KMS-3

Action Type: Capital

Action Extent: Single reach

Priority Ranking: -

	Watershed	Basin	Lat	Long	Modeling Subbasin	Reach(es)				
Action Location:	KMS	DN	-	-	-	DN1	-	-	-	-

Proposed Action - Implementation Steps (continued):

Attachments to describe Implementation Steps further? Yes

Pathway for attachment(s): Map of Potential Areas for Dean Creek Enhancement

Proposed Action - Implementation Steps (continued): The attached map identifies taxlots in the Dean Creeks area that are owned by Clackamas County or the State of Oregon. These areas were identified because it may be easier for the District to complete the restoration project on publically owned land.

The Sunrise Corridor Project is a transportation project beging undertaken by ODOT, depending on the chosen alignment the project could intersect with wetlands or stream enhancement project. Coordination with ODOT is an important component of this recommendation.

Detailed Cost Breakdown

Initial Implementation Cost Assumptions: Initial costs include project management, WES staff time for design, and a consultant to complete modeling and design of channel modificaiton and wetlands restoration. All restoration work is done on county owned property.

Ongoing Cost Assumptions: Assume 2,000 LF of channel modification, which includes permitting, grading, erosion control, flow management and post-construction plantings. Assume wetlands restoration includes mostly plantings with minor grading. Monitoring occurs for two years following implementation and includes visual observation of channel modification and vegetation planted in the riparian corridor. Visual observation and subsequent write-up occupies two FTE's for 4 hrs every two months.

Initial Implementation Cost Estimate:

Item	Quantity	Unit	Unit Cost	Estimated Cost
FTE Summary	0.20	FTE	$ 80,000	$ 16,000
Modeling & Design	320	hrs	$ 150	$ 48,000
				$ -
				$ -
				$ -
				$ -
				$ -
				$ -
Raw Cost				$ 64,000
Engineering, Administration, Contingency*			35%	
Sub-total				$ 64,000
Land Costs		acre	$ 100,000	$ -
Total Estimated Initial Implementation Costs (2009 dollars) *				$ 64,000

Ongoing Cost Estimate:

Project Lifetime (yrs) 2

Item	Quantity	Unit	Unit Cost	Estimated Cost
FTE Summary	0.10	FTE	$ 80,000	$ 8,000
Channel Modification	2000	lf	$ 200	$ 400,000
Wetlands Restoration	0.5	acre	$ 150,000	$ 75,000
Land easement coordination	1	LS	$ 20,000	$ 20,000
				$ -
				$ -
				$ -
Raw Cost				$ 503,000
Engineering, Administration, Contingency*			35%	$ 166,250
Sub-total				$ 669,250
Land Costs		acre	$ 100,000	$ -
Annual Ongoing Costs (2009 dollars)				$ 669,250
Total Ongoing Cost Over Project Life (2009 dollars)				$ 677,250

* Contingency and engineering mark-ups for capital projects only. Mark-ups linked to action type in cell C2

Action Name:	Enhance Mt. Scott Creek channel in the Three Creeks Area			**Action #**	KMS-4
Action Type:	Capital	**Action Extent:**	Single reach	**Priority Ranking:**	-

	Watershed	**Basin**	**Lat**	**Long**	**Modeling Subbasin**	**Reach(es)**				
Action Location:	KMS	LMS	-	-	-	MS4	-	-	-	-

Potential lead entity:	WES			**WES Lead:**	Asset Management	**Potential funding sources:**	WES (Rates)
Partner entities:	Clackamas Co. Parks	**Partner entities:**		**WES Support:**	Env. Policy & Watershed Health	**Potential funding sources:**	Grants
Partner entities:		**Partner entities:**		**WES Support:**		**Potential funding sources:**	
Partner entities:		**Partner entities:**		**WES Support:**		**Potential funding sources:**	

Action Description (see backside of sheet for more details)

Statement of Need: The stream channel of Mt. Scott Creek in the Three Creeks Area has been modified from previous development and is constrained on one side by RR tracks. Enhancing the stream channel would increase floodplain storage and hydraulic connectivity, and enhance aquatic habitat in the Three Creeks Area.

Proposed Action - Implementation Steps:

1. Select WES project manager
2. Set project goals and determine if project will be completed in-house or contracted out. Coordinate with the Parks Department Master Plan and Harmony Projects.
3. Complete survey and hydraulic modeling to determine project impacts on flooding and analyze capacity of project to meet project goals
4. Perform a cost/benefit analysis based on preliminary design information
5. Develop a detail design and more detailed cost estimate. Detail design includes a flow management strategy for construction
6. Identify partners and funding sources for CIP
7. Secure project funding
8. Coordinate permitting and project schedule based on in-stream work window
9. Develop monitoring plan to determine project success
10. Implement CIP
11. Monitor results according to specifications in the monitoring plan

Benefits of Action: Enhance aquatic habitat and improve hydrology in Three Creeks. Improved floodplain storage and hydraulic connectivity could reduce downstream flooding problems.

Action Cost Summary (see backside for detailed cost estimate)

						Subtotal
Initial Programmatic FTE estimate:	0.25	**Initial Programmatic FTE Cost:**	$ 20,000	**Initial Capital Cost Summary:**	$ 230,000	***$ 250,000***
Ongoing Programmatic FTE estimate:	0.02	**Ongoing Programmatic FTE Cost:**	$ 1,846	**Annual Ongoing Capital Cost**	$ -	***$ 1,846***
		(Programmatic Cost Summary is the FTE estimate translated into dollars)		**Years of Ongoing Cost Past Yr 1 included**		***2***
				Total Estimated 5-year Programmatic and Capital Cost		***$ 253,692***

Action Name: Enhance Mt. Scott Creek channel in the Three Creeks Area

Action # KMS-4

Action Type: Capital

Action Extent: Single reach

Priority Ranking: -

	Watershed	Basin	Lat	Long	Modeling Subbasin	Reach(es)				
Action Location:	KMS	LMS	-	-	-	MS4	-	-	-	-

Proposed Action - Implementation Steps (continued):

Attachments to describe Implementation Steps further? Yes

Pathway for attachment(s): Map of Mt. Scott Creek in Three Creeks

Proposed Action - Implementation Steps (continued):

Detailed Cost Breakdown

Initial Implementation Cost Assumptions: The area requires surveying prior to modeling, which is included in the modeling cost. Assume that modeling and the design of the channel is contracted to a consultant. Channel modification cost includes channel grading, flow management, erosion control, and post-construction plantings.

Ongoing Cost Assumptions: Monitoring occurs for two years following implementation and includes visual observation of channel modification and vegetation planted in the riparian corridor. Visual observation and subsequent write-up occupies two FTE's for 4 hrs every two months.

Initial Implementation Cost Estimate:

Item	Quantity	Unit	Unit Cost	Estimated Cost
FTE Summary	0.25	FTE	$ 80,000	$ 20,000
Modeling & Design	200	hrs	$ 150	$ 30,000
Channel Modification	1000	LF	$ 200	$ 200,000
				$ -
				$ -
				$ -
				$ -
Raw Cost				$ 250,000
Engineering, Administration, Contingency*			35%	
Sub-total				$ 250,000
Land Costs		acre	$ 100,000	$ -
Total Estimated Initial Implementation Costs (2009 dollars) *				$ 250,000

Ongoing Cost Estimate:

Project Lifetime (yrs) 2

Item	Quantity	Unit	Unit Cost	Estimated Cost
FTE Summary	0.02	FTE	$ 80,000	$ 1,846
				$ -
				$ -
				$ -
				$ -
				$ -
				$ -
Raw Cost				$ 1,846
Engineering, Administration, Contingency*			35%	$ -
Sub-total				$ 1,846
Land Costs		acre	$ 100,000	$ -
Annual Ongoing Costs (2009 dollars)				$ 1,846
Total Ongoing Cost Over Project Life (2009 dollars)				$ 3,692

* Contingency and engineering mark-ups for capital projects only. Mark-ups linked to action type in cell C2

Action Name:	Evaluate Flood Prone Culverts and Options for Reducing Impacts, Modify Culverts							**Action #**	KMS-5	
Action Type:	Programmatic			**Action Extent:**	Multiple reaches			**Priority Ranking:**		-
	Watershed	**Basin**	**Lat**	**Long**	**Modeling Subbasin**	**Reach(es)**				
Action Location:	KMS	-	-	-	-	-	-	-	-	-

Potential lead entity:	WES			**WES Lead:**	Stormwater Maintenance	**Potential funding sources:**	WES (Rates)
Partner entities:	DTD Clackamas Co.	**Partner entities:**		**WES Support:**	Asset Management	**Potential funding sources:**	Other
Partner entities:		**Partner entities:**		**WES Support:**		**Potential funding sources:**	
Partner entities:		**Partner entities:**		**WES Support:**		**Potential funding sources:**	

Action Description (see backside of sheet for more details)

Statement of Need: The SE Theissen Road, Parmenter Road, Mabel Avenue, Clackamas Road, and Rusk Road culverts in the Upper Kellogg subbasin were identified in the 2006 Master Plan as potential flooding problems. Upsizing culverts could result in exacerbating flooding conditions downstream. Hydraulic analysis of the culverts will allow the District to identify deficiencies in the culverts, assess the impacts of potential culvert improvements, and prioritize future culvert improvements. Setting aside capital funds to address undersized culverts in coordination with DTD would assist in implementing the preferred alternatives.

Proposed Action - Implementation Steps:

1. Select WES project manager and identify DTD liaisons
2. Set Goals and Levels of Service related to roadway and property flooding
3. Collect Site-Specific Data
    a. Review maintenance records and flooding complaints to identify all flood-prone culverts
    b. Physical dimensions
    c. Flows through culvert
    d. Culvert type and installation year
4. Conduct hydrualic modeling to evaluate the effect of the culverts on upstream and downstream flooding
5. Identify alternatives and a preferred culvert replacement/retrofit methods, or determine if problem would be better addressed through "willing seller" program for flood prone properties (Action KMS-6).
6. Develop an implementation program to improve culverts in coordination with DTD. Coordinate improvements with fish passage barrier enhancements in Action D-18.
7. The next phase would involve the design and implementation of culvert improvements. The design phase may have a new project manager and will coordinate funding, partners, engineering, permitting and construction. Capital funding for the replacement of two culverts identified in the 2006 Master Plan (Thiessen Road and Parmenter Road) is included in this Action as a placeholder for future culvert replacement projects.

Benefits of Action: Evaluation of flood prone culverts will allow the District address flooding issues effectively in coordination with DTD.

Action Cost Summary (see backside for detailed cost estimate)

						Subtotal
Initial Programmatic FTE estimate:	**0.2**	**Initial Programmatic FTE Cost:**	**$ 16,000**	**Initial Capital Cost Summary:**	**$ 37,500**	***$ 53,500***
Ongoing Programmatic FTE estimate:	**0.1**	**Ongoing Programmatic FTE Cost:**	**$ 8,000**	**Annual Ongoing Capital Cost**	**$ 356,000**	***$ 364,000***
		(Programmatic Cost Summary is the FTE estimate translated into dollars)		**Years of Ongoing Cost Past Yr 1 included**		***1***
				Total Estimated 5-year Programmatic and Capital Cost		***$ 417,500***

Action Name: Evaluate Flood Prone Culverts and Options for Reducing Impacts, Modify Culverts

Action # KMS-5

Action Type: Programmatic

Action Extent: Multiple reaches

Priority Ranking: -

	Watershed	Basin	Lat	Long	Modeling Subbasin	Reach(es)				
Action Location:	KMS	-	-	-	-	-	-	-	-	-

Proposed Action - Implementation Steps (continued):

Attachments to describe Implementation Steps further? No

Pathway for attachment(s):

Proposed Action - Implementation Steps (continued):

Detailed Cost Breakdown

Initial Implementation Cost Assumptions:

Initial implementation includes WES staff time to complete the evaluation of culverts prone to flooding and a contracted consultant to conduct hydraulic modeling associated with 6 culverts under existing conditions and alternative future scenarios. Evaluation could be completed in one year.

Ongoing Cost Assumptions:

Ongoing cost assumes WES staff time to implement 2 culvert replacement projects and capital funding for 2 culverts identified in 2006 Master Plan for replacement (Thiessen Road and Parmenter Road). Costs are shown as lump sum for each culvert based on 2006 Master Plan CIP Fact Sheets with 5% additional cost added to account for inflation.

Initial Implementation Cost Estimate:

Item	Quantity	Unit	Unit Cost	Estimated Cost
FTE summary	0.2	FTE	$ 80,000	$ 16,000
Hydrologic modeling	250	hrs	$ 150	$ 37,500
				$ -
				$ -
				$ -
				$ -
				$ -
				$ -
Raw Cost				$ 53,500
Engineering, Administration, Contingency*			35%	
Sub-total				$ 53,500
Land Costs		acre	$ 100,000	$ -
Total Estimated Initial Implementation Costs (2009 dollars) *				$ 53,500

Ongoing Cost Estimate: Project Lifetime (yrs) 1

Item	Quantity	Unit	Unit Cost	Estimated Cost
FTE summary	0.1	FTE	$ 80,000	$ 8,000
Thiessen Rd culvert	1	LS	$ 120,000	$ 120,000
Parmenter Rd culvert	1	LS	$ 236,000	$ 236,000
				$ -
				$ -
				$ -
				$ -
Raw Cost				$ 364,000
Engineering, Administration, Contingency*			35%	$ -
Sub-total				$ 364,000
Land Costs		acre	$ 100,000	$ -
Annual Ongoing Costs (2009 dollars)				$ 364,000
Total Ongoing Cost Over Project Life (2009 dollars)				$ 364,000

* Contingency and engineering mark-ups for capital projects only. Mark-ups linked to action type in cell C2

Action Name:	Willing-seller Property Acquisition Program			**Action #**	KMS-6
Action Type:	Programmatic & Capital	**Action Extent:**	Watershed	**Priority Ranking:**	-

	Watershed	**Basin**	**Lat**	**Long**	**Modeling Subbasin**	**Reach(es)**				
Action Location:	KMS	-	-	-	-	-	-	-	-	-

Potential lead entity:	WES			**WES Lead:**	Asset Management	**Potential funding sources:**	WES (Rates)
Partner entities:	DTD Clackamas Co.	**Partner entities:**		**WES Support:**	Env. Policy & Watershed Health	**Potential funding sources:**	Grants
Partner entities:	Parks Clackamas Co.	**Partner entities:**		**WES Support:**	Development Review	**Potential funding sources:**	Other
Partner entities:	Other	**Partner entities:**		**WES Support:**		**Potential funding sources:**	

Action Description (see backside of sheet for more details)

Statement of Need: There may be opportunities for WES to purchase properties from willing sellers in areas of the KMS watershed where the property purchase would improve watershed health and meet LOS goals. The 2006 Master Plan identified several areas around SE Lake Road, Rusk Road, Clackamas Road, and Mabel Road that could be included in a ‘willing seller’ approach.

Proposed Action - Implementation Steps: 1. Select WES project manager and identify DTD, Parks, and County Emergency Management liaisons

2. Set Goals and Levels of Service related to willing seller land acquisition
3. Collect Site-Specific Data on properties with willing sellers
    a. Review maintenance records, habitat data, riparian data, and other data to identify potential areas of interest
    b. Identify any existing properties for sale in areas of interest, monitor future real estate listings to determine if additional properties are listed
4. Conduct outreach with landowners to determine intersted landowners and willing sellers
5. As willing sellers are identified, conduct hydrualic modeling as needed to evaluate benefits of acquiring properties
6. Prioritize available properties for acquisition based on location, size, value, and likely benefits from acquisition
7. Develop an implementation program in coordination with DTD, Parks and Emergency Management that includes property acquistion process and long-term management plans for properties. Evaluate grant funding opportunities.
8. Capital funding for the purchase of properties is included in this Action as a placeholder.
9. The next phase after property acquistion would involve the design and implementation of watershed improvements to properties.
 The design phase may have a new project manager and will coordinate funding, partners, engineering, permitting and construction.

Benefits of Action: Purchasing property from willing sellers has many potential benefits. The reclaimed property may become part of a habitat, stream or wetland enhancement project, improving water quality, habitat and hydrology. There may also be opportunities for paths and trails.

Action Cost Summary (see backside for detailed cost estimate)

						Subtotal
Initial Programmatic FTE estimate:	0.2	**Initial Programmatic FTE Cost:**	$ 16,000	**Initial Capital Cost Summary:**	$ -	*$ 16,000*
Ongoing Programmatic FTE estimate:	0.1	**Ongoing Programmatic FTE Cost:**	$ 8,000	**Annual Ongoing Capital Cost**	$ 500,000	*$ 508,000*
		(Programmatic Cost Summary is the FTE estimate translated into dollars)		**Years of Ongoing Cost Past Yr 1 included**		*4*
				Total Estimated 5-year Programmatic and Capital Cost		*$ 2,048,000*

Action Name: Willing-seller Property Acquisition Program

Action # KMS-6

Action Type: Programmatic & Capital

Action Extent: Watershed

Priority Ranking: -

	Watershed	Basin	Lat	Long	Modeling Subbasin	Reach(es)				
Action Location:	KMS	-	-	-	-	-	-	-	-	-

Proposed Action - Implementation Steps (continued):

Attachments to describe Implementation Steps further? No

Pathway for attachment(s):

Proposed Action - Implementation Steps (continued):

Detailed Cost Breakdown

Initial Implementation Cost Assumptions: Assume 400 hours of WES staff time to coordinate and implement the Willing Seller Program in Year. Additional staff time provided by DTD, Parks, and Emergency Management. Additional WES staff time may be required to coordinate and implement higher complexity property transactions and plan for modifications to properties.

Ongoing Cost Assumptions: Assume 200 hours of WES staff time to coordinate and implement the program in Years 2-5. Assume $500,000 per year incapital funding for the purchase properties as a placeholder for future acquisitions. The total cost of property acquistions estimated in the 2006 Master Plan is over $12.5 million ($5.6 million for SE Lake Rd properties, $3.3 million for Rusk Rd properties, $3.2 million for Clackamas Rd properties, and $0.5 million for Mabel Rd properties). It is unlikely that all of these properties will be available from willing sellers during a 5-year period.

Initial Implementation Cost Estimate:

Item	Quantity	Unit	Unit Cost	Estimated Cost
FTE summary	0.2	FTE	$ 80,000	$ 16,000
				$ -
				$ -
				$ -
				$ -
				$ -
				$ -
				$ -
Raw Cost				$ 16,000
Engineering, Administration, Contingency*			35%	$ -
Sub-total				$ 16,000
Land Costs		acre	$ 100,000	$ -
Total Estimated Initial Implementation Costs (2009 dollars) *				$ 16,000

Ongoing Cost Estimate:

Project Life Past Yr 1 (yrs) 4

Item	Quantity	Unit	Unit Cost	Estimated Cost
FTE summary	0.1	FTE	$ 80,000	$ 8,000
Property Acquisitions	1	LS	$ 500,000	$ 500,000
				$ -
				$ -
				$ -
				$ -
				$ -
Raw Cost				$ 508,000
Engineering, Administration, Contingency*			35%	$ -
Sub-total				$ 508,000
Land Costs		acre	$ 100,000	$ -
Annual Ongoing Costs (2009 dollars)				$ 508,000
Total Ongoing Cost Over Project Life (2009 dollars)				$ 2,032,000

* Contingency and engineering mark-ups for capital projects only. Mark-ups linked to action type in cell C2

Action Name: Evaluate Water Quality Impacts of Human-made Lakes and Ponds
Action # KMS-8 (EAP)
Action Type: Programmatic
Action Extent: Multiple reaches
Priority Ranking: -

	Watershed	Basin	Lat	Long	Modeling Subbasin	Reach(es)				
Action Location:	KMS	KU	-	-	-	KG4	KG4A	-	-	-

Potential lead entity: WES
WES Lead: Env. Monitoring & Regulatory
Potential funding sources: WES (Rates)
Partner entities: City of Johnson City
Partner entities:
WES Support: Env. Policy & Watershed Health
Potential funding sources: City of Johnson City
Partner entities:
Partner entities:
WES Support:
Potential funding sources:

Action Description (see backside of sheet for more details)

Statement of Need: There are two significant human-made lakes in the KMS watershed. Kellogg Lake is in reach KG0 and is in the City of Milwaukie's jurisdiction. The Kellogg for Coho initiative is currently underway to investigate the feasibility of removing the lake. Leona Lake is in reach KG4.a in the City of Johnson City. Leona Lake may contribute to low summer flow, pollutant loads and high temperatures downstream in Kellogg Creek. However, extensive monitoring data is not currently available in this area. A study of Leona Lake was completed by University of Portland students in 2009 that evaluated limited field data and proposed potential alternatives for improving water quality in Leona Lake. The study identified additional monitoring data that would be useful, including flow data from the lake into Kellogg Creek. It is unknown at this time how much summer flow the lake contributes to the creek. WES is currently implementing a new monitoring program with Johnson City. Further evaluation of the water quality and hydrology impacts of Leona Lake is needed to determine the capacity for water quality improvement through lake management or enhancement.

Proposed Action - Implementation Steps:

1. Select WES project manager - see backside for more detail
2. Set project goals and determine if project will be in-house of contracted out
3. Identify partnering agencies and funding sources
4. Review existing studies and project examples
   a. CCSD#1 and City of Johnson City Water Quality Monitoring Program
   b. Leona Lake water quality and lake morphometry study by University of Portland (2009)
   c. Tanasbrook Lakes/Bronson Creek Enhancement by Clean Water Services (2007)
   d. Willow Creek Pond Enhancement by Clean Water Services (2006)
5. Develop a monitoring scheme that identifies monitoring sites and targeted water quality parameters and hydrology
6. Collect and analyze data
7. Conduct cost/benefit analysis of Leona Lake retrofit or management alternatives (e.g., flow management)
8. Recommend alternative for Leona Lake

Benefits of Action: Evaluation of water quality impacts will allow the District and Johnson City to quantify the cost and benefit of potential improvements to Leona Lake.

Action Cost Summary (see backside for detailed cost estimate)

						Subtotal
Initial Programmatic FTE estimate:	0.1	**Initial Programmatic FTE Cost:**	$ 8,000	**Initial Capital Cost Summary:**	$ 35,375	*$ 43,375*
Ongoing Programmatic FTE estimate:	0	**Ongoing Programmatic FTE Cost:**	$ -	**Annual Ongoing Capital Cost**	$ -	*$ -*
		(Programmatic Cost Summary is the FTE estimate translated into dollars)		**Years of Ongoing Cost Past Yr 1 included**		*0*
				Total Estimated 5-year Programmatic and Capital Cost		*$ 43,375*

Action Name: Evaluate Water Quality Impacts of Human-made Lakes and Ponds

Action # KMS-8 (EAP)

Action Type: Programmatic

Action Extent: Multiple reaches

Priority Ranking: -

	Watershed	Basin	Lat	Long	Modeling Subbasin	Reach(es)				
Action Location:	KMS	KU	-	-	-	KG4	KG4A	-	-	-

Proposed Action - Implementation Steps (continued):

Attachments to describe Implementation Steps further? Yes

Pathway for attachment(s): CCSD#1 and Johnson City WQ Monitoring Plan

Proposed Action - Implementation Steps (continued):

Step 1 Note: WES is currently coordinating with the City of Johnson City to implement a water quality monitoring program. The WES project manager for this project should be familiar with work already being done with the City of Johnson City and coordinate with the manager of the water quality monitoring program, which is being run by the WES Environmental Monitoring Manager. The University of Portland report on the lake should also be evaluated.

Detailed Cost Breakdown

Initial Implementation Cost Assumptions: Assume the project is completed internally, with exception of the water quality analysis and hydrologic modeling. It is assumed that a consultant will be hired to conduct hydrologic modeling and analyze flow monitoring results. Water quality analysis will include the 4 storm-event samples taken for the CCSD#1 and City of Johnson City Water Quality Monitoring Project, in addition to 4 dry weather samples. Hydrologic analysis will include a rain gage and flow monitoring at the lake outlet.

Ongoing Cost Assumptions:

There are no ongoing costs. Retrofit of Leona Lake if deemed beneficial will be a separate captial project. As an example, captial projects involving creation of a side channel while maintaining pond aesthetics have been completed in the Tualatin River Basin by Clean Water Services and could potentially cost $600,000 depending on the level of effort required.

Initial Implementation Cost Estimate:

Item	Quantity	Unit	Unit Cost	Estimated Cost
FTE summary	0.1	FTE	$ 80,000	$ 8,000
Hydrologic modeling	150	hrs	$ 150	$ 22,500
Lab analysis	8	each	$ 500	$ 4,000
Flow monitoring & rain gage	1	each	$ 1,000	$ 1,000
				$ -
				$ -
				$ -
Raw Cost				$ 35,500
Engineering, Administration, Contingency*			35%	$ 7,875
Sub-total				$ 43,375
Land Costs		acre	$ 100,000	$ -
Total Estimated Initial Implementation Costs (2009 dollars) *				$ 43,375

Ongoing Cost Estimate:

Project Lifetime (yrs) 0

Item	Quantity	Unit	Unit Cost	Estimated Cost
FTE summary		FTE	$ 80,000	$ -
				$ -
				$ -
				$ -
				$ -
				$ -
Raw Cost				$ -
Engineering, Administration, Contingency*			35%	$ -
Sub-total				$ -
Land Costs		acre	$100,000	$ -
Annual Ongoing Costs (2009 dollars)				$ -
Total Ongoing Cost Over Project Life (2009 dollars)				$ -

* Contingency and engineering mark-ups for capital projects only. Mark-ups linked to action type in cell C2

Action Name:	Involvement in City of Milwaukie's Kellogg-for-Coho Initiative					**Action #**	KMS-9 (EAP)
Action Type:	Programmatic	**Action Extent:**	Watershed			**Priority Ranking:**	-

	Watershed	**Basin**	**Lat**	**Long**	**Modeling Subbasin**	**Reach(es)**				
Action Location:	KMS	-	-	-	-	-	-	-	-	-

Potential lead entity:	WES			**WES Lead:**	Env. Policy & Watershed Health	**Potential funding sources:**	WES (Rates)
Partner entities:	City of Milwaukie	**Partner entities:**		**WES Support:**	Asset Management	**Potential funding sources:**	
Partner entities:		**Partner entities:**		**WES Support:**		**Potential funding sources:**	
Partner entities:		**Partner entities:**		**WES Support:**		**Potential funding sources:**	

Action Description (see backside of sheet for more details)

Statement of Need: The City of Milwaukie is leading the “Kellogg-for-Coho” initiative, which seeks to replace the Kellogg Lake Bridge, remove the Kellogg Lake dam, and restore the Kellogg Creek stream channel in the City of Milwaukie. As a part of the Kellogg-for-Coho initiative, the City of Milwaukie began hosting meetings with stakeholders in the watershed in September 2008. The City of Milwaukie has recently secured federal grant funds to begin studies and other necessary tasks to evaluate options for the dam. WES regularly coordinates with other juridictions and agencies on projects and initiatives to address watershed health issues in the Districts' watersheds. The fish ladder at Kellogg Lake dam has been identified as a partial barrier to fish passage at the mouth of Kellogg-Mt. Scott Creek. Removing Kellogg Lake dam would improve fish access to seven miles of riparian habitat in the KMS watershed.

Proposed Action - Implementation Steps: This programmatic measure will include involvement of WES staff with the Kellogg-for-Coho initiative, including attending meetings, reviewing plans for studies associated with the initiative, and coordinating information between the WAPs and the Kellogg-for-Coho initiative.

Benefits of Action:

Action Cost Summary (see backside for detailed cost estimate)

						Subtotal
Initial Programmatic FTE estimate:	0.02	**Initial Programmatic FTE Cost:**	$ 1,600	**Initial Capital Cost Summary:**	$ -	***$ 1,600***
Ongoing Programmatic FTE estimate:	0.02	**Ongoing Programmatic FTE Cost:**	$ 1,600	**Annual Ongoing Capital Cost**	$ -	***$ 1,600***
		(Programmatic Cost Summary is the FTE estimate translated into dollars)		**Years of Ongoing Cost Past Yr 1 included**		***1***
				Total Estimated 5-year Programmatic and Capital Cost		***$ 3,200***

Action Name: Involvement in City of Milwaukie's Kellogg-for-Coho Initiative

Action # KMS-9 (EAP)

Action Type: Programmatic

Action Extent: Watershed

Priority Ranking: -

	Watershed	**Basin**	**Lat**	**Long**	**Modeling Subbasin**	**Reach(es)**				
Action Location:	KMS	-	-	-	-	-	-	-	-	-

Proposed Action - Implementation Steps (continued):

Attachments to describe Implementation Steps further? No

Pathway for attachment(s):

Proposed Action - Implementation Steps (continued):

Detailed Cost Breakdown

Initial Implementation Cost Assumptions:

It is anticipated that a WES staff member will contribute 3-4 hours per month to this programmatic measure for two years.

Ongoing Cost Assumptions:

Initial Implementation Cost Estimate:

Item	Quantity	Unit	Unit Cost	Estimated Cost
FTE summary	0.02	FTE	$ 80,000	$ 1,600
				$ -
				$ -
				$ -
				$ -
				$ -
				$ -
				$ -
Raw Cost				$ 1,600
Engineering, Administration, Contingency*			35%	$ -
Sub-total				$ 1,600
Land Costs		acre	$ 100,000	$ -
Total Estimated Initial Implementation Costs (2009 dollars) *				$ 1,600

Ongoing Cost Estimate:

Project Life Past Yr 1 (yrs) 1

Item	Quantity	Unit	Unit Cost	Estimated Cost
FTE summary	0.02	FTE	$ 80,000	$ 1,600
				$ -
				$ -
				$ -
				$ -
				$ -
				$ -
Raw Cost				$ 1,600
Engineering, Administration, Contingency*			35%	$ -
Sub-total				$ 1,600
Land Costs		acre	$ 100,000	$ -
Annual Ongoing Costs (2009 dollars)				$ 1,600
Total Ongoing Cost Over Project Life (2009 dollars)				$ 1,600

* Contingency and engineering mark-ups for capital projects only. Mark-ups linked to action type in cell C2

Action Name: Enhance Rock Creek Wetlands in Reach RK6

Action # RC-1

Action Type: Capital

Action Extent: Single reach

Priority Ranking: -

	Watershed	Basin	Lat	Long	Modeling Subbasin	Reach(es)				
Action Location:	KMS	RC	-	-	-	RK6	-	-	-	-

Potential lead entity:	WES			**WES Lead:**	Development Review	**Potential funding sources:**	Grants
Partner entities:	Nonprofit Groups	**Partner entities:**		**WES Support:**		**Potential funding sources:**	WES (Rates)
Partner entities:	Private	**Partner entities:**		**WES Support:**		**Potential funding sources:**	
Partner entities:		**Partner entities:**		**WES Support:**		**Potential funding sources:**	

Action Description (see backside of sheet for more details)

Statement of Need: Reach RK6 is located within the Pleasant Valley Golf Course, which could be sold and re-developed in the future. Several hydrologic and aquatic habitat parameters analyzed in the assessment report were ranked poor throughout this reach. Due to the potential re-development, an opportunity exists in this reach to do a large scale restoration project that will restore functions and protect the reach from further degradation.

Proposed Action - Implementation Steps:

1. Select WES project manager
2. Set project goals and determine if project will be completed in-house or contracted out
3. Identify areas for wetlands restoration and for stream channel restoration
4. Survey project site and complete hydraulic modeling to determine project impacts on flooding and analyze capacity of project to meet project goals
5. Perform a cost/benefit analysis based on preliminary design information
6. Develop conceptual design and a more detailed cost estimate. Conceptual design includes flow management strategy.
7. Identify partners and funding sources for CIP
8. Secure project funding
9. Coordinate engineering, permitting and project schedule based on the in-stream work window
10. Develop monitoring plan to determine project success
11. Implement CIP
12. Monitor results according to specifications in monitoring plan

Benefits of Action: Wetlands and stream channel improvements could improve the hydrologic conditions, water quality and/or aquatic habitat in the creek.

Action Cost Summary (see backside for detailed cost estimate)

						Subtotal
Initial Programmatic FTE estimate:	0.2	**Initial Programmatic FTE Cost:**	$ 16,000	**Initial Capital Cost Summary:**	$ 75,000	*$ 91,000*
Ongoing Programmatic FTE estimate:	0.11	**Ongoing Programmatic FTE Cost:**	$ 8,769	**Annual Ongoing Capital Cost**	$ 1,050,000	*$ 1,058,769*
		(Programmatic Cost Summary is the FTE estimate translated into dollars)		**Years of Ongoing Cost Past Yr 1 included**		2
				Total Estimated 5-year Programmatic and Capital Cost		*$ 1,167,308*

Action Name: Enhance Rock Creek Wetlands in Reach RK6 **Action #** RC-1

Action Type: Capital **Action Extent:** Single reach **Priority Ranking:** -

	Watershed	Basin	Lat	Long	Modeling Subbasin	Reaches)				
Action Location:	KMS	RC	-	-	-	RK6	-	-	-	-

Proposed Action - Implementation Steps (continued):

Attachments to describe Implementation Steps further? No

Pathway for attachment(s):

Proposed Action - Implementation Steps (continued):

Detailed Cost Breakdown

Initial Implementation Cost Assumptions: Initial costs include project management, WES staff time for design, and a consultant to complete modeling and design of channel modification and wetlands restoration.

Ongoing Cost Assumptions: Assume 1500 LF of channel modification in year 2, which includes permitting, grading, erosion control, flow management and post-construction plantings. Assume 3 acres of wetland restoration, which includes mostly plantings with minor grading. In year two, supervision coordination and supervision of construction occupies one staff for 15 hours a week for 3 months. Monitoring occurs for two years following implementation and includes visual observation of channel modification and vegetation planted in the riparian corridor. Visual observation and subsequent write-up occupies two FTE's for 4 hrs every two months.

Initial Implementation Cost Estimate:

Item	Quantity	Unit	Unit Cost	Estimated Cost
FTE Summary	0.20	FTE	$ 80,000	$ 16,000
Modeling & Design	500	hrs	$ 150	$ 75,000
				$ -
				$ -
				$ -
				$ -
				$ -
				$ -
Raw Cost				$ 91,000
Engineering, Administration, Contingency*			35%	
Sub-total				$ 91,000
Land Costs		acre	$ 100,000	$ -
Total Estimated Initial Implementation Costs (2009 dollars) *				$ 91,000

Ongoing Cost Estimate: Project Lifetime (yrs) 2

Item	Quantity	Unit	Unit Cost	Estimated Cost
FTE Summary	0.11	FTE	$ 80,000	$ 8,769
Channel Modification	1500	lf	$ 200	$ 300,000
Wetlands Restoration	3	acre	$ 150,000	$ 450,000
				$ -
				$ -
				$ -
Raw Cost				$ 758,769
Engineering, Administration, Contingency*			35%	
Sub-total				$ 758,769
Land Costs	3	acre	$ 100,000	$ 300,000
Annual Ongoing Costs (2009 dollars)				$ 1,058,769
Total Ongoing Cost Over Project Life (2009 dollars)				$ 1,067,569

* Contingency and engineering mark-ups for capital projects only. Mark-ups linked to action type in cell C2. Total includes monitoring for 2 years.

Action Name:	Evaluate Regional Detention Needs and Opportunities, Purchase Land			**Action #**	RC-2
Action Type:	Programmatic & Capital	**Action Extent:**	Watershed	**Priority Ranking:**	-

	Watershed	**Basin**	**Lat**	**Long**	**Modeling Subbasin**	**Reach(es)**				
Action Location:	RC	-	-	-	-	-	-	-	-	-

Potential lead entity:	WES			**WES Lead:**	SWM Program Management	**Potential funding sources:**	WES (Devel. Fees)
Partner entities:	City of Damascus	**Partner entities:**	Parks Clackamas Co.	**WES Support:**	Stormwater Maintenance	**Potential funding sources:**	City of Damascus
Partner entities:	City of Happy Valley	**Partner entities:**		**WES Support:**		**Potential funding sources:**	City of Happy Valley
Partner entities:	DTD Clackamas Co.	**Partner entities:**		**WES Support:**		**Potential funding sources:**	Other

Action Description (see backside of sheet for more details)

Statement of Need: Hydrologic modeling indicates that streams in Rock Creek already exhibit the "flashy" conditions of higher peak flows over longer duration during storm events which are typically characteristic of urbanized watersheds, despite the relatively low proportion of impervious surfaces in the watershed. Infiltration of stormwater is challenging in areas of the watershed due to poorly infiltrating soils. Coordinating with Damascus, Happy Valley, and DTD to purchase land to use for future regional detention facilities is a prudent step for managing stormwater in this rapidly devleoping area. Damascus is developing a Stormwater Master Plan that may identify areas for stormwater management focus areas.

Proposed Action - Implementation Steps:

1. Select WES project manager and identify Damascus, Happy Valley, DTD, and Parks liaisons
2. Set Goals and Levels of Service related to regional detention
3. Collect Site-Specific Data
    a. Review property information and identify potential properties for future regional detention based on location, size, value and other likely benefits. The 2006 Master Plan identified several potential regional detention facility areas. These areas and other areas should be evaluated in coordination with the Damascus Stormwater Master Plan.
    b. Determine current market value of identified properties
    c. Identify any existing identified properties for sale, monitor future real estate listings to determine if additional properties are listed
4. Conduct outreach with landowners to determine intersted landowners and willing sellers
5. As willing sellers are identified, conduct hydrualic modeling to evaluate the effect of developing the sites as regional detention facilities
6. Prioritize properties for acquisition based on location, size, value, and likely benefits from acquisition
7. Develop an implementation program in coordination with Damascus, Happy Valley, DTD, and Parks that includes property acquistion process and long-term management plans for propertie
8. Capital funding for the purchase of properties and the construction of facilities is included in this Action as a placeholder.

Benefits of Action: Installation of regional detention facilities in the Rock Creek watershed could serve to enhance water quality performance while maximizing flow control for the 2 and 5-year storm events. Setting aside funding now for opportunistic purchase of properties that could be used for regional detention facilities will enhance regional stormwater management efforts over time. Properties may also serve as parks.

Action Cost Summary (see backside for detailed cost estimate)

						Subtotal
Initial Programmatic FTE estimate:	0.1	**Initial Programmatic Cost Summary:**	$ 8,000	**Initial Capital Cost Summary:**	$ 700,000	*$ 708,000*
Ongoing Programmatic FTE estimate:	0.1	**Ongoing Programmatic Cost Summary:**	$ 8,000	**Annual Ongoing Capital Cost**	$ 700,000	*$ 708,000*
		(Programmatic Cost Summary is the FTE estimate translated into dollars)		**Years of Ongoing Cost Past Yr 1 included**		*4*
				Total Estimated 5-year Programmatic and Capital Cost		*$ 3,540,000*

Action Name: Evaluate Regional Detention Needs and Opportunities, Purchase Land **Action #** RC-2

Action Type: Programmatic & Capital **Action Extent:** Watershed **Priority Ranking:** -

	Watershed	Basin	Lat	Long	Modeling Subbasin	Reach(es)				
Action Location:	RC	-	-	-	-	-	-	-	-	-

Proposed Action - Implementation Steps (continued):

Attachments to describe Implementation Steps further? No

Pathway for attachment(s):

Proposed Action - Implementation Steps (continued):

9. The next phase would involve the detailed design and construction of regional detention facilities on purchased properties. The design phase may have a new project manager and will include coordinating funding, partners, engineering, permitting and construction.

Detailed Cost Breakdown

Initial Implementation Cost Assumptions: Assume 200 hours of WES staff time to coordinate and implement the Regional Detention Property Acquisition Program per year. Additional staff time provided by Damascus, Happy Valley, DTD, and Parks. Additional WES staff time may be required to coordinate and implement higher complexity property transactions. This staff time could be coordinated with Action KMS-6 (Willing Seller Acquisition Program). $1,000,000 was set aside in FY 09-10 budget for addressing regional detention needs.

Ongoing Cost Assumptions: Assume 200 hours of WES staff time to coordinate and implement the program in Years 2-5. Assume $500,000 per year in additional capital funding for the purchase of properties as a placeholder for future acquisitions. Assume $200,000 per year in additional capital funding set aside for future regional facility design and construction. Assume the cost of constructing regional facilities will also be addressed through regional development fees and other funding sources coordinated between WES, Damascus, Happy Valley, DTD, and Parks. The total cost of constructing 3 regional facilities estimated in the 2006 Master Plan is approximately $5 million ($2.6 million for 162nd Ave, $1.3 million for North 172nd Ave, $0.9 million for South 172nd Ave).

Initial Implementation Cost Estimate:

Item	Quantity	Unit	Unit Cost	Estimated Cost
FTE summary	0.1	FTE	$ 80,000	$ 8,000
Property Acquisition	1	LS	$ 500,000	$ 500,000
Future design & construction	1	LS	$ 200,000	$ 200,000
				$ -
				$ -
				$ -
				$ -
Raw Cost				$ 708,000
Engineering, Administration, Contingency*			35%	$ -
Sub-total				$ 708,000
Land Costs		acre	$ 100,000	$ -
Total Estimated Initial Implementation Costs (2009 dollars) *				$ 708,000

Ongoing Cost Estimate: Project Life Past Yr 1 (yrs) 4

Item	Quantity	Unit	Unit Cost	Estimated Cost
FTE summary	0.1	FTE	$ 80,000	$ 8,000
Property Acquisition	1	LS	$ 500,000	$ 500,000
Future design & construction	1	LS	$ 200,000	$ 200,000
				$ -
				$ -
				$ -
Raw Cost				$ 708,000
Engineering, Administration, Contingency*			35%	$ -
Sub-total				$ 708,000
Land Costs		acre	$ 100,000	$ -
Annual Ongoing Costs (2009 dollars)				$ 708,000
Total Ongoing Cost Over Project Life (2009 dollars)				$ 2,832,000

* Contingency and engineering mark-ups for capital projects only. Mark-ups linked to action type in cell C2

Action Name:	Enhance Riparian Buffer in Reach RK1 and RK2			**Action #**	RC-3
Action Type:	Capital	**Action Extent:**	Multiple reaches	**Priority Ranking:**	-

	Watershed	Basin	Lat	Long	Modeling Subbasin	Reach(es)				
Action Location:	RC	RC	-	-	-	RK1	RK2	-	-	-

Potential lead entity:	WES			**WES Lead:**	Env. Policy & Watershed Health	**Potential funding sources:**	WES (Rates)
Partner entities:	Other Clackamas Co.	**Partner entities:**		**WES Support:**	Stormwater Maintenance	**Potential funding sources:**	Grants
Partner entities:	Nonprofit Groups	**Partner entities:**		**WES Support:**		**Potential funding sources:**	
Partner entities:	ODFW	**Partner entities:**		**WES Support:**		**Potential funding sources:**	

Action Description (see backside of sheet for more details)

Statement of Need: Reaches RK1 and RK2 were identified as areas that would benefit from targeted riparian and upland enhancement in the Assessment Report. WES and other partners co-own and manage a large undeveloped property adjacent to these reaches. There are opportunities to remove invasive vegetation (blackberry, etc.) and enhance native vegetation (including planting additional riparian trees to improve shade and temperature) in this area.

Proposed Action - Implementation Steps:

This action includes developing restoration plans for the site and coordination with County staff and one or more volunteer organizations for implementation. The capital expense will include the purchase of trees and vegetation as well as WES staff hours for supervison of planting work.

Volunteer groups and organizations such as SOLV, Friends of Trees, Soil and Water Conservation District, and the Clackamas River Basin Council could serve as partners in this Action.

This program would be conducted in coordination with Action D-17, targeted invasive species management.

Benefits of Action: Improving riparian and upland vegetation on publicly owned land will enhance aquatic and upland habitat and improve water qualtiy.

Action Cost Summary (see backside for detailed cost estimate)

						Subtotal
Initial Programmatic FTE estimate:	0.05	**Initial Programmatic FTE Cost:**	$ 4,000	**Initial Capital Cost Summary:**	$ -	*$ 4,000*
Ongoing Programmatic FTE estimate:	0.1	**Ongoing Programmatic FTE Cost:**	$ 8,000	**Annual Ongoing Capital Cost**	$ 10,000	*$ 18,000*
		(Programmatic Cost Summary is the FTE estimate translated into dollars)		**Years of Ongoing Cost Past Yr 1 included**		*4*
				Total Estimated 5-year Programmatic and Capital Cost		*$ 76,000*

Action Name:	Enhance Riparian Buffer in Reach RK1 and RK2						**Action #**	RC-3	
Action Type:	Capital			**Action Extent:**	Multiple reaches		**Priority Ranking:**	-	
	Watershed	**Basin**	**Lat**	**Long**	**Modeling Subbasin**	**Reach(es)**			
Action Location:	RC	RC	-	-	-	RK1	RK2	-	-	-

Proposed Action - Implementation Steps (continued):

Attachments to describe Implementation Steps further? No

Pathway for attachment(s):

Proposed Action - Implementation Steps (continued):

Detailed Cost Breakdown

Initial Implementation Cost Assumptions: Assumes 100 hours WES staff time (0.05 FTE) in first year to develop restoration plan and coordinate with partners.

Ongoing Cost Assumptions: Assumes 200 hours WES staff time (0.1 FTE) in Years 2 - 5 to implement enhancements with volunteer group assistance. Captial costs include expanding professional services agreement with Friends of Trees or SOLV to include targeted projects this area, which includes cost for plants and volunteer coordination.

Initial Implementation Cost Estimate:

Item	Quantity	Unit	Unit Cost	Estimated Cost
FTE summary	0.05	FTE	$ 80,000	$ 4,000
				$ -
				$ -
				$ -
				$ -
				$ -
				$ -
				$ -
Raw Cost				$ 4,000
Engineering, Administration, Contingency*			35%	
Sub-total				$ 4,000
Land Costs		acre	$ 100,000	$ -
Total Estimated Initial Implementation Costs (2009 dollars) *				$ 4,000

Ongoing Cost Estimate: Project Life Past Yr 1 (yrs) 4

Item	Quantity	Unit	Unit Cost	Estimated Cost
FTE summary	0.1	FTE	$ 80,000	$ 8,000
Capital costs	1	LS	$ 10,000	$ 10,000
				$ -
				$ -
				$ -
				$ -
				$ -
Raw Cost				$ 18,000
Engineering, Administration, Contingency*			35%	
Sub-total				$ 18,000
Land Costs		acre	$ 100,000	$ -
Annual Ongoing Costs (2009 dollars)				$ 18,000
Total Ongoing Cost Over Project Life (2009 dollars)				$ 72,000

* Contingency and engineering mark-ups for capital projects only. Mark-ups linked to action type in cell C2

Action Name: Riparian buffer acquisition or conservation easements in Reach RK5 **Action #** RC-4

Action Type: Programmatic & Capital **Action Extent:** Single reach **Priority Ranking:** -

	Watershed	Basin	Lat	Long	Modeling Subbasin	Reach(es)				
Action Location:	RC	-	-	-	-	RK5	-	-	-	-

Potential lead entity:	WES			**WES Lead:**	Asset Management	**Potential funding sources:**	WES (Rates)
Partner entities:	City of Damascus	**Partner entities:**	Parks Clackamas Co.	**WES Support:**	Env. Policy & Watershed Health	**Potential funding sources:**	City of Damascus
Partner entities:	City of Happy Valley	**Partner entities:**	ODFW	**WES Support:**		**Potential funding sources:**	City of Happy Valley
Partner entities:	DTD Clackamas Co.	**Partner entities:**	Nonprofit Groups	**WES Support:**		**Potential funding sources:**	Other

Action Description (see backside of sheet for more details)

Statement of Need: There are good quality riparian buffer areas in Reach RK5. Watershed health would benefit from protecting these good quality riparian buffer areas from future development or degradation. Clackamas County Soil and Water Conservation District (CCSWCD) could assist in coordinating with landowners for potential acquisitions or easements.

Proposed Action - Implementation Steps:

1. Select WES project manager and identify CCSWCD, Damascus, Happy Valley, and DTD liaisons
2. Set Goals and Levels of Service related to buffer protection
3. Collect Site-Specific Data
   a. Review property information and identify potential properties for potential acquistion/easement based on location, size, value and other likely benefits.
   b. Determine current market value of identified properties and of conservation easements
   c. Identify any existing identified properties for sale, monitor future real estate listings to determine if additional properties are listed
4. In coordination with CCSWCD, conduct outreach with landowners to determine intersted landowners and willing sellers or easement participants
5. As willing sellers or easement participants are identified, prioritize properties for acquisition based on location, size, value, and likely benefits from acquisition
6. Develop an implementation program in coordination with CCSWCD, Damascus, Happy Valley, DTD, and Parks that includes property acquistion process and long-term management plans for properties. Evaluate grant funding opportunities.
7. Capital funding for the purchase of properties and easements is included in this Action as a placeholder.

Benefits of Action: Protection of existing good riparian buffer areas improves water quality and aquatic habitat, and may also preserve hydrologic functions.

Action Cost Summary (see backside for detailed cost estimate)

						Subtotal
Initial Programmatic FTE estimate:	0.05	**Initial Programmatic FTE Cost:**	$ 4,000	**Initial Capital Cost Summary:**	$ 50,000	*$ 54,000*
Ongoing Programmatic FTE estimate:	0.05	**Ongoing Programmatic FTE Cost:**	$ 4,000	**Annual Ongoing Capital Cost**	$ 50,000	*$ 54,000*
		(Programmatic Cost Summary is the FTE estimate translated into dollars)		**Years of Ongoing Cost Past Yr 1 included**		*4*
				Total Estimated 5-year Programmatic and Capital Cost		*$ 270,000*

Action Name: Riparian buffer acquisition or conservation easements in Reach RK5

Action # RC-4

Action Type: Programmatic & Capital

Action Extent: Single reach

Priority Ranking: -

	Watershed	Basin	Lat	Long	Modeling Subbasin	Reach(es)				
Action Location:	RC	-	-	-	-	RK5	-	-	-	-

Proposed Action - Implementation Steps (continued):

Attachments to describe Implementation Steps further? No

Pathway for attachment(s):

Proposed Action - Implementation Steps (continued):

Detailed Cost Breakdown

Initial Implementation Cost Assumptions: Assume 100 hours of WES staff time to coordinate and implement the Buffer Acquisition and Easement Program per year. Additional staff time provided by CCSWCD and other partners. Additional WES staff time may be required to coordinate and implement higher complexity property transactions. This staff time should be coordinated with Action KMS-6 (Willing Seller Acquisition Program) and RC-2 (Regional Detention Acquisition Program). Assume $50,000 per year in capital funding for the purchase of properties and easements as a placeholder for future acquisitions.

Ongoing Cost Assumptions: Assume 100 hours of WES staff time to coordinate and implement the program in Years 2-5. Assume $50,000 per year incapital funding for the purchase of properties and easements as a placeholder for future acquisitions.

Initial Implementation Cost Estimate:

Item	Quantity	Unit	Unit Cost	Estimated Cost
FTE summary	0.05	FTE	$ 80,000	$ 4,000
Property Acquisition	1	LS	$ 50,000	$ 50,000
				$ -
				$ -
				$ -
				$ -
				$ -
				$ -
Raw Cost				$ 54,000
Engineering, Administration, Contingency*			35%	$ -
Sub-total				$ 54,000
Land Costs		acre	$ 100,000	$ -
Total Estimated Initial Implementation Costs (2009 dollars) *				$ 54,000

Ongoing Cost Estimate:

Project Life Past Yr 1 (yrs) 4

Item	Quantity	Unit	Unit Cost	Estimated Cost
FTE summary	0.05	FTE	$ 80,000	$ 4,000
Property Acquisition	1	LS	$ 50,000	$ 50,000
				$ -
				$ -
				$ -
				$ -
				$ -
Raw Cost				$ 54,000
Engineering, Administration, Contingency*			35%	$ -
Sub-total				$ 54,000
Land Costs		acre	$ 100,000	$ -
Annual Ongoing Costs (2009 dollars)				$ 54,000
Total Ongoing Cost Over Project Life (2009 dollars)				$ 216,000

* Contingency and engineering mark-ups for capital projects only. Mark-ups linked to action type in cell C2

Action Name:	Pilot Improvement Basin in Graham Creek Basin		**Action #**	RC-5
Action Type:	Programmatic & Capital	**Action Extent:** Multiple reaches	**Priority Ranking:**	-

Action Location:

Watershed	Basin	Lat	Long	Modeling Subbasin	Reach(es)				
RC	-	-	-	-	RK1	RK2	-	-	-

Potential lead entity:	WES			**WES Lead:**	Env. Policy & Watershed Health	**Potential funding sources:**	WES (Rates)
Partner entities:	Nonprofit Groups	**Partner entities:**		**WES Support:**	Asset Management	**Potential funding sources:**	Grants
Partner entities:	ODFW	**Partner entities:**		**WES Support:**	Env. Monitoring & Regulatory	**Potential funding sources:**	
Partner entities:	DTD Clackamas Co.	**Partner entities:**		**WES Support:**		**Potential funding sources:**	

Action Description (see backside of sheet for more details)

Statement of Need: The Graham Creek basin is a small residential basin that drains into Reach RK02, a valuable habitat area. There are opportunities to conduct targeted stormwater and watershed enhancement projects in the Graham Creek basin and to track the water quality benefits of these projects.

Proposed Action - Implementation Steps:
This action would be implemented as a targeted effort under the proposed new technical assistance program for watershed improvement called the Watershed Enhancement Technical Assistance Program (WET). This program would include technical assistance and capital funding to support stormwater retrofits. Other program elements of the proposed WET program are described in Action D-5. This action would also include collaborating with nonprofit groups and engaging private landowners to participate the WET program. Action includes the following steps:

1. Define and prioritize areas to focus WET program efforts in Graham Creek basin. Areas with high levels of imperviousness, which lack stormwater treatment systems, are areas to consider for high prioritization. These areas would be retrofitted with site design modifications to allow more stormwater runoff to be stored, treated, and infiltrated within vegetated areas or other treatment systems. For example, churches, schools, and commercial areas could install swales, curb cuts, and vegetated stormwater treatment facilities in parking lots. Residential landowners could install swales, raingardens, or other vegetated stormwater facilities near their homes or adjacent to roads. Riparian buffer plantings could be targeted in this area as well.
2. Develop an outreach program to target locations based on prioritization, as well as seek out participants which would be able to assist in implementation. For example, members of HOAs, schools, churches, and rotary clubs may desire to help improve water quality in their local watersheds. Watershed councils and nonprofit groups could also assist in promoting the WET program and help engage the surrounding communities.
3. Develop technical materials, ‘how to’ manuals, and guidelines to help assist participants. For example, materials could include explanations and examples of techniques to reduce runoff and improve water quality from impervious surfaces, such as how to implement low impact development (LID) techniques.
4. Review WET program applications, select participants, assist in implementation of projects.
5. Monitor effectiveness of projects and monitor water quality and geomorphic conditions in downstream reaches of Graham Creek and Rock Creek.

Benefits of Action: Targeted enhancement of small basins with improved stormwater quality feature retrofits of existing impervious areas improves water quality, hydrology, and aquatic habitat.

Action Cost Summary (see backside for detailed cost estimate)

						Subtotal
Initial Programmatic FTE estimate:	0	**Initial Programmatic FTE Cost:**	$ -	**Initial Capital Cost Summary:**	$ 100,000	*$ 100,000*
Ongoing Programmatic FTE estimate:	0	**Ongoing Programmatic FTE Cost:**	$ -	**Annual Ongoing Capital Cost**	$ 100,000	*$ 100,000*
		(Programmatic Cost Summary is the FTE estimate translated into dollars)		**Years of Ongoing Cost Past Yr 1 included**		*4*
				Total Estimated 5-year Programmatic and Capital Cost		*$ 500,000*

Action Name: Pilot Improvement Basin in Graham Creek Basin

Action # RC-5

Action Type: Programmatic & Capital

Action Extent: Multiple reaches

Priority Ranking: -

	Watershed	Basin	Lat	Long	Modeling Subbasin	Reach(es)				
Action Location:	RC	-	-	-	-	RK1	RK2	-	-	-

Proposed Action - Implementation Steps (continued):

Attachments to describe Implementation Steps further? No

Pathway for attachment(s):

Proposed Action - Implementation Steps (continued):

Detailed Cost Breakdown

Initial Implementation Cost Assumptions: Action D-13 provides funding for WET program (1 FTE and $200,000 capital funding per year). Assume additional capital funding for WET program to sponsor up to 5 additional stormwater retrofit projects per year in the Graham Creek pilot improvement basin at a cost of approximately $20,000 per project. Assume watershed council and other nonprofits provide volunteers support for outreach and implementation.

Ongoing Cost Assumptions: Action D-13 provides funding for WET program (1 FTE and $200,000 capital funding per year). Assume additional capital funding for WET program to sponsor up to 5 additional stormwater retrofit projects per year in the Graham Creek pilot improvement basin at a cost of approximately $20,000 per project. Assume watershed council and other nonprofits provide volunteers support for outreach and implementation.

Initial Implementation Cost Estimate:

Item	Quantity	Unit	Unit Cost	Estimated Cost
FTE summary	0	FTE	$ 80,000	$ -
Implementation	1	LS	$ 100,000	$ 100,000
				$ -
				$ -
				$ -
				$ -
				$ -
				$ -
Raw Cost				$ 100,000
Engineering, Administration, Contingency*			35%	$ -
Sub-total				$ 100,000
Land Costs		acre	$ 100,000	$ -
Total Estimated Initial Implementation Costs (2009 dollars) *				$ 100,000

Ongoing Cost Estimate: Project Life Past Yr 1 (yrs) 4

Item	Quantity	Unit	Unit Cost	Estimated Cost
FTE summary	0	FTE	$ 80,000	$ -
Property Acquisition	1	LS	$ 100,000	$ 100,000
				$ -
				$ -
				$ -
				$ -
				$ -
Raw Cost				$ 100,000
Engineering, Administration, Contingency*			35%	$ -
Sub-total				$ 100,000
Land Costs		acre	$ 100,000	$ -
Annual Ongoing Costs (2009 dollars)				$ 100,000
Total Ongoing Cost Over Project Life (2009 dollars)				$ 400,000

* Contingency and engineering mark-ups for capital projects only. Mark-ups linked to action type in cell C2

Action Name: Erosion Control (Existing Program Elements)

Action # D-22 (AEX)

Action Type: Programmatic

Action Extent: District-wide

Priority Ranking: -

	Watershed	**Basin**	**Lat**	**Long**	**Modeling Subbasin**	**Reach(es)**				
Action Location:	Multiple	-	-	-	-	-	-	-	-	-

Potential lead entity:	WES			**WES Lead:**	Erosion Prevention & Control	**Potential funding sources:**	WES (Rates)
Partner entities:		**Partner entities:**		**WES Support:**		**Potential funding sources:**	
Partner entities:		**Partner entities:**		**WES Support:**		**Potential funding sources:**	
Partner entities:		**Partner entities:**		**WES Support:**		**Potential funding sources:**	

Action Description (see backside of sheet for more details)

Statement of Need: Erosion prevention and sediment control protects streams from development-related erosion, which can be a major source of water quality degradation if uncontrolled.

Proposed Action - Implementation Steps:

WES currently provides erosion control services for development in CCSD No. 1, SWMACC, Boring, Hoodland, Gladstone, and in and out of district 1200c permits.

From July 2007 through June 2008, 817 erosion control permits were issued and 2,046 inspections were performed by CCSD No. 1 with 1.5 FTE.

Happy Valley took over responsibility for administering the erosion control program within their city limits in 2005. Happy Valley performed 215 erosion control inspections from July 2007 to June 2008.

Benefits of Action:

Erosion prevention and sediment control are very important to watershed health. Uncontrolled erosion at construction sites can contribute heavily to water quality problems including poor water clarity, high pollutant loads, damage to aquatic habitat, and maintenance problems in the storm drainage system from sediment deposition in pipes, catchbasins, culverts, outfalls, ponds, and swales.

Action Cost Summary (see backside for detailed cost estimate)

						Subtotal
Initial Programmatic FTE estimate:	0	**Initial Programmatic FTE Cost:**	$ -	**Initial Capital Cost Summary:**	$ 66,029	***$ 66,029***
Ongoing Programmatic FTE estimate:	0	**Ongoing Programmatic FTE Cost:**	$ -	**Annual Ongoing Capital Cost**	$ 66,029	***$ 66,029***
		(Programmatic Cost Summary is the FTE estimate translated into dollars)		**Years of Ongoing Cost Past Yr 1 included**		***4***
				Total Estimated 5-year Programmatic and Capital Cost		***$ 330,145***

Action Name: Erosion Control (Existing Program Elements) **Action #** D-22 (AEX)

Action Type: Programmatic **Action Extent:** District-wide **Priority Ranking:** -

	Watershed	Basin	Lat	Long	Modeling Subbasin	Reach(es)				
Action Location:	Multiple	-	-	-	-	-	-	-	-	-

Proposed Action - Implementation Steps (continued):

Attachments to describe Implementation Steps further? No

Pathway for attachment(s):

Proposed Action - Implementation Steps (continued):

Detailed Cost Breakdown

Initial Implementation Cost Assumptions: Current annual cost for program is estimated at $66,029 by WES.

Ongoing Cost Assumptions: Assume existing cost.

Initial Implementation Cost Estimate:

Item	Quantity	Unit	Unit Cost	Estimated Cost
FTE summary		FTE	$ 80,000	$ -
LS for ERCO	1	LS	$ 66,029	$ 66,029
				$ -
				$ -
				$ -
				$ -
				$ -
				$ -
Raw Cost				$ 66,029
Engineering, Administration, Contingency*			35%	$ -
Sub-total				$ 66,029
Land Costs		acre	$ 100,000	$ -
Total Estimated Initial Implementation Costs (2009 dollars) *				$ 66,029

Ongoing Cost Estimate: Project Life Past Yr 1 (yrs) 4

Item	Quantity	Unit	Unit Cost	Estimated Cost
FTE summary		FTE	$ 80,000	$ -
LS for ERCO	1	LS	$ 66,029	$ 66,029
				$ -
				$ -
				$ -
				$ -
				$ -
Raw Cost				$ 66,029
Engineering, Administration, Contingency*			35%	$ -
Sub-total				$ 66,029
Land Costs		acre	$ 100,000	$ -
Annual Ongoing Costs (2009 dollars)				$ 66,029
Total Ongoing Cost Over Project Life (2009 dollars)				$ 264,116

* Contingency and engineering mark-ups for capital projects only. Mark-ups linked to action type in cell C2

Action Name: Sampling/Water Quality (Existing Program Elements)

Action # D-23 (AEX)

Action Type: Programmatic

Action Extent: District-wide

Priority Ranking: -

	Watershed	Basin	Lat	Long	Modeling Subbasin	Reach(es)				
Action Location:	Multiple	-	-	-	-	-	-	-	-	-

Potential lead entity:	WES			**WES Lead:**	Env. Policy & Watershed Health	**Potential funding sources:**	WES (Rates)
Partner entities:		**Partner entities:**		**WES Support:**		**Potential funding sources:**	
Partner entities:		**Partner entities:**		**WES Support:**		**Potential funding sources:**	
Partner entities:		**Partner entities:**		**WES Support:**		**Potential funding sources:**	

Action Description (see backside of sheet for more details)

Statement of Need: The WES Environmental Monitoring program is responsible for tracking, reporting, and in some cases, managing environmental conditions associated with surface water, stormwater, and treated wastewater in order to meet regulations and permits as well as WES program objectives. The Environmental Monitoring program includes environmental permit program management, laboratory operation, non-residential waste management, and a biosolids program.

Potential improvements to the monitoring program are evaluated in Action D-3, Develop and Implement an Integrated Monitoring Program.

Proposed Action - Implementation Steps:

The Environmental Monitoring Program includes the following staff.

- 0.2 FTE Program Manager
- 0.6 FTE Water Quality Analyst
- 0.2 FTE Sample Collection (through Compliance Services)
- 0.2 FTE Additional staff performs spill response, laboratory analysis on samples and maintains continuous surface water monitoring equipment

As part of the MS4 permit requirements, WES, and other Clackamas County co-permittees are required to develop and implement a stormwater monitoring program. WES currently administers a routine and storm-event related water quality and flow monitoring program within CCSD No. 1. The monitoring program activities include:

• Water quality sample collection, • Flow measurement, • Laboratory and field analysis of water samples, • Water quality data management reporting

Benefits of Action:

Water Quality monitoring provides valuable information about watershed health conditions.

Action Cost Summary (see backside for detailed cost estimate)

						Subtotal
Initial Programmatic FTE estimate:	0	**Initial Programmatic FTE Cost:**	$ -	**Initial Capital Cost Summary:**	$ 34,192	*$ 34,192*
Ongoing Programmatic FTE estimate:	0	**Ongoing Programmatic FTE Cost:**	$ -	**Annual Ongoing Capital Cost**	$ 34,192	*$ 34,192*
		(Programmatic Cost Summary is the FTE estimate translated into dollars)		**Years of Ongoing Cost Past Yr 1 included**		*4*
				Total Estimated 5-year Programmatic and Capital Cost		*$ 170,960*

Action Name: Sampling/Water Quality (Existing Program Elements)

Action # D-23 (AEX)

Action Type: Programmatic

Action Extent: District-wide

Priority Ranking: -

	Watershed	Basin	Lat	Long	Modeling Subbasin	Reach(es)				
Action Location:	Multiple	-	-	-	-	-	-	-	-	-

Proposed Action - Implementation Steps (continued):

Attachments to describe Implementation Steps further? No

Pathway for attachment(s):

Proposed Action - Implementation Steps (continued):

Detailed Cost Breakdown

Initial Implementation Cost Assumptions: Current annual cost for program is estimated at $34,192 by WES.

Ongoing Cost Assumptions: Assume existing cost.

Initial Implementation Cost Estimate:

Item	Quantity	Unit	Unit Cost	Estimated Cost
FTE summary		FTE	$ 80,000	$ -
LS for Monitoring	1	LS	$ 34,192	$ 34,192
				$ -
				$ -
				$ -
				$ -
				$ -
				$ -
Raw Cost				$ 34,192
Engineering, Administration, Contingency*			35%	$ -
Sub-total				$ 34,192
Land Costs		acre	$ 100,000	$ -
Total Estimated Initial Implementation Costs (2009 dollars) *				$ 34,192

Ongoing Cost Estimate:

Project Life Past Yr 1 (yrs) 4

Item	Quantity	Unit	Unit Cost	Estimated Cost
FTE summary		FTE	$ 80,000	$ -
LS for ERCO	1	LS	$ 34,192	$ 34,192
				$ -
				$ -
				$ -
				$ -
				$ -
Raw Cost				$ 34,192
Engineering, Administration, Contingency*			35%	$ -
Sub-total				$ 34,192
Land Costs		acre	$ 100,000	$ -
Annual Ongoing Costs (2009 dollars)				$ 34,192
Total Ongoing Cost Over Project Life (2009 dollars)				$ 136,768

* Contingency and engineering mark-ups for capital projects only. Mark-ups linked to action type in cell C2

Action Name: Spills/Illicit Discharges (Existing Program Elements)
Action # D-24 (AEX)
Action Type: Programmatic
Action Extent: District-wide
Priority Ranking: -

	Watershed	Basin	Lat	Long	Modeling Subbasin	Reach(es)				
Action Location:	Multiple	-	-	-	-	-	-	-	-	-

Potential lead entity: WES
WES Lead: Env. Monitoring & Regulatory
Potential funding sources: WES (Rates)
Partner entities: DTD Clackamas Co.
Partner entities:
WES Support:
Potential funding sources:
Partner entities:
Partner entities:
WES Support:
Potential funding sources:
Partner entities:
Partner entities:
WES Support:
Potential funding sources:

Action Description (see backside of sheet for more details)

Statement of Need: The Spills/Illicit Discharges program is a part of the environmental permit program management element of WES. The environmental permit program management element is responsible for managing several permits, including the National Pollutant Discharge Elimination System (NPDES) Municipal Separate Storm Sewer System (MS4) permit and the Underground Injection Control (UIC) requirements. The MS4 permit program is one of the key regulatory tools used to address the stormwater impacts from urban development. The UIC program regulates the discharge of stormwater below ground.

Proposed Action - Implementation Steps: According to the federal Clean Water Act, MS4 permittees must implement a program to reduce the discharge of pollutants to the maximum extent practicable, including management practices, control techniques and systems, and design and engineering methods. The program varies by municipality and is intended to be developed in a flexible manner in consideration of site-specific conditions to optimize reductions in stormwater pollutants. The program includes BMPs, monitoring, and other available and reasonable controls, which are then documented as requirements in the permit and SWMP. SWMPs can be revised using adaptive management to improve overall program effectiveness. The proposed 2008 SWMP includes a Program to Detect and Remove Illicit Discharges and Improper Disposal Into the Storm Sewer System, which encompasses the following activities:

- Conducting dry weather inspections
- Implementing the spill response program
- Facilitating public reporting of illicit discharges and spills
- Controlling infiltration and cross connections to the storm sewer system.

Benefits of Action:

Action Cost Summary (see backside for detailed cost estimate)

Initial Programmatic FTE estimate: 0
Ongoing Programmatic FTE estimate: 0
Initial Programmatic FTE Cost: $ -
Ongoing Programmatic FTE Cost: $ -
(Programmatic Cost Summary is the FTE estimate translated into dollars)

		Subtotal
Initial Capital Cost Summary:	$ 13,687	*$ 13,687*
Annual Ongoing Capital Cost	$ 13,687	*$ 13,687*
Years of Ongoing Cost Past Yr 1 included		*4*
Total Estimated 5-year Programmatic and Capital Cost		*$ 68,435*

Action Name:	Spills/Illicit Discharges (Existing Program Elements)				**Action #**	D-24 (AEX)
Action Type:	Programmatic	**Action Extent:**	District-wide		**Priority Ranking:**	-

	Watershed	**Basin**	**Lat**	**Long**	**Modeling Subbasin**	**Reach(es)**				
Action Location:	Multiple	-	-	-	-	-	-	-	-	-

Proposed Action - Implementation Steps (continued): Attachments to describe Implementation Steps further? No

Pathway for attachment(s):

Proposed Action - Implementation Steps (continued):

Detailed Cost Breakdown

Initial Implementation Cost Assumptions:

Ongoing Cost Assumptions:

Initial Implementation Cost Estimate:

Item	Quantity	Unit	Unit Cost	Estimated Cost
FTE summary		FTE	$ 80,000	$ -
				$ -
				$ -
				$ -
				$ -
				$ -
				$ -
				$ -
Raw Cost				$ -
Engineering, Administration, Contingency*			35%	$ -
Sub-total				$ -
Land Costs		acre	$ 100,000	$ -
Total Estimated Initial Implementation Costs (2009 dollars) *				$ 13,687

Ongoing Cost Estimate: Project Life Past Yr 1 (yrs) 4

Item	Quantity	Unit	Unit Cost	Estimated Cost
FTE summary		FTE	$ 80,000	$ -
				$ -
				$ -
				$ -
				$ -
				$ -
				$ -
Raw Cost				$ -
Engineering, Administration, Contingency*			35%	$ -
Sub-total				$ -
Land Costs		acre	$ 100,000	$ -
Annual Ongoing Costs (2009 dollars)				$ 13,687
Total Ongoing Cost Over Project Life (2009 dollars)				$ 54,748

* Contingency and engineering mark-ups for capital projects only. Mark-ups linked to action type in cell C2

Action Name: Planning and Projects (Existing Program Elements)

Action # D-25 (AEX)

Action Type: Programmatic

Action Extent: District-wide

Priority Ranking: -

Action Location:

	Watershed	Basin	Lat	Long	Modeling Subbasin	Reach(es)				
Action Location:	Multiple	-	-	-	-	-	-	-	-	-

Potential lead entity: WES

WES Lead: SWM Program Management

Potential funding sources: WES

Partner entities:

Partner entities:

WES Support:

Potential funding sources:

Partner entities:

Partner entities:

WES Support:

Potential funding sources:

Partner entities:

Partner entities:

WES Support:

Potential funding sources:

Action Description (see backside of sheet for more details)

Statement of Need: The Capital Improvement Program plans, designs and builds major capital facilities in the three area Districts, so that operating divisions can serve district customers' wastewater and surface water needs.

Proposed Action - Implementation Steps: CIP project management includes design and construction of capital facilities and provides project controls in terms of cost, schedule, scope, program development and long range forecasting. Examples of CIP projects that affect watershed health include regional stormwater detention and treatment systems and public stormwater infrastructure projects including pipes and bioswales.

Benefits of Action:

Action Cost Summary (see backside for detailed cost estimate)

Initial Programmatic FTE estimate: 0

Ongoing Programmatic FTE estimate: 0

Initial Programmatic FTE Cost: $ -

Ongoing Programmatic FTE Cost: $ -

(Programmatic Cost Summary is the FTE estimate translated into dollars)

		Subtotal
Initial Capital Cost Summary:	$ 92,660	*$ 92,660*
Annual Ongoing Capital Cost	$ 92,660	*$ 92,660*
Years of Ongoing Cost Past Yr 1 included		*4*
Total Estimated 5-year Programmatic and Capital Cost		*$ 463,300*

Action Name: Planning and Projects (Existing Program Elements)

Action # D-25 (AEX)

Action Type: Programmatic

Action Extent: District-wide

Priority Ranking: -

	Watershed	Basin	Lat	Long	Modeling Subbasin	Reach(es)				
Action Location:	Multiple	-	-	-	-	-	-	-	-	-

Proposed Action - Implementation Steps (continued):

Attachments to describe Implementation Steps further? No

Pathway for attachment(s):

Proposed Action - Implementation Steps (continued):

Detailed Cost Breakdown

Initial Implementation Cost Assumptions:

Ongoing Cost Assumptions:

Initial Implementation Cost Estimate:

Item	**Quantity**	**Unit**	**Unit Cost**	**Estimated Cost**
FTE summary		FTE	$ 80,000	$ -
				$ -
				$ -
				$ -
				$ -
				$ -
				$ -
				$ -
Raw Cost				$ -
Engineering, Administration, Contingency*			35%	$ -
Sub-total				$ -
Land Costs		acre	$ 100,000	$ -
Total Estimated Initial Implementation Costs (2009 dollars) *				$ 92,660

Ongoing Cost Estimate:

Project Life Past Yr 1 (yrs) 4

Item	**Quantity**	**Unit**	**Unit Cost**	**Estimated Cost**
FTE summary		FTE	$ 80,000	$ -
				$ -
				$ -
				$ -
				$ -
				$ -
				$ -
Raw Cost				$ -
Engineering, Administration, Contingency*			35%	$ -
Sub-total				$ -
Land Costs		acre	$ 100,000	$ -
Annual Ongoing Costs (2009 dollars)				$ 92,660
Total Ongoing Cost Over Project Life (2009 dollars)				$ 370,640

* Contingency and engineering mark-ups for capital projects only. Mark-ups linked to action type in cell C2

Action Name:	On-Site Maintenance (Existing Program Elements)					**Action #**	D-26 (AEX)
Action Type:	Programmatic	**Action Extent:**	District-wide			**Priority Ranking:**	-

	Watershed	Basin	Lat	Long	Modeling Subbasin	Reach(es)				
Action Location:	Multiple	-	-	-	-	-	-	-	-	-

Potential lead entity:	WES			**WES Lead:**	Stormwater Maintenance	**Potential funding sources:**	WES
Partner entities:	DTD Clackamas Co.	**Partner entities:**		**WES Support:**		**Potential funding sources:**	
Partner entities:		**Partner entities:**		**WES Support:**		**Potential funding sources:**	
Partner entities:		**Partner entities:**		**WES Support:**		**Potential funding sources:**	

Action Description (see backside of sheet for more details)

Statement of Need: The WES Stormwater Maintenance program is responsible for the maintenance of all stormwater assets within the public right-of-way in the Districts, with the exception of assets that are the responsibility of the Clackamas County Department of Transportation and Development (DTD) or the Oregon Department of Transportation (ODOT). The WES Stormwater Maintenance program is responsible for inspecting and maintaining detention ponds, and pipes, vortex separators, pollution control systems, catch basins, manholes, open channels including natural drainage features, and public underground injection controls (UIC) systems. The stormwater maintenance crew primarily inspects sites and prescribes maintenance work. Most field maintenance is performed by the sanitary maintenance crew.

Proposed Action - Implementation Steps: As of 2008, WES stormwater maintenance is currently responsible for:

- 304 miles of stormwater pipe
- 23,000 storm structures including catch basins and manholes
- 262 detention ponds
- 700 detention pipes
- 31 treatment facilities (swales and underground devices)

Maintenance Staff and Equipment Statistics:

- 0.2 FTE Program Manager
- 2.0 FTE Surface Water Technicians
- 3.3 FTE Collection System Technicians
- 1.2 FTE Seasonal Employees
- 1.0 FTE contracted with DTD
- Use of 2 Fully Equipped Maintenance Utility Trucks
- Use of combination Vacuum/Hydrocleaner trucks (“Vactor trucks”)
- Use of regenerative air sweepers (for street sweeping)
- Use of pipe video equipment

Benefits of Action:

Action Cost Summary (see backside for detailed cost estimate)

						Subtotal
Initial Programmatic FTE estimate:	0	**Initial Programmatic FTE Cost:**	$ -	**Initial Capital Cost Summary:**	$177,033	*$ 177,033*
Ongoing Programmatic FTE estimate:	0	**Ongoing Programmatic FTE Cost:**	$ -	**Annual Ongoing Capital Cost**	$177,033	*$ 177,033*
		(Programmatic Cost Summary is the FTE estimate translated into dollars)		**Years of Ongoing Cost Past Yr 1 included**		*4*
				Total Estimated 5-year Programmatic and Capital Cost		*$ 885,165*

Action Name: On-Site Maintenance (Existing Program Elements)

Action # D-26 (AEX)

Action Type: Programmatic

Action Extent: District-wide

Priority Ranking: -

	Watershed	Basin	Lat	Long	Modeling Subbasin	Reach(es)				
Action Location:	Multiple	-	-	-	-	-	-	-	-	-

Proposed Action - Implementation Steps (continued):

Attachments to describe Implementation Steps further? No

Pathway for attachment(s):

Proposed Action - Implementation Steps (continued):

Detailed Cost Breakdown

Initial Implementation Cost Assumptions:

Ongoing Cost Assumptions:

Initial Implementation Cost Estimate:

Item	Quantity	Unit	Unit Cost	Estimated Cost
FTE summary		FTE	$ 80,000	$ -
				$ -
				$ -
				$ -
				$ -
				$ -
				$ -
				$ -
Raw Cost				$ -
Engineering, Administration, Contingency*			35%	$ -
Sub-total				$ -
Land Costs		acre	$ 100,000	$ -
Total Estimated Initial Implementation Costs (2009 dollars) *				$ 177,033

Ongoing Cost Estimate:

Project Life Past Yr 1 (yrs) 4

Item	Quantity	Unit	Unit Cost	Estimated Cost
FTE summary		FTE	$ 80,000	$ -
				$ -
				$ -
				$ -
				$ -
				$ -
				$ -
Raw Cost				$ -
Engineering, Administration, Contingency*			35%	$ -
Sub-total				$ -
Land Costs		acre	$ 100,000	$ -
Annual Ongoing Costs (2009 dollars)				$ 177,033
Total Ongoing Cost Over Project Life (2009 dollars)				$ 708,132

* Contingency and engineering mark-ups for capital projects only. Mark-ups linked to action type in cell C2

Action Name: Regulatory (Existing Program Elements)

Action # D-27 (AEX)

Action Type: Programmatic

Action Extent: District-wide

Priority Ranking: -

	Watershed	Basin	Lat	Long	Modeling Subbasin	Reach(es)				
Action Location:	Multiple	-	-	-	-	-	-	-	-	-

Potential lead entity:	WES			**WES Lead:**	Erosion Prevention & Control	**Potential funding sources:**	WES (Rates)
Partner entities:		**Partner entities:**		**WES Support:**		**Potential funding sources:**	
Partner entities:		**Partner entities:**		**WES Support:**		**Potential funding sources:**	
Partner entities:		**Partner entities:**		**WES Support:**		**Potential funding sources:**	

Action Description (see backside of sheet for more details)

Statement of Need: The environmental permit program management element of WES is responsible for managing several permits, including the National Pollutant Discharge Elimination System (NPDES) Municipal Separate Storm Sewer System (MS4) permit and the Underground Injection Control (UIC) requirements. The MS4 permit program is one of the key regulatory tools used to address the stormwater impacts from urban development. The UIC program regulates the discharge of stormwater below ground.

Proposed Action - Implementation Steps:

The Environmental Monitoring Program includes the following staff.

- 0.2 FTE Program Manager
- 0.6 FTE Water Quality Analyst
- 0.2 FTE Sample Collection (through Compliance Services)
- 0.2 FTE Additional staff

Benefits of Action:

Environmental Permit Program Management helps maintain and improve watershed health conditions.

Action Cost Summary (see backside for detailed cost estimate)

						Subtotal
Initial Programmatic FTE estimate:	0	**Initial Programmatic FTE Cost:**	$ -	**Initial Capital Cost Summary:**	$ 46,914	*$ 46,914*
Ongoing Programmatic FTE estimate:	0	**Ongoing Programmatic FTE Cost:**	$ -	**Annual Ongoing Capital Cost**	$ 46,914	*$ 46,914*
		(Programmatic Cost Summary is the FTE estimate translated into dollars)		**Years of Ongoing Cost Past Yr 1 included**		*4*
				Total Estimated 5-year Programmatic and Capital Cost		*$ 234,570*

Action Name: Regulatory (Existing Program Elements)

Action # D-27 (AEX)

Action Type: Programmatic

Action Extent: District-wide

Priority Ranking: -

	Watershed	Basin	Lat	Long	Modeling Subbasin	Reach(es)				
Action Location:	Multiple	-	-	-	-	-	-	-	-	-

Proposed Action - Implementation Steps (continued):

Attachments to describe Implementation Steps further? No

Pathway for attachment(s):

Proposed Action - Implementation Steps (continued):

Detailed Cost Breakdown

Initial Implementation Cost Assumptions: Current annual cost for program is estimated at $46,914 by WES.

Ongoing Cost Assumptions: Assume existing cost.

Initial Implementation Cost Estimate:

Item	Quantity	Unit	Unit Cost	Estimated Cost
FTE summary		FTE	$ 80,000	$ -
LS for Monitoring	1	LS	$ 46,914	$ 46,914
				$ -
				$ -
				$ -
				$ -
				$ -
				$ -
Raw Cost				$ 46,914
Engineering, Administration, Contingency*			35%	$ -
Sub-total				$ 46,914
Land Costs		acre	$ 100,000	$ -
Total Estimated Initial Implementation Costs (2009 dollars) *				$ 46,914

Ongoing Cost Estimate:

Project Life Past Yr 1 (yrs) 4

Item	Quantity	Unit	Unit Cost	Estimated Cost
FTE summary		FTE	$ 80,000	$ -
LS for ERCO	1	LS	$ 46,914	$ 46,914
				$ -
				$ -
				$ -
				$ -
				$ -
Raw Cost				$ 46,914
Engineering, Administration, Contingency*			35%	$ -
Sub-total				$ 46,914
Land Costs		acre	$100,000	$ -
Annual Ongoing Costs (2009 dollars)				$ 46,914
Total Ongoing Cost Over Project Life (2009 dollars)				$ 187,656

* Contingency and engineering mark-ups for capital projects only. Mark-ups linked to action type in cell C2

Action Name:	Customer Service Coordination (Existing Program Elements)					**Action #**	D-28 (AEX)
Action Type:	Programmatic	**Action Extent:**	District-wide			**Priority Ranking:**	-

	Watershed	**Basin**	**Lat**	**Long**	**Modeling Subbasin**	**Reach(es)**				
Action Location:	Multiple	-	-	-	-	-	-	-	-	-

Potential lead entity:	WES			**WES Lead:**	Customer Service	**Potential funding sources:**	WES (Rates)
Partner entities:	DTD Clackamas Co.	**Partner entities:**		**WES Support:**		**Potential funding sources:**	
Partner entities:		**Partner entities:**		**WES Support:**		**Potential funding sources:**	
Partner entities:		**Partner entities:**		**WES Support:**		**Potential funding sources:**	

Action Description (see backside of sheet for more details)

Statement of Need: WES provides customer service to ratepayers.

Proposed Action - Implementation Steps: Customer service includes taking information, fielding questions, and directing customers to resources via phone calls and in-person visits to the WES office.

Benefits of Action:

Action Cost Summary (see backside for detailed cost estimate)

						Subtotal
Initial Programmatic FTE estimate:	0	**Initial Programmatic FTE Cost:**	$ -	**Initial Capital Cost Summary:**	$ 20,407	***$ 20,407***
Ongoing Programmatic FTE estimate:	0	**Ongoing Programmatic FTE Cost:**	$ -	**Annual Ongoing Capital Cost**	$ 20,407	***$ 20,407***
		(Programmatic Cost Summary is the FTE estimate translated into dollars)		**Years of Ongoing Cost Past Yr 1 included**		***4***
				Total Estimated 5-year Programmatic and Capital Cost		***$ 102,035***

Action Name: Customer Service Coordination (Existing Program Elements) **Action #** D-28 (AEX)

Action Type: Programmatic **Action Extent:** District-wide **Priority Ranking:** -

	Watershed	Basin	Lat	Long	Modeling Subbasin	Reach(es)				
Action Location:	Multiple	-	-	-	-	-	-	-	-	-

Proposed Action - Implementation Steps (continued):

Attachments to describe Implementation Steps further? No

Pathway for attachment(s):

Proposed Action - Implementation Steps (continued):

Detailed Cost Breakdown

Initial Implementation Cost Assumptions:

Ongoing Cost Assumptions:

Initial Implementation Cost Estimate:

Item	Quantity	Unit	Unit Cost	Estimated Cost
FTE summary		FTE	$ 80,000	$ -
				$ -
				$ -
				$ -
				$ -
				$ -
				$ -
				$ -
Raw Cost				$ -
Engineering, Administration, Contingency*			35%	$ -
Sub-total				$ -
Land Costs		acre	$ 100,000	$ -
Total Estimated Initial Implementation Costs (2009 dollars) *				$ 20,407

Ongoing Cost Estimate: Project Life Past Yr 1 (yrs) 4

Item	Quantity	Unit	Unit Cost	Estimated Cost
FTE summary		FTE	$ 80,000	$ -
				$ -
				$ -
				$ -
				$ -
				$ -
				$ -
Raw Cost				$ -
Engineering, Administration, Contingency*			35%	$ -
Sub-total				$ -
Land Costs		acre	$ 100,000	$ -
Annual Ongoing Costs (2009 dollars)				$ 20,407
Total Ongoing Cost Over Project Life (2009 dollars)				$ 81,628

* Contingency and engineering mark-ups for capital projects only. Mark-ups linked to action type in cell C2

Action Name:	Intergovernment Coordination (Existing Program Elements)	**Action #**	D-29 (AEX)
Action Type:	Programmatic **Action Extent:** District-wide	**Priority Ranking:**	-

	Watershed	**Basin**	**Lat**	**Long**	**Modeling Subbasin**	**Reach(es)**				
Action Location:	Multiple	-	-	-	-	-	-	-	-	-

Potential lead entity:	WES			**WES Lead:**	Env. Policy & Watershed Health	**Potential funding sources:**	WES
Partner entities:		**Partner entities:**		**WES Support:**		**Potential funding sources:**	
Partner entities:		**Partner entities:**		**WES Support:**		**Potential funding sources:**	
Partner entities:		**Partner entities:**		**WES Support:**		**Potential funding sources:**	

Action Description (see backside of sheet for more details)

Statement of Need: Multiple government agencies and departments have jurisdictions in the watersheds in the Districts, including cities, state agencies, and additional departments within Clackamas County. Intergovernment Coordination between WES and these agencies and departments is an important aspect of managing watershed health.

Proposed Action - Implementation Steps: WES employs 1.0 FTE as an environmental policy specialist in the Environmental Policy and Watershed Health functional program element. This element is a part of WES Administration. The responsibilities of the environmental policy specialist include developing partnerships with other agencies and nonprofit groups in the implementation of watershed improvement projects, assessing watershed conditions in the Districts in coordination with state and local agencies, assisting in developing management strategies to improve or protect environmental conditions in coordination with state and local agencies, assisting in public information and outreach efforts, reviewing WES and other County projects for permit compliance, and serving as a representative of WES on a wide variety of committees and advisory bodies addressing watershed health issues. The Environmental Policy and Watershed Health functional program element addresses numerous environmental regulatory programs including the Endangered Species Act (ESA).

Benefits of Action:

Action Cost Summary (see backside for detailed cost estimate)

						Subtotal
Initial Programmatic FTE estimate:	0	**Initial Programmatic FTE Cost:**	$ -	**Initial Capital Cost Summary:**	$ 19,899	*$ 19,899*
Ongoing Programmatic FTE estimate:	0	**Ongoing Programmatic FTE Cost:**	$ -	**Annual Ongoing Capital Cost**	$ 19,899	*$ 19,899*
		(Programmatic Cost Summary is the FTE estimate translated into dollars)		**Years of Ongoing Cost Past Yr 1 included**		*4*
				Total Estimated 5-year Programmatic and Capital Cost		*$ 99,495*

Action Name: Intergovernment Coordination (Existing Program Elements) **Action #** D-29 (AEX)

Action Type: Programmatic **Action Extent:** District-wide **Priority Ranking:** -

	Watershed	**Basin**	**Lat**	**Long**	**Modeling Subbasin**	**Reach(es)**				
Action Location:	Multiple	-	-	-	-	-	-	-	-	-

Proposed Action - Implementation Steps (continued):

Attachments to describe Implementation Steps further? No

Pathway for attachment(s):

Proposed Action - Implementation Steps (continued):

Detailed Cost Breakdown

Initial Implementation Cost Assumptions:

Ongoing Cost Assumptions:

Initial Implementation Cost Estimate:

Item	**Quantity**	**Unit**	**Unit Cost**	**Estimated Cost**
FTE summary		FTE	$ 80,000	$ -
				$ -
				$ -
				$ -
				$ -
				$ -
				$ -
				$ -
Raw Cost				$ -
Engineering, Administration, Contingency*			35%	$ -
Sub-total				$ -
Land Costs		acre	$ 100,000	$ -
Total Estimated Initial Implementation Costs (2009 dollars) *				$ 19,899

Ongoing Cost Estimate: Project Life Past Yr 1 (yrs) 4

Item	**Quantity**	**Unit**	**Unit Cost**	**Estimated Cost**
FTE summary		FTE	$ 80,000	$ -
				$ -
				$ -
				$ -
				$ -
				$ -
				$ -
Raw Cost				$ -
Engineering, Administration, Contingency*			35%	$ -
Sub-total				$ -
Land Costs		acre	$100,000	$ -
Annual Ongoing Costs (2009 dollars)				$ 19,899
Total Ongoing Cost Over Project Life (2009 dollars)				$ 79,596

* Contingency and engineering mark-ups for capital projects only. Mark-ups linked to action type in cell C2

Action Name: SWM Program Admin (Existing Program Elements) **Action #** D-30 (AEX)

Action Type: Programmatic **Action Extent:** District-wide **Priority Ranking:** -

	Watershed	Basin	Lat	Long	Modeling Subbasin	Reach(es)				
Action Location:	Multiple	-	-	-	-	-	-	-	-	-

Potential lead entity:	WES			**WES Lead:**	SWM Program Management	**Potential funding sources:**	WES
Partner entities:		**Partner entities:**		**WES Support:**		**Potential funding sources:**	
Partner entities:		**Partner entities:**		**WES Support:**		**Potential funding sources:**	
Partner entities:		**Partner entities:**		**WES Support:**		**Potential funding sources:**	

Action Description (see backside of sheet for more details)

Statement of Need: Administration of the Surface Water Management (SWM) Program is needed to operate an efficient and effective program.

Proposed Action - Implementation Steps: SWM Program Administration includes management and direction of program elements and outcomes.

Benefits of Action:

Action Cost Summary (see backside for detailed cost estimate)

						Subtotal
Initial Programmatic FTE estimate:	0	**Initial Programmatic FTE Cost:**	$ -	**Initial Capital Cost Summary:**	$ 26,668	*$ 26,668*
Ongoing Programmatic FTE estimate:	0	**Ongoing Programmatic FTE Cost:**	$ -	**Annual Ongoing Capital Cost**	$ 26,668	*$ 26,668*
		(Programmatic Cost Summary is the FTE estimate translated into dollars)		**Years of Ongoing Cost Past Yr 1 included**		*4*
				Total Estimated 5-year Programmatic and Capital Cost		*$ 133,340*

Action Name: SWM Program Admin (Existing Program Elements)

Action # D-30 (AEX)

Action Type: Programmatic

Action Extent: District-wide

Priority Ranking: -

	Watershed	Basin	Lat	Long	Modeling Subbasin	Reach(es)				
Action Location:	Multiple	-	-	-	-	-	-	-	-	-

Proposed Action - Implementation Steps (continued):

Attachments to describe Implementation Steps further? No

Pathway for attachment(s):

Proposed Action - Implementation Steps (continued):

Detailed Cost Breakdown

Initial Implementation Cost Assumptions:

Ongoing Cost Assumptions:

Initial Implementation Cost Estimate:

Item	Quantity	Unit	Unit Cost	Estimated Cost
FTE summary		FTE	$ 80,000	$ -
				$ -
				$ -
				$ -
				$ -
				$ -
				$ -
				$ -
Raw Cost				$ -
Engineering, Administration, Contingency*			35%	$ -
Sub-total				$ -
Land Costs		acre	$ 100,000	$ -
Total Estimated Initial Implementation Costs (2009 dollars) *				$ 26,668

Ongoing Cost Estimate:

Project Life Past Yr 1 (yrs) 4

Item	Quantity	Unit	Unit Cost	Estimated Cost
FTE summary		FTE	$ 80,000	$ -
				$ -
				$ -
				$ -
				$ -
				$ -
				$ -
Raw Cost				$ -
Engineering, Administration, Contingency*			35%	$ -
Sub-total				$ -
Land Costs		acre	$ 100,000	$ -
Annual Ongoing Costs (2009 dollars)				$ 26,668
Total Ongoing Cost Over Project Life (2009 dollars)				$ 106,672

* Contingency and engineering mark-ups for capital projects only. Mark-ups linked to action type in cell C2

ACTION D-2

DETENTION POND WRITE-UP
KMS DETENTION POND SITE MAP
RC DETENTION POND SITE MAP

Action D-2: Evaluate and Prioritize Retrofit of SW Detention Facilities

WES is currently responsible for maintaining over 260 stormwater treatment ponds in the Districts and Happy Valley. Over 30 ponds in the Districts have been identified by WES staff as potential opportunities to retrofit to function better. The ponds were originally designed and constructed with various functions in mind (e.g., differing levels of flood control and water quality treatment), and at different stages of understanding of stormwater treatment opportunities to improve watershed health.
The following table shows design standards used by the District for detention facilities since 1993. According to the District, it typically takes 2 years after the design standards are changed before the changes are fully implemented in new facilities. For example, ponds built before 1995 would likely follow the standard in effect prior to 1993.

Detention Pond Design Standard History

Date	Detention Design Standard	Record of Change in Design Standard
October, 1993	25-year developed runoff rate to the 5-year pre-developed rate	
June 1, 1999	25-year to 5-year and 2-year to ½ the 2-year	Detention
May 1, 2000	25-year to 5-year and 2-year to ½ the 2-year	25-foot buffer requirements to a 50-foot buffer requirement
August 1, 2002	2-year to ½ the 2-year	Detention
February 1, 2005	2-year to ½ the 2-year	Redevelopment clause

In order to map the detention ponds by date and location, the District compiled as-built records and assigned 189 ponds that were built between 1976 and 2008 with a date. The date used for mapping was the earliest date found on the as-builts, so that it would correspond with the design standard in effect during design of the pond. The maps attached to action D-2(EAP) display the ponds by period of design standard and identify maintenance responsibility (e.g., WES-maintained ponds and privately maintained ponds).

Due to the large number of ponds in need of retrofit, retrofit activities must be prioritized. The first priority is to retrofit ponds that were built prior to 1995, which includes 19 ponds in the KMS watershed. No ponds were built prior to 1995 in the Rock Creek watershed.

Ponds built prior to 1995 should be retrofitted to treat flow from smaller storms, such as storms with a recurrence interval of 2-years and less. Storms at this recurrence are the channel forming storms and therefore more geomorphically significant. A “one size fits all” recommendation cannot be made to address every pond, due to varying basin and site conditions. The variables include changes in the watershed area, modifications to the original pond design, and changes in rainfall patterns throughout the watershed and over time as we see affects from climate change.

Because of these variables we are recommending “low tech” modifications or retrofits to the existing ponds. The recommended retrofits are intended to keep the implementation process simple, and will thus not require intense modeling or extensive design in an effort to match the hydraulics to a new design storm. The following are our recommendations based on our assessment of the watersheds and our discussion with WES staff.

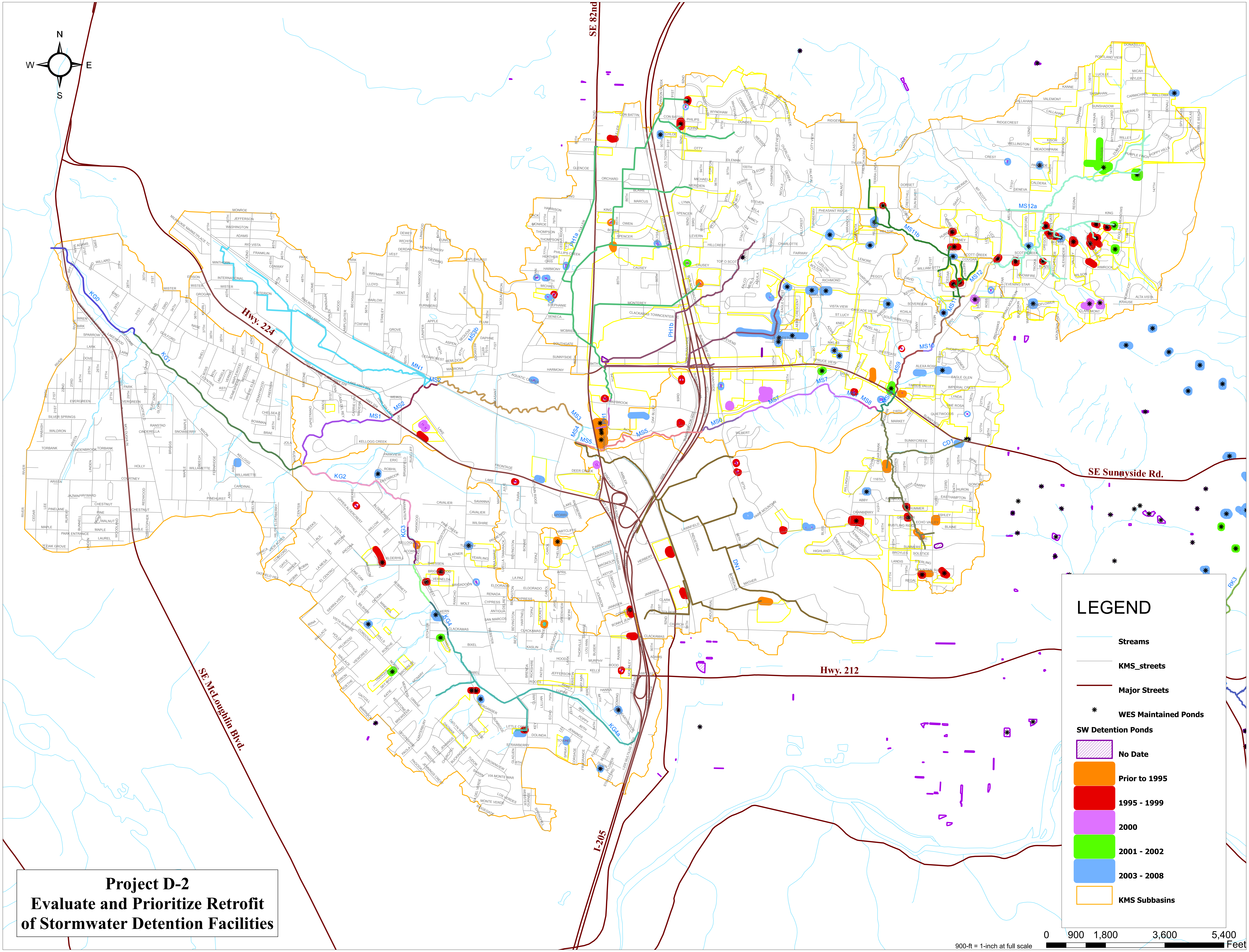
Recommendations for ponds built prior to 1995:

- If short circuiting is occurring, construct berms and a low flow channel to provide a longer flow path for the flow through the pond.
- If sediment is apparent at the inlet to the pond remove sediment and if room is available place a small rock weir to pool water and allow sediment to drop out prior to entering the main part of the pond. For many of the ponds observed the room might not be available to construct this sediment forebay.
- Place a rock weir around the outlet structure that will back smaller storms into the pond and provide more detention for smaller storms. This rock weir should be less than 30-inches tall and should not exceed 1/3 the overall pond depth.
- The length of the outlet weir should be a minimum of 3-feet per acre in the drainage basin.
- WES should experiment with placing a sand berm within the rock berm to provide water quality treatment. Sand filtering is very effective at removing TSS, Oils and Grease and Bacteria. It is moderately effective on metals and other pollutants. The construction and maintenance will require some experimenting and observing by WES. The sand berm within the rock berm should be 18” in width and be made of sand particles between 0.02 and 0.04 inches in diameter.
- Sand bags might be a simple approach to holding the sand in place and covering up with rocks for aesthetics.
- A plant management program should be implemented that includes removing non-native plants and installing a diverse assemblage of native plants including groundcovers, shrubs and trees to support water quality and habitat improvements. The basic planting detail for ponds can be used as a guide, where appropriate. Plant selection and placement will depend on maintenance access and should not obstruct maintenance activities. Mowed grass ponds should be enhanced with more diverse vegetation, unless the facilities serve other purposes such as a sports field.

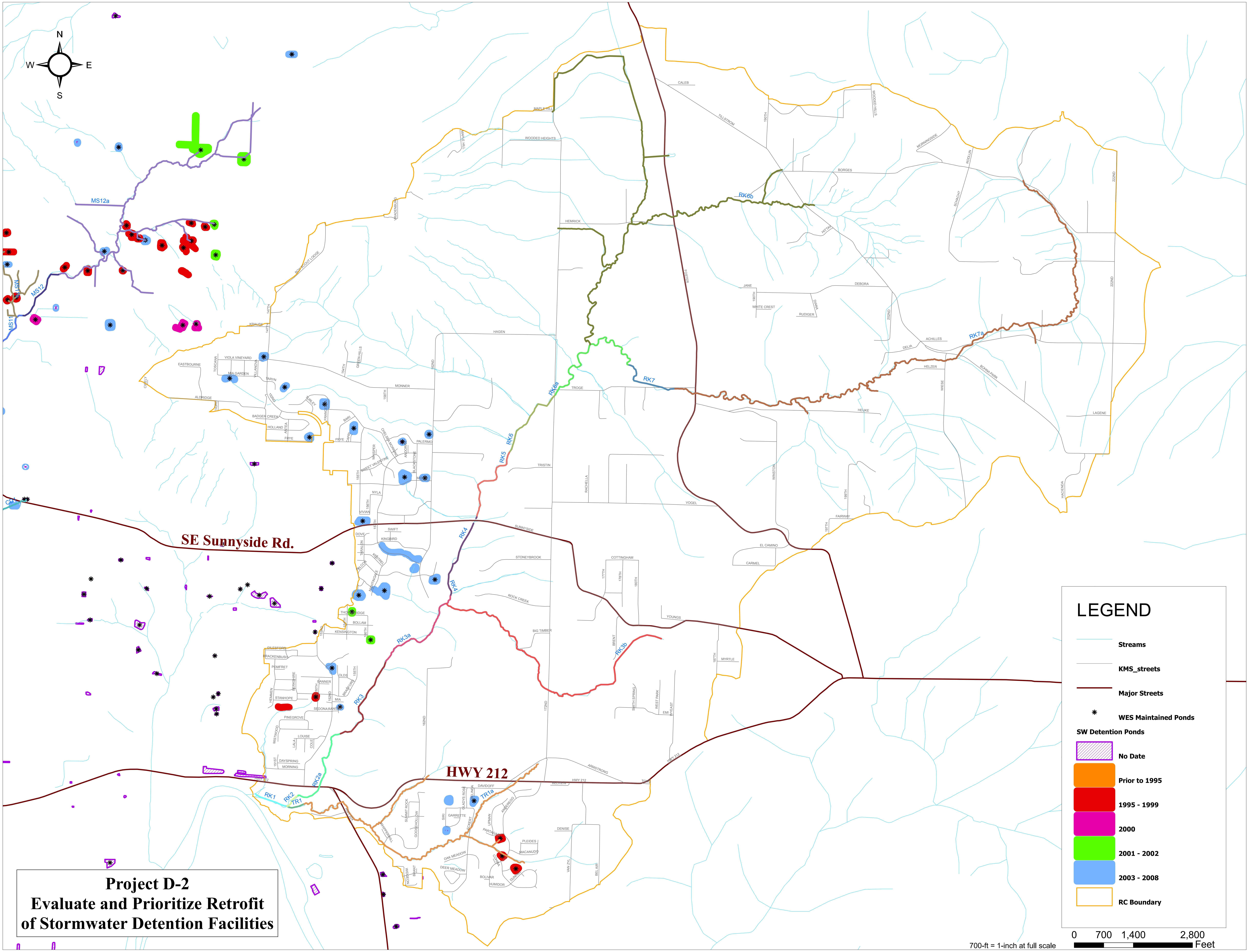
Recommendations for ponds built after 1995:

- If ponds appear to be holding back water for smaller storm events no modification to the outfall structure may be required. However, opportunities for implementing the plant management program and a sediment forebay should still be evaluated.
- If the pond is not holding back water for smaller storm events all of the recommendations for ponds constructed prior to 1995 should be implemented.

Detention pipes will need to be inspected and evaluated, with a retrofit solution determined following the evaluation.



Project D-2
Evaluate and Prioritize Retrofit of Stormwater Detention Facilities



Project D-2
Evaluate and Prioritize Retrofit of Stormwater Detention Facilities

ACTION D-10

KMS BENTHIC SITE MAP
RC BENTHIC SITE MAP

Kellogg/ Mt. Scott Creek
Benthic Sampling Sites

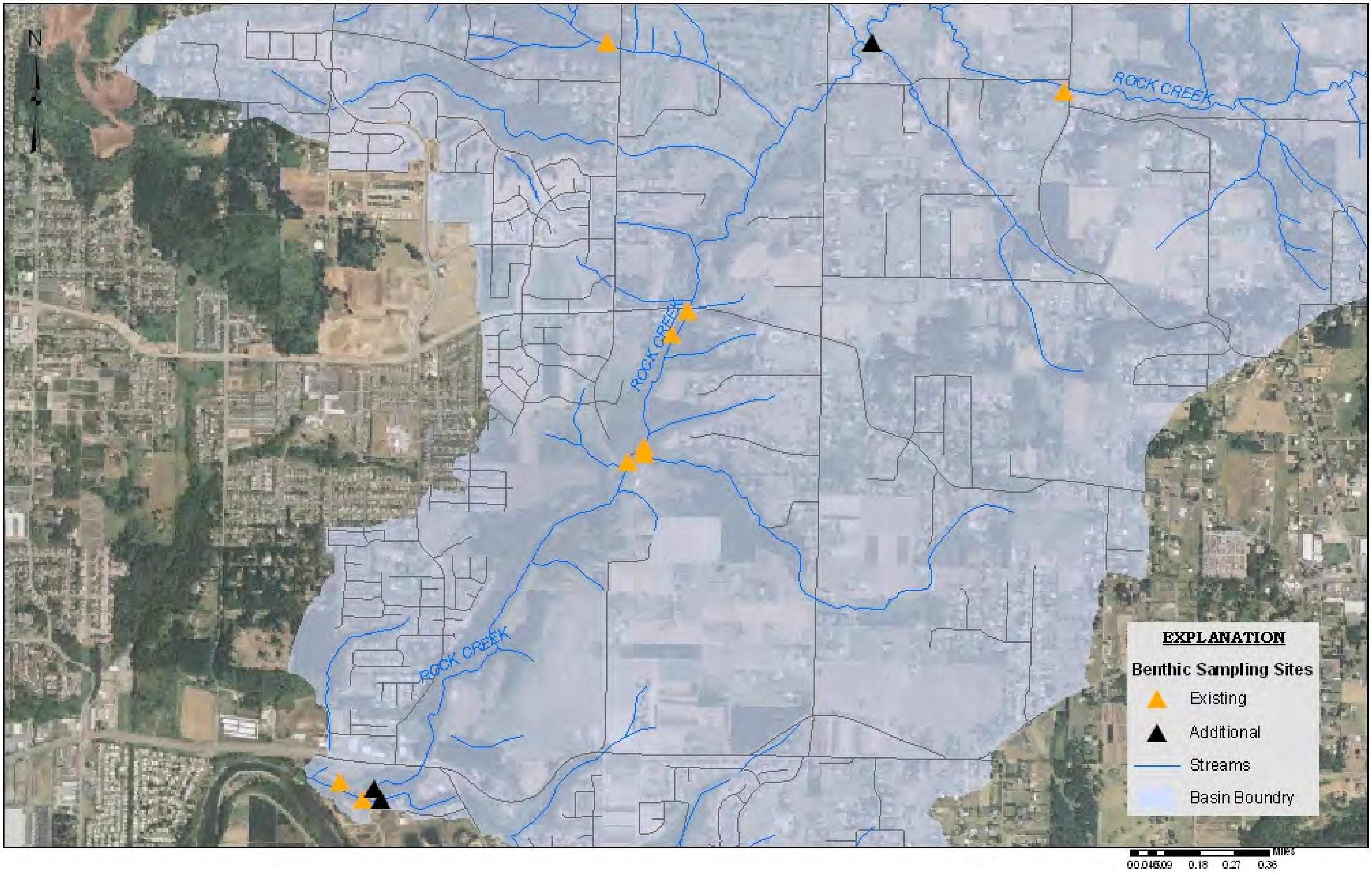
WES WATERSHED ACTION PLAN

WATER ENVIRONMENT SERVICES
Beyond clean water.

BROWN AND CALDWELL

Swanson Hydrology
+ Geomorphology

Ellis Ecological Services, Inc.



Rock Creek
Benthic Sampling Sites
WES WATERSHED ACTION PLAN

WATER ENVIRONMENT SERVICES
Beyond clean water. www.clackamas.us/wes

BROWN AND CALDWELL

Swanson Hydrology
+ Geomorphology

Ellis Ecological Services, Inc.

ACTION D-18

1999 ODFW CULVERT ASSESSMENT
FISH PASSAGE IMPLEMENTATION STEPS
KMS CHARACTERIZATION FIGURE 4-8
RC CHARACTERIZATION FIGURE 4-9

Assessment of Road Culverts for Fish Passage Problems on State- and County-Owned Roads

Statewide
Summary Report

September, 1999

Prepared by:
Albert H. Mirati, Jr.

Oregon Department of Fish and Wildlife

Preface

Between mid-1996 and mid-1999, the Oregon Department of Fish and Wildlife (ODFW) conducted assessments of fish passage conditions at State- and county-owned road culverts. At the conclusion of each phase of the assessments, the Department produced and distributed a limited number of reports for the Oregon Department of Transportation (ODOT) and the counties which summarized road culvert assessment activities by river basin.

Public interest in these reports was underestimated. Each month, ODFW and ODOT receive numerous requests for these reports that can not be filled because the reports are out of print.

In order to meet the current and future demand for this information, ODFW is offering this summary report as a substitute for the original reports. This report contains all the basic information contained in the original reports plus all the inventory data collected over the 3-year assessment project. Where the original reports were tailored for either State or county road authority use, this report contains information for both.

At some point in the near future, this summary report and all database tables will be offered electronically on the Oregon Department of Fish and Wildlife Home Page via the Internet. Contact the ODFW Fish Passage Coordinator at the ODFW headquarters office in Portland for progress on this posting.

Albert H. Mirati, Jr.
Fish Passage Coordinator
Oregon Department of Fish and Wildlife
September, 1999

Introduction

Human activities have created impediments to fish passage in Oregon streams that have reduced the number of stream miles available to salmonids (CSRI 1997). An undetermined number of road culverts present barriers to upstream migration of adult and juvenile salmonids on essentially all Oregon streams. These barriers seriously limit fish production in an unknown number of miles of historic habitat. Based on limited survey information, the problem appears to be significant and warrants investigation.

Botkin et al (1994) and the National Research Council (1996) concluded that migration barriers have substantially impacted fish populations. The extent to which culverts impede or block fish migration appears to be substantial. During fish presence surveys conducted in coastal basins during 1995, 96% of the barriers identified were culverts associated with road crossings (CSRI 1997).

Movement of salmonids throughout a watershed is necessary to meet a number of life history needs:

< Upstream migration of anadromous and resident adults to access suitable spawning areas;
< Juvenile and resident adult fish must be able to move upstream and downstream to adjust to changing habitat conditions (i.e., temperature fluctuations, high or low flows, competition for available food and cover);
< Resident fish need continuity of stream networks to prevent population fragmentation which decreases gene flow and genetic integrity;
< Catastrophic events can displace entire resident fish populations. Barriers can prevent the recolonization of these habitats.

Because there is no comprehensive inventory of in-channel obstructions on which to base a fish passage improvement program, the logical first step to improve fish passage at road culverts is to collect the required assessments. In mid-1996, the Oregon Department of Transportation (ODOT) and the Oregon Department of Fish and Wildlife (ODFW) entered into a contract (see Appendix 1) which committed ODFW to inventory, assess and prioritize for repair, all culverts associated with State- and county-owned roadways in the coastal river basins. These surveys did not include private (i.e., forest lands, residential property, etc.), federal or city roads. The contract was subsequently amended several times to include all river basins in the State.

The contract and culvert assessment effort responded to two primary incentives:

< Oregon Revised Statutes (Chapters 498 and 509) which require any person, municipal corporation or government agency placing an artificial obstruction across a stream to provide and maintain fish passage for anadromous, food and game fish species where these are present; and
< The Oregon Plan for Salmon and Watersheds (formerly the Oregon Coastal Salmon

Restoration Initiative) which identifies restoration of fish passage at artificial in-channel barriers as a high priority.

This project summary report describes:

< the inventory and assessment process in general;
< specific assessment methods used;
< criteria used to determine which culverts potentially impede passage; and
< the priority-setting process;

Process Overview

Prior to actual field surveys, possible culvert crossings were located on black-and-white copies (where available) of USGS 7.5-minute quadrangle maps obtained from the Oregon Department of Forestry, Salem. These maps had been previously modified with information from ODFW to indicate known or suspected (unverified) fish presence. Points where Afish-bearing≅ streams intersected with State or county roads (possible culverts) were marked for field inspection.[1] Project personnel then conducted on-site assessments of each intersection identified.

For each culvert failing to meet established fish passage criteria, information collected included:

UTM Coordinates
Road Number or Name
Road Mile (if known)
Roadway Owner
Stream Name and Basin
Culvert Type
Culvert Length
Culvert Diameter
Culvert Slope
Stream Slope Above
Stream Slope Below
Drop to Pool Below
Depth of Pool Below
Meets Criteria: Yes/No
Additional Comments

For culverts judged to be fish-passable, only name and location were recorded in the database

Information regarding fish species present, stream habitat quality and miles of stream above (to end of fish distribution or another blockage) were not determined at this time; these data were obtained later with assistance from ODFW field staff most familiar with the stream systems.

Methods

UTM Coordinate System

The geographic location of each culvert was fixed in two ways: (1) using Universal Transverse Mercator (UTM) coordinates (see Appendix 2 for an explanation of this system) and (2) by roadway number or name and road mile (where established). UTMs were chosen because the

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[1] In many instances, culverts were selected for assessment on streams not marked as fish-bearing if the stream appeared to the surveyor to have the potential to support fish.

degree of accuracy obtained using available maps was far superior to that obtainable using latitude-longitude or township-range-section systems. UTM coordinates are also completely compatible with GIS (Geographic Information System). Culvert locations were usually recorded in UTMs to the nearest 25 meters unless their location could be reasonably established to a closer tolerance.

State roads are usually identified by state route (highway) number and ODOT road number. County roads are usually identified by the number assigned by the subject county. In a few cases, road names were used. Whenever possible road miles were recorded to the nearest one hundredth of a mile as established in the ODOT straight-line charts or county atlas of roads. Occasionally, a stream crossing was not listed in either document, or it was unclear exactly which small tributary listed was the one in question. In these cases, road miles were approximated to the nearest 0.1 mile using odometer readings.

Fish Passage Criteria

Culverts on fish-bearing streams were evaluated against established passage criteria[2] for juvenile and adult salmonids. Parameters measured or estimated and recorded were:

- culvert diameter (inches) and length (feet);
- culvert slope (percent);
- presence/absence of a pool at the culvert outlet;
- distance (inches) of drop, if any, to the streambed or pool at the culvert outlet;
- pool depth, if present, in inches

Culvert diameter was usually measured. Where culverts were not entirely round (distended) or were arched pipe configurations, the width was recorded.

Water velocity, although a critical factor for upstream fish passage, was not measured directly. At the time of survey, flows were generally much lower than those typically encountered by adults moving upstream to spawning areas. Culvert slope is used as a surrogate indicator for possible velocity barriers in culverts.

Culvert slope was established using a clinometer whenever possible. Because this method requires a fixed point at eye level to sight on, it was occasionally impractical to use. Experience measuring many culverts, coupled with regular measurements where possible, gave the surveyors the ability to estimate slope where direct measurements were not practical. Also noted was whether slope was constant throughout the culvert length.

Generally, non-embedded metal and concrete culverts are considered impassable if the slope exceeds 0.5 to 1.0 per cent. At slopes greater than this, water velocities within the culvert are likely to be excessive and hinder passage, especially for juveniles fish.

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[2] See Appendix 3; ODFW Guidelines and Criteria for Stream-Road Crossings

Conditions at the culvert outlet were evaluated for drop (distance from culvert invert to stream below) and the presence or absence of a jump pool. If a pool was present, its depth was recorded. The general criteria for pool depth is 1.5- to 2.0-times the height of the jump (drop) into the culvert; pools shallower than this are considered inadequate for fish needing to jump to enter a culvert.

If the height of the jump (pool surface to water level in the culvert) into a culvert would exceed 12 inches during the period of adult migration, the culvert was judged inadequate for adult fish passage and listed as needing attention. If the jump was judged to be greater than 6 inches during juvenile migration periods, the culvert was judged to be a passage problem for juvenile. In many cases, estimating the effect of moderate to high flows on the height of the jump was difficult and based on limited knowledge of the particular stream in question. Seasonally passable culverts, when noted, were listed as such in the comments section of the database.

Other culvert-related factors, recorded as miscellaneous comments, include:

< whether the culvert was embedded into the streambed or contained natural substrate;
< whether water ran beneath (outside) the culvert at the upstream end (a problem for downstream migration of juvenile fish in low water) or the downstream end (often caused by holes in the culvert bottom, due to corrosion)
< fish size (juvenile, adult or both) likely to be hindered or blocked;
< other features bearing on the culvert=s condition and ability to pass fish. (presence of baffles, debris jams, trash racks, fishways, etc.)

All culverts surveyed were placed in one of 2 categories; *passable* or *deficient*, as indicated in the AOK?≅ field of the database. Culverts meeting ODFW fish passage criteria were judged to be passable (OK = Yes). Culverts failing one or more criteria were judged deficient (OK = No) and in need of maintenance or remedial construction.

Assigning Priority for Repair

Ranking deficient culverts for repair is a difficult task. Several approaches were explored with all but one rejected because one or more critical information elements were missing. In the end, each listed culvert was rated as HIGH, MEDIUM or LOW priority for repair by ODFW field staff most familiar with fish populations and habitat in each stream. The ratings indicated in the database are generally based on:

< the number and status of species present;
< population size and condition; and
< the estimated quantity and quality of habitat blocked.

No effort was made to include factors such as estimated cost of repair, proportion of passage improvement or estimated increase in production; there were too many unknowns associated with these elements.

In most cases, staff were sufficiently familiar with the relevant factors to assign a priority for repair. In some cases (usually small unnamed tributaries or headwater areas), ratings are based on uncertain knowledge and are no more than Abest estimates≅.

Data Summaries

All information collected pertaining to each culvert assessed was input into a Microsoft^8 Access^8 7.0 database for storage, sorting, display, analysis, summarization, reporting and distribution to interested parties. Summary tables appearing at the end of this report contain information on both good and problem culverts; those that meet passage criteria as well as those that do not. Electronic copies of database information are also available from the ODFW Fish Passage Coordinator.

Microsoft Access^8 7.0 Database

The following is a listing of the database fields in the culvert database printouts at the end of this report. Each parameter (units of measure, source of data, process of collection, etc) is explained below along with important limitations as to the accuracy and use of the information.

OK?--Does the culvert meet fish passage standards; YES or NO?

A ANO≅ does not mean that all fish are blocked at all flows; only that the culvert does not meet accepted fish passage criteria. The culvert probably inhibits or blocks adult and/or juvenile fish passage at some or all flows.

OWNER--the entity responsible for maintaining the culvert.

ZONE--the Universal Transverse Mercator (UTM) zone in which the culvert is located. Oregon contains 2 zones; zone 10 is to the west of 120° longitude, zone 11 to the east.

EASTING--the location of the culvert in meters east of 126° longitude.

NORTHING--the location of the culvert in meters north of the Equator.

ROAD--the State (ODOT) or county highway number (or name if unnumbered).

RM--Road mile of the culvert=s location listed in ODOT Bridge Log, ODOT straight-line chart or county road atlas. Odometer readings were used where stream crossings were not listed in these references. Points of origin for these are noted in the Acomments≅ section.

STREAM--the name of the stream containing the culvert. Names are taken from USGS quadrangle maps and information supplied by ODFW fish district personnel.

SUBBASIN--the stream or river into which STREAM flows.

BASIN--the stream or river into which SUBBASIN flows.

TYPE--the material that the culvert is composed of and the culvert=s shape. Where shape is not indicated, culverts are round. Codes used are standard ODOT abbreviations and are summarized in Appendix 6.

LENGTH--length of culvert in feet; determined from ODOT Bridge Log, ODOT straight-line chart, county road atlas or estimated by striding over the road surface.

DIAM--culvert diameter (or width if not round) in inches; determined from ODOT Bridge Log, county atlas, tape measure, or estimated.

DROP--measured or estimated distance in inches between water surface in culvert to the water surface of the stream below at the time of the survey.

DEPTH--measured or estimated depth, in inches, of the pool below the culvert (if present) during the period of migration.

SLOPE--measured or estimated slope of the culvert from horizontal, in per cent.
.
SPECIES--fish species present in the subject stream. Species suspected to be present (not verified) are enclosed in parentheses. Abbreviations used are summarized in Appendix 7.

STMMILE--estimated miles of stream above the subject culvert to (1) the verified end of fish distribution, (2) next known upstream passage barrier or (3) the end of stream as indicated on USGS 7.5 quadrangle maps. The maps used were previously modified to indicate known or suspected (unverified) fish presence. Since fish presence was not absolutely known in all cases, these figures should be considered estimates only, giving a general indication of how much stream is blocked by the culvert. Stream miles do not necessarily reflect miles of fish habitat.

HABQUAL--assessment of habitat quality by ODFW field personnel. Possible ratings are *Good*, *Fair*, *Poor*, and *Unknown* In some cases, the rating reflects firsthand knowledge of the stream. In others, the streams are not known individually and are ranked based on the raters knowledge of the area in general. When the rater was uncomfortable assigning rating because of uncertainty, a rating of *unknown* was used.

PRIORITY--ODFW district personnel rated each culvert as *High*, *Medium* or *Low* priority for repair based on personal knowledge of fish populations present and habitat conditions.

Disclaimer

Although we made every effort to trap and eliminate errors at each phase of this project, some undoubtedly were missed. With 5,500 culverts assessed, recorded and summarized in this effort, some undetected errors in determining, recording and transcribing UTM coordinates and other data are likely. If apparent errors are encountered, we wish to be informed so our records can be updated and improved. Please report any questionable data to the ODFW Fish Passage Coordinator, PO Box 59, Portland, OR 97207.

References

Botkin, D., K. Cummins, T. Dunne, H. Regier, M. Sobel, and L. Talbot. 1994. *Status and future of salmon of western Oregon and northern California: findings and options.* Report #8. the Center for the Study of the Environment, Santa Barbara, CA.

CSRI (Oregon Coastal Salmon Restoration Initiative) Plan, Draft Revision, February 24, 1997. State of Oregon, Salem, Oregon.

NRC (National Research Council). 1996. *Upstream--Salmon and Society in the Pacific Northwest,* National Academy Press, Washington, D.C.

Project: D-18: Evaluate and prioritize retrofit of potential fish passage barriers

Project Implementation Steps:

1. Select WES project manager
2. Set Goals
3. Collect Data
    a. Condition of barrier
        i. Year of installation
        ii. Purpose
        iii. Culvert Specific
            1. Diameter, length, slope
            2. Presence/absence of pool at culvert outlet
            3. Distance of drop to streambed or pool at culvert outlet
            4. Pool depth
        iv. Dam Specific
            1. Dimensions of dam and upstream reservoir
            2. Type of fish passage structure, if any
            3. Water quality and flow data upstream of reservoir and downstream of dam.
    b. Identify species and life stages affected
    c. Quality and availability of upstream habitat
        i. Review hydrologic, water quality and aquatic habitat data to determine if upstream habitat is suitable for identified species.
    d. Flooding hazards
        i. Evaluate downstream flooding effects of barrier replacement/retrofit
4. Evaluate extent of barrier using collected data, KMS and RC Characterization and Assessment Reports, ODFW Culvert Assessment, Clackamas County culvert inventory.
5. Identify preferred replacement/retrofit method and lower cost alternatives
6. Develop a fish passage barrier retrofit prioritization and rank projects
    a. Factors Affecting Prioritization – which could include cost, habitat improvements, species affected, location relative to unobstructed downstream access, potential to affect flood conditions.
7. Develop an implementation program to improve two fish passage barriers annually, working from downstream to upstream.
8. The next project would involve design of fish passage improvements. The design phase may have a new project manager and will coordinate funding, partners, engineering, permitting and construction.

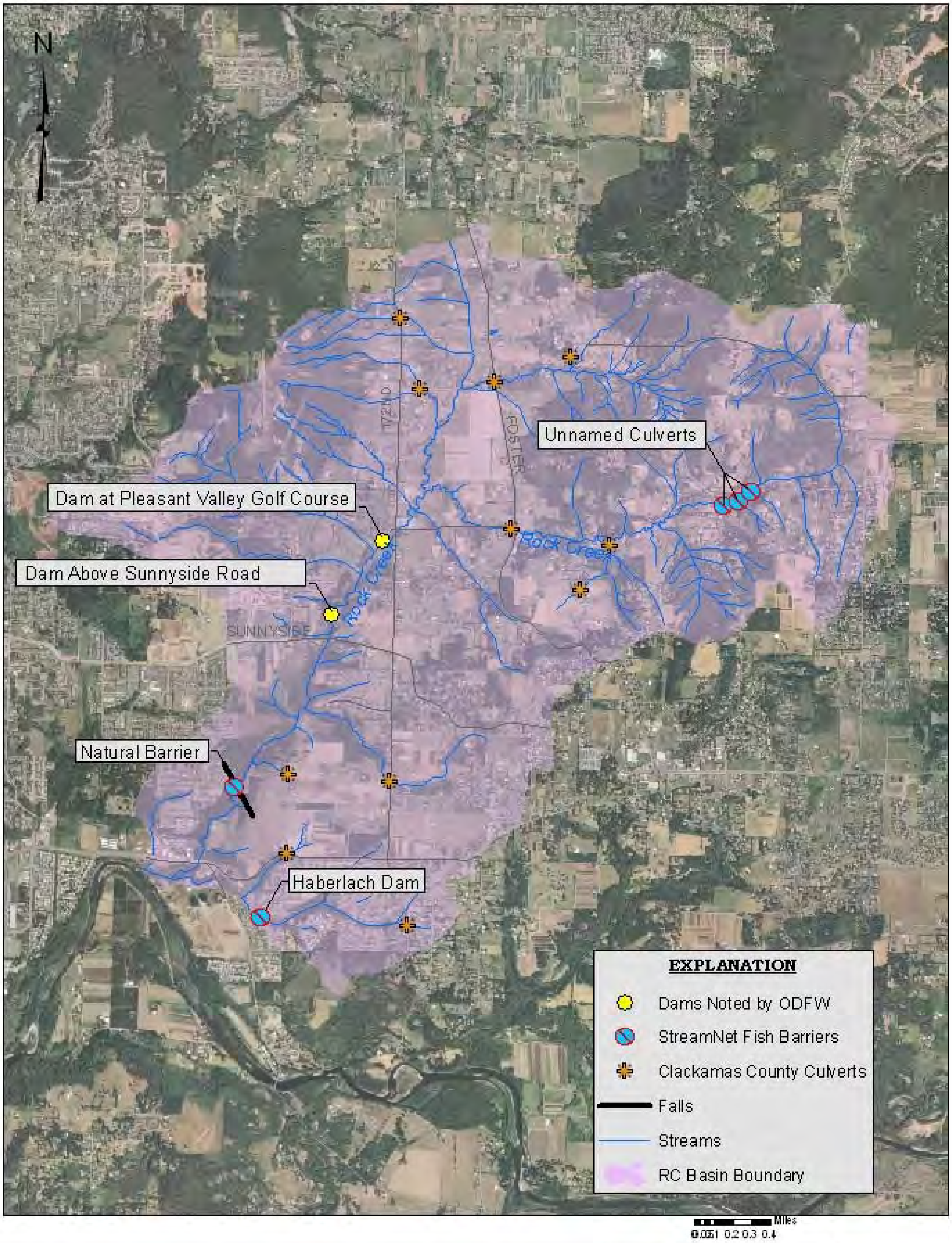


Figure 4-9
Potential Fish Barriers
WES WATERSHED ACTION PLAN

Water Environment Services

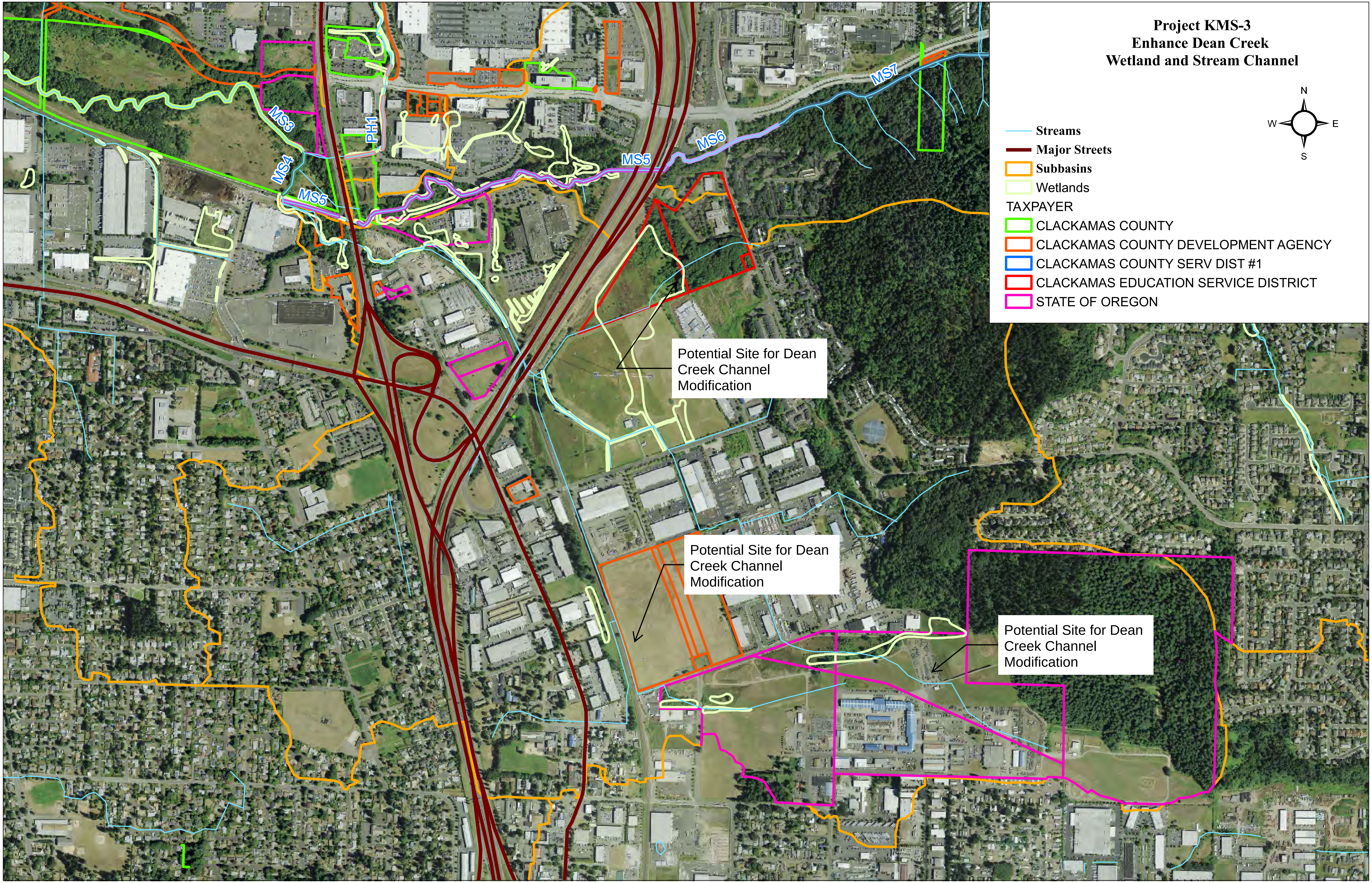
Brown and Caldwell

Swanson Hydrology + Geomorphology

Ellis Ecological Services, Inc.

ACTION KMS-3

ENHANCE DEAN CREEK WETLAND AND STREAM CHANNEL MAP



Project KMS-3
Enhance Dean Creek Wetland and Stream Channel

ACTION KMS-4

ENHANCE MT. SCOTT CREEK CHANNEL IN THREE CREEKS AREA MAP

Project KMS-4
Enhance Mt. Scott Creek Channel in Three Creeks Area

ACTION KMS-8

CCSD NO. 1 AND CITY OF JOHNSON CITY WATER QUALITY MONITORING PROJECT

ATTACHMENT #1
Clackamas County Service District #1 and City of Johnson City
Water Quality Monitoring Project

PURPOSE

The purpose of this attachment is to define the responsibilities of the City of Johnson City (Johnson City) and Clackamas County Service District No. 1 (District).

Johnson City desires to obtain water quality monitoring services from District in order to comply with their *Willamette Total Maximum Daily Load Implementation Plan* monitoring requirements.

PROJECT DESCRIPTION AND LOCATION

The project (Project) involves the collection of samples for field and laboratory analyses from two monitoring sites located in the City of Johnson City. The monitoring locations are representative of the flow at outflow of Leona Lake and a site on the west side of the city.

PROJECT COSTS

The cost of the project will be based upon time and materials and established laboratory fees. This data will be captured through the Water Environment Services Time Card and Financial Systems. Rates are adjusted annually and effective July 1.

RESPONSIBILITIES

The District Shall:

1. Collect field and lab samples at the Johnson City outfall site for 4 storm events prior to June 30, 2010. District will attempt to collect these samples during the same events when they are collecting their own samples to meet MS4 NPDES permit requirements.
2. An attempt should be made to collect lab samples represents the characteristics of the source. The time and date when these samples are collected should also be documented.
3. Analyze the composite samples in the lab for total copper, total lead, total zinc, alkalinity, total hardness, E. Coli, ammonia, nitrate and nitrite as N, total phosphorus and total suspended solids.
4. Analyze discharges in the field for specific conductivity, pH, temperature, dissolved oxygen, and turbidity. The time and date when these samples are collected should also be documented.
5. Collect adequate samples such as field blanks and duplicates in order to conduct the required quality assurance and quality control reviews of the data.
6. Provide hard copy and digital copy results of the field and laboratory analyses to Johnson City.

Johnson City Shall:

1. Submit payment to the District for Johnson City's share of the Project cost within 30 days of receipt of invoice from the District and all deliverables as described in Responsibilities above.

DISCLAIMER

Johnson City shall not be responsible for costs associated with this Project that are not specifically stated in this agreement.
Johnson City is and remains responsible for compliance with their TMDL Implementation Plan obligations; District assumes no liability regarding any fees, fines, or other costs by entering into this Agreement.

APPENDIX A

POLICIES AND PRACTICES

Water Environment Services Policies and Practices

Water Environment Services (WES) is a department within Clackamas County that conducts and manages wastewater and stormwater management services in several districts including Clackamas County Service District No. 1 (CCSD No. 1), the Surface Water Management Agency of Clackamas County (SWMACC), and the Tri-City Service District. CCSD No. 1 (the District) includes much of the Kellogg–Mt. Scott (KMS) watershed and a portion of the Rock Creek (RC) watershed. CCSD No. 1 includes an agreement with and encompasses portions of the City of Happy Valley as shown in Figure 1-2.

WES has retooled its surface water management program and is transitioning from a utility-based, regulatory driven program to an approach focused on watershed health focus and integrated watershed management. WES' vision is to improve watershed health by managing its surface water program efficiently and effectively, using financial resources to provide the most benefit through prioritized activities and investments. An organizational chart for WES is provided in Figure A-1.

Functional program elements within WES that relate to surface water management as shown in the current organizational chart are summarized below. It is important to note that as WES implements its vision to improve watershed health by managing its surface water program efficiently and effectively, changes may be made to the current organizational structure described below.

- Asset management
  - Development plan review and permitting
  - Erosion prevention and sediment control
- Water quality services
  - Stormwater system maintenance
  - Program management
- Environmental monitoring
  - Environmental permit program management
  - Laboratory operation
- Administration
  - Environmental policy and watershed health
  - Public information and outreach
- Business services
  - Customer service
- Financial services
  - Utility billing
  - Asset management reporting

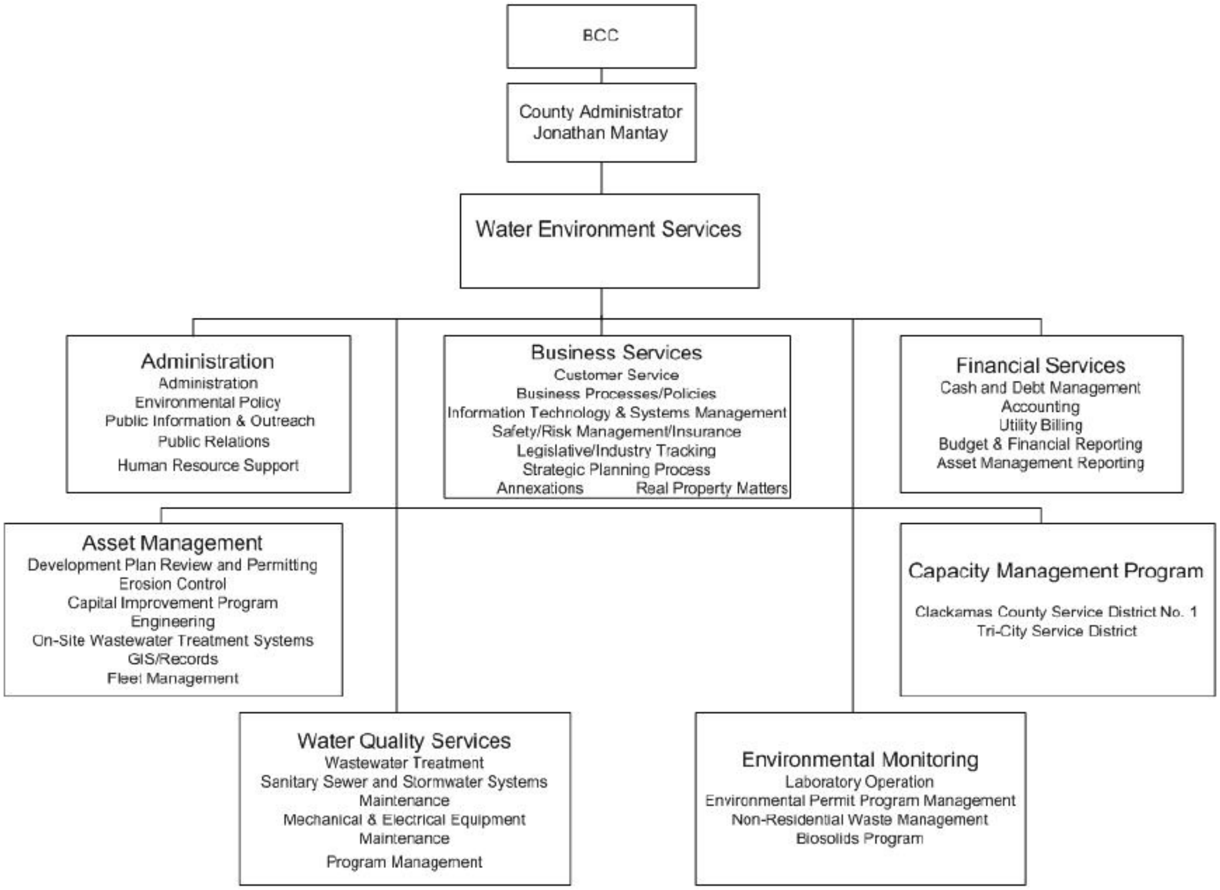


Figure A-1. WES Organizational Chart

WES currently provides stormwater management and development review services in the CCSD No. 1 service area and the western portions of Happy Valley served through an inter-governmental agreement. The purpose of the following section is to summarize existing policies and practices implemented by WES that affect watershed conditions and identify opportunities for potential improvements that will help WES to more efficiently and effectively improve and protect watershed health. These opportunities for potential improvements will be evaluated further during the assessment phase of the project, with WES staff input.

Asset Management

Asset management at WES includes the following program components: development plan review and permitting, erosion prevention and sediment control (ERCO), Capital Improvement Program (CIP), engineering, on-site wastewater treatment systems, Geographic Information Systems (GIS)/records, and fleet management.

The CIP plans, designs and builds major capital facilities in the three area Districts (CCSD No. 1, SWMACC, and Tri-City), so that operating divisions can serve district customers' wastewater and surface water needs. CIP project management includes design and construction of capital facilities and provides project controls in terms of cost, schedule, scope, program development and long range forecasting. Examples of CIP projects that affect watershed health include regional stormwater detention and treatment systems and public stormwater infrastructure projects including pipes and bioswales.

The annual process for developing CIP activities is illustrated in Figure A-2. The WES program elements submit projects to the candidate project list. Candidate projects include capacity management projects for the sewer system, surface water maintenance projects, and other projects. The need for projects is often evaluated using a criticality analysis, which is a process used to determine the potential impacts associated with completing or nor completing a given project. The candidate projects are then rated using prioritization criteria. Certain projects also go through a Business Case Evaluation to determine the optimal alternative to address a problem or issue based on life-cycle costs and benefits. Once the final project list is developed, funding options and availability are evaluated and the prioritized CIP is developed to guide project implementation.

The GIS/records program element is also an important element of asset management for watershed health. GIS is a useful tool for tracking watershed health metrics and management activities as well as analyzing information about watershed conditions. The WESworks GIS system is used by WES staff for data display and queries, such as to identify the location of stormwater assets. ArcGIS is used for data input, storage, and analysis. Opportunities are being identified to improve the efficiency and usefulness of the data that is collected by WES staff related to environmental monitoring, development review, maintenance, and erosion control. The collection, storage, display, and analysis of this data could potentially be improved with assistance from the GIS staff using capabilities in WESworks and ArcGIS.

The asset management program element includes the following WES staffing levels expressed as employee Full Time Equivalents (FTE) engaged in development review, capital projects, planning, and erosion control.

- 0.2 FTE Program Manager
- 0.5 FTE Surface Water Coordinator
- 0.2 FTE Soils Program Supervisor
- 0.2 FTE Development Review Supervisor
- 1.0 FTE Administrative Support
- 0.5 FTE Senior Civil Engineer
- 0.5 FTE Civil Engineer
- 1.0 FTE Surface Water Technician
- 1.5 FTE Plan Reviewer
- 1.5 FTE Erosion Control Inspectors
- 0.5 FTE Single Family Plan Reviewer
- 2.5 FTE for WES-related GIS work
- Additional staff through Clackamas County Department of Transportation and Development (DTD) for floodplain and miscellaneous land use issues

Development review and ERCO are discussed in more detail below.

Development Plan Review and Permitting

WES reviews development plans for installation of public sewers and stormwater systems within CCSD No. 1 and SWMACC. The development plan review and permitting process is performed by WES Development Review staff in conjunction with development review and permitting conducted by DTD and the Land Use Planning division (Planning) within DTD. The development review process includes subdivisions, partition plats, commercial and industrial development, single family residential (SFR), and other facilities that discharge into the public sanitary sewer or stormwater system. WES provides sewer and stormwater development review services for the City of Happy Valley areas within CCSD No. 1.

The development review process is a critical element of WES policies and practices that affects watershed health. The design standards and requirements for stormwater management applied by WES Development Review staff for the permitting of new development in the Districts have long-term consequences on water quality and hydrology in developed areas. These direct impacts also contribute to secondary impacts on aquatic habitat and biological communities.

This section describes the current development review process so that potential improvements to the process can be identified that may enhance WES efficiency and effectiveness in maintaining and improving watershed health. Following the discussion of the processes and the potential opportunities for improvements, this section includes a summary of the current design standards for stormwater, which are used by developers to guide the design of stormwater treatment systems included with new development.

The WES development review processes for subdivision/partition, commercial, and single family permit approval was discussed by WES staff during two workflow mapping workshops, held on October 30 and November 19, 2008. At the workshops, WES staff collaborated to revise the existing process map to reflect the actual processes for permit approval. The revised process maps are shown on Figures A-3 through A-5, and a summary of the current process follows.

Support Tools

DTD and Planning utilize Permits Plus to track permits. WES utilizes Permits Plus to approve its areas of responsibility in the permit process. For internal tracking prior to Permit Plus approval, WES utilizes Permits 2008 (or “Donworks”).

Permit Process – Planning and Plan Review

WES processes sewer and stormwater permits for subdivisions, partitions, and commercial development properties in CCSD No. 1. All of these processes go through the same initial planning and review process as shown in Figure A-3. However, when the permit is ready for approval the process for subdivisions and partitions differs from that of the commercial process. The subdivision/partition process is shown on Figure A-5, and the commercial process is shown on Figure A-4. These processes are explained in separate sections below.

The permit process starts in one of the following three ways:

1. An applicant (or owner’s representative) requests a pre-application meeting from DTD or Planning.
2. An applicant will skip the pre-application meeting request and submit a preliminary plan for feasibility directly to Development Review.
3. An applicant will submit only a construction plan if there is no approval needed for land use.

Items 2 and 3 are sub-processes within the first process. Most applicants request a pre-application meeting with County Planning, at which time County Planning will coordinate the meeting and distribute applicant information between the applicant, County Planning, and WES Development Review. At the same time, the Technical Services Assistant (TSA) will create a WES log for the permit.

After the pre-application meeting, the applicant will utilize the information obtained at the pre-application meeting to develop a preliminary plan for feasibility. This plan will be submitted to WES Development Review. If the plan is not feasible, the applicant will be informed of its deficiencies and will resubmit when complete. If the plan is feasible, the applicant will be asked to submit a land use application to County Planning. County Planning will then review the application, and once Planning deems the application is complete, Planning will send out requests to Clackamas County departments for comments and conditions. WES Development Review will then review the application and recommend permit conditions related to stormwater and sewer.

Planning will then take WES' conditions and select which conditions to incorporate into an overall set of conditions for the applicant. At this time, Planning can choose to accept or deny the application. If Planning denies at this time, the applicant must start the process over. If Planning approves the application with the conditions, the applicant can submit a construction plan. The construction plan is routed to the TSA. The TSA will determine if the submittal package for the construction plan is complete, if it is not complete, the TSA will request the needed information from the applicant. If it is complete, TSA will log the submittal, pass it onto Development Review, and request fees from the applicant.

WES Development Review will then review the sanitary, storm, natural resources, ERCO, conditions of approval, conservation, easement, collections sewer charge, and maintenance agreement portions of the construction plan and determine if it is ready for approval. The stormwater portions of the construction plan are designed based on the WES Design Standards for Stormwater, which require stormwater treatment systems to address both water quality and water quantity. These are discussed in detail at the end of this section.

WES Development Review previously conducted a buffer review process during the construction plan review to implement the natural resource buffers requirements in the design standards. This responsibility is being transitioned to Planning in early 2009 and the buffer requirements are being updated to be consistent with new requirements from Metro.

If the construction plan is not ready for approval, the applicant will be notified to address deficiencies. If it is ready for approval, separate processes will be followed depending on whether it is a subdivision/partition project or a commercial project. Detailed descriptions for both are provided below.

Subdivision/Partition Permit Process

If the applicant is developing a subdivision or partition, after the construction plan is ready for approval, the TSA will schedule a pre-conference meeting, issue an approval letter and sanitary permit, and approve the permit in Permits Plus. Meanwhile, the applicant will submit a plat to Planning. The plat process will occur concurrently with the construction process.

After the pre-conference meeting, ERCO will conduct the initial ERCO inspection (see ERCO process below). The applicant will then construct the project and ask for an engineering inspection once complete. Once complete, the applicant will submit a package to WES including a completion certificate, as-built drawings, and testing information. Development Review will review the submittal for completeness. If it is not complete, the applicant will be asked to address the deficiencies. Once complete, Development Review will perform an on-site inspection and review the file. If the information is not complete or the project was not constructed as designed and permitted, the applicant will again be asked to address deficiencies. Once complete, Development Review will send an acceptance letter to the applicant, and send mylars to GIS as well as field and asset information to the Finance department. At this time the warranty bond release will be established.

Concurrent with the construction process, the applicant will submit a plat for review. WES' Development Review staff will review the plat including the maintenance agreement, conservation, easement, and collection sewer charge. If the plat is not complete, the applicant will be asked to supply needed information. Once the plat is complete, WES will determine if it is acceptable. If it is not acceptable, the applicant will bond the project or complete it to WES' acceptance level. Once accepted, the plat will be approved in Permits Plus and the maintenance agreement will be forwarded to a surveyor. At this time the infrastructure will be inspected for completeness. If the infrastructure is complete, the developer is ready to start the single family permit process (see Single Family Permit Process below). If the infrastructure is not complete, WES will hold the permit until construction is completed and accepted per the construction process described previously.

Commercial Permit Process

If the applicant is developing a commercial project, after the construction plan is ready for approval, the TSA will approve the permit in Permits Plus and set up a customer account. A pre-conference meeting is not currently required.

At this point, ERCO will conduct the initial ERCO inspection (see ERCO process below). The applicant will then construct the project and ask for an engineering inspection once complete. Once complete, the applicant will submit a package to WES including a completion certificate, as-built drawings, and testing information. Development Review will review the submittal for completeness. If it is not complete, the applicant will be asked to address the deficiencies. Once complete, Development Review will perform an on-site inspection and review the file. If the information is not complete or the project was not constructed as designed and permitted, the applicant will again be asked to address deficiencies. Once complete, Development Review will approve the certificate of occupancy in Permits Plus and send mylars to GIS as well as field and asset information to the Finance department. At this time the TSA will bill the applicant and archive the associated files.

Single Family Permit Process

WES processes permits for single family home construction in the Districts and for Happy Valley. The single family permit process for the Districts is shown in Figure A-6. The single family permit process for Happy Valley is shown in Figure A-7. The process described below is for single family development in the Districts. The Happy Valley process is similar, however, there is further coordination between WES and Happy Valley and Happy Valley is responsible for administering erosion control within the city limits.

Single family applicants can come in as individual land owners or as part of a subdivision/partition development. The single family applicant or owner's representative will submit the permit to WES through the DTD, this will then be routed through the TSA who will set up and account for the permit and file the permit application request in the unpaid file. The TSA will then do an initial check to see if the permit looks complete.

If the TSA finds the application package is not complete, the Development Review staff review the permit application for completeness. Items reviewed include the lot of record, sanitary, storm, ERCO/1200C, easements, and natural resources. If the application is not complete, the applicant will be told about the deficiencies and be asked to complete the application. If the application is complete the applicant will be informed and asked to pay the permit fees. Once paid, DTD will issue the permit in Permits Plus and provide receipts to the finance and WES files. At this time the application is put in the paid file and the initial ERCO inspections are performed (see ERCO process below).

After construction, DTD will perform plumbing inspections and WES performs final ERCO and stormwater inspections. If the site does not meet inspection requirements, WES will provide feedback to the applicant and the applicant will make adjustments to the site. If the site passes the inspections, an acceptance report is developed along with associated drawings. A copy of the report and associated drawings are sent to both the applicant and to the TSA for final filing.

Current Issues/Problems

Current issues and problems with the Development Review processes identified by staff members at the October 30 and November 19 workshops include the following:

- The permit process is not performed consistently throughout Clackamas County causing inconsistency in permit application completeness.
- The Permits Plus system is good for plats and other systems, but WES cannot use it for its internal tracking and therefore uses Permits 2008.

- Planning does not check the GIS consistently to see if applications are in or out of District boundaries and thus sometimes WES is not involved in process early enough.
- The City of Happy Valley has identified a concern about the buffer review process no longer being conducted by WES during the development review process. This process is being transitioned to County Planning for development in the Districts in early 2009. Happy Valley is concerned about the length of time it may take for Planning to conduct the buffer review process for development in the City.

Opportunities for future improvements of updated design review processes were discussed by WES staff during the workflow mapping sessions. In addition, opportunities for future improvements were proposed in the 2006 Master Plan. Potential opportunities for process improvements to be evaluated further in the Assessment Report include the following:

- Set thresholds for development size, location, or other factors that establish when the pre-application process is required
- Update design standards and rules; create simpler standards where feasible
- Consider creating a stormwater design guidance manual
- Address low impact development (LID) in design standards and encourage site design BMPs
- Clarify the infiltration policy in the design standards and address exemptions to the policy to meet the intent of the policy
- Discourage the use of underground treatment technologies as the sole treatment approach where there is sufficient above-ground area to implement vegetated treatment
- Institute a process for better coordination between WES and DTD
- Consider a process mapping session with DTD
- Develop a routing system with points of contact for each project
- Develop a simpler way to determine if projects are within WES boundary
- Improve clarity around as-built drawing standards
- Institute a process that all commercial permits are reviewed by WES
- Provide training and education for Planning on WES' requirements
- Review alternatives for coordination systems between WES and Planning
- Determine appropriate information to share on-line, such as as-built drawings
- Include WES inspection during construction
- Review plan review fee for appropriateness
- Consider a grading approval requirement for single family development
- Consider more electronic processes in future
- Add a pre-design meeting following land use decision

Stormwater Design Standards

As discussed above, the development review process is a critical element of WES policies and practices that affects watershed health. The design standards and requirements for stormwater management applied by WES Development Review staff for the permitting of new development in the Districts have long-term consequences on water quality, hydrology, aquatic habitat, and biological communities. The creation of impervious surfaces, removal of vegetation, and modification of topography during development alters hydrology and creates pathways for pollutants to enter waterbodies. The requirements for stormwater treatment, site design, and site construction in the design standards are a key aspect of WES' work to protect and improve watershed health.

This section summarizes the current design standards in the Districts, which are used by developers, engineers, and contractors to guide the design of sites and the stormwater treatment systems included with new development. This summary is focused on elements of the design standards that affect watershed health, and is not intended to be a complete documentation of the current standards. In the assessment phase of the project, potential improvements to these design standards will be evaluated and recommendations will be developed to include in the Action Plan.

As a part of the 2006 Master Plan, an evaluation of the WES Stormwater Regulations and Design Standards was conducted. Technical Memorandum No. 8 of the Master Plan, "Stormwater Regulations and Design Standards Review" (Pacific Water Resources, August 23, 2005) reviewed the current regulations and implementation of the development review process.

Several of the key recommendations from the Master Plan included the following:

- Develop stormwater design guidance manuals
- Utilize LID techniques in stormwater design standards
- Discourage or prohibit the use of underground treatment technologies as the sole treatment approach where there is sufficient above-ground area to implement vegetated treatment
- Clarify the District policy on infiltration of stormwater to address varying soil conditions and exemptions to the policy more fully in order to meet the intent of the policy
- Review detention facility design and outlet criteria to better control smaller storms
- Review the hydrologic design criteria and consider using a flow-duration based standard instead of a single-event based standard

The recommendations and conclusions from the Master Plan will be incorporated into assessment of the watersheds as appropriate along with additional recommendations developed during the assessment. Some recommendations from the technical memorandum will be moved forward and others may not be incorporated into the Action Plans.

Stormwater is managed by WES using two documents: the *Surface Water Management Agency of Clackamas County Rules and Regulations* (December 15, 2002) and the *Surface Water Management Rules and Regulations for Clackamas County Service District No. 1* (February 1, 2005). These are referred to as the SWMACC Standards and CCSD No.1 Standards.

The Standards for both Districts are largely the same. Key elements of the Standards include:

- Under 5.2.4 Onsite Detention Design Criteria, CCSD No. 1 requires detention of the 25-year 24-hour post development flow to the 2-year 24-hour flow in areas with limited downstream capacity in the storm sewer system.
- CCSD No. 1 Standards contains Section 5.3 Water Quality Standards that requires treatment of two-thirds of a 2-year, 24-hour post development storm. The SWMACC Standards contains a larger Section 6 on Permanent Onsite Water Quality Facilities.
- All development and redevelopment must include a system for controlling storm/surface water within the development without causing harm to the natural environment or to property or persons (Section 5.1.1.3). Some exemptions are provided for SFR development.

- Infiltration systems are required for all new development and redevelopment. Infiltration systems must be able to infiltrate runoff from storm events up to 1/2 inch of rainfall in 24 hours (Section 5.2.6). Treatment must be provided prior to or concurrent with the infiltration system; for example, infiltration can be incorporated into detention facilities. Exceptions to the infiltration requirement are allowed where soil conditions are not adequate for infiltration.
- Water quality treatment using vegetated treatment systems is required for all new development and redevelopment (Section 5.2.6). Acceptable vegetated treatment facilities are: swales, filter strips, wetlands, wet ponds, and extended detention basins. Design criteria for these facilities are provided in Appendix D of the CCSD No. 1 Standard Surface Water Specifications.
- Proprietary mechanical stormwater treatment systems may also be used with approval from the District. Currently approved propriety systems include Stormceptor, CDS, Downstream Defender, Vortechnics, and Stormgate Separator.

Following is a more detailed bulleted summary of the Standards for both Districts.

General Requirements

- Introduction of pollutants to public system at or above state levels is prohibited.
- Failure to abide by terms of the National Pollutant Discharge Elimination System (NPDES) permit is prohibited.
- Discharge of non-stormwater spills is prohibited.
- Unpermitted connection or methods of conveyance are prohibited.
- Any discharge that will violate water quality standards is prohibited.
- Discharge to Creeks or Drainageways or encroachment into buffer areas is prohibited. Non-SFR development shall provide approved release water quality facility prior to any discharge.
- Pretreatment facilities can be required prior to water quality facilities.
- A connection permit is required to connect to any public storm drain or system.

Erosion Control

- Temporary and permanent erosion control measures are required for all construction projects.
- Temporary measures must remain in place until permanent measures are in place.
- Erosion control rules apply to all parcels within the District.
- Maintenance and repair of existing facilities are responsibility of the owner.
- Any activity accelerating erosion and introducing sediment into the public system including development, construction, grading, filling, excavating, and clearing must abide by these rules.
- No visible or measurable erosion shall leave the property during activity.
- Owner is responsible for cleanup including creeks and drainageways impacted from project.
- Erosion control permits are required for all earth altering activities that impact areas 800 square feet or greater.
- All sites shall submit an Erosion Control Plan. Requirements for Erosion Control Plans are contained within the Standards.
- Site Plans are required for all activities that meet Oregon Administrative Rules 340-41-445 through 340-41-470.
- Site Specific Plans are required if the site meets one of the following conditions: greater than 5 acres; on 15 percent slope or greater; contains highly eroded soils; adjacent to sensitive areas; or activities that occur between October 1 and April 30.

- All activities greater than 5 acres must obtain a 1200C permit.
- Applicant must submit bond, cashier 's check, or irrevocable letter for performance.
- Discount is applied if responsible party is certified for erosion control.
- Applicant is responsible for maintenance and inspection of erosion control measures.
- Discounts are available for owners whose responsible individuals are certified by the District.
- Construction must be initiated within 1 year of the date of issuance and permit will become null and void 24 months after the date of issuance unless extended by the Director.
- 1200C permits must be renewed annually as per the schedule set forth by the Oregon Department of Environmental Quality (DEQ).

Maintaining Water Quality

- Construction of new facilities shall be pursuant to permits issued by state and federal permits.
- Pollutants shall not be discharged to any watercourse or storm drainage system.
- The use of water from a stream or impoundment, wetland, or sensitive area shall not result in altering the temperature or water quality.
- All sediment-laden water shall be treated before release into the surface water system.
- Construction shall be done in a manner to minimize adverse effects on wildlife and fishery resources.
- Natural vegetation shall be protected as far as is practicable and trees shall be protected.
- The use of pesticides, fertilizers, and chemicals must adhere to restrictions and must be covered at the site and delivered in a method that will not pollute groundwater or surface water.
- If contaminated soils are discovered, the remediation actions must meet all local, state, and federal regulations.

General Standards

- All development shall be planned, designed, constructed, and maintained to protect natural drainage areas, protect property from flood hazards, and provide a stormwater management system that controls surface water without causing harm to the natural environment.
- Easements shall be provided for all natural drainageways on a development site.
- Channel obstructions are not allowed except with approval.
- Facilities shall be constructed in a manner consistent with the sub-basin management plan.
- All facilities shall be built to the District's specifications.
- Inspection of surface water facilities and approval of shop drawings shall be provided by the developer's engineer. Engineer shall submit document indicating all facilities are inspected.
- A maintenance program must be approved by the District.
- As-built drawings, easements, and approved maintenance programs must be provided to the District.
- All surface water facilities shall have adequate easements for construction, operation, and maintenance. Commercial or industrial users must maintain facilities.
- Proof of maintenance shall be submitted annually. District can perform maintenance and charge owner.
- All plans and calculations must be stamped and signed by a licensed civil engineer.
- The performance bond is released when a maintenance bond of 25 percent of construction cost is submitted. The maintenance bond can be released after 1 year.

- All developments and redevelopments must meet requirements.
- Development properties cannot be phased to avoid rules and regulations.

Water Quantity Standards

- All facilities up to 10 acres of land must be sized for the 10-year storm using the rational method.
- Storm sewer and outfall pipes serving less than 640 acres shall be designed to the 25-year, 24-hour design storm.
- Storm sewer and outfall pipes serving 640 acres or greater shall be designed to the 50-year, 24-hour design storm.
- Creek or stream channels draining less than 250 acres shall be designed to the 25-year, 24-hour design storm.
- Creek or stream channels draining 250 acres or greater shall be designed to the 50-year, 24-hour design storm.
- Creek or stream channels draining 640 acres or greater shall be designed to the 100-year, 24-hour design storm.
- Rational method shall be used for areas 10 acres and less. Alternative method may be used for larger areas.
- The drainage system shall be designed for all water on site including water entering the site.
- No drainage will be allowed into the street where a drainage system is available without connecting to the drainage system.

Onsite Detention Design Criteria

- Stormwater quantity detention facilities shall be designed so the 2-year, 24-hour post developed runoff rate matches half of the 2-year, 24-hour pre-developed discharge rate.
- Downstream analysis shall demonstrate adequate conveyance capacity where the project site contributes less than 15 percent of the upstream area or 1,500 feet downstream, which ever is greater. Owner must notify other jurisdictions if this analysis crosses a boundary.
- For residential subdivisions and partitions of parcels with the potential to create more than two lots or more than 5,000 square feet of impervious surface, on-site stormwater detention, treatment, and infiltration is required. For two- and three-lot partitions that cannot be further portioned under current zoning, detention and treatment is not required.
- Infiltration facilities are required where soil permits.
- Open detention facilities shall be planted per the Metro Native Plant List.

Onsite Detention Design Method

- Designer should use King County Surface Water Design Manual for sizing procedures.
- Sizing shall be based on the amount of impervious surface.
- Redevelopment shall require detention for all area impacted by construction.
- Subregional facilities are encouraged and can serve more than one development.
- The drainage system shall be designed for all water on site including water entering the site.
- Infiltration facilities are required where soil permit, volume must be available again in 96 hours.

Natural Resource Protection

- A study to identify sensitive areas can be required by the District when a parcel may contain sensitive lands or the parcel has inventoried sensitive areas.
- New development adjacent to sensitive areas shall maintain an undisturbed buffer to protect the water quality function. The buffer width is listed in Table A-1. *(Note: The buffer requirements are currently being re-evaluated by County Planning to be consistent with Metro requirements.)*
- Starting point for measurement is either the bankfull stage or 2-year storm level for streams and the Oregon Division of State Lands–approved delineation for wetlands.
- No construction, outfalls, or energy dissipation can occur in buffer area.
- The only activities that can be conducted in sensitive areas but must be approved by the District and state agencies are removing non-native vegetation, and building a road crossing to provide access over sensitive areas, utility crossing, a walkway, or bike path.
- A home owner may protect property from erosion if within the limits of state and federal regulations.
- The District may require fencing of buffer areas.

Table A-1. Buffer Area Requirements in 2008

Sensitive area	Upstream drainage area	Slope adjacent to sensitive area	Width of disturbed buffer, feet
Intermittent creek, rivers, streams	Less than 50 acres	Any slope	25
Intermittent creek, rivers, streams	50 to 100 acres	< 25 percent	25
Intermittent creek, rivers, streams	50 to 100 acres	≥ 25 percent	50
Intermittent creek, rivers, streams	Greater than 100 acres	< 25 percent	50
Intermittent creek, rivers, streams	Greater than 100 acres	≥ 25 percent	100 to 200
Perennial creeks, rivers, streams	Any upstream area	< 25 percent	50
Perennial creeks, rivers, streams	Any upstream area	≥ 25 percent	100 to 200
Wetlands, lakes (natural), springs	Any drainage	< 25 percent	50
Wetlands, lakes (natural), springs	Any drainage	≥ 25 percent	100 to 200

Erosion Prevention and Sediment Control

The erosion prevention and sediment control program (ERCO) is intended to prevent erosion and improve sediment control at construction sites and existing stormwater facilities within WES jurisdiction, including CCSD No. 1, SWMACC, Boring, Hoodland, Gladstone, and all 1200C permit sites in Clackamas County. 1200C permit sites are sites where construction activities disturb one or more acres of land, including smaller sites that are less than one acre that are part of a larger common plan of development.

Erosion prevention and sediment control are very important to watershed health. Uncontrolled erosion at construction sites can contribute heavily to water quality problems including poor water clarity, high pollutant loads, damage to aquatic habitat, and maintenance problems in the storm drainage system from sediment deposition in pipes, catchbasins, culverts, outfalls, ponds, and swales.

The following documents provide information on erosion control and prevention programs, rules, regulations and processes:

- Erosion Prevention and Sediment Control Design and Planning Manual, 2000
- CCSD No. 1 *Surface Water Management Rules and Regulations* (CCSD No. 1 Standards discussed above)
- SWMACC *Surface Water Management Rules and Regulations* (SWMACC Standards discussed above)
- Section 2 of the Surface Water Management Administrative Procedures
- New Construction Erosion Control Permit Process Map
- Grading Process Map

The WES process for erosion control permitting and inspecting for new construction sites was discussed by WES staff during two erosion control workflow mapping workshops, held on October 31 and November 19, 2008. At the workshops, WES staff collaborated to revise the existing process map to reflect the actual process for new construction permits. The revised process map is shown in Figure A-8, and a summary of the current process follows.

Grading permits are also an element of the erosion control permitting process; in that erosion control inspections are completed as enforcement for grading permits. Figure A-9 shows the current grading permit process. The grading permit process regulates and controls excavation, grading and earthwork construction, including fills and embankments for issuance of permits. It also provides for approval of plans and inspection of grading construction. Whether or not a permit is required, all excavation and grading must conform to Clackamas County Code requirements, and must control erosion and protect adjacent properties.

Support Tools

The Internal Voice Recognition (IVR) system is a tool used by WES inspectors to schedule and update the status of erosion control permits, the process of which is described in the following section.

New Construction Erosion Control Permit Process

WES currently provides erosion control services for development in CCSD No. 1, SWMACC, Boring, Hoodland, Gladstone, and in and out of district 1200C permits. From July 2007 through June 2008, 817 erosion control permits were issued and 2,046 inspections were performed by CCSD No. 1 with 1.5 FTE. Happy Valley took over responsibility for administering the erosion control program within its city limits in 2005. Happy Valley performed 215 erosion control inspections from July 2007 to June 2008.

The erosion control permit process is initiated when the owner or owner's representative sends permit information to ERCO personnel in Development Review. Following receipt of the application, a permit specialist identifies the type of permit needed, and depending on the location of construction and site size, issues a local erosion control permit or a 1200C permit.

Erosion control inspectors enter the process once the permit has been issued. When invited by Development Review, inspectors attend a preconstruction meeting to discuss appropriate erosion control measures. If in attendance at the preconstruction meeting, the inspectors make a field visit to verify site conditions with the owner's representative. If not invited, their first inspection is triggered by approval of the ERCO plan. All inspection results are recorded using IVR.

Following the initial site visit, erosion control inspectors make a mental note of site conditions, and have the option to make future unannounced site visits as they see fit. Site conditions of consideration include the time of year, developer history, location, seasonal impact, watershed, complaints, site severity, and phase.

If the developer is not meeting erosion control permit requirements, an inspector can request improvements and re-inspect to determine if improvements have been made. If the developer fails to meet the permit requirements again, an inspector can call for a stop of work and require reinspection fees. Erosion prevention and sedimentation control measures must be approved before work is allowed to restart.

Once the developer has completed work, a final inspection is conducted by a WES erosion control inspector. Results of the inspection are entered into IVR. If the final inspection does not pass, corrections must be made to the site. After passing the final inspection, the developer is issued a final permit and is asked to close out the project. Currently permits have no set expiration date, and if a permittee does not close their permit, it stays in the WES database indefinitely as an open permit.

Complaint-Driven Inspection and Maintenance

To maintain quality service to its customers, WES accepts call-in and over-the-counter complaints from the public with regard to erosion problems. Following receipt of a complaint, the receiver updates the WES maintenance management system. WES does not currently have an erosion control hotline phone number that is posted at construction sites to facilitate public reporting of erosion control problems, although such a hotline posting requirement is being considered for the future.

More information on the maintenance process is below.

Current Issues/Problems

Current issues and problems with the erosion control process, identified by staff members at the October 31 and November 19, 2008 workshops include the following:

- Ground breaking sometimes occurs prior to erosion control plan review and/or initial inspection.
- Erosion control plans submitted to WES do not always match site conditions, which are thought to be the consequence of the erosion control plan designer lacking familiarity with site conditions.
- No occupancy permit is required for single family housing.
- The owner's representative (permittee) does not close the erosion control permit.
- When are sewer and storm system development charges (SDCs) collected? When is the water fee collected?

Opportunities for future improvements of the New Construction Erosion Control Permit Process were discussed by WES staff during the workflow mapping sessions. Potential opportunities for process improvements to be evaluated further in the Assessment Report include the following:

- Institute erosion control hotline
- Keep erosion control in preconsultation process
- Have erosion control inspection prior to groundbreaking with owner's representative
- Have as precursor to issuing the permit
- Consider implementing a fine for owners who start construction without erosion control inspection
- Do a field check of the erosion control plan prior to permit issuance
- Erosion control permit sunset—enforce limit
- Issue a permit instead of a receipt for local permit
- Forgo minor revisit step
- Develop formal rating system for site monitoring schedule based on criticality/geographical sensitivity
- Tie erosion control to grading permit, if applicable
- Establish level of service for erosion and grading control

- Perform field visit on all non-single family projects prior to initial inspection
- Track more information about inspections and conditions in Permits 2008 and/or IVR
- Consider having owner's representative call to schedule field visit

Stormwater System Maintenance

The WES Stormwater Maintenance program is responsible for the maintenance of all stormwater assets within the public right-of-way in the Districts, with the exception of assets that are the responsibility of the Clackamas County Department of Transportation and Development (DTD) or the Oregon Department of Transportation. The WES Stormwater Maintenance program is responsible for inspecting and maintaining detention ponds, and pipes, vortex separators, pollution control systems, catch basins, manholes, open channels including natural drainage features, and public underground injection controls (UIC) systems.

The stormwater maintenance crew primarily inspects sites and prescribes maintenance work. Most field maintenance is performed by the sanitary maintenance crew.

As of 2008, WES stormwater maintenance is currently responsible for the following:

- 304 miles of stormwater pipe
- 23,000 storm structures including catch basins and manholes
- 262 detention ponds
- 700 detention pipes
- 31 treatment facilities (swales and underground devices)

Maintenance Staff and Equipment Statistics:

- 0.2 FTE Program Manager
- 2.0 FTE Surface Water Technicians
- 3.3 FTE Collection System Technicians
- 1.2 FTE Seasonal Employees
- 1.0 FTE contracted with DTD
- Use of two fully-equipped maintenance utility trucks
- Use of combination vacuum/hydrocleaner trucks (Vactor trucks)
- Use of regenerative air sweepers (for street sweeping)
- Use of pipe video equipment

Maintenance is performed primarily for cleaning and to ensure structural integrity. Catch basins, pollution control manholes, and other debris capturing structures are cleaned periodically to remove sediment, pollutants, debris, and other materials before they gain entrance into the storm system pipes and discharge to receiving waters. WES is directly responsible for maintenance in the maintenance agreement areas (generally all subdivisions constructed since 1998, including a large number in Happy Valley) and the storm sewer pipe network in the District. WES also began additional maintenance in the CCSD No. 1 road rights-of-way several years ago, although there is a lack of clarification of the responsibilities for stormwater infrastructure maintenance on Clackamas County roads.

In the maintenance agreement areas, which include over 240 subdivisions, WES collects a maintenance fee in addition to the standard surface water management fee from property owners. In other areas, the owners of stormwater treatment facilities and equipment are responsible for stormwater maintenance. However, WES has in the past stepped in and cleaned or serviced stormwater equipment or treatment systems in emergency cases even when they are not responsible for the asset.

Below is a summary of the maintenance activities conducted in CCSD No. 1 and Happy Valley as reported in the July 2007 to June 2008 Annual Report for the NPDES Municipal Separate Storm Sewer System (MS4) permit.

- 1,206 structures 108 ponds, and 275 feet of storm line were inspected and/or cleaned
- 14.69 tons of material was removed from the non-pipe storm drainage components and 2.75 tons of material was removed from the storm drain pipes
- 3,801 feet of storm drain ditches were maintained and 546.6 tons of material was removed
- 757 miles of streets were swept in the KMS watershed by DTD (1,292 miles of streets swept and 840 cubic yards of material removed in all of CCSD No.1)
- 83 miles of streets were swept in the Rock Creek watershed by DTD
- 105 miles of streets were swept and 50 cubic yards of material was removed by Happy Valley

Currently maintenance activity is generated in two ways: Compliant or service request generated activity and maintenance activity generated from the inspection of facilities. Other responsibilities of the maintenance staff include the inspection of facilities, the review of new development submittals for maintenance feasibility, and the acceptance of the facilities associated with new development.

WES is just beginning to develop its preventive maintenance (PM) program for stormwater assets. Data has been populated in the computerized maintenance management system (CMMS) for the past 14 months and an inspection system has been started. Currently, only 5 to 10 percent of the residential systems have been inspected through this program, although the stormwater ponds are inspected each spring. WES also has a 4-year-old cleaning program. Every maintenance agreement subdivision for which WES has responsibility for has been cleaned at least once in this time frame, and vortex separators are cleaned every 6 months.

WES stormwater maintenance is in the process of developing predictive maintenance programs for pond condition assessment and vortex cleaning. The maintenance staff also wants to develop predictive methods for refurbishment and replacement (R&R) of assets.

Street sweeping is contracted with DTD, and WES provides requests to DTD on occasion if it knows of a troubled area. Major arterial curbed streets are swept on a regular basis. The frequency varies depending on a variety of factors such as traffic volumes. In the KMS watershed, approximately 757 miles of streets were swept by DTD in 2007. Street sweeping within the City of Happy Valley is the responsibility of the City. In October 2008, Happy Valley began sweeping all city streets once per month.

The WES processes for existing work orders, reactive requests, and new system acceptance were discussed by WES staff during two maintenance workflow mapping workshops, held on October 30 and November 19, 2008. At the workshops, WES staff collaborated to revise the existing process map to reflect the actual maintenance processes. The revised process maps are shown on Figures A-10, 1-11, and 1-12 and a summary of the current processes follows.

Support Tools

WES utilizes the GBA master series CMMS to manage assets and the maintenance program. The system is 14 months old, and WES is in the process of fully populating the system. The CMMS is linked to the WESworks GIS which provides the location for the stormwater assets. Work codes are in the CMMS, PM work orders are currently being populated in the system. WES currently has unique identification numbers for 80 percent of its assets and an asset hierarchy that can report assets at the basin level.

Existing Work Order Process

WES develops work orders for maintenance reactively during system inspections. As seen in the workflow in Figure A-10, WES stormwater maintenance staff will perform a facility inspection. If the facility looks fine, a work order will be developed documenting the inspection. If the facility has a problem, stormwater maintenance will inform the sanitary maintenance crew. This is currently done via a written request or note. The sanitary maintenance will then perform the needed work and create a work order documenting the specific asset and work that was performed. Stormwater maintenance will then review the work order and close it in the CMMS.

Reactive Request Process

WES stormwater maintenance staff perform work on a reactive basis in response to customer requests as shown in Figure A-12. In this case, a customer will call WES. The TSA will log the request in the CMMS and collect appropriate information. If the problem is not WES' responsibility, the TSA will document the call and inform the responsible party. Stormwater maintenance will receive the request and first check to determine if WES is responsible for the asset. If WES is not responsible, the request will be documented in the CMMS and the responsible party will be informed. If WES is responsible, stormwater maintenance will inspect the site. If corrective action is required, the sanitary maintenance crew will perform the corrective action and create a work order. Sanitary maintenance will document the action in the CMMS.

Note that the process documented is not currently followed in all situations. TSA will often send the request to maintenance to determine the responsibility and WES maintenance staff will perform the corrective action work first regardless of responsibility and then inform the responsible party after the correction is in place. This occurs in situations where streets or parking lots are flooded and it is easier to clean just the stormwater asset while at the site.

New System Acceptance Process

WES stormwater maintenance is also responsible for inspecting and accepting new stormwater assets from new development into the system. In this process, graphically depicted in Figure A-11, Development Review will inform stormwater maintenance of a new system. At the same time, Development Review will document the start of a 2-year warranty period.

Stormwater maintenance will perform an acceptance inspection. If the system is not acceptable, the applicant will be informed and asked to address deficiencies. If the system is acceptable, as-built drawings will be submitted to Development Review and GIS will assign an asset number, scan the as-built drawings, and document information in the CMMS. If the system is commercial or private, WES is no longer responsible for maintenance. Otherwise, as-built drawings are sent to stormwater maintenance and a work order is set up to notify maintenance to do an inspection after the 2-year warranty has elapsed.

After 2 years, stormwater maintenance performs a warranty inspection. If the asset is clean and ready for acceptance, WES maintenance will accept the asset and notify Development Review. If not, the applicant will be asked to clean and/or repair the asset until it is ready for acceptance.

Current Issues/Problems

Current issues and problems with the maintenance processes identified by staff members at the October 30 and November 19, 2008 workshops are include the following:

- Current maintenance is reactive; PMs are being developed but are not complete yet.
- Responsibilities have not been fully defined for various maintenance activities including street sweeping. It is unclear what facilities in the roadways DTD is responsible for and for what facilities WES is responsible.
- Some private systems are in the CMMS and are not distinguished as being private versus those belonging to WES.

- Many stormwater treatment systems are mapped in GIS, but there is no current way to tell which systems are WES'.

Opportunities for future improvements of the updated maintenance processes were discussed by WES staff during the workflow mapping sessions. Potential opportunities for process improvements to be evaluated further in the Assessment Report include the following:

- Set up proactively PM for structure/system upon the inspection after the warranty period.
- Consider tying commercial maintenance plan to assets in the CMMS/GIS.
- Consider enforcement for the commercial and other maintenance agreements that WES is not responsible for.
- Identify which catch basins are associated with UICs in CMMS or GIS.
- Do a criticality assessment on structures and systems for prioritizing the new PM program.
- List, map, and prioritize wet weather flow areas.
- List and map emergency response areas.
- Develop projections for a long-term R&R program.
- Consider revising inspection to 2-year warranty or 90 percent build-out.
- Revise the detail of the planting plan standards.
- Consider limiting planting around ponds and surface water structures to non-problematic trees—develop appropriate planting list (no cottonwood, poplar).
- Require better irrigation and replanting at end of warranty period.
- Consider a zoning system for where to plant the selected list of plants and trees.
- Have detailed list for the inspection.
- Involve maintenance further in the design standards process to review access issues, flow/diversion considerations, hatches versus manholes, and address asset ownership issue. Maintenance currently has an opportunity to comment on submitted construction plans, but due to resource limitations as well as issues with lack of notification about plans they generally are not able to review plans in a timely fashion.
- Create work orders for sanitary for storm drain inspection.
- Utilize inspection to create PM schedule.
- Track Warranty Bond Period in CMMS and enter Warranty when as-built drawings are received.

Environmental Monitoring

The WES Environmental Monitoring program is responsible for tracking, reporting, and in some cases, managing environmental conditions associated with surface water, stormwater, and treated wastewater in order to meet regulations and permits as well as WES program objectives. The Environmental Monitoring program includes environmental permit program management, laboratory operation, non-residential waste management, and a biosolids program.

The Environmental Monitoring Program includes the following staff:

- 0.2 FTE Program Manager
- 0.6 FTE Water Quality Analyst
- 0.2 FTE Sample Collection (through Compliance Services)
- 0.2 FTE Additional staff performs spill response, laboratory analysis on samples and maintains continuous surface water monitoring equipment

The Environmental Monitoring program staff have conducted internal workflow mapping exercises during 2008. The following figures illustrate the process maps developed during these internal exercises:

- Figure A-13: Sampling and water quality monitoring
- Figure A-14: Source control inspections and complaint driven inspections of industrial and commercial stormwater facilities.
- Figure A-15: MS4 and total maximum daily load (TMDL) annual report
- Figure A-16: Illicit Discharge, Spill Response, and Non-stormwater Discharges process
- Figure A-17: MS4 Permitting, 1200Z, UIC permit renewal process
- Figure A-18: Storm Drain Cleaning Assistance Program

These processes are part of the environmental permit program management element within WES. The environmental permit program management element is an important part of WES' work to comply with the Clean Water Act (CWA), other regulations, and for the protection and improvement of watershed health. This element is discussed in detail below.

Environmental Permit Program Management

The environmental permit program management element of WES is responsible for managing several permits, including the NPDES MS4 permit and the UIC requirements. The MS4 permit program is one of the key regulatory tools used to address the stormwater impacts from urban development. The UIC program regulates the discharge of stormwater below ground. This section includes a summary of the evolution of the MS4 discharge permit program requirements and of the watershed management activities and monitoring implemented by WES as a part of the MS4 permit program, as well as a summary of the UIC program. Most of the KMS watershed is included in the MS4 permit area.

Most parts of the MS4-permitted surface-discharging storm sewer system are comprised of piped storm sewers, but some swales and open ditches are also present. Many privately owned surface discharging storm sewer systems are present near the District's MS4-permitted systems. These privately-owned surface-discharging storm sewer systems are not regulated by the District's MS4 permit.

NPDES MS4 Permit Background. In the early 1990s, the CWA required municipalities with populations greater than 100,000 to apply for and obtain an NPDES permit for their stormwater discharges under Phase 1 of the MS4 permit program. In Oregon, this program was delegated to DEQ. As a result, DEQ directed six Oregon jurisdictions and associated co-permittees to apply for and obtain a municipal NPDES stormwater permit.

CCSD No. 1 and SWMACC (the Districts), Oak Lodge Sanitary District, Clackamas County (including DTD), and the Cities of Happy Valley, Rivergrove, Gladstone, Johnson City, Lake Oswego, Milwaukie, Oregon City, West Linn, and Wilsonville are Phase 1 co-permittees on a NPDES MS4 permit that is referred to as the Clackamas County MS4 permit. Clackamas County co-permittees are classified as Phase 1 communities because they meet the threshold of greater than 100,000 in population collectively, though not separately. Only the Portland metro area subunit of CCSD No. 1 is regulated by the MS4 permit. This subunit is known as CCSD No. 1-urban growth boundary (UGB). The developed area of the City of Happy Valley lies within CCSD No. 1-UGB, and the remainder of Happy Valley will be annexed to CCSD No. 1 as it is developed.

The Clackamas County MS4 permit was issued by DEQ on December 15, 1995, was renewed by DEQ on March 3, 2004, and was modified by DEQ on July 27, 2005. As a part of the initial MS4 permit application, a joint Stormwater Management Plan (SWMP) was developed in 1993 for CCSD No. 1 and SWMACC. The SWMP included the requirement to develop specific categories of BMPs to address specific sources of pollutants. However, the requirements did not specify the number or type of BMPs that should be implemented. Instead, the federal requirement states that BMPs should be implemented to reduce the discharge of pollutants to the maximum extent practicable (MEP). The 1993 SWMP was updated in 2000.

During the 2000-2004 permit renewal process, third-party environmental groups expressed significant concern that the permits should include numeric discharge limits at stormwater outfalls as opposed to the more general requirement to implement BMPs to the MEP as stated in the CWA. This concern was also linked to another CWA requirement related to the development of TMDLs for creeks, rivers, and streams that are currently in violation of water quality standards.

With respect to numerical water quality standards in the 2004 NPDES permit, DEQ attempted to balance the demands of the third-party groups with the needs of larger municipalities such as the Districts as well as the abilities of the smaller co-permittees. For some jurisdictions that discharge to water bodies currently exceeding water quality standards, the 2004 permits set new requirements. Where TMDLs are established, jurisdictions must attempt to quantify the effectiveness of their SWMPs, set pollutant load reduction benchmarks for performance of SWMPs, check in on progress towards meeting those benchmarks, and apply an adaptive management process to continue to work towards achieving benchmarks.

The 2004 NPDES permit required the submission of an Interim Evaluation Report (IER), which CCSD No. 1 and SWMACC submitted separately on May 1, 2006. These IERs included the Districts' most recently approved SWMPs. In August 2008, WES submitted a permit renewal application to DEQ which included an updated SWMP. The 2008 permit renewal also included pollutant load estimates based on land use, an evaluation of trends in stormwater monitoring results, pollutant load reduction benchmarks, an MEP determination, and a fiscal evaluation of the WES Surface Water Management (SWM) program (WES 2008).

To ensure that the SWMP continues to meet the MEP standard, the effectiveness of the SWMP is revisited annually. Each year, Clackamas County and co-permittees are required to submit an annual compliance report for their MS4 NPDES permit. The annual report is required to describe the status of implementing the components of the SWMP; proposed changes to the SWMP; and water quality monitoring results. The annual report provides an overall assessment of the permittees' actions to minimize pollutants in MS4-regulated stormwater systems. The annual reports contain a wealth of information about stormwater management activities undertaken in the Districts in the reporting year.

NPDES MS4 Program Implementation. According to the CWA, MS4 permittees must implement a program to reduce the discharge of pollutants to the maximum extent practicable, including management practices, control techniques and systems, and design and engineering methods. The program varies by municipality and is intended to be developed in a flexible manner in consideration of site-specific conditions to optimize reductions in stormwater pollutants. The program includes BMPs, monitoring, and other available and reasonable controls, which are then documented as requirements in the permit and SWMP. SWMPs can be revised using adaptive management to improve overall program effectiveness.

WES' proposed 2008 SWMP is similar to the 2006 SWMP, which is the currently approved SWMP until the new permits are issued by DEQ. As a part of the 2008 permit renewal submittal, a comprehensive review of the SWMPs and an evaluation of program effectiveness, local applicability, and program resources was performed. As a result of this review, several changes were made to the 2008 SWMP, including updating the monitoring plan to include a plan for sampling for selective pesticides and implementing a new BMP related to inspecting and maintaining private stormwater systems for new development. Further changes to the SWMP may be required during the permit negotiation process in 2009.

The proposed 2008 SWMP includes the following components with key BMPs listed beneath each component:

- Component #1: Structural and Source Control BMPs to Reduce Pollutants from Commercial and Residential Areas
  - Stormwater system maintenance
  - Planning procedures for new development
  - Street sweeping
  - Water quality and flood management projects
  - Public education to reduce discharge of pesticides, herbicides and fertilizers
- Component #2: A Program to Detect and Remove Illicit Discharges and Improper Disposal Into the Storm Sewer System
  - Conducting dry weather inspections
  - Implementing the spill response program
  - Facilitating public reporting of illicit discharges and spills
  - Controlling infiltration and cross connections to the storm sewer system.
- Component #3: A Program to Monitor and Control Pollutants from Industrial Facilities
  - Addressing runoff from hazardous waste treatment, disposal and recovery facilities and other non-1200Z permitted industrial facilities
- Component #4: A Program to Reduce Pollutants in Stormwater Discharges from Construction Sites
  - Implementing requirements for structural and non-structural BMPs at construction sites
  - Identifying priorities for inspecting sites and conducting enforcement actions
  - Conducting training for construction site operators

Each BMP in the SWMP includes measurable goals and tracking measures appropriate for the BMP. Progress toward measurable goals and the results of tracking of the BMPs are reported in the annual reports.

The BMPs in the SWMP encompass most of the policy and practice areas described in this report. Several of the key BMPs have already been described in the earlier sections in this report on development review, erosion prevention and sediment control, and maintenance. Following is a summary of the water quality monitoring and illicit discharge detection and elimination performed as a part of the MS4 permit program, and a discussion of the UIC program.

Water Quality Monitoring. As part of the MS4 permit requirements, WES, and other Clackamas County co-permittees are required to develop and implement a stormwater monitoring program. Specific stormwater monitoring requirements and objectives are defined in Schedule B of the Clackamas County NPDES MS4 permit. The NPDES stormwater monitoring programs require two components. The first component is program monitoring, which involves the tracking and assessment of programmatic activities, as described in the individual permittees' SWMP, through the use of performance indicators or metrics. The second component is environmental monitoring which includes the actual collection and analysis of samples.

As a part of the 2008 permit renewal submittal, WES submitted an updated monitoring plan to DEQ (URS, 2008). Given the magnitude of effort associated with implementing an effective monitoring program that will adequately meet permit requirements and objectives, eight Clackamas County co-permittees agreed to consolidate efforts and prepare one comprehensive SWMP. The co-permittees include CCSD No. 1, SWMACC, and the Cities of Gladstone, Milwaukie, Oregon City, West Linn, Happy Valley, and Rivergrove.

WES currently administers a routine and storm-event related water quality and flow monitoring program within CCSD No. 1. The monitoring program activities include the following:

- Water quality sample collection
- Flow measurement
- Laboratory and field analysis of water samples
- Water quality data management reporting

In addition to monitoring conducted for the MS4 permit program, WES also conducts periodic monitoring of other environmental conditions that are related to water quality, including benthic macroinvertebrate sampling and fish sampling and associated habitat surveys. This monitoring is typically conducted under direction of the Environmental Policy Specialist as part of the Watershed Health functional element of WES (described below) and is not performed by the WES Environmental Monitoring program.

Parameters currently measured as a part of the MS4 permit monitoring include dissolved and total metals (copper, lead and zinc), hardness, *E. coli* bacteria, nutrients (nitrogen and phosphorus), solids (total, dissolved, volatile), and field measurements of conductivity, pH, temperature, flow, and dissolved oxygen.

In the proposed 2008 Monitoring Plan, WES has proposed monitoring for selective pesticides as requested by DEQ. It is likely that many of the other Clackamas County co-permittees will conduct this monitoring jointly in a single coordinated study. An initial meeting with the U.S. Geological Survey (USGS) was held in June 2008, and it appears likely that the USGS will be able to serve as a partner in this study. If a formal agreement is established, the USGS' role will likely include, at minimum, creation of the study's design, the provision of laboratory analytical services, data interpretation, and final report writing. At least two storms, one in spring and one in summer or early fall, will be captured at each selected monitoring location during this coordinated study. The pesticides to be analyzed have not yet been selected, but both herbicides and insecticides will be chosen. The monitoring locations have also not been selected, but no less than six will be selected in representative locations in the study area.

The monitoring program is discussed further in Chapter 3.

Illicit Discharge Detection and Elimination. Twenty-nine major outfalls are located in the portion of CCSD No. 1 regulated by the MS4 permit program (CCSD No. 1-UGB). Major outfalls include pipes greater than 36-inch-diameter, conveyance from lands zoned for industrial activity, and conveyance from lands serving a drainage area of more than 50 acres. In an effort to identify and control illicit discharges of non-stormwater substances to the stormwater system, each major outfall receives at least one dry-weather inspection per year.

Underground Injection Control Devices. Discharges from injection-type storm sewer systems that discharge stormwater below ground are regulated by the federal Safe Drinking Water Act under a program called UIC. Due to the program name, injection-type storm sewer devices are often called UIC devices or UICs. Discharges from injection-type storm sewer systems are not regulated by any MS4 permit as they convey stormwater to the subsurface rather than through an MS4 conveyance system into surface water bodies.

DTD and WES jointly manage about 150 injection-type storm sewer systems that are in or near CCSD No. 1. DTD and WES also jointly manage about 50 injection-type storm sewer systems near the SWMACC's MS4-permitted area. Nearly all of these stormwater injection devices are drywells, which are essentially perforated manhole shafts that discharge stormwater below the ground surface to infiltrate into the surrounding soil.

WES and DTD jointly applied for an area-wide Water Pollution Control Facility (WPCF) permit from DEQ for these devices on December 19, 2001. As of 2008, this WPCF permit had not been issued. A separate stormwater management plan guides WES' and DTD's stormwater management programs in the geographic areas that drain to drywells.

Currently, CCSD No. 1, SWMACC, and the City of Milwaukie are involved in an ongoing monitoring program in Oregon related to UIC devices. Coordination of this program is the result of UIC permit requirements, not MS4 permit requirements, and the monitoring program is expected to continue on an annual basis. The monitoring that is being conducted for this program is evaluating the effluent from structural BMPs prior to its discharge into a UIC. There are seven BMPs that are currently being evaluated including sedimentation manholes, catchbasin inserts, a Stormceptor, an oil-water separator, a StormFilter, and sumped catchbasins. Over 5 years of samples have been collected from each site. Sampling of these sites is conducted on a storm basis only. One of the sites is located within Clackamas County.

Current Issues/Problems

A workshop with WES staff to identify current issues/problems and potential opportunities for improvements in the environmental monitoring program has not yet been conducted. The 2006 Master Plan identified several potential opportunities for improvements. Further analysis of this program element will be conducted during the assessment phase of the project. Initial findings from the characterization phase include the following observations:

- The WES GIS layer for the water quality monitoring sites does not have a consistent naming convention for the monitoring sites. There is an opportunity to clarify the location, name, and associated data for each historic and current monitoring site.
- The water quality monitoring sites, benthic macroinvertebrate monitoring sites, and fish monitoring sites are generally not located together. It may be more useful to evaluate the combination of data from these monitoring efforts if the monitoring sites are located together in the future.
- There may be opportunities to re-evaluate the location of water quality monitoring sites in order to help answer questions about program effectiveness and changes in watershed conditions in the upper tributaries. Stormwater monitoring of MS4 discharges could be targeted to specific land use types of interest, such as commercial and industrial areas, and residential areas of varying density, type and age.
- There may be opportunities to perform more continuous monitoring of in-stream conditions and stormwater outfalls in order to help answer questions about program effectiveness.
- There may be opportunities to improve the coordination between water quality monitoring data collection and continuous flow and temperature monitoring data collection.
- To support TMDL compliance efforts, additional monitoring of TMDL constituents could be conducted. Additional and more frequent land use based *E. coli* monitoring could be conducted for source identification and BMP targeting. The District could consider special studies to identify animal versus human sources of *E. coli,* and/or studies that directly measure levels of human pathogens.
- Changes to the water quality monitoring program elements, including site locations, are possible through the adaptive management process for the SWMP but could prove challenging due to the coordinated monitoring plan in place for multiple co-permittees.

These issues and potential opportunities for improvement will be evaluated further with WES staff during the assessment phase.

Environmental Policy and Watershed Health

WES employs 1.0 FTE as an environmental policy specialist in the Environmental Policy and Watershed Health functional program element. This element is a part of WES Administration. The responsibilities of the environmental policy specialist are varied and include assessing watershed conditions in the Districts, assisting in developing management strategies to improve or protect environmental conditions, assisting in public information and outreach efforts, reviewing WES and other Clackamas County projects for permit compliance, and serving as a representative of WES on a wide variety of committees and advisory bodies addressing watershed health issues. The Environmental Policy and Watershed Health functional program element addresses numerous environmental regulatory programs including the Endangered Species Act. The

Environmental Policy program element conducts periodic monitoring of environmental conditions that are related to water quality, including benthic macroinvertebrate sampling, fish sampling, and habitat surveys.

The Environmental Policy Specialist is responsible for all of WES' biological monitoring programs, developing and tracking watershed health performance metrics, and development of a Watershed Health Index. This staff person also is responsible for developing partnerships with other agencies and nonprofit groups in the implementation of watershed improvement projects.

Public Information and Outreach

WES administers a public education program which provides information that attempts to motivate residents and workers in Clackamas County to reduce stormwater pollution and improve watershed health. WES employs 1.0 FTE as a public information and outreach specialist. This staff member is responsible for conducting public information and outreach related to both the sewer program and the surface water management program.

Educational information is shared with the public through the use of the following:

- Articles in WES newsletters (StreamLines in CCSD#1-UGB). These newsletters are mailed to all customers along with billing statements.
- WES's website.
- USGS publications. WES funds have been contributed towards the generation and publication of several relevant reports that help to educate the public and staff, including Report 2003-4145, entitled "Pesticides in the Lower Clackamas River Basin, Oregon, 2000-2001", and Report 2004-5061, entitled "Organochlorine Pesticides in the Johnson Creek Basin, Oregon, 1988-2002."
- Through local public involvement campaigns. A recent example of a relevant public involvement campaign is one that has been launched annually over the past several years throughout the Portland Metro area by many municipal partners, including the Districts. This group is called the Regional Coalition for Clean Rivers and Streams.
- Brochures (disseminated at the WES booth at fairs, for example)

WES was also recently approached by KOIN News 6 to participate with seven other agencies in an on-air campaign entitled, "Promoting Clean and Healthy Watersheds – Do the Right Thing." The purpose is to provide awareness, education, and motivation to change behaviors. A series of commercials, promotions, and news stories will be aired. It is expected that 360 commercials will be aired annually; reaching 564,000 adults, and each adult being reached will have seen the campaign an average of 11 times each. The following five issues will be addressed initially: 1) pesticides/fertilizers; 2) automotive care; 3) pet waste; 4) healthy lawns; and 5) native plants/noxious weeds.

Public survey results

In 2008, WES contracted with a research firm to conduct a telephone survey of residents in the cities of Gladstone, West Linn, Oregon City, and Milwaukie, the Oak Lodge Sanitary District and the Damascus area of Clackamas County. The research objectives were to assess community values regarding local rivers and streams, determine awareness of capacity issues facing Clackamas County's sewage treatment systems, measure support for plans to increase capacity and funding for expansion, and assess support for increasing collaboration for sewer system management and financing (CFM Research, 2008).

A stratified sample was used for the survey, with 75 interviews completed in each area, among residents age 18 years and older. For the geographic areas used in the survey, the percentages are statistically valid to a margin of error of ±11.5 percent at the 95 percent confidence level.

Rivers and streams are an important aspect of Clackamas County.

- Roughly nine in ten residents from all areas say they are very or somewhat interested in issues related to the Clackamas River, the Willamette River, and local streams. Forty-six percent are very interested and 43 percent are somewhat interested.
- Overall, 39 percent say they are very or somewhat involved with water sports, activities and issues.

Perceptions of key problems are similar in all communities.

- Overall, maintaining clean rivers and streams for fish and wildlife is the highest rated problem. Among eight problems facing Clackamas County, the largest share of residents rate maintaining clean rivers and streams for healthy fish and wildlife (50 percent) as a major problem.

More than four in ten rate four other issues as major problems:

- Maintaining a strong economy (45 percent major problem);
- Human health and safety (44 percent major problem);
- Maintaining clean rivers and streams for human recreational use (43 percent major problem); and,
- Adequate and efficient sewage treatment facilities and maintenance (42 percent major problem).

Less than four in ten considered three other issues major problems:

- Adequate clean drinking water (39 percent major problem);
- Residential growth (38 percent major problem); and,
- Industrial and commercial growth (22 percent major problem).

Issues identified in the survey vary somewhat by community.

- Clean rivers for wildlife and the economy are equally important to residents in Oregon City, Milwaukie and Damascus.
- Adequate and efficient sewage treatment facilities, and health and safety are top rated problems among Milwaukie residents.
- Residential growth is the top concern in Damascus.

Financial Services

WES operates the Districts and provides wastewater and surface water management services using revenue from several sources. The SWM Program for CCSD No. 1 is funded through three primary sources: monthly SWM utility fees, SDCs, and permit fees.

The SWM fee is based on the amount of impervious surface on each site. The monthly surface water management fee is based on the Equivalent Service Unit (ESU). One ESU equals 2,500 square feet of impervious surface.

The current SWM rate is $6 per month per ESU in CCSD No. 1 and $4 per month per ESU in SWMACC. Single family residences are charged for 2,500 square feet of impervious service area or 1 ESU (shown as 1.00 unit on your billing) per month, based on this average measurement. SFR customers who live in developments built since 1998 also pay a monthly maintenance agreement fee of $3 per ESU, which is dedicated for maintenance of local subdivision stormwater conveyance, detention, treatment, and infiltration facilities.

Non-single family properties, including businesses, schools, governments and industrial areas, pay based on their measured impervious area. For example, a business with 10,000 square feet of impervious surface (4 ESUs) would be charged $16 per month ($4 x 10,000 square feet ÷ 2,500 square feet = $16). Through this approach, properties that contribute more to the need for surface water management pay a greater proportion of the program costs.

SDCs are collected from new development and dedicated to planning, design, and construction of additional storm water infrastructure capacity needed to accommodate growth. The current SDC rate is $205 per ESU.

Table A-2 compares the number of ESUs in July 2005 and 2006 for residential and commercial/industrial land uses. Excluding roadways, the amount of impervious area in CCSD No. 1 increased by 44 acres (749 ESUs) during this period from 2005 to 2006. Based on aerial mapping, new roadways (not reflected in customer billing records) are estimated to account for an additional 22 acres of impervious surface added in CCSD No. 1 from 2005 to 2006.

Table A-2. Equivalent Service Units in CCSD No. 1 2005 to 2006

ESUs	July 2005	July 2006	Change
Residential	14,213	14,972	759
Commercial/Industrial	29,112	29,112	0
Total	43,325	44,084	759

Based on the period from 2003 to 2007, the average annual growth rate for the ESUs was calculated to be 3 percent, which is generally considered to be a reliable predictor of average future revenue, although current economic conditions could result in a slower growth rate in the near future. Table A-3 summarizes WES' projected surface water rate revenues for CCSD No. 1. This estimate uses the current surface water rate of $6 per ESU for CCSD No. 1. The surface water rate is held constant for estimating future revenue. The estimate also does not include revenue from SDCs.

In the fiscal evaluation as a part of the 2008 MS4 permit renewal, WES anticipates that the annual surface water budgets for CCSD No. 1 will continue to grow in order to meet regulatory requirements, system expansion, and to refurbish and enhance existing system facilities. In the permit renewal, it is noted that it is likely that future budgets may require rate increases and possibly additional staffing.

Table A-3. CCSD No. 1 Surface Water Rate Revenue Forecast

Year	ESUs	Rate revenue, dollars
2008	45,504	3,432,372
2009	46870	3,535,343
2010	48,276	3,641,403
2011	49,724	3,750,646
2012	51,216	3,863,165
2013	52,752	3,979,060

SWM fees are used to fund the following:

- Maintenance of stormwater facilities
- Response to customer service enquiries
- Monitoring of water quality
- Planning and design of regional water quality and flood reduction projects
- Providing long-term watershed planning
- Providing public outreach and partnerships for pollution prevention

Other Clackamas County Departments

The following Clackamas County departments and divisions also implement policies and practices that affect watershed health:

- DTD
- Sustainability
- Development Agency
- Engineering
- Planning
- Parks Department
- North Clackamas Parks and Recreation District

Department of Transportation and Development. DTD is responsible for a broad range of Clackamas County services involving land use planning and permitting, building permits, county code enforcement, sustainability, road construction and maintenance, surveying, plat approvals, public land corner restoration, and dog services. The county's urban renewal programs are also under the DTD umbrella.

These programs and services are managed through eight divisions that report to the department director: Building Codes, Community Environment, Development Agency, Dog Services, Engineering, Land Use Planning, Surveyor and Transportation Maintenance. Of these divisions, Community Environment (which includes Sustainability), Development Agency, Engineering, and Land Use Planning have the most impact on watershed health.

Sustainability. Clackamas County is committed to sustainability, to "using, developing and protecting resources at a rate and in a manner enabling people to meet their current needs and also provides that future generations can meet their own needs." The Clackamas County Office of Sustainability supports and coordinates sustainability activities within and throughout Clackamas County, and is a resource for the community. In November 2008, the Sustainable Clackamas County Advisory Task Force submitted to the County Commissioners the "Action Plan for a Sustainable Clackamas County." The action plan framework includes seven goals for the year 2050 with associated actions and tasks for the next 3 to 5 years.

Development Agency. Using urban renewal authority, the Development Agency implements programs that provide for economically, socially and environmentally sound development and redevelopment to revitalize blighted areas; building Clackamas County's property tax base and creating jobs for the citizens of Clackamas County. The Clackamas County Development Agency currently administers four urban renewal areas.

- Clackamas Town Center Area
- Clackamas Industrial Area
- Government Camp
- North Clackamas Revitalization Area

Engineering. Engineering includes engineering inspections, transportation infrastructure improvements, including design and construction, development review oversight, and traffic safety and operations.

Planning. Planning includes land use permit approval, the development review process, long-range planning, land use regulations, and the CIP.

Parks Department. The County Parks Department manages the following areas: Barton Park, Boones Ferry Marina, Carver Park, Eagle Fern Park, Feyrer Park, Hebb Park, Metzler Park, and Hoodland Park.

North Clackamas Parks and Recreation District. North Clackamas Parks and Recreation District (NCPRD) is a service district of Clackamas County government. It offers about 50 parks and greenspaces to about 100,000 residents in the north portion of the county. Stretching from the Clackamas River on the south to the Multnomah County border on the north, the Willamette River on the west and reaching to the 1979 UGB on the east, NCPRD includes the City of Milwaukie, the City of Happy Valley, and unincorporated areas.

Cities

The KMS watershed encompasses the Cities of Milwaukie, Happy Valley, Gladstone, and Johnson City as described earlier. CCSD No. 1 includes a service agreement with Happy Valley to provide stormwater management services.

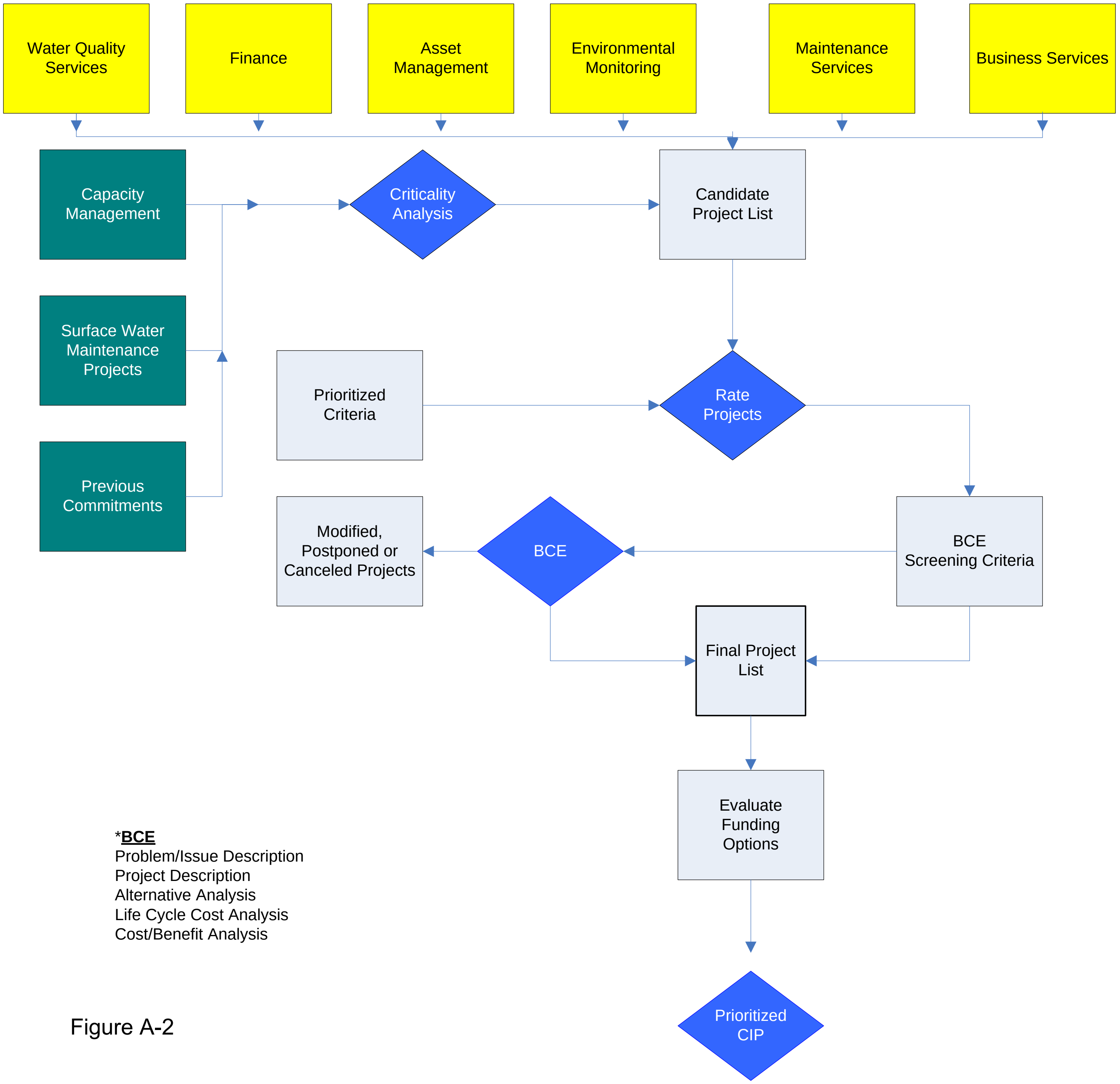
The City of Milwaukie is currently undertaking an initiative called Kellogg for Coho, which is evaluating options to improve fish passage through the dam on Kellogg Creek at Highway 99 and restore Kellogg Lake to a free-flowing section of the stream. The primary option being evaluated is to remove Kellogg Dam during replacement of the Highway 99 bridge. The City of Milwaukie has held several public and stakeholder meetings on this project and has obtained some limited grant funds. The City has partnered with the U.S. Army Corps of Engineers (USACE) and has conducted a few preliminary environmental studies. WES is a current partner (limited at this time to staff support and study review and attendance at meetings) in the project and has been invited to all of these meetings. The City and USACE are planning additional surveys and analysis of the project. The City of Milwaukie is continuing to look for additional partners and funding opportunities in association with its downtown and redevelopement plans in this area.

Other Agencies and Organizations

There are a wide variety of other agencies and organizations that implement policies and practices that affect watershed health in the KMS watershed, including state and federal agencies, Metro, local service providers, watershed groups, community groups, and others.

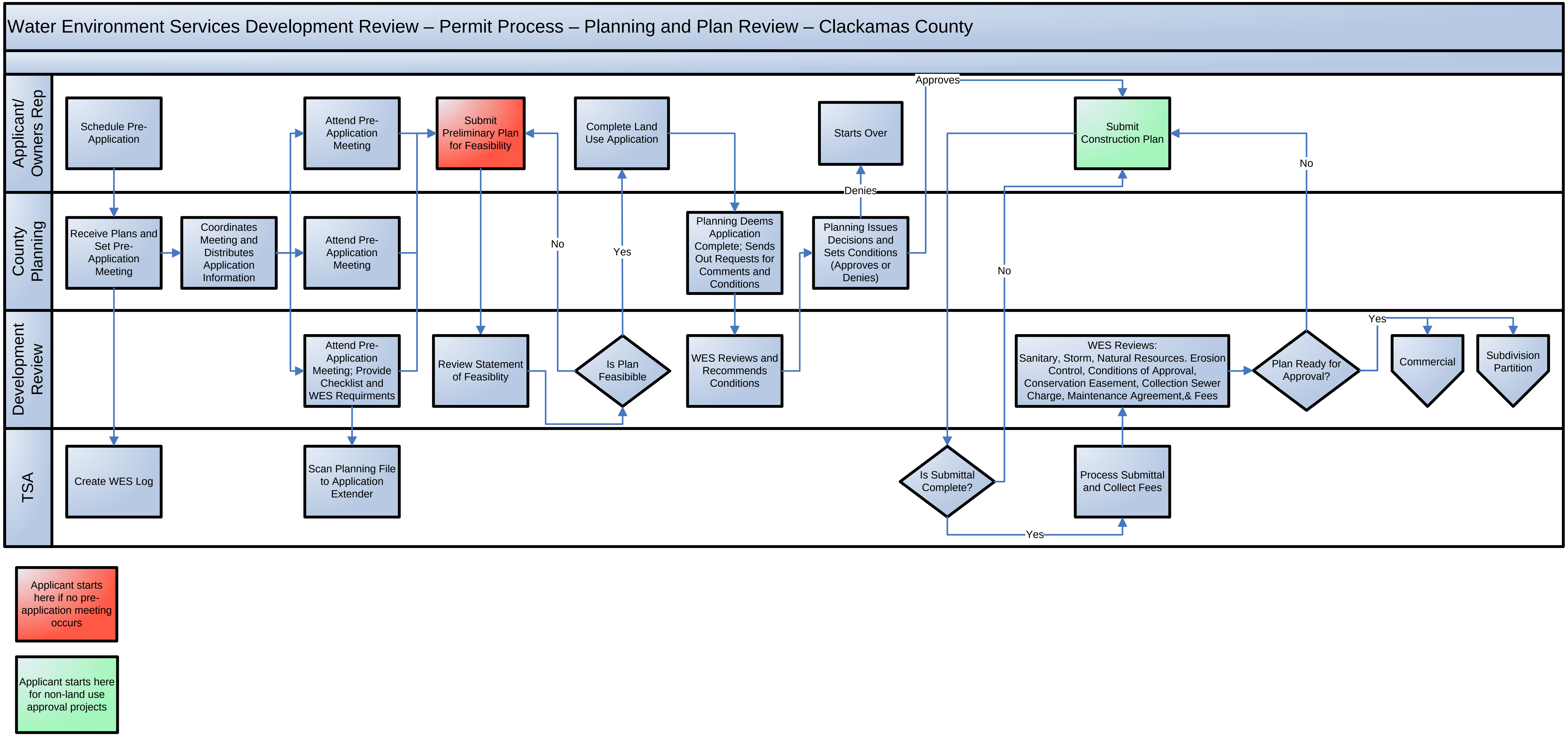
Figures A-2 through A-18

WES PRIORITIZED CAPITAL IMPROVEMENT PROGRAM PROCESS



*__BCE__
Problem/Issue Description
Project Description
Alternative Analysis
Life Cycle Cost Analysis
Cost/Benefit Analysis

Figure A-2



Water Environment Services Development Review – Permit Process – Planning and Plan Review – Clackamas County

Figure A-3a

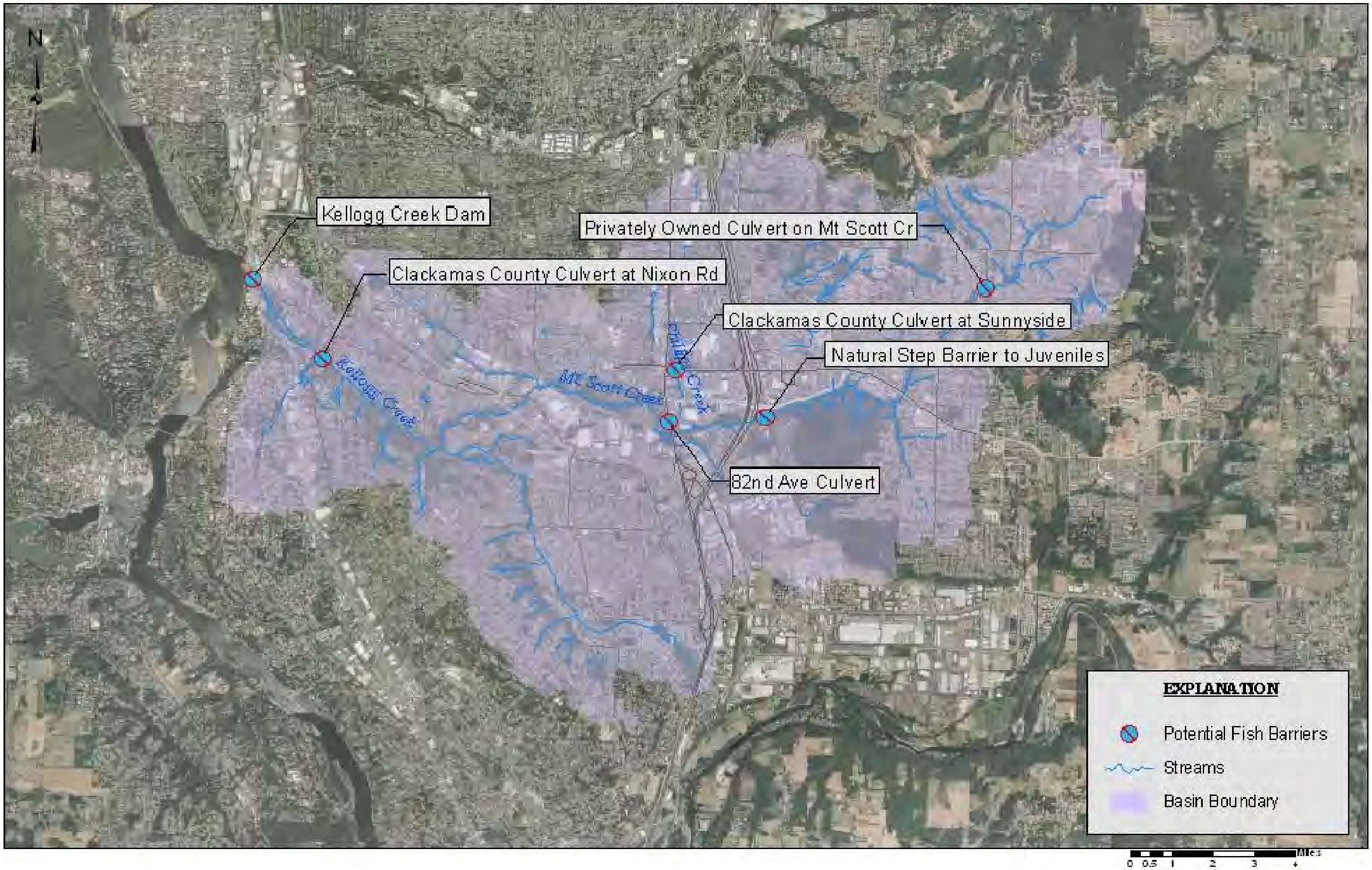


Figure 4-8
Potential Barriers to Fish Within the Kellogg-Mt. Scott Watershed
WES WATERSHED ACTION PLAN

Water Environment Services
[illegible]

Brown and Caldwell
Swanson Hydrology + Geomorphology
Ellis Ecological Services, Inc.

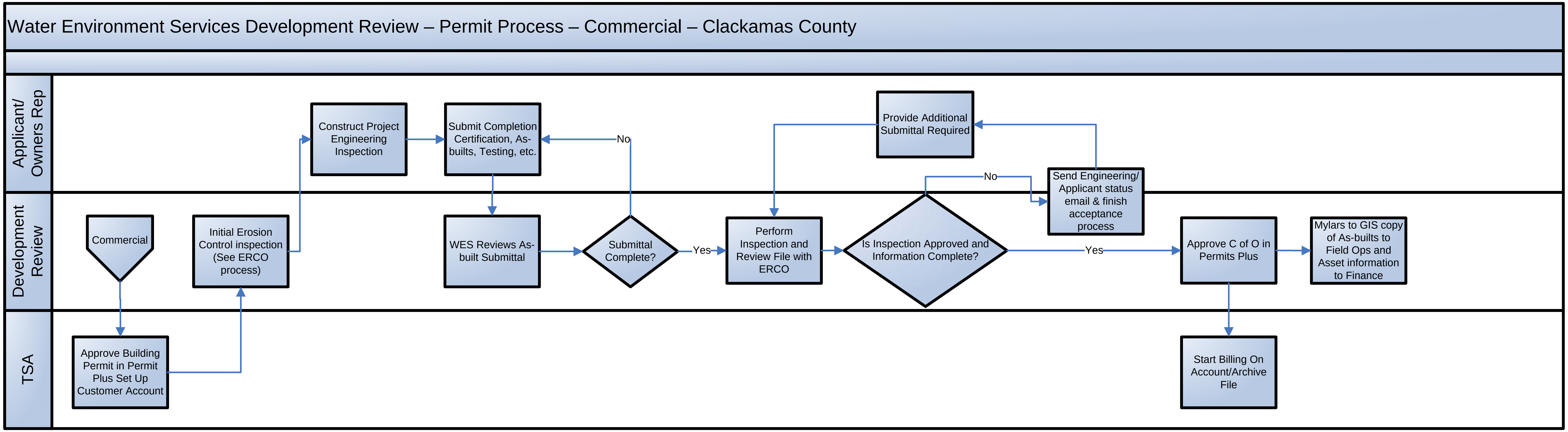

Water Environment Services Development Review – Permit Process – Commercial – Clackamas County

Figure A-4a

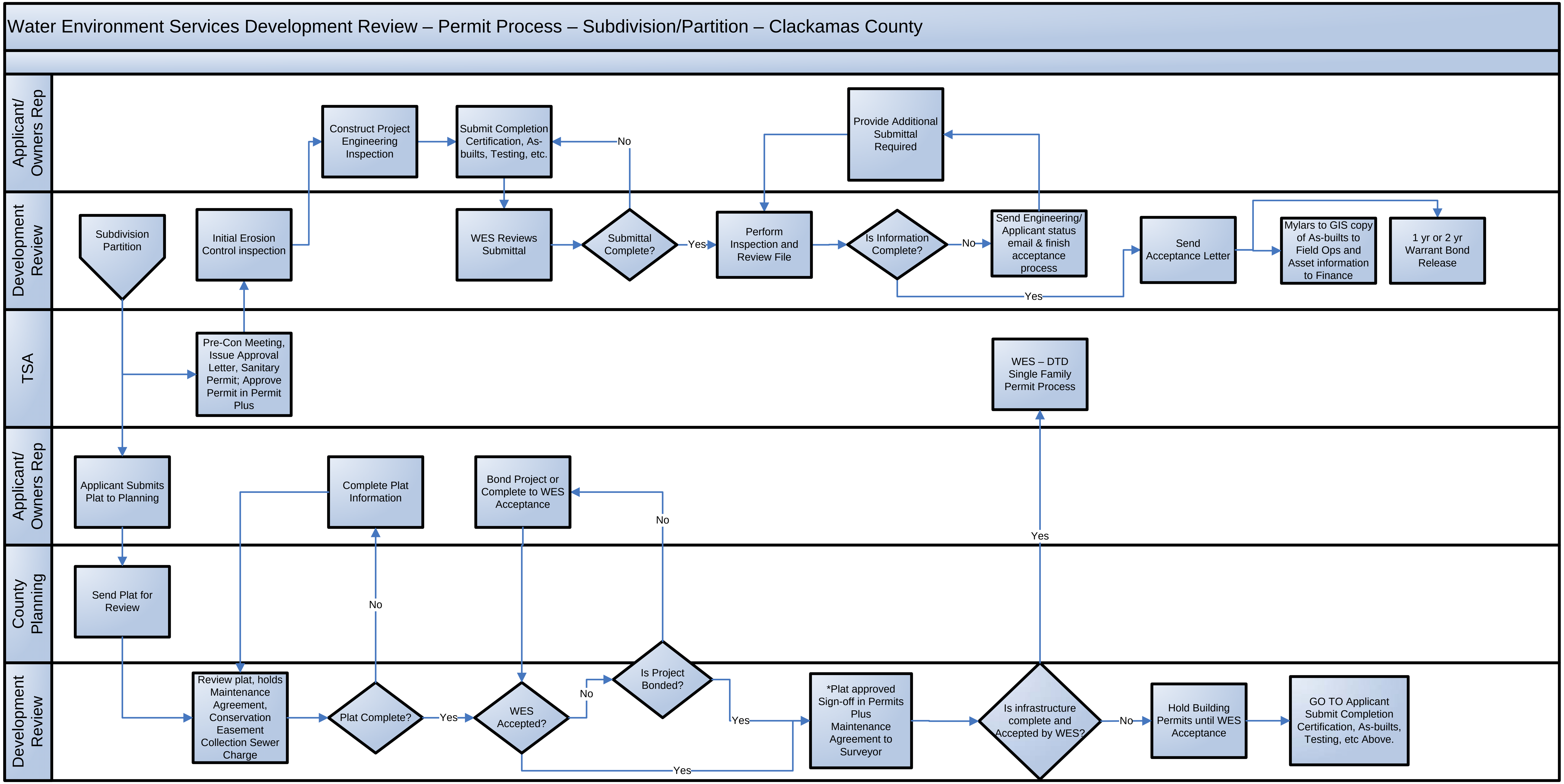

Water Environment Services Development Review – Permit Process – Subdivision/Partition – Clackamas County
Applicant/ Owners Rep
Construct Project Engineering Inspection
Submit Completion Certification, As-builts, Testing, etc.
No
Provide Additional Submittal Required
Development Review
Subdivision Partition
Initial Erosion Control inspection
WES Reviews Submittal
Submittal Complete?
Yes
Perform Inspection and Review File
Is Information Complete?
No
Send Engineering/ Applicant status email & finish acceptance process
Yes
Send Acceptance Letter
Mylars to GIS copy of As-builts to Field Ops and Asset information to Finance
1 yr or 2 yr Warrant Bond Release
TSA
Pre-Con Meeting, Issue Approval Letter, Sanitary Permit; Approve Permit in Permit Plus
WES – DTD Single Family Permit Process
Applicant/ Owners Rep
Applicant Submits Plat to Planning
Complete Plat Information
Bond Project or Complete to WES Acceptance
No
Yes
County Planning
Send Plat for Review
No
Development Review
Review plat, holds Maintenance Agreement, Conservation Easement Collection Sewer Charge
Plat Complete?
Yes
WES Accepted?
No
Is Project Bonded?
Yes
Yes
*Plat approved Sign-off in Permits Plus Maintenance Agreement to Surveyor
Is infrastructure complete and Accepted by WES?
No
Hold Building Permits until WES Acceptance
GO TO Applicant Submit Completion Certification, As-builts, Testing, etc Above.

Figure A-5a

Water Environment Services Development Review – Planning and Plan Review – Happy Valley

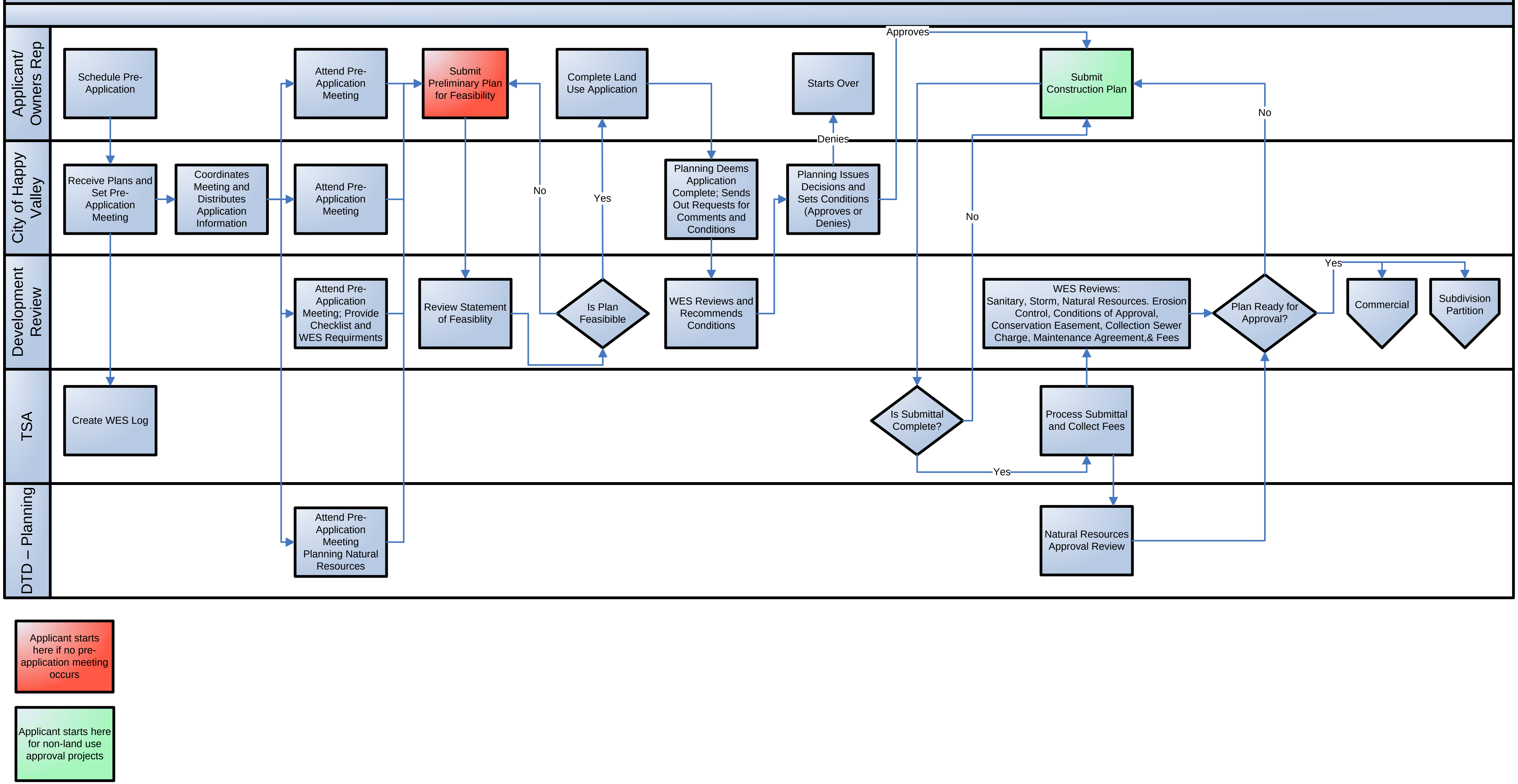


Figure A-3b

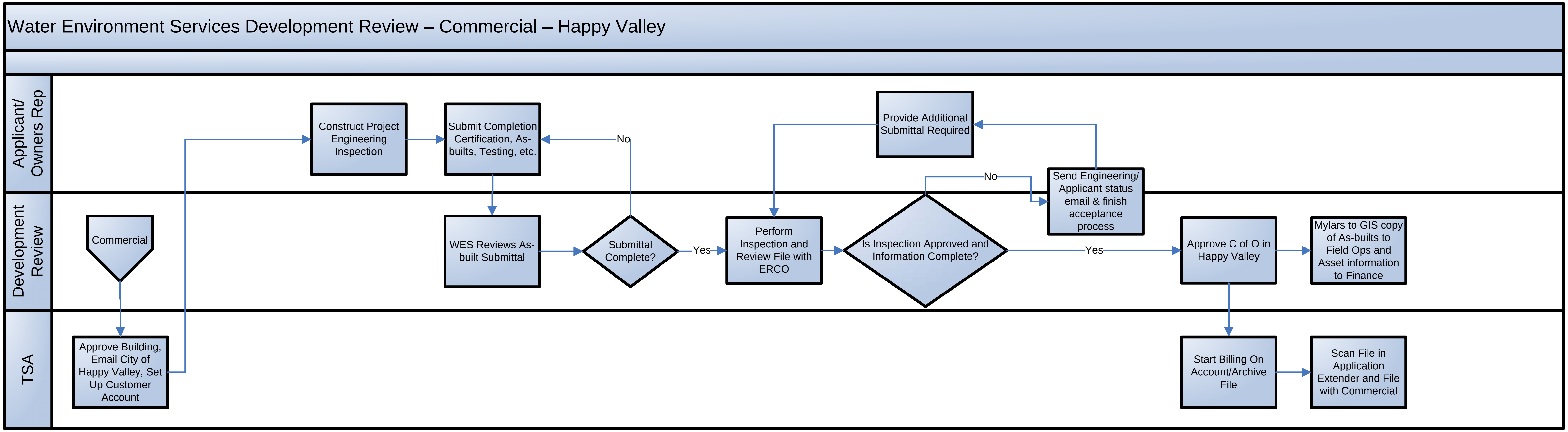

Water Environment Services Development Review – Commercial – Happy Valley
Applicant/ Owners Rep
Development Review
TSA
Commercial
Approve Building, Email City of Happy Valley, Set Up Customer Account
Construct Project Engineering Inspection
Submit Completion Certification, As-builts, Testing, etc.
WES Reviews As-built Submittal
Submittal Complete?
No
Yes
Perform Inspection and Review File with ERCO
Provide Additional Submittal Required
Is Inspection Approved and Information Complete?
No
Send Engineering/ Applicant status email & finish acceptance process
Yes
Approve C of O in Happy Valley
Mylars to GIS copy of As-builts to Field Ops and Asset information to Finance
Start Billing On Account/Archive File
Scan File in Application Extender and File with Commercial

Figure A-4b

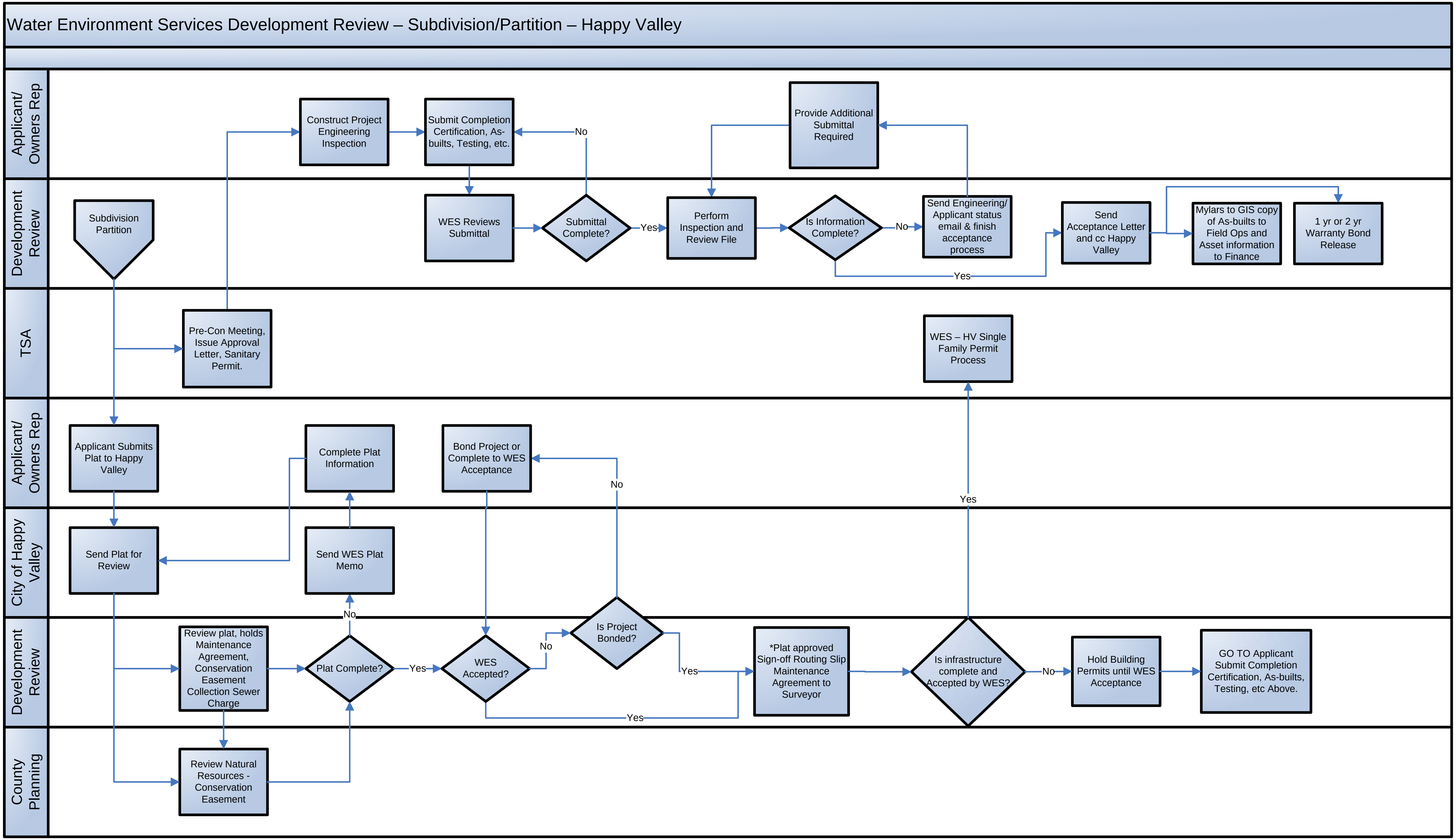

Water Environment Services Development Review – Subdivision/Partition – Happy Valley

Figure A-5b

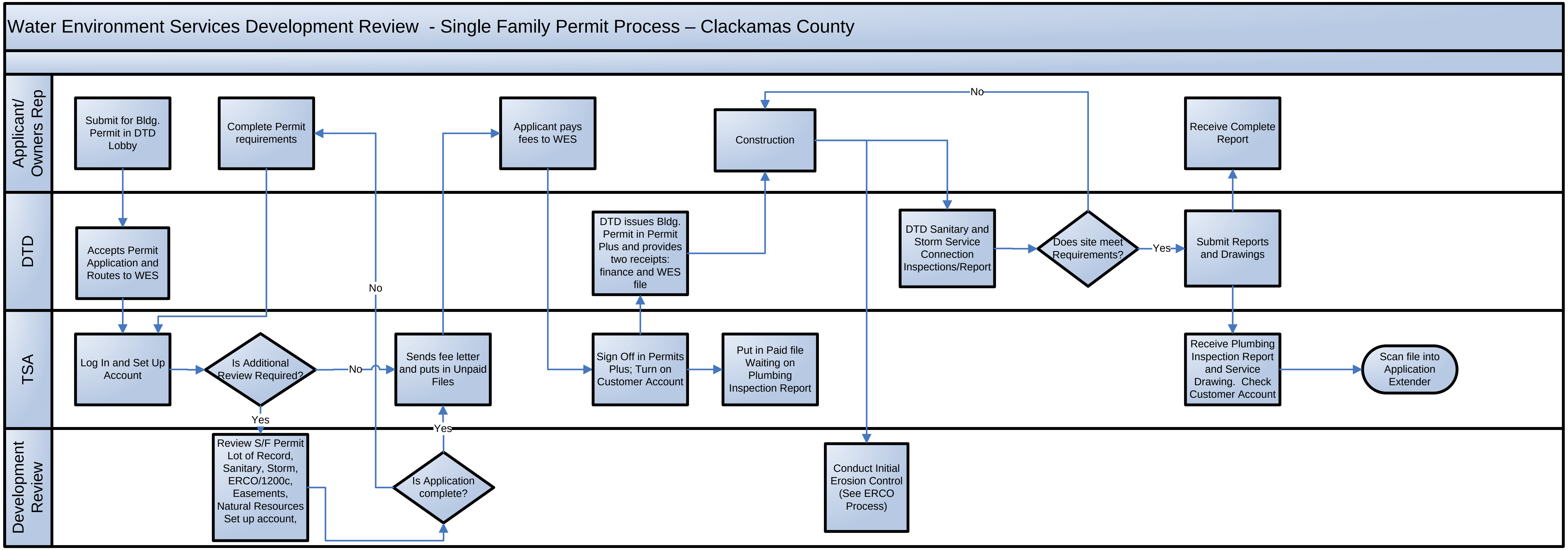

Water Environment Services Development Review - Single Family Permit Process – Clackamas County
Applicant/ Owners Rep
DTD
TSA
Development Review
Submit for Bldg. Permit in DTD Lobby
Complete Permit requirements
Applicant pays fees to WES
Construction
No
Receive Complete Report
Accepts Permit Application and Routes to WES
No
DTD issues Bldg. Permit in Permit Plus and provides two receipts: finance and WES file
DTD Sanitary and Storm Service Connection Inspections/Report
Does site meet Requirements?
Yes
Submit Reports and Drawings
Log In and Set Up Account
Is Additional Review Required?
No
Sends fee letter and puts in Unpaid Files
Sign Off in Permits Plus; Turn on Customer Account
Put in Paid file Waiting on Plumbing Inspection Report
Receive Plumbing Inspection Report and Service Drawing. Check Customer Account
Scan file into Application Extender
Yes
Yes
Review S/F Permit Lot of Record, Sanitary, Storm, ERCO/1200c, Easements, Natural Resources Set up account,
Is Application complete?
Conduct Initial Erosion Control (See ERCO Process)

Figure A-6

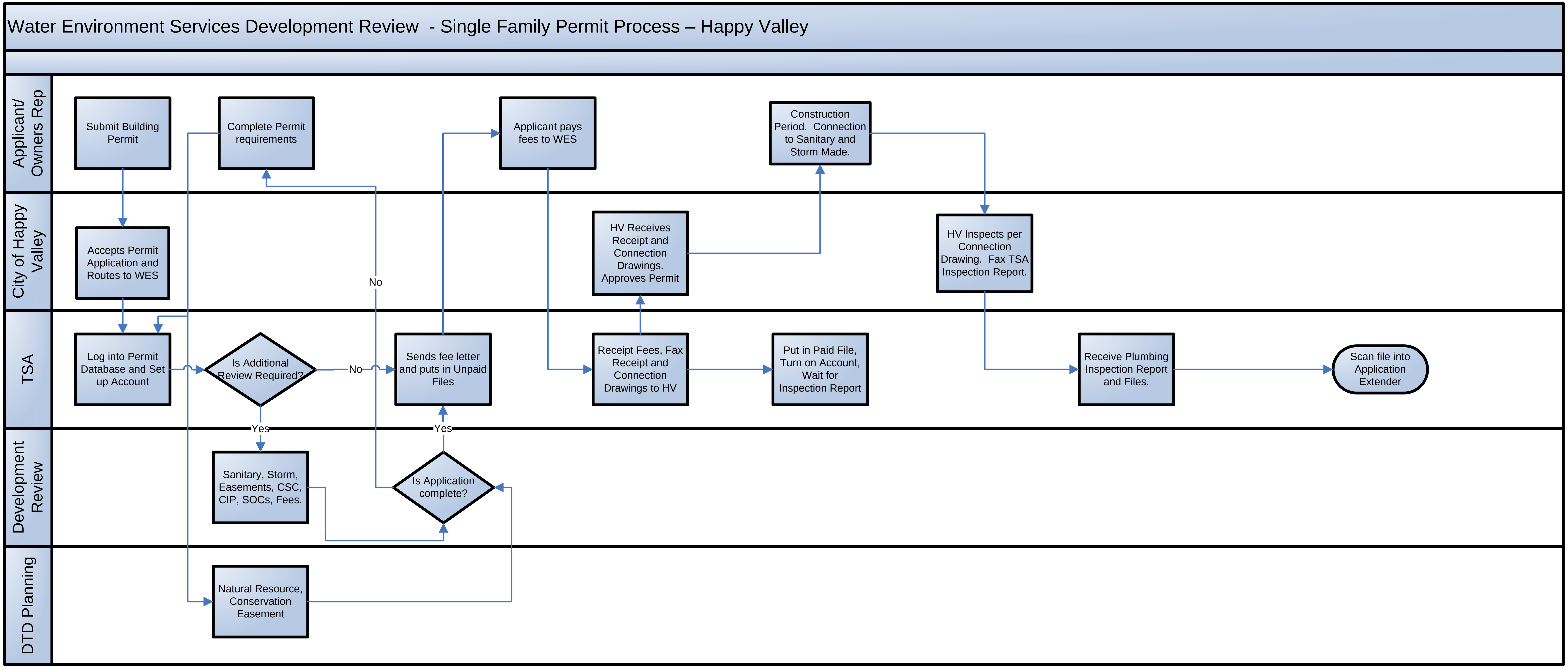
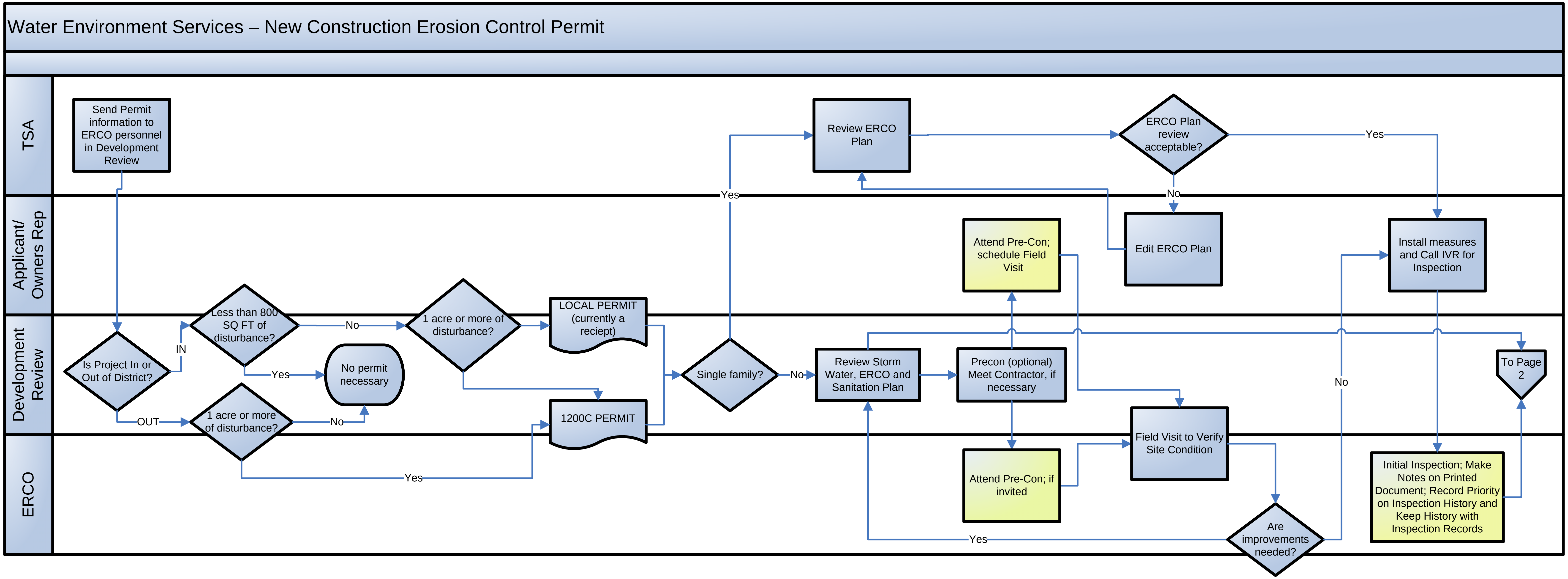

Water Environment Services Development Review - Single Family Permit Process – Happy Valley
Applicant/ Owners Rep
City of Happy Valley
TSA
Development Review
DTD Planning
Submit Building Permit
Complete Permit requirements
Applicant pays fees to WES
Construction Period. Connection to Sanitary and Storm Made.
Accepts Permit Application and Routes to WES
No
HV Receives Receipt and Connection Drawings. Approves Permit
HV Inspects per Connection Drawing. Fax TSA Inspection Report.
Log into Permit Database and Set up Account
Is Additional Review Required?
No
Sends fee letter and puts in Unpaid Files
Receipt Fees, Fax Receipt and Connection Drawings to HV
Put in Paid File, Turn on Account, Wait for Inspection Report
Receive Plumbing Inspection Report and Files.
Scan file into Application Extender
Yes
Yes
Sanitary, Storm, Easements, CSC, CIP, SOCs, Fees.
Is Application complete?
Natural Resource, Conservation Easement

Figure A-7



Yellow shading denotes potential “To Be” process

Figure A-8 (page1)

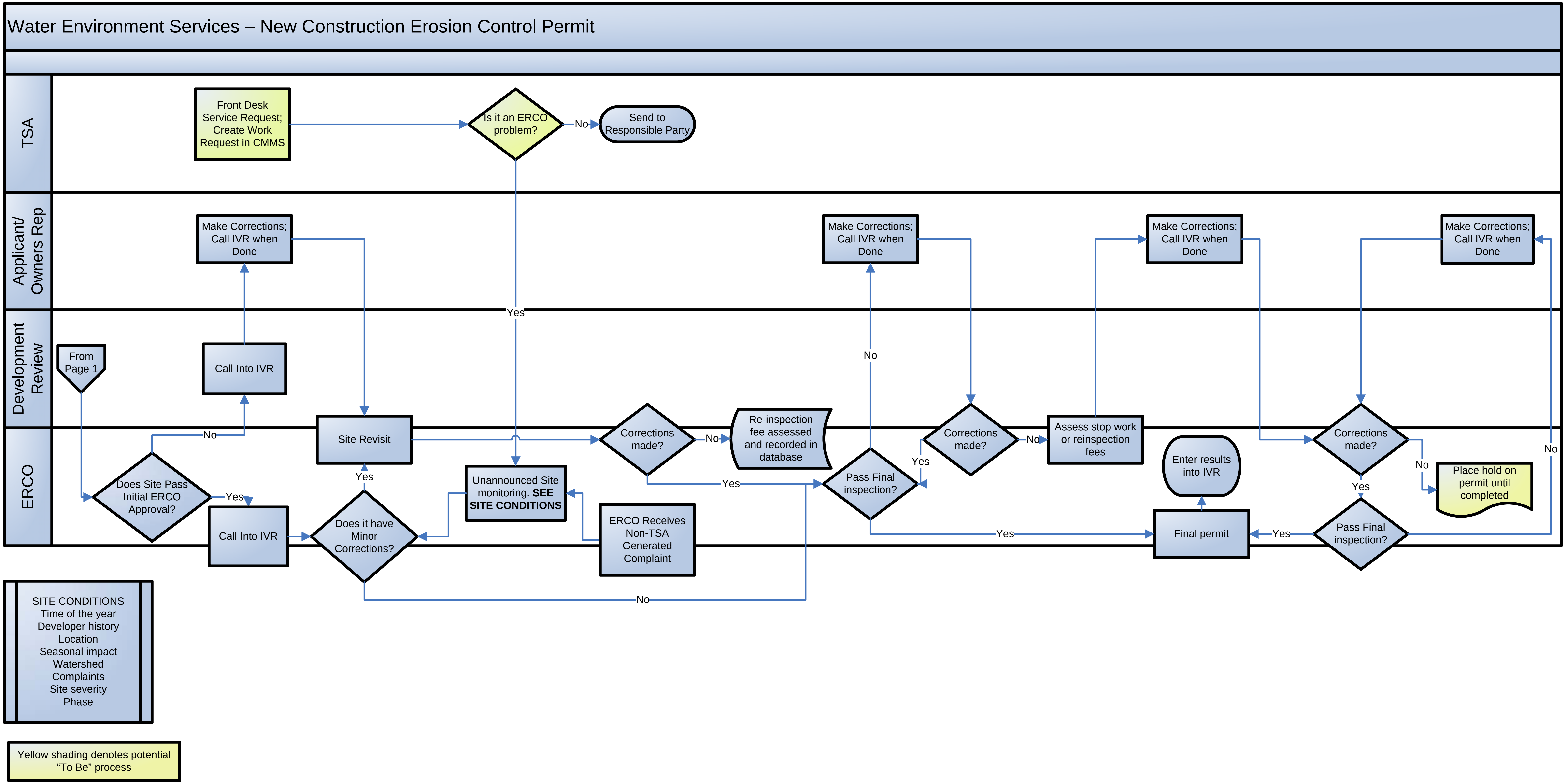


Figure A-8 (page 2)

WES SOILS PROGRAM

GENERAL GRADING PERMIT
FLOW CHART

1/28/2008

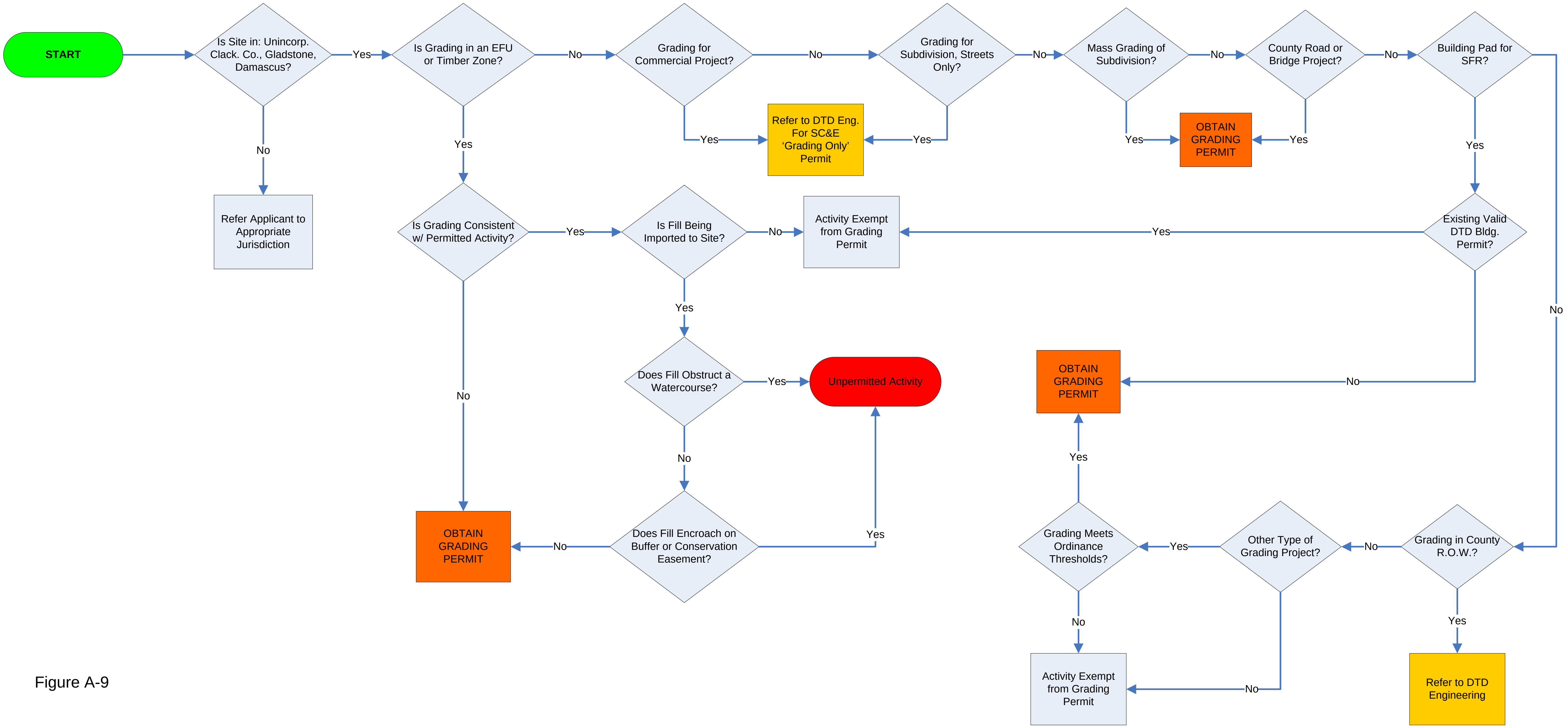


Figure A-9

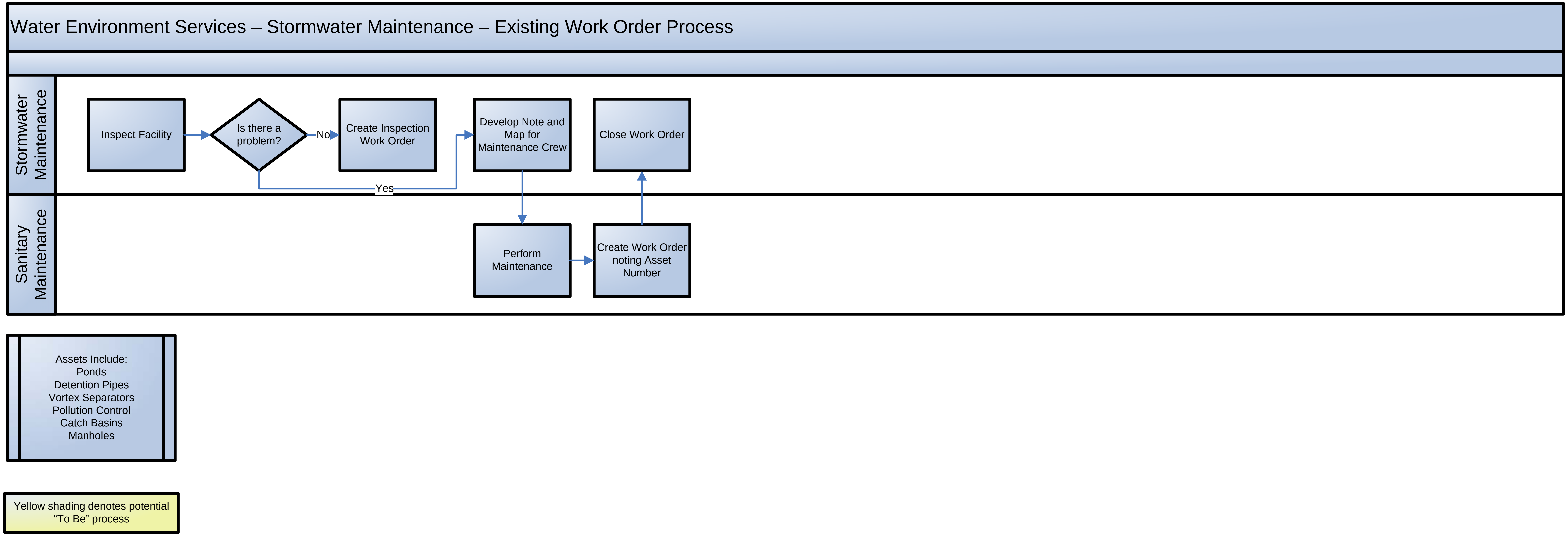

Water Environment Services – Stormwater Maintenance – Existing Work Order Process
Stormwater Maintenance
Sanitary Maintenance
Inspect Facility
Is there a problem?
No
Yes
Create Inspection Work Order
Develop Note and Map for Maintenance Crew
Close Work Order
Perform Maintenance
Create Work Order noting Asset Number
Assets Include:
Ponds
Detention Pipes
Vortex Separators
Pollution Control
Catch Basins
Manholes
Yellow shading denotes potential "To Be" process

Figure A-10

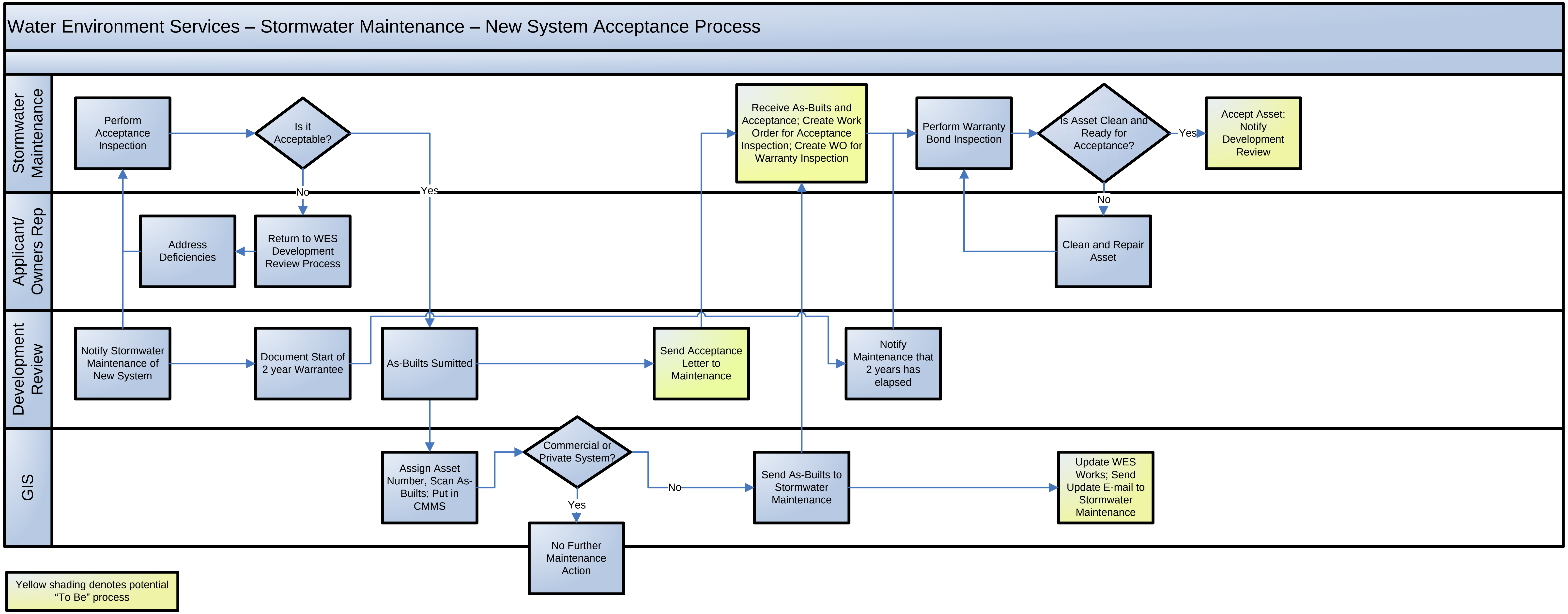

Water Environment Services – Stormwater Maintenance – New System Acceptance Process
Stormwater Maintenance
Applicant/ Owners Rep
Development Review
GIS
Perform Acceptance Inspection
Is it Acceptable?
No
Yes
Receive As-Buits and Acceptance; Create Work Order for Acceptance Inspection; Create WO for Warranty Inspection
Perform Warranty Bond Inspection
Is Asset Clean and Ready for Acceptance?
Yes
No
Accept Asset; Notify Development Review
Address Deficiencies
Return to WES Development Review Process
Clean and Repair Asset
Notify Stormwater Maintenance of New System
Document Start of 2 year Warrantee
As-Builts Sumitted
Send Acceptance Letter to Maintenance
Notify Maintenance that 2 years has elapsed
Assign Asset Number, Scan As-Builts; Put in CMMS
Commercial or Private System?
No
Yes
Send As-Builts to Stormwater Maintenance
Update WES Works; Send Update E-mail to Stormwater Maintenance
No Further Maintenance Action
Yellow shading denotes potential “To Be” process

Figure A-11

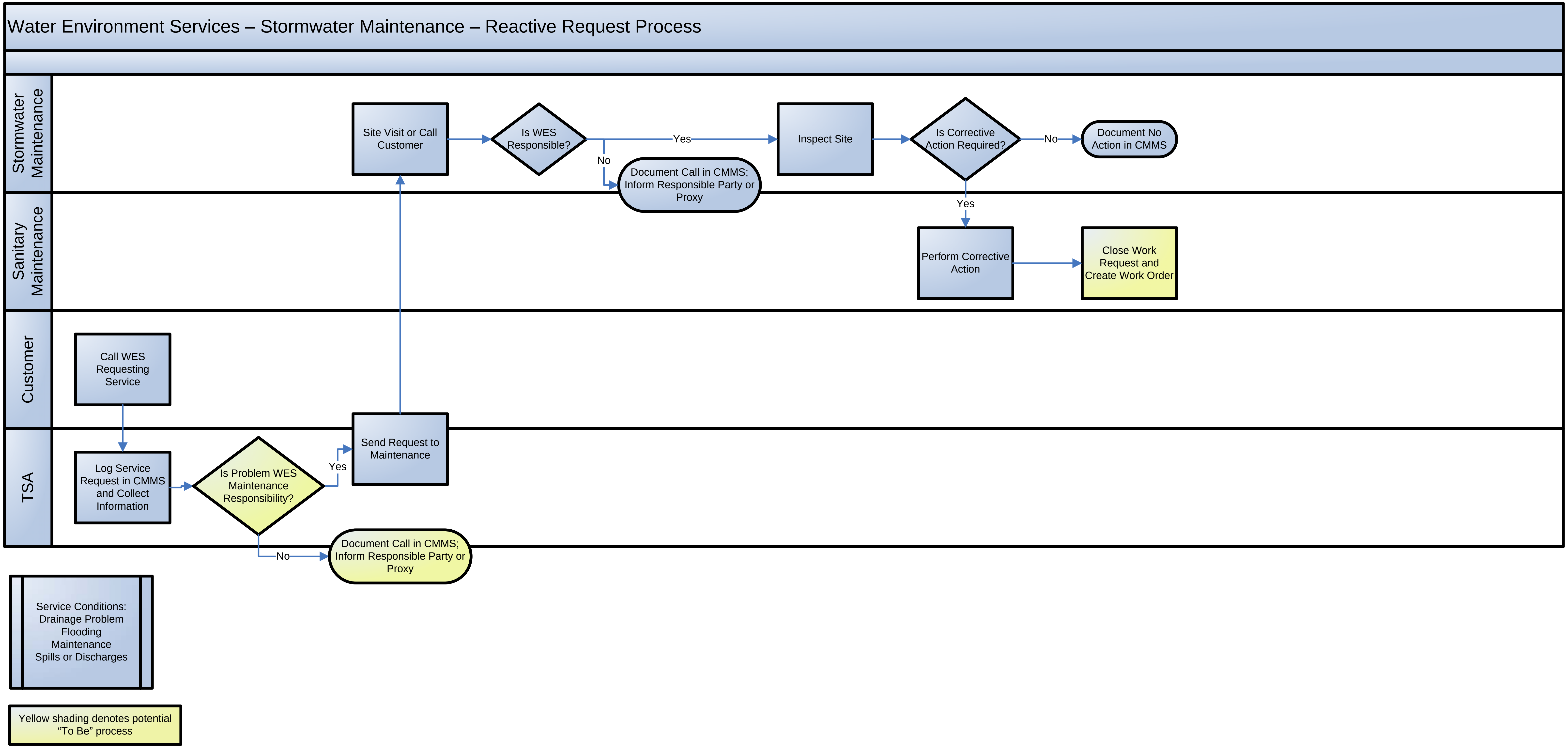

Water Environment Services – Stormwater Maintenance – Reactive Request Process
Stormwater Maintenance
Sanitary Maintenance
Customer
TSA
Call WES Requesting Service
Log Service Request in CMMS and Collect Information
Is Problem WES Maintenance Responsibility?
Yes
No
Send Request to Maintenance
Document Call in CMMS; Inform Responsible Party or Proxy
Site Visit or Call Customer
Is WES Responsible?
Yes
No
Document Call in CMMS; Inform Responsible Party or Proxy
Inspect Site
Is Corrective Action Required?
No
Document No Action in CMMS
Yes
Perform Corrective Action
Close Work Request and Create Work Order
Service Conditions:
Drainage Problem
Flooding
Maintenance
Spills or Discharges
Yellow shading denotes potential “To Be” process

Figure A-12

10/16/2008

Environmental Monitoring Division

Subtitle

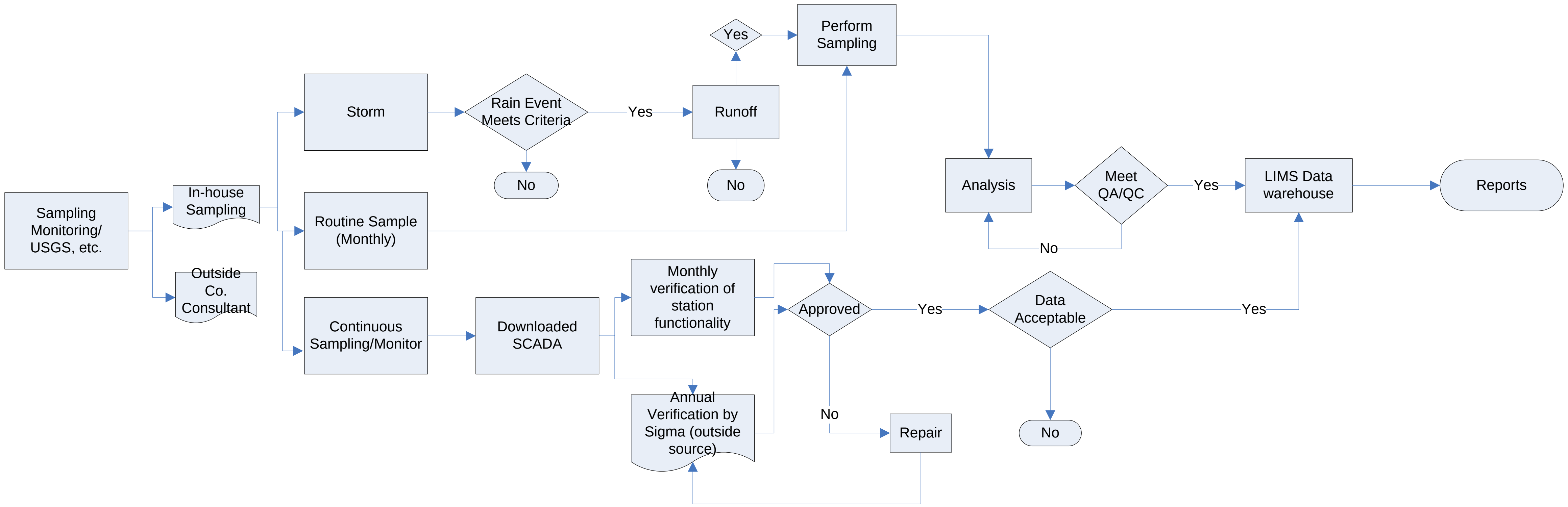


Figure A-13

Revised 10/16/08

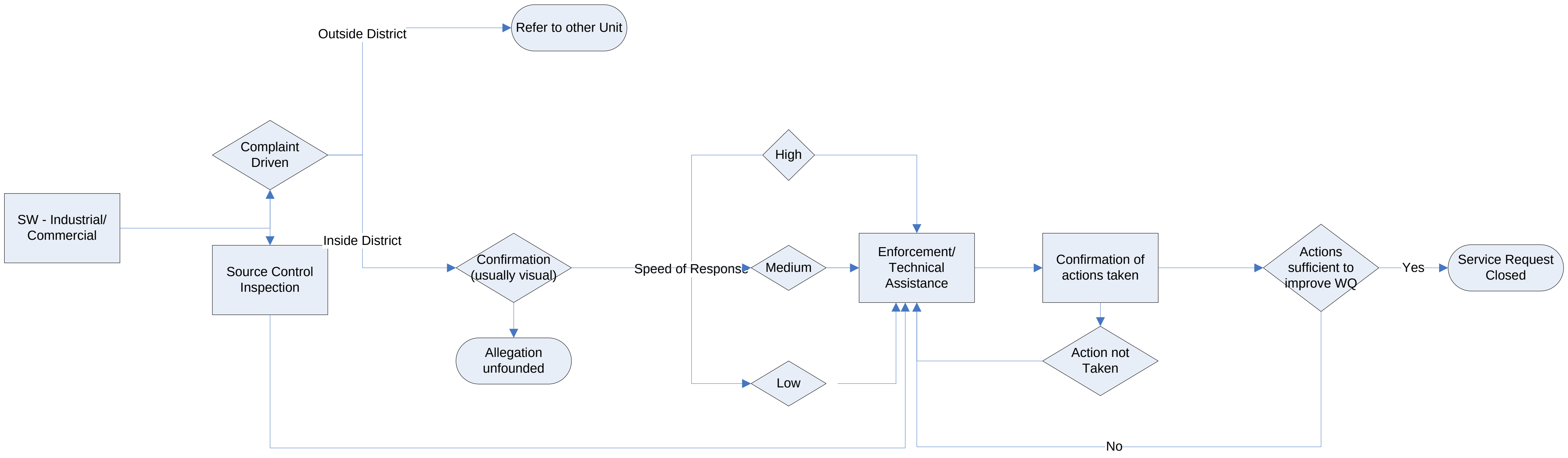


Figure A-14

Revised 10/16/08

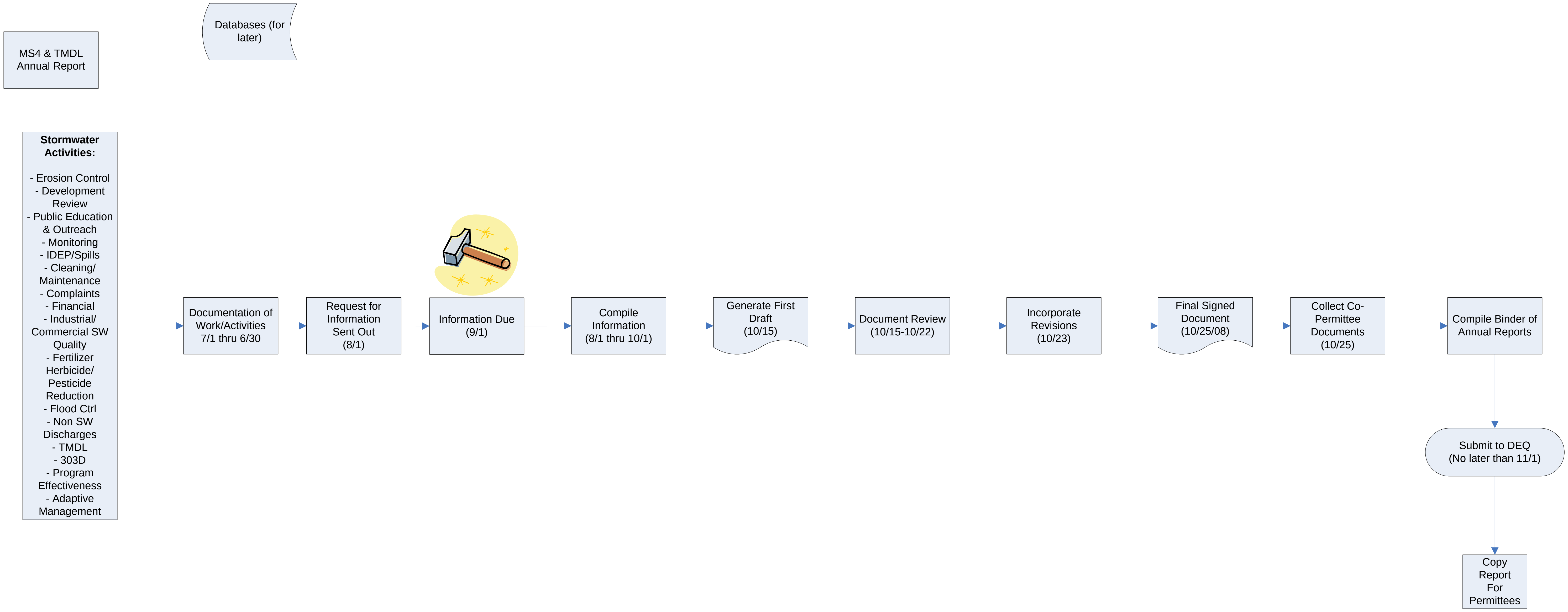


Figure A-15

Revised 10/16/08

10/16/2008

Environmental Monitoring Division

Subtitle

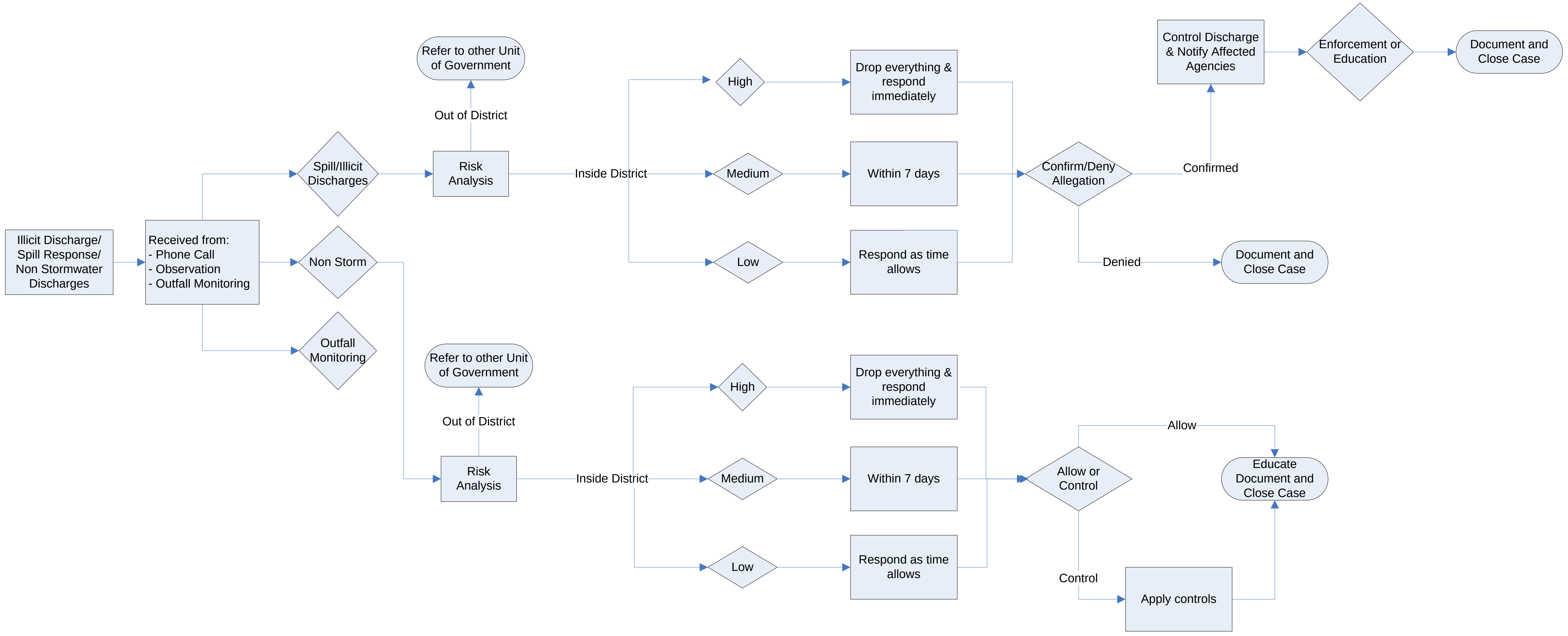


Figure A-16

Revised 10/16/08

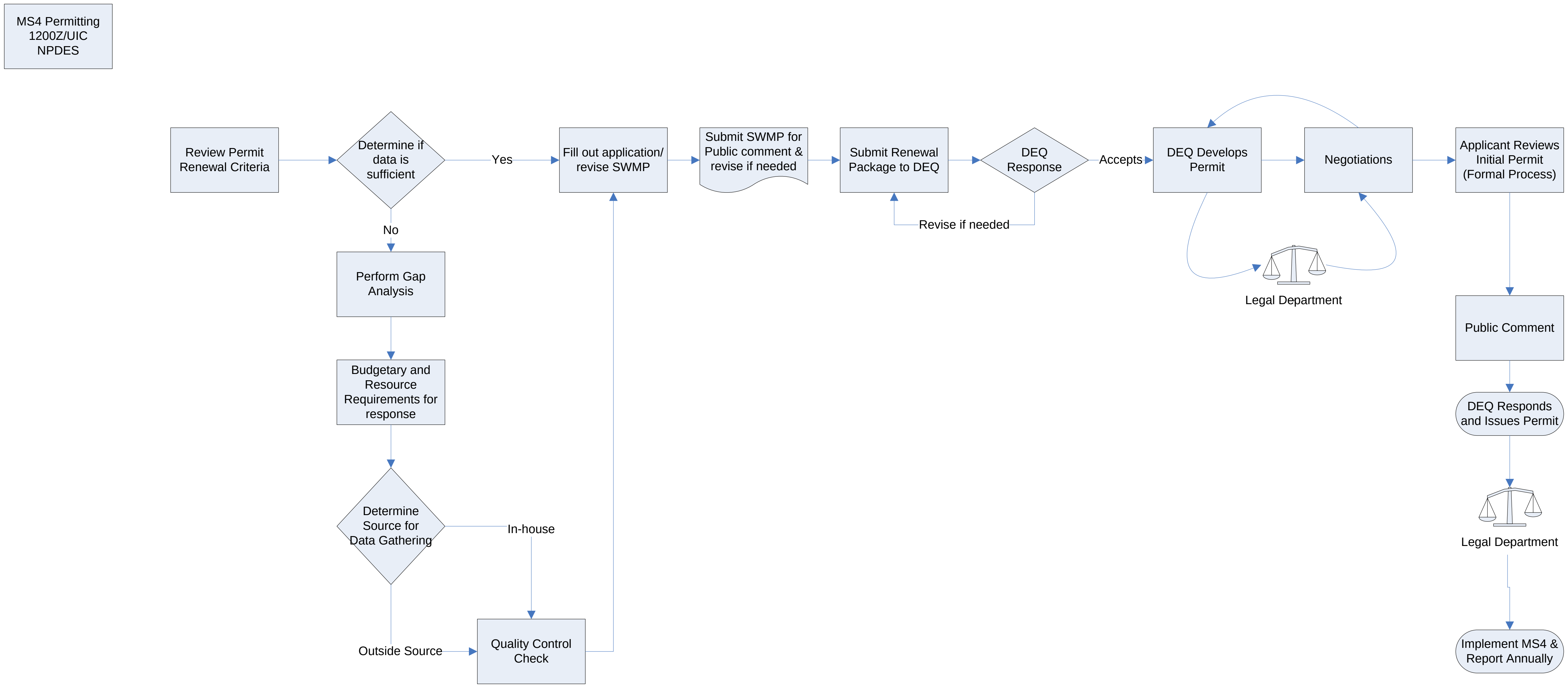


Figure A-17

Revised 10/16/08

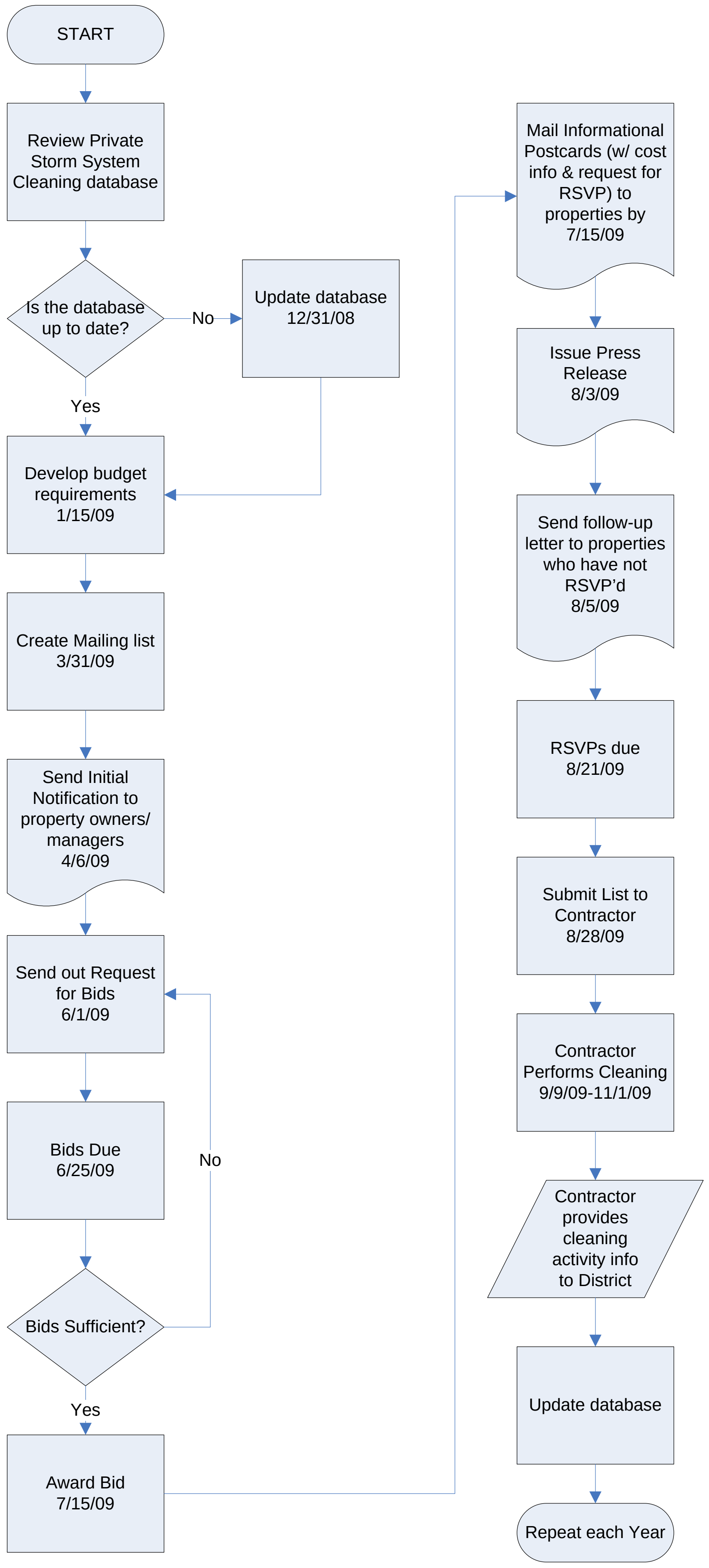


Figure A-18 (page 1)

Revised 10/16/08

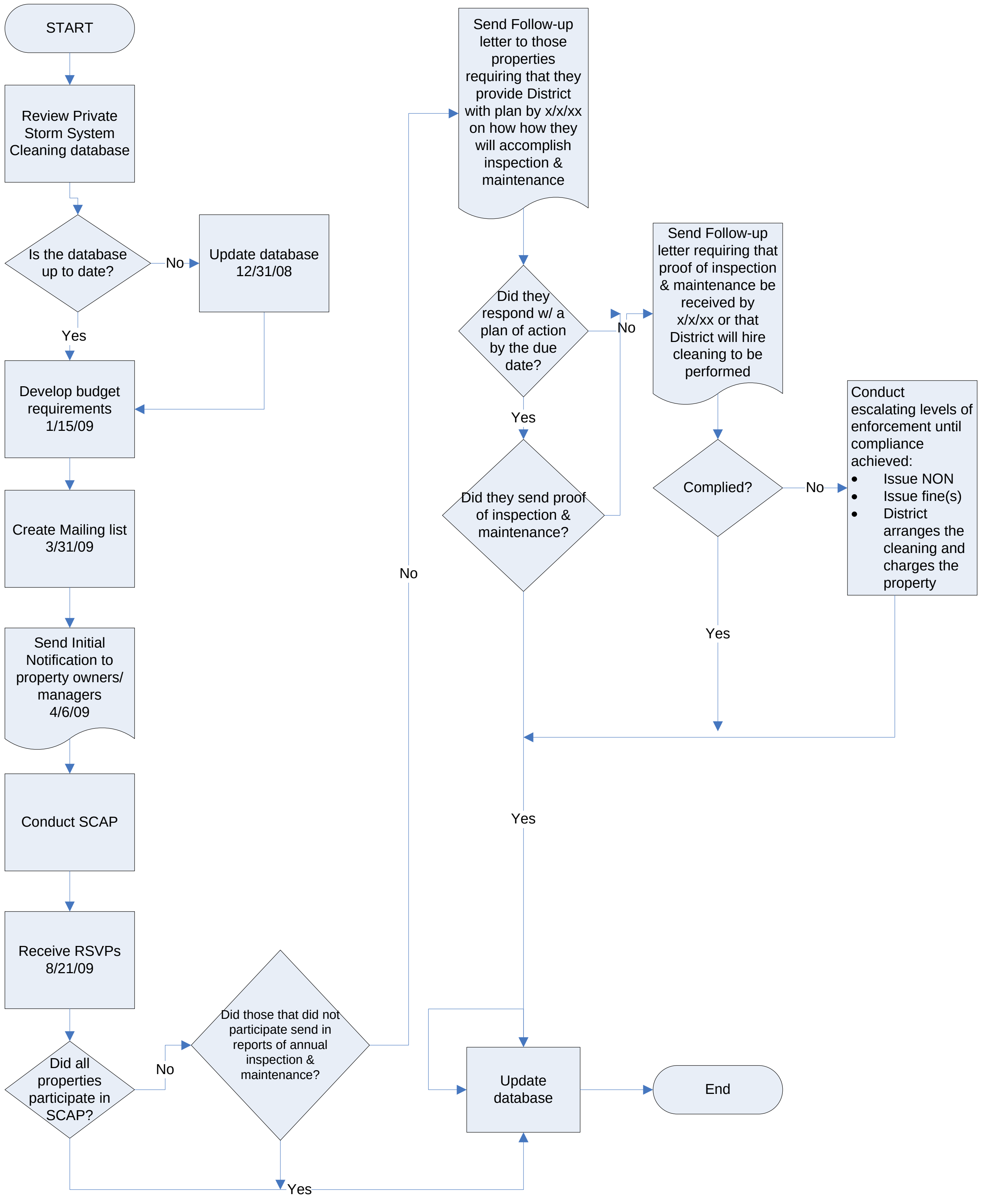


Figure A-18 (page 2)

Revised 10/16/08

APPENDIX B

WES EXISTING DATA INVENTORY

Document Name	Prepared By	Year Completed	Comments
Macroinvertebrate Communities in Streams of the CCSD#1 Area of Clackamas County	ABR, Inc	2008	Similar to the 2002 study, the 2007 study involved the collection and evaluation of habitat, water quality and benthic community data for CCSD#1. All streams were impaired, however, a few improved from moderately impaired in 2002 to slightly impaired in 2007. Additional studies are required to determine if the stream health improvement is a trend. The study also compared the RIVPACS analysis method with the mutimetric index, the two agreed in this study.
Macroinvertebrate Communities in Streams of the SWMACC Area of Clackamas County	ABR, Inc	2008	Not in our area of study, but similar to the CCSD#1 Macroinvertebrate study in scope. CCSD#1 is document number 90.
Clackamas County Wetland Mitigation Monitoring Report (Happy Valley Nature Park), 6th Monitoring Event	amec	2008	6th and final monitoring report for the Sunnybrook West Clackamas County transportation project. Monitoring results indicate that goals of the wetland mitigation have been reached.
Clackamas County Wetland Mitigation Monitoring Report (Sunnyside Road Improvements, Phase 1), 5th event at Mt. Scott Creek and 6th event at Valley View Church	amec	2008	Some mitigation goals were not met; the unmet goals were related to required native plant survirorship and percent cover and percent cover of non-native species. Vandalization of plants under the bridge of the Mt. Scott Creek site was noted as a reason for reduced plant survivorship.
Nature-friendly Development Practices: City of Happy Valley Policies, Code, and Procedures Audit	Angelo Planning Group	2008	A planning memo summarizing how the draft City of Happy Valley Development Code and related documents addresses the Title 13 program (Nature in Neighborhoods, compliance required by 01/05/2009), what current barriers to meeting Title 13 are and recommendations to incorporate more nature friendly standards into the code.
Clackamas County Sustainability Action Plan	Board of County Commisioners	2008	
Water Quality Data Trend Analysis 1995 - 2008 (for NPDES MS4 Permit Renewal)	Brown and Caldwell	2008	
Telephone survey about sewage management	CFM Research	2008	
Action Plan Framework for a Sustainable Clackamas County, Action Plan Data Request from Robert Storer, Action Plan Framework Related E-mails.	Clackamas County	2008	Email: Contains a list of WES departmental areas, the employees associated with them and the information they should provide. Table: Breaksdown the 2050 goals, the needed actions and subsequent tasks.
Clackamas River Water Providers Annual Report, Fiscal Year 2007-08	CRWP	2008	Created in September 2007, the CRWP is a new organization including the City of Lake Oswego, Clackamas River Water, the North Clackamas County Water Commission, South Fork Water Board, Sunrise Water Authority. Staff members include a Water Resource Manager and a Water Conservation Program Coordinator. Plans, projects and programs are summarized as part of the annual report.
City of Damascus Pilot Scale Stormwater Master Planning	Damascus and CH2MHill	2008	
Flood Insurance Rate Maps (FIRMS)	FEMA	2008	Flood Insurance Rate Maps (FIRMS). Individual maps for each panel shown on the paper index map.

Document Name	Prepared By	Year Completed	Comments
Flood Insurance Study (FIS)	FEMA	2008	The flood insurance study for Clackamas Co. and incorporated areas, covering the same area as the FIRMS. The document discusses past flooding and hydrologic conditions for specific panels.
FISH SPECIES DISTRIBUTION AND ABUNDANCE AND HABITAT ASSESSMENT OF STREAMS IN CLACKAMAS COUNTY SERVICE DISTRICT	ODFW	2008	
Exhibit A: Statement of Work, CCSD#1 Abundance and Distribution of Fish Species in Streams of Clackamas County	ODFW	2008	Outlines what will be included in the 2008 survey. There are six objectives for the 2008 survey, the 5th identifies the goal of the survey: Identify and prioritize streams and/or stream reaches that are valuable to native fish and prepare a list of actions to protect and restore priority areas within the CCSD#1
Kellogg and Mt. Scott Water Temps	ODFW	2008	
ODFW CCSD1 Fish IBI 2008 vers 2003 Preliminary	ODFW	2008	One page document listing IBI scores for specific stream reaches. Of the reaches where 2003 and 2008 data is available, 8 reaches improved, 2 reaches declined. One of the thirteen reaches is acceptable (rock creek).
ODFW Fish Survey	ODFW	2008	Data is available in Access database. Data has not yet been linked to GIS files. WES would like guidance on level of detail (specific fields from database) to add to GIS.
ODFW Progress Report: Abundance and Distribution of Fish in Streams of CCSD#1	ODFW	2008	Objective one has been completed. Appendicies contain record of data collection. Reaches are identified.
FINAL Hydrologic Flashiness Index	Pacific Water Resources, Inc	2008	The basins studied lack long-term flow data, which elimiates the use of some indicies. The $Q_{10/2}$ Index is recommended. This index is a ratio of the 10-year forested peak flow over the 2-year existing peak flow, it is recommended because it can be used without waiting for more flow data to be collected and verified.
DRAFT Hydrologic Flashiness Index	Pacific Water Resources, Inc.	2008	The memo provides a brief literature review for proposals of various hydrologic flashiness indicies and proposes an index for use by WES.
Pesticide Occurrence and Distribution in the Lower Clackamas River Basin, Oregon, 2000-2005 (No. 2008-5027)	USGS	2008	Provides pesticide concentrations, outlines pesticide sources based on land use and indicates possible biological effects from pesticide exposure. An updated version of the 2000-01 report (No. 03-4145), 1,500 additional pesticides were registered between the two reports.
Capital Improvements Program, Five Year Plan, Fiscal Years 2009-2013	WES	2008	The purpose of the report is to outline needed facilities and infrastructure upgrades. The recommended CIPs are meant to reflect a shift from a utility based management approach to a watershed management philosophy. SWM is a component of the report, which aims to meet regulatory requirements, provide flood protection and adequate drainage, while supporting water quality, wildlife habitat enhancement and recreations opportunities. The bulk of the planned dollars to be spent on SWM CIPs are targeted for 2010-2012.
CCSD#1 and SWMACC Annual Report Draft	WES	2008	Report on SW compliance and Tualitin basin TMDL
GIS data	WES	2008	WES has extensive GIS data for review. Brown and Caldwell has reviewed layers available and requested a list of maps.

Document Name	Prepared By	Year Completed	Comments
MS4 2008 Maintenance	WES	2008	List of maintenance activities
Table 2: Clackamas County WES (SWMACC, CCSD#1, and the Cities of Happy Valley and Rivergrove) MS4 Annual Report Submittal 2007-2008	WES	2008	
UIC (Underground Injection Control) WPCF permit application	WES	2008	Permit requirements will include a monitoring plan. Andrew Swanson is working on application currently. DEQ plans to develop WPCF permit for multiple cities at the same time during 2008-2009.
Watershed Action Plans (WAP) Pre-proposal meeting	WES	2008	The powerpoint for the pre-proposal meeting that WES had to discuss needs and criteria for selection of a firm to do the watershed assessment work. The folder is labeled #17
CCSD#1 and SWMACC NPDES MS4 Permit Application	WES and URS	2008	
Clackamas County Wetland Mitigation Monitoring Report (Happy Valley Nature Park), 5th Monitoring Event	amec	2007	5th report for Happy Valley Nature Park. Condition 2: *Native wetland species must cover 80% of wetlands in the created depressions in Area E* was **not met**. All other conditions were met or exceeded requirements.
City of Happy Valley Engineering Design Standards Manual	City of Happy Valley Public Works Department	2007	The manual's engineering design standards are written generally for environmental protection during construction, but refer the reader to DEQ, WES, AWWA and USACE standards for more details. Includes CAD standard details for roadwork.
DRAFT Biology Technical Report (Sunrise Project, I-205 to Rock Creek Junction)	ODOT/Clackamas County	2007	The report inventories current wildlife habitat and species located within those habitats. Sensitive plants, mammal and fish species are considered in the selection of a build alternative. Maps show riparian and upland habitat at the sunrise location in addition to the construction/operation boundaries of each project alternative.
DRAFT Water Quality Technical Report (Sunrise Project, I-205 to Rock Creek Junction)	ODOT/Clackamas County	2007	The report describes the potential water quality impacts that the Sunrise Project will have on Dean Creek, Cow Creek, Sieben Creek and Rock Creek. Includes potential alignments and resulting areas of impact. A full EIS has been completed for the project, copies available from Clackamas County upon request.
DRAFT Wetlands and Other Waters of the State and U.S. Technical Report (Sunrise Project, I-205 to Rock Creek Junction)	ODOT/Clackamas County	2007	The report describes potential impacts to wetlands for the various design alternatives of the Sunrise Project and possible wetland mitigation strategies.
Metro Stormwater Ordinance Review	Otak, Inc.	2007	Metro teamed with WES to provide the stormwater ordinance review, which contains current design practices, ordinances, design standards and future plans for five stormwater management agencies (CWS, City of Beaverton, City of Portland, City of Gresham and King County, WA).
Riparian Shade Assessment and Restoration Priorities Analysis in the Damascus Urban Growth Boundary Expansion Area	Robin K. Leferink, PSU	2007	The report objective was to "quantify existing riparian shade levels and identify priority reaches for shade restoration on CRB streams in the Damascus expansion area. GIS data was interpreted for this report. Headwaters in the Rock Creek basin were found to be less shaded than lower stream reaches. Recommendations for restoration planning included in Appendix B.

Document Name	Prepared By	Year Completed	Comments
Rock and Richardson Creek Master Plan Data	URS and WES	2007	SWMM Model Data
City of Happy Valley Stream Riparian Assessment	VIGIL AGRIMIS and Ellis Ecological Services, Inc.	2007	Study limited to East Happy Valley Expansion Area. The purpose of the report is to guide land use planning and regulations, as the area develops, based on stream riparian resources. A specific goal of the report was to verify accuracy of the GIS stream layer used by the County. Stream reaches were identified and photos of each reach provided as Appendix A.
2006-2007 Water Quality and Flow Monitoring Report	WES	2007	The report presents results of water quality investigations for CCSD#1's municipal separate storm sewer system. Section three describes the areas covered by the report and the results from storm event monitoring at outfalls and drywells. Section four focuses on water quality data (field parameters, nutrients, metals and lab parameters).
Water Quality and Flow Monitoring Report for Clackamas County Service District No. 1's Municipal Separate Storm Sewer System Permit No. 101348	WES	2007	Report summarizes water samples and field measurements that were collected on a monthly basis from July 2005 - June 2006. The purpose of the data collection was to provide a representative look at water quality in CCSD#1. Field parameters included temperature, pH, DO, flow, TDS and conductivity. Laboratory parameters included nutrients (ammonia, nitrate, OrthoP, TotP), E. coli bacteria, metals (Cr, Cd, Cu, Pb, Ni, Zn), oil/grease and TSS.
Damascus Natural Features Inventory	Winterbrook Planning	2007	Inclues Hazards Report and Natural Resources Report with maps and appendicies.
Pleasant Valley Stormwater Master Plan Amendment	WRG Design, Inc	2007	Details for 5 addendums to the Pleasant Valley Stormwater Maaster Plan
Clackamas County Wetland Mitigation Monitoring Report (North Clackamas Regional Park and Flood Control Facility), 4th monitoring event	amec	2006	Mitigation goals were met. Mointoring is in Year 4, however, the vegetation has been in for 6 years. Permission to stop monitoring was requested.
Clackamas County Wetland Mitigation Monitoring, 5th and Final Report	amec	2006	The report shows results of the 5th and final year of wetland mitigation monitoring. Previous monitoring was conducted by Pacific University; amec was hired because Pacific University was not available. Wetland vegetation density has increased from planting density and Himalayan blackberry is the only one of three nuissance species that have been observed on the site. The mitigation site meets permit conditions based on the final year of monitoring.
Sunnyside Road Rock Creek Wastewater Conveyance Project	Bob Storer at WES	2006	One photo in each group is generally labelled, none are individually labelled. One folder of pictures is of the Rock Creek Interceptor.
Damascus Boring Concept Plan	Clackamas Co., Metro, City of Damascus, City of Happy Valley, OTAK, ODOT	2006	Folder includes report and figures
ODOT Cover letter containing: Biology Mitigation Monitoring Report Kellogg Creek Fish Ladder Improvements Project ODOT Key No. 12522	MB&G	2006	Provides recommendations for fish ladder improvements and monitoring observations.

Document Name	Prepared By	Year Completed	Comments
NPDES Storm Water Regulations for Construction Projects	ODEQ	2006	NPDES #1200-C Permit Application Form, Land Use Compatibilty Statement Form, and Erosion and Sediment Control Plan Narrative.
Resident Poll	Riley Research Associates	2006	Results and original survey used to poll WES customers about awareness and satisfaction. Folder #15
CCSD#1 SWMP MASTER PLAN	Shaun Pigott Associates, LLC, Pacific Water Resources, Inc., GeoSyntec Consultants, Norton Arnold & Company	2006	Much of Damascus development has not occured, called the "expansion area" in the report. Large and comprehensive report, including identification of needs, a public incentives plan, study area characterisitics, hydrologic and hydraulic analysis, surface water management plan, water quality management plractives, stream reach quality evaluation and recommended projects. Appendices, technical memos and issue papers contain more detailed information, mostly related to hydraulics and hydrology.
Annual NPDES MS4 report 2006	WES	2006	Report on SW compliance and Tualitin basin TMDL
Rock Creek Large Woody Debris (LWD) Mitigation	WES	2006	Pictures of installation of logs
RFP and Proposal for Happy Valley Local Wetland Inventory (LWI) and Stream Riparian Assessment and map	WES and VIGIL AGRIMIS and Ellis Ecological Services, Inc.	2006	The RFP and proposal for the Happy Valley LWI and stream riparian assessment. Project was scheduled to be complete in December 2007. One of the main project goals was to identify sensitive habitats and subsequently protect those areas from urbanization. Comes with the LWI full size map.
DRAFT Damascus/Boring Concept Plan	Clackamas County	2005	The folder contains materials used for an open community forum to discuss the Damascus/Boring Concept Plan. Land use mapping and planning is included.
Environmental Baseline at Providence Happy Valley Site	DEA, INC	2005	General information related to obtaining necessary permits to move forward with Providence Health Systems Happy Valley site.
Oregon DEQ Water Quality Limited Streams Database in Clackamas Basin	DEQ	2005	The hardcopy list is dated 2005. The following links to a DEQ database, which contains information on water bodies in Oregon currently on the 303(d) and recently removed from the 303(d) list. http://www.deq.state.or.us/wq/assessment/rpt0406/search.asp
Email from Ed Salminen to Bob Storer Subject: Clackamas Watershed Action Plan Sub-basin Maps.	Ed Salminen	2005	Ed responded to a request by Bob for detailed maps for the Damascus area (Rock Creek). He provided three links: 1) http://www.inforain.org/mapsatwork/rockrichardson 2) http://www.mwcouncil.org/fw/subbasinplanning/willamette/plan 3) http://www.mobrain.com/edt/; follow the link to NW Power & Conservation Council. The full EDT assessment is in the inventory and the first link provided no longer exists. Inforain is a watershed locator, which can be found at www.inforain.org/watershed/index.php
Damascus 2003 Macroinvertebrate Study Sites	Metro	2005	DO NOT disturb or contact property owners on list without checking first with Lori H. (Metro).
Metro's Technical Report for Fish and Wildlife Habitat	METRO	2005	The report is more of a guide that introduces a watershed perspective, followed by a discussion of aquatic and riparian habitat, upland habitat, and restoration in an urban environment. The restoration section begins with basic definitions and ends with specific restoration strategies and watershed assessment activities. There is also an extensive list of cited literature.

Document Name	Prepared By	Year Completed	Comments
Surface Water Management Rules and Regulations for CCSD#1	WES	2005	Includes a declaration of the policy, definition of terms, dishcharge regulations, environmental protection and erosion control rules, additional surface water management standards, rates for surface water service, collection of charges, enforcement, appeals and supplementary rules. Website link http://www.co.clackamas.or.us/wes/rule.jsp.
WES Rates and Charges Effective October 1, 2005	WES	2005	Table of rates. Website link for Customer and Financial Services with current information: http://www.co.clackamas.or.us/wes/financial.htm
Clackamas River Basin Action Plan	WPN	2005	A report that encompasses the entire Clackamas River Basin and includes basin background, basinwide strategies and actions, and geographic area strategies and actions. Rock and Richardson Creeks are included. 91% of the rock creek watershed is in the UGB, so CRBC is focusing efforts to preserve the streams as urbanization occurs.
DRAFT and FINAL 2003 Baseline Assessment of Streat Habitat and Macroinvertebrate Communities in and Adjacent to the Damascus Area UGB Expansion, Oregon	ABR, Inc	2004	Lower reaches of Rock Creek are more heavily forested than upper reaches. Benthic conditions are more favorable in lower reaches. Conclusion: forested riparian areas provide streams with significant protection, resulting in improved benthic communities.
Future Potentially Viable Farmland	Clackamas Co. Soil and Water Conservation District	2004	The map illustrates agricultural use and groundwater limited areas for Damascus and Boring.
Sunrise Project Environmental Baseline Report	DEA	2004	Land use information in the proposed project area, which includes general zoning, specific ownership information, and an inventory of wildlife and wetland areas. Other general corridor conditions covered include socioeconomics, archaeology, historic resources, biology, wetlands and other waters, water quality and geology and soils. The report is aimed to cover environmental issues that will cause design constraints as the Sunrise project goes forth, therefore, possible animal/plant species are listed, but an actual site inventory is not completed.
Summary Report for Clackamas County and CCSD-Owned/Operated Stormwater Injection Devices	Department of Transportation & Development CCSD#1 SWMACC	2004	Report contains eight BMP updates related to UIC and an appendix with more related information.
Chapter 6: Clackamas Sub Basin TMDL of DRAFT Willamette Basin TMDL	DEQ	2004	Report contains sub basin overview followed by temperature and bacteria TMDL summaries, loading capacities, wasteload allocations, surrogate measures, margins of safety and reserve capacities. Portland General Electric (PGE) and Portland State University (PSU) co-developed a 2-D model to evaluate the effects of hydroelectric project operations on stream temperature; their data was used with ODEQ data to compile report. Pages 69-76 are attached TMDL regulation information.
DRAFT EDT Assessment of Aquatic Habitat in the Clackamas Subbasin	Mobrand Biometrics, Inc.	2004	Specific sections of the Clackamas River Subbasin are selected and assessed for salmon habitat; habitat is first evaluated by fish population and secondly by geographic area. General recommendations are made based on assessment results. See page 52 for Lower Clackamas tributaries.

Document Name	**Prepared By**	**Year Completed**	**Comments**
Portland Plant List	Portland Bureau of Planning	2004	List of plants native to Portland, OR. Includes name, description and illustration. Insert includes a list of plants and their preferred habitat, i.e. wetland, forest, etc.
Pesticides in the Lower Clackamas River Basin, Oregon, 2000-01 (No. 03-4145)	USGS	2004	Provides pesticide concentrations, outlines pesticide sources based on land use and indicates possible biological effects from pesticide exposure. Data from this report can be obtained from Clackamas Basin Water-Quality Assessment http://oregon.usgs.gov/clackamas
Customer Satisfaction & Community Values Questionnaire	WES	2004	A report of results from a customer satisfaction and community values survey. The goal of the questionnaire was to determine customer satisfaction and expectations, awareness of services and programs, identify needs and prioritize programs, and provide a framework for measuring the results of our communications efforts.
Summary of Erosion and Pollution Prevention Requirements	WES	2004	Brief one page summary of requirements for inspection approval.
Metro Bug 2003 Habitat Data	Metro	2003	8 compilations of hard copy excel data. Data is unlabeled, the excel file and an acronym key would be needed to use the data.
Abundance and Distribution of Fish in Clackamas County Urban Streams (Final Report 2002-03)	ODFW	2003	The report presents results of investigations of fish communities. Specifically listed and relavent were Mt. Scott watershed, Kellogg watershed and Rock Creek watershed. Much of the stream habitat surveyed was deemed unacceptable, but some improvements in stream quality, believed to be a result of restoration efforts, were noted.
Rock & Richardson Creek FEMA Floodplain Study. Project #W150123. Volumes 1-3	Pacific Water Resources and WES	2003	Volumes 1-3 contain all project related information, from the RFP in Volume 1 to the final deliverable in Volume 3. The final deliverable report from Pacific Water Resources is also in the inventory seperately (Hydrologic Modeling for the Floodplain Mapping of Rock and Richardson Creeks). The objective of the report is to develop flows for the mapping of floodplains in the Rock/Richardson Creeks watershed.
Hydrologic Modelling for the Floodplain Mapping of Rock and Richardson Creeks	Pacific Water Resources, Inc. and DHI Water and Environment	2003	The objective of the report is to develop flows for the mapping of floodplains in the Rock/Richardson Creeks watershed. The MIKE II model with its unit hydrograph module (UHM) was used for modelling.
Surface Water Management Administrative Procedures for CCSD#1 and SWMACC	WES	2003	Admin procedures updated in Jan. 2003 that include 1. Provisions for reduction/credit of the surface water service charge, 2. Erosion control certification program and 3. Application of undisturbed buffer requirements, natural resource assessments and process for requesting a variance on standard buffers.
Subregional Detention Facilities, Happy Valley	WRG	2003	Design report for two regional detention ponds.

Document Name	**Prepared By**	**Year Completed**	**Comments**
Assessment of Macroinvertebrate Communities in Streams of North Clackamas County	ABR (Michael B. Cole)	2002	26 study reaches in North Clackamas County were analyzed for macroinvertebrate communities, physical habitat and water chemistry. The report objective is to use macroinvertebrate communities as an indicator of watershed health. In CCSD#1 only Richardson Creek scored high enough to be classified as only slightly impaired. In SWMACC, only Fields Creek scored high enough to only be in the slightly impaired range.'
North Clackamas Regional Flood Control Facility Operations Manual	Kurahashi & Associates, Inc	2002	Operations Manual. 2 CD's were attached to binder. One has pictures from benthic surveys and the other is pictures of CCSDI Storm Events 2005-2007
2002 Kellogg Creek Restoration Project: Section 206: Sediment Quality Evaluation	Milwaukie	2002	Restoration Plan for the Kellogg Dam Removal
Clackamas County and County Service District-Owned/Operated Storm Water Injection Devices	Department of Transportation & Development CCSD#1 SWMACC	2001	Contents include WPCF Permit Application and Facility Plan Report, Evaluation of Potential Groundwater Impact from Storm Water Injection, and Rule-Authorized Certification.
Mt. Scott Screek Fish Passage & Stream Restoration Decision Recommendation Report	KPFF	2001	Report details five options to restore a dam to allow for fish passage near Scott Creek Park Subdivision. Cost included. No recommendations for the best option.
A Watershed Assessment of Kellogg and Mt. Scott Creeks	MWH	2001	The report objective was to assess the watershed to determine current fish habitat, evaluate potential barriers to fish passage in Kellogg basin and develop restoration recommendations.
Clackamas County Service District No. 1 Sanitary Sewer Rules and Regulations	WES	2001	http://www.co.clackamas.or.us/wes/rules.jsp
Registration of Underground Injection Systems which are Owned and/or Operated by Clackamas County	Department of Transportation & Development CCSD#1 SWMACC	2000	Appendix A, maps of Clackamas County, missing from report.
Rock and Richardson Creek Watershed Assessment	Ecotrust	2000	A general report wrtitten for Rock Creek and Richardson Creek watersheds, which provides information on the basin history, future land use, wildlife habitat and flow information. http://www.clackamasriver.org/basins/rockRichardson/rr.html
Upper Kellogg Creek Flood Hazard Reduction Projects Report	Harper houf Righellis, Inc.	2000	The report investigated the feasibility of CIPs suggested in the Kellogg-Mt.Scott Creeks Watershed Surface Water Master Plan (July 1997), specifically the effectiveness of channelizing Kellogg Creek vs. using detention. Channelization of Kellogg Creek was deemed physically possible, but not feasible from a permitting or cost standpoint.
Rock and Richardson Creek Landscape and Natural Resource Assessment	METRO	2000	A wholistic report focused on Rock/Richardson Creek watershed, which touches on existing conditions and landscape ecology and subsequently provides recommendations and suggests further studies.

Document Name	Prepared By	Year Completed	Comments
Rock & Richardson Creek SWMP	URS	2000	An analysis of Rock Creek watershed followed by recommendations for improvement. Also includes Richardson.
Erosion Prevention and Sediment Control Planning and Design Manual	WES, Unified Sewerage Agency of WA County, City of West Linn	2000	http://www.co.clackamas.or.us/wes/designmanual.htm
Distribution of Fish and Crayfish and Measurement of Available Habitat in Streams of the North Clackamas County (Final Report- 1997-1999)	ODFW	1999	The report provides an overview of current fish and crayfish populations in the Kellogg, Mt. Scott, and Rock Creek watersheds. Conclusions and recommendations about fish/crayfish populations are also made; in general the habitat is poor and fish populations are significantly lower than historic populations.
SWM Work in Happy Valley (January-Present)	WES	1999	A record of maintenance requests and repairs. Most issues are related to drainage and flooding in subdivisions.
The Functions of Riparian Buffers in Urban Watersheds	Jennifer Leavitt (M.S. University of Washington)	1998	A general report on the functions of riparian buffers with a specific case study for Rock Creek and Richardson Creek. The original report contained soil maps, temperature data and riparian buffer information that was appendicized but not included with this hard copy.
Kellogg-Mt. Scott Creeks Watershed SWMP Main Report	Montgomery Watson	1997	Focused on flooding and meeting permit requirements.
E.S.E.E Analysis of Conservation Wetland Sites	Clackamas County Department of Transportation and Development	1996	A record of wetland resource sites within clackamas county.
DRAFT Kellogg-Mt. Scott Creeks Watershed SWMP Volume 3- Plan Report	Montgomery Watson	1996	DRAFT Milwaukie section of the Kellogg-Mt. Scott Creeks Watershed SWMP Main Report (1997)
Clackamas Towncenter Area Drainage Study	Otak, Inc.	1982	Drainage study and recommendations. Could be useful in comparing drainage characteristics then vs. now. Hydraulic modelling was conducted with SWMM and 100-year hydrographs included.
Kellogg Creek Storm Drainage	CH2M	1970	Purpose of the study was to develop a drainage plan that would prevent and remediate problem areas in the drainage system where land use is imparied by local flooding and poor drainage.
Clackamas River Watershed	Ecotrust		A list of documents for the Clackamas River Watershed and a list of watershed assessments done, including a Rock and Richardson Creek Watershed Assessment (http://www.clackamasriver.org/basins/rockRichardson/rr.html). The assessment was done in October of 2000 and prepared by Ecotrust. It includes channel stability, soil types, water supply, water quality, hydrology, land use and salmonid distribution.
1996 Flood Map	WES		1996 Inundation map with possible willing sellers program locations.

Document Name	Prepared By	Year Completed	Comments
CCSD#1 Surface Water Management Maintenance Agreement Program Q&A	WES		Describes the shift from a subdivision paying for their own maintenance of their storm system through a Homeowner's Association to the District collecting fees and performing the maintenance. WES Home: http://www.co.clackamas.or.us/wes
Natural Resource Assessments	WES		Section 3.3, 3.3.1 Introduction states: This section presents methodologies for determining the location, size, and condition of sensitive areas, vegetated corridors, and steep slopes in project areas, as well as the definitions and data required for these determinations.
Rules and Specifications for Grading: County Code Title 9, section 9.03 Excavation and Grading	WES		Standard specification for excavation and grading. Website link for current information: http://www.co.clackamas.or.us/wes/rules.jsp#grading
Section 3: Application of Undisturbed Buffer Requirements and Process for Requesting a Variance on Standard Buffers	WES		Guidelines on buffer requirements and the application to request a variance on standard buffers.
Standard Surface Water Specifications, Sections 1-4, Appendicies A-D	WES		Standard surface water specs. Website link for current information: http://www.co.clackamas.or.us/wes/specifications.htm
SWMP Stream Reach Evaluation Tool Notes	WES		Compilation of various handwritten and word processed notes for reaches of Rock Creek.
Kellogg Lake Section 206 Sediment Volume and Characteristics	Milwaukie		
LIDAR Data in GIS	WES		SH+G has begun review.
Happy Valley Information	Happy Valley and consultants	Varies	Happy Valley Hazards Map, 2008 Transpo Plan, Zoning Map, PSU report, Rock Creek Comprehensive Plan, Steep Slopes
Studies for SG Group Webiste	Various authors	Varies	Various studies evaluating methodology for watershed assessment and the effectiveness of BMPs and restoration techniquies. Summary of each article in the folder.
Student Watershed Research Project (SWRP): Clackamas Sites	SWRP	Ongoing	SWRP is a program at Portland State University in the department of Environmental Sciences and Resources. A table suggests the site contains watershed information including a regional map, hydrology, geology, land use, water quality and a list of test sites. http://www.swrp.org
Watershed Health Index	Brown and Caldwell	2008 (pending)	Brown and Caldwell is preparing the WHI
Work Process Mapping for WES Functions	WES and Brown and Caldwell	2008 (pending)	WES has recently developed draft Work Process Flows for Erosion Control and Inspections, Soils Evaluation for Grading, Natural Resource Buffer Review, Happy Valley Single Family Res. Permitting, Maintenance, and CIP Development. Brown and Caldwell will review and then meet with WES work groups to discuss gaps, opportunities, and other issues.
Shierman Portion 2007-08 MS-4 Report	WES	2007-08	WES data on storm system maintenance
Comparison of B-IBI vs TIA and Hydrologic Flashiness Index	WES	2007	A table containing hydrologic flashiness, IBI and TIA scores for eight reaches in the watershed.

APPENDIX C

RATIONALE FOR SELECTION OF KEY HABITAT PARAMETERS

Percent Primary Channel Area Represented by Pool Habitat. Pools are important holding habitat for upstream migrating adult fish and important rearing habitat for juveniles. For the north Cascades, streams with at least 24 percent of their primary channel as pools were considered to be good relative to undisturbed reference conditions, and those with less than 7 percent pools were considered to be poor (Kavanaugh et al., 2006). However, for Coho salmon, optimal habitat is from 40 to 60 percent pools (McMahon, 1983), and Foster et al. (2001) identified less than 10 percent pools and greater than 35 percent pools as undesirable and desirable respectively. Furthermore, it follows, that as the percentage of pools increases above 60 percent, other habitat types decrease proportionally, reducing the habitat complexity. This suggests that an upper boundary is also needed for a high score on the percentage of habitat as pools parameter. Because of the interest in providing Coho salmon habitat within the study area streams we utilized a combination of the Coho habitat suitability index and the Kavanaugh et al. data and established high habitat quality with respect to pools from 40 to 60 percent. Moderate habitat quality ranges from 7 to 40 percent and from 60 to 90 percent pools. Habitats with greater than 90 percent or less than 7 percent pools were considered poor.

Number of Deep Pools per Kilometer. Not only is the absolute number of pools important, but the quality of those pools is key to salmonid growth and survival. Deep pools can provide summer low flow habitat, cold water refugia, cover, and simply more volume for rearing and holding, thereby accommodating more fish and increasing the carrying capacity of a particular reach. The Oregon Department of Fish and Wildlife (ODFW) considered more than four deep pools per kilometer (defined as those greater than 1 meter deep) to be high quality habitat (Kavanaugh et al., 2006). No number was provided for low values. We assigned high scores to reaches with ≥ 4 pools per kilometer, moderate score to reaches with 2 to 4 deep pools per kilometer and low scores to reaches with less than 2 pools per kilometer.

Percent Slackwater Pools. Slackwater pools include beaver ponds, alcoves, dammed ponds and backwaters and are important rearing habitat and refugia during flashy high water events. ODFW considered greater than 0.5 percent of the main channel as slackwater pools to be a high value. As is the case with any habitat unit (riffle, glide, pool, etc.) percentage increases in one habitat unit logically decrease the percentage of others. Therefore it is necessary to put an upper boundary on amount of slackwater pools that is desirable. We considered high quality habitat to be from 0.5 to 30 percent slackwater pools, moderate habitat to be from 0.25 to 0.5 percent slackwater pools, and low quality habitat to contain less than 0.25 percent slackwater pools. From 0.5 to 30 percent for optimal habitat quality is admittedly a very large range. The percentage of the reaches as slackwater pools in the study area ranged from 0 to 67.54 percent and there were no reaches that had between 6.81 and 57.2 percent slackwater pools. Thirty percent was selected as the upper boundary for high quality habitat somewhat arbitrarily; with the thinking being that a particular reach could have roughly one-third slackwater and still provide high quality habitat provided other habitat units (riffle, glide, and pool) were also represented.

Percent Secondary Channels. Secondary channels are also important as rearing habitat and refugia during high flows. Channels with a small percentage of slackwater may make up for this lack of habitat if they have secondary channels available. Secondary channels are reported as the percentage of the total channel area (primary plus secondary). ODFW considered values greater than 4 percent to be high (Kavanaugh et al., 2006). We assigned habitats with less than 2 percent secondary channel habitat a low score; those with from 2 to 4 percent a moderate score and those with > 4 percent a high score.

Percent Fines in Riffles. Excessive fines (silt, organics, and sand particles smaller than 2 millimeters in diameter) can fill the interstices between gravel and cobble substrates that are critical for salmonid spawning and incubation. High amounts of fines in riffles also reduce the habitat available for macroinvertebrates, an important salmonid food source. ODFW (Kavanaugh et al., 2006) considered greater than 19 percent fines in riffles to be excessive. However, Foster et al. (2001) stated that in streams with volcanic parent material, fines percentages greater than 15 percent were undesirable and less than 8 percent were desirable. Maximum Coho habitat suitability occurs when fines are less than or equal to 10 percent and the suitability of the habitat then declines rapidly between 10 and 20 percent fines in riffles. Therefore, we chose 10 percent fines in riffles as the upper boundary for high scores, 10 to 20 percent fines as the range for moderate scores, and > 20 percent fines as the range for low scores.

Percent Gravel in Riffles. Appropriately-sized gravel is important for salmonid spawning and incubation. ODFW (Kavanaugh et al., 2006) considered greater than 49 percent gravel in riffles to be ideal and less than 25 percent to be undesirable. However, Foster et al. (2001) stated that gravel percentages greater than or equal to 35 percent were desirable and less than 15 percent were undesirable. Maximum Coho habitat suitability occurs when gravel is greater than or equal to 60 percent. Taking each of these data sources into account, we assigned high scores to habitat reaches with > 49 percent gravel, moderate scores to those with 20 to 49 percent gravel in riffles, and low scores to those with less than 20 percent gravel.

Pieces of Large Woody Debris (LWD) per 100 meters; Volume of LWD per 100 meters; and Key Pieces of LWD per 100 meters. LWD provides cover directly for salmonids; directs water flow resulting in scour, which shapes the stream bed; and traps gravel important for spawning and incubation. Decomposition of LWD provides organic inputs to the stream at the base of the food chain. Different aspects of LWD are all important, including the number of pieces, volume, and number of key (very large) pieces. The number of pieces and volume are important in that a large number of smaller pieces of LWD would return a high score for that parameter, but a few larger pieces (which would increase the volume) could be just as biologically significant (especially if those larger pieces included root wads). Key pieces of large wood are important because they resist downstream transport and persist in the stream for longer periods, leading to long-term retention of wood (and likely gravel) in the stream. Table A-1 provides ODFW benchmarks for each of the wood parameters from Kavanaugh et al. (2006) and Foster et al. (2001), and the selected benchmarks.

Table C-1. Fish Habitat Scores

Study	Parameter					
	Pieces LWD per 100 meters		Volume LWD per 100 meters		Key Pieces LWD per 100 meters	
	Low	High	Low	High	Low	High
Kavanaugh et al. (2006)	< 7	> 20	< 23	> 68	< 1	> 4
Foster et al. (2001)	< 10	> 21	< 20	> 30	< 1	> 3
Selected benchmarks	< 7	> 21	< 20	> 30	< 1	> 3

Percent Shade. Shade is important in regulating stream temperature. Foster et al. (2001) stated that the low (undesirable) benchmark for west side Cascade streams less than 12 meters in width was < 60 percent and the high (desirable) benchmark was > 70 percent. Kavanaugh et al. provided low and high benchmarks of 80 percent and 92 percent respectively. Because of the greater specificity provided by Foster et al. (2001) in regard to the regional applicability, we selected the 60 and 70 percent low and high benchmarks for use in our rankings.

Number of Large Boulders per 100 Square Meters of Channel. The habitat reaches within the study area are generally lacking in large wood, with none of the reaches in Kellogg, Mt. Scott, or Phillips Creeks receiving a high score on any of the three LWD parameters. However, in stream cover is not only provided by large wood; rather, boulders too can contribute to the development of pools and provide cover both from predators and during high flows. In order to account for another aspect of in stream cover, we included a boulder metric. Previous studies have not provided guidance on benchmarks for boulders in streams, but large differences were apparent in the data for the study reach. We selected benchmarks of 0.1 boulders per 100 meters as the lower benchmark for poor quality habitat and 0.25 boulders per 100 meters as the upper benchmark, above which represented high quality habitat.

APPENDIX D

WES LEVEL OF SERVICE-BASED PRIORITIZATION TOOL FOR WATERSHED ACTION PLANS

Clackamas County Water Environment Services (WES)
Level of Service-based Prioritization Tool for Watershed Action Plans (6/12/09)

Program Elements	WES Goals	Performance Measures	Performance Measure Goal
Environmental permit program management	Meet Permit Requirements	Percent compliance	Full NPDES TMDL UIC implementation
	Reduce pollutant loads through structural BMPs	Percent land treated with BMPs	60% developed land treated with structural BMPs or LID
	Reduce pollutant loads through non-structural BMPs	Percent implementation of non-structural BMPs	100% implementation of NPDES TMDL non structural BMP programs
Environmental policy and watershed health	Support Functioning aquatic ecosystems	See Reach Assessment Criteria	90% reaches Good or Fair average rating for all assessment parameters
	Improve Water Quality	See Reach Assessment Criteria	70% reaches Good or Fair average rating
	Improve Aquatic Habitat and Biological Communities	See Reach Assessment Criteria	90% reaches Good or Fair average rating for Aquatic Habitat & Biological Com.
	Improve Hydrology and Geomorphology	See Reach Assessment Criteria	90% reaches Good or Fair average rating for Hydrology & Geomorphology
Erosion prevention and sediment control	Prioritized Erosion Control (ERCO) site inspections tied to surface water program to preseve ecosystem services	Number of ERCO site inspections done based on priority	100% Inspections Based on Priority
		Reduce Water Quality Impacts of Construction	Full Implementation of WQ BMPs
Program Management	Effective Partnering	Partnering aligned with WES goals	100% Partnering Strategic; Aligned with WES Goals
	Staff understand roles and skills, resources, and abilities meet needed services	Understanding of goals and skill alignment	More than 95% Understand Roles and Skills Aligned
	Monitoring activities increase understanding of ecosystem functions and/or measure progress toward surface water program goals	Data results used to inform management decisions	80% WES Activities Data-Driven

Program Elements	WES Goals	Performance Measures	Performance Measure Goal
Program Management	Program Evaluation and Effectiveness	Program result in better understanding of watershed	Fully Increases Understanding of Management Activities and/or Watershed Conditions
Development Plan Review & Permitting	Development policy allows development while protecting ecosystem services	Maintain existing ecosystem; improve future development sites	90% reaches Good or Fair maintained, Poor Improved to Fair or Good average rating for all assessment parameters
Asset Management	Maximize Cost/Benefit Service	Services for SWM program within revenue base	>80% LOS Implemented, Expenses Met with Revenue
	AM Program Implmentation	SW Program incorporates AM Initiatives	100% SW Projects in alignment with AM Program
	System Reliability	Number of unplanned repairs to assets defined as critical	90% Maintenance & Repairs to Critical Systems Planned
Customer Service	Implement Clackamas County Sustainability Action Plan	Sustainability Action Plan goals and tasks are incorporated in WES activities	SWM program provides full support for relevant Action Items
	Effective Public Outreach Program	Customers recognize WES Services	70% Customers Recognize WES Services
	Maintain Employee Health and Safety	Employee health and safety	0 reportable OSHA incidents
Business Management	Maximize use of alternative funding sources	% funding from alternative sources	5% of funding comes from alternative sources
	Full CIP implementation	CIP Budget Spending	90% Planned CIP Budget spent
	Rate Adequecy	Rates adequate to cover needs	Actual rates in alignment with rate model prediction
	Budget Management Effectiveness	Budget is managed in an effective manner	Actual budgets within 10% of predicted budgets
	Appropriate Polices for Watershed Action Plans	Policies align with goals of Watershed Action Plans	Fully correllated with Watershed Action Plans
Stormwater system maintenance	Regularly scheduled maintenance	Meet inspection goals, set maintenance based on inspection	Meet inspection goals, set maintenance based on inspection
	Sheduled maintenance versus non-scheduled	Maintenance is performed on a scheduled basis not an emergency or non-scheduled basis	80% Maintenance scheduled
	Request-driven maintenance	Request-driven maintenance respond within 72 hours of request	100% request-driven maintenance respond within 72 hours of request

WES Surface Water Program - Level of Service Performance Measures and Gap Analysis, 2009

Notes:

The score of 0 represents the Level of Service goal.

Current score refers to WES staff evaluation of current program metrics.

Anticipated score refers to WES staff evaluation of future program metrics, assuming existing activities are continued and no new activities are undertaken.

The LOS prioritization process evaluates the ability of an action to close the LOS "gap" between the LOS goal and the current and anticipated scores.

Environmental permit program management

Meet Permit Requirements

0	Full NPDES TMDL UIC implementation
1	Full NPDES UIC, Partial TMDL implementation
2	Full NPDES, Partial UIC TMDL implementation
3	Partial NPDES UIC TMDL implementation
4	Partial NPDES, No UIC TMDL implementation
5	No NPDES UIC TMDL implementation

Current: 2

Anticipated: 2

Reduce Pollutant Load Structural BMPs

0	60% developed land treated with structural BMPs or LID
1	50% developed land treated with structural BMPs or LID
2	30% developed land treated with structural BMPs or LID
3	40% developed land treated with structural BMPs or LID
4	20% developed land treated with structural BMPs or LID
5	10% developed land treated with structural BMPs or LID

Current: 4

Anticipated: 4

Reduce Pollutant Load Non-Structural BMPs

0	100% implementation of NPDES TMDL non-structural BMP programs
1	80% implementation of NPDES TMDL non-structural BMP programs
2	60% implementation of NPDES TMDL non-structural BMP programs
3	40% implementation of NPDES TMDL non-structural BMP programs
4	20% implementation of NPDES TMDL non-structural BMP programs
5	0% implementation of NPDES TMDL non-structural BMP programs

Current: 1

Anticipated: 1

Environmental Policy and Watershed Health

Support Functioning Aquatic Ecosystems

0	90% reaches Good or Fair average rating for all assessment parameters
1	75% reaches Good or Fair average rating for all assessment parameters
2	60% reaches Good or Fair average rating forall assessment parameters
3	45% reaches Good or Fair average rating for all assessment parameters
4	30% reaches Good or Fair average rating for all assessment parameters
5	<30% reaches Good or Fair average rating for all assessment parameters

Current: 3

Anticipated: 3

Improve Water Quality

0	70% reaches Good or Fair average rating for Water Quality
1	60% reaches Good or Fair average rating for Water Quality
2	50% reaches Good or Fair average rating for Water Quality
3	40% reaches Good or Fair average rating for Water Quality
4	30% reaches Good or Fair average rating for Water Quality
5	<30% reaches Good or Fair average rating for Water Quality

Current: 3

Anticipated: 3

Improve Aquatic Habitat and Biological

0	90% reaches Good or Fair average rating for Aquatic Habitat & Biological Communities
1	75% reaches Good or Fair average rating for Aquatic Habitat & Biological Communities
2	60% reaches Good or Fair average rating for Aquatic Habitat & Biological Communities
3	45% reaches Good or Fair average rating for Aquatic Habitat & Biological Communities
4	30% reaches Good or Fair average rating for Aquatic Habitat & Biological Communities
5	<30% reaches Good or Fair average rating for Aquatic Habitat & Biological Communities

Current: 3
Anticipated: 3

Improve Hydrology & Geomorphology

0	90% reaches Good or Fair average rating for Hydrology & Geomorphology
1	75% reaches Good or Fair average rating for Hydrology & Geomorphology
2	60% reaches Good or Fair average rating for Hydrology & Geomorphology
3	45% reaches Good or Fair average rating for Hydrology & Geomorphology
4	30% reaches Good or Fair average rating for Hydrology & Geomorphology
5	<30% reaches Good or Fair average rating for Hydrology & Geomorphology

Current: 1
Anticipated: 1

Erosion prevention and sediment control

Number Inspections Done on Priority

0	100% Inspections Based on Priority
1	80% or Greater Based on Priority
2	60% Based on Priority
3	40% Based on Priority
4	20% Based on Priority
5	0% Based on Priority

Current: 4
Anticipated: 4

Reduce Water Quality Impacts of Construction

0	Full Implementation of WQ BMPs
1	80% Implementation of WQ BMPs
2	60% Implementation of WQ BMPs
3	40% Implementation of WQ BMPs
4	20% Implementation of WQ BMPs
5	10% Implementation of WQ BMPs

Current: 3
Anticipated: 3

Program Management

Effective Partnering

0	100% Partnering Strategic; Aligned with WES Goals
1	80% Partnering Strategic; Aligned with WES Goals
2	60% Partnering Strategic; Aligned with WES Goals
3	40% Partnering Strategic; Aligned with WES Goals
4	20% Partnering Strategic; Aligned with WES Goals
5	Ad Hoc Partnering only, 0% Strategic

Current: 3
Anticipated: 3

Staff Understand Roles and Skills, Resources, and Abilities meet Needs

0	More than 95% Understand Roles and Skills Aligned
1	More than 90% Understand Roles and Skills Aligned
2	More than 80% Understand Roles and Skills Aligned
3	More than 70% Understand Roles and Skills Aligned
4	More than 60% Understand Roles and Skills Aligned
5	Less than 60% Understand Roles and Skills Aligned

Current: 2

Anticipated: 2

Monitoring Activities Data Used for Decision-making

0	80% WES Activities Data-Driven
1	65% WES Activities Data-Driven
2	50% WES Activities Data-Driven
3	35% WES Activities Data-Driven
4	20% WES Activities Data-Driven
5	All Activities Reactive; Not Data-Driven

Current: 4
Anticipated: 4

Program Evaluation and Effectiveness

0	Fully Increases Understanding of Management Activities and/or Watershed Conditions
1	
2	
3	Partially Increases Understanding of Management Activities and/or Watershed Conditions
4	
5	Does Not Increases Understanding of Management Activities and/or Watershed Conditions

Current: 3
Anticipated: 3

Development Plan Review and Permitting

Develop Needs Met and Ecosystem Services Protected

0	90% reaches Good or Fair maintained, Poor Improved to Fair or Good ave. rating for all assessm. parameters
1	75% reaches Good or Fair maintained, Poor Improved to Fair or Good ave. rating for all assessm. parameters
2	60% reaches Good or Fair maintained, Poor Improved to Fair or Good ave. rating for all assessm. parameters
3	45% reaches Good or Fair maintained, Poor Improved to Fair or Good ave. rating for all assessm. parameters
4	30% reaches Good or Fair maintained, Poor Improved to Fair or Good ave. rating for all assessm. parameters
5	15% reaches Good or Fair maintained, Poor Improved to Fair or Good ave. rating for all assessm. parameters

Current: 3
Anticipated: 3

Asset Management

Maximize Cost/Benefit Service

0	>80% LOS Implemented, Expenses Met with Revenue
1	>60% LOS Implemented, Expenses Met with Revenue
2	>50% LOS Implemented, Expenses Met with Revenue
3	>30% LOS Implemented, Expenses Met with Revenue
4	<30% LOS Implemented, Expenses Exceeded Revenue
5	<20% LOS Implemented, Expenses Exceeded Revenue

Current: 3
Anticipated: 3

AM Program Implemented

0	100% SW Projects in alignment with AM Program
1	80% SW Projects in alignment with AM Program
2	60% SW Projects in alignment with AM Program
3	40% SW Projects in alignment with AM Program
4	20% SW Projects in alignment with AM Program
5	0% SW Projects in alignment with AM Program

Current: 4
Anticipated: 4

Reliability: Number of Unplanned Maintenance and Repairs to Critical Systems

0	90% Maintenance & Repairs to Critical Systems Planned
1	75% Maintenance & Repairs to Critical Systems Planned
2	60% Maintenance & Repairs to Critical Systems Planned
3	45% Maintenance & Repairs to Critical Systems Planned
4	30% Maintenance & Repairs to Critical Systems Planned
5	0% Maintenance & Repairs to Critical Systems Planned

Current: 2
Anticipated: 2

Customer Service

Implement Sustainability Action Plan

0	SWM program provides full support for relevant Action Items
1	SWM program provides 80% support for relevant Action Items
2	SWM program provides 60% support for relevant Action Items
3	SWM program provides 40% support for relevant Action Items
4	SWM program provides 20% support for relevant Action Items
5	SWM program provides no support for relevant Action Items

Current: 2
Anticipated: 0

Effective Public Outreach

0	70% Customers Recognize WES Services
1	50% Customers Recognize WES Services
2	30% Customers Recognize WES Services
3	20% Customers Recognize WES Services
4	10% Customers Recognize WES Services
5	Zero Customer Recognition

Current: 4
Anticipated: 3

Maintain Employee Safety

0	0 reportable OSHA Incidents
1	1 incident
2	2 incidents
3	3 to 5 incidents
4	6 to 10 incidents
5	More than 10 incidents

Current: 0
Anticipated: 0

Business Management

Maximize Use of Alternative Funding Sources

0	5% of Funding Comes from Alternative Source
1	4% of Funding Comes from Alternative Source
2	3% of Funding Comes from Alternative Source
3	2% of Funding Comes from Alternative Source
4	1% of Funding Comes from Alternative Source
5	0% of Funding Comes from Alternative Source

Current: 5
Anticipated: 5

Full CIP Implementation

0	90% Planned CIP Budget spent
1	75% Planned CIP Budget spent
2	60% Planned CIP Budget spent
3	45% Planned CIP Budget spent
4	30% Planned CIP Budget spent
5	15% Planned CIP Budget spent

Current: 1
Anticipated: 2

Rate Adequecy

0	Actual rates in alignment with rate model prediction
1	
2	
3	Actual rates somewhat above/below rate model prediction
4	

5 Actual rates significantly above/below rate model prediction
Current: 4
Anticipated: 4

Budget Management Effectiveness

0 Actual budget within 10% of predicted budget
1
2
3 Actual budget within 10-20% of predicted budget
4
5 Actual budget within 20-30% of predicted budget
Current: 6
Anticipated: 4

Appropriate Polices for Watershed Action Plans

0 Fully correlated with WAPs
1
2
3 Somewhat correlated with WAPs
4
5 No correlation with WAPs
Current: 6
Anticipated: 4

Stormwater System Maintenance

Regularly Scheduled Maintenance

0 More than 90% Inspection Goals Met; 60% Maintenance Planned
1 More than 80% Inspection Goals Met; 50% Maintenance Planned
2 More than 70% Inspection Goals Met; 40% Maintenance Planned
3 More than 60% Inspection Goals Met; 30% Maintenance Planned
4 More than 50% Inspection Goals Met; 20% Maintenance Planned
5 Less than 50% Inspection Goals Met; less than 20% Maintenance Planned
Current: 2
Anticipated: 2

Scheduled vs. Non-Scheduled Maintenance

0 80% Maintenance is Scheduled
1 65% Maintenance is Scheduled
2 50% Maintenance is Scheduled
3 40% Maintenance is Scheduled
4 20% Maintenance is Scheduled
5 No Maintenance is Schedule
Current: 2
Anticipated: 2

Request-Driven Maintenance

0 100% WES Request-Driven Maintenance performed in 72 hours
1 90% WES Request-Driven Maintenance performed in 72 hours
2 80% WES Request-Driven Maintenance performed in 72 hours
3 70% WES Request-Driven Maintenance performed in 72 hours
4 60% WES Request-Driven Maintenance performed in 72 hours
5 50% WES Request-Driven Maintenance performed in 72 hours
Current: 2
Anticipated: 2