

**City of Portland
Bureau of Environmental Services**



**Fanno/Tryon Water Quality and TMDL
CIP Pre-design #7622 Report**

2008

June 2008 Final Report

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Acknowledgements

City of Portland Bureau of Environmental Services (BES) Project Staff

Amin Wahab, Project Manager, Watershed Services
Adrienne Aiona, Engineering Services
Shannon Axtell, Watershed Services
Casey Cunningham, Watershed Services
Jennifer Devlin, Watershed Services
Joe Dvorak, Maintenance Engineering
David Elkin, Watershed Services
Leonard Gard, Southwest Neighborhoods Inc.
Todd Gunter, Maintenance Engineering
Eugene Lampi, Watershed Services
Chris Lastomirsky, Watershed Services
Tom Liptan, Watershed Services
Colleen Mitchell, Watershed Services
Nick Naval, Jr, Construction Services
Darian Santner, Engineering Services
Cindy Studebaker, Watershed Services
Greg Savage, Systems Analysis
Holly Walla, Engineering Services
Frank Wildensee, Watershed Services
Binhong Wu, Systems Analysis

Oversight Committee

Susan Aldrich, BES Capital Improvement Program
Mark Braun, BES Maintenance Engineering
Scott Clement, BES Engineering Services
Jamie de la Garza, BES Capital Improvement Program
Scott Gibson, BES Engineering Services
Mike Rosen, BES Watershed Services
Bill Ryan, BES Engineering Services
Mary Wahl, BES Watershed Services

Advisory Committee

The Advisory Committee included representatives from BES, other City bureaus, local and state agencies, and community groups. The Advisory Committee met periodically from April 2006 through June 2008.

Dennis Ades, Oregon Department of Environmental Quality
Shannon Buono, City of Portland Bureau of Planning
Daniela Cargill, City of Portland Bureau of Environmental Services
Jaime de la Garza, City of Portland Bureau of Environmental Services
M.G. Devereux, Oregon State Parks

Kathy Harnden, City of Portland Bureau of Development Services
Ron Kroop, Oregon Department of Transportation
Lester Lee, City of Portland Bureau of Environmental Services
Harvey Lockett, City of Portland Bureau of Environmental Services
Jan Miller, Clean Water Services
Liz Moorhead, City of Portland Office of Transportation
Steve Mullinax, Bridlemile Creek Stewards
Kathleen Murrin, City of Portland Parks and Recreation
Jonna Papaefthimiou, City of Lake Oswego
Jim Sjulín, City of Portland Parks and Recreation
Stephanie Wagner, Friends of Tryon Creek State Park and Tryon Creek Watershed Council

1.0 Introduction

Purpose

This *Fanno Tryon Water Quality and TMDL CIP Pre-design #7622 Report* (Pre-design) recommends a comprehensive and strategic set of projects for the Fanno Creek and Tryon Creek watersheds to improve watershed health and meet regulatory obligations.

Bureau of Environmental Services (BES) staff from Watershed Services, Engineering Services, Systems Analysis, and Maintenance Engineering collaborated throughout the entire development of this report. This collaboration is reflected in the breadth of the recommended projects.

Watershed Approach

The watershed approach moves away from watershed management that responds individually to different environmental regulations with independent and single-focus efforts that don't consider overlapping issues. Built on a scientifically sound foundation, the watershed approach addresses the sources and causes of environmental problems rather than focusing on symptoms or meeting specific regulatory requirements. This approach seeks efficiencies and greater flexibility to find creative, multi-objective solutions that meet multiple requirements and save money. By identifying goals, objectives, strategies, and actions, this approach aims to protect the best remaining resources and improve watershed functions and conditions citywide.

The Pre-design is based on the watershed approach. It recommends projects that address multiple watershed goals to improve watershed health and meet regulatory obligations.

Regulatory Background

TMDLs and MS4 Permit

The Clean Water Act (CWA) of 1972 and later amendments regulate discharges of pollutants to waters of the United States from both point sources (such as wastewater treatment plants and industrial discharges) and non-point sources (such as stormwater runoff). Under section 303(d) of the CWA, states are required to develop lists of impaired waters that do not meet state water quality standards designed to protect beneficial uses. Beneficial uses range from water contact recreation and fish and aquatic life to irrigation and public water supply. The Oregon Department of Environmental Quality (DEQ) has developed a statewide 303(d) list that identifies water body reaches that are "water quality limited" because they do not meet instream water quality standards set for certain pollutants to ensure support for the beneficial uses designated for that reach. DEQ then establishes total maximum daily loads (TMDLs) that specify the maximum amounts of the designated pollutants the water body can receive from all point and non-point sources.

TMDLs for total phosphorus and ammonia were established for Fanno Creek (Tualatin Subbasin TMDL) in 1988. The TMDLs were revised in 2001, and additional TMDLs were established for temperature, bacteria, and dissolved oxygen. The TMDLs include both waste load allocations (for point sources) and load allocations (for non-point sources).

In 1995, DEQ issued an NPDES Municipal Separate Storm Sewer System (MS4) permit to the City of Portland. The permit required the City to implement various categories of stormwater quality best management practices (BMPs) in order to reduce pollutants in runoff to the maximum extent practicable (MEP).

A renewed MS4 permit was issued in 2004; following a reconsideration process, the permit was reissued in 2005. The MS4 permit retained the requirement to reduce pollutants to the MEP. In addition, it required the establishment of pollutant load reduction benchmarks for all existing TMDL parameters with waste load allocations, including the Fanno Creek TMDLs. These benchmarks were submitted to DEQ as part of a revised Stormwater Management Plan (SWMP) in 2006.

In 2006, DEQ established TMDLs for temperature and bacteria in Tryon Creek (Lower Willamette Subbasin TMDL).

See Section 8.1: TMDL and MS4 Technical Memorandum for additional details and specific requirements of the TMDLs and MS4 permit.

Endangered Species Act (ESA)

The Endangered Species Act (ESA) of 1973 provides for the conservation of threatened and endangered plant and animal species and the ecosystems on which they depend. The National Marine Fisheries Service has enacted regulations that make it unlawful to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect listed aquatic species or even to attempt to engage in such conduct. The definition of “harm” includes habitat modification if the modification kills or injures fish by significantly impairing essential behavioral patterns such as feeding, sheltering, rearing, migrating, breeding, and spawning.

Lower Tryon Creek (up to Highway 43) is designated critical habitat for Upper Willamette and lower Columbia River Chinook, and all mainstem reaches of Tryon Creek (up to Marshall Cascades) are designated critical habitat for lower Columbia River coho (threatened) and lower Columbia River steelhead (threatened). Upper Willamette River steelhead (threatened) historically populated the Fanno Creek Basin.

The City of Portland (COP) is committed to ensuring that ongoing activities do not jeopardize listed and threatened species and to supporting the recovery of ESA listed and proposed species.

Any project that directly or indirectly impacts listed coho, steelhead, or Chinook or the habitats in which they reside will require federal consultation with NOAA Fisheries. Projects that enhance aquatic habitat, improve habitat connectivity, and manage stormwater runoff will contribute toward the recovery of ESA-listed species. A number of projects described in this report will assist in recovery.

Watershed Planning Background

The Pre-design recommends projects that address multiple watershed goals to improve watershed health and meet regulatory obligations. This comprehensive approach to improving Portland's watershed conditions is reflected in the 2005 *Portland Watershed Management Plan* (PWMP), adopted by Portland's City Council in March 2006. Built on a scientifically sound foundation, the watershed approach addresses the sources and causes of environmental problems rather than focusing on symptoms or meeting specific regulatory requirements.

The PWMP identifies 20 actions, organized into 6 strategies: aquatic and terrestrial enhancement, revegetation, stormwater management, policy and protection, education and outreach, and operations and maintenance. The PWMP describes and maps the strategies to show where they can be applied throughout the City to advance the PWMP's goals and objectives. The PWMP also identifies existing projects, programs, and areas of opportunity to incorporate improvement strategies into existing City priorities. From this analysis, a Watershed Priority Areas map highlights priority areas of interest and strategies for improving watershed conditions over the next 2 to 5 years. This list of priorities will be updated every 5 years to reflect monitoring results of implemented projects and continuing research and evaluation of watershed conditions.

The *Fanno and Tryon Creeks Watershed Management Plan* (FTCWMP) (BES, 2005) provides a detailed characterization of conditions in the Fanno Creek and Tryon Creek watersheds, identifies specific problems and opportunities, describes goals and objectives, and outlines projects and programs to improve watershed health. Major factors that limit watershed health in these watersheds are:

- Development and high levels of impervious surface cover contribute to increased stormwater runoff volumes and velocities that can cause streambank instability, undercutting, erosion, in-stream sedimentation, and channel incision.
- Water quality is impaired for certain water quality parameters. Stormwater runoff from upland sources and from development contributes pollutants to streams, and erosion contributes to high levels of total suspended solids. Fanno Creek has TMDLs for total phosphorus, temperature, dissolved oxygen, and bacteria. Tryon Creek has TMDLs for temperature and bacteria. The Oregon Water Quality Index ranks water quality for both Fanno Creek and Tryon Creek as poor.
- Physical habitat conditions are generally simplified and disconnected. Development has narrowed and disconnected streams and riparian corridors. In-stream habitat suffers from lack of structure (e.g., wood and boulders) and from high proportions of sand and silt substrate; the latter is contributed by eroding streambanks caused partly by increased stormwater runoff from upland development. Numerous culverts severely constrain fish passage.

- Existing sanitary sewers are commonly located in sensitive stream corridors where they can potentially impact water quality and stream habitat. For example, the Tryon Creek interceptor sanitary sewer runs along Lower Tryon Creek, with numerous stream crossings.

The FTCWMP identifies and recommends various actions and programs to address these conditions. Actions include stormwater retrofits, revegetation, land acquisition, ditch-to-swale conversions, and stream enhancement. Most actions are identified on maps; some are specific sites, while others are general target areas. A general implementation approach is outlined for each watershed.

CIP Pre-design Project and Report

Following completion of the FTCWMP, BES conducted the Pre-design project to further analyze, coordinate, and prioritize the potential actions identified in the FTCWMP and to develop important projects up to the pre-design phase. This Pre-design report documents the pre-design process, findings, and recommendations. It contains the following chapters:

2.0 Watershed Overview

This chapter briefly describes watershed conditions and the recommended actions and approach described in the FTCWMP.

3.0 Goals and Objectives

Goals and objectives were used to develop project prioritization and design criteria.

4.0 Approach

This chapter describes how the Pre-design project was organized and conducted.

5.0 Project Summaries

This chapter summarizes pre-design projects and describes the basis for cost estimates.

6.0 Evaluation of Benefits

This chapter describes the process used to evaluate projects in relation to the multi-objective pre-design goals.

7.0 Recommendations and Implementation Plan

This chapter presents a prioritized list of recommended projects.

8.0 Technical Documents

This chapter contains the technical memorandums and pre-designs.

2.0 Watershed Overview

Purpose

The purpose of chapter is to briefly describe watershed conditions and summarize the recommended actions and approach described in the Fanno and Tryon Creeks Watershed Management Plan (FTCWMP) (BES, 2005).

Fanno Creek Watershed

Watershed Characteristics

The Fanno Creek Watershed, located within the southwest Portland metropolitan area, covers an area of approximately 20,259 acres, or 32 square miles (90 square kilometers) (Figure 2-1). Approximately 4,528 acres are within Portland's city limits. This number does not include areas of northwest Portland along Skyline Boulevard and in the Cedar Mill Creek basin that also drain into the Tualatin Watershed. The remaining watershed area is within the jurisdictions of Durham, Tigard, and Beaverton. Unless otherwise noted, the data provided in this chapter apply to the portion of the watershed within Portland's jurisdiction.

The Fanno Creek Watershed is divided into eight subwatersheds, as shown in Table 2-1. These subwatersheds contain about 23 miles of open streams. Approximately 5 miles of streams are in culverts or pipes.

Table 2-1: Fanno Creek Subwatersheds—Acreage and Streams

Subwatershed	Area (acres)	Open Channel (miles)	Pipe or Culvert (miles)
Fanno Creek Mainstem	1,830	12.2	2.7
Pendleton Creek	230	0.9	0.2
Vermont Creek	758	3.5	0.6
Woods Creek	575	2.9	0.4
North Ash Creek	282	1.3	0.3
South Ash Creek	359	1.2	0.3
Red Rock Creek	413	0.4	0.1
Sylvan Creek	79	0.3	0.0
Total (Watershed)	4,528	22.6	4.6

The current major land use in the watershed is single-family residential (Table 2-2). Commercial land uses are located primarily along major transportation routes, particularly Beaverton Hillsdale Highway along Fanno Creek mainstem. Impervious surfaces, such as streets, parking lots, and buildings, are concentrated along these transportation and commercial corridors. Overall, impervious surfaces cover about 33 percent of the Fanno Creek Watershed. Parks and open space, including public and private property, total about 6 percent of the watershed. Major

parks and open space include Gabriel Park (84 acres), Woods Memorial Park (33 acres), and Mt. Calvary Cemetery (17 acres).

Table 2-2: Base Zoning within the Fanno Creek Watershed

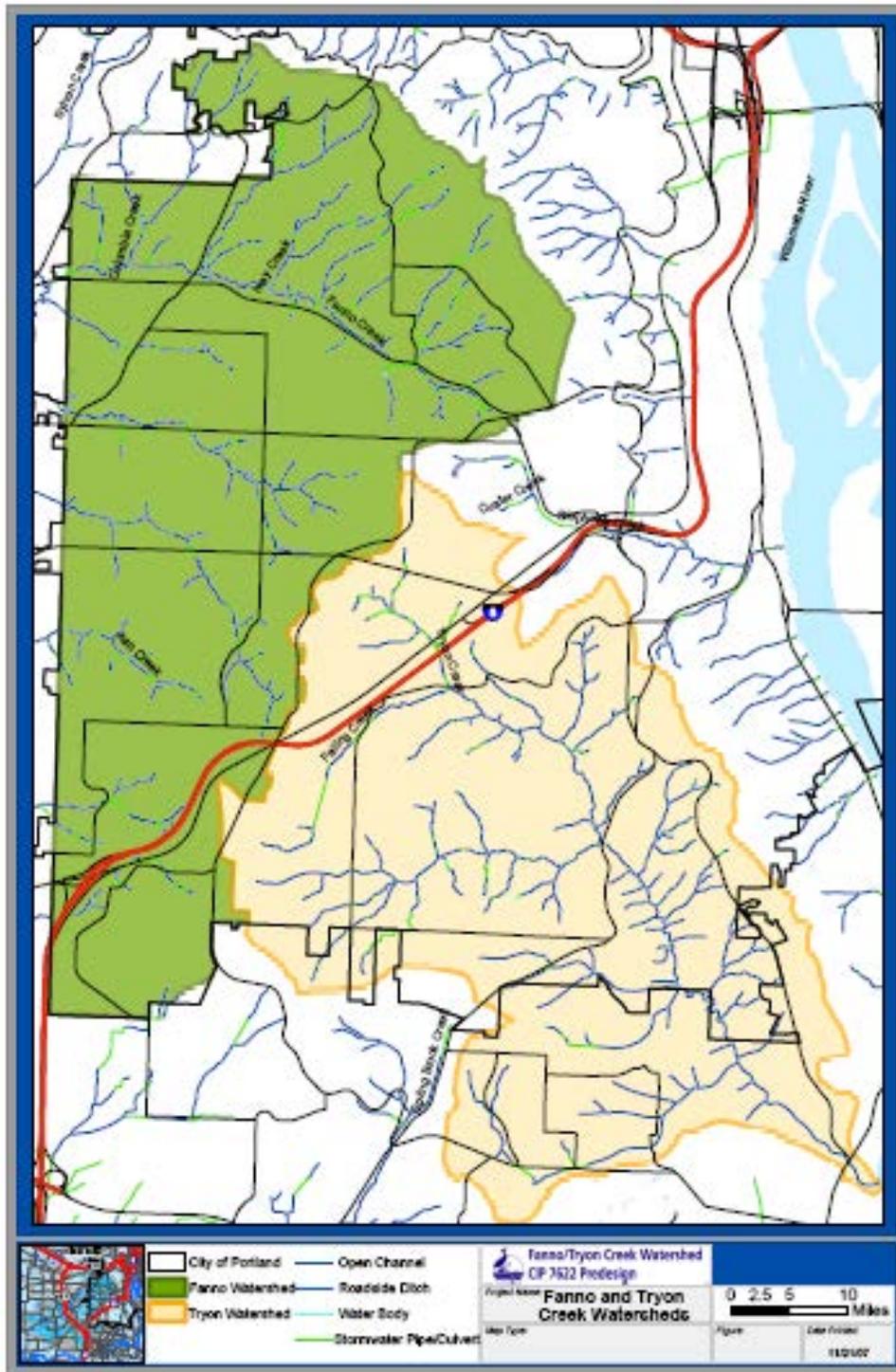
Land Use Category	Current Area	
	<i>Acres</i>	<i>Percentage</i>
Commercial	173	4
Multi-family Residential	353	8
Parks/Open Space	261	6
Single-family Residential	3,741	82
Total	4,528	100

Fanno Creek Watershed’s topographic features, soils and hydrology, and impervious surfaces are closely linked to the physical stability of the watershed and stream systems. They are critical in defining channel morphology and structure, slope stability, and soil erosion and sediment transport. Overall, the topography is characterized by steep slopes, soils that are slow to infiltrate rainfall, and impervious surfaces that result in a “flashy” urban stormwater system.

In 2001, the Oregon Department of Fish and Wildlife (ODFW) conducted habitat surveys in Fanno Creek mainstem, North Ash Creek, South Ash Creek, Woods Creek, and Vermont Creek. Development has altered physical habitat throughout all of these subwatersheds. Riparian corridors are generally narrow, and vegetation cover is low along much of the creeks. The creeks do not substantively interact with the floodplain. In-stream habitat suffers from lack of structure (e.g., wood and boulders) and from high proportions of sand and silt substrate contributed by eroding stream banks, resulting partly from increased stormwater runoff from upland development. Numerous culverts severely constrain fish passage.

In 1999-2001, ODFW conducted Index of Biotic Integrity (IBI) fish evaluations and surveys to assess the biological integrity of Fanno Creek and Ash Creek. The results show that Upper Fanno Creek is severely impaired much of the year. Ash Creek is severely impaired year round.

Figure 2-1: Fanno and Tryon Creek Watersheds



Watershed Problems and Opportunities

Based on the characterization and analysis of watershed conditions, the following critical problems that limit watershed health were identified, as well as opportunities for improvement.

Problems

- Fanno Creek's hydrology and hydraulics have been altered as a result of changes in natural drainage complexity, loss of vegetation, and development, particularly along Beaverton Hillsdale Highway, which is parallel to Fanno Creek. Impervious surfaces increase stormwater runoff and decrease summer base flows. These altered conditions affect natural stream channel-forming processes, contribute to aquatic habitat degradation (e.g., stream channel incision, simplification of channel complexity), and degrade water quality.
- Water quality in Fanno Creek is impaired for certain water quality parameters. Monitoring indicates that summer in-stream temperatures exceed the water quality standard of 64 degrees F necessary for protection of salmonid rearing. E. coli levels exceed the water quality standard in 50 percent of samples in summer and 25 percent during winter. Fanno Creek was ranked as poor on the Oregon Water Quality Index because of high levels of nutrients (total phosphorus and ammonia+nitrate nitrogen), total solids, and bacteria. Alterations in hydrology, hydraulics, and habitat, particularly resulting from development, contribute to water quality impairment. Stormwater runoff from existing sources and development contributes pollutants to streams.
- Physical habitat throughout the Fanno Creek mainstem has been altered by development. The riparian corridor is narrow, and vegetation cover is low along most of the creek. The creek does not substantively interact with the floodplain. In-stream habitat suffers from lack of structure (e.g., wood, and boulders) and from high proportions of sand and silt substrate contributed by eroding stream banks, resulting partly from increased stormwater runoff from upland development. Fish passage is severely constrained by numerous culverts.
- Biological communities are limited in Fanno Creek. Sensitive macroinvertebrate populations are lacking throughout the watershed, largely because of a lack of suitable substrate and possibly because of water quality impairment. Index of Biotic Integrity (IBI) assessments indicate that upper Fanno Creek lacks diverse fish communities and is severely impaired in the summer, fall, and winter.

Opportunities

- Opportunities exist to retrofit existing development to manage stormwater runoff. This includes installation of site-specific retrofits such as parking lot swales, water quality and detention facilities, and improvements to existing highway drainage facilities. These actions will filter stormwater runoff and help attenuate flows, helping to improve water quality and return hydrologic conditions toward a more natural hydrograph.
- Opportunities exist to improve aquatic habitat connectivity for native fish communities by retrofitting or replacing culverts.

FTCWMP Actions and Recommended Approach

To address watershed problems and take advantage of opportunities, the FTCWMP recommends specific actions and an overall approach to guide implementation of the actions.

Actions are divided into the following categories:

- Stormwater Management
- Revegetation
- Aquatic and Riparian Enhancement
- Protection and Policy
- Operations and Maintenance
- Outreach, Stewardship, and Education

Two main elements of the overall implementation approach for Fanno Creek are:

1. Implementation of programs and stormwater retrofit actions in highly developed portions of the watershed to manage stormwater runoff from impervious areas onsite. Actions and programs will initially focus on transportation and commercial corridors.
2. Implementation of actions and programmatic and policy measures to protect and improve aquatic and riparian habitat.

Implementation of these actions will meet FTCWMP goals and objectives. Benefits include:

- Treatment and detention of stormwater runoff, helping to protect in-stream habitat, biological communities, and meet total maximum daily load (TMDL) water quality regulatory obligations.
- Enhancement of aquatic and riparian habitat through stream restoration and revegetation, improving habitat for fish and other biological communities and restoring the natural watershed functions.
- Protection and rehabilitation of City sanitary sewer infrastructure to provide long-term service and protect water quality.
- Rehabilitation and replacement of stream culverts to improve fish passage and meet City design standards.
- Protection of land that connects and/or expands existing natural areas to protect existing natural watershed functions and provide critical habitat connectivity for biological communities.

Tryon Creek Watershed

Watershed Characteristics

The Tryon Creek Watershed in southwest Portland covers an area of approximately 4,142 acres, or 6.5 square miles (Figure 2-1). Approximately 3,058 acres (nearly 80 percent of the watershed) is within Portland’s city limits. The remaining watershed area is within the jurisdictions of Multnomah County, Clackamas County, and the City of Lake Oswego. Unless otherwise noted, the data provided in this chapter apply to the portion of the watershed within Portland’s jurisdiction.

The Tryon Creek Watershed is divided into three subwatersheds, as shown in Table 2-3. These subwatersheds contain about 27 miles of open streams. Approximately 3 miles of streams are in culverts or pipes.

Table 2-3: Tryon Creek Subwatersheds Acreage and Streams

Subwatershed	Area (acres)	Open Channel (miles)	Pipe or Culvert (miles)
Tryon Creek Mainstem	3,083	20.9	2.1
Arnold Creek	775	5.6	0.9
Falling Creek	283	1.0	0.5
Total (Watershed)	4,142	27.5	3.4

The predominant land use in the Tryon Creek Watershed is single-family residential (Table 2-4). Commercial and multi-family residential land uses are concentrated along major transportation corridors, particularly along Interstate 5 and Barbur Boulevard in the upper Tryon Creek Watershed. Impervious surfaces, such as streets, parking lots, and buildings, are concentrated along these transportation and commercial corridors. Overall, impervious surfaces cover about 24 percent of the Tryon Creek Watershed. Parks and open space, including public and private property, total over 14 percent of the watershed. The most significant open space is Tryon Creek State Natural Area (approximately 630 acres, a portion of it is outside Portland), located in lower and middle Tryon Creek. Other major parks and open space throughout the watershed include Marshall Park (25 acres), West Portland Park (21 acres), and Maricara Nature Park (17 acres).

Table 2-4: Base Zoning within the Tryon Creek Watershed

Land Use Category	Current Area	
	<i>Acres</i>	<i>Percentage</i>
Commercial	127	3
Multi-family Residential	185	5
Parks/Open Space	592	14
Single-family Residential	2,289	55
Outside City Boundary	857	21
Insufficient Data	92	2
Total	4,142	100

Tryon Creek Watershed’s topographic features, soils and hydrology, and impervious surfaces are closely linked to the physical stability of the watershed and stream systems. They are critical in

defining channel morphology and structure, slope stability, and soil erosion and sediment transport. Overall, the topography is characterized by steep slopes, soils that are slow to infiltrate rainfall, and impervious surfaces that result in a “flashy” urban stormwater system.

In 2001, the ODFW conducted habitat surveys of Tryon Creek and its tributaries. Conditions in lower and middle Tryon Creek and portions of Arnold Creek are best. Generally, development has altered physical habitat throughout the watershed. In-stream habitat suffers from lack of structure (e.g., wood and boulders) and from high proportions of sand and silt substrate contributed by eroding stream banks, resulting partly from increased stormwater runoff from upland development. Numerous culverts severely constrain fish passage.

In 2002, ODFW conducted extensive (spring, summer, and fall) and intensive (summer) stream surveys in Tryon Creek. Coho, Chinook, steelhead, and cutthroat were observed in different parts of Tryon Creek during different seasons of the year. Of all the salmonid species observed, cutthroat trout were most abundant. While large numbers of steelhead, Chinook, coho, and cutthroat were not encountered in Tryon Creek, individuals are present and use Tryon Creek during all or parts of their freshwater life stage.

Watershed Problems and Opportunities

Based on the characterization and analysis of watershed conditions, the following critical problems that limit watershed health were identified, as well as opportunities for improvement.

Problems

- Tryon Creek hydrology and hydraulics have been altered as a result of changes in natural drainage complexity, loss of vegetation, and high-density impervious surfaces in upper Tryon Creek. Impervious surfaces increase stormwater runoff and decrease summer base flows. These altered conditions affect natural stream channel-forming processes, contribute to aquatic habitat degradation (e.g., stream channel incision and simplification of channel complexity), and affect water quality.
- Water quality in Tryon Creek is impaired for certain water quality parameters. Monitoring indicates that summer in-stream temperatures exceed the water quality standard of 64 degrees F for protection of salmonid rearing. E. coli levels exceed water quality standard in about 20 percent of samples. Tryon Creek was ranked as poor on the Oregon Water Quality Index because of high levels of nutrients (total phosphorus, ammonia+nitrate nitrogen), total solids, and bacteria. High silt and sediment loads are transported from upland urban sources to the stream and accumulate in depositional areas in lower portions of the watershed. Alterations in hydrology, hydraulics, and habitat, particularly resulting from development, contribute to water quality impairment. Stormwater runoff from development in upper portions of the watershed may contribute a number of pollutants.
- Aquatic habitat conditions are degraded because of narrow riparian corridors (particularly in upper Tryon Creek), degraded and poorly connected floodplains, lack of in-stream and channel complexity, and silt that covers spawning gravels. Stream connectivity is severely degraded by the Highway 43 culvert and the Boones Ferry Road culvert.

Highway 43 is a seasonal fish passage barrier, and the Boones Ferry Road culvert completely prevents fish passage to upper Tryon Creek.

- Biological communities are limited in Tryon Creek. Sensitive macroinvertebrate populations are low throughout the watershed. Coho salmon, Chinook salmon, steelhead, and cutthroat have recently been observed in different parts of Tryon Creek, but abundance is low. Distribution is limited by culverts; particularly the Highway 43 and Boones Ferry Road culverts. Generally, the Index of Biotic Integrity (IBI) indicates that much of the watershed is severely impaired throughout most times of the year.
- City infrastructure is often located in stream channel corridors; in particular, a sanitary sewer interceptor is located along much of Tryon Creek mainstem. Natural channel-forming processes can expose and undermine these facilities, making them vulnerable.

Opportunities

- Opportunities exist to retrofit existing development to manage stormwater runoff. This includes installation of site-specific retrofits such as parking lot swales, water quality and detention facilities, and improvements to existing highway drainage facilities. These actions will filter stormwater runoff and help attenuate flows, helping to improve water quality and return hydrologic conditions toward a more natural hydrograph.
- Opportunities exist to protect, enhance, and restore aquatic habitat throughout Tryon Creek. This includes acquiring key parcels to connect existing natural areas, retrofitting or replacing fish passage barriers to reconnect aquatic habitat, enhancing existing aquatic and riparian habitat through restoration (particularly on public lands), and daylighting existing storm pipes where feasible to create open streams. These actions improve habitat and water quality and provide significant benefits to biological communities and recreation.
- Opportunities exist to protect and rehabilitate BES stormwater and sanitary sewer infrastructure and simultaneously improve aquatic habitat. These opportunities are most prevalent in lower and middle Tryon Creek, where a BES sanitary sewer interceptor is located in the stream corridor.

FTCWMP Actions and Recommended Approach

To address watershed problems and take advantage of opportunities, the FTCWMP recommends specific actions and an overall approach to guide implementation of the actions.

Actions are divided into the following categories:

- Stormwater Management
- Revegetation
- Aquatic and Riparian Enhancement
- Protection and Policy
- Operations and Maintenance
- Outreach, Stewardship, and Education

Two main elements of the Tryon Creek implementation approach are:

- Implementation of programs and stormwater retrofit actions in upper Tryon Creek to manage stormwater runoff from impervious areas onsite. Actions and programs will initially focus on transportation and commercial corridors.
- Implementation of actions and programmatic and policy measures to protect and restore habitat, initially below Boones Ferry Road, and to increase fish access to Tryon Creek State Natural Area. Breaks in longitudinal stream connectivity, particularly at Highway 43 and Boones Ferry Road culverts, severely impede resident and anadromous fish movement.

Implementation of these actions will meet FTCWMP goals and objectives. Benefits include:

- Treatment and detention of stormwater runoff, helping to protect in-stream habitat, biological communities, and meet total maximum daily load (TMDL) water quality regulatory obligations.
- Enhancement of aquatic and riparian habitat through stream restoration and revegetation, improving habitat for fish and other biological communities and restoring the natural watershed functions.
- Protection and rehabilitation of City sanitary sewer infrastructure to provide long-term service and protect water quality.
- Rehabilitation and replacement of stream culverts to improve fish passage and meet City design standards.
- Protection of land that connects and/or expands existing natural areas to protect existing natural watershed functions and provide critical habitat connectivity for biological communities.
- Improvements to water quality, aquatic habitat, and fish passage to further the recovery of ESA listed species.

3.0 Goals and Objectives

Introduction

Watershed goals represent the primary domains of the natural environment. The *Framework for Integrated Management of Watershed Health* (BES, 2005) established four watershed health goals: hydrology, physical habitat, water quality, and biological communities. As part of the development of the *Fanno and Tryon Creeks Watershed Management Plan* (FTCWMP), three additional goals were added for the Fanno and Tryon watersheds: infrastructure; public involvement, education, and stewardship; and consistency with other plans, policies, and regulations.

Objectives are specific outcomes in watershed functions and conditions that will help achieve these goals. Generally, several objectives must be met to achieve a given goal.

Improving watershed conditions toward these goals and objectives demonstrates progress toward improving watershed health. For the *Fanno Tryon Water Quality and TMDL CIP Pre-design #7622 Report* (Pre-design), goals and objectives were used for the following purposes:

- Technical Memorandums: Used to develop project-specific prioritization and design criteria/guidance (e.g., for culvert repair and replacement).
- Pre-designs: Used as guidance for project design and for prioritization of projects.
- Benefits Evaluation: Used to develop project indicators and scoring guidance, which were used to score and rank projects based on benefits.

Watershed Goals and Objectives

Hydrology Goal

Move toward normative¹ flow conditions to protect and improve watershed and stream health, channel functions, and public health and safety.

Objectives

HYD1 - Restore stream flows to a normative hydrograph to protect in-stream habitat, minimize channel erosion, and limit impacts on water quality.

Rationale: High flows can degrade stream channels by eroding banks, scouring, and channel incision. Reducing peak flows fosters stable streambanks, protects in-stream complexity, and reduces channel incision. Volume control can greatly increase flood

¹ A normative flow regime provides characteristics of flow magnitude, frequency, duration, and timing essential to support diverse and productive salmonids and other flow-dependent resources.

control, especially in closed basins; help recharge aquifers and maintain stream baseflow; minimize stream channel erosion and habitat loss; and protect water quality by reducing loadings.

Physical Habitat Goal

Protect, enhance, and restore aquatic and terrestrial habitat conditions to support key ecological functions and improved productivity, diversity, capacity, and distribution of native fish and wildlife populations and biological communities.

Objectives

HAB1 - Improve spawning and rearing habitats for native fish communities.

Rationale: Deposition of sediment from erosion on stream substrate degrades aquatic habitat. Reducing bank and channel erosion can reduce the deposition of sediment over salmon-spawning stream substrate.

HAB2 - Increase stream channel complexity to improve bank form habitats, protect and stabilize stream banks, provide areas for wood and substrate (e.g., fine sediment) to accumulate and settle (e.g., deep pools), and aid channel-building processes, such as pool riffle formation, flood flow attenuation, etc.

Rationale: Channel complexity provides critical rearing and refuge habitat that benefits all native aquatic communities.

HAB3 - Protect existing natural areas to help retain existing natural watershed functions and critical habitat.

Rationale: Remaining natural areas provide natural watershed functions and critical habitat. Further degradation of these remaining areas could critically undermine overall habitat restoration efforts.

HAB4 - Protect and restore riparian and floodplain condition and connectivity to help restore normative flow regimes and aquatic and terrestrial habitat conditions.

Rationale: Floodplain interactions provide wood, gravel, organic matter, and off-channel habitat to streams. Restoring floodplains improves aquatic habitat. Improving riparian areas improves both aquatic and terrestrial habitat. Wide, contiguous, and vegetated riparian buffers provide critical organic matter to streams and habitat for a variety of species.

HAB5 - Remove significant fish passage barriers (physical and hydraulic) to improve stream connectivity and potential fish population productivity.

Rationale: Fish barriers, such as long perched culverts, prevent fish migration within a stream system. Removing these barriers makes additional aquatic habitat available to fish. Increasing the distribution of fish in a stream system can enhance the resilience of the species.

Water Quality Goal

Protect and improve surface water and groundwater quality to protect public health and support native fish and wildlife populations and biological communities.

Objectives

WQ1- Reduce summer in-stream temperatures to improve surface water quality.

Rationale: Cooler water is necessary for the health of aquatic communities and to support salmonid rearing and spawning.

WQ2 - Reduce in-stream bacteria concentrations to improve surface water quality.

Rationale: Reducing in-stream bacteria concentrations helps protect public health.

WQ3 - Reduce in-stream pollutant concentrations to levels that do not threaten aquatic life or human health.

Rationale: Stormwater runoff can contain a variety of pollutants, including heavy metals, nutrients, and sediment. Reducing loads of these pollutants from various known/suspected sources, such as transportation corridors and spills, will improve aquatic habitat.

WQ4 - Reduce total suspended solids (TSS) to improve in-stream water quality.

Rationale: Suspended sediment in streams impacts water quality and can be deposited on channel substrate, both of which degrade aquatic habitat. Reducing sediment loads helps to improve aquatic habitat.

WQ5 - Reduce phosphorus concentrations in stormwater.

Rationale: High phosphorus concentrations spur algal growth, resulting in reduced concentrations of dissolved oxygen.

WQ6 – Meet dissolved oxygen standard.

Rationale: Maintaining an adequate dissolved oxygen level in streams is critical for native fish populations.

Biological Communities Goal

Protect, enhance, and restore native aquatic and terrestrial species and biological communities to improve and maintain biodiversity in Portland's watersheds.

Objectives

BC1 - Restore healthy, self-sustaining populations of all native fish communities.

Rationale: Fish need clean and cool streams with large woody debris, off-channel habitat, and sediment-free gravel substrate for spawning and rearing. Improving these and other habitat conditions will help increase native fish populations and benefit other aquatic species.

BC2 - Increase macroinvertebrate abundance and production.

Rationale: More study is needed. However, macroinvertebrate production is connected to all processes occurring in the aquatic - terrestrial continuum. By improving riparian vegetation (e.g., overhanging vegetation), getting marine-derived nutrients back into the system, and improving water quality (such as reducing fine sediment and toxins), the overall habitat conditions for macroinvertebrates will improve.

Infrastructure Goal

Provide adequate sanitary and stormwater infrastructure to protect public health and safety while preserving natural watershed functions.

Objectives

INF1 - Restore infrastructure such that all storm drainage facilities within the closed conduit system are designed to pass a 10-year storm without surcharge and provide conveyance of the 100-year storm meeting health and safety requirements.

Rationale: Public stormwater facilities protect human health and safety, as well as protect public and private properties from catastrophic damages.

INF2 - Remove physical and hydraulic barriers for fish passage. Physical barriers include culverts with downstream invert elevations that are 12 inches above residual pools, lengths greater than 100 feet, and/or with gradients >0.5 percent. Hydraulic barriers include lack of flow depth and flow velocities greater than 2 feet per second.

Rationale: Culverts and in some cases storm drainpipes impact the ability of fish to access spawning and rearing habitats and to migrate throughout the system.

INF3 - Replace or rehabilitate sewer and stormwater infrastructure that is in poor condition.

Rationale: Degraded, failing, and/or exposed (in active stream channels) sanitary sewer infrastructure can fail, resulting in the discharge of sanitary sewer flow into southwest streams. This threatens the health and safety of residents and the natural environment. Rehabilitating, replacing, and/or protecting vulnerable sewer infrastructure ensures sewer service and protects the environment and human health and safety.

Public Involvement, Education, and Stewardship Goal

Maintain long-term community-wide commitment to improve and sustain watershed health.

Objectives

PI1 - Establish strategies for promoting and carrying out community stewardship projects and programs to improve watershed health.

Rationale: The strategies will identify City services to be provided, establish targeted opportunities for stewardship activities, and identify partnerships and funding opportunities for implementation of community- and City-initiated projects.

PI2 - Raise community awareness by educating citizens about the impacts that their actions have on watershed health.

Rationale: People affect watershed health everyday by the choices they make. Public outreach strategies should be geared toward educating citizens about pollutant sources of concern to evoke behavioral changes that will reduce non-point source pollutants and restore natural functions to the watershed.

PI3 – Foster citizen involvement in the development and implementation of watershed plans, programs, and projects.

Consistency with Other Plans, Policies, and Regulations Goal

Meet watershed goals and objectives, and achieve consistency with applicable plans, policies, and regulations.

Objectives

CP1 - Establish strategies and actions for coordination with agencies and organizations within and external to the Bureau of Environmental Services (BES) to ensure that projects, programs, and plans are compatible and that watershed plan goals and objectives are met.

Rationale: The actions of many different agencies affect the health of the watershed. Through coordination and collaboration with other agencies, watershed staff can help to ensure that these agencies' projects, programs, and plans incorporate goals and objectives to improve watershed health.

CP2 - Establish strategies, projects, and programs that satisfy regulatory requirements and address watershed health goals.

Rationale: Watershed plan strategies, projects, and programs should meet the requirements of existing regulations designed to improve the health of the watershed.

4.0 Approach

This chapter briefly describes how projects in the *Fanno Tryon Water Quality and TMDL CIP Pre-design #7622 Report* (Pre-design) were organized, evaluated, prioritized, and pre-designed. Figure 4-1 depicts the approach.

Further information on the approach is available in the pre-designs contained in the Chapter 8.0 technical documents.

Project Scope, Workplan, and Schedule

The Pre-design recommends projects based on actions identified in the *Fanno and Tryon Creeks Watershed Management Plan* (FTCWMP) (BES, 2005) and the *Portland Watershed Management Plan* (BES, 2005). Analysis and multi-objective evaluation demonstrates that these projects will provide significant environmental and infrastructure system benefits, helping the City reach watershed health and regulatory compliance goals.

The scope of work, workplan, and schedule for the Pre-design were developed in consultation with the Bureau of Environmental Services (BES) Engineering Services group and endorsed by BES leadership. These documents follow established procedures and protocols.

The Pre-design scope of work (Appendix A), finalized September 15, 2005, established the following:

- Components of the CIP Pre-design project.
- Tasks required to develop the Pre-design report and related deliverables.
- Expectations for the Pre-design report and deliverables, and the resources needed to complete the required tasks.

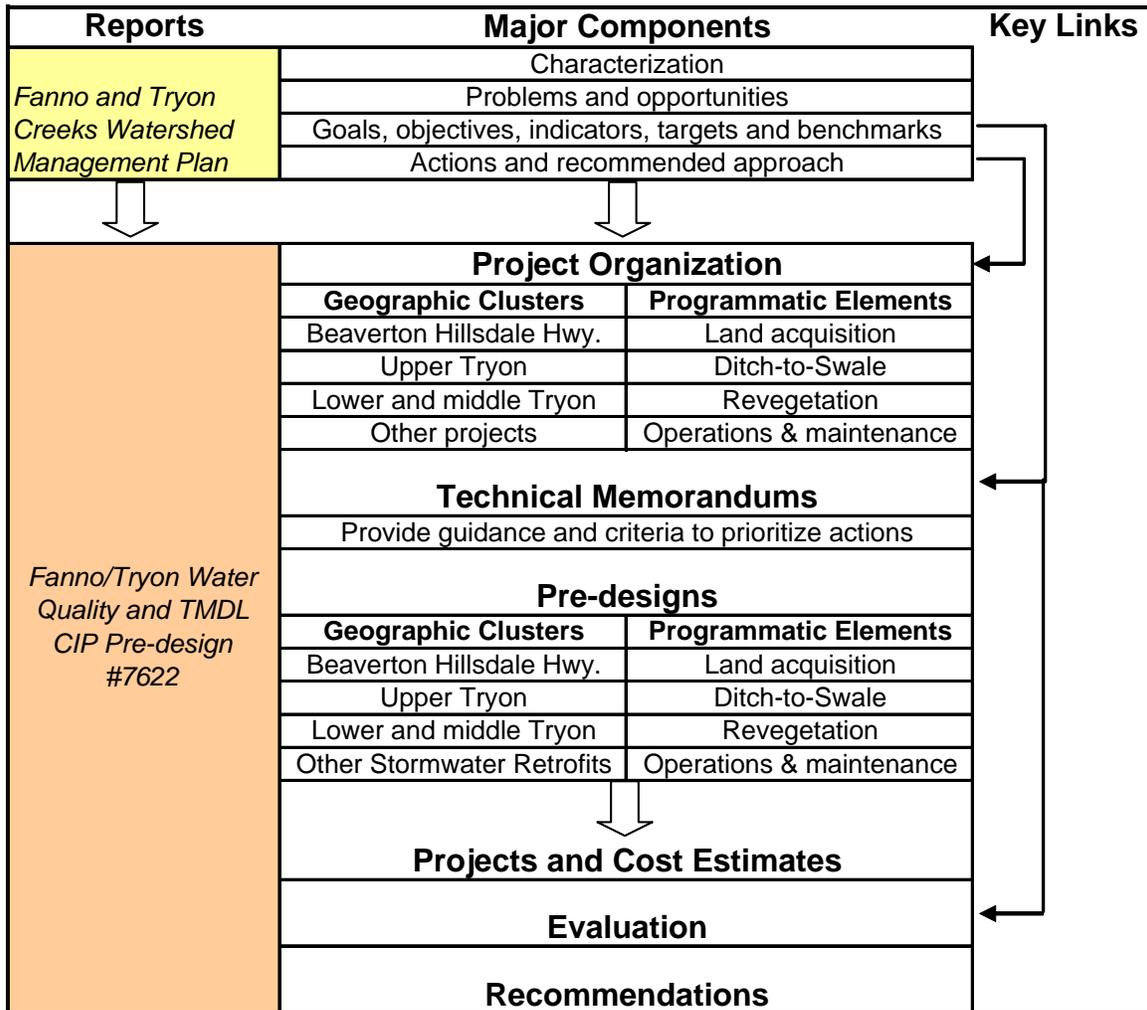
The level of detail in the scope of work reflected the understanding of each task at that time. Additional details were developed as the CIP Pre-design project proceeded, and revisions were made to the scope of work as required.

The Pre-design workplan (Appendix B), finalized September 15, 2005, provided the framework to complete the CIP Pre-design project within CIP guidelines. The CIP guidelines are specified in the *Implementation Procedures for Capital Projects* (BES, June 30, 2003). Key elements of the Pre-design workplan included project management, scope of work, project budget, and schedule.

The Pre-design schedule provided initiation and completion dates for the tasks described

in the CIP Pre-design project scope of work, as well as milestones and anticipated product delivery dates. As the CIP Pre-design project was implemented, the Oversight Committee made and approved adjustments to the schedule when required.

Figure 4-1: Pre-design Approach Chart



Project Organization

The FTCWMP identifies over 100 actions in the Fanno and Tryon Creek watersheds to meet established watershed goals and objectives. The actions include stormwater retrofits, stream restoration, culvert repair and replacement, land acquisition, revegetation, ditch-to-swale conversions, and water quality facilities. In accordance with the Pre-design scope of work, these multi-component and multi-objective actions were organized into geographic and programmatic groupings to facilitate analysis, coordination, and further development of individual projects. Table 4-1 shows the groupings.

Table 4-1: Geographic and Programmatic Groupings

Geographic Clusters	Programmatic Elements
Beaverton Hillsdale Highway Cluster	Land Acquisition
Upper Tryon Creek Cluster	Ditch-to-Swale
Lower and Middle Tryon Creek Cluster	Revegetation
Other Projects	Operations and Maintenance

Geographic clusters contain groups of similar projects concentrated in a particular area that are evaluated together in order to prioritize and sequence actions to maximize benefits. Projects in these geographic clusters can target watershed-specific concerns, such as Tualatin Basin total maximum daily load (TMDL) water quality requirements in the Beaverton Hillsdale Highway cluster and fish passage and sewer infrastructure/stream enhancement in the Lower and Middle Tryon Creek cluster.

Programmatic elements are groups of similar projects that are distributed throughout the watersheds. Projects are grouped by type to facilitate prioritization and development of recommendations. For example, potential land acquisition sites are located throughout the watersheds. The pre-design describes potential acquisition methods, describes each site and the benefits of acquisition in detail, prioritizes sites, and includes an estimated cost for acquisition. The Pre-design would support establishment of a willing-seller acquisition program.

Stakeholder and Community Involvement

The Pre-design included development and implementation of a stakeholder and community involvement plan, as described in the public involvement technical memorandum. The activities described below were implemented.

Advisory Committee

The Advisory Committee included representatives from BES, other City bureaus, state and local agencies, and community groups. The Advisory Committee met six times from April 2006 through December 2007. It provided review and feedback throughout the project.

Open Houses

Periodic community open houses were held to present Pre-design project elements to the community. Comments were received, documented, and incorporated into the Pre-design. A total of over 200 people attended four open houses.

Educational Materials and Website

All draft and final Pre-design project materials were made available on BES's website. Fact sheets were developed for the overall Pre-design project, as well as for specific project elements.

Community Group Presentations

Specific Pre-design project elements were presented to many interested community groups throughout the project. These included the Multnomah Village Business Association and the Tryon Creek Watershed Council.

Project-specific Involvement

Presentations and meetings were held with Portland Public Schools, Oregon Department of Transportation, Portland Community College, and TriMet to discuss involvement in pre-designs for specific project sites.

Stormwater retrofit pre-design projects on private properties also required project-specific involvement. This included at least two letters: (1) An initial letter informing the property owners of the project and selection of their site, and (2) Follow-up letters and phone calls as needed to discuss the stormwater pre-designs. In some cases, BES staff met with property owners to discuss projects. These are documented in the project-specific pre-designs.

Ongoing Involvement

Ongoing involvement included responding to e-mails and phone calls about the project and providing project updates in the *Southwest Neighborhoods News*.

Technical Memorandums

Technical memorandums (TMs) were developed to provide background information, design guidance, and alternatives analysis and prioritization criteria. The TMs also ensured consistency with City standards and practices. The following TMs were prepared:

- Land Acquisition
- Revegetation
- Ditch-to-Swale
- TMDL (total maximum daily loads) and MS4 (municipal separate storm sewer system)
- ESA (Endangered Species Act)
- Culverts

- Culvert Ranking
- Public Involvement
- Operations and Maintenance
- Stormwater Retrofits

Pre-design

The actions located within each geographic cluster were organized by the following types for the pre-design:

- Stormwater Retrofits
- Highway Drainage
- Stormwater Outfalls
- Culverts
- Water Quality Facilities
- Stream Daylighting
- Infrastructure Protection and Stream Enhancement

A pre-design was developed for each geographic cluster. The pre-design includes the pre-designs of individual projects, including analyses, pre-designs, and cost estimates. An analysis of alternatives on a project-specific level and/or pre-design type level was performed, as appropriate, along with development of recommendations for project implementation.

The programmatic elements comprise watershed-wide actions at multiple locations, including within the various geographic clusters. A pre-design was developed for each programmatic element. These identify implementation opportunities, evaluate design alternatives, and estimate costs. They also provide a prioritized list of projects for implementation.

Pre-design summaries for both the geographic clusters and programmatic elements are provided below.

Beaverton Hillsdale Highway Cluster

The Beaverton Hillsdale Highway cluster of projects was organized to address FTCWMP-recommended actions that are concentrated along the Beaverton Hillsdale Highway corridor. The Beaverton Hillsdale Highway corridor is the most highly developed area within the watershed and includes multi-family residential and commercial land uses. Hydraulic and pollutant load modeling has shown that the highly impervious areas within this cluster, including Beaverton Hillsdale Highway, impact water quality and flow in Fanno Creek. Ecosystem diagnosis and treatment (EDT) modeling has shown that high flows, pollutants, and fish passage are limiting factors for resident native trout in Fanno Creek. Fanno Creek also has established TMDLs for total phosphorus, dissolved oxygen, bacteria, and temperature.

The pre-design for this geographic cluster addresses the project types described below.

Stormwater Retrofits

Pre-designs were developed for stormwater management retrofits at seven private property sites identified in the FTCWMP. The pre-designs were developed through contracts with private consultants, using a prototype developed by BES's Sustainable Stormwater group and in accordance with the City's *Stormwater Management Manual*. The pre-designs include site analysis, recommended concept designs, and cost estimates.

In addition to the seven site pre-designs, additional opportunities for stormwater retrofits within the cluster were identified, with estimated costs and benefits.

Highway Drainage

The FTCWMP identifies stormwater runoff from Beaverton Hillsdale Highway as having a significant impact on water quality and flows in Fanno Creek. The stormwater retrofits are designed to maximize reduction of pollutants in stormwater runoff discharged into Fanno Creek.

The 2 miles of highway were divided into 27 separate drainage subcatchments for analysis and pre-design of stormwater retrofits. A stormwater retrofit concept design was developed for each subcatchment, based on a review of existing information, field investigations, delineation of drainage, flow calculations, and BMP sizing. A recommended stormwater retrofit concept plan was developed for all subcatchments, including a site map, estimated BMP performance, and cost estimates.

Stormwater Outfalls

The FTCWMP identifies stormwater outfalls as having a significant impact on water quality in Fanno Creek from localized erosion and bank stability issues. To accommodate time and budget constraints of the Pre-design project, the 22 MS4 basins with the most total impervious area were selected for additional investigation. Combined, these 22 outfalls drain 80 percent of the impervious area in the MS4 system within this cluster.

Field investigations were completed for each of the 22 outfalls to obtain data related to the structural condition of the outfall, as well as the condition of the adjacent stream channel and banks. Based on the field investigation results, potential repairs or retrofits were identified for each outfall. These results were evaluated, and five outfalls were selected for development of more detailed designs. A pre-design was completed for each of the five outfalls, including site maps, flow analysis, proposed solutions, and cost estimates.

Culverts

The Beaverton Hillsdale Highway cluster includes 38 culverts, located either on the mainstem or tributaries of Fanno Creek. Available data and previous hydraulic modeling results were compiled for all 38 culverts. Field investigations were conducted to gather additional data where required. The culverts were then prioritized for further pre-design, using the criteria and ranking system developed in two culvert technical memorandums

(see Section 8.1).

Based on the results, the four highest-ranked culverts were selected for pre-design. Individual detailed pre-designs were developed for the four selected culverts. At each site, additional field investigations were performed, survey information was collected, and additional hydraulic analysis and modeling were conducted. Pre-design alternatives were then developed and evaluated for hydraulic capacity, fish passage, operation and maintenance, and cost. The final pre-design for each site includes a recommended alternative for implementation, along with engineering drawings and cost estimates.

Water Quality Facilities

Two potential water quality treatment facilities were identified during field assessments conducted for the pre-design of outfall and culvert projects. Both sites would treat stormwater runoff primarily from Beaverton Hillsdale Highway. A pre-design was developed for each site, including site maps, proposed facility concept and sizing, and cost estimates.

Upper Tryon Creek Cluster

The Upper Tryon Creek cluster of projects was organized to address FTCWMP-recommended actions that are concentrated in the upper Tryon Creek Watershed, specifically along the Barbur Boulevard and Interstate 5 highway corridors. These corridors are the most highly developed areas in the Tryon Creek Watershed. Hydraulic modeling has shown that the concentration of impervious areas in the upper Tryon Creek Watershed increases peak flows and modifies hydrology throughout Tryon Creek. Grid pollutant load modeling indicates that these highly impervious areas also generate high pollutant loads. EDT modeling indicates that high flows and pollutants from the upper Tryon Creek Watershed degrade in-stream conditions and are a limiting factor for ESA-listed steelhead in Tryon Creek. Tryon Creek also has established TMDLs for total bacteria and temperature.

The pre-design for this geographic cluster addresses the project types described below.

Stormwater Retrofits

Pre-designs were developed for stormwater management retrofits at seven private property sites identified in the FTCWMP and for Multnomah Village and Jackson Middle School.

The pre-designs for the seven private property sites were developed through contracts with private consultants, using a prototype developed by BES's Sustainable Stormwater group and in accordance with City stormwater management and design criteria. The pre-designs include site analysis, recommended concept designs, and cost estimates.

The FTCWMP identifies Multnomah Village as a watershed area with a high percentage of impervious area and recommends additional stormwater management for this area. As part of the Pre-design project, BES staff conducted site assessments and identified over 30 potential stormwater management projects on both public and private properties.

After evaluation of these potential projects, staff developed concept designs and cost estimates for five high-priority street stormwater management projects. In addition, cost estimates were developed for all of the remaining potential projects.

The FTCWMP also identifies the Jackson Middle School site for multiple actions, including stream daylighting and stormwater retrofits. As part of the Pre-design project, a site assessment of stormwater management opportunities was conducted, in conjunction with proposed stream daylighting at this site. Based on the site assessment, a pre-design for stormwater retrofits was developed, including recommended concept designs and cost estimates.

Highway Drainage

The FTCWMP identifies stormwater runoff from Barbur Boulevard and adjacent streets as having a significant impact on water quality and flows in Tryon Creek. The stormwater retrofits are designed to maximize reduction of pollutants in stormwater runoff discharged into Tryon Creek.

The 2 miles of highway were divided into 15 separate drainage subcatchments for analysis and pre-design of stormwater retrofits. A stormwater retrofit concept design was developed for each subcatchment, based on a review of existing information, field investigations, delineation of drainage, flow calculations, and BMP sizing. A recommended stormwater retrofit concept plan was developed for all subcatchments, including a site map, estimated BMP performance, and cost estimates.

Stormwater Outfalls

The FTCWMP identifies stormwater outfalls as having potential impacts on water quality in Tryon Creek from localized erosion and bank stability issues. During field investigations for culverts in the Upper Tryon cluster, outfalls above the I-5 highway were also investigated. No obvious problems were noted. Additional field investigations were conducted to address outfalls from the Upper Tryon Creek cluster area that discharges to Falling Creek. Field investigation teams gathered data related to the structural condition of the outfalls and the stream and bank condition of the surrounding areas. Based on evaluation of these data, one outfall was determined to need repair. A pre-design for this outfall was developed, including a site map, recommended solutions, and cost estimate.

Culverts

The Upper Tryon Creek cluster includes 11 culverts, located either on the mainstem or tributaries of Tryon Creek. Available data and previous hydraulic modeling results were compiled for all 11 culverts. Field investigations were conducted to gather additional data where required. The culverts were then prioritized for further pre-design, using the criteria and ranking system developed in two culvert TMs. Based on the results, no culverts within the upper Tryon Creek cluster were recommended for pre-design.

Stream Daylighting

The FTCWMP identifies stream daylighting as an action to improve watershed health.

The FTCWMP identifies daylighting of Falling Creek at the Jackson Middle School site as one opportunity. Field assessments conducted as part of the Pre-design project identified daylighting an unnamed tributary of Tryon Creek in Spring Garden Park as another opportunity. Pre-designs were developed for each of these sites, including flow analysis, concept designs, and cost estimates.

Water Quality Facilities

Two potential water quality treatment facilities were identified during Barbur Boulevard highway drainage field assessments. Both sites would treat stormwater runoff primarily from Barbur Boulevard and adjacent streets. A pre-design was developed for each site, including site maps, proposed facility concept and sizing, and cost estimates.

Lower and Middle Tryon Creek Cluster

The FTCWMP identifies lower and middle Tryon Creek as a priority project area for the following reasons:

- A BES sanitary sewer interceptor runs along and crosses Tryon Creek in this cluster area. BES has conducted two recent projects to protect sanitary sewer infrastructure exposed in the active stream channel. Further field work was needed to identify any additional exposed infrastructure.
- ESA-listed steelhead are located in this portion of Tryon Creek. EDT modeling indicates that this area is critical habitat for listed species, but that additional stream enhancement is needed. In particular, Highway 43 and Boones Ferry Road are impediments to fish passage; Highway 43 is a seasonal barrier, and Boones Ferry Road is a complete barrier.
- BES and the Oregon Department of Transportation are working collaboratively to retrofit the Highway 43 culvert, a major fish passage impediment. This project is under design, and construction is anticipated for summer 2009. This work will improve fish passage up to Boones Ferry Road.

The pre-design in this geographic cluster addresses the project elements described below.

Boones Ferry Road Culvert

The FTCWMP identifies the Boones Ferry Road culvert as a critical barrier to fish passage. A pre-design for replacement of the culvert was developed through a contract with a private consultant. The pre-design report includes background, project objectives, site description, modeling, alternatives development and evaluation, and a recommended alternative and cost estimate. The pre-design drawings include a proposed site plan, channel profile, cross-sections, culvert and roadway profile, and rock weir details.

Lower and Middle Tryon Creek Infrastructure Protection and Stream Enhancement

BES staff conducted field investigations in fall 2006 and winter 2007 to assess stream condition and identify any sewer infrastructure problems. Four sites were identified for

infrastructure protection/rehabilitation and stream enhancement. Pre-designs were developed for each of the four sites, including documentation of existing conditions, site-specific objectives, alternatives evaluation criteria, concept-level alternatives, evaluation and selection of a preferred concept alternative, and a preliminary cost estimate.

Other Stormwater Retrofits

This cluster of projects was organized to address stormwater retrofit projects for sites that are outside the other geographic clusters of the Pre-design project.

Pre-designs were developed for stormwater management retrofits at seven private property sites identified in the FTCWMP. The pre-designs were developed through contracts with private consultants, using a prototype developed by BES's Sustainable Stormwater group and in accordance with City stormwater management and design criteria. The pre-designs include site analysis, recommended concept designs, and cost estimates.

Operations and Maintenance (O&M)

The purpose of this pre-design is to identify and prioritize O&M projects and actions that meet the Pre-design project goals and objectives. The pre-design summarizes the O&M needs of the sanitary collection and stormwater drainage systems in the Fanno and Tryon Creek watersheds, including CIP-funded maintenance reliability projects. The pre-design provides evaluation criteria and a method for prioritizing O&M projects; the criteria and method were then used to prioritize identified O&M projects.

Ditches-to-Swales

The purpose of this pre-design is to provide a programmatic approach for converting ditches to swales in the Fanno and Tryon Creek watersheds. The ditch-to-swale conversions replace suitable roadside ditches with roadside swales.

Criteria developed in a ditch-to-swale technical memorandum (see Section 8.1) were used to prioritize potential ditch-to-swale sites identified in the FTCWMP, as well as additional sites identified during the pre-design. A total of eight high-priority sites (30,100 feet) and nine medium-priority sites (37,450 feet) were identified for conversion. A site description and cost estimate for implementation were developed for each site. This pre-design also includes design criteria, implementation protocols, and site-specific considerations. For high-priority Fanno Creek sites, flow modeling was conducted to support development of designs and to estimate benefits.

Land Acquisition

The purpose of this pre-design is to provide a land acquisition strategy for the Fanno and Tryon Creek watersheds. The strategy can serve as a basis to apply for CIP funding, grants, and other funding sources to acquire ownership and/or protection of these priority areas as opportunities arise.

Potential land acquisition sites identified in the FTCWMP, along with additional sites identified during the pre-design, were prioritized, using the criteria developed in the land

acquisition technical memorandum (see Section 8.1). A total of 10 high-priority, 12 medium-priority, and 8 low-priority sites were identified for land acquisition. The pre-design includes a detailed description of each site, including a site description and map, benefits of acquisition, potential acquisition methods, and cost estimates.

Revegetation

The purpose of this pre-design is to provide a revegetation strategy for the Fanno and Tryon Creek watersheds. The strategy can serve as a basis to apply for CIP funding, grants, and other funding sources to revegetate proposed sites.

Potential revegetation sites identified in the FTCWMP were prioritized, using the criteria developed in the revegetation technical memorandum (see Section 8.1). Three high-priority sites and seven medium-priority sites were identified for revegetation. The pre-design includes detailed descriptions, site maps, and estimated costs for each revegetation site.