City of Shoreline
Surface Water Master Plan

Planning Commission Recommended Draft
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Prepared for:
City of Shoreline
Shoreline, WA

Prepared by:
R. W. Beck, Inc.
Seattle, WA

Acknowledgments

This Surface Water Master Plan was prepared by R. W. Beck, Inc., in coordination with the City of Shoreline. The Surface Water Master Plan supports and implements the City of Shoreline Comprehensive Plan, which was developed concurrently by Berryman & Henigar in coordination with the City of Shoreline.

The Surface Water Master Plan required the expertise of various City staff and consultants. The Plan was prepared and reviewed by the following lead staff:

Project Managers:	Jesus Sanchez, Operations Manager Jerry Shuster, P.E., SWES Coordinator Donna Pacanovsky, P.E., R. W. Beck
Flooding Analysis:	Jesus Sanchez, Operations Manager Jessica Guerrette, P.E., R. W. Beck
Water Quality Analysis:	Andy Loch, Surface Water Quality Specialist Rika Cecil, Environmental Programs Coordinator Donna Pacanovsky, P.E., R. W. Beck
Habitat Analysis:	Rika Cecil, Environmental Programs Coordinator Andy Loch, Surface Water Quality Specialist Donna Pacanovsky, P.E., R. W. Beck Cathie Conolly, Adolfson Associates
Regulatory Issues:	Jessica Guerrette, P.E., R. W. Beck
Financial Analysis:	Debbie Tarry, Finance Director Patti Rader, Senior Budget Analyst Phil Ramon, Administrative Services Manager Jerry Shuster, P.E., SWES Coordinator Jesus Sanchez, Operations Manager Art Griffith, P.E., R. W. Beck
Technical Editor:	Todd Crandell, R. W. Beck
Shoreline Planning Commission Surface Water and Environment Workgroup:	Commissioner Carol Doering Commissioner Sidney Kuboi Commissioner David Harris
QA/QC:	Steve Swenson, P.E., R. W. Beck
Additional City Review:	Tim Stewart, PDS Director Paul Haines, Public Works Director Jill Marilley, P.E. City Engineer Andrea Spencer, Senior Planner, PDS Bob Olander, Deputy City Manager Steve Burkett, City Manager
Washington Department of Fish and Wildlife:	Douglas G. Hennick, Area Habitat Biologist

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Executive Summary

While the City of Shoreline is a relatively new city, it is has been a community for more than 50 years. The City's surface water system has been installed incrementally over this time, with the majority of its development in the 1960s. It now consists of an established network of storm drains, pipes, and open water courses. These facilities are showing their age and many need repair and improvement. In addition, the City must ensure that new development is implemented in a way that meets regulatory requirements, enhances the City's system, and does not exacerbate existing problems.

This Surface Water Master Plan looks at the City of Shoreline's surface water management program to identify problems, prioritize needs, and develop long-term solutions that are in line with community priorities.

To identify problems, the project team used information from several sources:

- Public comment from two open houses held on September 24 and 25, 2003
- Guidance from the Shoreline Planning Commission's Stormwater and Environment Workgroup
- Goals and policies from 2004 Shoreline Comprehensive Plan update
- Review of existing reports and other information provided by the City.

The City assigned priority levels to the problems, and the project team evaluated potential projects and programmatic activities to address these problems. These needs are described in terms of the three main areas of service within the City's surface water program: (1) providing flood protection from stormwater impacts, (2) protecting water quality, and (3) preserving stream habitat for aquatic species.

Chapter 9 of this Surface Water Master Plan includes a financial analysis of the potential projects and programs that the City of Shoreline's surface water management program could provide to its ratepayers, and describes their impacts on rates. The recommended plan in Chapter 9 reflects the needs and priorities of the City and community and balances those against the desire to charge reasonable rates.

Part I: Background and Current Program

Part I of this Surface Water Master Plan describes the City of Shoreline's current surface water management program, its history, and the regulations and policies that have shaped it.

Chapter 1. Introduction

1.1 Purpose

This Surface Water Master Plan (Plan) was written to guide the City of Shoreline's surface water management program and to identify surface water problems, prioritize needs, and develop long-term solutions that meet regulatory requirements, reflect the community's priorities, and can be funded by the City. Although Shoreline is a relatively new city, it is has been an established community for many years. The City's surface water facilities are aging and in need of repair and improvement. In addition, new development must be implemented in a way that meets regulatory requirements, enhances the City's system, and does not exacerbate existing problems.

1.2 History of the City of Shoreline's Drainage Program

Although it became a city in 1995, Shoreline's development history begins with original settlements dating back to the late 1800s. Most of the development in the City took place in the 1940s and 1950s, prior to the implementation of stormwater mitigation regulations in the 1970s. Prior to 1995, the City's drainage facilities were owned and maintained by King County. Drainage facilities in the City consist of a combination of stormwater conveyance pipes, ditches, and stream channels.

Since incorporating in 1995, Shoreline has focused on making the most critical fixes to these systems—many of them through small construction projects that could bring immediate relief to problems residents had been enduring for many years. The City also began performing routine maintenance of storm drainage systems that had not been experienced prior to incorporation. Programs to improve water quality have also been implemented

In its short history, the City of Shoreline has:

- Established a surface water management utility
- Added staff to its Public Works Department to operate, maintain, and administer its surface water management system
- Taken over responsibility for drainage system maintenance from King County
- Developed procedures to contract maintenance services to King County and private entities
- Compiled an inventory of its drainage facilities (in progress)
- Implemented a program to inspect City and privately owned retention/detention facilities
- Planned, designed, and begun construction on two major flood control projects (3rd Ave. NW and Ronald Bog)

- Obtained over $5 million in low-interest loans for small flood control projects.
- Implemented a program to improve and characterize the water quality of Shoreline's lakes and streams. These activities have included:
  - Implementing a program with King County and privately contracted crews to provide street sweeping on arterials and residential streets
  - Applying to be covered by the Washington State Department of Ecology's general permit for National Pollutant Discharge Elimination Program (NPDES) Phase II municipal stormwater systems
  - Adopting pollution source containment measures
  - Adopting erosion control standards
  - Implementing an environmental education program
  - Working with the community to provide education on herbicide application practices
- Participated in regional committees to address regional environmental issues
- Initiated this Surface Water Master Plan.

This Plan represents the City's desire to comprehensively identify and prioritize its most important drainage needs so that it can continue to improve its system.

1.3 Goals and Policies

The basis for the City's current surface water management activities was established in the 1998 Shoreline Comprehensive Plan. The plan contains policies to accomplish goals that include accommodating growth, promoting compatible development, protecting the natural environment, and making effective and efficient use of public funds. The goals and policies that have driven the current surface water management program are summarized in Chapter 4.

This Plan was developed in concert with the City's 2004 update to its 1998 Comprehensive Plan. Updates to the 1998 surface water–related goals and policies are summarized in Chapters 5, 6, and 7.

1.4 Program Areas

The many activities that make up a surface water management program can be expressed in terms of three basic areas of service. The City's program is intended to (1) provide flood protection from stormwater impacts, (2) protect water quality, and (3) preserve stream habitat.

Flood protection involves preventing flood damage to property and disruption of mobility and critical services. This is accomplished primarily through the planning, design, implementation, and maintenance of channels, pipes, roadside ditches, culverts, detention ponds, and natural and manmade open water courses.

The water quality program area involves preventing pollution through public education and involvement, enforcement, maintenance, and capital projects. This includes monitoring

pollutant levels in water bodies throughout the City, addressing sources of pollution, constructing treatment facilities, and maintaining the City's stormwater drainage systems through street sweeping, catch basin cleaning, and other activities as well as inspections and code enforcement of commercial facilities.

The stream habitat program area involves identifying and preserving existing habitat, identifying high-quality stream habitat in the City, enforcing development standards that prevent development in critical areas such as stream and wetland buffers, providing public education, and coordinating public efforts to protect or enhance habitat.

1.5 Community Input

On September 24 and 25, 2003, two open houses were held in the City of Shoreline to gather public input on the issues to be addressed in the City's update of the Comprehensive Plan and preparation of Surface Water, Parks, and Transportation Master Plans. Public comments relevant to this Surface Water Master Plan are summarized in Appendix A.

In addition, the Shoreline Planning Commission established a Stormwater and Environment Workgroup to guide City staff and the project team during the development of this Plan. The objective of the workgroup was to help ensure that the draft plan was designed with the needs and expectations of the community in mind.

1.6 Priority Levels

The City has assigned priority levels to projects identified in this Plan. These priority levels, which will be used to make decisions on the timing of projects and the expenditure of limited resources, are defined as follows:

- **Priority Level 1:** Projects with Priority Level 1 are deemed critical because they will improve public safety and reduce property damage. The City plans to implement these projects within the next 6 years.
- **Priority Level 2:** Priority Level 2 projects would improve the effectiveness of the City's surface water system. The City plans to implement these projects between years 7 and 20 of the 20-year planning period.
- **Priority Level 3:** These are the lowest priority projects. Projects with Priority Level 3 would provide additional benefits to surface water conditions. These projects will probably not get funded solely with City surface water funds. Based on the recommended plan described in Chapter 9, the City will not be able to implement these projects in the next 20 years. Implementing these projects will likely require additional sources of funding such as grants, developer mitigation fees, or local improvement districts.

More details on priority levels with respect to the three main program areas—flood protection, water quality, and stream habitat—are provided in Chapters 5, 6, and 7, respectively.

Chapter 2. Study Area Characteristics

2.1 Introduction

The study area for the Surface Water Master Plan consists of the incorporated area of the City of Shoreline, Washington. Shoreline is bounded by Puget Sound on the west and by the cities of Edmonds, Woodway, Mountlake Terrace, Lake Forest Park, and Seattle. The study area is 11.74 square miles and contains 3.4 miles of Puget Sound shoreline. Most of the area west of Aurora Avenue drains to Puget Sound via Boeing Creek and smaller creeks, while most of the area east of Aurora drains to Lake Washington through Thornton, McAleer, or Lyon creeks (see Figure 2-1).

2.2 Climate

Shoreline's climate is typical of the mild, mid-latitude coastal climate of the Pacific Northwest, moderated by marine air from the Pacific Ocean. In the summer, temperatures range from the 70s to the 90s during the day and drops to the 60s at night. In the winter, temperatures average in the 40s during the day and 30s at night, with occasional cold spells and temperatures in the low 20s.

Precipitation in the study area is influenced by the moist marine air, which is lifted and cooled by the mountains as it moves inland, causing persistent cloudiness and precipitation and resulting in an average of about 40 inches of precipitation annually. Snowstorms occur rarely, often followed by warming temperatures and rain. The frozen ground is unable to absorb the snowmelt and rainfall, which can cause severe flooding, as during the 1996 holiday storm. Most of the rain falls during the wet season, approximately October to May, usually with low intensity but long duration. While prevailing winds are from the southwest, severe storms occasionally blow in from the north.

2.3 Geology and Soils

Surficial geology develops from geologic activity (glacial advance and retreat for example), while the soil layer is formed as the weather acts upon particular geologic layers. Since the soil layer can be very thin in areas of erosion, the geologic layer is often found at the ground surface and can be mistaken for the soil layer. Thus, the geologic layer, which typically does not infiltrate water as well as soil does, can dominate the infiltration and seepage characteristics of an area.

2.3.1 Geology

Shoreline's surficial geology developed from sedimentation, folding, volcanic activity, and glacial advances and retreats. Glacial activity from 2.5 million to 11,000 years ago caused glacial scour, till and outwash. Till, often referred to as hardpan, is an impermeable layer formed by the glacial compression that contains clay and fine sediment. Till is typically very dense as a result of having been deposited under the weight of several thousand feet of glacial ice. Outwash consists of rocks and soil deposited by advancing and retreating glaciers.

Till is the predominant geologic unit found in Shoreline. Areas of Esperance sands are found south and east of Ronald Bog and along 175th Street. Esperance sand is highly permeable and easily erodible. Areas of the McAleer and Lyon Creek Basins in eastern Shoreline have significant areas of Esperance sands, transitional beds, and outwash deposits. McAleer Creek has eroded its valley into the recessional deposits and locally into the underlying silt and clay. Boeing Creek and other creeks that drain to Puget Sound in the western part of the City also have large areas of Esperance sands and transitional beds in their valleys. Along the Puget Sound shoreline and at the mouths of the creeks are areas of transitional beds, Whidbey formation, landslide deposits, procession drift, and beach deposits. Recessional outwash deposits are found in the northwest corner of the City.

Till is resistant to infiltration, but sand and gravel layers can be used as locations for infiltration ponds. Caution should be used when locating infiltration ponds to avoid surcharging the groundwater table in areas prone to landslides.

2.3.2 Soils

The predominant soil type in most Shoreline basins is Alderwood gravelly sandy loam. Alderwood soils can drain slowly during heavy rains and cause rainfall to pond or run off in sheet flow. Everett gravelly sandy loam and Everett gravelly loamy sand are found in greater proportions in the Middle Puget Sound Basins (North and South) and in the Lyon Creek basin in the eastern edge of the City. Everett soils infiltrate stormwater much better than Alderwood soils, and thus produce less ponding and runoff during heavy rains. Other soil types found in much smaller proportions in the City are: Norma fine sandy loam, Kitsap silt loam, Indianola fine sandy loam, Coastal beach, Carbondale muck, Rifle peat, Mukilteo peat, and Greenwood peat. The muck and peat soils are hydric soils which frequently support wetlands. Peat soils are predominantly located in Twin Ponds and Ronald Bog parks (Tetra Tech/KCM 2004a, 2004b, 2004c, 2004d).

2.4 Drainage System

Figure 2-1 depicts the study area, showing the boundaries of the major drainage basins in the City of Shoreline. The figure also shows the drainage system's major features. The stream systems in Shoreline consist of open water courses (including drainage ditches) and piped water courses.

The City of Shoreline study area contains nine separate drainage basins:

- Boeing Creek Basin
- McAleer Creek Basin
- Thornton Creek Basin

- Lyon Creek Basin
- West Lake Washington Basin
- Middle Puget Sound Basins (north and south)
- Seattle Golf Course Basin (not shown on Figure 2-1)
- Bitter Lake Basin (not shown on Figure 2-1).

Figure 2-1. Study Area and Drainage System Features

Figure 2-1 (back)

The western portions of the City drain to Puget Sound either directly or through Boeing Creek and smaller drainage systems. A small drainage basin, the Seattle Golf Course Basin, has no surface water outlet, but infiltrates to the groundwater below. The rest of the City drains to Lake Washington, primarily through McAleer Creek, Thornton Creek, and Lyon Creek. The features and land use of each drainage basin are discussed in more detail below.

2.4.1 Boeing Creek Basin

The Boeing Creek Basin drains approximately 1,600 acres in the western portion of the City (Figure 2-1). The basin is approximately 90 percent developed, lies primarily west of Aurora Avenue North, and drains to Puget Sound. Land use in the basin is mostly single-family residential; other uses are roads, open space, schools, and commercial/industrial development. A small portion is used for multifamily or high-density housing. Shoreline Community College, Shoreview Park, and Boeing Creek Park each take up large areas within the basin. Commercial areas are mostly along Aurora Avenue North.

Upstream of the intersection of Carlyle Hall Road Northwest and Greenwood Avenue North, the creek's south tributary is contained primarily in pipes that drain a large area including the City's most densely developed commercial areas along Aurora Avenue North. The south tributary then flows in an open water course to the M1 Dam, which forms a detention pond (maximum storage of 14 acre-feet) at the edge of Shoreview Park. Below the M1 Dam the stream flows in a heavily riprapped, steep forested ravine, with numerous cascades (4 to 12 percent gradient) and abundant amounts of large wood that help control the grade of the channel (King County 1994). Inside Shoreview Park, the south tributary meets up with the north tributary to become the Boeing Creek main stem.

The north tributary, including both an eastern and western stem, is almost entirely piped. Stormwater flows in the north tributary are directed through several regional detention ponds. The Crista and Pan Terra ponds are on the eastern stem and service the northeast portion of the area. The western stem follows 6th Avenue NW and drains the northwest portion of the basin. Both stems of the North Tributary drain into the Shoreview (North) Regional Retention/Detention Pond south of the intersection of 6th Avenue NW and NW 175th Street. A high-flow bypass located on 6th Avenue NW near NW 175th Court diverts high flows from the western stem into North Pond, while base flows enter the tributary downstream of North Pond.

From the confluence of the two tributaries, the Boeing Creek main stem descends through forested ravines to Hidden Lake, a small, constructed lake that the City regulates as a storm detention facility. Hidden Lake and its associated wetlands occupy approximately 2.1 acres. Downstream from Hidden Lake, the stream passes though a culvert under NW Innis Arden Way. This section has a steep gradient, and several weirs have been constructed to reduce erosion. The stream flows downhill to a steel-pile dam that acts as a barrier to upstream fish passage. Just upstream of the steel-pile dam, a small tributary enters the main stem. This unnamed tributary begins in a ravine west of the Shorewood Hills community and collects a portion of its stormwater.

From the steel-pile dam, the stream descends 2,300 feet through forest to the mouth. The stream channel below the dam is characterized by steep incised channels with moderate-to-severe erosion of the channel beds and banks. Many sections below the dam have experienced slope failure, and the substrate is generally embedded having been filled in with sediment, providing poor spawning habitat for salmonids (King County 1994). Boeing

Creek enters Puget Sound through a large box culvert under the Burlington Northern Santa Fe (BNSF) railroad track. The lower portion of the stream is tidally influenced at high tides.

Natural watercourses and wetlands are largely absent from the upper basin because of extensive human alteration. The loss of these natural habitat features means the loss of natural runoff storage, infiltration, and flow reduction. The lower portions of the basin still contain streams and wetlands, and the drainage system resembles a more natural pattern. Urbanization of the drainage basin without mitigation to address runoff impacts has led to higher peak flows with resulting increases in erosion and sedimentation. Urbanization has also eliminated or severely impacted fish and wildlife habitat as streams were channelized or diverted into pipes and riparian habitat was removed. These changes have resulted in a loss of total stream length and degradation of the stream sections that remain. Residential development along stream banks has further degraded the natural environment around open channel sections.

2.4.2 Middle Puget Sound Basins

The Middle Puget Sound Basins (north and south) empty into Puget Sound through dozens of small creeks and storm drainage systems (Figure 2-1). The portions of the Puget Sound drainages that lie within the City of Shoreline encompass approximately 1,250 acres north of Boeing Creek and about 30 acres south of Boeing Creek. The two basins are separated by the Boeing Creek Basin. According to a 1997 estimate by Tetra Tech/KCM (KCM 1997), the Middle Puget Sound North Basin is almost 90 percent developed, while the Middle Puget Sound South Basin is approximately 67 percent developed. Current land use is mostly single-family residential, followed by roads. Small areas are developed as multifamily, schools, commercial, and parks and open space (KCM 1997). Commercial areas are primarily along the Richmond Beach Road corridor.

The drainage system of the Middle Puget Sound Basins (North and South) is composed of six major drainage courses that are not hydraulically connected. The only major drainage course in Middle Puget Sound South is Highlands Creek. The drainages in Middle Puget Sound North are: Innis Arden North Creek, Innis Arden South Creek, Storm Creek, Upper Puget Sound North, and Upper Puget Sound South.

Drainage in the Middle Puget Sound Basins begins as urban runoff or as seepage from hillsides (King County 1987). The headwaters of Upper Puget Sound and Storm Creek are located to the north in Snohomish County. All other streams originate from wetlands, hillside seeps, and urban runoff. Each stream drainage is discussed in more detail below.

- **Highlands Creek.** Highlands Creek is entirely within the Highlands development, a gated community within the city limits. From its headwaters upstream of Olympic Drive, the stream flows west, adjacent and through private property, mostly in a pipe. The approximate length of the water course is 1,200 feet, of which 350 feet is an open water course and the rest is piped. Flow seems to originate primarily from groundwater and is relatively constant throughout the year.
- **Innis Arden South Creek.** Innis Arden South begins as three or more branches that extend into ravines with relatively steep side slopes. These branches come together on private property near NW 175th Street. Flows in the upper portion of the creek are intermittent and are strongly affected by stormwater inflow. The stream gradients in this creek range from 4 to 8 percent in the upland areas, with slightly steeper gradients in the bluff region near Puget Sound (King County 1987). Below the confluence of these branches, the creek flows another 1,700 feet before entering

Puget Sound. The lower portion of the creek flows through a private tract called the Coyote Reserve and through Innis Arden Reserve.

- **Innis Arden North Creek.** Innis Arden North Creek begins as a north stem and a south stem. The north stem begins near the intersection of NW Richmond Beach Road and 8th Avenue NW. The north stem flows generally southwest until it joins with the south stem downstream of Springdale Court NW. The south stem begins near the intersection of 10th Avenue NW and NW 180th Street and flows approximately 2,600 feet in a northwest direction until it joins with the north stem. Below the confluence of the stems, the creek flows generally southwest until it reaches Puget Sound. Much of this stream flows through the private Blue Heron Reserve. Innis Arden North Creek drains a larger area than Innis Arden South Creek and experiences larger flows.
- **Storm Creek.** Storm Creek begins upstream of NW 195th Street and flows generally southwest to Puget Sound. Several small unmapped tributaries enter the creek between NW 195th Street and NW Richmond Beach Road. One of the piped tributaries begins as seepage in a wetland area on undeveloped property just west of 12th Avenue NW. The other tributary inlets are likely additional drainages from the wetland area (Tetra Tech/KCM 2004b). To accommodate development, the stream was split in the vicinity of the Meadowbrook Apartment complex and joined again near NW 191st Street. There are continual maintenance issues with the conveyance system in this area as a result of this alteration; flooding is commonplace during heavy rains.

  Below NW 191st Street, the creek continues southwest for 3,000 feet through the privately owned Eagle Reserve in Innis Arden before entering Puget Sound. The stream is confined within a very steep ravine between the mouth and 17th Place NW. Severe erosion occurs in the lower sections of Storm Creek through the Eagle Reserve. Bank hardening and several weirs have been constructed to protect private property, a pump station, and a sewer line crossing Storm Creek.
- **Upper Puget Sound.** The Upper Puget Sound drainage is a drainage course locally known as Barnacle Creek. It has a north stem and a south stem that join together before flowing into Puget Sound. This stream flows through highly developed residential areas. The north stem begins upstream of NW 204th Street and flows west through developed areas. A 600-foot section of the stream is piped in this area. After the stream daylights downstream of Richmond Beach Drive NW, the stream enters a wetland area east of the Burlington Northern Santa Fe (BNSF) railroad track and flows generally south. At an undefined location, the north stem joins with the south stem and flows through a culvert and into Puget Sound.

  An open water course is present along the BNSF Railroad east of the tracks. The basin characterization report states, “It appears that drainage collects along the east side of the railroad before exiting into Puget Sound through culverts underneath the railroad” (Tetra Tech/KCM 2004b). One open water course begins at approximately NW 194th Place and flows from the south to the north along the east side of the BNSF Railroad and joins Barnacle Creek at the culvert immediately upstream of the BNSF Railroad. This stream is strongly affected by stormwater inflow. The lower section of Barnacle Creek is tidally influenced upstream for a distance of about 20 feet.

  The basin characterization report (Tetra Tech/KCM 2004b) describes three additional sections of open water courses that flow to Barnacle Creek. One was mapped from

its culvert outlet near NW 194th Street to the NW 196th Street bridge over the BNSF Railroad. A divide at the bridge separates this first reach from a second reach. The second reach begins at the NW 196th Street bridge (south divide) and ends at the subbasin divide at NW 198th Street (north divide). The last open water course section mapped in the basin characterization study begins in Snohomish County and flows south along the BNSF Railroad to a culvert just north of NW 204th Street. Most of the tributary area for this open water course appears to be in Snohomish County.

2.4.3 Thornton Creek Basin

The Thornton Creek Basin drains approximately 2,418 acres in the southeast quarter of the City of Shoreline (Figure 2-1). The basin is almost completely developed, with only about 3 percent of the basin remaining as vacant or open space. Land use in the basin is primarily single-family residences and roads; commercial areas are the next most prevalent land use type. Institutional uses, including Fircrest, schools, and other public facilities, make up a significant portion of the Thornton Creek Basin. There is a relatively small amount of multifamily use or apartments. A dominant feature in the City of Shoreline portion of the Thornton Creek Basin is Interstate 5, which traverses the basin in a north-south direction. The highway and the extensive residential development result in high proportion of the basin area being categorized as roads.

The Thornton Creek drainage system within the City of Shoreline contains primarily piped and channeled stormwater conveyance. Natural water courses are largely absent from the upper basin because the drainage pattern has been altered by humans to the point where most historical features are difficult to discern. Many wetlands have also been filled. With the loss of these natural habitat features, important areas where stormwater runoff could be naturally stored and infiltrated to reduce peak flows were lost. Peat mining in Ronald Bog and Twin Ponds in the post World War II era and construction of Interstate 5 in the 1960s significantly altered the hydrologic cycle and destroyed much of the natural wetland and riparian habitat.

The piped stormwater conveyance systems that dominate the upper basin and accommodate much of the runoff from this area drain into Thornton Creek or one of its tributaries. Over the years, urbanization of the drainage basin without mitigation to address runoff impacts has increased erosion and sedimentation due to increased peak flows. Urbanization has also eliminated or severely impacted fish and wildlife habitat as former streams were placed in pipes, other streams were channelized and riparian habitat was removed. These changes have resulted in a loss of open water courses and degradation of the remaining sections. Housing development along the stream banks has further degraded the natural environment around the remaining sections of open water courses of Thornton Creek.

Three primary drainage courses comprise the City of Shoreline portion of the Thornton Creek Basin, the Thornton Creek main stem, Littles Creek, and Hamlin Creek.

- **Thornton Creek Main Stem:**
  - **Ronald Bog.** The north branch of Thornton Creek's main stem begins near the intersection of 180th Street and Corliss Avenue. This drainage flows through piped water courses into Ronald Bog, a 7.7-acre pond that was previously a peat bog. Outflow from the pond is regulated by a 30-inch-

diameter pipe extending over 1,000 feet. This pipe is at a reverse grade and contributes to flooding in the area immediately south of Ronald Bog.

  - **Twin Ponds.** South of Ronald Bog, the Thornton Creek main stem flows south approximately one mile to Twin Ponds, another former peat bog. In this area the drainage flows through backyards, ditches and culverts, and through pipes under King County's solid waste transfer station and Metro's bus facility. Throughout this area, the gradient is flat and flooding is common. Downstream of Twin Ponds, the water course passes through a small wetland called Peverly Pond and eventually through a concrete-lined channel into a 15,000-foot-long, 72-inch culvert under Interstate 5, where it emerges as an open channel in the City of Seattle's Jackson Park Golf Course.
  - **Meridian Park Drainage.** The Meridian Park drainage system, which comprises Thornton Creek's west branch, originates north of Meridian Park, flows as an open water course through the Meridian Park wetland, and runs south to North 152nd Street in a pipe. From there, the drainage flows east and daylights just east of Burke Avenue North at Evergreen School, where it becomes Evergreen Creek. Evergreen Creek flows into the southwest corner of Twin Ponds.

- **Littles Creek.** Littles Creek flows south along the east side of Interstate 5 to Thornton Creek. The tributary originates as a piped system near NE 174th Street and 14th Avenue NE and collects drainage from mostly residential areas. A retention pond with a pumped overflow at the southwest corner of 170th Street NE and 15th Avenue NE drains to Littles Creek. A piped water course carries drainage from Paramount Park to the tributary. The tributary then passes through the Paramount Park Open Space, which has a 6.9-acre wetland system and two open water ponds.
- **Hamlin Creek.** This tributary joins the Thornton Creek main stem near 20th Avenue NE just south of NE 130th Street south of the city limits. The upper drainage consists of east and west stems that join on the Fircrest campus. The drainage for the west stem originates near NE Serpentine Place, south of NE 177th Street; the east stem begins southwest of the intersection of 23rd Avenue NE and NE 165th Street. The drainage in both stems is mostly piped. The west stem flows through Hamlin Park as an intermittent stream discharging to the piped system at the south of the park. The east stem begins with a short section of pipe and continues as an open water course to NE 160th Street. Below NE 160th Street, the system is piped to its confluence with Thornton Creek.

2.4.4 McAleer Creek Basin

Within the City of Shoreline, the McAleer Creek Basin includes the area tributary to Echo Lake (which drains into Lake Ballinger), the area that drains directly into Lake Ballinger, and the area tributary to McAleer Creek itself (Figure 2-1). The portion of this basin within the City totals approximately 1,322 acres. Land use in the McAleer Creek Basin is predominantly residential, although there is a moderately large commercial/industrial section along the Aurora Avenue North corridor. There are small areas of schools, parks, open space, a cemetery, and Echo Lake. Roads make up the largest impervious area in the basin.

Five drainage courses make up the McAleer Creek drainage within the City of Shoreline: the McAleer Creek main stem, the McAleer Creek west tributary, Brookside Creek, Whisper Creek (also called Cedar Brook Creek), and Echo Lake.

- **Main Stem.** The headwaters of McAleer Creek begin in the Hall's Creek and Echo Lake watersheds, both of which drain into Lake Ballinger. McAleer Creek begins at Lake Ballinger's outlet and flows through the City of Mountlake Terrace, the City of Shoreline, and the City of Lake Forest Park. The main stem of McAleer Creek enters the City of Shoreline in the area enclosed by the south cloverleaf off-ramp for Interstate 5 at NE 205th Street and exits the City just downstream of NE 196th Street.

  The creek passes beneath NE 205th Street through a 4-by-6-foot box culvert. The creek flows approximately 300 feet in an open water course before entering a culvert beneath the south cloverleaf off-ramp for Interstate 5.

  Downstream of the south cloverleaf, the stream flows 24 feet before entering a 72-inch diameter culvert beneath Forest Park Drive NE. Downstream of Forest Park Drive NE, the stream gently meanders approximately 1,500 feet to a 4-by-4-foot box culvert beneath 15th Avenue NE. The west tributary flows into the main stem upstream of 15th Avenue NE.

  From there, the creek continues its meander until it reaches the McAleer Creek Regional Detention Pond on the north side of NE 196th Street and approximately 500 feet east of 15th Avenue NE. The pond is controlled with a sluice gate at the upstream end of the dam. The pond's maximum surface area is 1 acre and it extends 550 feet upstream of NE 196th Street in a natural ravine on McAleer Creek.

  After exiting the pond, McAleer Creek flows through a 12-by-8-foot box culvert under NE 196th Street, where it leaves the City of Shoreline and enters the City of Lake Forest Park. The channel section in this area transitions gradually from a manicured residential channel to a natural ravine. The main stem of McAleer Creek then flows through Lake Forest Park and empties into Lake Washington.

- **West Tributary.** The west tributary drains the Interstate 5 corridor and west basin south of NE 205th Street. The west tributary follows along the west side of winding 6th Avenue NE as an open water course. It remains open, running east along NE 200th Street, until it enters a culvert just west of Interstate 5. The tributary remains piped for approximately 1,500 feet and daylights just before its confluence with the main stem. The west tributary drainage enters the main stem in an open channel upstream of 15th Avenue NE.

- **Brookside Creek.** Brookside Creek drains into McAleer Creek just downstream of NE 178th Street in the City of Lake Forest Park. At the Brookside Elementary School in Lake Forest Park, the tributary divides into west (Hillside Creek) and south (Brookside Creek) forks. The basin characterization report states that is not evident in the field whether either fork extends into the City of Shoreline (Tetra Tech/KCM 2004d).

- **Whisper Creek.** Whisper Creek (also called Cedar Brook Creek) enters McAleer Creek from the west out of a ravine approximately 200 feet downstream from Perkins Way near NE 185th Street. Segments of the creek lie inside Shoreline's city limits. The total length of the segments in the City is approximately 1,300 feet. Predominantly spring-fed from five major sources within the Shoreline city limits, the

tributary potentially offers, for its size, the best continuous clean water source, cover, and substrate in the basin, and contributes to good water quality in the lower main stem of McAleer Creek.

- **Echo Lake Drainage.** Echo Lake is in the western portion of the McAleer Creek Basin. Echo Lake has a year-round open water area of approximately 13 acres. The outlet stream from the lake, beginning at the lake's north end, flows north to Lake Ballinger (outside the City), whose outlet stream is McAleer Creek (which flows back into the City to the east of Interstate 5). The outlet of the lake is piped until passing beneath North 200th Street. North of the street crossing, the drainage is highly confined as it flows through an open water course surrounded by a commercial development to the west and residential neighborhood to the east. The primary inlet to the lake is a pipe entering at the south end that drains an area extending west of Aurora Avenue North.

2.4.5 Lyon Creek Basin

The Lyon Creek Basin extends through Snohomish County as well as the cities of Shoreline, Lake Forest Park, Mountlake Terrace, and Brier (Figure 2-1). The size of the basin within Shoreline's city limits is approximately 184 acres. The most common land use is single-family and multifamily residential, but there is a mix of all other land uses in the area. The commercial uses are clustered along NE Ballinger Way north of 19th Avenue NE. Multifamily is also found along NE Ballinger Way, mostly south of 19th Avenue NE. A large school complex is at the intersection of 25th Avenue NE and NE 200th Street. Bruggers Bog and Ballinger Park are located along 25th and 24th Avenues NE, respectively (KCM 1997).

The only drainage course in this basin within Shoreline is a portion of Ballinger Creek and its associated tributaries, all of which are in the northeast corner of the City. Ballinger Creek, a tributary to Lyon Creek, originates north of the City in Snohomish County. It flows south between 21st and 22nd Avenues NE and enters the Ballinger Creek Condominiums, where it flows alternately through buried culverts and open water courses. The creek flows through a City-owned trash rack just upstream of the Ballinger Creek Condominiums. The creek daylights in Bruggers Bog and flows to the southeast. As it enters Bruggers Bog Park it meets with an unnamed stream flowing from the west. Just upstream of its confluence with Ballinger Creek, this unnamed tributary forks into a north and a south branch. Ballinger Creek flows southeast across Bruggers Bog and picks up flow from two unnamed tributaries flowing in from the east. At the southeast corner of Bruggers Bog Park, Ballinger Creek enters a network of pipes at 25th Avenue NE. The creek daylights on the southeast side of 25th Avenue NE and flows in an open water course prior to leaving the City and flowing under NE Ballinger Way into the City of Lake Forest Park. In the City of Lake Forest Park, the creek flows roughly parallel to NE Ballinger Way and enters Lyon Creek outside the Shoreline city limits near the intersection of NE Ballinger Way and 35th Avenue NE.

2.4.6 Smaller Basins

Small portions of other basins also lie within the Shoreline city limits. However, no specific flood protection, water quality, or stream habitat issues have been identified for these areas. These areas share the general characteristics of nearby basins.

- **West Lake Washington Basin.** Two portions of this basin lie within the City of Shoreline boundary in the southeast part of the City, one about 118 acres and the

other about 18 acres (Figure 2-1). This area is adjacent to the Thornton Creek Basin and shares the general geologic, land use, and habitat characteristics of that basin. None of this basin's major water courses lie within the City of Shoreline.

- **Seattle Golf Course Basin.** The Seattle Golf Course Basin lies in the southwest portion of the City (not shown on Figure 2-1). Until recently, this basin was a closed depression that did not have a surface water outlet. Runoff in the basin collected in a 2.1-acre wetland and infiltrated into the groundwater table. The outlet now discharges into Highlands Creek. The basin is approximately 138 acres and is situated almost entirely within the City of Shoreline, with a small proportion in Seattle. The geology of this area is mostly till and land use in the basin consists of recreation.
- **Bitter Lake Basin.** Only 54 acres of this basin lie within the City of Shoreline in the southwest of the City (not shown on Figure 2-1). This area shares the general geologic, land use, and habitat characteristics of the Middle Puget Sound South Basin. None of this basin's major water courses lie within the City of Shoreline.

2.5 Environmental Resources

2.5.1 Vegetation and Wildlife Habitat

Residents characterize the City of Shoreline as a wooded community; this is often cited as a key reason for locating to the area. Large evergreen trees can be seen rising above residential neighborhoods, on hilltops, and even on the periphery of Aurora Avenue. As the City has become more urbanized, the area covered by native ground cover and/or shaded by native trees has been vastly reduced.

Forested open space, wetlands, and native vegetation found on steep slopes and larger residential lots are important resources. Trees help stabilize soils on steep slopes and act as barriers to wind and sound. Plants replenish the soil with nutrients and generate oxygen and clean pollutants from the air. Native vegetation provides habitat for wildlife; the native vegetation found near creeks, lakes, and saltwater areas offer habitats for many migrating and resident birds and other wildlife. Less developed wooded areas and City parks also provide habitats for many birds and mammals. Wetlands and riparian vegetation provide surface water storage and help clean surface water of pollutants and sediment.

Aerial photos show that the community is a mosaic of various types of vegetation. The largest, most contiguous areas of native vegetation in Shoreline are primarily found in City parks, publicly owned open space, privately owned designated open space (such as the Boeing Creek area of The Highlands) and designated sensitive areas (such as steep slopes along the Puget Sound shoreline). These areas provide the highest quality wildlife habitat found in the City. However, areas of less intensive residential development also contain mature trees and other native vegetation that provide secondary wildlife habitat and substantially contribute to the quality of life in the City. Native vegetation in residential areas that may be subdivided or otherwise more intensely developed is at the greatest risk of being lost.

The process of urbanization results in the conversion of wildlife habitat to other uses. The loss of certain types of habitat can have significant, adverse effects on the health of certain species. These types of habitat are referred to as critical wildlife habitats. Critical wildlife habitats include lands important for the protection, management, or public enjoyment of

certain wildlife species. These include habitats of species which state or federal agencies have designated as endangered, threatened, sensitive, candidate, or priority species, anadromous fish habitat, waterfowl and raptor nests, heron rookeries, and habitats of local importance that are identified and designated through a wildlife conservation plan.

2.5.1.1 Priority Habitat and Species

The Washington Department of Fish and Wildlife (WDFW) maintains priority habitat and species information for Washington State, including the status of species as threatened or endangered. The City of Shoreline occurs within WDFW Region 4. Priority habitats within Region 4 include consolidated marine/estuarine shorelines, cliffs, caves, snags, riparian areas, old-growth/mature forests, and urban open spaces. These areas combined comprise less than 5 percent of the total land area of the City and are primarily found within existing City parks, public open space, designated private open space, and designated sensitive areas. Additional priority habitats and species may occur in areas not currently known to WDFW biologists or in areas for which comprehensive surveys have not been conducted. WDFW's Priority Habitats and Species (PHS) data can only show that a species or habitat type may be present. These data do not show that a species or habitat type is not present. Site-specific surveys may be necessary to rule out the presence of priority species and priority habitats on an individual project site. WDFW has established guidelines that enable local governments to designate and protect species of local importance. These habitats may contain up to 13 species of invertebrates, 62 species of vertebrates, and 20 species of mammals (Shoreline 1998).

This report discusses salmonids and certain forage fish that are priority species and are known to occur in City of Shoreline stream systems. More information on other species, including birds, shellfish, and marine fish, is included in the 2004 update to the Shoreline Comprehensive Plan.

Salmonids

The *Salmonid Habitat Limiting Factors: Water Resources Inventory Area (WRIA) 8 Final Report* (Kerwin 2001) identifies the known presence of salmon in local streams. Boeing Creek has documented salmonid use including chinook salmon (listed as threatened under the ESA), chum salmon, coho (federal candidate species), sea run cutthroat trout, and resident cutthroat trout. It is likely that many of the fish are products of the "Fish in the Classroom" program (Daley Design 2004). Coho are listed by the WRIA 8 report as occurring in Boeing Creek (Kerwin 2001).

McAleer Creek has documented salmonid use including chinook salmon, coho salmon, and sockeye salmon, and resident cutthroat trout (Daley Design 2004). Most use occurs outside the City limits, but coho salmon and resident cutthroat trout have been observed in portions of McAleer Creek within the City limits.

WDFW's Area Habitat Biologist identified an adult steelhead in Thornton Creek upstream of Twin Ponds and NE 155th Street on February 4, 2004. In addition, a biologist with Washington Trout has identified a chinook juvenile upstream of Twin Ponds, and Aegis and City biologists have identified coho and sockeye juveniles in the vicinity of Peverly Pond. It is possible that the coho and chinook were planted from hatchery stock, but this is not known for certain. However, the sockeye is most likely wild.

Highlands Creek contains no salmonids. All other streams in the City are likely to contain resident cutthroat trout in some portions of the stream (Tetra Tech/KCM 2004b; Daley Design 2004).

Nearshore habitat is an important environment for juvenile salmonids, where the shallow water depth obstructs the presence of larger, predator species (Kerwin 2001). All shoreline segments within the City's shoreline jurisdiction are known or expected to contain juvenile salmonids including bull trout (federally listed), chinook, chum, coho, cutthroat, pink, and sockeye, based on the knowledge of species life histories (King County 2001).

Forage Fish

Forage fish include species that as adults breed prolifically and are small enough to be prey for larger species. They are often non-game fish. Four primary sources were referenced in compiling information on potential forage fish spawning areas within the City's shoreline jurisdiction: Marine Resource Species (MRS) data maintained by WDFW (2003), the *Water Resources Inventory Area (WRIA) 8 Final Report* (Kerwin 2001), *Fish Utilization in the City of Shoreline Streams* (Daley Design 2004), and the *Reconnaissance Assessment of the State of the Nearshore Environment* (King County 2001).

The five forage fish species most likely to occur in the City's shoreline jurisdiction include surf smelt, sand lance, Pacific herring, longfin smelt, and eulachon (Kerwin 2001, King County 2001). The mouth of Boeing Creek has been identified as an important area for the feeding, migration, and spawning and rearing of all five of these forage fish species (Daley Design 2004).

2.5.2 Water Resources and Shorelines

2.5.2.1 Wetlands

Wetlands perform valuable functions that include storm and floodwater storage, water quality improvement, groundwater exchange, stream base flow augmentation, and biological habitat support. Chapter 20.80, Critical Areas, of the Shoreline Municipal Code (SMC) establishes development standards, construction techniques, and permitted uses in critical areas and/or their buffers (i.e., geologic hazard areas, fish and wildlife conservation areas, wetlands, flood hazard areas, aquifer recharge areas, and stream areas) to protect these areas from adverse impacts (for more information, see Chapter 3 and Appendix B). Designated critical areas are found throughout the City's jurisdiction, particularly wetlands and streams, flood hazard areas, and geologic hazard areas.

The characterization of wetlands is based on the recent inventory and classification of existing wetlands in the City of Shoreline that was completed by Tetra Tech/KCM in October and November 2001. The wetland inventory identified significant unmapped wetlands and classified both previously known and unknown wetlands within the City's boundaries. No wetland delineations were conducted as part of that study. Wetlands were classified according to the *Classification of Wetlands and Deepwater Habitats of the United States* (Cowardin et al. 1979).

The inventory identified 24 previously unmapped areas as potential wetlands: nine in the Boeing Creek watershed, six in the Middle Puget Sound watersheds (North and South), two in the McAleer Creek watershed, and seven in the Thornton Creek watershed. Of the 24 unmapped areas, four were found to be wetlands. In addition, 17 previously mapped wetland areas were verified for size, location, and classification (Tetra Tech/KCM 2004a, 2004b, 2004c, 2004d).

These wetlands range from the large estuarine system (a mixture of salt and fresh waters) adjacent to Puget Sound, to lakes and small excavated ponds. With the exception of the Puget Sound estuarine system, all wetlands in the City are palustrine systems (freshwater).

The largest palustrine system, at approximately 6.9 acres, is in the Paramount Park Open Space within the Thornton Creek Basin. Other large wetlands include Meridian Avenue (in Twin Ponds Park), Twin Ponds, Seattle Golf Course, Hidden Lake, and ponds within Ronald Bog Park. Most wetlands in the City are relatively isolated systems and are surrounded by development.

Under the current Shoreline Municipal Code (SMC 20.80.320), wetlands are designated Type I, Type II, Type III, Type IV, or artificial. Development restrictions, including minimum buffers, vary by type. Type I wetlands receive the highest level of protection. All wetlands, regardless of size, are regulated under the Shoreline Municipal Code, whether or not they are mapped. When a development is proposed on a site with known or suspected wetlands, a wetland evaluation is required to verify and classify wetlands and delineate boundaries and buffer areas.

All of the documented wetlands within the City have experienced some level of disturbance as a result of development and human activity. Most of the disturbances have included major alterations such as wetland excavation or water impoundment. Disturbances in many wetland systems appear to be ongoing. Most of the wetland areas occur within parks and receive constant use by people. Trash and altered and trampled buffer areas were documented problems in many areas.

2.6 References

The following sources were used to develop this chapter:

- Daley Design. 2004. "Fish Utilization in City of Shoreline Streams," Appendix C to *City of Shoreline Stream and Wetland Inventory and Assessment.* Prepared for Tetra Tech/KCM, Inc., by Daley Design, Bainbridge, WA. May 2004.
- KCM. September 1997. *City of Shoreline Stormwater Study for GMA Comprehensive Plan/EIS.* Prepared for the City of Shoreline by KCM, Inc., Seattle, WA. Cited in Tetra Tech/KCM 2004b and Tetra Tech/KCM 2004d.
- Kerwin, J. 2001. *Salmonid Habitat Limiting Factors: Water Resources Inventory Area (WRIA) 8 Final Report.* Washington State Conservation Commission, Olympia, WA.
- King County. 1987. *Reconnaissance Report No. 21: Middle Puget Sound Basin.* Prepared by King County Department of Public Works Surface Water Management Division, Seattle, WA. Cited in Tetra Tech/KCM 2004b.
- King County. 1994. *Boeing Creek Tributary 0019 special study.* Prepared by King County Department of Public Works Surface Water Management Division, Seattle, WA. November 7, 1994. Cited in Tetra Tech/KCM 2004a.
- King County. 2001. *Reconnaissance Assessment of the State of the Nearshore Report: Including Vashon and Maury Islands (WRIAs 8 and 9).* Prepared by King County Department of Natural Resources, Seattle, WA.
- Seattle Public Utilities. 2000. *Thornton Creek Watershed Characterization Report.* Cited in Tetra Tech/KCM 2004c.
- Shoreline. 1998. *City of Shoreline Comprehensive Plan.* Adopted November 23, 1998.

- Tetra Tech/KCM. 2004. *City of Shoreline Stream and Wetland Inventory and Assessment.* Prepared for City of Shoreline by Tetra Tech/KCM, Inc., Seattle, WA. May 2004. The following basin characterization reports, published as separate volumes as part of this project, were used extensively for this chapter.
  - Tetra Tech/KCM. 2004a. *Boeing Creek Basin Characterization Report.*
  - Tetra Tech/KCM. 2004b. *Middle Puget Sound, Seattle Golf Club and Bitter Lake Basins Characterization Report.*
  - Tetra Tech/KCM. 2004c. *Thornton Creek and West Lake Washington Basins Characterization Report.*
  - Tetra Tech/KCM. 2004d. *McAleer Creek and Lyon Creek Basins Characterization Report.*
- WDFW (Washington State Department of Fish and Wildlife). 2003. Priority Habitats and Species (PHS), "StreamNet," and Marine Resources Species (MRS) databases. Olympia, WA.

Chapter 3. Regulatory Issues

The City of Shoreline's surface water program must comply with a number of state and federal regulations that are pertinent to stormwater. A detailed review of the existing city, state, and federal policies, regulations, and ordinances relevant to stormwater management is presented in Appendix B. Table 3-1 presents a summary of these policies, regulations, and ordinances and shows how they apply to the City of Shoreline. The table also lists the current status of the City's stormwater management program and recommended actions to bring the City of Shoreline into compliance with the regulations. As these recommendations show, code enforcement should be one of the City's main priorities.

By implementing its own policies, regulations, and ordinances, the City is succeeding in complying with the regulations as well as meeting local needs. The table is divided into six sections that represent key activities of the City's stormwater program. The key activities listed on the table are:

- development of needed regulations and standards
- operations and maintenance
- public education
- program funding
- interlocal coordination
- implementation.

The table is organized to show how the different state and federal regulations relate to these key activities.

Table 3-1
Surface Water Program Requirements

Insert Table 3-1 (11 x 17, 6 pp) from separate Word file

Table 3-1, p. 2

Table 3-1, p. 3

Table 3-1, p. 4

Table 3-1, p. 5

Table 3-1, p. 6

Chapter 4. Current Program

4.1 Introduction

The City of Shoreline's surface water management (SWM) program carries out the policy direction set in the City's Comprehensive Plan, as well as directions expressed by City staff and the public. The City's 1998 Comprehensive Plan contained adopted goals and policies that expressed the community's desires related to surface water management. These goals and policies, plus the need to meet regulatory requirements, have resulted in the services that the City currently provides to ratepayers in three program areas: flood protection, water quality, and stream habitat.

To provide background on how 1998 Comprehensive Plan goals and policies have provided direction to the City's current program, Tables 4-1, 4-2, and 4-3 summarize this information according to the three program areas. The 2004 Comprehensive Plan Update includes revisions to some of these policies, and the current goals and policies that shape the recommended (future) SWM program are described in Chapters 5, 6, and 7.

Table 4-1
Flood Protection–Related Goals and Policies from the 1998 Comprehensive Plan

1998 Comprehensive Plan Goals and Policies	Direction Given to Surface Water Management Program
Goal EN V Policies U14, U15, EN63, EN36, EN42, EN44, and EN46	▪ Manage the storm and surface water system through a combination of engineered solutions and the preservation of natural systems in order to provide for public safety, prevent property damage, protect water quality, preserve and enhance fish habitat, and maintain a hydrologic balance. ▪ Resolve existing flooding problems and prevent new ones. ▪ Develop surface water facilities that protect water quality, enhance public safety, preserve and enhance habitat, and protect critical areas. ▪ Review new development so that it does not aggravate existing flooding problems. ▪ Manage larger development projects to retrofit existing paved areas with new controls that help alleviate downstream flooding problems. ▪ Promote low-impact new development that reduces runoff from the site and helps to alleviate downstream flooding. This includes protecting natural flood storage areas. ▪ Identify the City as the responsible party for maintaining stormwater systems in City right-of-way to prevent flooding. ▪ Identify private property owners as the responsible party responsible for

1998 Comprehensive Plan Goals and Policies	Direction Given to Surface Water Management Program
	maintenance of their own systems to prevent flooding on their land. ▪ Design and construct flood protection projects to solve existing flooding problems, but also to provide multiple benefits to the extent possible that meet goals, policies, and community needs expressed for habitat and surface water quality.

Table 4-2
Water Quality–Related Goals and Policies from the 1998 Comprehensive Plan

1998 Comprehensive Plan Goals and Policies	Direction Given to Surface Water Management Program
Goal EN V Policies EN36, EN37, EN38, EN39, EN40, EN41, EN43, EN44, EN45, EN46, EN58, and EN62	▪ Manage the storm and surface water system through a combination of engineered solutions and the preservation of natural systems in order to provide for public safety, prevent property damage, protect water quality, preserve and enhance fish habitat, and maintain a hydrologic balance. ▪ Maintain surface water quality as defined by federal and state standards. ▪ Restore water quality of runoff from properties to predevelopment levels for new development and redevelopment. ▪ Rehabilitate degraded surface water by reducing nonpoint source pollution, controlling erosion, and improving the stormwater system. ▪ Actively pursue state and federal grants to improve surface water management and water quality ▪ Support the use of appropriate landscaping, swales, retention facilities, and treatment facilities to enhance water quality and the percolation of water at natural rates near its source to limit soil instability or damage to roadways or other improvements. ▪ Sweep streets to reduce pollutants entering the stormwater drainage system ▪ Educate citizens about proper waste disposal. Prevent direct disposal into storm drains. ▪ Promote practices that prevent pollutants from entering the stormwater system as a result of lawn and garden maintenance, car cleaning or maintenance, and roof cleaning or maintenance. ▪ Maintain and enhance natural drainage systems. ▪ Identify the City as the responsible party for maintaining stormwater systems in City right-of-way to prevent flooding. ▪ Identify private property owners as the responsible party responsible for maintenance of their own systems to prevent flooding on their land. ▪ Cooperate with other jurisdictions and agencies to improve regional surface water management, protect water quality, and resolve related interjurisdictional concerns.

- Design and construct water quality projects to solve existing water quality problems, but also to provide multiple benefits to the extent possible that meet goals, policies, and community needs expressed for flood protection and habitat.
- Pursue funding to conduct baseline monitoring and improvement of water quality in lakes and streams in the City.
- Protect water quality through regulation and educational outreach.
- Adhere to state and federal environmental standards in all City-funded projects.

Table 4-3
Stream Habitat–Related Goals and Policies from the 1998 Comprehensive Plan

1998 Comprehensive Plan Goals and Policies	Direction Given to Surface Water Management Program
Goals EN V and EN VI Policies EN29, EN46, EN47, EN57, EN59, EN60, EN61, EN63, EN65, EN66, and EN67	▪ Manage the storm and surface water system through a combination of engineered solutions and the preservation of natural systems in order to provide for public safety, prevent property damage, protect water quality, preserve and enhance fish habitat, and maintain a hydrologic balance. ▪ Preserve, protect, or restore wetlands, shorelines, surface water, and groundwater for wildlife, appropriate human use, and the maintenance of hydrological and ecological processes. ▪ Actively participate in regional species protection efforts, including salmon habitat protection and restoration. ▪ Preserve wetlands and aquatic and riparian habitats in a natural state and maintain appropriate buffers around these areas. ▪ Study issues related to Hidden Lake and develop a management plan for the lake. ▪ Avoid filling or permanently altering streams. Place a higher priority on projects that allow streams to return to natural channel migration patterns. Give preference to channel stabilization over culverting. ▪ Promote citizen involvement and seek community consensus on attempts to restore surface water features which have been altered. Restoration efforts may include the daylighting of streams which have been diverted into underground pipes or culverts. ▪ Identify, prioritize, and eliminate barriers to fish passage. Work with citizen volunteers, state and federal agencies, and tribal governments in these efforts. ▪ Protect natural flood storage areas. ▪ Use the state Shoreline Management Act to guide protection efforts for shorelines of statewide significance and for other water features that do not qualify for state regulation. ▪ Cooperate with adjacent county and local governments, regional governments, state agencies, and tribal governments to develop and implement Watershed Action Plans and other types of basin plans for basins that lie within or partially within Shoreline's boundaries. ▪ Expand public access to Shoreline's natural features, including the Puget Sound shoreline. Seek consensus of local communities and neighborhoods when private property owners might be negatively affected by this action. ▪ Design and construct habitat projects to solve existing habitat problems, but also to provide additional benefits to the extent possible that meet goals, policies, and community needs expressed for flood protection and surface water quality.

4.2 Existing Surface Water Management Responsibilities (Current Activities)

This section describes the City's current surface water management program, including both operation and maintenance (O&M) and capital improvements. In general, the City's current SWM activities fulfill the policy direction summarized in Tables 4-1, 4-2, and 4-3. This section begins with an inventory of drainage facilities, followed by a description of SWM activities.

4.2.1 Inventory of Drainage Facilities

Shoreline's drainage system consists of facilities to convey and treat stormwater prior to its discharge into receiving waters that include local streams and Puget Sound. The following paragraphs describe drainage system components.

- **Stormwater Pipe.** The city's stormwater pipes range in diameter from eight inches to five feet, and convey stormwater to outfalls into receiving waters such as Boeing Creek or Puget Sound. Some stormwater pipes have storage or water quality treatment structures built into the system. Maintenance requirements include cleaning lines, making minor repairs, and removing roots, sand, gravel, and other debris from the pipe.
- **Culverts.** Culverts are short sections of pipe used to convey stormwater, generally either under or adjacent to roads. Culvert pipes are usually concrete or corrugated metal. Inspections and minor cleaning are conducted throughout the year. Maintenance activities include inspection, repairs, and removal of sediment, debris, and vegetation.
- **Catch basins.** Catch basins are underground sumps which are typically in-line between catch basin inlets and the piped storm drain system. In Shoreline, some stormwater pipes discharge directly into catch basins. The sump at the bottom of the catch basin is used to capture sediment and other debris from incoming stormwater. A trapped outlet prevents most floating debris and oil from leaving the catch basin. Maintenance includes regular inspection, removal of sediment and debris, and repairs.
- **Ditches.** Ditches are constructed earth trenches, lined with vegetation or concrete, that convey stormwater in areas not served by piped systems. Ditch maintenance includes removal of debris, mowing, and periodic reshaping.
- **Biofiltration swales.** Biofiltration swales are grass-lined, flat-bottomed ditches. The shape, slope, width, and length of the swale are designed to provide water quality treatment. Routine maintenance includes inspection, mowing, debris removal, and occasional removal of built-up sediments. Grass must be mowed frequently.
- **Retention/detention ponds and underground storage facilities.** Retention/detention ponds and underground storage facilities (such as vaults and pipes) store stormwater. The purpose of these facilities is to temporarily store stormwater so that it can be released at a controlled rate to nearby receiving water bodies or into the ground. Routine maintenance includes inspection, sediment removal, and grass cutting for ponds.

- **Oil/water separators.** Oil/water separators are generally underground vaults designed to trap sediments, oil, and floatable materials. Some oil/water separators contain oil-absorbing booms. Routine maintenance includes inspection; removal of oil, sediment, and floating debris; and replacement of oil booms.

Table 4-4 summarizes the estimated quantity of drainage system infrastructure in the City of Shoreline.

Table 4-4
Drainage System Infrastructure

Drainage System Component	Estimated Quantity	Unit
Stormwater Pipe	500,000 (95)	LF (miles)
Catch Basins	5,500	Each
Ditches	180,000 (34)	LF (miles)
Outfalls (to open water courses)	60	Each
Outfalls (to Puget Sound)	unknown	Each
Retention and Detention Facilities (maintained by the City)	95	Each
Retention and Detention Facilities (privately maintained)	219	Each
Lift Stations	2	Each

4.2.2 Current Operation and Maintenance Program

4.2.2.1 Maintenance Activities

Maintenance activities are those directly related to the physical maintenance of the drainage system, and do not include programmatic activities. Currently, the City relies on King County, private contractors, and City crews to complete these maintenance activities.

Each year, the City reviews service level needs and available resources. In recent years, the City has been transferring services previously provided by King County to private contractors in those cases where it is more cost effective. The City's future evaluations will consider partnerships with other agencies and in-house delivery of services, for continued stabilization or reduction of costs.

Appendix C contains a list of maintenance activities and identifies the current roles of City crews, King County, and private contractors in completing these activities.

In general, maintenance is contracted if specialized equipment is required. The City does not own street sweepers, and as a result, it contracts out street sweeping services. Similarly, the City does not own vactor trucks, and it contracts out catch basin cleaning that requires vactor trucks. The City often prefers to use King County for emergency repairs because of the County's responsiveness.

The following six maintenance activities have required the majority of expense and effort to date:

- **Vactoring.** Vactoring of catch basins is required to keep debris out of the drainage pipes and to provide a water quality benefit by removing settleable pollutants from stormwater. Currently, there are approximately 5,500 catch basins in the City. In 2004, the City anticipates cleaning approximately 4,300 catch basins, or approximately 80 percent of the total. The City has received a bid of approximately $25 per catch basin from private contractors for this service, and expects to continue shifting the responsibility of catch basin cleaning to private contractors in the future.
- **Ditch Reshaping.** Ditch reshaping is periodically required to maintain the proper conveyance of stormwater in the ditch. The City allots three weeks of crew time throughout the year to ditch reshaping, and expects to complete an estimated 7,500 lineal feet (LF) each year. This is equivalent to reshaping the City's ditches on an approximately 25-year cycle.
- **Shoulder Reconstruction.** Shoulder reconstruction is occasionally required to ensure proper drainage from streets. Generally, shoulder reconstruction involves regrading the slope of the shoulder toward the ditch, followed by placement of a thin gravel layer to cover muddy areas. City staff report that shoulder reconstruction is currently done on an approximately 10-year cycle. The unit cost for shoulder reconstruction is approximately $1 to $2 per LF. Shoulder reconstruction is funded by both the City's SWM Fund and the Street Fund. This is because shoulder reconstruction promotes proper drainage as well as proper use of the street and shoulder areas for traffic.
- **Maintenance of Retention and Detention Facilities.** The City contracts with King County for maintenance of these facilities. In 2004, the City is budgeting approximately $80,000 for maintenance of these facilities. A specific inventory of maintenance activities is not yet available (see discussion of the City's maintenance management system later in this section).
- **Street Sweeping.** The City contracts with King County and with private companies for street sweeping services. In 2004, street sweeping is planned on the following schedule:
  - Arterials and collectors: monthly. (See Figure 4-1 for a map of arterial and collector street sweeping routes.)
  - Residential streets: three times per year.
  - City-owned parking lots: six times per year.

  Street sweeping unit costs budgeted for 2004 range between $50 and $60 per lane mile. Street sweeping is funded by both the City's SWM Fund and the Street Fund because street sweeping improves water quality as well as use of the street for traffic.
- **Dredging of Hidden Lake.** This is done biennially by a private contractor.

Dams are another type of facility that requires maintenance. There are eight dams located in the City. Two of these are privately owned and maintained, and the remaining six are owned and maintained by the City. Maintenance activities involve vegetation management occupying a two-person crew for two to three weeks per year, plus groundwater monitoring at the North Pond dam due to recent dam modifications.

Figure 4-1. Monthly Arterial and Collector Street Sweeping

Figure 4-1 (back)

Three of the City's dams are regulated by the Washington State Department of Ecology and have operating permits. Prior to the City's incorporation, the permits were held by King County. Although King County no longer owns the dams, the County is still the permittee under its National Pollutant Discharge Elimination Program (NPDES) Phase I permit. The City anticipates working with King County to resolve any permitting issues for the City's dams.

Table 4-5 summarizes 2004 budgeted maintenance expenditures broken down by task as available.

Table 4-5
Budgeted 2004 Maintenance Expenditures

Maintenance Activity	2004 Budgeted Expenditure
Catch Basin Cleaning	$131,960
Street Sweeping[a]	71,522
All Other Activities[b]	384,263
Total	**$587,745**

[a] Does not include the cost of street sweeping funded by the City's Street Fund, which in 2004 is budgeted to be $76,108.
[b] Does not include shoulder reconstruction funded by the City's Street Fund

In 1999, City staff developed a series of unit cost estimates for many maintenance tasks performed by City crews. These unit cost estimates have been useful to the City in the areas of estimating maintenance costs and workload planning. The City intends to review these unit cost estimates after full implementation of its new maintenance management system, and to make changes based on several years' worth of actual maintenance records.

4.2.2.2 Programmatic Activities

In addition to maintaining the drainage system, City staff are currently involved in a number of programmatic activities shown in Table 4-6. Many of these activities focus on working with Shoreline's residents and businesses to prevent stormwater pollution and to improve water quality. Other programmatic activities focus on working with entities outside the City on regional watershed planning and regulatory compliance activities. Not shown in Table 4-6 (but included in Appendix C) are activities funded from the City's Waste Management Fund.

The estimated SWM staffing for programmatic activities is 1.7 regular FTEs (full-time equivalents) plus two part-time interns who combine for 1.0 FTE. SWM staff do not specifically record their time spent on each programmatic activity, so the values shown in Table 4-6 are estimates intended to convey an approximate level of effort for each activity. The majority of programmatic activities provide a water quality benefit, with some activities providing flood protection or habitat benefits. Programmatic activities include enforcement of Shoreline's municipal code through inspection and source control activities.

Table 4-6
SWM Programmatic Activities

Activity [a]	Description of Current Efforts	Benefit	Current FTEs
No-Spray Zone Project	Training and materials to teach right-of-way plant eradication. This project is currently being done in the Richmond Beach area in response to a neighborhood request.	Improves water quality by reducing runoff containing pesticides and herbicides.	0.05
Clean Car Wash Program	Present efforts are limited and are incidental to other activities listed in this table.	Improves water quality by reducing discharge of soaps, metals, and turbidity.	0.0
Natural Lawn and Garden Care	Coordinate an annual event containing incentive tools and products; coordinate three annual training workshops for residents. Funded 75% by a grant using City funds as local match.	Improves water quality by reducing runoff containing pesticides and herbicides.	0.25
Storm Drain Stenciling Program	Support for use of stencil kit loaned to residents; provide resource and training support for teachers. Most storm drain stenciling is currently done by student volunteers.	Improves water quality by reducing illegal dumping to the drainage system.	0.1
Community Involvement Restoration Program	Co-lead Earth Day activities in Boeing Creek Park; train teachers and lead student groups in watershed analysis and restoration; educate/train residents to improve lake and stream water quality.	Provides public education on a variety of issues related to surface water management.	0.05
Compost Facility Program	Coordinate compost O&M; maintain records; write reports.	Improves water quality by offering residents alternatives for natural lawn and garden care.	0.2[b]
Regional Road Maintenance/ESA/NPDES Program	Train staff; participate in Regional Forum; maintain road maintenance best management practices (BMP) records; submit quarterly reports.	Improves water quality by reducing discharge of pollutants through road maintenance; ensures continued regulatory compliance.	0.1
Water Quality Monitoring	Collect field measurements of parameters such as dissolved oxygen, pH, TDS, salinity, turbidity, and temperature.	Characterizes water quality of Shoreline's open water courses and helps identify pollutant sources.	0.4
Regional Committee Participation	WRIA 8 activities (forum, steering committee, and public outreach).	Ensures the City participates in and is informed of ongoing regional planning and regulatory compliance efforts.	0.1
Surface Water Monitoring and Source Control Program	Investigate water quality complaints, spill response, and provide public outreach on various source control issues.	Improves water quality by reducing discharge of pollutants.	0.4
Retention and Detention (R/D) Facility Inspection	Inspect City-maintained facilities to define required maintenance activities. Inspect privately maintained facilities to enforce maintenance requirements. Average one inspection per year. Conduct follow-up inspections to verify maintenance activities.	Improves flood protection by ensuring proper O&M of R/D facilities; improves water quality by ensuring proper O&M of treatment aspects of R/D facilities.	1.0[c]
		Total	**2.7**

[a] Activities listed are those completed by SWM program staff and do not include finance department activities such as SWM account maintenance and billing.

[b] The City has included this activity as part of its BMPs in its NPDES municipal stormwater permit application. The 0.2 FTE funded from the SWM program does not include the actual O&M of the facility, which is completed by City roads crews and funded by the City's Street Fund.

[c] Currently, two interns, each working 1,040 hours per year, complete retention/detention facility inspections.

The City considers its recycling program and its solid waste management program, both funded from its Waste Management Fund, to be BMPs related to its future NPDES Phase II municipal stormwater permit. Recycling activities include annual coordination of two general recycling events and a Christmas tree recycling program, maintaining the ongoing battery recycling program, writing grant applications, and grant administration. Solid waste management program activities include hazardous waste/recycling events and outreach, monitoring customer satisfaction, and solid waste disposal contract re-negotiation. The combined staffing for these programs is approximately 0.6 regular FTE and 1.0 intern FTE.

The City reviews planned drainage facilities proposed by developers according to the requirements of its municipal code. This review is done to meet regulatory requirements and to ensure consistency with policy direction established in the City's Comprehensive Plan.

4.2.2.3 Support Activities

Support services to the SWM program are provided by a number of different City departments, and include budget and financial management, policy development and leadership, administrative support, vehicle maintenance, building maintenance, accounting, purchasing, and human resources. The City's Community Response Team receives feedback from residents for all City services, including surface water management. King County provides billing support services.

4.2.2.4 O&M Expenditures for Each Program Area

Tables 4-7 and 4-8 show an estimate of a division of 2004 budgeted O&M expenditures among the flood protection, water quality, and habitat program areas. These tables also include support expenditures, which are not directly attributed to one of the three program areas.

Table 4-7
Approximate Functionalization of SWM O&M Expenses

O&M Activity	Flood Protection	Water Quality	Stream Habitat	Support
Maintenance				
Street Sweeping	50%	50%		
Catch Basin Cleaning	50%	50%		
Other Maintenance	100%			
Programmatic				
R/D Facility Inspection	50%	50%		
WRIA Activities		50%	50%	
ESA, Biological Evaluations			100%	
Billing				100%
Other Programmatic		100%		

General Fund Cost Allocation	100%

Table 4-8
Estimated 2004 O&M Expenditures
for SWM Program Areas

Program Area	2004 Budgeted Expenditure[a]	Percent of Total
Flood Protection	$500,000	36%
Water Quality	407,000	30%
Stream Habitat	28,000	2%
Subtotal	$928,000	
Support	$ 436,000	32%
Total	$1,371,000	100%

[a] Data taken from line items in the City's 2004 Proposed Budget, using the functionalization percentages shown in Table 4-8.

4.2.3 Capital Improvement Activities

Since incorporation and establishment of the City's Surface Water Management Utility, drainage system capital improvements have been limited. More focus was provided to ensuring continuity of maintenance service as the drainage system was transferred from King County to the City. As the SWM program has matured, increasing focus is being provided to capital improvements. Currently, the City is in the design phase of two large flood protection improvements serving the 3rd Avenue NW and Ronald Bog areas.

One consequence of not spending a large amount of SWM funds on capital improvements is that the City SWM and SWM Capital Funds have accumulated significant capital reserves to help meet flood protection, water quality, and stream habitat priority levels described in Chapters 5, 6, and 7. Use of these reserves is discussed in the financial analysis contained in Chapter 9.

4.2.4 Funding of SWM Activities

This section is a brief description of the funding sources for SWM activities. Chapter 9 of this report is a financial analysis which explores funding issues in more detail.

Stormwater service fees are the primary funding source for the City's surface water management activities. Some maintenance tasks, such as street sweeping and shoulder reconstruction, are partially funded from the City's Street Fund because street sweeping serves both street maintenance and drainage system maintenance functions.

Part II: Problem Identification and Solution Development

Part II of this Surface Water Master Plan describes potential changes to the City's surface water management program to address known problems and meet regulatory requirements. The chapters in Part II look at known flooding, water quality, and stream habitat problems, and the prioritization and estimated costs of projects and programs to address these problems. Operations and maintenance, which provides services related to all three program areas, is also discussed.

Chapter 5	Flood Protection
Chapter 6	Water Quality
Chapter 7	Stream Habitat
Chapter 8	Operations and Maintenance

Chapter 5. Flood Protection

5.1 Introduction

This chapter includes a summary of the surface water system flooding problems within the City of Shoreline. The chapter describes the process that was used to identify these problems and lists the various problems that were identified. Conceptual project solutions and planning-level cost estimates that were developed as part of this Plan in response to the identified problems are also summarized. In many cases, more detailed designs or cost estimates have already been developed in previous studies; these items are included in this chapter as well.

The implementation of these project activities, which will provide flood protection from drainage impacts identified in this chapter, is focused on first improving public safety and reducing property damage, then improving the effectiveness of the City's surface water system, and, lastly, providing additional benefits to surface water conditions. The City has defined three priority levels that reflect these three objectives. These priority levels were established based on internal discussions at the City and with input from the public and from the Shoreline Planning Commission's Stormwater and Environment Workgroup. Policy ENg directs the City to give priority to implementation of projects and programs that meet the criteria of these priority levels. Table 5-1 provides a summary of all of the City's flood protection–related policies.

5.2 Identified Flooding Problems

5.2.1 Background

As described in Chapter 4, the surface water system in the City of Shoreline includes pipe systems, open water courses, ditches, culverts, and detention facilities. The City has performed maintenance and constructed small capital projects in the years since the City was incorporated. As a result, many large and small flooding problems have been alleviated. The City's policy typically has been to address major trunk drainage system problems first, and then address localized problems that affect fewer people and cause little or no property damage. The City initiated a major drainage projects program to solve problems associated with the trunk system, and a Surface Water Small Projects Program to solve localized problems with projects that would cost up to $50,000 to complete. In 2002, the Small Projects Program was suspended because the projects that remained on the small projects list exceeded the available resources and funding and really needed to be addressed by the major drainage projects program.

5.2.2 Data Review and Identification of Problems

In order to identify current flooding problems in the City of Shoreline, several steps were completed. First, all available drainage studies, basin plans, and other related reports were

reviewed. The City's drainage complaints database was reviewed at the beginning of the development of this Plan and once again after the October 2003 storm, which was a major and infrequent event. For complaints that were listed as "complete" in the database, it was assumed that the problem had been resolved. From this review, a preliminary list of flooding problems was developed and presented to City staff. This list included current problems and problems intended to be addressed by projects that remained on the small projects list after the suspension of that program. City staff confirmed which of the problems still exist and also added some others to the list. Most of the problems involve localized flooding due to the lack of a collection system or to an undersized system.

Table 5-1
Flood Protection–Related Goals and Policies
from the 2004 Comprehensive Plan Update

2004 Comprehensive Plan Update Goals and Policies	Direction Given to Surface Water Management Program
Goal EN V Policies U14, U15, EN63, EN36, EN42, EN44, EN46, and Eng	▪ Manage the storm and surface water system through a combination of engineered solutions, the preservation of natural systems, and public education in order to provide for public safety, prevent property damage, protect water quality, and preserve and enhance fish habitat, streams, and wetlands. ▪ Resolve existing flooding problems and prevent new ones. ▪ Ensure adequate surface water services to provide defined levels of service to new and future development. ▪ Develop surface water facilities that protect water quality, enhance public safety, prevent erosion, preserve and enhance habitat, and protect critical areas. ▪ Manage new development so that it does not aggravate existing flooding problems. ▪ Manage larger development projects to retrofit existing paved areas with new controls that help alleviate downstream flooding problems. ▪ Promote low-impact new development that reduces runoff from the site and helps to alleviate downstream flooding. This includes protecting natural flood storage areas. ▪ Identify the City as the responsible party for maintaining stormwater systems in City right-of-way to prevent flooding. ▪ Identify private property owners as the responsible party responsible for maintenance of their own systems to prevent flooding on their land. ▪ Design and construct flood protection projects to solve existing flooding problems, but also to provide additional benefits to the extent possible that meet goals, policies, and community needs expressed for habitat and surface water quality. ▪ Prioritize the feasible resolutions of flooding problems such that problems which frequently cause property/structure damage or pose a public safety risk have the highest priority. ▪ Erosion that causes damage to natural stream channels should also be given

2004 Comprehensive Plan Update Goals and Policies	Direction Given to Surface Water Management Program
	the highest priority.

The problems that were identified through the data review process are summarized on Table 5-2. The table summarizes each problem by providing its approximate location, the basin in which the problem is located, a description of the problem, and a reference to the source of the information. The approximate location of each problem is shown on Figure 5-1.

Most of the identified flooding problems result from inadequate capacity of the existing drainage system, lack of a formal drainage system, and/or lack of adequate detention to mitigate for development. A variety of types of flooding problems were identified.

- Some of the problems identified cause flooding on major roadways and erosion on major water courses. During large storm events, it is desirable to prevent flooding of principal, minor, and collector arterial roadways to provide emergency vehicles access, to allow traffic to move safely at posted speeds, to prevent traffic jams, and to protect the public's mobility.
- Some cause flooding of and damage to structures, including commercial buildings and private homes.
- Finally, some cause flooding of private yards, driveways, and residential streets, as well as erosion along water courses.

Some flooding problems occur where the public storm drain system is constructed across private property and buildings, residential streets, and/or yards experience flooding. To resolve this type of problem, the City would first need to obtain easements from property owners to maintain or upgrade the system. Specific problems of this type are shown on Table 5-2. In addition, problem 17 on Table 5-2 is intended to account for additional problems of this type that may be identified in the future.

Nuisance-type flooding, which would include areas where ponding occurs on the roadway shoulders, does not pose a public safety risk and would not impede the public's mobility. The public may be inconvenienced in areas where the roadway shoulders are used for parking, but this is not seen as a high priority for the City. This Plan does not address nuisance flooding problems.

As shown on Table 5-2, there are several areas in the City where homes are frequently flooded and it is important to the City and the public that these problems be addressed. Two main flooding problem areas that the City has identified and already begun working to solve are the Ronald Bog subbasin in the Thornton Creek Basin and the 3rd Avenue NW subbasin in the Boeing Creek Basin (see Figure 2-1). Residents of the Ronald Bog subbasin have experienced frequent flooding of arterials, streets, yards, and homes. Over 20 residents between 3rd and 6th Avenues NW have also experienced frequent flooding during moderate storms. The various problems in these two areas are summarized as problems 1 though 5 and problems 11 and 12. The City's efforts to develop solutions for these problem areas are discussed in Section 5.2 of this chapter.

Table 5-2
Flood Protection Problems

Problem ID	Basin	Problem Area	Problem Description	Reference
1	Boeing Creek – 3rd Ave Drainage Subbasin	3rd Ave NW and NW 185th St	Yard and driveway flooding is experienced annually at at least 5 properties south of NW 185th St, 3 properties along the north side of NW 185th St, and at least 1 property upstream of NW 185th St (all near 3rd Ave NW). One of these properties on NW 185th St also experiences garage flooding.	Shoreline 2004b; Shoreline 1998; R. W. Beck field visit; Surface Water Database; City staff
2	Thornton Creek	NE 175th St and 10th Ave NE	NE 175th St used to overtop annually near the intersection with 10th Ave NE. King County installed a detention pipe downstream of the intersection, but the result has been the flooding of adjacent properties, including structures, yards, and driveways. Specifically, a property owner on 11th Ave NE just downstream of the NE 175th St and 10th Ave NE intersection experiences structure, yard, and driveway flooding many times per year.	Tetra Tech/KCM 2004c; R. W. Beck field visit; Northwest Engineering Company 1986; Otak 2001e; City staff; Customer Request
3	Thornton Creek	12th Ave NE and 11th Ave NE between NE 175th St and NE 170th St	Flooding occurs along 11th and 12th Ave NE between NE 175th St and NE 170th St where there is no formal drainage system. An old creek bed between properties conveys flows, but there are no pipes. The roadway elevation is significantly higher than many of the properties, which results in yard and structure flooding.	City staff; R. W. Beck field visit
4	Thornton Creek	Ronald Bog – Corliss Ave N at N 172nd St	The outflow pipe has inadequate capacity, is at reverse grade, and is in poor condition. This contributes to the flooding of as many as 5 downstream properties. Up to 20 homes have had damage in major storm events. Ronald Bog, Twin Ponds, and Peverly Pond do not provide adequate storage volumes to prevent downstream flooding during high-flow events.	City staff; Shoreline 2004b; Tetra Tech/KCM 2004c; Rasmussen & Huse 1987; R. W. Beck field visit; Otak 2001e

Table 5-2
Flood Protection Problems

Problem ID	Basin	Problem Area	Problem Description	Reference
5	Thornton Creek	N 175th St/N 178th St at Serpentine Place near 5th Ave NE	The neighborhood west of 5th Ave N and north of Serpentine Place drains to a closed depression on the 2nd Place cul-de-sac where Pump Station No. 25 is located. Stormwater is pumped to an elevation 20 feet above the pump to discharge to the system on 5th Ave N, which then connects to the system on NE 175th St. During high-flow events, the 5th Ave N system overflows and water flows back down 5th Ave N and N 178th St to the low point at the pump station. Structure flooding is frequent, as is yard and driveway flooding. Additionally, the pump is old and is often submerged. Under these conditions the pump cannot operate because it is not a submersible pump.	Shoreline 1998; Rasmussen & Huse 1987; Rasmussen & Huse 1986; Otak 2001e; City staff
6	Boeing Creek	Midvale Ave N and N 178th St (problems extend from N 180th St to N 183rd St as well)	Flooding of apartment complex parking area and building near Midvale Ave N and N 178th St, and extending from N 180th St to N 183rd St as well. There is an existing detention facility underground in this area, but it may not have sufficient volume to store flood waters.	Shoreline 1998; City staff
7	Boeing Creek	N 165th St and Stone Ave N	Three to five homes along N 165th St near Darnell Park and the intersection with Stone Ave N experience structure, yard, and driveway flooding. The N 165th St roadway also floods. The system has insufficient capacity. Flow is conveyed across N 165th St through a 24-inch-diameter pipe (including two 90-degree bends) which discharges to Darnell Park. The park acts as a detention facility during some flow events, but does not have a large storage volume. The discharge pipe from the park is 18 inches in diameter and water	Brown and Caldwell 1979; Tetra Tech/KCM 2004a; Otak 2001c; Private property owner; City staff

Table 5-2
Flood Protection Problems

Problem ID	Basin	Problem Area	Problem Description	Reference
			backs up behind this pipe, through the park, and up to the property owners. Limited modeling and hydraulic calculations have been performed for the City. At one time, this project was part of the Small Projects Program, but the scope became too large for that program.	
8	North Middle Puget Sound	NW Richmond Beach Rd near NW 191st St (Storm Creek)	Flooding of apartment units and parking lot on NW Richmond Beach Rd near NW 191st St. Channel overtopping south of Richmond Beach Rd as well. Primarily caused by plugged pipes and inadequate conveyance capacity.	Foley 1993; Tetra Tech/KCM 2004b; City staff
9	Thornton Creek	12th Ave NE (near NE 148th St); also up to NE 155th St and NE 162nd St	Multiple properties experience yard flooding and one property experiences basement flooding on 12th Ave NE near NE 148th St and also up to NE 155th St and NE 162nd St. The problem results from an undersized open channel and pipe system. City staff indicate the system is old and not performing optimally. This problem is primarily a private property issue, but there are multiple flooding problems further upstream and this area is at the downstream end of the drainage basin.	Shoreline 1998; Otak 2001d; City staff
10	Thornton Creek	N 167th St to N 165th St between Wallingford Ave N and Ashworth Ave N	Flooding results from lack of drainage system in the vicinity of N 167th St to N 165th St between Wallingford Ave N and Ashworth Ave N. Wetland area in Meridian Park is partially drained through piping to just south of N 167th St between Wallingford Ave N and Ashworth Ave N. Piping ends on property at end of private road, causing structure, yard, and driveway flooding of two homes and other properties on west side of Wallingford Ave N to N 165th St.	City staff

Table 5-2
Flood Protection Problems

Problem ID	Basin	Problem Area	Problem Description	Reference
11	Boeing Creek – Dayton Ave Drainage Subbasin	Dayton Ave and N 183rd St	Structure, roadway, and private property flooding in the vicinity of Dayton Ave and N 183rd St.	Shoreline 1998
12	Boeing Creek – Dayton Ave Drainage Subbasin	Downstream of Pan Terra Pond	Structure, roadway, and private property flooding downstream of Pan Terra Pond.	Tetra Tech/KCM 2004a
13	Boeing Creek	N 167th St – Also general flooding around N 167th St and Whitman Ave N	Flooding of yards and driveways at several single-family homes and two apartment complexes, as well as residential roadways on N 167th St and in the general vicinity of N 167th St and Whitman Ave N. A large drainage area flows along N 167th St to the intersection with Whitman Ave N and then south between properties bordering Aurora Ave N and Linden Ave N. An existing ditch that has been filled in by a property owner causes flooding by preventing the water from draining. There is an enforcement issue here that was referred to Planning and Development Services (PADS). PADS required pipe work as condition of building permit. This was supposed to have been done last year but nothing has been done to date and property owner now has a used car lot on property.	Surface Water Database; City staff
14	Thornton Creek	NE 148th St	Flooding in roadway shoulder and front yard area of apartment complex on NE 148th St, apparently due to an infiltration system failure.	Otak 2001a; City staff

Table 5-2
Flood Protection Problems

Problem ID	Basin	Problem Area	Problem Description	Reference
15	Thornton Creek	Ridgecrest at 10th Ave NE near NE 174th St	Flooding of structures, yards, and streets resulting from limited capacity of existing drainage system. Approximately 3 to 4 homes are affected on 10th Ave NE near NE 174th St.	City staff
16	Boeing Creek	Hillwood Park near 3rd Ave NW	Homes on 3rd Ave NW flood during high-flow events. The City currently uses sump pumps to redirect overflow into Hillwood Park, but a more permanent solution is desired.	City staff
17	Various	Various	Public storm drains constructed across private property cause yard and residential roadway flooding. These problems may not have been specifically identified yet.	City staff

Figure 5-1. Flooding Problems

Figure 5-1 (back)

5.3 Proposed Flood Protection Projects and Programs

5.3.1 Priority Levels

Consistent with existing and proposed goals and policies, three priority levels for flood protection have been identified by the City in order to prioritize flood protection projects presented in this Plan. This chapter describes the three priority levels and the projects for each priority level which provide solutions to flooding problems identified in the previous section, along with estimated project costs. The project descriptions and benefits are also summarized. Related programs and program costs are discussed in Chapter 8, and more detailed cost estimates for projects and programs are provided in Appendix D. As discussed in Section 1.5 of this Plan, these projects and programs will be phased over time in accordance with their priority level.

5.3.2 Project Development and Cost Estimates

5.3.2.1 Project Development

Project solutions were developed for the problems summarized on Table 5-2. The City then assigned each project to a priority level. The projects for Priority Levels 1, 2, and 3 are listed on Tables 5-3, 5-4, and 5-5, respectively. This section describes how projects were developed. Projects related to two main flooding areas—Ronald Bog subbasin and 3rd Avenue NW subbasin—were developed as part of previous study or design efforts. All solutions developed for these two priority areas were incorporated into this Plan without further analysis.

Conceptual project solutions were developed for other problems based on previous studies, a brief field reconnaissance, and other information provided by the City (including GIS information showing a current inventory of the existing storm drain system as well as drainage basin delineations and topographic information). The development of a conceptual project solution began with a review of the area around the problem to determine if land was available to locate a detention pond, or whether there was an opportunity to enlarge an existing pond. If neither of these options would be possible, it was assumed that the City preferred not to construct detention vaults and therefore, a conveyance improvement was assumed. Typically, these projects included upsizing an existing piping system or adding a new pipe system where one currently does not exist. Pipe sizes were assumed based on the sizes of adjacent or existing pipe systems. In addition, it was assumed that a downstream analysis would be completed prior to implementation of any conveyance improvement project to confirm that the project solution would not increase downstream flows significantly, thereby causing or exacerbating downstream flooding problems. The tables note any previous evaluation or study that was done for problems or projects. In a few cases, the City requested certain projects be added to the lists, and these are later in this chapter.

No hydrologic analysis, hydraulic analysis, survey, or technical engineering analysis was performed when developing any of these conceptual solutions. It was beyond the scope of work of this Plan to complete detailed modeling analysis. Therefore, the first step in implementing these solutions will be to do the necessary engineering in order to confirm all assumptions and confirm any preliminary design information. In general, these projects will require hydrologic modeling to determine frequency of flood events and hydraulic modeling

to evaluate the extent and frequency of flooding under existing and future conditions. This will provide an assessment of the capacity and operation of the existing systems. Hydraulic models can be used to conduct part of the downstream analysis, as well as to size improvements based on the level of protection that can be achieved.

It is recommended that all projects be designed to provide 100-year storm event level of protection. However, it is recognized that in some locations, it may be cost-prohibitive or physically impossible to provide this degree of protection. The City will determine the level of protection to be provided on a case-by-case basis for each project.

Projects have been developed (either for this Plan or in previous studies) for all of the problems listed on Table 5-2 with one exception. Problem 14 on NE 148th Street has been evaluated in great detail by the City and it has been concluded that little can be done to solve this flooding problem. The City should consider this project if any improvements are constructed along 15th Avenue NE in the future. If so, it may be possible to lower the catch basins on 15th Avenue NE so that the drainage from this property can be picked up. In addition, it may be possible to pipe the drainage to the south through other properties until it can be connected to an existing system at a lower elevation. It is not recommended that the City study this problem at this time because improvements here would be very costly and would benefit only one property owner.

5.3.2.2 Cost Estimates

Planning-level cost estimates are provided for new projects developed for this Surface Water Master Plan. These costs are shown in Tables 5-3, 5-4, and 5-5 and details on these cost estimates are included in Appendix D. The tables in this chapter also present cost estimates (adjusted to 2004 dollars) published in prior studies for projects where the solutions were already developed by others. In addition, some cost estimates shown in the tables were provided by the City with no further backup, and some costs were developed as part of the Parks and Transportation Master Plans, as noted.

The cost estimates prepared for this Plan include an item for preliminary engineering, which is intended to include the necessary study, modeling and analysis, downstream analysis, and survey that would be required prior to design. The status of existing easements and the need for new easements was not determined for this Plan. Assumptions about costs for easements are shown in the detailed cost estimates in Appendix D.

Costs are also allocated to each priority level for flood protection maintenance activities. These program activities are discussed in Chapter 8 and include maintenance of new conveyance and detention facilities, catch basin cleaning, periodic inspections, vegetation management and minor repairs, and additional ditch reshaping. The maintenance costs for priority levels 1 and 2 also include an allocation for maintaining public storm drains that are constructed across private property. The assumptions for determining the maintenance costs for this undefined inventory are discussed in Chapter 8 as well.

5.3.3 Flood Protection Priority Level 1: Critical Projects and Programs

Flood protection Priority Level 1 includes projects that are deemed critical because they will improve public safety and reduce property damage. The City plans to implement these projects within the next six years. Most of the projects at this priority level are projects for which funding already exists and/or the design has already been started. Achieving this priority level would largely prevent or minimize structure damage and flooding of principal, minor, and collector arterials and would promote public safety and mobility.

5.3.3.1 Priority Level 1 Projects

Table 5-3 presents summaries of the Priority Level 1 projects. Projects F-1 and F-2a through f were developed as part of previous study or design efforts, as noted on the table, to address problems 1 through 5 and problems 11 and 12 (see Table 5-2). Conceptual project solutions F-3 and F-4 were developed as part of this Surface Water Master Plan to address problems 6 and 7, respectively.

The City has decided to proceed with one early action project in the Ronald Bog subbasin and one project in the 3rd Avenue NW subbasin in order to provide some flood protection to the public quickly. These projects are listed in Table 5-3 as the 3rd Avenue NW drainage improvements (project F-1) and the Serpentine Place storm drainage improvements (project F-2f). As of November 1, 2004, design of project F-1 is completed and construction will begin by the end of the year; and construction of project F-2f is nearly completed. Projects F-2a through e are expected to be completed within the next six years.

The rest of the projects included under Priority Level 1 are included at the City's request as they are projects that the City is currently funding or otherwise developing. The City has added the Hillwood Park emergency bypass project (project F-9), which is intended to provide additional conveyance capacity and detention during high-flow events to address problem 16. The City has also added the Ridgecrest Drainage at 10th Avenue NE project (project F-13), which involves acquiring property and building a water quality/detention pond to solve flooding problems in the neighborhood (problem 15).

The SWM CIP Formulation category, shown on Table 5-3 as project F-14, includes an annual budget set aside by the City to perform initial engineering conceptualization as capital projects rise in their priority level and imminent implementation. Also included is a Surface Water Small Projects category (project F-15), which includes an annual budget to respond to calls from residents and businesses reporting local infrastructure failure, and any occurrences of flooding and/or property damage. These two lines (projects F-14 and F-15) are also included in Priority Levels 2 and 3 because these are budget items intended to fund unspecified projects over the 20-year period and beyond.

Finally, Table 5-3 includes categories for parks projects (project F-16) and for transportation projects (project F-17) that are intended to cover the stormwater components of miscellaneous parks projects and transportation projects categorized under Priority Level 1. This includes instances in which the City may use drainage funds to pay for the drainage elements of parks or transportation projects. In addition, any new drainage systems constructed as a component of transportation projects would need to be maintained under the surface water management program, as discussed in Chapter 8. In some cases, it is possible that a transportation project would be constructed that includes a drainage component, but for which no drainage funding is used for construction. These systems would still need to be maintained under the surface water management program. Chapter 8 discusses this issue in relation to the Aurora Corridor project. For more information on projects F-16 and F-17, please refer to the Parks and Transportation Master Plans.

5.3.3.2 Cost Estimates for Priority Level 1 Projects

Table 5-3 presents cost estimates (adjusted to 2004 dollars) that were published in prior studies for the Ronald Bog and 3rd Avenue NW projects. Planning-level cost estimates were developed as part of this Surface Water Master Plan for projects F-3 and F-4, and more information on these estimates is provided in Appendix D. The costs for projects F-13 through F-15 were provided by the City and no further backup is provided. Costs for

projects F-16 and F-17 were developed as part of the Parks and Transportation Master Plans.

5.3.4 Flood Protection Priority Level 2: Improve Effectiveness of the Surface Water System

Flood protection Priority Level 2 includes projects that would improve the effectiveness of the City's surface water system. The City plans to implement these projects between years 7 and 20 of the 20-year planning period. In general, most of the projects in this priority level would prevent or minimize flooding and damage in structures, yards, driveways, and on residential streets, as well as further increasing public mobility by ensuring that residential roads are passable during flood events.

5.3.4.1 Priority Level 2 Projects

Table 5-4 presents summaries of the Priority Level 2 projects. Conceptual project solutions F-6a/b, F-7, and F-8 were developed as part of this Surface Water Master Plan to address problems 9, 10, and 13, respectively, from Table 5-2.

Also included on this table are projects F-18 and F-19, which include the stormwater components of miscellaneous parks and transportation projects, respectively, that are categorized under Priority Level 2. Please refer to the Parks and Transportation Master Plans for details on specific projects.

5.3.4.2 Cost Estimates for Priority Level 2 Projects

Table 5-4 presents planning-level cost estimates developed as part of this Surface Water Master Plan for projects F-6a/b, F-7, and F-8. More information on these estimates can be found in Appendix D. Costs for projects F-18 and F-19 were developed as part of the Parks and Transportation Master Plans.

5.3.5 Flood Protection Priority Level 3: Provide Additional Flood Protection Benefits

Flood protection Priority Level 3 includes projects that are deemed the lowest priority by the City. These projects would provide additional benefits to surface water conditions. In general, most of the projects in this priority level would prevent or minimize flooding and damage in yards, driveways, and on residential streets. Based on the recommended plan described in Chapter 9, the City will not be able to implement these projects in the next 20 years. Implementing these projects will likely require additional sources of funding such as grants, developer mitigation fees, or local improvement districts.

5.3.5.1 Priority Level 3 Projects

Table 5-5 presents summaries of the Priority Level 3 projects. Conceptual project solution F-5 was developed as part of this Surface Water Master Plan to address problem 8 from Table 5-2. Table 5-5 also includes projects F-20 and F-21, which include the stormwater components of miscellaneous parks and transportation projects, respectively, that are categorized under Priority Level 3. Please refer to the Parks and Transportation Master Plans for details on specific projects.

5.3.5.2 Cost Estimates for Priority Level 3 Projects

Table 5-5 presents planning-level cost estimate developed as part of this Surface Water Master Plan for project F-5. More information on this estimate can be found in Appendix D. Costs for projects F-20 and F-21 were developed as part of the Parks and Transportation Master Plans.

Table 5-3
Flood Protection Priority Level 1 Projects and Programs

Insert Excel file; letter size; 4 pp.

Table 5-3, page 2

Table 5-3, page 3

Table 5-3, page 4

Table 5-4
Flood Protection Priority Level 2 Projects and Programs

Table 5-3, page 2

Table 5-5
Flood Protection Priority Level 3 Projects and Programs

5.4 References

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Chapter 6. Water Quality

6.1 Introduction

The water quality assessment that was performed for this Surface Water Master Plan represents a limited evaluation of the existing water quality within the City of Shoreline. This evaluation is based on the 1998 Shoreline Comprehensive Plan, input from public meetings and the planning commission work group and interviews with City staff. This input emphasizes resolution of water quality problems in the City based on a system that requires the City to first meet regulatory requirements and then to take steps to improve degraded waters. Policy EN37 directs the City to "maintain surface water quality as defined by federal and state standards and [to] rehabilitate degraded surface water through reduction of non-point source pollution, erosion control, and the development of stormwater system improvements." Policy EN62 directs the City to take a "leadership role in protecting water quality through regulation, educational outreach, and by adhering to state and federal environmental standards in all City funded projects." A summary of surface water quality policies is provided in Table 6-1.

A discussion of surface water quality problems typically found in urbanized areas is presented in this chapter. No field reconnaissance was conducted as part of this assessment. This assessment identifies surface water quality improvement programs and projects the City plans to implement in the 20-year planning period.

6.2 Identified Water Quality Problems

6.2.1 Surface Waters

Portions of Thornton Creek, Lyon Creek, and McAleer Creek are listed on the Washington Department of Ecology's (Ecology's) section 303(d) list of impaired and threatened water bodies for fecal coliforms. Impaired waters are those not meeting state water quality standards. Water bodies on Ecology's 303(d) list are selected for further studies referred to as total maximum daily load (TMDL) determinations. A TMDL is a calculation of the maximum amount of a pollutant that a water body can receive and still meet water quality standards. Section 303 of the federal Clean Water Act establishes the water quality standards and TMDL programs. Water quality standards identify the uses for each water body (for example, drinking water supply, swimming, and fishing) and the scientific criteria to support those uses.

A TMDL study includes a problem formulation and an analysis of how to control the discharge of particular pollutants to surface waters. TMDL studies have not yet been completed by Ecology for these three listed waters as of the date of this Surface Water Master Plan. The City should keep abreast of any new TMDL plans for these waters and determine if the plans require specific actions that affect the City.

Table 6-1
Water Quality–Related Goals and Policies
from the 2004 Comprehensive Plan Update

2004 Comprehensive Plan Update Goals and Policies	Direction Given to Surface Water Management Program
Goal EN V Policies EN37, EN38, EN39, EN40, EN41, EN43, EN44, EN45, EN46, EN58, EN62, and ENi	▪ Manage the storm and surface water system through a combination of engineered solutions, the preservation of natural systems, and public education in order to provide for public safety, prevent property damage, protect water quality, and preserve and enhance fish habitat, streams, and wetlands. ▪ Maintain surface water quality as defined by federal and state standards. ▪ Rehabilitate degraded surface water by reducing nonpoint source pollution, controlling erosion, and improving the stormwater system. ▪ Actively pursue state and federal grants to improve surface water management and water quality ▪ Support the use of appropriate landscaping, swales, "green street" improvements, retention facilities, and treatment facilities to enhance water quality and the percolation of water at natural rates near its source to limit soil instability or damage to roadways or other improvements. ▪ Sweep streets to reduce pollutants entering the stormwater drainage system ▪ Educate citizens about proper waste disposal. Prevent direct disposal into storm drains. ▪ Promote practices that prevent pollutants from entering the stormwater system as a result of lawn and garden maintenance, car cleaning or maintenance, and roof cleaning or maintenance. ▪ Maintain and enhance natural drainage systems. ▪ Identify the City as the responsible party for maintaining stormwater systems in City right-of-way to prevent flooding. ▪ Identify private property owners as the responsible party responsible for maintenance of their own systems to prevent flooding on their land. ▪ Cooperate with other jurisdictions and agencies to improve regional surface water management, protect water quality, and resolve related inter-jurisdictional concerns. ▪ Design and construct water quality projects to solve existing water quality problems, but also to provide additional benefits to the extent possible that meet goals, policies, and community needs expressed for flood protection and habitat. ▪ Pursue funding to conduct baseline monitoring and improvement of water quality in lakes and streams in the City. ▪ Protect surface water quality through regulation and educational outreach. ▪ Adhere to state and federal environmental standards in all City-funded projects. ▪ Work with neighboring communities to improve water quality and stream habitat in basins that share interjurisdictional boundaries.

The City is currently on the state's list of proposed jurisdictions that need to obtain a National Pollutant Discharge Elimination System (NPDES) Phase II stormwater permit. The City will need to obtain coverage under a NPDES Phase II stormwater general permit. As discussed in Chapter 3, the general permit for Phase II permittees has not yet been issued by Ecology, so the specific requirements are unknown, but the City has already submitted its application in accordance with the deadline stipulated in the Federal Rule. Based on minimum requirements in the Federal Rule, it can be assumed that the City will need to have programs in place to requiring pre- and post-construction best management practices (BMPs), provide public involvement and education, and provide maintenance of stormwater facilities. Also, enforcement of TMDLs through the NPDES Phase II program for improved nonpoint source pollution prevention would most likely be required.

Urbanization has resulted in modifications to area creeks and this has led to erosion, increased temperature, and other water quality problems. Much of the City's system conveys untreated runoff from roadways and other developed areas directly to water bodies, allowing sediment, oil and grease, and other roadway pollutants to drain directly to Hidden Lake, Twin Ponds, Echo Lake, Lake Washington, and Puget Sound. Cost estimates for projects and programs to improve water quality are given in Tables 6-2, 6-3, and 6-4 later in this chapter.

6.2.2 General Water Quality Problems

Urban development can lead to a wide range of water quality problems resulting from a variety of common development activities. Water quality problems in the vicinity of Shoreline are typical of problems encountered in other urban areas. Surface water in the City generally flows overland, collecting in small roadside ditches and traveling to storm drain inlets, streams, or other waterways, which lead to Puget Sound or Lake Washington. The quantity of runoff from rainfall, flooding, the erosion of soils and stream channels, and the transport of nonpoint source pollutants all are factors in the decline of water quality in an urban watershed. Nonpoint source pollution is pollution that is generated on the land surface over a large area that then washes off into the storm drainage system during storm events. Examples of nonpoint source pollutants include chemical contamination from automobiles and machinery operation (e.g., oil, grease, hydraulic fluids, and heavy metals), erosion and sediment transport from disturbed soils (sediment and nutrient loading), and nutrient and biological pollution from domestic pets (e.g., phosphorus and fecal coliform bacteria).

Although provisions for water quality treatment and protection facilities are now required as part of new developments, much of the existing development in the City occurred before stormwater treatment requirements were established. Thus, runoff from most of the existing developed areas in the City receives little or no treatment before it reaches the nearest waterway.

General water quality problems have been divided into the following five categories, each of which is discussed in detail below, followed by water quality improvement projects and programs.

- Nonpoint source pollution from impervious surfaces
- Nonexistent or inadequate stormwater treatment facilities
- Erosion and sediment transport from disturbed areas
- Pollutant inputs from residences

- Accidental or intentional discharge of chemical contaminants.

6.2.2.1 Nonpoint Source Pollution from Impervious Surfaces

Development and urbanization inevitably result in increased impervious surface areas. At a minimum, impervious surfaces result in increased rates and volumes of stormwater runoff, resulting in the potential for increased erosion and scour in downstream waterways. In urban settings, impervious areas also provide a medium for the deposition and transport of common urban pollutants. Roadways collect tire fragments, oil and grease, heavy metals, sand and grit, and other contaminants generated from vehicular traffic. Parking lots and driveways also collect concentrated amounts of these pollutants as vehicles drip and deposit various automotive chemicals directly onto parking lot surfaces. Inevitably, stormwater runoff across roadways and parking lots entrains these pollutants and transports them to downstream receiving waters. To prevent water quality degradation, it is important that runoff from impervious surfaces receives some form of water quality treatment to remove pollutants to the maximum extent possible.

Most existing impervious areas within the City are contributing to cumulative water quality problems in the area. Runoff from all but the most recent developments receives little or no water quality treatment before being routed to downstream waters. Thus, pollutants deposited in these impervious areas can be entrained by stormwater and transported to the receiving water systems without any treatment to remove the contaminants. In addition, because water quality treatment does not remove 100 percent of all pollutants, even treated runoff from impervious surfaces carries some level of pollutant loads to receiving waters. As the City continues to redevelop, new water quality treatment facilities or other methods of preventing water quality degradation will be installed as a condition of many redevelopment projects. The new water quality treatment facilities will have a positive impact on surface waters, although the degree to which any specific water body water quality will be improved will depend on the timing, size, and number of redevelopment projects in a basin.

Water Quality Improvements

Effective methods of reducing the water quality impacts associated with impervious surfaces include implementing new and redevelopment standards that require water quality treatment, constructing water quality treatment and detention systems where possible, and implementing source control best management practices. Impervious surfaces are a necessary component of development, and many of the water quality problems associated with them can be mitigated with structural treatment measures and source controls to prevent pollutants from coming into contact with surface waters. The City is required to implement flow control and water quality treatment measures in accordance with the 1998 *King County Surface Water Design Manual* for any new or redevelopment projects to adequately manage stormwater from their sites to reduce impacts in downstream systems.

Public education also helps to control stormwater pollution. Efforts to improve public awareness of existing problems may help to reduce the deposition of pollutants on impervious surfaces and reduce impacts on receiving waters. For example, improving public awareness of the detrimental effects of allowing automotive fluids to be deposited onto roadways and parking lots could help to reduce impacts on streams and rivers.

Maintenance of stormwater facilities is important for improving water quality. For example, the City's regular maintenance of catch basins is an effective means of reducing stormwater pollution because it removes pollutants from these structures before they accumulate to the point that they get washed into receiving waters. Maintaining water quality treatment and detention systems also keeps them functioning properly. Maintenance of the City's system

to improve water quality is discussed in Chapter 8 of this plan. The City also institutes a program requiring private drainage systems to be maintained. In accordance with the Puget Sound Water Quality Management Plan and NPDES Phase II requirements, jurisdictions will be responsible for maintenance of the overall storm drain system. Since the City does not maintain all privately owned facilities itself, it implements a program requiring private property owners to maintain private facilities. The City has an inspection and enforcement program to ensure that facilities get maintained on a regular basis.

The City should stay abreast of current technological advances that might reduce the adverse effects of impervious surfaces. For example, studies have been conducted on the feasibility of constructing semi-pervious parking lot surfaces. These semi-pervious surfaces are more porous than concrete or asphalt and allow precipitation to infiltrate through them, thereby reducing runoff and pollutant transport. In addition, a variety of urban planning and design techniques are currently being explored that reduce the area of impervious surfaces in new developments, such as reduced street widths, landscaped cul-de-sacs, and placement of sidewalks on only one side of the street. Whenever feasible, these and other advances should be evaluated and included in development proposals that come before the City.

6.2.2.2 Nonexistent or Inadequate Stormwater Treatment Facilities

As noted earlier, many areas within the City of Shoreline were developed prior to the establishment of significant stormwater treatment requirements. These areas include roadways, parking lots, commercial areas, residential areas, and industrial areas constructed before stormwater treatment facilities were required. These areas typically generate pollutants that can adversely affect downstream receiving waters. Runoff from these areas is not treated, and any contaminants present in the runoff are transported directly downstream.

The lack of stormwater treatment systems in existing urban areas is one of the main contributors to surface water quality problems within the City. The most common occurrence is roadway and parking lot runoff that is collected in catch basins and conveyed directly to receiving waters without water quality treatment. The majority of the existing developed areas convey stormwater runoff in this manner, thereby generating a pollutant load on downstream waters.

Water Quality Improvements

One approach to improving water quality is to retrofit the existing stormwater systems to include water quality treatment measures. Although retrofitting existing systems is costly and therefore may not be the preferred course of action, new development in the City will present opportunities to retrofit existing drainage systems to protect water quality as part of larger development projects. As part of the mitigation requirements for new developments, the City requires developers to improve stormwater management systems where they are needed. The City is also requiring redevelopment projects to retrofit existing systems so they are now equipped with treatment systems.

BMPs that could be used to retrofit existing water quality controls include oil/water separators, oversized catch basins, wetponds, modifications to roadside ditches to provide water quality treatment, and construction of biofiltration swales and vegetative filter strips. For example, parking areas that currently have no water quality treatment facilities could incorporate oil/water separators. Roadways that receive sand and grit applications in the winter months should be fitted with oversized catch basins to help prevent these materials from being washed downstream. Roadside slopes and ditches could be retrofitted with

vegetative filter strips and ditches could be reconstructed, similar to the City of Seattle's "SEA Street" project, to provide treatment for runoff that currently receives little or no treatment. These individual improvements are generally minor but cumulatively would result in significant improvements compared to existing conditions.

These types of structural BMPs could be implemented on a case-by-case basis where City staff observe an opportunity to improve water quality. For systems within the public right-of-way, the improvements could be made using the system replacement budget identified in the proposed operation and maintenance (O&M) budget. This is further discussed in Chapter 8. For systems on private property, the City can work with the property owner first on a voluntary basis. If the water quality problem is very severe, the City can take additional steps to require improvements.

Future developments are not expected to cause significant long-term impacts on water quality in the area. In following the water quality requirements outlined in the *King County Surface Water Design Manual* (KCSWDM), many of the problems associated with new (or redeveloped) impervious surfaces will be addressed for new developments or redevelopment. Thus, the City should focus on addressing water quality problems associated with older roadways and existing developments. Nonetheless, allocating additional funds and personnel for enhanced maintenance of stormwater systems and ensuring that stormwater treatment systems are functioning properly would help to improve water quality in the City. This is discussed in more detail in Chapter 8.

6.2.2.3 Erosion and Sediment Transport from Disturbed Areas

Another common source of water quality impairment can be the erosion and transport of sediment from disturbed land. Excessive sediment loads can cause a variety of water quality and habitat problems, including turbidity violations, temperature increases, increased pollutant loads (i.e., pollutants bound to the sediments), and shifts in stream substrate composition with the potential for habitat impairment or losses. The primary cause of sediment transport is the disturbance of soils, usually for construction purposes, without effective measures to limit and control erosion of these disturbed soils.

The majority of the City is zoned for single-family residential use and has already been developed. The remaining area will probably be developed in the near future. Every new development is accompanied by temporary land disturbance that can cause erosion and lead to water quality pollution. Each time land is disturbed to provide for new development, the threat of erosion and sediment transport is introduced. Disturbed land can be exposed to wind and rain that can easily erode unprotected soils. Disturbed soils that are not properly covered and stabilized can result in significant sediment loads reaching downstream waters. Without the incorporation of settling basins, soil covering, filtration systems, or other measures to control the transport of these materials along the conveyance system, much of the eroded soil reaches downstream receiving waters, contributing to water quality and habitat impairment. Proper soil stabilization, combined with measures to limit the off-site transport of any eroded material, will greatly reduce the potential for erosion and water quality problems. In addition, construction activities can also generate other pollutants such as chemicals from fertilizers and pesticides, petroleum products, construction chemicals, and various solid wastes.

Water Quality Improvements

The best solution for erosion and sediment transport problems is to enforce the City's erosion control standards and BMPs. The City has adopted the temporary erosion and sediment control requirements as contained the KCSWDM and this program could be

improved by also informing and educating area contractors about the erosion control requirements. The enforcement of these standards is crucial. City staff should continue to review all stormwater pollution prevention plans and temporary sedimentation and erosion control plans that are submitted with development applications, to ensure adequate water quality protection. In addition, the City needs to ensure that erosion control facilities are frequently inspected and that developers are held responsible for any failure to adhere to the approved plans.

6.2.2.4 Pollutant Inputs from Residences

Residential parcels are likely a significant source of water quality impairment within the waterways of the City of Shoreline. Many small sources can cumulatively contribute significant amounts of pollutants, including nutrients, oils and greases, sediments, organics, metals, pathogens, and bacteria. The main concerns associated with residential land result from chemical inputs from overfertilization, misuse of pesticides, domestic pet wastes, car washing, spills or improper disposal of hazardous wastes, and construction-related soil disturbance.

Many residential properties use fertilizers and pesticides in landscaping. When used properly, these chemicals should not contribute to significant water quality problems. However, problems can arise when excess chemicals that are not taken up by plants or pests are entrained into stormwater runoff and transported to downstream waters. These chemicals can be directly hazardous to aquatic organisms or may exacerbate existing water quality problems. Additional water quality problems can result from a lack of attention to domestic pet wastes on residential property. Pet wastes that are allowed to concentrate near a stormwater conveyance system or natural waterway can add bacteria and nutrients to runoff, thereby contributing to water quality degradation.

Residential additions or other property modifications that result in areas of disturbed ground can also result in considerable erosion and sediment transport to downstream waters. Small developments or landscaping on individual properties can often result in significant ground disturbance, sometimes for extended periods of time. During periods of frequent or heavy rainfall, any exposed soils can easily be eroded by stormwater runoff and transported to downstream waters. Many residents are not aware of the potential impacts and do little to control erosion-related problems. These problems are of particular concern in the Shoreline area because several of the open channel stream and creek systems pass directly through residential properties where water quality is easily affected by activities on adjacent properties.

Older, dense residential areas provide little roadside area for biofiltration in ditches, and the minimal filter strips or buffer widths provide little biofiltration between yards and drainage ways.

Water Quality Improvements

Perhaps the best way to reduce water quality problems associated with private residences is to educate homeowners about water quality degradation and encourage source control of stormwater pollution. For example, providing information on the environmental hazards associated with pesticides, fertilizers, and hazardous wastes would help to limit overapplication (and application preceding storm events) of chemicals used in landscaping activities. Information should also be provided on certified waste collection facilities where hazardous waste from these products can be disposed of. Providing information on the wise use of pesticides and herbicides or alternative methods of pest control would also help to reduce their use. Implementation of an Integrated Pest Management Plan (IPMP) rather

than using chemical treatment should be encouraged. Any efforts to inform property owners about how they can help to improve water quality just by altering their own land use practices would be beneficial.

The City's current activities do include community outreach programs to educate and inform on ways to reduce water quality problems. These include a clean car wash program, a natural lawn and garden care program, a storm drain stenciling program, and community involvement restoration programs. Much of this information is disseminated in the form of flyers, city meetings, newspaper articles, and workshops. Homeowners and developers are encouraged to incorporate soil amendments such as compost into the top soil layer when creating lawn areas. These soil amendments in a lawn will increase runoff infiltration and reduce overland runoff. These lawns not only promote better surface water quality, but also reduce watering needs, reduce flooding, and recharge the groundwater system.

In addition, the City also makes efforts to ensure that catch basins in existing and new residential areas are labeled with warnings such as "Do not dump—drains to surface waters" where appropriate.

Encouraging property owners to plant native vegetation along drainage ways through private property and reduce the physical disturbances to these systems would help to improve water quality. The use of recommended BMPs would reduce stormwater exposure.

The City's solid waste collection service provides the surface water group support in educating City residents on the effects of and ways to prevent hazardous waste spills and information on where to recycle or properly dispose of hazardous material.

6.2.2.5 Accidental or Intentional Discharge of Chemical Contaminants

As with most urbanized areas, the threat of accidental or intentional spills of chemicals in storm drainage systems increases with increasing human activity. Automobile use and repair, construction work, auto service stations, small manufacturing businesses, and chemical storage areas all present some risk of spills or contamination. Whether the discharge is intentional or accidental, the end result is generally the same: materials spilled on land can easily and readily be transported to a stormwater conveyance system and ultimately to a stream. Under the best-case scenario, any environmentally hazardous spills would be promptly and properly cleaned up, with minimal impacts on water quality. However, if cleanup equipment and procedures are lacking, the contaminants will likely find their way to a storm drain and ultimately to receiving waters. Chemical contaminants are also sometimes directly discharged to a storm drain or ditch illegally.

Because there are no records of illegal dumping, it is difficult to determine how significant this problem might be in Shoreline. It is likely that household and commercial hazardous wastes are dumped into storm drains, ditches, or backyards, where they contribute to nonpoint pollution by directly entering the drainage ways, streams, and groundwater. The City also sponsors a spring and fall cleanup program to collect batteries, transmission fluid, and computer monitors as a deterrent to illegal dumping activities.

Ideally, the affected stormwater system would include a spill containment mechanism (e.g., oil/water separator), and most of the spill would not be carried downstream. However, the more common situation throughout most urbanized areas, including Shoreline, is that stormwater conveyance systems do not include spill containment measures or water quality treatment systems. As a consequence, spills flow directly to receiving waters without treatment. The impacts are highly dependent on the type and volume of chemical spilled, but clearly there is a potential for severe water quality impacts to occur. Although no

records of significant spills of this nature have been recorded in Shoreline, other urbanized stream systems have been impacted by fuel spills. Therefore, measures to avoid these types of impacts should be considered.

Water Quality Improvements

The best methods to limit or prevent this type of pollution are prevention, structural barriers, and public education. New development that has areas prone to hazardous material spills (e.g., gas stations, auto repair lots, and industrial areas) are required to have spill containment mechanisms in place that are able to prevent a spill from reaching a storm drain. For existing development that does not have appropriate stormwater controls or programs, they can be achieved one of three ways. First, if an area is redeveloping, water quality capital facilities should be required as a part of the redevelopment. Second, if there is an observed water quality problem, the City can enforce proper BMPs. The City can also enforce its discharges policy. Third, the City can encourage property owners' voluntary compliance.

Structural or capital measures could greatly reduce the risk of surface water contamination. The preferred means of accomplishing this is to install some type of oil/water separator facility into the on-site drainage system. This could be as simple as an inverted elbow added to a catch basin, or a more elaborate oil/water separation system for larger sites. In either case, the end result is that most of the oil and similar chemicals that drain to catch basins are separated from the water by gravity and are not allowed to drain to the receiving water. The chemicals can then be removed from the catch basin before they reach the downstream receiving waters.

Education regarding the water quality impacts of chemical contaminants and the ease with which these pollutants can enter a creek or stream would also help to significantly reduce water quality pollution. Citizens and businesses alike should be made clearly aware of the connection between the storm drains and nearby waterways. Likewise, they should be informed about the cumulative impacts a city can have on a waterway, from numerous seemingly insignificant chemical inputs to storm drains. The City should encourage a neighborhood watch mentality to help enforce regulations regarding any illegal chemical dumping to storm drains. Clear labels on individual drains reading "Do not dump—drains to surface waters" would also help to prevent illegal dumping. The City has stenciled some of its catch basins and it is recommended that it stencil all other catch basins in the City.

6.3 Proposed Water Quality Projects and Programs

As explained in this chapter, the City has policies in place to improve surface water quality and will implement some new policies with the 2004 Comprehensive Plan Update. The City has and will continue to implement these policies through a number of projects and programs. To prioritize these activities, the City has identified three priority levels that it has assigned to projects or programs that maintain or improve water quality. As discussed in Section 1.5 of this Plan, these activities will be phased in over time in accordance with their priority level.

Ecology's upcoming NPDES Phase II stormwater general permit will likely include numerical water quality benchmarks. It is expected that over time the City's stormwater discharges will need to meet these benchmark requirements, so it will be beneficial to the City to incorporate water quality treatment into other capital projects where possible and also to construct stand-alone water quality projects to benefit receiving waters. Projects that are

not required by current regulations are planned to be implemented over the 20-year period in anticipation of these new regulations.

In addition to regulatory agencies, the citizens of Shoreline have expressed a desire for clean surface waters. This Plan is intended to respond to regulatory requirements and also to meet the public's expectations of improved water quality.

This section provides a summary of projects and programs for the three priority levels. Tables 6-2, 6-3, and 6-4 list the projects and programs for each priority level, along with estimated project costs. Program costs are discussed in Chapter 8, and more detailed project cost estimates are provided in Appendix D.

It should be noted that detailed field studies were not performed as part of this master planning process. However, the consultants obtained information from individuals involved in the City's stream and wetland inventory and assessment and other City staff who have performed detailed field reconnaissance. The recommended projects and costs presented here are based on this information.

6.3.1 Water Quality Priority Level 1: Critical Projects and Programs

Water quality Priority Level 1 includes critical activities that need to be implemented to meet minimum regulatory requirements, particularly for the NPDES Phase II municipal stormwater permit. These activities are expected to be implemented within the next six years. Priority Level 1 primarily consists of programs and maintenance activities (see Table 6-2). Maintenance activities include catch basin cleaning, street sweeping, and maintenance of retention/detention facilities.

The City's current programmatic activities include programs to minimize the use of pesticides and fertilizers; community involvement and public education activities; inspection, monitoring, and enforcement activities; water quality monitoring; source control activities; and participation in regional committees.

The City has also identified four Priority Level 1 water quality capital projects that would be constructed in coordination with flood protection projects to improve water quality. Each of these projects would either add a wetpond to a proposed detention pond project or add biofiltration swales to proposed conveyance system upgrades. The wetpond projects include addition of wetpond elements to proposed detention facilities in Darnell Park (WQ-2), Cromwell Park (WQ-3), and in the Ridgecrest Neighborhood in the vicinity of 10th Avenue NE (WQ-4). Biofiltration swales are proposed for the Third Avenue flood protection project (WQ-1). Further discussion of these flood protection projects is provided in Chapter 5.

A wetpond contains a permanent pool of water to settle out fine sediment and pollutants, and to allow biologic activity to occur that metabolizes nutrients and organic pollutants. Because this enhancement simply requires overexcavation of the detention pond, the additional cost is significantly less than if the water quality pond were constructed as a stand-alone treatment facility. The additional cost to add a wetpond feature to a detention pond can largely be attributed to the costs associated with the additional labor and disposal of the additional excavated materials. No additional cost would typically be required for land acquisition or inlet and outlet structures.

Incorporation of water quality features into detention facilities specifically addresses the policy that requires the City to consider providing multiple benefits when designing stormwater facilities.

Summaries of Priority Level 1 projects, along with planning-level cost estimates, are provided in Table 6-2.

6.3.2 Water Quality Priority Level 2: Enhance the Ability of the System to Improve Water Quality

Water quality Priority Level 2 includes both project and programmatic activities that would enhance the ability of the City's surface water system to improve water quality. Water Quality Priority Level 2 projects (WQ-5) include funding for miscellaneous stand-alone water quality projects such as vault treatment systems, engineering studies, wetponds, or additional biofiltration swales that will be implemented between years 7 and 20 of the 20-year planning period.

Because these miscellaneous stand-alone water quality projects have not been specifically identified, the City would need to conduct future studies to identify sites and types of stand-alone water quality structures that would most benefit the City's surface waters. Stand-alone water quality projects would be best located in high-traffic areas that are currently discharging untreated runoff to surface waters. For example, a park-and-ride lot that drains untreated runoff directly to a lake or creek would be a good candidate site for a water quality structure.

Planning-level cost estimates for Priority Level 2 projects are provided in Table 6-3. Priority Level 2 also includes funds to increase programmatic activities (costs for these additional activities are described in Chapter 8).

6.3.3 Water Quality Priority Level 3: Provide Additional Water Quality Benefits

Water quality Priority Level 3 includes both project and programmatic activities that would provide additional benefits to surface water quality. Water quality Priority Level 3 projects (WQ-5) include funding for additional miscellaneous stand-alone water quality projects such as water quality ponds, vaults, or biofiltration swales. Planning-level cost estimates for Priority Level 3 projects are provided in Table 6-4.

Based on the recommended plan described in Chapter 9, the City will not be able to implement Priority Level 3 projects in the next 20 years. Implementing these projects will likely require additional sources of funding such as grants, developer mitigation fees, or local improvement districts.

Priority Level 3 does include funds to increase programmatic activities (costs for these additional activities are described in Chapter 8). These activities are expected to be implemented between years 13 and 20 of the 20-year planning period.

6.4 References

The following sources were used to develop this chapter:

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Table 6-2
Water Quality Priority Level 1 Projects and Programs

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Table 6-2, page 2

Table 6-3
Water Quality Priority Level 2 Projects and Programs

Table 6-4
Water Quality Priority Level 3 Projects and Programs

Note: both tables are on one page

Chapter 7. Stream Habitat

7.1 Introduction

This chapter provides an analysis of stream habitat as it relates to flood protection, water quality, and surface water management within the City of Shoreline. This evaluation is based on a review of information contained in the City of Shoreline 1998 Comprehensive Plan and the *City of Shoreline Stream and Wetland Inventory and Assessment* (Tetra Tech/KCM 2004). No field reconnaissance was conducted as part of this assessment. Chapter 2 includes a characterization of the City's existing vegetation and wildlife habitat.

This chapter is organized into two areas—identified problems and recommended projects and programs. The analysis focuses on the existing aquatic environment within the City and identifies surface water problems that affect aquatic habitat. This is followed by a description of proposed projects and programs that will help the City to protect and improve stream habitat. This chapter also describes the priority levels that have been assigned to recommended activities to indicate the order in which the City plans to implement them.

7.2 Identified Problems

The following problems affecting fisheries habitat and preventing fish access to upper reaches of stream systems were identified in the *City of Shoreline Stream and Wetland Inventory and Assessment* (Tetra Tech/KCM 2004). The problems are of four types: anadromous fish year-round access, fish passage for non-anadromous fish, erosion and sedimentation to streams, and control of invasive species. Each of these types of problems contributes to the degradation of fisheries resources and their habitat.

Based on discussions with City staff and with input from the planning commission work group and the public, emphasis for resolving habitat problems in the City is based on a system that first prioritizes protecting and preserving existing habitat, then focuses on problems that impact locations where anadromous fish are present by enhancing and expanding their existing habitat, and lastly addresses those problems that impact locations where other types of fish species are present by enhancing and expanding their existing habitat. Several policies are the primary drivers for defining habitat problems. Policy EN47 directs the City to preserve wetlands and aquatic and riparian habitats in a natural state and to maintain appropriate buffers around shorelines, wetlands, lakes, creeks, and streams to protect native vegetation, water quality, habitat for fish and wildlife, and hydrologic function. Policy EN61 directs the City to "work with citizen volunteers, state and federal agencies, and tribal governments to identify, prioritize, and eliminate barriers and other impediments to anadromous fish spawning and rearing habitat." For example, City residents have provided many hours of volunteer time to improve stream habitat and water quality throughout the City, including improvements within Twin Ponds Park and Paramount Park. Policy EN29 directs the City to "participate in regional species protection efforts, including salmon habitat and restoration." Policy ENh defines how solutions to stream habitat problems should be prioritized. Policy ENh states that solutions to habitat problems related to the City's storm drainage system should focus on those types of activities that first protect and preserve existing habitat, then

enhance and expand habitat in areas where wild anadromous fish are present, and lastly, enhance and expand habitat in areas where other wild fish are present. ENi prompts the City to establish an interjurisdictional stewardship committee to use as a forum for working with neighboring communities to improve water quality and stream habitat in basins that share interjurisdictional boundaries. A listing of stream habitat policies is provided in Table 7-1.

Table 7-1
Stream Habitat–Related Goals and Policies from the 2004 Comprehensive Plan Update

2004 Comprehensive Plan Update Goals and Policies	Direction Given to Surface Water Management Program
Goals EN V and EN VI Policies EN29, EN46, EN47, EN57, EN59, EN60, EN61, EN63, EN65, EN66, EN67, ENh, and ENi	▪ Manage the storm and surface water system through a combination of engineered solutions, the preservation of natural systems, and public education in order to provide for public safety, prevent property damage, protect water quality, and preserve and enhance fish habitat, streams, and wetlands. ▪ Preserve, protect, or restore wetlands, shorelines, surface water, and ground water for wildlife, appropriate human use, and the maintenance of hydrological and ecological processes. ▪ Actively participate in regional species protection efforts, including salmon habitat protection and restoration. ▪ Preserve aquatic and riparian habitats in a natural state and maintain appropriate buffers around these areas. ▪ Develop a basin stewardship program to prevent negative impacts to stream habitat and identify opportunities for restoration. ▪ Avoid filling or permanently altering streams. Place a higher priority on projects that allow streams to return to natural channel migration patterns. Give preference to channel stabilization over culverting. ▪ Promote citizen involvement and seek community consensus on attempts to restore surface water features which have been altered. Restoration efforts may include the daylighting of streams which have been diverted into underground pipes or culverts. ▪ Identify, prioritize, and eliminate barriers to fish passage. Work with citizen volunteers, state and federal agencies, and tribal governments in these efforts. ▪ Preserve and protect natural flood storage areas. ▪ Use the state Shoreline Management Act to guide protection efforts for water features that do not qualify for state regulation. ▪ Work with citizen and watershed groups and cooperate with adjacent county and local governments, regional governments, state agencies, and tribal governments to develop and implement watershed action plans and other types of basin plans for basins that lie within or partially within Shoreline's boundaries. ▪ Provide public access to Shoreline's natural features, including the Puget Sound shoreline. Seek consensus of local communities and neighborhoods when private property owners might be negatively affected by this action. ▪ Design and construct habitat projects to solve existing habitat problems, but also to provide multiple benefits to the extent possible that meet goals, policies, and community needs expressed for flood protection and surface water quality. ▪ Implement activities that, in the following order of priority, (1) protect and

preserve existing habitat, (2) enhance and expand habitat in areas where wild anadromous fish are present, and (3) enhance and expand habitat in areas where other wild fish are present.

- Work with neighboring communities to improve water quality and stream habitat in basins that share interjurisdictional boundaries.

Specific habitat problems for fisheries resources were identified for four streams within the City: Boeing Creek, Thornton Creek, McAleer Creek, and Storm Creek. Although non-anadromous fish are present in several other water courses within the City, these four streams have the best habitat available and/or potential for fish habitat within the City. The "City of Shoreline Stream Inventory and Assessment" (Tetra Tech/KCM 2004e) contains the following recommendations for habitat improvements:

> *Taking the results directly from the USBEM [Urban Streams Baseline Evaluations Method], the foremost option for recovery within the Shoreline area is enhancement of the BC1 [Boeing Creek reach 1], BC8, and TC14 [Thornton Creek reach 14] reaches. In these areas, there are several site-specific enhancement options to address poor or fair conditions and improve the overall habitat conditions.*

The report indicates that these are the only reaches that received a "fair" rating overall. It further states: "All fair reaches would benefit from planting of native riparian vegetation and underplanting of native conifers and deciduous trees, as well as eradication of invasive plants, such as Himalayan blackberry and Japanese knotweed." (Tetra Tech/KCM 2004e)

Table 7-2 identifies the habitat problems and their location on the identified water courses.

Boeing Creek (reaches 1 and 1a), Thornton Creek (reaches TC1 through TC7), and McAleer Creek (as far upstream as Lake Ballinger) have anadromous fish access at this time. All other stream reaches have non-anadromous fish (usually cutthroat trout). Some reaches have juvenile salmon that were outplanted by school groups; however, this is not indicative that they are habitat for anadromous fish, as the adults cannot return there due to blockages. Some of the blockages are only at low or high flow, so some fish will get through. The steel pile dam (which defines the end of Boeing Creek reach 1 and the start of reach 2 is a total anadromous fish blockage.

7.3 Proposed Stream Habitat Projects and Programs

The City has policies in place to protect and improve stream habitat (Table 7-1). The City has and will continue to implement these policies through a number of programs and capital projects. Stream habitat projects and programs focus on protecting and preserving existing habitat to maintain the current level of function of the system, enhancing known and potential habitat for salmonid fish species, and, lastly, focusing on lower priority problems to enhance habitat for other fisheries resources.

To prioritize all of the proposed activities, the City has identified three priority levels that it has assigned to projects or programs that protect or improve stream habitat. As discussed in Section 1.5 of this Surface Water Master Plan, these activities will be phased in over time in accordance with priority level.

The citizens of Shoreline have expressed a desire for improved stream habitat. This Plan is intended to respond to regulatory requirements and also to meet the public's expectations that the City protect and enhance stream habitat.

This section describes the projects and programs included in each priority level. Tables 7-3, 7-4, and 7-5 list the projects and programs by priority level for specific habitat programs and capital projects for the problems identified in Table 7-2 and for other activities identified by the City. These tables also provide estimated costs for conceptual projects. Program costs are discussed in Chapter 8, and more detailed project cost estimates are provided in Appendix D.

It should be noted that detailed field studies were not performed as part of this master planning process. However, the consultants obtained information from individuals involved in the City's stream and wetland inventory and assessment and other City staff who have performed detailed field reconnaissance. The recommended projects and costs presented here are based on this information. In addition, because the problems identified in Table 7-2 do not identify every potential habitat problem in the City, the City will undertake additional engineering and reconnaissance to identify project solutions for additional habitat projects throughout the City.

Table 7-2
Stream Habitat Problems

Problem ID	Problem Location	Problem Description	Reference
1	Thornton Creek – Reach 14 (Maintenance to remove invasive species)	Invasive plant species are invading the restoration project in Paramount Park.	Tetra Tech/KCM 2004e
2	Boeing Creek – Reach 1 (Bank Stabilization)	High stormwater flows are causing erosion and sedimentation to the stream.	Tetra Tech/KCM 2004e
3	Boeing Creek – Reach 8 (Bank Stabilization)	High stormwater flows are causing erosion and sedimentation to the stream. Also, erosion in this area is a significant contributor to sediment in Hidden Lake.	Tetra Tech/KCM 2004e; Pers. Comm., Jesus Sanchez, Rika Cecil, Andy Loch, City of Shoreline, February 2004
4	McAleer Creek – Reach 1 (Fish Passage Blockage)	48-inch box culvert beneath 15th Avenue NE may be a fish barrier at times.	Tetra Tech/KCM 2004e; Pers. Comm., Andy Loch, City of Shoreline, December 2003
5	Thornton Creek – Reach 7 (Fish Passage Blockage)	In Twin Ponds Park, a hanging culvert located north of the north pond is a fish barrier. Also, a culvert passing beneath a pedestrian trail likely prevents juvenile fish passage due to its	Tetra Tech/KCM 2004e

Problem ID	Problem Location	Problem Description	Reference
		jumping height of 20 inches and the high downstream flow velocity.	
6	Storm Creek – Reach 1 (Substrate Improvement)	Concrete streambed constructed over pipeline provides poor substrate for fish.	Tetra Tech/KCM 2004e
7	Thornton Creek – Reach 3	The culvert beneath 1st Avenue NE may be a low-flow fish blockage.	Tetra Tech/KCM 2004e
8	Thornton Creek – Reach 12	A previous study (Otak 2001) identified a piped section that has settled and caused flooding problems and backed up flow to Ronald Bog. The long outlet pipe and associated catch basin may prevent fish passage. This problem will be covered under the Ronald Bog project described in Chapter 5.	Otak 2001 (referenced in Tetra Tech/KCM 2004)
9	Ballinger Creek – Reach 2	Three concrete culverts convey Ballinger Creek at the north end of Bruggers Bog Park; the jumping height is a minimum of 30 inches, and is a fish blockage.	Tetra Tech/KCM 2004e

7.3.1 Stream Habitat Priority Level 1: Critical Projects and Programs

For stream habitat Priority Level 1, the primary implementation activities would include meeting regulatory requirements, monitoring, enforcement, removal of invasive plants, and other actions that would enhance habitat in streams with salmonid fish species. Capital projects include stabilizing the streambank on sections of Boeing Creek, plus funding for other miscellaneous projects to enhance stream habitat. Because these miscellaneous projects have not been specifically identified, the City would need to conduct future studies to identify sites and to engineer projects that would most benefit the City's stream habitat.

Table 7-3 provides summaries of Priority Level 1 projects and programs. These projects include streambank restoration work on Boeing Creek (H-1 and H-2), implementation of a stream rehabilitation and habitat enhancement program (H-3) and acquisition of stormwater right-of-way (H-4). Projects H-3 and H-4 are also included in Priorities 2 and 3 because they include funds that will be spent for unspecified projects over the 20-year planning period. Table 7-3 gives planning-level cost estimates for capital projects; program costs are discussed in Chapter 8. These projects and programs are expected to be implemented within the next 6 years.

7.3.2 Stream Habitat Priority Level 2: Enhance and Expand Habitat in Areas Where Wild Anadromous Fish Are Present

Stream habitat Priority Level 2 includes both programs and projects that would further focus on enhancement of habitat in streams with salmonid fish species. Projects in this priority level include a culvert replacement on McAleer Creek (H-5), funding for miscellaneous stream habitat projects such as bank stabilization (H-6), and funds for projects H-3 and H-4 as discussed under Priority Level 1.

Table 7-4 provides summaries of Priority Level 2 projects along with planning-level cost estimates. Priority Level 2 also includes funds to increase programmatic activities (costs for these additional activities are described in Chapter 8). These projects and programs are expected to be implemented between years 7 and 20 of the 20-year planning period.

7.3.3 Stream Habitat Priority Level 3: Provide Additional Benefits to Stream Habitat

Stream habitat Priority Level 3 includes both project and programmatic activities that would provide additional benefits to stream habitat such as enhancing sections of streams with potential habitat immediately upstream of existing reaches with salmonid fish. Priority Level 3 activities may also focus on stream reaches with habitat for non-salmonid fish, thereby providing additional benefit to the overall surface water system. Project activities include miscellaneous stream habitat projects such as bank stabilization (H-7), and funds for projects H-3 and H-4 as discussed under Priority Level 1. Summaries of Priority Level 3 projects, along with planning-level cost estimates, are provided in Table 7-5.

Based on the recommended plan described in Chapter 9, the City will not be able to implement Priority Level 3 projects in the next 20 years. Implementing these projects will likely require additional sources of funding such as grants, developer mitigation fees, or local improvement districts.

Priority Level 3 does include funds to increase programmatic activities (costs for these additional activities are described in Chapter 8). These activities are expected to be implemented between years 13 and 20 of the 20-year planning period.

Table 7-3
Stream Habitat Priority Level 1 Projects and Programs

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Table 7-4
Stream Habitat Priority Level 2 Projects and Programs

Table 7-5
Stream Habitat Priority Level 3 Projects and Programs

Note: both tables are on one page

7.4 References

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- King County. 1987. *Reconnaissance Report No. 21: Middle Puget Sound Basin.* Prepared by King County Department of Public Works Surface Water Management Division, Seattle, WA. Cited in Tetra Tech/KCM 2004b.
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- TCWMC (Thornton Creek Watershed Management Committee). 2003. *Thornton Creek Watershed Action Plan Draft.* Prepared for TCWMC with assistance from Seattle Public Utilities. Seattle, WA. May 2003.
- Tetra Tech/KCM. 2004. *City of Shoreline Stream and Wetland Inventory and Assessment.* (Five volumes including four report volumes, listed below as 2004a through 2004d, and one volume of appendices). Prepared for City of Shoreline by Tetra Tech/KCM, Inc., Seattle, WA. May 2004.
  - Tetra Tech/KCM. 2003a. *Boeing Creek Basin Characterization Report.*
  - Tetra Tech/KCM. 2003b. *Middle Puget Sound, Seattle Golf Club and Bitter Lake Basins Characterization Report.*
  - Tetra Tech/KCM. 2003c. *Thornton Creek and West Lake Washington Basins Characterization Report.*
  - Tetra Tech/KCM. 2003d. *McAleer Creek and Lyon Creek Basins Characterization Report.*
  - Tetra Tech/KCM. 2004e. "City of Shoreline Stream Inventory and Assessment," Appendix A to *City of Shoreline Stream and Wetland Inventory and Assessment.*
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Chapter 8. Operation and Maintenance

This chapter describes the City of Shoreline's operation and maintenance (O&M) program needs that support the flood protection, water quality, and stream habitat priority level alternatives presented in Chapters 5, 6, and 7, respectively. This chapter also includes a discussion of drainage infrastructure repair and replacement. A description of the City's current O&M program is contained in Chapter 4.

The following sections describe the projected O&M needs associated with each priority level alternative. Additional detail is found in Appendix E. All O&M costs in this chapter are in 2004 dollars.

8.1 Flood Protection O&M Needs

Table 8-1 summarizes projected O&M needs for the flood protection priority level alternatives. Over the next 20 years, as new drainage infrastructure is built, it will require maintenance. Maintenance costs for new capital improvements are a large component of projected O&M expense increases.

Drainage and surface water infrastructure currently owned and maintained by the City is located in the publicly owned right-of-way. There are, however, drainage and surface water systems that were installed to follow predevelopment drainage paths that are not located in the public right-of-way but instead on private property. These systems located on private property are critical elements of the city's drainage system, but the City has limited access for maintenance or inspection. The City may choose to spend additional funds to assume maintenance responsibility of these systems.

Over the next six years, the number of privately maintained retention and detention structures is expected to increase, and the City will devote additional resources to inspection of these structures. To improve the effectiveness of the drainage system, expanded ditch reshaping and shoulder reconstruction efforts are also proposed.

Table 8-1
Projected Flood Protection O&M Needs

Flood Protection Priority Level Alternative	O&M Activities	Estimated Annual Financial Impact (2004$)
Priority Level 1: improves public safety and reduces property damage	Current activities, plus: ▪ O&M of new capital facilities ▪ O&M of systems on private property ▪ Additional ditch reshaping ▪ Additional inspection/source control	Current O&M expenditures plus $126,500 per year
Priority Level 2: improves the effectiveness of the City's surface water system	Priority Level 1 activities, plus: ▪ O&M of new capital facilities ▪ O&M of additional systems on private property ▪ Additional shoulder reconstruction	Priority Level 1 O&M expenditures plus $44,500 per year

Flood Protection Priority Level Alternative	O&M Activities	Estimated Annual Financial Impact (2004$)
Priority Level 3: provides additional benefits to surface water conditions	No additional Priority Level 3 activities	Same as Priority Level 2 O&M expenditures

8.2 Water Quality O&M Needs

Table 8-2 summarizes projected new water quality O&M needs. Priority Level 1 needs, totaling a projected $157,000 per year, are primarily due to O&M needs for new capital projects and the anticipated requirements of the City's National Pollutant Discharge Elimination System (NPDES) Phase II permit.

Expansion of the City's street sweeping program is proposed in Priority Level 3, which provides water quality benefits by removing pollutants prior to reaching Shoreline's surface waters. Priority Level 3 includes expanded water quality monitoring of Shoreline's creeks and lakes.

Within the next year, the Washington State Department of Ecology (Ecology) is expected to issue an NPDES Phase II General Permit, which would be applicable to Shoreline. After the permit requirements are finalized, the City intends to review projected O&M needs to be consistent with permit requirements.

Table 8-2
Projected Water Quality O&M Needs

Water Quality Priority Level Alternative	O&M Activities	Estimated Annual Financial Impact (2004$)
Priority Level 1: deemed critical to meet minimum regulatory requirements	Current activities, plus: ▪ O&M of new capital facilities ▪ Additional catch basin cleaning ▪ Additional retention/detention facility inspection ▪ Additional source control efforts ▪ Expand programs: clean car wash, no-spray zone, community involvement restoration, natural lawn and garden care ▪ Additional water quality monitoring	Current O&M expenditures plus $157,000 per year
Priority Level 2: enhances the ability of the City's surface water system to improve water quality	Priority Level 1 activities, plus: ▪ O&M of new capital facilities	Priority Level 1 O&M expenditures plus $8,000 per year
Priority Level 3: provides additional benefits to surface water quality	Priority Level 2 activities, plus: ▪ More frequent street sweeping ▪ Use of regenerative air street sweepers ▪ Additional water quality O&M activities	Priority Level 2 O&M expenditures plus $169,500 per year

8.3 Stream Habitat O&M Needs

Table 8-3 summarizes projected stream habitat O&M needs. Increases in O&M expenditures throughout the 20-year planning period are primarily due to maintenance of new facilities (such as culverts for fish passage), additional maintenance in targeted areas such as Paramount Park, and coordination of additional community/volunteer restoration projects.

Table 8-3
Projected Stream Habitat O&M Needs

Stream Habitat Priority Level Alternative	O&M Activities	Estimated Annual Financial Impact (2004$)
Priority Level 1: protects and preserves existing habitat	Current activities, plus: ▪ O&M of new capital facilities ▪ Additional maintenance in Paramount Park	Current O&M expenditures plus $18,000 per year
Priority Level 2: enhances and expands habitat in areas where wild anadromous fish are present	Priority Level 1 activities, plus: ▪ O&M of new capital facilities ▪ Additional volunteer restoration projects, invasive plant species removal, and public education	Priority Level 1 O&M expenditures plus $25,000 per year
Priority Level 3: enhances and expands habitat in areas where other wild fish are present	Priority Level 2 activities, plus: ▪ Additional volunteer restoration projects, invasive plant species removal, and public education	Priority Level 2 O&M expenditures plus $26,000 per year

8.4 O&M Needs from Parks and Transportation Projects

As part of other concurrent planning efforts, the City has developed projected parks and transportation improvements over the 20-year planning period. Many of these improvements include upgrading the storm drainage system, including the installation of new storm drainage facilities (see Section 9-2 for a more detailed explanation). These new facilities must be maintained, and Table 8-4 summarizes the estimated O&M impacts. These O&M costs were allocated by priority level to coincide with the timing of the construction of those parks and transportation projects.

Table 8-4
Projected O&M Needs from SWM Facilities
in Parks and Transportation Projects

Parks and Transportation Projects	O&M Activities	Estimated Annual Financial Impact
Priority Level 1	O&M of new capital facilities	Additional $9,000 per year
Priority Level 2	Priority Level 1 activities, plus: ▪ O&M of new capital facilities	Priority Level 1 O&M expenditures plus $24,000 per year
Priority Level 3	No additional Priority Level 3 activities	Same as Priority Level 2 O&M expenditures

8.5 General Fund Cost Allocation Impact

Each year, some surface water utility funds are transferred to the City's General Fund to pay for a variety of support activities. Some of the support activities funded by the General Fund include other City departments such as human resources, the customer response team, the City attorney's office, the City manager's office, and the City Council. The General Fund also funds some public works department staff such as the public works director, the public works administrative manager, and portions of various other public works department positions.

The City has developed a detailed methodology to calculate the General Fund Cost Allocation for each City department. The methodology is based on items such as the square feet of office space (for facilities expenses) and the number of FTEs (for the human resources department).

As the content and staffing of the surface water management program change, so does the General Fund Cost Allocation. For financial planning purposes, 25 percent is added to each new annual O&M expenditure for the General Fund Cost Allocation. The estimated costs shown in Tables 8-1 through 8-4 include this additional General Fund Cost Allocation.

8.6 Repair and Replacement

The majority of the City's current drainage system has been installed incrementally over the past 60 years. Portions of the drainage system are nearing their useful life, and will require replacement in the near future.

Currently, repair and replacement of relatively short sections of the drainage system are typically done via the City's Small Works Program on an as-needed basis.

A comprehensive long-term repair and replacement program has not been developed because the condition of the underground drainage infrastructure has not been fully evaluated. Over the next six years, the City intends to complete a condition assessment of drainage infrastructure. This condition assessment will enable the City to develop a long-term repair and replacement program. For financial planning purposes, an annual repair and replacement expenditure of $150,000 (in 2004 dollars) is projected. These dollars will

initially be used for a condition assessment to develop the long-term repair and replacement program. The results of the condition assessment will help prioritize R&R projects that will be funded at the $150,000 per year level. There will continue to be a Small Works Program to fix ongoing system problems at $150,000 per year. The Small Works Program is funded through the Capital Improvement Projects.

8.7 Summary

Table 8-5 summarizes the proposed new O&M expenditures resulting from implementation of Priority Level 1, 2, and 3 projects and programs.

Table 8-5
Summary of Projected New O&M Expenditures

Program Area	New O&M Expenditures ($/Year, 2004$) Priority Level 1 (Years 1–6)	Priority Level 2[a] (Years 7–12)	Priority Level 3[b] (Years 13–20)
Flood Protection	$126,500	$171,000	$171,000
Water Quality	157,000	165,000	334,500
Stream Habitat	18,000	43,000	69,000
SWM Facilities in new Parks and Transportation Projects	9,000	33,000	33,000
Total	$310,500	$412,000	$607,500

[a] The estimated new O&M expenditure for Priority Level 2 is $412,000 per year, which includes the $310,500 new O&M expenditure associated with Priority Level 1 plus an additional $101,500.

[b] The estimated new O&M expenditure for Priority Level 3 is $607,500 per year, which includes the $412,000 new O&M expenditure associated with Priority Level 2 plus an additional $195,500.

Part III: Recommended Plan and Financial Analysis

Part III of this Surface Water Master Plan presents a financial analysis of the potential projects and programs that the City of Shoreline's surface water management program could provide to its ratepayers, and describes their impacts on rates. The recommended plan presented in Part III reflects the needs and priorities of the City and community and balances those against the desire to charge reasonable rates.

Chapter 9. Recommended Plan and Financial Analysis

9.1 Introduction

This chapter includes a summary of the recommended plan for the City's surface water management (SWM) program. This recommended plan was developed as a result of:

- Listening to the community regarding its flood protection, water quality, and stream habitat priorities
- Working with City staff to obtain the best available technical analysis of the City's surface water management infrastructure, maintenance procedures, program activities, and anticipated regulatory requirements
- Evaluating the financial impacts

The recommended plan includes funding for repair and replacement (R&R) of aging infrastructure, operation and maintenance (O&M) of the system, and new capital improvement projects (CIP). The plan was developed through an iterative process, as described in Appendix G. Following the recommended plan is a financial analysis that consists of:

- A description of Shoreline's existing SWM fee schedule
- The results of a long-range financial projection for the City's SWM program, including the possible financial impacts of implementing the recommended plan
- A SWM fee comparison with 11 other local jurisdictions

Appendix F contains more detailed financial information.

9.2 Recommended Plan

Table 9-1 shows the recommended capital spending plan. The proposed SWM fee structure described later in this Chapter will fund all of the Priority Level 1 capital improvements described in Chapters 5, 6, and 7 between 2005 and 2010. The proposed SWM fee structure will also fund all of the Priority Level 2 capital improvements between 2011 and 2024 but will not fund any of the Priority Level 3 capital improvements. A more detailed list of capital improvements is included in Appendix F.

Table 9-1
Recommended SWM Capital Spending (2004 dollars, in millions)

Type of Improvement	Priority Level 1 (2005–2010)	Priority Level 2 (2011–2024)	Priority Level 3 (Not Affordable)	Total	Reference
Flood Protection	$9.604	$1.244	$0.0	$10.848	Chapter 5 SWMP
Water Quality	0.388	2.020	0.0	2.408	Chapter 6 SWMP
Stream Habitat	4.016	1.527	0.0	5.543	Chapter 7 SWMP
SWM Facilities: Transportation Projects[a]	2.083	5.950	0.0	8.033	See Below
SWM Facilities: Parks Projects[a]	0.100	0.350	0.0	0.450	See Below
Total	**$16.192**	**$11.091**	**$0.0**	**$27.283**	

[a] Costs for transportation and parks projects come from the Transportation and Parks Master Plans, respectively. These costs are allocated by priority level to coincide with planned construction of projects during the time periods shown on this table.

The redevelopment of Shoreline's parks and improvement of roads will provide an opportunity (in some cases) to fix the aging and sometimes failed storm drainage infrastructure within the City. In Shoreline, surface water is classified as a utility. Other utilities such as water, sewer, and power generally find it to be cost-effective to perform necessary upgrades when a major Parks or Transportation project is undertaken. This is a cost-effective way of upgrading the City's vital infrastructures by providing multiple beneficiaries for a single capital improvement project. This programmatic approach allows funding to be available at the time a Parks or Transportation project is scheduled without disrupting other surface water priorities.

Surface water dollars will only be used to fund flood protection, water quality, and habitat issues associated with future Parks and Transportation projects. For flood protection, these dollars would generally be used to replace or upgrade pipes, catch basins, manholes, and other drainage infrastructure. For water quality, surface water dollars could be used to purchase oil/water separators or sediment traps to keep pollutants out of the City's surface water bodies. In the case of parks projects, surface water dollars may be used toward wetland restoration if it provides a water quality benefit. In some cases, surface water dollars may allow the City to go above and beyond the water quality requirements in place at the time of the project to provide a higher level of water quality protection. Surface water dollars would go towards replacing a road culvert that is currently a potential fish migration barrier with one that is not.

For planning purposes, the SWM program is being assigned 10 percent of the cost of pedestrian projects, 20 percent of the cost of road and intersection projects, and 10 percent of the cost of parks projects.

O&M needs for the City's SWM program will continue to include activities that preserve the system's flood conveyance function, such as cleaning catch basins, maintaining ditches, and sweeping streets. Upcoming stormwater regulations, in the form of the general NPDES Phase II Municipal Stormwater Permit (NPDES stormwater permit), are expected to significantly impact the City's O&M activities and O&M expenditures. Additional emphasis will be placed on programs to improve water quality, and on increasing inspection and pollutant source control activities. Additional repair of gravel shoulders, additional ditch maintenance, and changes to street sweeping practices are also anticipated.

As the City's SWM infrastructure ages, planning for its repair and replacement will become more critical. The recommended plan includes a condition assessment of SWM infrastructure and annual spending for repairs and replacements.

Figure 9-1 shows a proposed implementation schedule for the 20-year planning period. Priority Level 1 capital projects would be constructed over the six-year period from 2005 to 2010, and new O&M expenses would be phased in over this same period. Priority Level 2 capital projects would be completed between years 7 and 20 of the 20-year planning period. Priority Level 2 O&M activities would be phased in between years 7 and 12, and Priority Level 3 O&M activities would be phased in between years 13 and 20. After the NPDES stormwater permit is issued by Ecology, the City will re-evaluate its O&M activities and define necessary changes to ensure consistency with the permit.

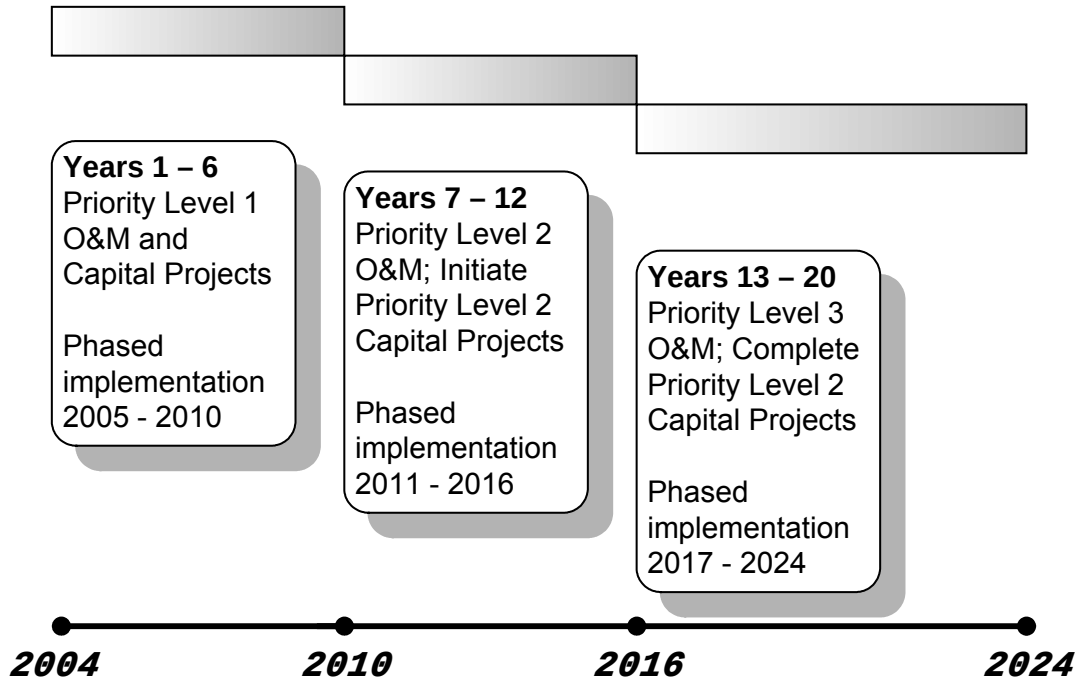

Figure 9-1. SWM Program Implementation Schedule

9.3 Financial Analysis

9.3.1 Existing Fee Schedule

In 2003, the Shoreline City Council adopted the SWM fee schedule shown in Table 9-2. The SWM fee for single-family residences in the City is $102 per parcel per year. Multifamily and commercial users are charged an annual fee on a per-acre basis that depends on the percentage of impervious surface.

Table 9-2
2003 Surface Water Management Fees

Category	Percent Impervious Surface	Annual Fee
Single-Family Residences		$102/parcel
Other Customers		
Very Light	Less than or equal to 10%	$102/parcel
Light	10% to 20%	$238/acre
Moderate	20% to 45%	$493/acre
Moderately Heavy	45% to 65%	$952/acre
Heavy	65% to 85%	$1,207/acre
Very Heavy	85% to 100%	$1,581/acre

Exemptions and discounts are available for several categories of customers. Homes occupied by low-income disabled and low-income senior citizens can qualify for an exemption. Discounts are available for parcels with officially designated open space.

A SWM fee discount is available to property owners that maintain an on-site retention/detention facility. The rate discount is a one category deduction. For example, a parcel with a retention/detention facility classified as “moderate” would be charged the “light” rate. The SWM fees shown in Table 9-2 do not apply to the City’s rights-of-way.

Figure 9-2 compares Shoreline’s SWM fees with those of 11 other local SWM utilities. The example annual bill is for a single-family residence.

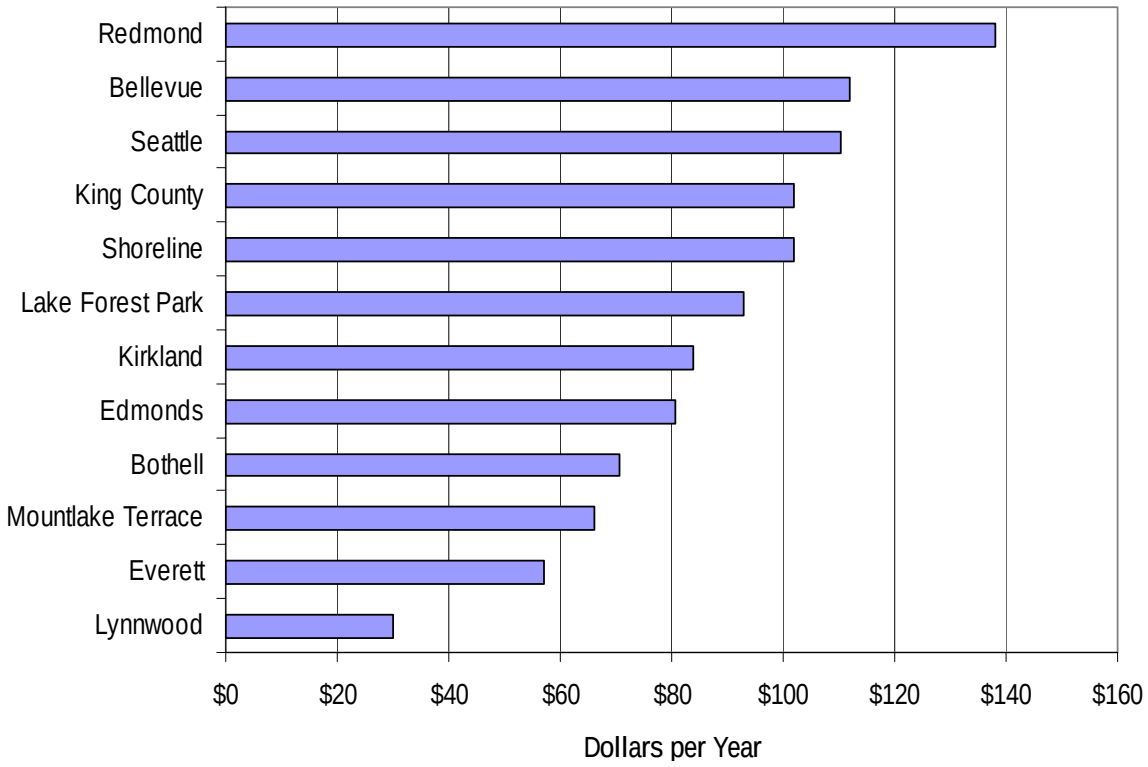

Figure 9-2. Single-Family Residential SWM Fee Comparison

9.3.2 Equivalent Service Units

The equivalent service unit (ESU) concept provides a way to consider the entire drainage system in terms of an equivalent number of single-family residences. In this financial analysis, an ESU is defined as a single-family residence and the number of ESUs is determined in terms of the amount of revenue collected through SWM fees. For 2004, the City has budgeted total revenue from SWM fees to be $2,492,192. The estimated number of ESUs is 24,000, calculated by dividing the SWM fee revenues by the single-family residential SWM fee ($102 per parcel per year).

Use of ESUs is a way to quickly approximate the financial impacts of proposed expenditures. A $1 per year per ESU SWM fee increase would fund an annual expenditure of $24,000.

9.3.3 Long-Range Financial Projection

This section provides a long-range financial projection of SWM fees for a 20-year period. The financial projection is based on a number of assumptions, which are described below. The assumptions represent the best data currently available, and should be expected to change over time. The projected SWM fees are intended to show the financial consequences of implementing the recommended plan over a 20-year period. The projected SWM fees do not represent a commitment by the City to adopt the fees; the City regularly evaluates the financial condition of its SWM utility to make policy decisions regarding services to be provided and the required level of SWM fees.

A spreadsheet-based financial planning model was developed for the City's SWM program. Revenues, consisting primarily of SWM fees, were projected, as were O&M and capital expenditures. SWM fee revenues were projected to provide revenues sufficient to cover expenses and meet the City's financial policy targets, which are also described below.

Capital Spending Assumptions

- 20-year total, in 2004 Dollars, of $27,283,000, as shown in Table 9-1 and Appendix F
- Capital project costs in future years are adjusted for inflation at 2.5 percent per year
- Repair and replacement funding of $150,000 per year (in 2004 dollars)

Capital Funding Assumptions

- Repair/replacement is funded through SWM fees
- Future debt is issued at a 5.0% interest rate, with levelized principal and interest payments over a 20-year period
- No debt service coverage ratio criterion is included in this analysis

O&M Spending Assumptions

- O&M spending consists of current expenditures (from 2004 budget) plus phase-in of new O&M expenditures. Chapter 8 contains a summary of projected new O&M expenditures.
- New O&M expenditures are phased in over the period represented by each priority level
- Most other O&M spending increases at 3 percent per year (growth plus inflation)
- New expenditures include the additional General Fund Cost Allocation, estimated to be 25 percent of the new O&M expenditure

Other Assumptions

- 2.5 percent annual inflation
- 0.5 percent annual system growth
- Financial policy target: minimum SWM Fund balance is 10 percent of operating revenues
- Financial policy target: minimum SWM Capital Fund balance is >$0
- Fund balances and debt reserve balances earn 3 percent interest

9.3.4 Projected SWM Fees

Figure 9-3 shows the 20-year projection of SWM fees for a single-family residence and the relative distribution of spending among repair/replacement, capital improvements, and O&M.

This graph indicates that approximately 35 percent of the current SWM fee pays for capital projects and repair and replacement. Over time, the O&M component increases due to inflation, added O&M activities associated with the completed capital improvements, and the costs to comply with assumed new regulatory requirements (i.e., NPDES Phase II).

The capital project component reflects cash-financed capital improvements and debt service payments on debt-financed capital improvements. Repair and replacement projects are cash-funded without issuance of debt. The projected amount of capital improvements

funded by debt from 2004 through 2024 is approximately 70%. The assumed sources of this funding are revenue bond proceeds and loans from the Public Works Trust Fund.

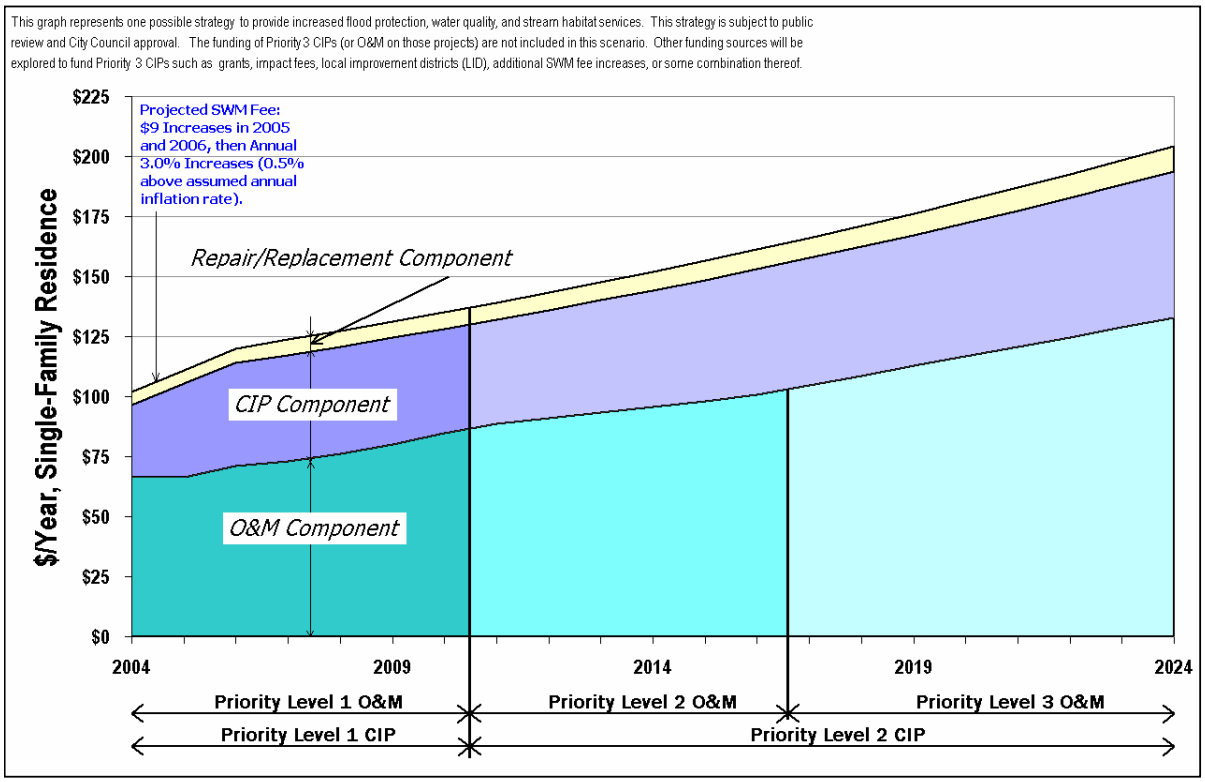

Figure 9-3. 20-Year Projection of Single-Family Residential SWM Fees

The ability of the SWM program to finance capital improvements depends in part on the level of SWM fees. If SWM fees higher than those described above were implemented, then additional capital improvements could be funded. Conversely, if SWM fees are not raised to the levels described above, fewer capital improvements could be funded.

The following additional factors could also facilitate completion of a greater amount of capital improvements:

- Receipt of additional low interest rate loans (the recommended plan assumes loans would be obtained with a 5.0 percent interest rate)
- Loans with longer payback periods (the recommended plan assumes a 20-year payback period)
- Receipt of grants (the recommended plan assumes no grant funding is received, though the City will continue to seek grant funding)
- Use of other, non-SWM funding sources such as impact fees, local improvement districts (LIDs) or partnering with other government and non-government entities on projects (the recommended plan assumes no additional funding sources)

A major factor affecting the SWM program is the contents of the upcoming NPDES stormwater permit (a first draft is expected from Ecology in spring 2005). If permit requirements are less extensive than what has been anticipated in this plan, then the City

could choose either to (1) defer projected SWM fee increases, or (2) construct additional capital improvements.

Appendices

Appendix A.
Summary of Public Comments

Appendix B.
Background Information on Regulatory Issues

Appendix C.
Background Information on Current SWM Program

Appendix D.
Project Cost Estimates

Appendix E.
Operation and Maintenance Supporting Information

Appendix F.
Financial Analysis Supporting Information

Appendix G.
Changes in the Recommended Plan and the Financial Analysis from the Public Review Draft

Acknowledgments

This Surface Water Master Plan was prepared by R. W. Beck, Inc., in coordination with the City of Shoreline. The Surface Water Master Plan supports and implements the City of Shoreline Comprehensive Plan, which was developed concurrently by Berryman & Henigar in coordination with the City of Shoreline.

The Surface Water Master Plan required the expertise of various City staff and consultants. The Plan was prepared and reviewed by the following lead staff:

Project Managers:	Jesus Sanchez, Operations Manager Donna Pacanovsky, P.E., R. W. Beck
Flooding Analysis:	Jesus Sanchez, Operations Manager Jessica Guerrette, P.E., R. W. Beck
Water Quality Analysis:	Andy Loch, Surface Water Quality Specialist Rika Cecil, Environmental Services Coordinator Donna Pacanovsky, P.E., R. W. Beck
Habitat Analysis:	Rika Cecil, Environmental Services Coordinator Andy Loch, Surface Water Quality Specialist Donna Pacanovsky, P.E., R. W. Beck Cathie Conolly, Adolfson Associates
Regulatory Issues:	Jessica Guerrette, P.E., R. W. Beck
Financial Analysis:	Debbie Tarry, Finance Director Patti Rader, Senior Budget Analyst Phil Ramon, Administrative Services Manager Jerry Shuster, P.E., SWES Coordinator Art Griffith, P.E., R. W. Beck
Technical Editor:	Todd Crandell, R. W. Beck
Shoreline Planning Commission Surface Water and Environment Workgroup:	Commissioner Carol Doering Commissioner Sidney Kuboi Commissioner David Harris
QA/QC:	Steve Swenson, P.E., R. W. Beck
Additional City Review:	Jerry Shuster, P.E., SWES Coordinator Tim Stewart, PDS Director Paul Haines, Public Works Director Jill Marilley, P.E. City Engineer Andrea Spencer, Senior Planner, PDS Bob Oleander, Deputy City Manager Steve Burkett, City Manager
Washington Department of Fish and Wildlife:	Douglas G. Hennick, Area Habitat Biologist

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