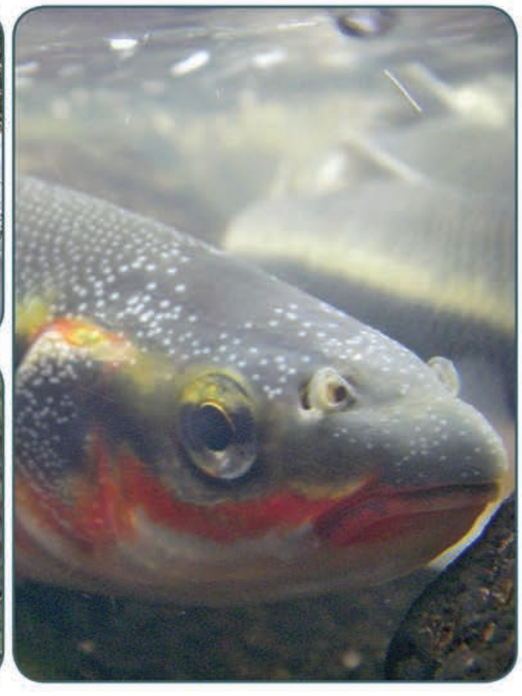
# 2012 Storm and Surface Water System Plan

## REVIEW DRAFT



City of Bellevue
Utilities Department

CITY OF BELLEVUE WASHINGTON

# Review Draft 2012 Storm and Surface Water System Plan

**City of Bellevue**

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# 308 Acronyms and Abbreviations

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|---|---|
| APWA | American Public Works Association |
| Ballard Locks | Hiram M. Chittenden Locks |
| B-IBI | Benthic Index of Biotic Integrity |
| BMP | best management practice |
| BURP | Bellevue Urban Runoff Program |
| CAO | Critical Areas Ordinance |
| CCTV | closed-circuit television |
| CDP | Comprehensive Drainage Plan |
| CFR | Code of Federal Regulations |
| cfs | cubic feet per second |
| CIP | Capital Investment Program |
| City | City of Bellevue |
| CPI | Consumer Price Index |
| CRS | Community Rating System |
| Ecology | Washington State Department of Ecology |
| EOP | Emergency Operations Plan |
| ESA | Endangered Species Act |
| ESC | City of Bellevue’s Environmental Services Commission |
| ET | evapotranspiration |
| FEMA | Federal Emergency Management Agency |
| FIRM | Flood Insurance Rate Map |
| GIS | geographic information system |
| GMA | Growth Management Act |
| HPA | Hydraulic Project Approval |
| ICS | Incident Command System |
| IDDE | illicit discharge detection and elimination |
| I&I | inflow and infiltration |
| KCM-WRE/YTO | Kramer Chin & Mayo – Water Resources Engineers/Yoder, Trotter, Orlob & Associates |
| LID | low impact development |
| LMD | Lake Management District |
| LOS | Level of Service |

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| | |
|---|---|
| LWD | large woody debris |
| µg/L | micrograms per liter |
| NAFSMA | National Association of Flood and Stormwater Management Agencies |
| NAS | National Academy of Sciences |
| NFIP | National Flood Insurance Program |
| NOAA | National Oceanic and Atmospheric Administration |
| NPDES | National Pollutant Discharge Elimination System |
| O&M | Operations and Maintenance |
| PCP | pentachlorophenol |
| PDI | Private Drainage Inspection |
| Plan | Storm and Surface Water System Plan |
| PSM | pre-spawn mortality |
| RCW | Revised Code of Washington |
| RMCS | Resource Management and Customer Service |
| R&R | Renewal and Replacement |
| SCADA | Supervisory Control and Data Acquisition |
| SCS | Soil Conservation Service |
| SEPA | State Environmental Policy Act |
| Ship Canal | Lake Washington Ship Canal |
| SWG | Stormwater Work Group |
| SWPPP | Stormwater Pollution Prevention Plan |
| TAPE | Technology Assessment Protocol – Ecology |
| TMDL | Total Maximum Daily Load |
| TSS | total suspended solids |
| UGA | urban growth area |
| USACOE | U.S. Army Corps of Engineers |
| USEPA | U.S. Environmental Protection Agency |
| USGS | U.S. Geological Survey |
| Utility | Storm and Surface Water Utility |
| WDFW | Washington Department of Fish and Wildlife |
| WRIA | Watershed Resource Inventory Area |
| WSDOT | Washington State Department of Transportation |

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# List of Definitions

Adapted from: Western Washington Phase II Municipal Stormwater Permit, 2007; Usher, Laurie, et al., *Discover Wetlands,* Washington State Department of Ecology, Olympia, WA, Publication #88-16-a,b,c,d (revised July 1995); the Tri-County Stormwater proposal to NOAA Fisheries for Puget Sound Chinook 4(d) rule; and City codes.

The terms below are used in this Storm and Surface Water System Plan as follows:

**Acre-foot:** The amount of water it would take to cover an acre to 1 foot deep (equivalent to 43,560 cubic feet).

**Basin:** An area drained by a single stream or river system or the drainage areas that drain directly to a particular water body or Puget Sound.

**Beneficial Uses:** Uses of waters of the state which include, but are not limited to, use of domestic, stock watering, industrial, commercial, agricultural, irrigation, mining, fish and wildlife maintenance and enhancement, recreation, generation of electric power and preservation of environmental and aesthetic values, and all other uses compatible with the enjoyment of the public waters of the state.

**Best Management Practices (BMPs):** Schedules of activities, prohibitions of practices, capital improvements, maintenance procedures and other management practices that, when used singly or in combination, prevent or reduce the release of pollutants and other adverse impacts to the waters of Washington State. BMPs also include, but are not limited to, treatment requirements, operating procedures, and practices to control plant site runoff, spillage or leaks, sludge or wastewater disposal, or drainage from raw material sludge.

**Capital Improvement Project:** A funded project intended to improve the drainage system, the performance of that system, and/or reduce site-specific or cumulative adverse stormwater impacts.

**Clearing:** The act of destroying or removing vegetation by any means, including chemical, mechanical, or by hand.

**Conveyance Capacity:** A term generally referring to the maximum capability of the physical drainage system to safely transport water (from a hydraulic perspective).

**Critical Areas:** Areas required to be protected under the state Growth Management Act, Chapter 37.70A, RCW. These areas (e.g., riparian corridors, wetlands, floodplains, coal mines, and steep slopes) are designated by the City as ecologically sensitive or hazard areas and regulated to protect the functions and values of these areas and the public health, safety, and welfare, and to allow the reasonable use of private property.

**Detention or Flow Control**: The act of temporarily detaining stormwater runoff, in a pond, tank, or vault, collected from developed surfaces and releasing it back into the stormwater system at a pre-determined rate that is slower than what would otherwise be expected.

**Development:** 1. (Land Use Code [LUC]) All structures and modifications of the natural landscape above and below ground or water, on a particular site. 2. (NOAA) Any land altering activity creating impervious surfaces or otherwise modifying site hydrologic response, generally requiring a permit or approval. Such permits or approvals may include, but are not limited to, a building permit, clearing and grading permit, shoreline substantial development permit, conditional use permit, special use permit, zoning variance or reclassification, subdivision, short subdivision, Urban Planned Development, binding site plan, site development, or right-of-way use permit.

**Direct Discharge:** Undetained discharge from a proposed project to a “major receiving water.”

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**Drainage System:** A combination of facilities (e.g., ditches, pipes, conduits, storage facilities, trenches, etc.) and natural features (e.g., open streams, ponds, etc.) which operate together to convey surface water from the point of origin to an ultimate discharge point.

**Dredging:** The process of removing sediment from canals, rivers, streams, ponds, and harbors.

**Drought:** Prolonged period of dry weather.

**Duration Control Standard:** A design standard applied to stormwater facilities that provide flow control. The standard seeks to match both flow duration and peak flow rates from the post-development site to the pre-developed site for a certain time period.

**Effective Impervious Surface:** Any impervious surface that is connected or has the effect of being connected directly to the downstream drainage system.

**Erosion:** The group of natural processes, including weathering, dissolution, abrasion, corrosion, and transportation, by which material is worn away from the earth's surface.

**Flooding or Erosion Impacts:** Includes impacts such as flooding of septic systems, crawl spaces, living areas, outbuildings, etc.; increased ice or algal growth on sidewalks/roadways; earth movement/settlement; increased landslide potential; and erosion and other potential damage.

**Flow Control Facility:** A drainage facility designed to temporarily store stormwater runoff from developed surfaces and release it at a slower rate than it is collected (e.g., detention ponds, tanks, vaults, etc.) or to store the runoff for a considerable length of time and release it by evaporation, plant transpiration, and/or infiltration into the ground (e.g., retention or infiltration ponds, rain gardens, pervious pavement, tanks, vaults, trenches, etc.).

**Flow Duration**: The aggregate time that peak flows are at or above a particular flow rate of interest. For example, the amount of time that peak flow rates are at or above 50 percent of the 2-year rate for a period of record.

**Forest Canopy or Tree Canopy:** The area of land covered by tree canopy when looking from directly above, regardless of the land cover beneath the trees. For this document, tree canopy was measured using satellite images.

**Forested or Forest Cover:** A natural land condition comprising native trees and understory vegetation, and a relatively non-compacted surface layer of soil typical of Puget Sound forests.

**Grading:** Any excavating or filling or combination thereof.

**Habitat:** The location where a particular species (or identified subspecies) of plant or animal lives and its surroundings, both living and non-living. Habitat includes the presence of a group of particular environmental conditions surrounding an organism including air, water, soil, mineral elements, moisture, temperature, and topography.

**Hydrologic balance:** An accounting of the inflow to, outflow from, and water storage in a hydrologic unit such as a drainage basin, aquifer, soil zone, lake or reservoir. The relationship between evaporation, precipitation, runoff, and the change in water storage.

A statement of the conservation of matter as applied to a ground water basin. All water entering an area during any given period of time must either go into storage within its boundaries, be consumed, exported or flow out, either on the surface or underground during that time period. Hydrology Handbook—American Society of Civil Engineers.

A general water balance equation is: $P = Q + E + \Delta S$ , where

$P$ is precipitation

$Q$ is runoff

$E$ is evapotranspiration

$\Delta S$ is the change in storage (in soil)

**Impervious Surface:** A hard surface area, which either prevents or retards the entry of water into the soil mantle at a rate lower than that present under natural conditions prior to development; and/or a hard surface area that causes water to run off the surface in greater quantities and at an increased rate of flow from the flow present under natural conditions prior to development. Common impervious surfaces include, but are not limited to, roof tops, walkways, patios, driveways, parking lots, or storage areas, concrete or asphalt paving, gravel roads, and packed earthen materials, or other surfaces which similarly impede the natural infiltration of surface and stormwater runoff.

**Low Impact Development (LID):** A stormwater management and land development strategy applied at the parcel and subdivision scale that emphasizes conservation and use of on-site natural features integrated with engineered, small-scale hydrologic controls to more closely mimic pre-developed hydrologic functions.

**Low Impact Development BMPs:** A category of BMPs designed to incorporate open space preservation techniques, such as rain gardens, pervious pavements, cluster residential developments or rooftop runoff management, foundation design, vegetation enhancement, etc., that reduce hydrological impacts of development as compared to more traditional practices.

**Mitigation:** Methods used to compensate for impacts on critical areas. Options include:

a) Avoiding the impact altogether by not taking a certain action or parts of an action.
b) Minimizing impacts by limiting the degree of magnitude of the action and its implementation.
c) Rectifying the impact by repairing, rehabilitating, or restoring the affected environment.
d) Reducing or eliminating the impact over time by preservation and maintenance operations during the life of the action.
e) Compensating for the impact by replacing or providing substitute resources or environments.

**Native Vegetation:** Vegetation consisting of plant species that are indigenous to the Puget Sound region and which reasonably could have been expected to naturally occur on the site. Examples include trees such as Douglas fir, western hemlock, western red cedar, alder, big-leaf maple, and vine maple; shrubs such as willow, elderberry, salmonberry, and salal; and herbaceous plants such as sword fern, foam flower, and fireweed.

**Natural Drainage Practices (**synonymous with LID BMPs): BMPs approved for use in Bellevue to manage stormwater on developed sites to more closely mimic natural hydrologic conditions. They include bioretention (rain gardens, etc.), pervious pavement, amended soils, rain recycling, vegetated roofs, reverse-slope sidewalks, and minimal excavation foundations.

**Nutrient:** Nourishing substances necessary to life and growth, such as nitrogen and phosphorus.

**Phytoplankton:** Microscopic plants that live drifting in water. They are the base of almost all aquatic food chains.

**Practicable:** Available and capable of being done, after taking into consideration cost, existing technology, and logistics in light of overall project and/or program purposes.

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**Public Stormwater Facility:** Any stormwater system or portion thereof that is owned or operated by a public entity.

**Public storm and surface water system or public drainage system:** Means those elements of the storm and surface water system maintained and operated by the City of Bellevue Utilities Department, which includes elements located on property owned by the department or in public right-of-way except to the extent that private ownership is indicated as a matter of record or by law and elements located on property on which the City has an easement, license, or other right of use for utility purposes. (Storm and Surface Water Utility Code, 24.06.040 Definitions)

**Recharge:** Water that seeps through the soil to replenish an aquifer.

**Recovery:** The process by which the decline of an endangered or threatened species is arrested or reversed, and threats neutralized so that its survival in the wild can be ensured. The goal of the Endangered Species Act (ESA) is for the recovery of listed species to levels where protection under the ESA is no longer necessary [50 CFR 402.02].

**Redevelopment:** Any land altering activity (except routine maintenance) or change in use on an already developed site which requires a permit or approval and which creates new impervious surface/cleared area or replaces existing impervious surface (i.e., replaced impervious surface) or modifies existing cleared area (also known as modified cleared area or modified pervious surface) or has a potential to increase runoff or release new pollutants from the site. New pollutants means a pollutant that was not discharged from the site immediately prior to a change in use, as well as a pollutant that was discharged in less quantities prior to a change in use.

**Revenue:** All the income produced by a particular source.

**Right-of-way:** Right-of-way means all public streets and property granted or reserved for, or dedicated to, public use for street purposes, together with public property granted or reserved for, or dedicated to, public use for walkways, sidewalks, bikeways, and horse trails, whether improved or unimproved, including the air rights, sub-surface rights, and easements related thereto.

**Riparian Corridor:** A perennial or intermittent water body, its lower banks and upper banks, and the vegetation that stabilizes the slopes, protects the waterway from erosion and sedimentation, provides cover and shade, and maintains the fish and wildlife habitat.

**Runoff:** Water that travels across the land surface and discharges to water bodies either directly or through a collection and conveyance system. Also see "Stormwater."

**Salmonid:** Any member of the taxonomic family Salmonidae, which includes all species of salmon, trout, and char [Salmon and Steelhead Stock Inventory].

**Storm and Surface Water System**: Also referred to as the drainage system, means the entire system within the city, both public and private, naturally existing and manmade, for the drainage, conveyance, detention, treatment, or storage of storm and surface waters. However, facilities directly associated with buildings or structures such as foundation drains, rockery/retaining wall drains, gutters, and downspouts or groundwater under-drains are not considered parts of the storm and surface water system.

**Stormwater:** Runoff during and following precipitation and snowmelt events, including surface runoff and drainage.

**Stream**: Any aquatic area where surface water produces a channel, not including a wholly artificial channel, unless the artificial channel is: 1) used by salmonids; or 2) used to convey a stream that occurred naturally before construction of the artificial channel. The definition of "stream" and designation thereof is set forth in Part 20.25H LUC.

**Study (or basin study):** An analysis or assessment that focuses on one or more science-based issue(s) of scope less than a full basin plan. The study is consistent with, but can modify a basin plan. The study is approved by the legislative body.

**Subbasin:** A drainage area that drains to a watercourse or water body named and noted on common maps and which is contained within a basin. A basin or area that is part of a larger drainage basin or area. Also see "Basin."

**Total Impervious Area (TIA):** The total amount of actual impervious surface on a site or within a drainage area, basin, or sub-basin (see "Impervious Surface").

**Total Maximum Daily Load (TMDL):** A water quality planning and implementation tool required under Section 303(d) of the Clean Water Act. This measure specifies, through the use of a scientifically based process, the amount of a pollutant that can be discharged to a water body without affecting beneficial uses and mechanisms for ensuring discharges do not exceed that amount. TMDLs can focus on both point and nonpoint sources of pollution, and one watershed may have a TMDL developed for both simultaneously.

**Undeveloped:** A property in a state generally approaching being native or natural covered with living, mature vegetation.

**Water Quality Treatment Facility:** A drainage facility designed to reduce pollutants once they are already contained in surface and stormwater runoff. Water quality treatment facilities are the structural component of best management practices (BMPs); when used singly or in combination, water quality treatment facilities reduce the potential for contamination of surface and/or ground waters.

**Watershed:** A geographic region within which water drains into a particular river, stream, or body of water as identified and numbered by the State of Washington Water Resource Inventory Areas (WRIAs) as defined in Chapter 173-500 Washington Administrative Code (WAC).

**Water Resource Inventory Area (WRIA):** A geographic area, defined by hydrologic boundaries on the basin and sub-basin scale, designated by the state as a way to describe administrative units for resource management; the state comprises 63 WRIAs, with those adjacent to bodies of saltwater customarily including a major river drainage and nearby smaller drainages.

**Wetland: A** habitat that is characterized by soils that are saturated with water, or has shallow standing water, for part of the growing season.

# EXECUTIVE SUMMARY

## Introduction

This Storm and Surface Water System Plan (Plan) is a guidance document that establishes storm and surface water policy, is in support of the City's Comprehensive Plan, evaluates the operational management of the storm and surface water Utility, provides a "roadmap" for future planning, and is a tool to help the City meet federal, state, and regional regulations. It is intended for Bellevue residents, business owners, City staff, developers, and other interested parties. The plan does not include a comprehensive list of potential capital projects, although it does identify recommended capital investments. Capital projects are prioritized and funded separately in the City's seven-year capital investment plan, which is updated every two years as part of the City's budget process.

This Plan is an update of (and supersedes) the 1994 Comprehensive Drainage Plan. It is being updated now due to major changes that have occurred since 1994, including:

- Issuance of the Phase II municipal stormwater discharge permit (National Pollutant Discharge Elimination System) to the City of Bellevue (City) in 2007;
- City participation in regional efforts for salmon recovery, due to Chinook salmon being listed under the Endangered Species Act in 1999;
- Changing climate conditions;
- Emerging technology and practices;
- Adoption of Critical Area ordinances; and
- New City initiatives such as the Environmental Stewardship Initiative and updates to the City's Comprehensive Plan.

The specific Plan objectives include:

- Reviewing and updating operating system policies to ensure consistency and cohesiveness with
    - Other utility operations and management;
    - City Comprehensive Plan policies;
    - Relevant City regulations; and
    - Regulatory requirements.
- Refining the Mission Statement for Storm and Surface Water Management.
- Identifying water flow, water quality, and habitat management data gaps and developing tactics to address them.
- Developing Plan recommendations that will guide operations, system, and outreach/education improvements.

The City Council directed that the Environmental Services Commission (ESC) be the review body for this Plan. Opportunities for public review and input on the Plan components were provided at several ESC meetings in 2010 and 2011, and at a public open house on March 1, 2012. Further opportunities for public review and comment were provided through the State Environmental Protection Act (SEPA) process and during Council review and adoption of the Plan.

## Policies

Policies that govern the operation of the Storm and Surface Water Utility include policies that address Customer Service, Water Quality, Regional Issues, and Utilities Department Finance. Policies were updated by a Utilities Department team composed of technical and policy staff, and reviewed by the ESC and the public. The policies were reviewed for consistency with the City's Comprehensive Plan which contains elements (i.e. Utilities, Environmental and Capital Facilities) that are directly relevant to storm and surface water management.

This Plan includes the addition of one new policy and the deletion of four others. The remaining policies were not substantially modified, but rather revised for clarity or consistency with other City policies or regulatory requirements.

The new policy, **Encourage the Use of Low Impact Development Techniques Where Feasible,** reflects the evolution of stormwater management practices in the Northwest. This policy is intended to support and promote the implementation of low impact development (LID) techniques, because of the general recognition that LID techniques have a positive effect on the hydrologic balance in watersheds where they are used. The Storm and Surface Water Utility has a unique role in promoting the environmental benefits associated with LID techniques.

Four policies were deleted because they are either included in other programs or are now required by the City's Storm and Surface Water Code or Engineering Standards and no longer needed specific policy guidance. Deletion of these policies does not functionally change the services provided by the Storm and Surface Water Utility. The deleted policies are:

- Residential Drainage Assistance Policy;
- Neighborhood Enhancement Projects Policy;
- Stormwater Runoff Control Requirements Policy; and
- Property Restoration Policy.

## Planning Considerations

Bellevue's specific mission for stormwater management is

> *A surface water system that controls damage from storms, protects surface water quality, supports fish & wildlife habitat, and protects the environment.*

Stormwater management supports many elements of a highly desirable and productive community. Economic development and a stable economy depend on good infrastructure, including stormwater conveyance systems to allow open access, without flooding, to businesses and homes. Maintaining high quality streams and lakes supports safe human recreation opportunities, allowing swimming and fishing without health concerns. Given these economic, transportation, human health, and recreational benefits, everyone benefits from a strong stormwater management program whether they live near a stream or in an upland area.

Regulatory drivers, including local, state and federal regulations, and regional plans are some of the mechanisms used to promote stormwater management that results in high quality communities for the benefit of all. This Plan considered all of these factors in the development of system evaluation criteria and analysis, and resulting recommendations.

## System Analysis

Bellevue's current storm and surface water system was evaluated with respect to how well it achieves the stated mission for stormwater management, including flood protection, water quality and habitat. The system goals, planning criteria and evaluation metrics are shown in Table ES-1.

**Table ES-1. Planning criteria and evaluation metrics or indicators used to evaluate basins in terms of storm and surface water goals.**

| Goals | Planning Criteria | Evaluation Metrics |
|---|---|---|
| Control Damage from Storms | Minimize damage from the 100-year, 24-hour storm event | 1) Flooded structures during large storms<br>2) Number of flood damage claims<br>3) Number of street closures |
| Protect Surface Water Quality | Identify pollution "hot-spots" | 1) Percent compliance with NPDES Permit<br>2) Number of Clean Water Act Violations<br>3) Number of Illicit Discharge Corrections<br>4) Number of basins classified as Impaired under Clean Water Act Section 303(d)<br>5) Number of basins classified as a high risk for water quality problems |
| Support Fish and Wildlife Habitat | Improve stream habitat conditions and biotic integrity (B-IBI) scores | 1) Large woody debris frequency per channel width<br>2) Pool frequency per channel width<br>3) B-IBI score<br>4) Number of stream reaches with hardened banks |
| Protect the Environment | Incorporated above | Combination of all categories |

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Analysis confirmed that Bellevue does not have widespread flooding problems. However, there are certain areas within the City that have been subject to street closures, flood damage claims or flooded structures during large storm events.

The City is in 100 percent compliance with its Phase II NPDES Municipal Permit, and has had no fines for Clean Water Act violations during the permit period. One-hundred eighty-two illicit discharges were corrected in 2010-2011, the first year of the City's Illicit Discharge and Detection Elimination (IDDE) Program, and ten sub-basins were rated as high risk for potential illicit discharges based on land use, outfalls to streams, and fish usage. Seven different stream segments in five Bellevue drainage basins were rated as "impaired" in 2008 based on state criteria for water quality support of beneficial uses under the Clean Water Act. Streams were rated as impaired due to high fecal coliform bacteria counts, high water temperatures, and/or low dissolved oxygen; these affect their acceptability for human recreation (primary physical contact) and aquatic life support. These ratings are fairly typical for urban streams.

Most of Bellevue's streams have been included in habitat-related surveys for large woody debris, pool frequency and B-IBI scores. Typical of most urban streams in the Puget Sound basin, these habitat evaluation metrics have poor to fair ratings. Several in-stream restoration projects have occurred since some of the data described in this Plan was originally collected, so it is possible, that aquatic habitat conditions in some stream segments have improved.

The functionality of the storm and surface water system and how well it achieves the goals in the Utilities mission statement is dependent on management of the assets, operation and maintenance, financial considerations, and the behavior of the public. The Plan includes specific recommendations for the asset management program, the Storm and Surface Water Utility's appropriate role in support of other City departments and the region, as well for public education and outreach.

## Plan Recommendations

The recommendations in this Plan are grouped into two categories: Capital Investments and Storm and Surface Water Emerging Issues. A brief description of the recommendations is provided here, with more detail provided in the Plan.

### *Capital Investment Program*

The following investments are recommended for continuation or addition to the City's Capital Investment Program. These investments serve to minimize flooding, protect surface water quality and support fish and wildlife habitat while protecting the environment in Bellevue.

- Continue investing in the **Flood Control Capital Program** to reduce or eliminate local flooding caused by insufficient public drainage system capacity.
- Continue to use King County Flood Control Zone District Sub-Regional Opportunity funds to supplement local rates that partially fund projects in the **City's Flood Control Capital Program**.
- Invest in cost-effective water quality projects, where appropriate.
- Consider emerging technologies and techniques that improve water quality for pilot projects.
- Continue to invest in the **Fish Passage Improvement Program** to remove fish passage barriers created by impassable culverts, debris jams, or accumulated sediment, which opens spawning and rearing habitat for salmon populations.
- Continue to invest in the **Stream Channel Modification Program** to construct habitat improvements on stream channels.
- Invest in the **Stream Restoration for Mobility and Infrastructure Initiative** to implement the stormwater improvements associated with this initiative (a city-wide initiative that seeks to address high priority mobility and infrastructure needs in downtown Bellevue and the Bel-Red corridor).
- Continue to invest in the **Stormwater System Conveyance Infrastructure Rehabilitation Program** to rehabilitate or replace defective storm drainage pipelines and ditches identified in the condition assessment program or by other means.
- Replace the Coal Creek Parkway Culvert at Coal Creek, because recent inspections revealed the pipe is heavily corroded, with limited remaining structural integrity. This could be a potential threat to the integrity of Coal Creek Parkway and two high-pressure fuel pipelines that are located near the culvert.
- Continue to invest in **Minor (Small) Storm and Surface Water Capital Improvement Projects**, by making small improvements to Bellevue's surface water system to resolve deficiencies, improve efficiencies, or resolve maintenance problems, often in conjunction with other Bellevue programs such as the transportation overlay program.
- Continue to invest in capital programs and projects so that critical facilities (e.g., large diameter pipes and culverts) are repaired or replaced prior to failure.

## Storm and Surface Water Emerging Issues

The management of storm and surface water has changed significantly since 1994, when this Plan was last updated. To address these changes and be prepared for anticipated future changes, this Plan includes the following recommendations:

- Continue to encourage use of emerging low impact development (LID) technologies and collect data on their effectiveness.
- Continue to educate the public on how to optimize on-site stormwater runoff management.
- Monitor the effectiveness of structural and outreach programs over time.

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- Continue to support regional planning efforts and activities related to water quality, quantity, and habitat consistent with community values and resources.
- Continue to implement the planned NPDES activities described in the City's annual Stormwater Management Program report.
- Verify the state's list of water quality impairments in Bellevue (303(d) listed water bodies) to determine if existing programs will address identified water quality impairments.
- Continue to participate in and support the recommendations of the Regional Stormwater Work Group (SWG), which provide more meaningful and useful results, are less expensive to implement than traditional approaches, and meet multiple objectives such as Chinook salmon recovery or Growth Management Act directives.

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# CHAPTER 1 INTRODUCTION

## Plan Purpose

This Storm and Surface Water System Plan (Plan) is intended for Bellevue residents and business owners, City of Bellevue (City) staff, developers, and other interested parties. This Plan describes the storm and surface water system, management and operations of the system, and system needs and recommendations. However, this Plan does not include a comprehensive list of potential capital projects. Capital projects are prioritized and funded separately in the City's 7-year Capital Investment Plan, which is updated every 2 years by City Council.

This Storm and Surface Water System Plan is an update of the 1994 Comprehensive Drainage Plan. In the early days of the Storm and Surface Water Utility, Bellevue City Code required that the comprehensive drainage plan be updated every 5 years. In 1996, the code was changed, and current code requires the storm and surface water system plan be revised as needed (Storm and Surface Water Utility Code 24.06.045).

This update highlights changes to the manner in which the storm and surface water system has been managed since 1994, describes the current state of the storm and surface water system, and recommends future actions to adapt to changing conditions and regulations. Major changes since 1994 are summarized below.

- Stormwater management regulatory requirements have become more rigorous since the Washington State Department of Ecology (Ecology) issued a Phase II municipal stormwater discharge permit (National Pollutant Discharge Elimination System [NPDES]) to the City in 2007.
- The City participated in regional efforts, such as salmon recovery, due to Chinook salmon being listed under the Endangered Species Act in 1999.
- Climate forecasts indicate changing climatic conditions that are still uncertain, but planning is needed to ensure the City can continue to operate a storm and surface water system that protects public health and safety, protects the environment, and remains affordable.
- New City programs, such as the Environmental Stewardship Initiative and updates to the City's Comprehensive Plan, emphasize some aspects of storm and surface water management, such as low impact development.

The framework for the management of the storm and surface water system and changes since 1994 are described in more detail in Chapter 3 Community Vision and Regulatory Framework.

## Guidelines for Current Plan Update

This Plan is an update of (and supersedes) the 1994 Comprehensive Drainage Plan. The objectives for this update include:

- Refine the Community Vision for Storm and Surface Water Management, published most recently in the Utilities Strategic Plan (Bellevue Utilities 2011) for clarity of purpose.
- Review and update operating system policies to ensure consistency and cohesiveness with
    - Other utility operations and management;
    - City Comprehensive Plan policies;
    - Relevant City regulations, including the Critical Areas Ordinance; and
    - Bellevue initiatives such as the Environmental Stewardship and Green Infrastructure initiatives.

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- Review the regulatory requirements, including but not limited to the City's NPDES Municipal Stormwater Permit, the Clean Water Act, and the Endangered Species Act.
- Identify water flow, water quality, and habitat management data gaps and develop tactics to address them.
- Develop a set of plan recommendations that guide operations, system, and outreach/education improvements.

## How this Plan was Completed

This Plan is intended to provide strategic direction for effectively managing stormwater facilities, streams, and lakes into the future. The following planning principles, developed by staff while scoping the project, guided this update:

- Promote a healthy environment, public safety, and a strong economy, which are essential to maintaining the City's and region's quality of life;
- Steward the City's stormwater system to protect water quality and provide sustainable urban habitat;
- Strive to minimize flooding and reduce damage from storms;
- Align with federal, state, and regional regulations;
- Align with authority granted to the Utilities Department by the Bellevue City Code;
- Ensure consistency with the City's Comprehensive Plan;
- Integrate stormwater management efforts with city-wide initiatives, such as the Environmental Stewardship Initiative and the Bel-Red Corridor Plan; and
- Ensure reasonable and prudent fiscal policies on behalf of ratepayers.

General stormwater policies were developed or revised by experts in the policy subject matter. Prior to adoption by the City Council, policies were reviewed by Utilities Department's managers, directors, and other City departments including the City's Legal Department. The Environmental Services Commission (ESC) then reviewed proposed policies over several months, inviting public comments at each of their meetings. Plan chapters were drafted by subject experts, then reviewed by the Utilities Department's managers, directors, and other City departments. As the Plan developed, major elements, such as the evaluation criteria and plan recommendations, were submitted to the ESC prior to preparing the draft document. The ESC reviewed the entire Plan and made a recommendation to the City Council for adoption of the Plan.

***Public Input***

In 2009, the Bellevue City Council established the ESC as the public review body for the Storm and Surface Water System Plan update process. Staff provided introductory information to the ESC, with opportunity for public input, in July and October 2010. Beginning in December 2010, as items of substance were introduced, specific public announcements were released before each ESC meeting where the Plan update issues were discussed. On March 1, 2011, staff hosted an open house inviting the public's comments on the Plan. The Washington State Environmental Policy Act (SEPA) process provided an additional opportunity for the public to comment on the Plan prior to submittal to the City Council. Further opportunities for public comment were available during the City Council's review and adoption of the Plan.

## Bellevue Storm and Surface Water System, General Information

The city of Bellevue is located in King County, Western Washington, and is part of the Puget Sound lowlands. The city is in the Lake Washington/Cedar River Watershed, and all storm and surface water

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originating in Bellevue eventually drains to Puget Sound via Lake Washington, the Lake Washington Ship Canal, Lake Union, and the Hiram M. Chittenden Locks (Ballard Locks). City drainage areas have been divided into 26 small drainage basins (Figure 1-1). Seventeen of these basins drain into Lake Washington, and nine drain towards Lake Sammamish. Some of the basins are only partially contained within city limits. The storm and surface water system is described in more detail in Chapter 6 Current Conditions—State of the Storm and Surface Water System.

The city of Bellevue's population in 2010 was 122,363 according to the U.S. Census. The Utilities Department had 30,681 storm accounts as of March 2011.

The Utilities Department may be contacted as follows:

City of Bellevue

Utilities Department

450 - 110th Avenue NE

Bellevue, WA 98009-9012

(425) 452-6800 (general information)

(425) 452-7840 (24-hour emergency number for reporting problems)

http://www.bellevuewa.gov/utilities.htm

## Bellevue Storm and Surface Water History

The City of Bellevue was incorporated in 1953. Citizens of Bellevue have a long history of keen interest in their streams, wetlands, and open spaces. Concerns about the impact of increasing urbanization on city water resources led to the formation of the Citizen's Advisory Committee on Stream Resources in 1970. With the aid of a consultant, this group prepared a set of recommendations dealing with streamside development and requirements for surface water drainage related to streams.

Prior to 1970, the City had relied on the traditional approach to stormwater management typical in the Puget Sound region. This approach was to treat storm runoff as a nuisance to be eliminated as quickly as possible. Public roads and private property were drained to the nearest watercourse, which often had to be dredged, armored against erosion, and lined or piped to mitigate impacts of increased flows. Those impacts often included flooding, erosion, and other forms of property damage, as well as a deterioration of water quality. Consequently, natural streams, wetlands, and open spaces were permanently lost to human use and enjoyment. Fisheries and wildlife habitats were also destroyed. Drainage planning was rarely coordinated between or within government agencies.

By 1970 the problems associated with urbanization had already become apparent in Bellevue. A series of studies on Kelsey Creek stream ecology, started in 1971 by the University of Washington, showed that while the system was generally in "good" condition, profound changes were beginning to occur (Comis et al. 1971). The study concluded that "…the present management mentality for engineering the fastest storm runoff collection and discharge from the point of interception is in error." It was determined that costs for solving these problems would be high, and that a funding source committed to stormwater management would be needed. It was also apparent that an agency was needed to take responsibility for all aspects of stormwater management within the City.

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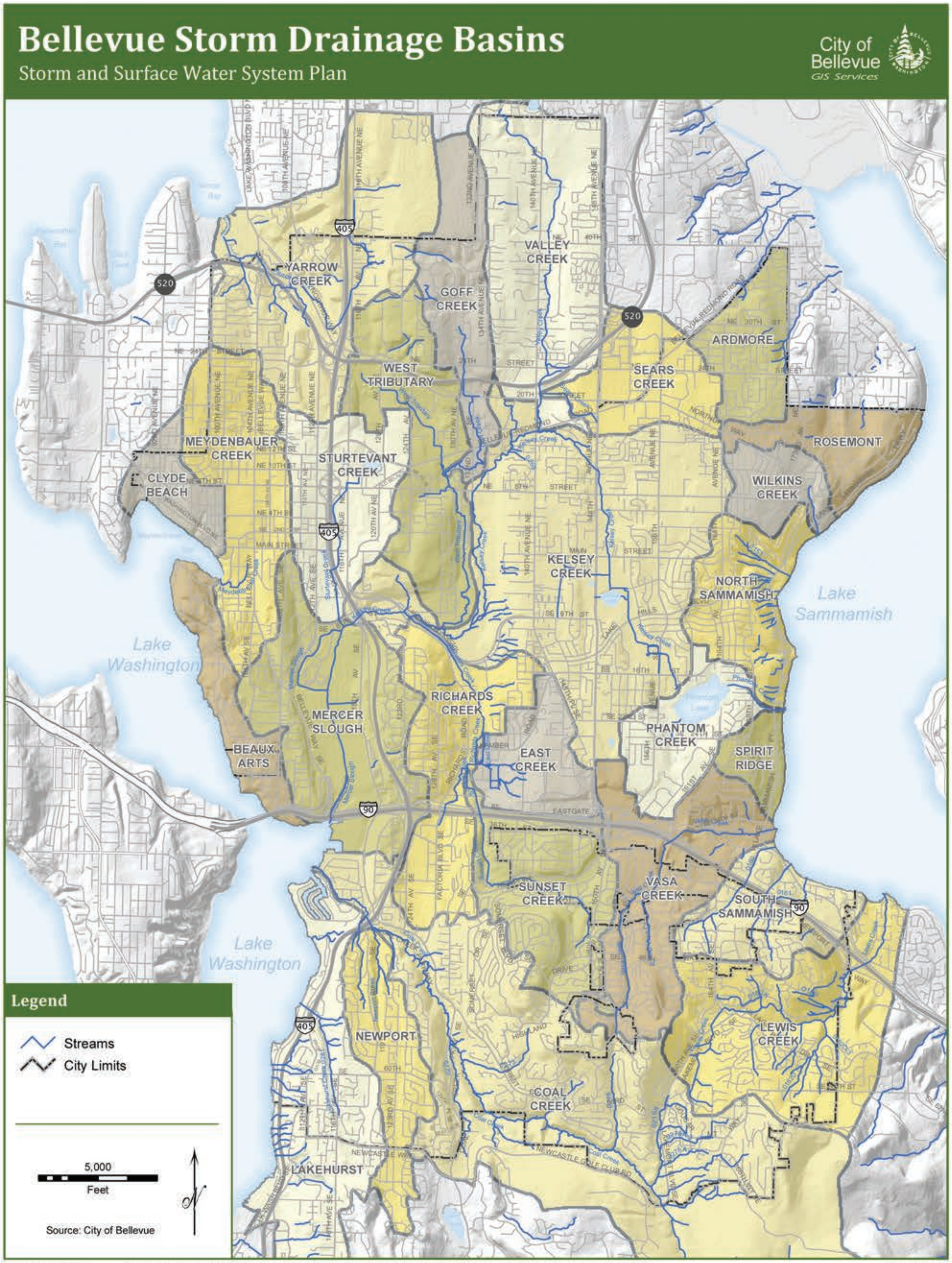


Plot Date: 9/2/2011 File Name: V:\utpl\ArcGIS\Storm\UtilCompPlan_2010\ArcGIS\Bellevue_Location_and_Storm_Drainage_Basins.mxd IT Department

**Figure 1-1. Location of the city of Bellevue and the 26 storm drainage basins.**

**Note that some basins are located partially outside city limits**

During this period, Bellevue's community leaders recognized that innovative planning and funding solutions would be needed to deal with the impacts of future urbanization. In 1967 the State Legislature had amended the state law (Cities RCW 35.67 and Counties RCW 36.94) to include storm drainage as a utility function along with such traditional areas as water supply and sanitary sewerage. This action was seen as a means to obtain a dedicated revenue source to accomplish the community's goals of preserving natural streams and water resources.

The Bellevue City Council formed the Storm and Surface Water Utility (Utility) in the spring of 1974 (Ordinance 2003). At that time, a consulting team was formed to investigate funding alternatives. They recommended a service charge to each property based on runoff rate. Funds received from this source would be used for maintenance and operation of the existing system and capital improvement projects needed to reduce flooding and erosion within the city. This approach was considered innovative at the time, and was looked upon as a model for other agencies across the nation seeking alternative financing sources for stormwater management.

Despite considerable effort to involve the citizens in formation of the Utility, the first service charge bills raised many questions. In response to a petition from area residents, a Storm Drainage Utility Task Force was set up to study past decisions and recommend future actions for the Utility. The primary recommendations from the Task Force were:

1. All actions taken by the Utility in the future should be based on a comprehensive system plan.
2. Maximum use should be made of the existing natural, open drainage system.
3. Surface water control requirements should be strengthened to protect those streams.
4. The Utility should consider alternative financing schemes for capital improvements and put these alternatives before the electorate in an advisory ballot.
5. The existing Utility service charge should be used to cover startup costs, maintenance, and operations but not long-term capital improvements.
6. The Utility should act to improve water quality as well as to control flooding and property damage.

In a study considered to be a departure from traditional drainage system master plans, the consulting team of Kramer, Chin & Mayo – Water Resources Engineers/Yoder, Trotter, Orlob & Associates (KCM-WRE/YTO) prepared the City's original Drainage Master Plan in order to mitigate impacts from past development (KCM-WRE/YTO 1976). This plan listed projects to construct, identified properties to be acquired for project construction, and provided preliminary budget estimates for the construction program. In addition to traditional drainage concerns, the consulting team considered alternative drainage control methods, aesthetics, water quality, and system reliability factors in evaluating alternative improvement schemes. The 1976 Drainage Master Plan recommended combining on-site stormwater controls with regional flood control facilities that maximized the use of existing open channel drainage systems (i.e., keep streams rather than building a pipe network for the streams). This plan recommended 1) a capital improvement program to improve conveyance capacity such that the system could safely convey the existing (early 1970s) 10-year flow rate without causing damage, and 2) that increased flows due to future development would be addressed by regulations. The plan also identified a phased approach for constructing regional flood control detention ponds. The first phase was to obtain land for the regional flood control ponds, construct minor control structures, and conduct stream improvements so that the ponds could function properly. The second phase was a long-range plan to construct the regional flood control ponds and other pipe and channel improvements, and eventually enlarge the ponds to achieve the goals identified in the 1976 Drainage Master Plan.

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Concurrent with the work involved with the 1976 Drainage Master Plan, the City established a council-appointed, citizen's Storm and Surface Water Advisory Commission charged with providing the following:

1. Short-term and long-range storm and surface water planning;
2. Annual storm and surface water management budget;
3. Storm and surface water rate structures;
4. Storm and surface water bond proposals;
5. Major property development proposals, and major land use changes directly related to storm and surface water management;
6. Storm and surface water management-related ordinances and resolutions; and
7. City of Bellevue policies related to storm and surface water control.

The City conducted an alternatives analysis of the Drainage Master Plan recommendations and updated the work done by the original consulting team. The City Council formally adopted the plan on December 14, 1979, provided that voters approved funding for project construction. The capital improvement program adopted with this plan continued the two-phased approach. Phase 1 was estimated to cost $8,395,000 and Phase 2, $22,030,000 in 1979 dollars.

Cost for the first phase was projected over the first 5 years at $10 million. The budget was approved with over 60 percent of the vote in 1980. The major portions of the plan were completed between 1981 and 1984. Approximately 70 acres of wetlands and riparian areas were acquired to construct projects. Eight regional flood control facilities and 13,000 linear feet of pipeline were constructed. In 1983, the Utility's Department capital projects were incorporated into the City's first overall Capital Improvement Program plan. A separate drainage basin plan was prepared for the Meydenbauer Creek basin in 1980, recommending direct discharge to Lake Washington in this intensely developed area; the 1976 Drainage Master Plan was subsequently amended. Some of the projects recommended in the 1976 Drainage Master Plan, including the second phase of the regional detention pond network, were not constructed due to improved conditions.

Between 1984 and 1987, over 50 public meetings were held between citizens and City officials concerning the City's Natural Determinants policies and regulations. The Natural Determinants policies and regulations were the City's first set of regulations that protected sensitive natural areas. On April 30, 1985, the City Council adopted an update to the Natural Determinants Element of the Comprehensive Plan (Resolution No. 4541). The stated goals of this amendment were to provide for the preservation and enhancement of water, earth, and vegetation resources. In April 1987, Natural Determinants regulations were adopted with the establishment of the Sensitive Area Overlay District (now called the Critical Areas Overlay District) Section 20.25H of the Land Use Code (Ordinance 3775) and amendments to the Clearing and Grading Code (Ordinance 3776). The City's Design and Development Department and the Storm and Surface Water Utility were initially given joint authority over the Sensitive Area regulations in the Land Use Code.

In 1985, the consulting firm of Brown and Caldwell was retained to update the 1976 Drainage Master Plan. The resulting 1988 Comprehensive Drainage Plan update included 14 new Utility operating policies, a new stormwater rate structure, and goals listed within the Natural Determinants Element of the City's Comprehensive Plan pertaining to protecting or improving water quality, system capacity, fish, aquatic and riparian habitat, and wetlands. This 1988 update also included potential capital projects with predesign reports, and a utility rate study (City of Bellevue 1988). The environmental impact statement and budget were prepared separately as part of the city-wide Capital Investment Program.

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On January 18, 1986, an intense storm hit the central Puget Sound area. Over 4 inches of rain fell in 24 hours, causing damage of over $1 million in unanticipated costs to the Utility. As a result of this storm, the Apple Valley ravine stabilization and Bel-Red Road streambank stabilization projects were constructed on an emergency basis. The Newport Shores Berm project was accelerated to construction in 1987. In addition, ten projects were added to the capital project list.

In early 1988, following extensive work by the Storm and Surface Water Advisory Commission, Bellevue City Council and King County Metro adopted the Coal Creek Basin Plan and its attendant Interlocal Agreement. This landmark agreement called for strict erosion and stormwater controls on new development in the Coal Creek basin, outlined joint funding responsibilities for approximately $7 million worth of flood control and sedimentation control facilities, and prescribed means to enhance salmon spawning habitat in Coal Creek.

In January 1990, the city of Bellevue received 3.02 inches of rainfall in a 24-hour storm event. This amount of rainfall had a probability of occurring once in 15 years. However, due to very wet conditions prior to the rain, the runoff volumes approached a 100-year flow event. In contrast to the 1986 storm, very little damage occurred. The drainage improvements constructed following the previous storm were instrumental in preventing damage in 1990.

In June 1991, the City Council voted to create a new council-appointed citizen's advisory commission, the ESC, to replace the Storm and Surface Water Advisory Commission. The ESC assists the City Council in establishing City policy and rates regarding water, sewer and solid waste functions, as well as storm and surface water services.

In 1993, the Storm and Surface Water Utility was combined with other City department utilities into a comprehensive Utilities Department. With this City reorganization, most of the authority over the Critical Area regulations and clearing and grading development regulations were transferred to the City department responsible for Land Use and Development Approvals. The Utilities Department was assigned the responsibility of managing drinking water, wastewater, surface water, and solid waste. The storm and surface water functions of the Utilities Department included flood control, maintenance and enhancement of surface water quality, protection of critical areas, and public education.

The 1988 Comprehensive Drainage Plan was updated in 1994. The 1994 plan updated storm and surface water general policies and provided a list of potential capital projects. This 2012 Plan update supersedes the 1994 plan. Drivers for the 2012 update are detailed in Chapter 2 Stormwater Management Challenges and Opportunities, and Chapter 3 Community Vision and Regulatory Framework.

# CHAPTER 2 STORMWATER MANAGEMENT CHALLENGES AND OPPORTUNITIES

The concept of stormwater management has evolved over time as the city of Bellevue has developed and as issues associated with runoff have changed. This chapter describes the history of Bellevue's stormwater management, and highlights the challenges and opportunities that lie ahead.

## Nature of Stormwater

Stormwater is a term that describes water that falls as rain or snow and then either infiltrates into the ground or flows across the land surface or through a conveyance system (constructed pipes or ditches), until it reaches a receiving water body (lakes, streams, wetlands). Stormwater is both a resource and a nuisance. It provides flow to streams, lakes, and wetlands, and replenishes groundwater supplies. It also collects and transports pollutants from the surfaces it flows across and deposits them in streams, lakes, and other water bodies. Stormwater also contributes to flooding and streambank erosion when flows are large or prolonged.

Stormwater is everywhere, following the topography from high points to low, and crossing jurisdictional boundaries and property boundaries. Stormwater flows from one property owner to the next and each owner bears the responsibility to receive and convey stormwater across their property downstream to the next. Property owners take different approaches to managing the runoff, and stormwater management philosophies and techniques have changed over time. Today's stormwater system reflects these various management approaches. It is a combination of open infrastructure such as ditches and streams, and closed infrastructure that largely consists of collection points (catch basins), conveyance pipes, and culverts under driveways and roads. Since the 1970s, many best management practices (BMPs) have been used either as a single technique or in combination to address problems related to stormwater, including flooding, pollution, and erosion. While there are options available to manage stormwater (i.e., pollutant source control, runoff treatment, and maintenance of conveyance systems), some elements are beyond the City's control, including the timing, duration, and magnitude of rainfall or the air deposition of pollutants, such as mercury.

## History of Stormwater Management

Management of stormwater is a relatively recent concept. The Bellevue Storm and Surface Water Utility was the first fully operational stormwater utility in the nation, established only 36 years ago. Bellevue was incorporated in 1953 (population 6,000), more than a decade *after* the construction of the I-90 floating bridge (1940), and a decade *before* the completion of the SR 520 floating bridge (1963). During this period, Bellevue's population grew from 6,000 to over 14,000. By the time the Storm and Surface Water Utility formed in 1974, the city's population was 63,940. At that point, 38 percent of the area within the present city boundaries, which includes areas that would later be annexed, was already developed.

As described in Chapter 1, the original focus of the Storm and Surface Water Utility was to provide control of stormwater to reduce flooding, erosion, and property damage; prevent the deterioration of water quality; and construct regional detention ponds to remediate previous development. Streams, lakes, and wetlands were to be used as integral parts of the stormwater system. Some of the major drivers and events for stormwater management in Bellevue are illustrated in Figure 2-1.

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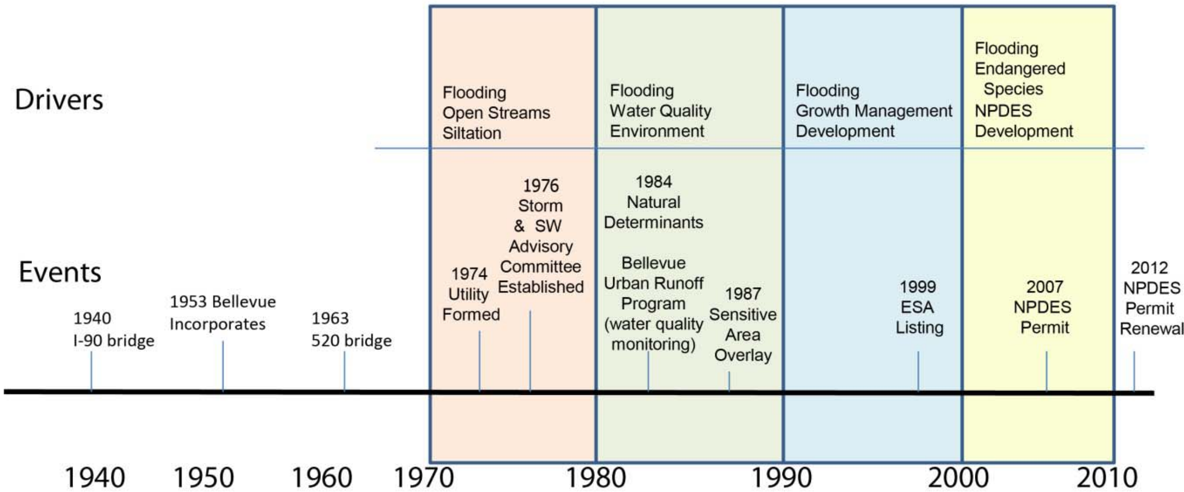


**Figure 2-1. Timeline of stormwater-related drivers and events**

Figure 2-1 shows the chronology of a few key activities affecting stormwater management. These actions included:

- 1974–Storm and Surface Water Utility formed. Established local funding mechanism for stormwater management.
- 1977, 1981, 1988, 2008–Voters approved parks bond measures. Allowed purchase of open space and natural areas, protecting forest cover, wetlands, lakes, and streams.
- 1979–Drainage Master Plan, a city-wide assessment of flows and potential flooding concerns that included a phased approach to capital projects, was adopted by the City Council.
- 1984–Original Storm and Surface Water Utility Phase 1 land purchase and regional pond construction was completed. Acquired significant areas of wetlands and constructed additional stream flow storage to remediate runoff from previous development to reduce flooding and erosion.
- 1984, 1995–Bellevue participated in national urban runoff program and then conducted second monitoring assessment to detect changes. Provided scientific characterization of pollutant levels running off urban development. Identified target pollutants for local education and remediation efforts.
- 1987–First Sensitive Areas regulations established. Provided regulatory protection for streams, floodplains, wetlands, and steep slopes, as development occurred.
- 1995–Regional Needs Assessment was approved. Established a regional funding approach to large river flooding, water quality issues in shared water bodies, and salmon recovery.
- 2007–Bellevue was issued a Phase II municipal stormwater permit under the National Pollutant Discharge Elimination System (NPDES). Established city-wide requirements for pollution prevention under the Clean Water Act.

A large portion of the city had been developed prior to the formation of the Storm and Surface Water Utility and the application of storm and surface water regulations, which have evolved over time (Figure 2-2). As shown in Figure 2-2, 84 percent of the city has been developed. The undeveloped area comprises 16 percent, which consists of parks and open spaces that are not anticipated to be developed; only 6 percent of the city is vacant land that is likely to be developed. Therefore, today's stormwater regulations will mostly be employed during redevelopment of existing properties. Originally, flood control and sedimentation were the primary issues, so strategies were employed to manage peak flows.

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The construction of the regional detention facilities by 1984 remediated smaller storm event flows in some areas that had been developed before the establishment of regulations (as illustrated in the brown-colored columns in Figure 2-2).

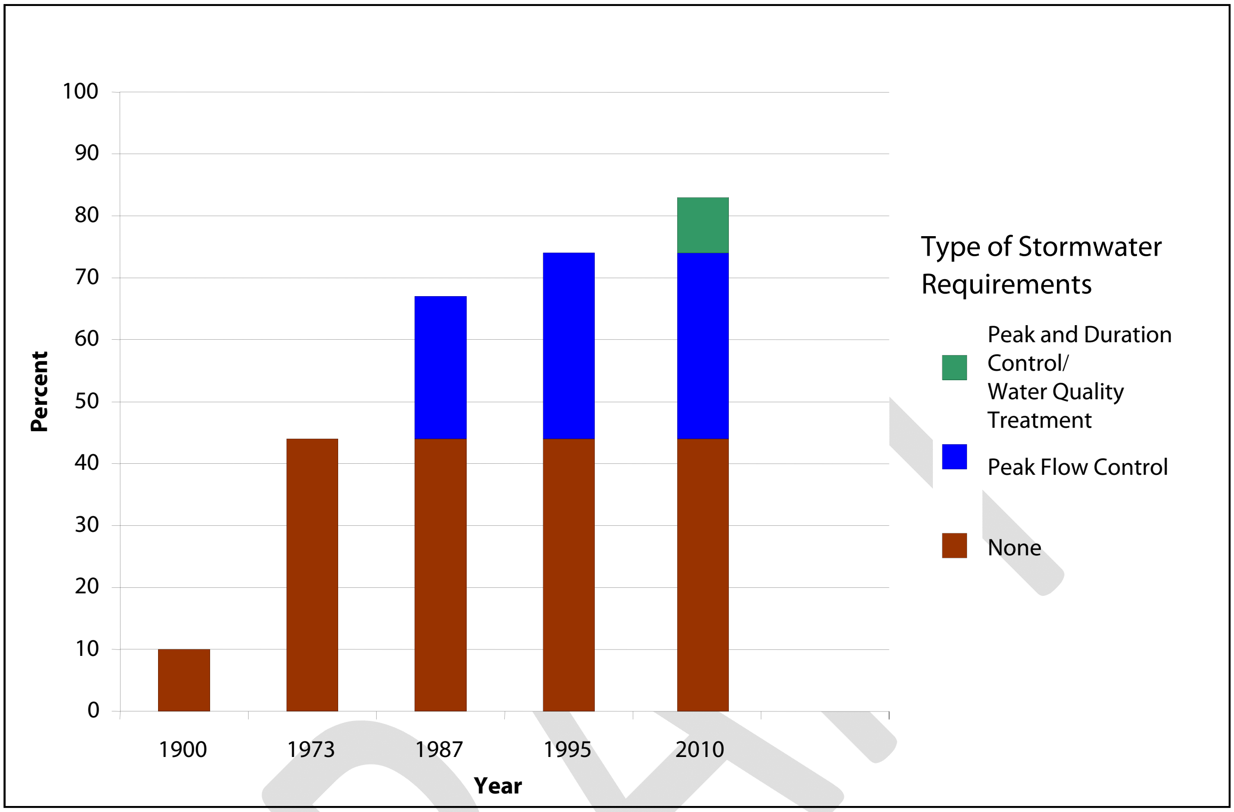


**Figure 2-2. Percent of city developed vs. type of stormwater requirements**

Over time, it was recognized that efforts to manage flow *durations* were also needed to address runoff impacts on aquatic habitat. Water quality became a more central focus in the early 1980s and again in the early 1990s. When Puget Sound Chinook salmon were listed under the Endangered Species Act (ESA) in 1999, habitat received an even greater emphasis, leading to the development of procedures for regional road maintenance and stormwater management, as well as BMPs that comply with Section 4(d) of the ESA. Integrated on-site water systems that manage and more fully utilize groundwater, surface water, and wastewater are emerging as next-generation stormwater management techniques.

Advances in stormwater management have historically been driven by and/or supported by the citizens of Bellevue. In a recent budget survey, 9 out of 10 respondents agree that careful and balanced stewardship of our natural environmental resources will result in long-term improvement in the quality of life in Bellevue (City of Bellevue 2010 Performance Measures Survey, June 2010).

## Current Challenges

A number of stormwater management challenges currently face Bellevue in the context of increased growth and environmental protection. The Washington State Growth Management Act (GMA) requires the City to encourage and accommodate growth and density while maintaining environmental protection—a task not easily achieved. As illustrated in Figure 2-2, much of the city was built prior to modern stormwater standards.  Bringing these areas up to the more protective standards would require extensive retrofitting, which is difficult and expensive in highly urban settings.  While stormwater improvements will occur as redevelopment progresses, it will take decades to realize the resulting stormwater benefits.

As the field of stormwater management has evolved, approaches have migrated from end-of-pipe solutions to more holistic, programmatic approaches.  This evolution challenges the Bellevue Utilities Department to merge the old systems with the new practices, from both systematic and programmatic standpoints.  Examples of new approaches include restoration of ecological processes and basin management.  For instance, rather than fixing specific habitat features, such as constructing pools in a stream reach where they are lacking, the preferred approach is restoring ecological processes that create and sustain habitat features.  This approach requires addressing historical stormwater runoff and management actions that have concentrated or otherwise changed flows.  Given that stormwater managers have limited influence over land use development and limited opportunities for stormwater restoration in highly urbanized areas, the new approaches pose significant implementation challenges. Today's basin management approach for stormwater maintenance activities means that stormwater is managed by land geography, rather than by roadways or grid systems.  This approach often results in a more comprehensive view of basin-specific problems, with the understanding that solutions will vary according to basin-specific conditions (natural, constructed, and social).  This approach allows for better targeting of problem areas, although it may not be as simple as the historical practices of following the roadways and maintaining any facilities that are encountered.

As was noted in the Nature of Stormwater section, much of the management of stormwater is outside the authority and control of the Storm and Surface Water Utility.  Many of the pollutants entering the stormwater system are from non-point pollution, such as heavy metals from automotive brake linings, pesticides, or pet wastes.  Some pollutants come from natural sources.  Phosphorus (a nutrient that can increase algae growth in streams and lakes) and arsenic are found in soils in Bellevue and can leach into waters through streambank erosion.  Some bacteria come from wildlife, such as geese or ducks.  Current technologies offer only limited ability to remove pollutants once they have entered the system. Educational programs that focus on behavioral changes and source control methods are often the best tools to address these concerns.

As with any public agency, budgetary and staffing resources within the City of Bellevue and the Utilities Department are limited by fiscal resources, primarily stormwater utility rate revenue.  Increasing demands and regulations typically come without commensurate funding, so adapting to new management needs can be challenging and often requires significant time to fully implement.

## Future Challenges and Opportunities

Emerging stormwater management advances provide great opportunities for positive improvements for Bellevue's citizens and the environment, even as we face significant challenges.

Primary challenges include aging infrastructure, reduced forest cover, and global climate change.  Global climate change represents the greatest amount of uncertainty and thus is the most difficult for which to plan.  There is potential for changes in the intensity and timing of rain events, which could lead to increased winter flooding magnitude and frequency, summer drought, and changes to receiving water biology and chemistry (U.S. Global Research Program 2009; Water Environment Research Foundation 2009).  Potential stormwater management modifications to address these issues include changes to 1) system maintenance requirements (need, frequency, and schedule), 2) design standards to provide adequate protection for changed conditions, and 3) regulatory and operational response to flooding and other storm-related emergencies.  Global climate change could add complexity for meeting water

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quality standards and recovering salmon populations, particularly if summers are warmer and drier, increasing water temperatures and changing the chemical balance in receiving waters.

Between 1974 and 1996 areas of high tree cover (>50 percent tree cover) decreased by 37 percent in the Puget Sound area (American Forests 1998). Bellevue tree canopy declined 20 percent between 1986 and 2006 (American Forests 2008). If this trend continues, it will create even greater stormwater management challenges because mature forests and tree canopy intercept and absorb stormwater runoff.

Constructed infrastructure will become more of a challenge as it ages, requiring more frequent maintenance and eventual replacement. The drainage system assets such as pipelines, catch basins, etc. are relatively new with an average estimated age of approximately 35 years as of 2010. Although most assets are in good condition, some assets such as corrugated metal steel pipelines are reaching the end of their useful lives and have been replaced or will need replacement in the near future. Additionally, even infrastructure that has years left on its design life can become functionally obsolete if it does not meet current or future capacity needs. The opportunities for positive improvements in the face of these challenges include new technologies and attitudes, as well as an updated Storm and Surface Water System Plan.

Low impact development (LID) is a stormwater management approach that preserves and restores natural hydrologic processes through appropriate site design, runoff control, and natural water quality treatment techniques. LID has the potential to reverse or minimize stormwater challenges through preservation and restoration of forests and vegetation for stormwater management, and treatment of stormwater closer to the source so that conventional infrastructure does not need to be upsized to meet higher capacity requirements. LID, however, has known limitations and is not appropriate for all sites. Many LID techniques rely on infiltration, which has the potential for unforeseen consequences as it is applied on a greater scale. Some of the concerns raised about LID techniques include the potential for increased landslides in unstable areas, basement or crawlspace flooding, migration of groundwater contaminants, increased maintenance costs, and the long-term viability of small, dispersed facilities, such as rain gardens.

A new class of pollutants has emerged as a potential threat to aquatic and human health over the last decade. Pharmaceuticals (usually from wastewater systems) and endocrine disrupters (found in some pesticides or other products applied to the landscape) are increasingly being detected in receiving water bodies. Effective pollutant removal technologies are not yet available. Even so, within the next decade, it is likely that stormwater managers will be implementing new best management practices to address these emerging concerns.

As knowledge about stormwater impacts increases and more is understood about runoff quality effects on aquatic and human health, there will likely be a call for new and stricter regulations, including stormwater effluent limitations and more restrictive water quality standards. Effluent limitations may spur treatment improvements; however, they may focus attention on individual parameters rather than more holistic approaches to stormwater problems.

Stormwater has been identified by the Puget Sound Partnership as a primary pressure impacting the health of Puget Sound. The Puget Sound Partnership is a community effort of citizens, governments, tribes, scientists, and businesses working together to restore and protect Puget Sound. The Puget Sound Partnership was tasked with creating an Action Agenda to clean up Puget Sound by 2020. The Legislature intends that all government entities within Puget Sound will exercise their existing authority to implement the applicable provisions of the Action Agenda (RCW 90.71.350). The major focal areas for the Action Agenda are land development, shoreline alteration, runoff from the built environment

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(stormwater), wastewater, and loss of floodplain function. Efforts to reduce the impact of stormwater have already increased regulatory requirements. It is likely that additional changes to strengthen water quality standards, environmental guidelines, retrofit of existing facilities, and other processes will be made to reduce stormwater impacts.

New attitudes about sustainability are transforming views of stormwater as a resource, not a problem. Integrated on-site water management, such as LID, is an example of this paradigm shift to a more holistic approach. Another example is rainwater harvesting, where roof runoff is harvested for beneficial uses, rather than contributing to increased stormwater flows.

This Storm and Surface Water System Plan provides an opportunity to integrate these issues, provide recommendations to prepare for future challenges, and make a positive difference for flood control, water quality, and aquatic habitat in Bellevue.

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# CHAPTER 3 COMMUNITY VISION AND REGULATORY FRAMEWORK

The Utilities Department's management of stormwater is guided by the vision of the Bellevue community and the regulatory framework imposed by federal, state, and municipal regulations and requirements. This chapter builds upon the earlier discussion of the nature of stormwater and its unique challenges in Chapter 2 by introducing the legal context and regulatory drivers under which stormwater is managed. These chapters will provide the background to foster a greater understanding of the Utilities Department's approach to stormwater management.

## Goals for Stormwater Management (Vision/Mission)

The City of Bellevue Comprehensive Plan contains a community vision projected to 2025 (http://www.bellevuewa.gov/pdf/PCD/CompPlan_Vol_1_01.Introduction.pdf [pp. 14-20]) reflecting the desire for a healthy environment for people and wildlife, a strong economy of diverse people and businesses, a safe and secure community with outstanding facilities and services, a center for culture and arts, an active and engaged community, a city that meets housing and transportation needs, and a city role in regional leadership. Within that overall vision of dedicated environmental stewardship, excellent stormwater management is required, among other land use and management activities, to achieve the Comprehensive Plan's vision.

> *Growth is occurring without harm to environmentally sensitive land and water resources. Many wetlands, riparian corridors and shorelines are protected in their natural state; others are being restored so they provide higher quality fish and wildlife habitat. As a result, more salmon are found in local creeks and streams, fish are spawning in several locations.*

The Bellevue Utilities Department Mission Statement is

> **Bellevue Utilities delivers exceptional services for our community.**
>
> *Working together to actively support neighborhood livability, a healthy, sustainable economy, and the environment by effectively managing:*
>
> - *Drinking water*
> - *Wastewater*
> - *Surface water*
> - *Solid waste*
> - *Street, walkway and bikeway maintenance*

In addition, the specific mission for stormwater management is

> *A surface water system that controls damage from storms, protects surface water quality, supports fish & wildlife habitat, and protects the environment.*

Stormwater management supports many elements of a highly desirable and productive community. Economic development and a stable economy depend on good infrastructure, including stormwater conveyance systems to allow open access, without flooding, to businesses and homes. Maintaining high quality streams and lakes supports safe human recreation opportunities, allowing swimming and fishing without health concerns. Given these economic, transportation, human health, and recreational benefits, everyone benefits from a strong stormwater management program whether they live near a stream or in an upland area.

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## Regulatory Drivers

Bellevue's management of stormwater is guided and constrained by a number of regulatory drivers that have their basis in federal, state, county, and municipal regulations and laws. These regulations establish both lower and upper bounds on the quantities and pollutants that can be discharged from the collection and conveyance system, as well as determining the development capacities and where development may occur. These regulatory drivers often identify and stipulate specific roles and requirements for the involved jurisdictions (state, county, and city) as well as for private landowners (see below for specific details and an overall summary in Table 3-1).

### *Clean Water Act*

The basis for many of the environmental programs and regulations within which Bellevue's stormwater management program operates is the Clean Water Act (Table 3-1). This federal regulation allows the U.S. Environmental Protection Agency (USEPA) to authorize state agencies to administer the regulations and conditions of this act. As such, the local role of the Clean Water Act is largely programmatic and not site-specific. As part of the authorization process, USEPA sets minimum requirements and guidelines for water quality but allow states to enact stricter standards that exceed the USEPA minimum requirements.

In addition to the Clean Water Act, the Washington State Legislature has enacted its own water quality legislation in the Washington Water Pollution Control Act (Revised Code of Washington [RCW] Chapter 90.48). The National Pollutant Discharge Elimination System (NPDES) permit program includes the State Waste Discharge Permits based on this regulation that limit pollution from industry, municipal governments, construction, and other activities. These federal and state legislations have led to the development of numerous regulations, standards, and designations that directly influence, guide, and constrain the management of stormwater in Bellevue, and in some cases require permits. Specifically, these are as follows:

- Water quality standards;
- Discharge of pollutants from point sources (NPDES permits);
- Freshwater-designated uses;
- Assessments of impaired waterways (the 303[d] list);
- Total Maximum Daily Load (TMDL) assessment;
- Wetlands filling and stream lake dredging (Section 404 permits); and
- Landfill closures.

The applicable water quality standards for Bellevue stormwater, and surface water features are administered by the Washington State Department of Ecology (Ecology), which publishes numerical standards for freshwater in streams and lakes. Ecology also has nutrient standards for lakes (applicable to Phantom Lake, Lake Washington, and Lake Sammamish). In addition to these specific numeric criteria for discharges to surface waters, Ecology recently developed and published designated uses for specific water bodies in Washington State. These designations are intended for the specific protection of human and aquatic life uses (in many cases, the protection of habitat characteristics required by salmon species). These are monitored and managed locally by the Seattle-King County Public Health Department.

The primary mechanism employed by the state for administering these water quality standards is the issuance of general and individual permits, as part of the NPDES permit program. These permits put specific conditions on public and private parties that discharge any water, whether domestic sewage, industrial process water, or stormwater, to the public waterways. This program allows for many enforcement measures, including fines and prison sentences for willful violation of permit conditions and state water quality regulations.

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**Table 3-1. Regulatory framework of surface water management in the city of Bellevue**

| Law | Implementing Entity | Regulatory Programs | Intent and Specifics | Relevance to Bellevue |
|---|---|---|---|---|
| | U.S. Army Corps of Engineers (USACE) | Section 404 | Regulates the discharge of dredged, excavated, or fill material in wetlands, streams, rivers, and other U.S. waters. | All work requiring the removal or addition of material to a stream, lake, or wetland must comply with these regulations. |
| Clean Water Act | Washington State Department of Ecology (Ecology) | National Pollutant Discharge Elimination System (NPDES) Phase II Municipal Separate Storm Sewer System Permit | Eliminate discharge of pollutants to the maximum extent practicable into the nation's water, and achieve water quality levels that are protective of beneficial uses. | Bellevue is a NPDES Phase II permittee and must comply with conditions of the permit. |
| | | Surface Water Quality Standards | Protect and regulate the quality of surface water in Washington State through 1) sustaining "designated uses," 2) meeting numeric water quality criteria, and 3) implementing "antidegradation" policies. | The 303(d) Listed Waterways[1]: Coal Creek—dissolved oxygen, fecal coliform; Idylwood Creek—dissolved oxygen, fecal coliform; Kelsey Creek—temperature, dissolved oxygen, fecal coliform; Mercer Slough—temperature, fecal coliform; Unnamed Creek (Overlake Sears Trunkline)—dissolved oxygen, fecal coliform. |
| | | Total Maximum Daily Loads (TMDLs) | Identify sources of contaminants that result in impaired water bodies listed under section 303(d), establish limits on pollutant discharges to clean up impaired water bodies to achieve beneficial uses. | The impaired waterways listed above await future TMDL processes. |
| Endangered Species Act | U.S. Fish and Wildlife Service (USFWS) and National Oceanic and Atmospheric Admininstration (NOAA) Fisheries Service in consultation with lead federal agencies | Puget Sound Chinook Salmon Recovery Plan, 2007 | Prevent further decline of listed terrestrial and aquatic species, including Puget Sound Chinook salmon, steelhead trout, and other species. | Chinook salmon, bull trout, Lake Washington steelhead, and Lake Sammamish kokanee are listed under the Endangered Species Act, and are present in various water bodies within Bellevue city limits. |

**Table 3-1. Regulatory framework of surface water management in the city of Bellevue**

| Law | Implementing Entity | Regulatory Programs | Intent and Specifics | Relevance to Bellevue |
|---|---|---|---|---|
| National Flood Insurance Act of 1968 | Federal Emergency Management Agency (FEMA) | National Flood Insurance Program | Floodplain ordinance/development review<br>Community Rating System (CRS) | Floodplain Management Program |
| Washington State Hydraulic Code | Washington Department of Fish and Wildlife (WDFW) | Hydraulic Project Approval (HPA) | Construction activities and other work that affect the bed or flow of state waters are done in a manner to prevent damage to the state's fish, shellfish, and their habitat. | All work within streams, lakes, or wetlands must comply with these requirements and reviews. |
| Growth Management Act | King County implements Growth Management Act (GMA) | King County Comprehensive Plan, Bellevue Community Plan | Regulate land use to meet growth targets while providing necessary services and protecting sensitive environmental resources. | Bellevue watershed is located in a designated urban growth area within King County. |

1. Department of Ecology 303d listed waterwarys constituents identified in City of Bellevue waters

As required by the Clean Water Act, Ecology also maintains a registry of the quality of surface water bodies in the state. This registry, termed the "303(d) list" after the specific section of the Clean Water Act that requires the compilation of these data, identifies whether or not specific reaches of rivers, streams, lakes, and ponds comply with the numeric criteria described above. Most importantly for the City, the list identifies waters considered as "impaired" that require a cleanup plan through the development and implementation of TMDLs. The TMDL is a calculation of the maximum amount of the pollutant of concern that can be discharged to the impaired water by all entities, both public and private.

### *Endangered Species Act*

All management activities of Bellevue's surface water resources—whether streams, lakes, or stormwater—must take into account the federal Endangered Species Act (ESA). In addition, Native American tribes and the Washington Department of Fish and Wildlife (WDFW) co-manage state fish, shellfish, and wildlife resources. The tribes have federal recognition for fish and wildlife habitat management, including habitat, through treaty obligations. The ESA provides for the conservation of species that are determined to be either endangered or threatened as well as the conservation of the ecosystems on which they depend. Both Puget Sound Chinook salmon (listed as threatened on March 24, 1999) and steelhead (listed as threatened on May 11, 2007) are present in the Bellevue area. Bull trout (listed as threatened on November 1, 1999) are not known to use Bellevue streams, but are assumed to forage in Lakes Washington and Sammamish. Additionally, Lake Sammamish kokanee (a type of sockeye salmon that do not migrate to the ocean) is a candidate species for federal protection under the ESA.

As part of a broadly coordinated effort to recover salmon, Bellevue participates in the Lake Washington/Cedar/Sammamish Watershed (Water Resource Inventory Area [WRIA] 8) salmon recovery effort. This involves working with a coalition called Shared Strategy to identify and develop a coordinated salmon recovery plan endorsed by the people living and working in the watersheds of Puget Sound. The Bellevue City Council adopted the Lake Washington/Cedar/Sammamish Watershed (WRIA 8) Chinook Salmon Conservation Plan on June 21, 2005. Bellevue also participates in the Regional Road Maintenance ESA Program Guidelines (Bellevue City Council action, November 6, 2001). This regional program has 10 elements related to training, best management practices (BMPs), monitoring, emergency response, and other coordination and operational elements. The program is designed so that when they are used, as a single element or in combination, they reduce the impacts on road maintenance activities, water, and habitat used by threatened salmon species.

### *National Flood Insurance Program*

Bellevue is a participant in the National Flood Insurance Program (NFIP) administered by the Federal Emergency Management Agency (FEMA). This program makes flood insurance available to citizens when cities adopt and enforce floodplain management ordinances to reduce future flood damage. Flood insurance provides an alternative to disaster assistance by reducing the escalating costs of repairing damage to buildings and their contents caused by floods. The City further participates in the Community Rating System (CRS), which can reduce flood insurance premium rates for Bellevue policyholders as much as 45 percent. Additionally, implementing some CRS activities can help projects qualify for other federal assistance programs.

### *Growth Management Act*

The Washington State Legislature adopted the Growth Management Act (GMA) in 1990 to promote comprehensive land use planning to prevent uncoordinated and unplanned growth. Uncontrolled growth is believed to threaten the environment, sustainable economic development, and the health, safety, and high quality of life enjoyed by residents of Washington State. The GMA requires counties to designate urban growth areas (UGAs) where urban development will occur, delineated by urban growth boundaries. These boundaries are used to direct urban infilling and set regional housing targets for development. Locally, King County implements the state's GMA by developing the King County Comprehensive Plan under which all city comprehensive plans are developed. The City of Bellevue, through its Planning and Community Development and Development Services Departments, implements its own community land use plan and regulations to achieve population targets while protecting the environment.

To further protect the environment with the UGAs, the GMA requires the development and adoption of critical area ordinances (CAOs). Critical areas, such as streams, riparian areas, and habitats for locally important species, are given extra protection due to the unique environmental functions they provide. These special protections include buffers and structure setbacks applied to the edges of these critical areas to protect their functions and values. The City protects critical areas through its 2006 Critical Areas Ordinance by prohibiting disturbance or modifications to critical areas, unless specifically allowed in the code, and by requiring buffers and building setbacks.

***Bellevue Storm and Surface Water Utility Code***

The Bellevue Storm and Surface Water Utility Code is enacted under the City of Bellevue's municipal authority as outlined in the Washington State Constitution. The principles of the Storm and Surface Water Utility Code are to:

A. Provide for the planning, security, design, construction, use, maintenance, repair and inspection of public and private storm and surface water systems;
B. Establish programs and regulations to assure the quality of the water, to preserve the integrity of the storm and surface water system, and to minimize the chance of flooding;
C. Protect the public interest in drainage and related functions;
D. Protect the receiving waters or waters of the state from pollution, mechanical damage, excessive flows and other conditions, which may increase erosion, turbidity, or other forms of pollution, which reduce flow or which degrade the environment;
E. Comply with requirements of local, state, and federal law, including the National Pollutant Discharge Elimination System (NPDES) permit for municipal stormwater discharges;
F. Protect the functions and values of critical areas as required under the state's Growth Management Act, Shoreline Management Act, and City of Bellevue Land Use Code (LUC);
G. Provide for the enforcement of the provisions of this code, the engineering standards and related city manuals and code provisions; and
H. Provide for and promote the health, safety and welfare of the general public and not to create, establish, or designate any particular class or group of persons who may be especially protected or benefitted.

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***Regional and Local Plans***

Lastly, management of the City's surface water resources are guided and constrained by a number of regional and local plans, in which many Utilities Department employees participate and contribute. The City is a signatory to many of these plans, which require the establishment and implementation of local regulations and ordinances. Examples of these types of programs are:

- Lake Sammamish Initiative [Resolution 5929, 9/25/95]);
- 1976 City of Bellevue Drainage Master Plan (Ordinance 2798, 12/14/79); and
- Meydenbauer Local Improvement District #265, (Ordinance 3304, 10/17/83).

**Summary**

This intricate web of federal, state, and local regulations and complex legal framework requires the Utilities Department, at a minimum, to consider in policies and practices whether 1) public health and safety are protected, 2) the system responsibilities are public or private, 3) publicly funded practices provide a greater public benefit, and 4) programs and practices are in place to protect water quality and endangered species.

# CHAPTER 4 POLICIES

Storm and surface water policies are contained in this chapter. These stormwater policies provide the framework for guiding the Utilities Department in its management of the Storm and Surface Water Utility system. Current financial policies guiding the Waterworks Utility (Storm and Surface Water, Water, and Wastewater) are also included in this chapter.

The City of Bellevue Comprehensive Plan, updated and adopted each year, is an ‘umbrella plan’ that “provides a broad statement of community goals and policies that guide the orderly development of Bellevue into the future.” The City’s Comprehensive Plan is divided into several elements that provide additional policy details to help the City achieve the Plan’s stated goals. In particular, the Utilities, Environmental, and Capital Facilities Elements of the City’s Comprehensive Plan have special relevance for storm and surface water management. The Utilities Element establishes the foundation for the Utilities Department vision and goals across the Water, Wastewater, and Storm and Surface Water programs.

Policies specific to storm and surface water management stated in the Utilities Element are:

- **Policy UT-22**–Participate in regional watershed based efforts with the goals of achieving local watershed health and addressing Endangered Species Act issues, and strive to manage the city’s storm and surface water system within a system wide, watershed based context.
- **Policy UT-23**–Manage the storm and surface water system in Bellevue to maintain a hydrologic balance in order to prevent property damage, protect water quality, provide for the safety and enjoyment of citizens, and preserve and enhance habitat and sensitive areas.
- **Policy UT-24**–Enforce surface water controls to protect surface water quality.
- **Policy UT-25**–Educate the public on water quality issues.

The Environmental Element has 94 separate policies to help integrate the natural and built environments. The Capital Facilities Element has 20 separate policies to facilitate the planning and construction of new public facilities. Subservient to the City’s Comprehensive Plan are several functional plans including the Storm and Surface Water System Plan. Storm and Surface Water System Plan policies are carefully written to be in alignment with and in support of the City’s Comprehensive Plan policies without establishing precedent. The relationship between the City’s Comprehensive Plan and the Storm and Surface Water System Plan is shown in Figure 4-1.

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**City of Bellevue Comprehensive Plan**

Bellevue's Comprehensive Plan is a broad statement of community goals and policies that direct the orderly and coordinated physical development of the city. A comprehensive plan anticipates change and provides specific guidance for future legislative and administrative actions.

Minor changes are made to Bellevue's Comprehensive Plan every year; significant updates are made every decade or so. However, the focus of the Plan remains constant:

- well-maintained, livable neighborhoods;
- a vibrant urban center;
- a healthy environment;
- a strong, diverse local economy; and

Environmental Element → 94 policies–"To integrate the natural and developed environments to create a sustainable urban habitat with clean air and water, habitat for fish and wildlife, and comfortable and secure places for people to live and work."

Capital Facilities Element → 20 policies–"Provide adequate public facilities that address past deficiencies and anticipated growth at acceptable levels of service using fiscal resources efficiently and with realistic timelines."

Utilities Element → 75 policies– "To ensure Bellevue will have Utility capacity to adequately serve the Land Use Plan and to address the quality, reliability, safety and regulation of Utility services."

**Utilities Element Policies Specific to the Storm and Surface Water Utility**

- **Policy UT-22**–Participate in regional watershed based efforts with the goals of achieving local watershed health and addressing Endangered Species Act issues, and strive to manage the city's storm and surface water system within a system wide, watershed based context.
- **Policy UT-23**–Manage the storm and surface water system in Bellevue to maintain a hydrologic balance in order to prevent property damage, protect water quality, provide for the safety and enjoyment of citizens, and preserve and enhance habitat and sensitive areas.
- **Policy UT-24**–Enforce surface water controls to protect surface water quality.
- **Policy UT-25**–Educate the public on water quality issues.

**Storm and Surface Water Mission Statement**

A surface water system that controls damage from storms, protects surface water quality, supports fish and wildlife habitat, and protects the environment. *(Utilities Business Profile 2009)*

Storm and Surface Water System Plan Policies
(Department-specific policies for Utility operation and management)

**Figure 4-1. The city's comprehensive plan and the storm and surface water system plan**

## Storm and Surface Water General Policies

The Utilities Department strives to manage the storm and surface water system in a manner that "controls damage from storms, protects surface water quality, supports fish & wildlife habitat, and protects the environment." Development of the plan involved interdepartmental staff, commissions, and public review of all policies from the 1994 plan. There were no significant changes to existing policies. Clarifying edits were made to the 1994 policies (as described below); two of the 1994 policies were combined into one, and four obsolete ones were deleted. One new policy was added concerning the evolving topic of Low Impact Development techniques. The Utilities Department Storm and Surface Water policies can be organized into four broad categories as shown in Table 4-1 - Customer Service, Water Quality, Regional, and Financial.

**Table 4-1. Summary of storm and surface water policies by categories**

| Customer Service | Water Quality | Regional | Financial |
|---|---|---|---|
| Emergency Response | Surface Water Quality | Regional, State, and Federal Policy Involvement | General Financial |
| Storm and Surface Water System Responsibility | Lake Management | | Capital Investment Program Policies |
| Capital Investment | Encourage the Use of Low Impact Development Techniques Where Feasible | | System Expansion and Connection Policies |
| Deltas | | | Rate Policies |
| | | | Operating Reserve |

A summary of the changes is presented below followed in a later section by the complete text of each policy.

***Customer Service Policies***

- **Emergency Response**.This policy was not substantially modified. The basic policy message was retained with minor edits to update the policy and discussion language.
- **Storm and Surface Water System Responsibility**. This policy is the result of combining two policies—Conveyance System Responsibility and Detention System Responsibility—into one. There was sufficient overlap and redundancy between the two that would allow a single policy document to retain the essence of each, yet present a more concise policy about System Responsibility. The policy goals from the original policies were preserved in this combined version.
- **Capital Investment**. This policy that was updated to reflect City Council policy decisions conducted during budget processes. Minor word and grammatical edits were also made.
- **Deltas**. This policy was updated to reflect current conditions and provide improved clarity of policy intent and to explain the role of delta management by the Utilities Department.

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***Water Quality Policies***

- **Surface Water Quality**. The wording of the Surface Water Quality policy was updated to acknowledge issuance of the City's National Pollutant Discharge Elimination System (NPDES) Municipal Stormwater Permit in 2007. Policy intent was not substantially changed.
- **Lake Management**. This policy was revised for clarity. Specifically, the policy acknowledged a need for coordination with lake management and to provide general background information on lakes with more recent examples of the Utilities Department lake management policy in action.
- **Encourage the Use of Low Impact Development Techniques Where Feasible.** This is a new policy intended to support and promote the implementation of low impact development (LID) techniques. The policy was developed because there is general recognition that LID techniques have a positive effect on the hydrologic balance in stormwater basins where they are used. The Storm and Surface Water Utility has a unique role in promoting the environmental benefits associated with LID techniques.

***Regional Policies***

- **Regional, State, and Federal Involvement**. Changes were made to this policy to clarify, update, and make it consistent with other City processes without substantially altering the original intent of the policy.

***Financial Policies***

- Five separate financial policies are evaluated with each budget cycle. For the Storm and Surface Water System Plan, they were not part of the policy review process.

***Deleted Policies***

- **Residential Drainage Assistance Policy**. *"The Utility should offer education and advice to single-family property owners with private drainage problems."*

  This policy was deleted because the service described in the policy is an existing Level of Service (LOS) now in place for several years across all utility services (water, wastewater, and storm) and is not limited to residential areas.

- **Neighborhood Enhancement Projects Policy.** *"Each year the Utility shall allocate part of the capital budget to construct drainage projects identified through the Neighborhood Enhancement Program."*

  This policy was deleted because the Utilities Capital Investment Program includes an ongoing program to support the City's Neighborhood Enhancement Program.

- **Stormwater Runoff Control Requirements Policy.** *"The Utility should develop appropriate Codes, Regulations and Standards to carry out the City Comprehensive Plan policy of restricting the runoff from all new development and re-development. The goal of this policy is to maintain a hydrologic balance that provides for the safety and enjoyment of citizens, and preserves and enhances habitat and sensitive areas. To address the goal of this policy, the City must minimize the potential for flooding and streambank erosion."*

  This policy was deleted because runoff control requirements are now required by the City's Phase II NPDES Municipal Stormwater Permit that is issued by Washington State Department of Ecology (Ecology). Runoff control requirements for new and redeveloping properties consistent

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with the permit are included in the City's Storm and Surface Water Codes, which have been adopted by the City Council.

- **Property Restoration Policy.** *"During the project design process, the Utility shall consider the impact to private property due to Utility construction.*

  *When property disruption is unavoidable, the Utility shall restore the area to the pre-existing conditions to the extent practical. Where not practical, the Utility may compensate the owner for ornamental landscaping in lieu of restoration; compensation is limited to the reasonable replacement value of destroyed specimens in kind, but not in size.*

  *Consistent with state and local law, the Utility shall not install landscaping improvements that increase the value of private property unless that is compensation for property rights granted to the Utility or unless the primary purpose is to benefit the City-wide drainage system."*

  This policy was deleted because property restoration standards described in this policy are now included in the Storm and Surface Water Engineering Standards, as well as the easement documents necessary to gain access to the property.

## Storm and Surface Water Policies

The full text of storm and surface water policies that are being implemented as part of this Plan is provided below.

***Customer Service Policies***

**<u>Emergency Response</u>**

**Policy**

> *The Utilities Department responds to drainage-related emergencies and may undertake emergency protective measures or activities as needed in the event of an imminent threat to public health, safety, or public resources (such as infrastructure, endangered salmonids, and water quality), or an imminent threat of significant property damage*.

**Discussion**

The City responds to many kinds of emergencies. The Utilities Department has historically responded to drainage-related threats to life, health, or property. Since the 1988 Comprehensive Drainage Plan (CDP) was adopted, the Utilities Department has also responded to threats to water quality and aquatic resources.

It is sometimes necessary to undertake activities on private property to adequately respond to an emergency. The Utilities Department will seek permission from the owner; however, it may not be possible to reach the owner, and delaying response may lead to significant property or resource damage. In those cases, the Utilities Department may proceed with the activities as long as they are consistent with general policy direction from the City's Emergency Operations Plan and the NPDES Municipal Stormwater Permit. In that way, the Utilities Department attempts to minimize the liability associated with work on private property while protecting property and resources.

In emergency situations, the Utilities Department shall follow the Bellevue Utilities Emergency Management Plan priorities and procedures and assure consistency with the City's Incident Command Structure and City emergency protocols. During emergency situations, the City's resources are often overloaded and it cannot respond to all needs. Priority shall be given to facilities that provide critical and essential services.

When major flooding is anticipated, the Utilities Department may provide sandbags to threatened neighborhoods. However, the Utilities Department crews will generally not provide public assistance to individual private properties for implementing preventative measures.

Private property owners are responsible for implementing preventative measures such as placing the sandbags to protect their property. It is the responsibility of the property owner to follow City codes and ensure that such measures shall not adversely impact streams, lakes, shorelines, or other critical areas. Removal and proper disposal of the sandbags after the event are also the responsibility of the private property owners.

## Storm and Surface Water System Responsibility

### Policy

*The Utilities Department shall own and maintain all components of the storm and surface water system in city-owned right-of-way and in easements or tracts dedicated to, and accepted by, the Utilities Department. The Utilities Department should not acquire or accept additional new or existing System components outside the city-owned right-of-way (through easements, ownership, or other property rights) except when needed for Utilities Department construction projects identified in the Utilities Department Capital Investment Program, or when all of the following conditions are met:*

1. *There is a public benefit;*
2. *Easement or property is offered by the property owner at no cost;*
3. *The system meets current City standards or is brought up to current City standards by the owner;*
4. *There is access for Utilities Department maintenance from public right-of-way;*
5. *The Utilities Department has adequate resources to maintain the system, and for detention systems;*
6. *The system serves a residential plat or short plat (rather than a commercial property).*

### Discussion

Much of the stormwater system in Bellevue is not owned by the Utilities Department. Private drainage conveyance and detention systems are those components for which the Utilities Department does not have a property interest. Detention and conveyance systems located in City-owned right-of-way are owned and maintained by the Utilities Department. In addition, the Utilities Department has acquired easements, rights-of-way, or fee titles (through purchase or dedication) for some additional system components.

All detention systems must be maintained to ensure they function as designed for flood control. Detention system maintenance also benefits water quality when trapped pollutants are removed from the system rather than being flushed downstream during a major storm. The Utilities Department maintains its facilities through ownership and allocation of maintenance resources. The functionality of private detention facilities is sought through the City’s private drainage inspection (PDI) program.

Where practical, and when in the public interest, multi-purpose detention facilities should be encouraged.

The City's historical policy has been to acquire control of system components on an as-needed basis when brought up to current City standards by others or through an approved Utilities Department project.

An aggressive program to acquire additional segments of the stormwater system (conveyance and detention) is not recommended because:

- Owning and maintaining the stormwater system would not address the City's water quality and flood control responsibilities because pollutants and runoff originate throughout each drainage basin. Also, most of the primary conveyance systems are streams (riparian corridors), and streams are regulated through local and state regulations.
- Acquiring all conveyance systems and bringing them up to standard would be high in cost and would also result in increased operation and maintenance costs.
- Assuming substandard systems could increase City liability.
- Continuing to work with property owners to ensure maintenance of privately owned detention systems is an objective of the Utilities Department's private maintenance and inspection program.
- Assuming ownership of private systems is not necessarily equitable to ratepayers.

**<u>Capital Investment Policy</u>**

**Policy**

*The Utilities Department shall invest resources as necessary to further its mission, provided such investment is consistent with Utilities Department financial policies. Specifically, resources shall be invested for capital projects which:*

- *protect property from flooding or other stream-related damage; or*
- *protect or improve water quality; or*
- *maintain or improve the reliability, effectiveness, and/or integrity of the storm drainage system infrastructure; or*
- *promote fiscal stewardship by generating cost savings or reducing potential liability; or*
- *promote resource stewardship by improving fish and/or riparian wildlife habitat; or*
- *respond to regulatory requirements or legal obligations of the Storm and Surface Water Utility; AND PROVIDED*
- *such investment has a public benefit, and if the cost is justified by that benefit.*

*Prioritization and implementation of capital projects shall be based on objective guidelines that are periodically reviewed and published as part of the City's adopted Capital Investment Program plan (CIP). The most recently adopted CIP budget reflects the most current Capital Investment Policy.*

**Discussion**

The mission of the Storm and Surface Water Utility is to provide a surface water system designed to control damage from storms, protect surface water quality, support fish and wildlife habitat, and protect the environment. Capital projects that prevent or reduce property damage from flooding or streams,

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protect or improve water quality, maintain or improve the reliability and integrity of the storm and surface water system, or improve fish and/or riparian wildlife habitat are consistent with this mission.

Projects should be prioritized based on rational, objective criteria that are periodically evaluated as part of the Capital Investment Program update. Due consideration should be given to cooperative collaboration with other City of Bellevue projects or priorities to achieve desired outcomes. Cost/benefit analysis should include long-term ecological cost to the extent it is reasonably quantifiable. While the regional impact or beneficial significance of a project should not merit higher ranking, any such regional benefit should be included in the project description, because such a project may be appropriate for regional mitigation, or could be assumed by a regional entity, such as the King County Flood Control District.

The Storm and Surface Water Utility capital investment program is not intended to be a property acquisition program. The City's development regulations protect sensitive areas, and Bellevue has from time to time pursued open space acquisition initiatives for various objectives. That said, property acquisition as part of the Storm and Surface Water Utility Capital Investment Plan is not precluded, if that (in part or in total) is the optimal solution to achieve a project's objective.

### Deltas

#### Policy

*The Utilities Department will fund delta modification only in situations involving a threat to life or dwellings from flooding or where the Utilities Department has an existing legal obligation by easement or agreement. Any delta modification should be limited to that needed to alleviate such flooding or to fulfill the legal obligation.*

*The Utility may provide non-financial support to any private or third-party-funded dredging projects that are found to be environmentally acceptable.*

#### Discussion

Delta formation is a natural process. Deltas are dynamic; sediment deposition rates and channel location are likely to change over time. Deltas are typically fan-shaped deposits of sediment, such as gravel, sand, and silt that are found at the mouths of streams or rivers, and sometimes at piped stream outfalls. Sediments are carried by streams or through pipes and settle to the bottom when the water velocity slows to the point where the water no longer has enough energy to move the soil particles downstream. Larger particles take more energy to move than smaller ones, so larger-sized particles carried in suspension or dragged along the streambed will be dropped before smaller ones. Fine sediments are deposited when the stream enters still water, such as a lake.

Sediment in the streams may come from naturally occurring streambed erosion or slides or may result from human activities such as logging or construction. Development activities that increase peak stream flows may increase stream erosion. Therefore, deltas will and do form naturally, but any human activity that increases erosion will also tend to increase delta growth.

Many problems associated with deltas do not pertain to the Utilities Department's overall mission. The Utilities Department will not modify deltas for navigation, recreation, or aesthetic purposes. Moreover, the Utilities Department is not an insurer against all natural and human-caused hazards. Therefore, the Utilities Department should not have a role in delta modification unless the delta involves a threat to life or dwellings from flooding or it has an existing legal obligation by easement or agreement. Any delta modification should be limited to that needed to alleviate the flooding or fulfill the legal obligation. The Utilities Department will consider petitions from a majority of

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affected property owners to assist with establishing a privately funded Lake Improvement District or special surcharge to assist with delta management issues.

Finally, the Utilities Department requires water quantity and water quality source controls throughout the city, consistent with other policies in the Storm and Surface Water System Plan. Such source controls—including strict application of erosion control measures on new construction, drainage facility maintenance, and the construction of detention and sediment control facilities—slow the rate of delta formation. Requiring basin-wide water quantity and water quality source controls is consistent with the Utilities Department's flood control and water quality mission.

***Water Quality Policies***

**<u>Surface Water Quality</u>**

**Policy**

*The City shall develop and update surface water quality protection programs as needed and shall carry out those programs and best management practices (BMPs) in order to make progress toward meeting state and federal requirements and the City Comprehensive Plan water quality and related resource goals. City surface water quality programs may include (but not necessarily be limited to):*

- *Water quality studies and investigations;*
- *A water quality response program, including enforcement;.*
- *Education programs (including promoting source controls);*
- *Preservation of lakes, wetlands and streams;*
- *Stormwater quality controls on new development, redevelopment(including, but not limited to, temporary erosion and sedimentation controls during construction as well as permanent on-site storm water management, flow control and runoff treatment best management practices);*
- *An operation and maintenance program, including an inspection program to ensure private maintenance of private drainage systems.*
- *Capital projects to address identified water quality problems; and*
- *Participation in regional studies and in the development of regional, state, and federal surface water quality policy. See Storm and Surface Water System Plan policy Regional, State and Federal Policy Involvement.*

**Discussion**

<u>Background</u>

Surface water quality protection is required by federal, state, and local regulations and policies. The City of Bellevue Comprehensive Plan includes a policy to "maintain surface water quality defined by federal and state standards and restore surface water that has become degraded to the maximum extent practicable." Related City Comprehensive Plan policies call for protection of natural surface water systems, biological health and diversity, wetlands, aquatic and riparian habitats, and groundwater resources.

To a large extent, protecting surface water quality in the city depends on managing stormwater runoff. Stormwater runoff collects pollutants such as oil, grease, and sediment as it travels along the ground

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surface, and can therefore become a significant transporter of pollutants. These “non-point source pollutants,” unlike pollution from industrial and sewage treatment plants, come from many diffuse and hard-to-trace sources. As the runoff moves, it picks up and carries away natural and human-made pollutants, finally depositing them into wetlands, streams, and lakes. Many of these non-point source pollutants are beyond the control of the City, such as those from fuel additives, brake pads, and pesticide applications. Successful management of these pollutants requires implementing effective practices from private interests, as well as other government entities, in addition to City management practices.

Stormwater management and surface water quality protection is required by state and federal mandates, most notably:

1. The federal Clean Water Act (through rules promulgated by the U.S Environmental Protection Agency [USEPA]) requires municipalities to obtain an NPDES permit for their stormwater systems. USEPA has delegated permit authority for administering the permit to Ecology—the state’s environmental agency. In January 2007, Ecology issued municipalities in Western Washington, including Bellevue, the National Pollutant Discharge Elimination System and State Waste Discharge General Permit for Discharges from Small Municipal Separate Storm Sewers in Western Washington, effective February 16, 2007 (referred to as the Western Washington Phase II Municipal Stormwater Permit). The permit is also intended to ensure compliance with provisions of the state of Washington Water Pollution Control law, Chapter 90.48, Revised Code of Washington (RCW). An NPDES Municipal Stormwater Permit involves meeting the stormwater management program requirements prescribed in the permit plus complying with additional requirements such as monitoring. City implementation of the permit includes adopting the Ecology 2005 Stormwater Management Manual for Western Washington (referred to herein as Ecology’s Stormwater Management Manual), or as revised by the state of Washington, or as modified through adoption by the City of Bellevue.
2. The Clean Water Act includes additional requirements that affect surface water management. Most notably, state surface water quality standards are promulgated by Ecology, and are revised every 3 years. Different water quality standards may apply to a particular water body depending on which beneficial uses the water body is classified as providing. Relative to these standards, every 2 years, Ecology must submit to USEPA a “water quality limited list,” which is a list of water bodies that do not meet current standards and are not subject to documented water quality protection programs likely to result in compliance with the standards. Once the list is approved by USEPA, Ecology must prioritize the listed water bodies and conduct studies to determine the Total Maximum Daily Loads (TMDLs) of the violating pollutant for the affected water bodies. The local jurisdictions (along with other dischargers to the affected water bodies) must then meet the TMDLs through implementation of water quality cleanup plans. Compliance with all current regulatory standards is not always possible; nonetheless, the City of Bellevue continues to proactively work to ensure all achievable state and federal requirements are met.

Both federal and state regulations focus on mitigating surface water quality impacts through source controls and head-of-the-pipe treatment. Source controls include any measures that keep pollutants out of the stormwater runoff (for example, erosion control and spill containment). Head-of-the-pipe treatment includes facilities such as oil/water separators and sedimentation ponds that remove

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pollutants from runoff before they enter the main stormwater conveyance system. Source controls are different from preventative measures; prevention avoids water quality problems. Examples of preventative measures are limitations on land development and reduction in use or prohibition of polluting materials, such as lead in gasoline and copper in brake pads. In general, source controls are specific to a given site while preventative measures are applied across the landscape.

The emphasis on source controls and head-of-the-pipe treatment is intended to ensure a supply of clean water throughout the surface water system, to avoid irreversible resource damage, and to reduce the possible need for costly future treatment. Additional treatment of urban runoff could be required in the future if the current approach proves inadequate.

To meet federal and state requirements, source controls and head-of-the-pipe treatment are needed both during and after construction. Other ongoing pollution prevention strategies may be needed as well. Different aspects of water quality protection are discussed further below.

Controlling Pollutants from Construction

Construction activities can be a significant source of sediment. As stated by the EPA in 40 Code of Federal Regulations (CFR), Part 122, "Over a short period of time, construction sites can contribute more sediment to streams than was previously deposited over several decades." Construction activities also can contribute other pollutants such as lubricants, oils or greases, and construction wastes.

Through the Clearing and Grading Permit process, the City requires erosion and sedimentation control BMPs to mitigate construction-related impacts to streams, lakes, and wetlands, as well as the constructed drainage system.

The City's clearing and grading development regulations and standards, together with Ecology's Stormwater Management Manual and the NPDES Municipal Stormwater Permit, provide guidance on erosion and sedimentation control BMPs. Such BMPs include, but are not limited to, marking clearing limits, restricting construction in some drainage basins to the dry weather season, constructing temporary sedimentation ponds, and installing runoff filtering devices. City approval is also required for Stormwater Pollution Prevention Plans for construction sites.

City of Bellevue staff strive to ensure that BMPs to control erosion, sedimentation, and other construction-related pollutants are adequate considering site conditions, the proposed development, expected weather conditions, and inspections made during the actual construction. However, erosion and sedimentation can occur regardless of the BMPs employed. Some degree of adverse impacts to the natural and designed drainage systems is inevitable. Costs associated with mitigating these impacts should be borne by the responsible parties.

Permanent Stormwater Controls on New Development and Redevelopment

Once construction is complete, the potential for pollution still may exist. Therefore, to mitigate the potential impacts, new development and redevelopment over a certain threshold are required to install permanent stormwater quality controls. These include, but are not limited to, source controls and runoff treatment BMPs (such as wet ponds, oil/water separators, sand filters, biofiltration swales, and LID techniques, where feasible). Because water quality control knowledge is advancing over time, the state requirements may be revised from time to time and may necessitate additional controls. The City desires to modify local codes and standards as necessary to address amendments to state or federal standards.

When a site is developed or redeveloped, City staff strive to ensure that wetlands, lakes, and streams are protected, and that disturbance of steep slopes and landslide hazard areas are avoided or minimized

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consistent with the Critical Area and Shoreline Overlay District requirements in the City's Land Use Code. These regulations are intended to prevent direct destruction of streams, lakes, and wetlands, as well as prevent major erosion and other problems otherwise caused from inappropriate development practices in geologically hazardous areas.

Ongoing Pollution Prevention

In addition to the runoff controls discussed above with respect to new development and redevelopment, the City has other water quality protection programs that are consistent with federal and state requirements. These are summarized below.

Public education and outreach. The City manages education programs intended to ensure residents, businesses, and students understand their ongoing role in pollution prevention. Education is important because many source controls require ongoing actions such as properly disposing of wastes and minimizing the use of pesticides and other pollution-causing products.

Public involvement and participation. In addition to making its staff readily available to its citizens, the City provides opportunities for the public to be involved in water quality management decisions by accepting public comment at Environmental Services Commission and City Council water quality policy discussions. The City also posts education and relevant documents on the City website to inform customers and to provide another avenue for public input.

Spill control and water quality response (also known as illicit discharge detection and elimination, or IDDE, in the NPDES Permit). The City manages a program to detect and eliminate illicit connections and discharges to the municipal stormwater system and receiving waters, including a water quality response program. Pollutants are sometimes spilled or dumped into the storm drainage system (in violation of federal, state, and local laws). The City's water quality response program responds to water quality complaints, spills, and other illicit discharges or disposal, and can initiate enforcement actions, if warranted. The escalating enforcement process emphasizes education first and then proceeds, if necessary, to issue correction notices, stop work orders, notices of violation, and fines. The IDDE program provides training for staff who may observe illicit discharges in the field. Responding to pollutant spills and eventually eliminating improper disposal of pollutant materials to surface waters are program goals.

Pollution prevention and operations and maintenance requirements. The City's Operations and Maintenance (O&M) program include staff training on pollutant reduction from municipal operations, pollutant reducing drainage system maintenance standards, drainage system inspections and spot checks of drainage facilities for proper system functions, and maintenance of the public storm drainage system. The program also includes policies and procedures to reduce discharge from City-owned lands and facilities, including development of Stormwater Pollution Prevention Plans for equipment maintenance yards and storage facilities.

Stormwater controls should be properly operated and maintained in order to function as intended in protecting water quality. Therefore, in addition to the O&M program to maintain its own facilities, the City has an inspection program to ensure private maintenance of private stormwater flow control and treatment facilities pursuant to federal and state requirements. Ineffective operation of private drainage systems could result in an increased need for public system maintenance or construction of new public capital facilities.

Monitoring and other investigations. In addition to performing water quality monitoring required by the NPDES Permit, the City investigates water quality in order to evaluate problems and assess how best to protect water quality. For example, the City has conducted monitoring and has also monitored

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individual watersheds and water bodies (such as Phantom and Larsen Lakes). When appropriate, the City coordinates with other jurisdictions when conducting studies and developing action plans.

The state and federal stormwater monitoring requirements are likely to increase over time.

Capital projects. Capital projects may be necessary to solve or provide mitigation for an identified water quality problem. Capital projects are identified and prioritized as discussed in the Storm and Surface Water System Plan Capital Investment policy.

Regional cooperation and input on state and federal policy. Bellevue and other jurisdictions are working to ensure that state and federal requirements are practicable and achievable. See the Storm and Surface Water System Plan Regional, State, and Federal Policy Involvement policy below (see page 4-16) for further discussion of the City's role.

Summary

It is clear that no single action can guarantee surface water quality protection. Protecting surface water quality requires a societal and cultural shift in citizen behavior combined with local, state, and federal actions. The City desires to meet federal and state requirements for the protection of surface water quality where practical and achievable. Therefore, consistent with state and federal mandates, the City has and continues to do its part in protecting surface water quality through a number of programs.

New state and federal requirements may result in regulatory changes that are intended to provide improvements to water quality and would likely increase costs to property owners and the City's required level of service. These expected changes may include additional operation and maintenance of targeted facilities; increased emphasis on basin studies; additional monitoring; increased emphasis on LID requirements, where feasible, for new development and redevelopment; and requirements or an emphasis on retrofitting stormwater systems to improve water quality and flow control. As these potential changes occur, the City intends to modify applicable policies, codes, standards, and procedures to address such changes.

## Lake Management

### Policy

*The Utilities Department should take a lead role in lake management for flood control and water quality purposes only. Maximum use should be made of grants or other outside funding sources and financial cooperation of benefited lake property owners. The Utilities Department should not take a role in lake management issues for recreational or aesthetics purposes.*

*For Lakes that are sensitive to nutrient loadings and require special controls (see City of Bellevue Storm and Surface Water Engineering Standards) throughout their watershed the Utilities Department should:*

- *Ensure that nutrient controls (and other mitigating measures related to flood control or water quality that are identified in a pertinent lake management plan adopted by City Council) are required of new development and re-development throughout the lakes' watersheds. These controls are in addition to standard City requirements for controlling water quantity and quality.*
- *Continue to educate and involve businesses and residents in lake protection through on-going Utilities Department education programs and other management mechanisms.*

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**Discussion**

Bellevue is bounded on the west and east by Lake Washington and Lake Sammamish, respectively. Bellevue also includes three small lakes—Larsen Lake which is City owned, Phantom Lake which includes private and public land, and Lake Bellevue which is privately owned. Larsen Lake is managed as a regional detention (flood control) facility.

Lakes tend to become repositories for pollutants (such as nutrients, oil, and pesticides) that enter them with urban runoff, groundwater, air deposition, or, to a lesser extent, rainfall. In addition, once nutrients enter a lake and settle to the bottom, they can cycle from the bottom sediments back to the water, where they are available for algae growth. High nutrient levels can fuel nuisance amounts of algae; in turn, decaying algae can deplete dissolved oxygen levels needed by fish and other aquatic animals.

The 1988 and 1994 Comprehensive Drainage Plans concluded that the Utilities Department should have a role in lake management for water quality and flood control only; in addition, maximum use should be made of outside funding sources such as grants and financial cooperation of benefitted lake property owners.

Consistent with that policy, the Utilities Department obtained state grants to pursue several water quality projects related to lake protection. Specifically, the Utilities Department

- Completed the $2 million Phantom/Larsen Lakes Restoration project (1985 to 1993) aimed at breaking the lakes' cycle of nutrient enrichment; about 70 percent of that cost was paid from state grants.
- Participated in a grant-funded water quality study of Lake Sammamish (1985 to 1993) involving multiple jurisdictions.
- Formed a public/private partnership (1990 to 1994) to construct a combined nutrient-control/detention facility at a development in the Lake Sammamish watershed (the Lakemont dry pond filtration facility).
- Obtained grants to monitor the effectiveness of three nutrient-control techniques recommended in the Lake Sammamish study (1993 to 1995).

More recent examples of actions taken consistent with this policy include

- The City Council created a Phantom Lake Watershed Committee and authorized expenditure of funds in support of the Committee to develop a plan for the creation of a Lake Management District (LMD) in a 1995 resolution (Resolution No. 5968). The resolution states that "Future City funding of additional Phantom Lake watershed studies and projects will be contingent on implementation of a Lake Management District, in which the City will participate as a partner along with other stakeholders in the watershed." The Committee defined lake water quality goals, and reviewed and developed an LMD plan for $1.4 million in water quality and quantity improvements over a 7-year period. The Committee subsequently decided not to pursue formation of the LMD.
- The City performs ongoing lake water quality monitoring and operates and/or maintains Phantom Lake water quality capital investments as part of the 1985 to 1993 Phantom/Larsen Lakes Restoration project at an annual cost of $40,000 to $65,000.
- The Utilities Department managed a City-funded study of Lake Bellevue (2006). The study is the City's contribution towards a resident-proposed public/private partnership

to obtain grant funding for lake quality improvements. The study determined that managing in-lake phosphorus cycling (76 percent of phosphorus loading to the lake) would be more effective at improving lake quality than targeting phosphorus entering the lake from urban runoff (24 percent of phosphorus loading to the lake).

The work related to Phantom/Larsen Lakes and Lake Sammamish emphasized the need for ongoing lake and watershed management to limit phosphorus loading. Ongoing management involves maintaining capital facilities and working to minimize the entry of phosphorus and other pollutants into the lakes.

Reducing pollution can be accomplished by:

1. Ensuring BMPs are required of new development and redevelopment, including BMPs for nutrient control.
2. Continuing to educate businesses and residents on their role in lake protection.

The City routinely requires BMPs to control runoff from new development and redevelopment (except for very minor projects). Consistent with requirements in Ecology's Stormwater Management Manual, the City requires BMPs for water quality control, not just quantity control (see the Storm and Surface Water System Plan surface water quality policy).

In addition to requirements that apply city-wide, nutrient controls are warranted on new development and redevelopment in the watersheds of Lake Sammamish and Phantom and Larsen Lakes. This is consistent with minimum requirement #6 in Ecology's Stormwater Management Manual, which requires jurisdictions to impose more stringent water quality controls where needed to protect water quality sensitive areas. In particular, the Ecology manual requires nutrient controls (such as constructed wetlands and specially designed wet ponds) for new development and redevelopment in watersheds draining to receiving waters where nutrients are a concern.

The Phase II NPDES Municipal Stormwater Permit also requires local jurisdictions to have educational programs. In Bellevue, education programs are already in place.

Because a lake is affected by residents and businesses throughout its watershed, and lakes are highly valued by many residents, the Utilities Department should involve public outreach when undertaking its lake management activities. For example, the Utilities Department could create a watershed management group to involve watershed businesses and residents in setting lake management priorities related to flood control and water quality.

**<u>Encourage the Use of Low Impact Development Techniques Where Feasible</u>**

**Policy**

*The Utilities Department encourages and promotes the appropriate use of low impact development techniques where feasible, and may participate in research and/or use incentives to foster implementation and increased awareness of low impact development benefits toward achieving a sustainable urban environment.*

**Discussion**

Several existing policies in the City of Bellevue Comprehensive Plan, Environmental Element, and the Bel-Red Subarea Plan support low impact development implementation. Low impact development is generally defined as a stormwater management strategy that emphasizes conservation and use of existing natural site features integrated with distributed, small-scale stormwater controls to more closely mimic natural hydrologic patterns in residential, commercial, and industrial settings. Promoting and implementing low impact development practices are important to achieving the goals of the City and the Utilities Department. The Utilities Department has an opportunity to play a pivotal role in low impact development promotion and implementation because of its responsibility for stormwater management. As such, the Utilities Department may consider:

1. Promoting and encouraging the use of low impact development and/or voluntary upgrades to flow control standards, and developing incentives as needed to target specific surface water problems or basins;
2. Providing technical support to customers to identify and encourage opportunities for incorporating low impact development techniques;
3. Creating educational and/or promotional materials that describe the benefits of low impact development and seek low impact development grant or partnership opportunities;
4. Advocating for public education on low impact development topics; and
5. Collaborating with other City departments to facilitate the community's use of low impact development by updating codes, standards, regulations, and procedures to remove barriers to and encourage the use of low impact development techniques.

***Regional Policy***

**Regional, State, and Federal Policy Involvement**

**Policy**

*The Utilities Department shall seek to:*

- *Accomplish the City's environmental goals to promote a healthy environment, public safety and a strong economy, essential to maintaining the city's and region's quality of life;*
- *Ensure reasonable and prudent fiscal policies on behalf of ratepayers;*
- *Ensure state and federal requirements are fiscally prudent and achievable; and*
- *Maintain local control and flexibility in policy/program implementation.*

*The Utilities Department's role is to develop proposed guiding principles/interests for Council approval. Pursuant to Council direction, the Utilities Department role in monitoring, influencing, developing and implementing regional, state, and federal surface water policies and programs may include:*

- *Influencing legislation through lobbying and written/verbal testimony;*
- *Participating in rule-making;*
- *Reviewing technical documents;*
- *Serving on regional forums and coalitions, advisory committees and work groups; and*
- *Providing technical and staff support for Council members serving on regional, state, or federal storm and surface water committees.*

**Discussion**

The Utilities Department has participated in the development and implementation of regional, state, and federal drainage policies and programs for a number of reasons:

- Water resource issues are by nature regional; watersheds cross jurisdictional boundaries, and different watersheds can often benefit from similar flood control and water quality protection programs.
- The City has a direct interest in helping shape state and federal water resource mandates because they affect utility costs, can result in rigid programs that preclude more creative or effective local ones, or can result in requirements that are impossible to meet.
- The City has been looked to as a regional and national leader with respect to storm and surface water management and therefore has had an opportunity to serve as a technical resource and participant in shaping policy and programs to benefit the City.
- The City benefits from learning about the experiences and technical expertise of others.

The Utilities Department’s role in developing regional, state, and federal policies and programs varies from influencing legislation, rules, and policy to sharing technical information and participating in joint studies. Through its involvement, the Utilities Department seeks to achieve the City’s environmental goals while keeping down costs to utility rate payers and maintaining local control and flexibility.

## Waterworks Utility Financial Policies

These policies were last updated December 2010 and are included below without revisions or amendments.

***Introduction***

The Waterworks Utility is the financial consolidation of the Sewer, Storm & Surface Water and Water Utilities of the City of Bellevue for debt rating and coverage purposes as established in Ordinance No.'s 2169, 2845, 3158 and 4568. It pledges the strengths and revenues of the three separate Utilities for the common financial good while keeping each Utility financially separate for budgeting, rate-setting, revenues, expenditures, debt and accounting.

These "Financial Policies" apply uniformly to the Sewer, Storm & Surface Water and Water Utilities with few, unique exceptions which are identified separately. This update reflects changes consistent with current long-range financial planning, particularly with regard to renewal and replacement funding, the use of debt and rate policies. They supersede the Financial Policies, which were adopted under Resolution No. 5967 in 1995.

These policies do not stand-alone. They must be taken in context with the other major City and Utilities documents and processes. For instance, each Utility has its own Comprehensive Plan, which documents its unique objectives, planning, operations and capital needs. These Comprehensive Plans have historically had a 20-year planning horizon. Future Comprehensive Plans will need to evaluate long term renewal and replacement of aging facilities, much of which were constructed in the 1950's and 1960's during periods of high growth rates and are approaching the end of their useful life. Life cycle costs should be considered in planning the future capital facilities and infrastructure needs.

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The City has a seven-year City-wide Capital Investment Program (CIP) Plan which is updated with each biennial budget cycle. All major City capital projects are included. Generally, they are described as over $25,000; involving new physical construction, reconstruction or replacement; and involving City funding. The CIP identifies the level and source of funding for each project. The CIP includes specific sections for each Utility which identify near-term capital projects consistent with each current Utility Comprehensive Plan and several projects of general scope including renewal and rehabilitation, capital upgrades, response to growth and other system needs.

***General Policies***

**Fiscal Stewardship**

The Waterworks Utility funds and resources shall be managed in a professional manner in accordance with applicable laws, standards, City financial practices and these Financial Policies.

**Discussion**

It is incumbent on Utility management to provide professional fiscal management of utility funds and resources. This requires thorough knowledge of and conformance with the City financial management processes and systems as well as applicable laws and standards. It also requires ongoing monitoring of revenues and expenses in order to make decisions and report to City officials, as needed, regarding the status of Utilities financing. Independent financial review, analysis, and recommendations should be undertaken as needed.

**Self-sufficient Funding**

Each utility shall remain a self-supporting enterprise fund.

**Discussion**

The revenues to each Utility primarily come from customer charges dependent on established rates. State law requires that utility funds be used only for utility purposes. Since each Utility has somewhat differing service areas, it is essential for ratepayer equity that they be kept financially separate and accountable. The City's General Fund can legally contribute to the Utility funds but does not. The City budgeting process includes a balanced and controlled biennial Utility budget. This requires careful preparation of expense and revenue projections that will be reviewed by City management, the Environmental Services Commission, the general public and the City Council prior to approval of any change in Utility rates.

**Comprehensive Planning Policies**

*Comprehensive Plans for the Water and Sewer Utilities shall be completed or updated every six years, using a 20-year planning horizon or greater and considering life cycle costs to identify funding needs. Comprehensive Storm & Surface Water System Plans and individual Storm & Surface Water Basin Plans will be completed and updated as required using similar criteria for planning infrastructure needs.*

Substantial portions of the City utility systems were constructed in the 1950s and 1960s. These systems are approaching the end of their useful life as illustrated on the following Exhibit 1 - Watermain Replacement Spending and Exhibit 2 - Sewermain Replacement Spending. The storm & surface water infrastructure is of similar age but has not been graphed. It most likely has a relatively shorter expected life span. The object is to determine and follow a survivor curve replacement schedule rather than the replacement schedule based on age alone. Assumptions for survivor curves and useful lives are revisited

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periodically. These were assessed in 2004 and updated for the most recent engineering and financial findings. Significant changes include the adjustment of replacement costs to current price levels, categorization of pipe assets based on expected useful lives, and replacement of major non-pipe Utility assets such as pump stations and reservoirs. The exhibits illustrate an example survival replacement curve based on preliminary estimates only. As real needs are determined, they will replace the estimated curves.

Renewal and/or replacement will require substantial reinvestment in the future and have major rate impacts if large portions of the systems have to be replaced in relatively short periods of time. The actual useful life of underground utilities is difficult to determine and the best available data is needed to be able to plan for the orderly and timely renewal and/or replacement. For this purpose, the comprehensive plans need to have at least 20 year planning horizons and must address the aging of the Utility systems.

Long term comprehensive planning for the Utility systems is required in order to assure that the future financial needs are anticipated and equitable funding plans can be developed. In order to keep funding plans current, comprehensive plans need to be updated approximately every six years (as required by State law for water and sewer comprehensive plans). These Financial Policies will then be reviewed and updated as needed.

***Capital Investment Program Policies***

**General Scope**

*The Utilities Capital Investment Program (CIP) will provide sufficient funds from a variety of sources for implementation of both short- and long-term capital projects identified in each Comprehensive Plan and the City-wide Capital Investment Program as approved by the City Council.*

*Financial planning for long-term capital investment shall be based on principles that result in smooth rate transitions, maintain high credit ratings, provide for financial flexibility and achieve inter-generational equity.*

**Discussion**

These near-term capital projects are usually identified in each Comprehensive Plan which also provides the criteria and prioritization for determining which projects will be constructed. Several projects of general scope are also included to allow for on-going projects that are less specifically identified due to their more inclusive nature.

In addition to these near-term projects, funding should be provided for long-term capital reinvestment in the system to help minimize large rate impacts as the systems near the end of their useful life and have to be renewed or replaced. Ordinance No. 4783 (attached) established a Capital Facilities Renewal & Replacement (R&R) Account for each Utility to provide a funding source for this purpose. Other policies describe how this Account is to be funded and expended.

A reinvestment policy by itself, without some form of planned and needed expenditure, could lead to excessive or unneeded expenditures, or conversely unnecessary accumulations of cash reserves. The reinvestment policy needs to tie the planned expenditures over time with a solid, long-term financial plan that is consistent with these policies.

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The actual needs for the renewal/replacement expenditures should relate to the on-going need to minimize system maintenance and operating costs consistent with providing safe and reliable service, the age and condition of the system components, and any regulatory or technical obsolescence. In essence, plant should be replaced when it is needed and before it fails. As such, the goal setting measure of how much is an appropriate annual or periodic reinvestment in renewals and replacement of existing assets should be compatible with the age and condition of the infrastructure and its particular circumstances.

**Funding Levels**

Funding for capital investments shall be sustained at a level sufficient to meet the projected 20 year (or longer) capital program costs.

Funding from rate revenues shall fund current construction and engineering costs, contributions to the Capital Facilities Renewal and Replacement (R&R) Account, and debt service, if any.

Inter-generational equity will be assured by making contributions to and withdrawals from the R&R Account in a manner which produces smooth rate transitions over a 20 year (or longer) planning period.

On an annual basis, funding should not fall below the current depreciation of assets expressed in terms of historical costs less any debt principal payments.

**Discussion**

These policies are based on the experience gained by developing a long-term Capital Replacement Funding Plan. In absence of such a plan, the range of capital investment funding should fall between the following minimum and maximum levels:

- The minimum annual rate funding level would be based on the current depreciation of assets expressed in terms of historical costs, less any debt principal payments.
- The maximum annual rate funding level would be based on the current depreciation of assets expressed in terms of today's replacement costs, less any debt principal payments.
- The minimum level based on historical cost depreciation approximates the depletion of asset value. Some of the cost may already be in the rates in the form of debt service. Depreciation less debt principal repayment provides a minimum estimate of the cost of assets used. Any funding level below this amount defers costs to future rate payers and erodes the Utility’s equity position, which puts the Utility’s financial strength and viability at risk.
- The maximum level based on replacement cost depreciation represents full compensation to the utility, in terms of today's value, for the depletion of assets. The replacement cost depreciation, again less debt principal repayment, provides a ceiling to an equitable definition of "cost of service".

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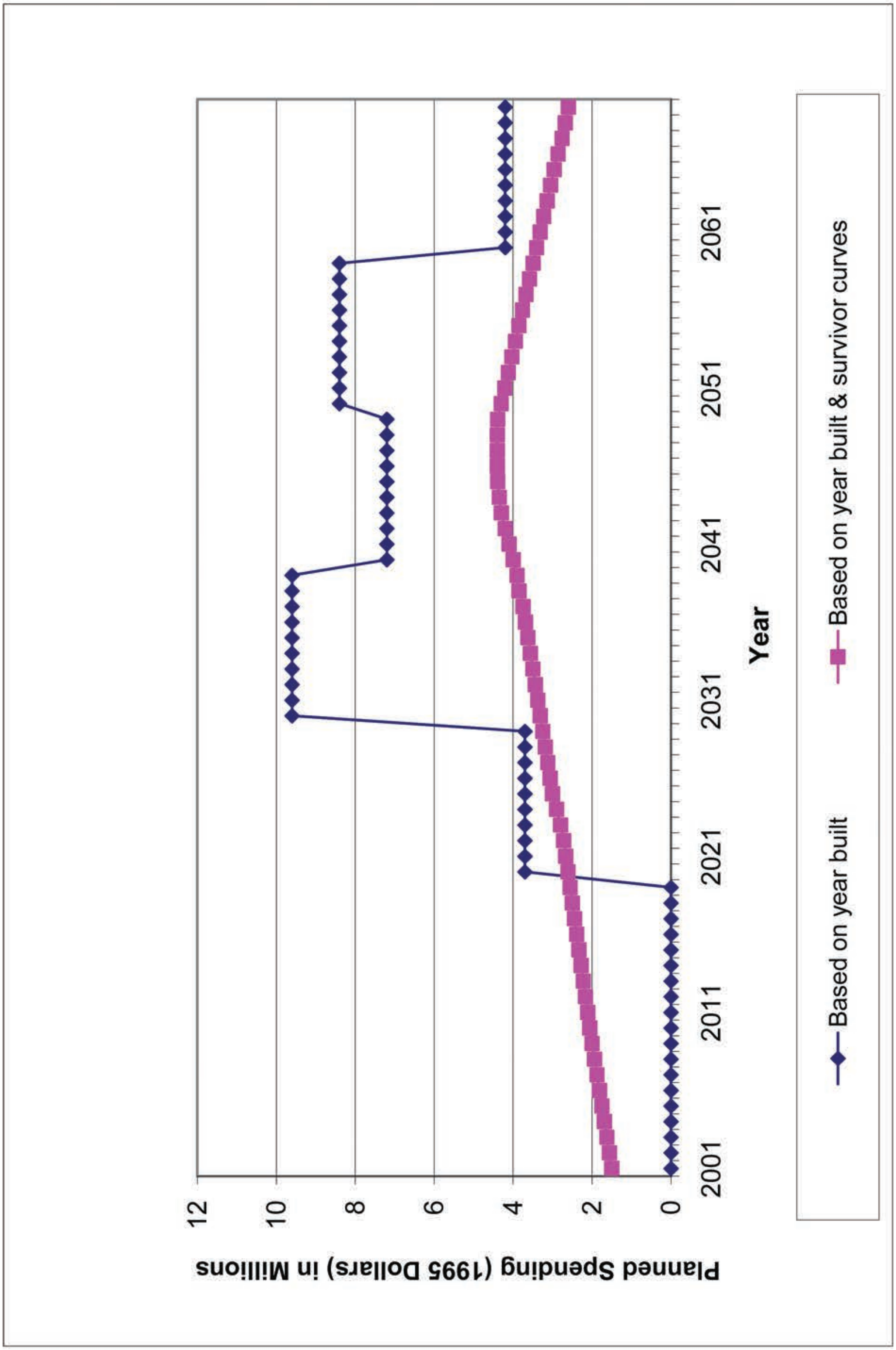


**Exhibit 1. Watermain replacement spending (based on 75-year expected asset life).**
**Source: Comprehensive Financial Management Policies Figure 9-1. Utilities Department Financial Policies**

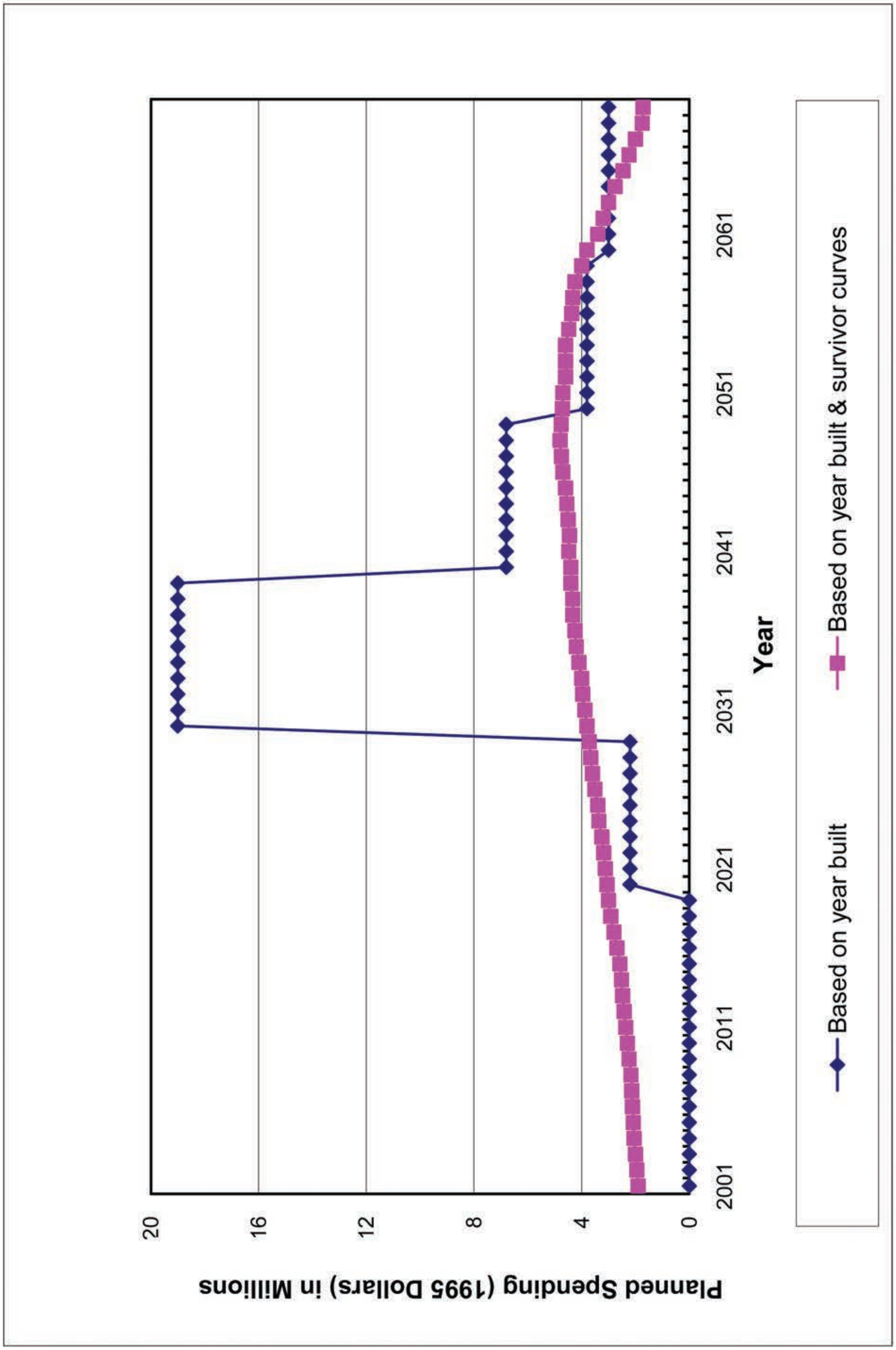


**Exhibit 2. Sewermain replacement spending (based on 75-year expected asset life).**
**Source: Comprehensive Financial Management Policies Figure 9-1. Utilities Department Financial Policies**

ORIGINAL

WP0459C-ORD
06/27/95

CITY OF BELLEVUE, WASHINGTON

ORDINANCE NO. 4783

AN ORDINANCE creating utility capital replacement accounts for the Water, Sewer and Storm and Surface Water Utilities within the Utility Capital Investment Fund for the purpose of accumulating funding for long term replacement of utility facilities.

WHEREAS, the Utilities 1995 Cost Containment Study prepared by Financial Consulting Solutions Group, Inc. (FCSG) recommends that current utility rates recover from the ratepayers amounts which at a minimum are equal to the depreciated value of the original cost of utility facilities and at a maximum are amounts equal to the replacement value of utility infrastructure; and

WHEREAS, FCSG recommends that utility funds not needed for current expenditure be placed in a replacement account to be used in the future in combination with current revenues and/or debt financing to replace capital facilities nearing the end of their useful life; and

WHEREAS, implementation of FCSG's recommendations would promote intergenerational rate equity and provide more stable rates to customers over the long term; and

WHEREAS, the Council desires to make an initial, 1995 deposit of $600,000 in savings from the Water Fund into the new capital replacement account for the Water Utility; now, therefore,

THE CITY COUNCIL OF THE CITY OF BELLEVUE, WASHINGTON, DOES ORDAIN AS FOLLOWS:

Section 1. The purpose of this ordinance is to establish capital facilities replacement accounts within the Utility Capital Investment Fund in order to assure a future funding source for replacement of utility facilities nearing the end of their useful life. The City Council will determine each year, as part of the adoption of the utilities operating budgets, how much, if any, utility revenue during the upcoming year shall be designated for transfer to a replacement account. The City Council may also authorize the receipt of other funds directly into these capital facility replacement accounts. Once deposited the funds will accumulate with interest. The decision regarding when and how to utilize such accumulated funds for the replacement of utility facilities will be made as part of the Utility Comprehensive Plans and Utility Capital Investment Program approval process.

# ORIGINAL

WP0459C-ORD
06/27/95

Section 2. The following new accounts are established in the Utility Capital Investment Fund:

Capital Facilities Replacement Account - Sewer
Capital Facilities Replacement Account - Water
Capital Facilities Replacement Account - Storm and Surface Water

Section 3. There is hereby authorized the 1995 transfer from the Water Utility Operating Fund to the Capital Facilities Replacement Account - Water the amount of $600,000.

Section 4. This ordinance shall take effect and be in force five days after its passage and legal publication.

PASSED by the City Council this 24th day of July, 1995, and signed in authentication of its passage this 24th day of July, 1995.

(SEAL)

Donald S. Davidson, DDS, Mayor

Approved as to form:

Richard L. Andrews, City Attorney

Richard L. Kirkby, Assistant City Attorney

Attest:

Myrna L. Basich, City Clerk

Published July 28, 1995

The purpose of long-term capital reinvestment planning is to establish a target funding level which is based on need and to assure that funds will be available for projected capital costs in an equitable manner. The best projection of the needed capital reinvestment is based on a "survival curve" approach, approximating the timing and cost of replacing the entire system. This defines the projected financial needs and allows determination of equitable rate levels, funding levels for current capital construction and engineering, contributions to and withdrawals from the R&R Account, and the use of debt, if any. It also provides a means to project depreciation on both historical cost and replacement cost basis which are used to calculate minimum and maximum funding levels, debt to fixed asset ratios, and debt coverage levels, if debt is used. These later measures can be used to assure that the financial plan meets conventional standards.

**Use of Debt**

*The Utilities should fund capital investment from rates and other revenue sources and should not plan to use debt except to provide rate stability in the event of significantly changed circumstances, such as disasters or external mandates.*

*Resolution No. 5759, attached, states that the City Council will establish utility rates/charges and appropriations in a manner intended to achieve a debt service coverage ratio (adjusted by including City taxes as an expense item) of approximately 2.00". Please note that the Moody's Investor Services rating should be Aa2 (not Aa as stated in Resolution No. 5759).*

**Discussion**

The Utilities are in a strong financial position and have been funding the Utility Capital Investment Program from current revenues for a number of years. The current 20 year and 75 year capital funding plans conclude that the entire long-term renewal and replacement program can be funded without the use of debt if rates are planned and implemented uniformly over a sufficient period. Customers will pay less over the long-term if debt is avoided, unless it becomes truly necessary due to unforeseen circumstances such as a disaster or due to changes in external mandates. Having long-term rate stability also assures inter-generational equity without the use of debt because the rate pattern is similar to that achieved by debt service.

Use of low interest rate debt such as the Public Works Trust Fund loans, by offering repayment terms below market rates, investment earnings or even inflation, should be viewed as a form of grant funding. When available or approved, such sources should be preferred over other forms of rate or debt funding, including use of available resources. Since such reserves would generate more interest earnings than the cost of the loan, the City's customers would be assured to benefit from incurring such debt.

**Capital Facilities Renewal & Replacement (R&R) Account**

**Sources of Funds**

*Revenues to the R&R Account may include planned and one-time transfers from the operating funds, transfers from the CIP Funds above current capital needs, unplanned revenues from other sources, Capital Recovery Charges, Direct Facility Connection Charges and interest earned on the R&R Account.*

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WP0254C-RES
03/03/94

CITY OF BELLEVUE, WASHINGTON

RESOLUTION NO. 5759

A RESOLUTION relating to financial policy for the Waterworks Utility and adopting a debt service coverage policy for the Waterworks Utility

WHEREAS, the City of Bellevue is consistently recognized for its prudent financial management; and

WHEREAS, the City of Bellevue's Water and Sewer Bonds are currently rated Aa by Moody's Investor Services and AA- by Standard & Poor's Corporation, which are considered to be excellent ratings; and

WHEREAS, these excellent ratings result in lower interest costs on the City's Water and Sewer bonds, which, in turn, may result in lower water, sewer and storm drainage costs; and

WHEREAS, it is important to the rating agencies and to the financial community that the City articulate its financial goals for its Waterworks Utility; and

WHEREAS, a desirable debt service coverage ratio, the ratio of revenues available for debt service to the annual debt service requirement, positively affects the Utility's bond ratings; and

WHEREAS, the City Council deems it in the City's best interest to establish a debt service coverage policy target for the purpose of protecting its current bond rating and to allow for the development of financial projections, NOW, THEREFORE,

THE CITY COUNCIL OF THE CITY OF BELLEVUE, WASHINGTON, DOES RESOLVE AS FOLLOWS:

Section 1. The City Council hereby adopts the following debt service coverage policy for the bonds issued by the City's Waterworks Utility.

The City Council will establish utility rates/charges and appropriations in a manner intended to achieve a debt service coverage ratio (adjusted by including City taxes as an expense item) of approximately 2.00. The City Council authorizes the Waterworks Utility to utilize this policy in development of pro

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forma projections which will be disseminated to the bond rating agencies and to the financial community generally.

PASSED by the City Council this 7th day of March, 1994, and signed in authentication of its passage this 8th day of March, 1994.

(SEAL)

Donald S. Davidson, DDS, Mayor

Attest:

Myrna L. Basich

Myrna L. Basich, City Clerk

**Use of Funds**

*Funds from the R&R Account shall be used for system renewal and replacement as identified in the CIP. Because these funds are invested, they may be loaned for other purposes provided repayment is made consistent with the need for these funds and at appropriate interest rates. Under favorable conditions, these funds may be loaned to call or decrease outstanding debt.*

**Accumulation of Funds**

*The R&R Account will accumulate high levels of funds in advance of major expenses. These funds will provide rate stability over the long-term when used for this purpose and should not be used for rate relief.*

**Discussion**

Revenues from Capital Recovery Charges, Direct Facility Connection Charges and interest earned on the R&R Account are deposited directly into the R&R Account. Other transfers are dependent on the long-term financial forecast, current revenues and expenses, and CIP cash flows. The long-term financial forecast projects a certain funding level for the transfers to the CIP and the R&R Accounts. Rates should be established consistent with this long-term financial plan and will generate the funds for such transfers. Setting rates at lower levels may result in current rate payers contributing less than their fair share for long-term equity.

R&R Account funds must only be used for the purpose intended; that is, the long-term renewal and replacement of the utility systems. They may be used for other purposes if it is treated as a loan, which is repaid with appropriate interest in time for actual R&R needs for those funds.

These accounts are each projected to accumulate tens of millions of dollars in order to meet the anticipated costs for the actual projects at the time of construction. It is the intent of these policies that these reserve funds will not be used for other purposes or to provide rate relief because that would defeat the long-term equity and could lead to the need for the use of debt to fund the actual needs when they occur.

***System Expansion and Connection Policies***

**<u>Responsibilities</u>**

*Those seeking or who are required to have Utility service are responsible for extending and/or upgrading the existing Utility systems prior to connecting.*

**Discussion**

It is the responsibility of the party seeking Utility service to make and pay for any extensions and/or upgrades to the Utility systems that are needed to provide service to their property. The extensions or upgrades must be constructed to City standards and requirements. This is typically accomplished through a Developer Extension Agreement with the City wherein requirements are documented, standards are established, plans are reviewed and construction is inspected and approved. Service will not be provided until these requirements are met.

The philosophical underpinning of this policy is that “growth pays for growth”. Historically, developers constructed much of the City’s utility infrastructure. If the infrastructure eventually would benefit more than the initial developer, the Utility signed a Latecomer Agreement to reimburse the original financier from charges to those connecting and receiving benefit at a later point in time. When the cost to extend and/or upgrade the system to accommodate development or redevelopment is beyond the means of a single developer, the Utility has employed a variety of methods to assist in the construction of the necessary infrastructure. Local Improvement Districts (LID's) historically have been used to provide financing for infrastructure for new development, with the debt paid over time by the property owners. Most of the older Utilities infrastructure was financed by this method.

The Utility has in some cases up-fronted the infrastructure construction for new development or redevelopment from rate revenues which are later reimbursed with interest, in whole or in part, by subsequent development through direct facility connection charges (see Cost Recovery Policy). Examples are the water and sewer infrastructure for Cougar Mountain housing development and Central Business District (CBD) redevelopment. Another example is the use of the Utility's debt capacity to provide for development infrastructure whereby the City sells bonds at lower interest rates than can private development, constructs the infrastructure, and collects a rate surcharge from the benefited area to pay off the bonds. Examples of this type of financing include the Lakemont development drainage infrastructure and the Meydenbauer Drainage Pipeline in the CBD.

**<u>Cost Recovery</u>**

*The Utility shall establish fees and charges to recover Utility costs related to 1) development services, and 2) capital facilities that provide services to the property.*

*The Utility may enter into Latecomer Agreements with developers for recovery of their costs for capital improvements, which benefit other properties in accordance with State law. The Utility will add an administrative charge for this service.*

**Discussion**

In general, Utility costs related to development services are recovered through a variety of fees and charges. There are fixed rates for some routine services based on historical costs and inflation. There are fixed plus direct cost charges and applicable overhead for developer extension projects to cover the lengthy but variable level of development review and inspection typically required to implement these projects. These rates are reviewed periodically to ensure that the cost recovery is appropriate.

When the means of providing the infrastructure to serve a new development or redevelopment are beyond the means of a single developer, the Utility may elect to assist the developer by using LID's, Latecomer Agreements, special debt (to be paid by special rate surcharges), up-fronting the costs from Utility rate revenues (to be reimbursed by future developers with interest through direct facility connection charges), or other lawful means. It is the intent of this policy to fully recover these costs, including interest, so as to reimburse the general rate payer.
Latecomer charges allow cost recovery for developers and private parties, for facilities constructed at their own expense and transferred to the Utility for general operation. Properties subsequently connecting to those systems will pay a connection charge that will be forwarded to the original individual or developer or the current owner depending on the terms of the Latecomer Agreement. The Utility collects an overhead fee on this charge for processing the agreements and repayments.

**<u>Use of Revenues</u>**

*All capital-related revenues such as Capital Recovery Charges and Direct Facility Connection Charges should be deposited in the Capital Facilities Renewal & Replacement Accounts.*

**Discussion**

Capital Recovery Charges are collected from all newly developed properties in the form of monthly rate surcharges over a ten year period to reimburse the Utility for historical costs that have been incurred by the general rate base to provide the necessary facilities throughout the service area. These Capital Recovery Charges should be deposited in the Capital Facilities Renewal & Replacement Accounts.

Direct Facility Connection Charges are collected for capital improvements funded by the City as described above in Section 2 under Cost Recovery. The total cost of the improvement is allocated to the area of benefit and distributed on an equitable basis such as per residential equivalent unit. Interest is collected in accordance with State law.

**Affordable Housing Consideration**

*The Utility shall base connection charges on the number of units allowed under the basic zoning. Only incremental cost increases will be charged to affordable housing units.*

**Discussion**

The City has adopted bonus density incentives for developers to build units specifically for affordable housing. Under historical practices these additional units would have been charged the same connection fee as all other units, resulting in a lower cost per unit for all units. While this is fair, it does not create any incentive to develop affordable housing. By charging only the incremental increased facility cost to the affordable housing units, all developers who include an affordable housing component will experience no increase in cost because of the affordable bonus density units. The cost per unit for affordable units is thereby reduced. The cost per unit for all other units, based on underlying land use zoning, remains unchanged.

*Rates shall be set at a level sufficient to cover current and future expenses and maintain reserves consistent with these policies and long-term financial forecasts.*

*Changes in rate levels should be gradual and uniform to the extent that costs (including CIP and R&R transfers) can be forecast.*

*Cost increases or decreases for wholesale services shall be passed directly through to Bellevue customers.*

*Local and/or national inflation indices such as the Consumer Price Index (CPI) shall be used as a basis for evaluating rate increases.*

*At the end of the budget cycle, fund balances that are greater than anticipated and other one-time revenues should be transferred to the R&R account until it is shown that projected R&R account funds will be adequate to meet long-term needs, and only then used for rate relief.*

**Discussion**

A variety of factors including rate stability, revenue stability, the encouragement of practices consistent with Utility objectives and these Waterworks Utility Financial Policies are considered in developing Utility rates. The general goal is to set rates as low as possible to accomplish the on-going operations, maintenance, repair, long-term renewal and replacement, capital improvements, debt obligations, reserves and the general business of the Utility.

Long-range financial forecast models have been developed for each of the Utilities, which include estimated operating, capital and renewal/replacement costs for a 75 year period in order to plan for funding long-term costs. Operating costs are assumed to remain at the same level of service and don’t include impacts of potential changes due to internal, regional or federal requirements. Capital costs, including renewal/replacement, are projected based on existing CIP costs and approximated survival curves for the infrastructure. The models are used to project rate levels that will support the long-term

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costs and to spread rate increases uniformly over the period. This is consistent with the above policy that changes in rate levels should be gradual and uniform. Uniform rate increases help ensure that each generation of customers bears their fair share of costs for the long-term use and renewal/replacement of the systems.

The biennial budget process provides an opportunity to add to or cut current service levels and programs. The final budget, with the total authorized expenses including transfers to the CIP Fund and the R&R Account, establishes the amount of revenue required to balance the expenses. A balanced budget is required. The budgeted customer service revenue determines the level of new rates. For example, if the current rates do not provide sufficient revenues to meet the projected expenses, the costs have to be reduced or the rates are increased to make up the shortfall.

For purposes of these policies, wholesale costs are defined as costs to the Utilities from other regional agencies such as the Seattle Public Utilities and/or the Cascade Water Alliance (CWA), and King County Department of Natural Resources for sewer treatment and any agreed upon Storm & Surface Water programs. Costs which are directly based on the Utilities' revenues or budgets such as taxes, franchise fees and reserve levels that increase proportionally to the wholesale increases are included within the definition of wholesale costs.

***Rate Policies***

<u>**Rate Levels**</u>

*Rates shall be set at a level sufficient to cover current and future expenses and maintain reserves consistent with these policies and long-term financial forecasts.*

*Changes in rate levels should be gradual and uniform to the extent that costs (including CIP and R&R transfers) can be forecast.*

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Long-range financial forecast models have been developed for each of the Utilities, which include estimated operating, capital and renewal/replacement costs for a 75 year period in order to plan for funding long-term costs. Operating costs are assumed to remain at the same level of service and don’t include impacts of potential changes due to internal, regional or federal requirements. Capital costs, including renewal/replacement, are projected based on existing CIP costs and approximated survival curves for the infrastructure. The models are used to project rate levels that will support the long-term costs and to spread rate increases uniformly over the period. This is consistent with the above policy that changes in rate levels should be gradual and uniform. Uniform rate increases help ensure that each

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generation of customers bears their fair share of costs for the long-term use and renewal/replacement of the systems.

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**Debt Coverage Requirements**

*Utility rates shall be maintained at a level necessary to meet minimum debt coverage levels established in the bond covenants and to comply with Resolution No. 5759 which establishes a target coverage ratio of 2.00.*

**Discussion**

Existing revenue bond covenants legally require the City's combined Waterworks Utility, which includes the Water, Sewer and Storm & Surface Water Utilities, to maintain a minimum debt coverage ratio of 1.25 on a combined basis. In 1994, Council also adopted Resolution No. 5759 that established a policy, which mandates the Utilities to maintain a target combined debt coverage ratio of approximately 2.00, to further protect the City's historically favorable Utility revenue bond ratings. Water and Sewer Utility resources are counted in the official coverage calculation though Storm & Surface Water is responsible for the major portion of current outstanding Utility debt. Requiring Storm & Surface Water to separately maintain the minimum 1.25 legal debt coverage level and to move toward the 2.00 level will help ensure that necessary coverage requirements are met, and that customers of the other Utilities will not be unfairly burdened with the cost of meeting this obligation. It also ensures that sufficient coverage is available to the Water and Sewer Utilities if they need to incur debt.

**Frequency of Rate Increases**

*Utility rates shall be evaluated annually and adjusted as necessary to meet budgeted expenses including wholesale cost increases and to achieve financial policy objectives.*

**Discussion**

In 1996, the City changed to a biennial budget process and adopted a two-year Utilities budget including separate rates for 1997 and 1998. This practice will continue on a biennial basis. However, Utility rates will be evaluated on an annual basis and adjusted as necessary to ensure that they are effectively managed to achieve current and future financial policy objectives. Annual rate reviews will include preparation of forecasts covering a twenty-year period for Utility revenues, expenditures, reserve balances and analysis of the impact of various budgetary elements (i.e. CIP transfers, R&R Account transfers, debt service costs, debt coverage levels, operating expenses, and reserves) on both current and future rate requirements.

**<u>Rate Structure - Sewer</u>**

*The Sewer Utility rate structure will be based on a financial analysis considering cost-of-service and other policy objectives, and will provide for equity between customers based on use of the system and services provided.*

**Discussion**

In 1993, a Sewer Rate Study was performed that resulted in Council approval of a two-step, volume-based rate structure for single-family customers based on winter average metered water volumes instead of the traditional flat rate structure. Flat rate structures were seen as inequitable to low-volume customers who paid the same amount as high volume customers. Rates are based on the level of service used, rather than the availability of service.

The revenue requirements are based on the "average" single-family winter average volume calculated annually from the billing database. The charge for an individual customer is based on their winter average and then charged at that level each bill for the entire year to avoid charging for irrigation use. The customer's winter average is based upon the prior year's three winter bills because the current year's bills include winter months, which would result in the average constantly changing. Customers without prior winter averages to use for a basis are charged at the "average" volume until they establish a “winter-average” or sufficient evidence that their use is significantly different than the "average".

**<u>Rate Structure - Storm & Surface Water</u>**

*The Storm & Surface Water Utility rate structure will be based on a financial analysis considering cost-of-service and other policy objectives, and will provide adjustments for actions taken under approved City standards to reduce related service impacts.*

**Discussion**

In the existing Storm & Surface Water rate structure, customer classes are defined by categories of development intensity, i.e., undeveloped, lightly developed, moderately developed, heavily developed and very heavily developed. Based on theoretical run-off coefficients for each of these categories, higher rates are charged for increasing degrees of development to reflect higher run off resulting from that development. Under this structure, billings for both residential and non-residential customers are determined by total property area and rates assigned to applicable categories of development intensity. Customers providing on-site detention to mitigate the quantity of run-off from their property receive a credit equal to a reduction of one rate level from their actual development intensity. Property classified as "wetlands" is exempt from Storm & Surface Water service charges.

Large properties, over 35,000 square feet, with significantly different levels of intensity of development may be subdivided for rate purposes in accordance with Ordinance No. 4947. In addition, properties with no more than 35,000 square feet of developed area in the light and moderate intensity categories may, at the option of the owner, defer charges for that portion of the property in excess of 66,000 square feet. The property owner may apply for a credit against the Storm & Surface Water charge when they can demonstrate that the hydrologic response of the property is further mitigated through natural conditions, on-site facilities, or actions of the property owner that reduce the City’s costs in providing Storm & Surface Water quantity or quality services.

Future design of a water quality rate component will also use cost-of-service principles to assign defined water quality costs to customer classes, according to their proportionate contribution to Utility service demand. It is anticipated that these rate structure revisions will also provide financial incentives to customers taking approved actions to mitigate related water quality impacts.

**<u>Rate Structures - Water</u>**

*The water rate structure will be based on a financial analysis considering cost-of service and other policy objectives, and shall support water conservation and wise use of water resources.*

**Discussion**

The water rate structure consists of fixed monthly charges based on the size of the customer's water meter and volume charges, which vary according to customer class and the actual amount of water that the customer uses. There are three different meter rate classifications: domestic, irrigation, and fire standby. The different charges are based on a cost-of-service study.

State law and the wholesale water supply contract require the Utility to encourage water conservation and wise use of water resources. Seattle first established a seasonal water volume rate structure for this purpose in 1989 with higher rates in the summer than in the winter. In 1990, based on a water rate study and the desire to provide a conservation-pricing signal to our customers, the City adopted an increasing block rate structure for local volume rates. The rate structure was revised in 1991 to pass through an increase in wholesale water costs, which also included a higher seasonal water rate for summer periods. The block water rate structure was revised again in 1997, to incorporate new cost-of-service results from a 1996 water rate study.

An increasing block rate structure, charges higher unit rates for successively higher water volumes used by the customer. The current rate structure has four rate steps for single-family and three rate steps for multi-family customers, based on metered water volumes. All irrigation  metered water is charged at a separate, higher rate. Because non-residential classes do not fit well in an increasing block rate approach due to wide variations in their size and typical water use requirements, seasonal rates, with and without irrigation, were established for these customers. This rate structure will be thoroughly reviewed, as more historical information is available on the effect of the increasing block and seasonal rate structure.

In 1997, an additional category of fire protection charges was added for structures and facilities that benefit from the City water system but are not otherwise being charged for water service. For example, a number of homes are on private wells but are near a City-provided fire hydrant and enjoy the additional benefit of fire protection yet didn't pay for the benefit on a water bill. The charge is based on an equivalent meter size that would normally serve the facility. It also applies to facilities that have terminated water service but still stand and require fire protection, such as homes or buildings that are not occupied.

**<u>Rate Equity</u>**

*The rate structure shall fairly allocate costs between the different customer classes. Funding of the long-term Capital Investment Program also provides for rates that fairly spread costs over current and future customers.*

**Discussion**

As required under State law, Utility rates will provide equity in the rates charged to different customer classes. In general, rates by customer class are designed to reflect the contribution by a customer group to system-wide service demand, as determined by cost-of-service analysis. The RCW also authorizes utility rates to be designed to accomplish "any other matters, which present a reasonable difference as a ground for distinction". For example, increasing water rates for irrigation and higher levels of use is allowed to encourage the wise use and conservation of a valuable resource. Formal rate studies are periodically conducted to assure ongoing rate equity between customer classes and guide any future rate modifications necessary to support changing Utility program or policy objectives.

Contributions from current rates to the R&R Account also provide equity between generations of rate payers by assuring that each user pays their fair share of capital improvements, including renewal and replacement, over the long-term. (See sections B and D under the Capital Investment Program Policies).

**Rate Uniformity**

*Rates shall be uniform for all utility customers of the same class and level of service throughout the service area. However, special rates or surcharges may be established for specific areas, which require extraordinary capital investments and/or maintenance costs. Revenues from such special rates or surcharges and expenses from capital investments and/or extraordinary maintenance shall be accounted for in a manner to assure that they are used for the intended purposes.*

**Discussion**

The City Water and Sewer Utilities originally formed by assuming ownership of three separate operating water districts and two sewer districts. In the assumption agreements, each included a provision that requires the Utility to uniformly charge all customers of the same class throughout the entire service area. The basic rates are set for all customers, inside and outside of the City, except for local utility taxes in Bellevue, and franchise fees in Clyde Hill, Hunts Point, Medina, and Yarrow Point. Unlike the Water and Sewer Utilities, the Storm & Surface Water Utility only serves areas within the City limits.

Under state law, Utilities are required to charge uniform rates to all customers in a given customer class, regardless of property location within the service area. The only exception permitted is for certain low-income customers (see below).

However, when conditions in particular service areas require extraordinary capital improvement or maintenance costs to be incurred, special rates or surcharges may be adopted to recover those costs directly from properties contributing to the specific service demand, instead of assigning that cost burden to the general Utility rate base. This will only apply for costs above and beyond normal operations, maintenance and capital improvements. For example, rate surcharges are being used to recover debt service costs for capital facilities in Lakemont and the CBD. An additional rate surcharge for Lakemont properties is being collected for extraordinary maintenance costs of the storm water treatment facility.

**Rate Assistance**

*Rate assistance programs shall be provided for specific low-income customers as permitted by State law.*

**Discussion**

Continual increases in all utility rates have had a significant impact on low-income customers. The City has adopted a rate discount or rebate program for disabled customers and senior citizens over 62 years old and with income below certain levels as permitted under State law and defined in Ordinance No. 4458. It has two levels, one discounting Utility rates by 40 percent and the other level by 75 percent, based on the customer's income level. Customers that indirectly pay for Utility charges through their rent can obtain a rebate for the prior year's Utility charges on the same criteria. The City also rebates 100 percent of the Utility Tax for these customers. The cost of this program is absorbed in the overall Utility expenses and is recovered through the rate base. The General Fund provides for the Utility tax relief.

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There are other low-income customers who are less than 62 years old and currently receive no Utility rate relief. However, the City has instituted a separate rebate of Utility taxes for qualified low-income citizens.

### *Operating Reserve Policies*

**Operating Reserve Levels**

*The Utilities' biennial budget and rate recommendations shall provide funding for working capital, operating contingency, and plant emergency reserve components on a consolidated basis in accordance with the attached Summary of Recommended Consolidated Reserve Levels table and as subsequently updated.*

**Discussion**

Utility resources not spent for operations remain in the fund and are referred to as reserves. At the end of each year, these funds are carried forward to the next year's budget and become a revenue source for funding future programs and operations. Under the terms of this policy, the Utility budget is targeted to include a balance of funds for the specific purposes stated above. While included in the total operating budget, these reserves will only be available for use pursuant to these reserve policies. Setting aside these budget resources in the reserve balance will help to ensure continued financial rate stability in future Utility operations and protect Utility customers from service disruptions that might otherwise result from unforeseen economic or emergency events.

The working capital reserve is maintained to accommodate normal cyclical fluctuations within the two month billing cycle and during the budget year. These are higher for Water than for Sewer and Storm & Surface Water due to more variable revenues and expenditures. They are described in terms of a number of days of working capital as a percentage of a full-year's budget.

The operating contingency reserve protects against adverse financial performance or budget performance due to variations in revenues or expenses. Again, the Water Utility is most susceptible to year-to-year variations in water demand. They are described in terms of percentages of budgeted wholesale costs and operations and maintenance (O&M) costs.

The plant emergency contingency reserve provides protection against a system failure at some reasonable level. The Storm & Surface Water Utility requires the largest reserve due to the risk of major flood damage to Utility facilities. Water and Sewer Utilities protect against the cost of a major main break or failure. These do not protect against the loss of facilities that are covered by the City's Self-Insurance to which the Utilities pay annual premiums nor are they sufficient to respond to a major disaster, such as a major earthquake.

The reserves of the three utilities have historically been treated separately. This protects against cross-subsidy, thereby retaining rate equity for each utility, each of which has different customers. However, it results in higher reserve targets, with more funds retained than otherwise may be needed. Sharing risks among utilities can reduce reserves. This does not require that reserves actually be consolidated into a single fund, but simply that individual reserve targets reflect the strength provided by the availability of cross-utility support. Under the "consolidated" scenario, cash shortfalls in one reserve could be funded through inter-utility loans, to be repaid from future rates. The likelihood that a serious shortfall would occur in more than one fund at the same time is slight and the benefits of lower overall reserve levels will benefit rate payers. Also, the rate policies and the debt coverage policy will ensure that there will be a strong financial response to any significant shortfall. The risk is considered a prudent financial policy

For this purpose, O&M costs are the entire annual operating budget of the Utility less the annual debt service, Capital Investment Program transfers and R&R Account transfers. Independent reserve levels are the levels that would be required by an individual Utility Fund (Water, Sewer and Storm & Surface Water) at any point in time to cover financial obligations if any one of the three reserve components where called for; i.e., working capital, operating contingency or plant emergency. At any single time, the full independent reserve levels should be available for the individual stated purpose, again because it is unlikely that all three components would be called for at once. For example, the Water Utility needs $100,000 available for an emergency repair but it is not likely that the Sewer Utility will need $100,000 and the Storm & Surface Water Utility will need $500,000 all at the same point in time.

The consolidated basis is for budget and rate setting purposes only, to reduce the total revenue requirement by considering the reserve risk shared between the three utilities. The dual reserve levels should be considered as circumstances evolve.

In 2004, the Financial Consulting Solution Group (FCSG) performed an analysis of recommended

changes to the Water Utility’s working capital and operating contingency reserves to reflect the new wholesale water contract with CWA and to update reserve levels for current conditions. Under the new contract, billing practices for wholesale costs have changed as follows:

1. CWA payment occurs before the associated revenues are collected, resulting in a greater lag between wholesale expense and when revenues are collected.

2. CWA payments are distributed over the whole year based on predetermined percentages and not based on actual consumption during the year. Due to seasonal revenue variation, there is an accumulative deficit in revenues prior to the peak revenue period.

In addition, the total costs to Bellevue are now largely fixed for the year due to the “take or pay” nature of the contract between CWA and Seattle Public Utilities. This shifts the risk during a poor water sales year to the City since there will not be a corresponding reduction in water purchase costs when water sales are down.

Changes in both billing practices as well as the fixed nature of the wholesale costs will result in an increase in required reserves for working capital and operating contingency for the Water Fund.

As part of their 2004 analysis, FCSG recommended increasing working capital operating reserve requirements for the Water fund from 48 days of budgeted O&M costs (excluding debt service and capital funding) to 70 days. The change was primarily related to an expected increase in seasonal revenue variation resulting from Cascade’s fixed monthly billing percentages. However, our experience has been that since implementing the change in 2005 there has been essentially no increase in seasonal revenue variation. As a result, beginning in 2011, working capital operating reserve requirements for the Water fund will be reduced from 70 days of budgeted O&M costs (excluding debt service and capital funding) to the original level of 48 days.

**<u>Management of Operating Reserves</u>**

*Related to the recommended target reserve levels, a working range of reserves is established with minimum and target levels. Management of reserves will be based on the level of reserves with respect to these thresholds, as follows:*

*Above target - Reserve levels will be reduced back to the target level by transferring excess funds to the R&R Accounts in a manner consistent with the long-range financial plan.*

*Between Minimum and Target - Rate increases would be imposed sufficient to ensure that*

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*1) reserves would not fall below the minimum in an adverse year; and 2) reserves would recover 50% of the shortfall from target levels in a normal year. Depending on the specific circumstances, either of these may be the constraint, which defines the rate increase needed.*

*Below Minimum - Rate increases would be imposed sufficient to ensure that even with adverse financial performance, reserves would return at least to the minimum at the end of the following year. To meet this "worst case" standard, a year of normal performance would be likely to recover reserve levels rapidly toward target levels.*

*Negative Balance - Reserves would be borrowed from another utility to meet working capital needs. Similar to the "below minimum" scenario, rate increases would be imposed sufficient to ensure that even with adverse financial performance, reserves would return from the negative balance to at least the minimum target at the end of the following year, which would allow for loan repayment within that time frame.*

**Discussion**

"Adverse financial performance" or "worst case" are defined by the 95% confidence interval based on historical patterns. The worst case year is currently defined as a year with sales volumes 15% below the sales volume for a normal year. This was determined by using statistical measurements of sales volumes for 18 years with a 95% confidence interval. That is, in any given year there is only a 5% chance that the worst case year would be more than 15% below the normal year. Another way to say the same thing is that in 19 out of 20 years the worst case year would not be more than 15% below the normal year.

Maintaining the 95% confidence interval, as more and more data becomes available, a worst case year could change upward or downward from the 15% variation from a normal year.

The recommended reserve policies are premised on the vital expectation that reserves are to be used and reserve-levels will fluctuate. Although budget and rate planning are expected to use the target reserve number, reserve levels planned to remain static are by definition unnecessary. It is therefore important to plan for managing the reserves within a working range between the minimum and target levels as stated in the above policies. There may be situations in short-range financial planning where reserves are maintained above target levels to overcome peaks in actual expenses.

In the event of an inter-utility loan, the balance for the borrowing utility would essentially be any cash balance less the amount owed. The lending utility would count the note as a part of its

reserves, so that it does not unnecessarily increase rates to replenish reserves that are loaned.

In this management approach, there is still a risk that a major plant emergency could exceed the amount reserved. Such a major shortfall would require rate action to assure a certain level of replenishment in one year. To avoid rate spikes due to this type of action, they should be considered on a case-by-case basis. This will provide the flexibility to use debt or capital reserves in lieu of operating reserves to cover the cost and allow a moderated approach to replenishing reserves out of rates.

**Asset Replacement Reserves**

*Utility funds will maintain separate Asset Replacement Accounts to provide a source of funding for future replacement of operating equipment and systems.*

*Anticipated replacement costs by year for the upcoming 20-year period, for all Utility asset and equipment items, will be developed as a part of each biennial budget preparation process. Budgeted contribution to the Asset Replacement Account will be based on the annual amount needed to maintain a positive cash flow balance in the Asset Replacement Account over the 20-year forecast period. At a* *minimum, the ending Asset Replacement Account balance in each Utility will equal, on average, the next year's projected replacement costs for that fund.*

*The Utilities Department will observe adopted Equipment Rental Fund (ERF) and Information Services budget policies and procedures in formulating recommendations regarding specific equipment items to be replaced.*

**Discussion**

Providing reserves for equipment and information technology systems replacement allows monies to be set aside over the service life of these items to pay for their eventual replacement and alleviate one-time rate impacts that these purchases might otherwise require. Annual revenues set aside for this purpose will be based on aggregate Utility asset replacement cash flow needs over the long-term forecast period, instead of individual asset replacement amounts.

This strategy will allow Utilities to minimize the progressive build-up of excess Asset Replacement Account balances that would result from creating and funding separate reserve accounts for individual Utility asset and equipment items.

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# CHAPTER 5 STORM AND SURFACE WATER MANAGEMENT ROLES, RESPONSIBILITIES, AND COMMUNICATIONS

The regulation and management of storm and surface water is distributed across local (city and county), state, and federal agencies. In the City of Bellevue, regulation and management is distributed City-wide. This chapter clarifies the City's roles and responsibilities at a general level, identifies types of information sharing that occurs regarding storm and surface water issues within the Utilities Department, and documents areas needing additional communication or clarification. This chapter provides an overview of these topics and is not intended to be a detailed examination of the actions needed for specific management activities. The local, state, and federal agency roles are documented in Chapter 3 Community Vision and Regulatory Framework.

## City of Bellevue Roles and Responsibilities

The primary roles and responsibilities for managing and regulating the environmental actions affecting storm and surface water resources in the City of Bellevue are shared across various departments, including Utilities, Planning and Community Development, Development Services, Transportation, Parks and Community Services (Parks), and the City Manager's Office. The inter-relationships among the roles and responsibilities of different departments are described below.

### *Regulations and Enforcement*

As noted in Chapter 3, federal and state regulations, policies, and permits apply to and set the policies and standards for protecting the City's natural resources including shorelines, open space, wetlands, streams, floodplains, groundwater, and lakes. Many state and federal programs have overlapping requirements, permitting authority, and associated enforcement actions. Within the City, Development Services is the primary department tasked with developing and enforcing land use regulations (commercial, industrial, multi-family and single family residential, parks and roads), shorelines, steep slopes, wetlands, streams, floodplains, groundwater (limited to designating Critical Aquifer Recharge Areas within the Critical Areas Ordinance), and lakes. The Utilities Department is responsible for enforcing stormwater regulations (runoff control and water quality) and coordinating the City-wide implementation and documentation of National Pollutant Discharge Elimination System (NPDES) permit compliance.

### *Planning*

Several departments are tasked with planning roles that affect surface water, groundwater, and associated aquatic habitat. The Planning and Community Development Department plans for city and geographic sub-areas through the City's Comprehensive and Land Use Plans. These plans focus on land use, and integrate stream and wetland planning through critical areas and shoreline regulations. The plans recognize these natural areas are a critical component to the quality of life for residents and visitors. Other departments have plans that support the City Comprehensive Plan, such as this Storm and Surface Water System Plan, Parks Master Plans, and Transportation Comprehensive Plans.

For site-specific planning, shared planning responsibilities for aquatic resources and environmental actions sometimes reveal conflicting objectives. For instance, Utilities, Parks, and Transportation could include the same water body in their individual plans for storm and surface water, parks, or transportation improvements. The Parks Department may plan for trails and other recreational access to the surface water; however, the Utilities Department may plan for flood storage in that same area. While there are methods to allow flooding of recreational areas, the facilities must be specially designed to accommodate inundation. Without coordination, these two plans could be in conflict. The Utilities Department may develop basin plans or conduct targeted studies to identify holistic methods for addressing flooding/detention, water quality, or stream habitat problems for surface waters that cross parks, other publicly owned land, and private properties.

The Transportation Department and the City Manager's Office do not have direct planning roles for surface water or groundwater. However, City objectives of economic development and mobility may result in policy, capital investments, or operational actions that influence surface water or groundwater.

***Operations and Maintenance***

**Public (Utilities Department) Stormwater System**

The term "public stormwater system" as used in this document refers only to stormwater facilities located in public rights-of-way, on Utilities Department-owned land, or in easements dedicated specifically to the City of Bellevue Utilities Department. The Utilities Department is responsible for the inspection, operation, and maintenance of these facilities. The Utilities Department operations and maintenance activities are explained more fully in Chapter 9 Utilities Operations.

**Private Stormwater Systems**

The operations and maintenance responsibilities for private stormwater systems generally lie with the entity that owns the stormwater facilities. Businesses and other private property owners are responsible for the stormwater facilities and collection systems (e.g., roof gutters and downspouts) on their property. The Utilities Department is authorized to inspect the system's function and enforce maintenance requirements for privately owned stormwater facilities. The private facilities are integral to the storm and surface water system, and must be maintained by the property owner to the levels specified in the stormwater maintenance standards to mitigate off-site flooding and protect water quality. It is the property owner's responsibility to maintain storm conveyance systems, such as culverts, pipelines, and other facilities located on private property.

***Capital Projects***

Construction of stormwater detention, conveyance, and water quality facilities is the responsibility of various City departments, as well as private property owners. As manager of the public storm and surface water system (which includes open streams), the Utilities Department invests in capital projects for stormwater management (conveyance and water quality), riparian habitat improvements on City-owned reaches of streams, and flood control. The City's Transportation Department and the Washington State Department of Transportation (WSDOT) are responsible for capital road projects in Bellevue; such projects often require upgrades or modifications to the storm and surface water system. The Parks Department develops and constructs capital projects in City parks, including stormwater facilities, stream and wetland restoration, as well as recreational and upland projects.

Capital projects often require inter-department coordination and planning to ensure multiple City objectives are met and to avoid conflicts. The Utilities Department's Capital Investment Program is explained in more detail in Chapter 9 Utilities Operations. Private property owners plan and implement capital projects on shorelines, wetlands, streams, and floodplains. All capital projects, whether public or private, are required to meet environmental permit criteria, codes, and engineering standards.

***Education***

The Utilities and Parks Departments share responsibility for providing educational information and volunteer opportunities to the public to advance environmental stewardship of Bellevue's surface water resources. The Utilities Department conducts programs related to pollution prevention and stewardship of aquatic resources for the general community, commercial property owners and managers, residential property owners, and schools. Since 2007, many of these educational programs have become mandatory for compliance with Bellevue's NPDES Municipal Stormwater Permit. The Utilities Department also manages volunteer programs that provide opportunities for the public to engage in aquatic restoration and monitoring activities. Many of these volunteer and outreach activities occur on Parks properties. These programs are more fully described in Chapter 10 Public Education and Outreach. The Parks Department provides educational activities within city parks and open spaces that are focused on terrestrial and wetland ecology and other naturalist programs in which the parks are often used as outdoor classrooms. Particular highlights are the Mercer Slough Environmental Education Center, where the City partners with the Pacific Science Center to offer programs on nature and sustainable building to children and adults; and Lewis Creek Park and Visitor Center, which showcases LID practices and ranger-led programs on a variety of nature-related topics.

***Emergency Response***

The Utilities Department has primary responsibility for responding to emergencies related to surface water within Bellevue. This responsibility includes providing a 24-hour emergency hotline to report flooding of streets or structures, pollutant spills, and illegal discharge of pollutants to the storm and surface water system. Staff is on call 24 hours, 7 days a week, to respond to reported surface water emergencies.

The Utilities Department has prepared an Emergency Management Plan that is consistent with and supports the City of Bellevue Emergency Operations Plan and emergency response plans at the regional, state, and federal levels. The Utilities Department Emergency Management Plan is also consistent with the federal government's National Incident Management System requirements and guidelines and has adopted the Incident Command System model for coordinating its emergency and disaster response efforts. In case of a large event, the Utilities Department may be called to participate in the Emergency Operations Center to coordinate City efforts across multiple departments and effectively respond to priority needs.

***Water Quality/NPDES Municipal Stormwater Permit***

The Utilities Department is the City's lead for coordinating documentation of City-wide compliance with the NPDES Permit. Most City departments have some responsibility under this permit; for example, the Civic Services and Parks Departments develop and implement pollution prevention plans for their facilities. The Fire Department implements best management practices (BMPs) during fire training and system testing to avoid surface water contamination. Information Services tracks implementation of permit-required activities. The Utilities Department provides numerous permit compliance activities, ranging from illicit discharge detection and elimination to conducting stormwater facilities inspection and cleaning at specified intervals. These activities are further described in Chapter 9 Utilities Operations and the City of Bellevue's 2011 Stormwater Management Program (City of Bellevue 2011).

***Chinook Salmon Recovery (ESA) Regional and City-wide Coordination***

In 1999, the Bellevue City Manager directed the Utilities Department to lead City efforts for Endangered Species Act (ESA) response and planning. The Utilities Department has primary responsibility for supporting Bellevue-elected officials at the Lake Washington/Cedar/Sammamish Salmon Recovery Council, participating in regional planning efforts, and coordinating local implementation of recovery plans.

The primary role of local government in the conservation of listed salmon is the protection and restoration of aquatic habitat. Appendix A provides examples of the types of activities the Utilities

Department conducts for aquatic habitat and stormwater, such as spill response and capital projects to improve fish passage through culverts, as well as invasive plant management.

***Monitoring and Modeling***

Many federal and state regulations that guide the City's environmental actions require monitoring and reporting of environmental conditions and compliance. Within the City, the Utilities Department monitors surface water flow in streams and at regional stormwater detention facilities for operational purposes, and supports operation of U.S. Geological Survey flow gauges at lower Kelsey Creek and Lake Sammamish. The Utilities Department also operates temporary gauges for special projects, basin plans, or other planning or operational purposes. Water quality monitoring is conducted in Phantom and Larsen Lakes to assess whether water quality objectives defined as part of a lakes restoration project continue to be met. As priorities and funding allow, the Utilities Department also conducts limited trend monitoring of aquatic life in streams throughout Bellevue because they serve as environmental indicators of water quality and stream health (Appendix A). King County monitors the water quality of streams and rivers that are crossed by their major wastewater conveyance pipes or facilities, as well as Lake Washington and Lake Sammamish. The numbers of locations for monthly monitoring have evolved over the last couple of decades; currently, three stream sites are being monitored within Bellevue. The Utilities Department manages the hydrologic and hydraulic computer modeling of floodplains and individual drainage basins. The Parks Department monitors water quality at public swimming beaches, in conjunction with King County, and also monitors upland conditions, such as tree canopy, to evaluate potential parks operational impacts to streams. Water level elevation is monitored at Phantom Lake, Lake Sammamish, and Lake Bellevue. No monitoring roles or responsibilities are currently identified for City departments for shorelines, wetlands, groundwater, or Lake Washington.

## Communication and Coordination

Stormwater issues are raised in many different City efforts; interdepartmental coordination and ongoing communication are key to successful outcomes.

The City's Comprehensive Plan and Sub-Area Plan updates conducted by the Planning and Community Development Department often include policy discussions about aquatic resources. These issues affect multiple departments, including the Utilities Department. All affected departments are provided opportunities for input and discussion during those updates.

Transportation planning and projects usually involve stormwater issues including detention, water quality and stream crossing regulatory requirements, which are similar to any other development. In addition, the Transportation Department often leads coordination efforts for WSDOT and Sound Transit projects requiring substantial intergovernmental efforts for mitigation and project planning. For such projects, the Transportation Department convenes the Utilities, Development Services, Planning and Community Development, and Parks Departments to identify stream and wetland mitigation options, prioritize locations, and review proposals for large regional projects.

The Parks Department develops open space and specific park master plans. These plans sometimes include trails and facilities within riparian corridors and wetlands on properties partially owned or managed by the Utilities Department. Communication between departments is necessary to assure that multiple department objectives, such as regional trail linkages, flood storage, or salmon recovery are acknowledged and addressed.

The Civic Services Department is responsible for maintaining stormwater facilities on City properties not owned or operated by the Parks or Utilities Departments. The Utilities Department provides technical assistance for stormwater management questions, on request.

Even within the Utilities Department, cross-divisional communication is critical. For instance, the Engineering Division within the Utilities Department is responsible for planning, designing, and constructing Storm and Surface Water Utility capital improvements. Once projects are constructed, they are maintained and operated by the Operations and Maintenance Division. Upfront communication between the Engineering and Operations and Maintenance Divisions ensures that capital projects are designed for ease of operation and maintenance, as well as initial construction design. Another example is the outreach and education programs within the Resource Management and Customer Service Division. These programs are designed based on coordination with other divisions to optimize meeting multiple objectives such as fulfilling NPDES municipal stormwater education requirements, coordinating with the Stream Team Program, and meeting the Utilities Department outreach priorities. Coordination and communication have improved with implementation of standardized format and repository of standard operating procedures. Ongoing improvements are realized through regular, topical meetings between division managers and technical staff.

## Interaction with Non-stormwater Programs

Managing City storm and surface water involves coordinating with other municipal utilities and city activities where those programs affect stormwater. These non-stormwater programs may affect the volumes and flow rates of stormwater and the levels of pollutants in stormwater discharged to Bellevue streams, lakes, and city infrastructure.

### *Water*

Delivering drinking water to City customers requires the regular maintenance of City water mains—the pipelines used to deliver water to consumers. City water mains are regularly flushed to maintain the highest level of drinking water quality. Almost 100 miles of water main are flushed each year, which pushes about 10 million gallons of chlorinated and pH-buffered water from the drinking water system. To prevent stream erosion and harmful changes to surface water quality, the preferred method of flushing is to divert the discharged water into the sanitary sewer system. Unfortunately, in many areas this option is not viable due to sewer pipe capacity. In this case the water is treated, according to NPDES Municipal Stormwater Permit guidelines, to remove chlorine and return the water to a neutral pH before it is discharged to the stormwater system.

Water main breaks can lead to large unanticipated releases of drinking water to the storm drainage network, including local streams, lakes, and wetlands. These emergencies require communication among drinking water, water quality, and surface water staff, as well as immediate notification to the Washington State Department of Ecology (Ecology).

### *Wastewater*

Wastewater pipes typically rely on gravity to convey sewage, so they are usually located in low areas. They often follow drainage routes for a portion of their length. Sometimes the sewer pipe trenches intercept shallow groundwater flowing along its natural pathway to a stream. Stormwater that enters the City's wastewater system (termed inflow and infiltration, or I&I) reduces wastewater pipe capacity, adds to wastewater treatment costs, and can lead to wastewater overflows, affecting local streams, lakes, and wetlands. This infiltration can also reduce stream baseflows. Infiltration quantity is strongly influenced by local soils and topography, as well as sewer pipe condition. The growing interest and use of low impact development (LID) techniques in Bellevue could further accelerate infiltration and therefore affect wastewater capacity. Infiltrating stormwater in some areas could raise shallow groundwater tables and increase the amount of stormwater entering the buried wastewater pipes.

Wastewater pipes that are connected to stormwater systems are illegal and pose serious risks to human health and the environment. The Utilities Department has a program to investigate suspected accidental or illicit connections and requires the responsible party to remedy any such cross-connections.

***Street Maintenance***

The National Marine Fisheries Service (NOAA Fisheries) has approved a Regional Road Maintenance Program under the ESA (Regional Road Maintenance Technical Working Group 2001). Bellevue participates in this program, following those guidelines for physical, structural, and managerial BMPs, designed to reduce the impact of road maintenance activities on surface water and aquatic habitat. The Regional Road Maintenance ESA Program provides guidelines regarding staff training about storm and surface water issues; describes management tools that are appropriate for different surface water situations; addresses emergency response issues; and provides guidance for agency research and adaptive management practices. Participation in this program provides critical information for the Bellevue street maintenance staff about surface water issues and management techniques.

Street maintenance is fundamental to the protection of the life and safety of Bellevue residents. This is particularly true in winter when applying salt or sand to icy roads can reduce sliding and prevent accidents. However, after application, the applied sand and salts can move from roads to streams, wetlands, and lakes through the drainage network. To reduce these impacts, the City has established priority road sand and salt removal route maps, so the sand or salt is removed first from streets that drain to salmon streams or other sensitive aquatic habitat.

## Opportunities for Additional Coordination

***Groundwater***

Groundwater protection is the purview of the state through Ecology. While not a groundwater regulator, the Utilities Department's activities often benefit groundwater quality. The Utilities Department regulations to protect surface water quality and encourage natural runoff also help to protect groundwater quality and quantity. For example, natural drainage practices that use infiltration provide water quality treatment before it is infiltrated into the ground. These natural drainage practices are intended to reduce surface water runoff and increase the amount of groundwater without detrimental impacts to groundwater. Pollution prevention efforts, such as private drainage inspections, system repairs, elimination of illicit discharges, and facilities pollution plans help protect groundwater quality. Operational techniques and capital projects, such as building and operating bioswales and detention ponds, also provide treatment and indirectly protect groundwater. Education and outreach efforts that change people's behaviors contribute to groundwater protection, as well as the protection of surface water quality.

***Stream Planning and Projects***

A number of departments have roles in protecting and managing streams and wetlands. Currently, the Utilities Department provides technical and field expertise to the Transportation Department and the Development Services Department to mitigate stream and wetland impacts related to shoreline management and state transportation projects such as Interstate 405, State Route 520, and Link light rail. These mitigation efforts are done on a project basis. Comprehensive city-wide planning among departments is important for optimal results. The Utilities Department also conducts various aquatic habitat protection, restoration, and evaluation activities (Appendix A).

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#### *Stormwater and Streams Maintenance*

As mentioned above, “public stormwater facilities” are defined as those pipes and structures owned or managed by the Utilities Department. The Utilities and Transportation Departments have a Memorandum of Understanding that the Utilities Department will operate and maintain road stormwater facilities, once constructed. The Parks and Civic Services Departments maintain stormwater facilities on their properties independently.

The Utilities Department conducts stream maintenance activities on public lands to operate and maintain stormwater facilities, minimize street flooding, and enhance fish passage to primary spawning habitat for salmon protected under the ESA. Standard operating procedures have been established for stream activities such as beaver dam management that affect flooding and salmon passage. The Utilities Department management responsibilities for Utilities-owned properties include removal of invasive weeds and other required stream maintenance. Other City departments and private property owners are responsible for stream maintenance on their properties.

#### *Capital Projects in Parks*

The Utilities and Parks Departments have occasionally proposed stream and wetland capital projects in areas of contiguous or cooperatively owned Utilities and Parks properties. Projects for stream stability, salmon habitat improvements, wetland trails, and park infrastructure projects have potentially conflicting objectives. Cross-departmental coordination is critical to identifying and avoiding conflicting proposals and balancing multiple needs. Staff-level communications have been employed successfully to resolve such conflicts.

#### *Aquatic Education*

The Utilities and Parks Departments share responsibility for environmental education and stewardship activities within park lands. Coordination is critical to ensure key messages are consistent. The Development Services Department provides some outreach for critical areas and shorelines, such as development vegetation templates for native vegetation along shorelines. The Utilities Department conducts similar educational programs about native vegetation along shorelines as well as natural yard care. Coordination ensures that despite this overlap in roles, messages remain consistent, and efficiencies are maintained by keeping programs unique.

#### *Environmental Permitting*

Environmental regulations can be complex and confusing to people not regularly involved in aquatic projects. Permit requirements change frequently and there may be conflicting or overlapping requirements among the Development Services Department critical areas or shoreline permits, the Utilities Department permits and agreements with property owners. Environmental permits issued by Washington Department of Fish and Wildlife, the U.S. Army Corps of Engineers, and Ecology each have their own permit conditions. For example, shoreline management requirements may dictate using native vegetation where shorelines are disturbed, but the Utilities Department often works on private utility easements and needs to replace disturbed vegetation with the type of plants that previously existed. Opportunities to streamline the environmental permitting process are continuously examined among the respective stakeholder groups to resolve these types of issues.

### Summary of Key Roles and Communication Needs

Similar to the City’s transportation network, the storm and surface water system touches every part of the city, and is affected by the actions of almost every City department, as well as other agencies, jurisdictions, and private citizens. Managing such a system requires extensive coordination and communication, both internally within the City government and externally with the public and regulatory agencies. The following roles and responsibility statements are key to understanding how storm and surface water responsibilities are administered:

- The state is responsible for groundwater; City departments share responsibility for coordinating with the state on groundwater issues.
- No single entity can plan and implement stream and wetland projects or mitigation opportunities.
- The Utilities Department manages the Transportation and Utilities Departments' stormwater facilities, but not those of other City departments. (This has created confusion about the maintenance role of the Utilities Department among other departments.)
- Roles for aquatic stewardship outreach and education among the Utilities, Parks, and Development Services Departments could be more clearly defined, including a statement of desired outcome, City-wide.
- There are overlapping and sometimes conflicting permit requirements from local, state, and federal agencies. For those priority issues, sufficient City of Bellevue staff time will need to be allotted to resolve such discrepancies and make any necessary code and regulatory changes.

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# CHAPTER 6 CURRENT CONDITIONS - STATE OF THE STORM AND SURFACE WATER SYSTEM

This chapter describes the state of the natural and constructed storm and surface water system as it exists in the first decade of the 21st century. Existing or baseline conditions of the storm and surface water system are described and used to evaluate the system that forms the basis of the Storm and Surface Water Basin Plan recommendations. This chapter is organized into three major categories 1) Flood Protection, 2) Water Quality Protection, and 3) Fish and Wildlife Habitat. Storm and Surface Water System Plan recommendations in each of these categories are the outcome of the analysis.

## Existing Conditions of the Storm and Surface Water System

***Background***

The City of Bellevue is part of the larger Puget Sound drainage basin. Located in the Washington State Cedar/Sammamish Water Resource Inventory Area, stormwater originating in Bellevue either drains to Lake Sammamish east of the city or Lake Washington to the west. Lake Sammamish itself is a tributary to Lake Washington via the Sammamish River. Lake Washington drains to the Puget Sound via the Lake Washington Ship Canal (Ship Canal) at Montlake, then to Lake Union, and eventually through the Hiram M. Chittenden Locks (Ballard Locks) in Seattle to the Puget Sound. The storm and surface water system in Bellevue consists of a series of open streams, a network of pipes, storage facilities, lakes, ponds, wetlands, collection, and treatment facilities all in a mix of public and private ownership. As described in the City's original Drainage Master Plan (KCM-WRE/YTO 1976), the mosaic of public and private drainage system components work together to perform the system's critical functions of conveyance, flood protection, and environmental protection.

**Historic logging in western Washington created long-term impacts to streams and watersheds.**

Bellevue's storm and surface water system is a direct result of the topography, current and historic land uses, regulations, and geology of the area. The city covers approximately 32 square miles. There are about 79 miles of streams within the city limits; approximately 13 miles of large-lake shoreline (Lake Washington and Lake Sammamish); and 3 small lakes (Larsen Lake, Lake Bellevue, and Phantom Lake). Figure 6-1 shows the open channel stream system in Bellevue, including the 26 drainage basins.

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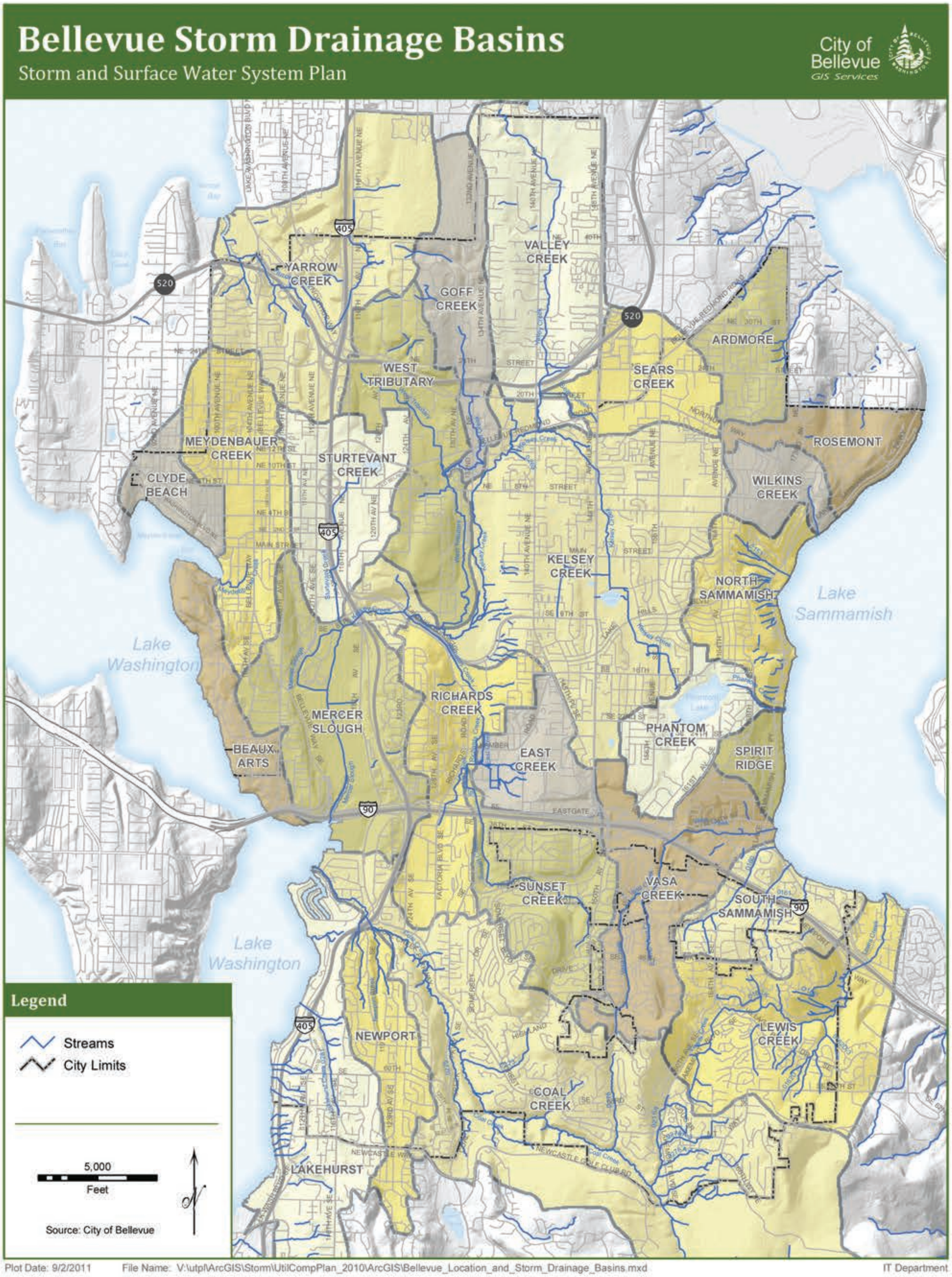


**Figure 6-1. City of Bellevue streams and drainage basins.**

Appendix B-1 provides the Bellevue Stormwater Basin Fact Sheets for each drainage basin. Stormwater systems collect and convey the portion of total rainfall that is not otherwise lost to evaporation, plant uptake, or soil storage. The "excess" rainfall flows through pipes and streams while making its way to the receiving water body. Establishing the existing conditions of the storm and surface water system requires a brief discussion of the variables that contribute to the state of the system. The quality, volume, and rate of stormwater runoff is influenced by rainfall patterns, soils, geology of the area, land surfaces, vegetative cover, and social behavior.

### *Rainfall*

Storm and surface water systems are intrinsically related to climate. The timing and distribution of rainfall events in the Pacific Northwest have sculpted the physical, biological, and chemical balances of open stream systems. Bellevue receives on average 34.3 inches of rain each year (see Figure 6-2 Annual Rainfall). The Pacific Northwest rainfall pattern is distinctly divided into two seasons—a dry summer and fall followed by a prolonged rainy season in the winter. On average, 71 percent of the annual precipitation falls during the wet season from October through April (see Figure 6-3 Average Monthly Rainfall).

Because most of the precipitation occurs during the winter months, plant uptake and evaporation have marginal effects on rainfall consumption. The remainder must either be stored in the soil profile or it becomes the source of water for streams. In October, when the rainy season begins, the soil profile has been largely depleted of excess moisture because the growing season has just ended. The availability of soil moisture storage is an important component for overall stormwater management. Flood control, water quality improvement, and habitat protection are directly affected by how much of the total amount of precipitation becomes stormwater runoff rather than being infiltrated into the soil profile, or lost to plant uptake and evaporation. What remains, the excess precipitation, becomes the stormwater runoff that the Utilities Department and private property owners are tasked with managing.

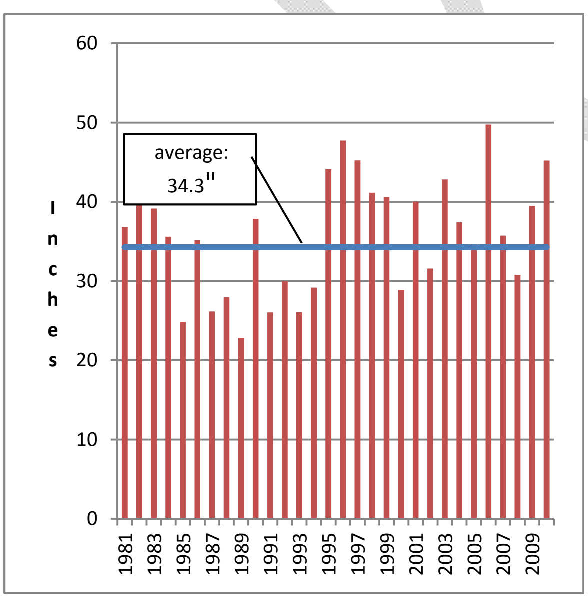


Figure 6-2. Annual rainfall, Bellevue, WA, 1981-2010.

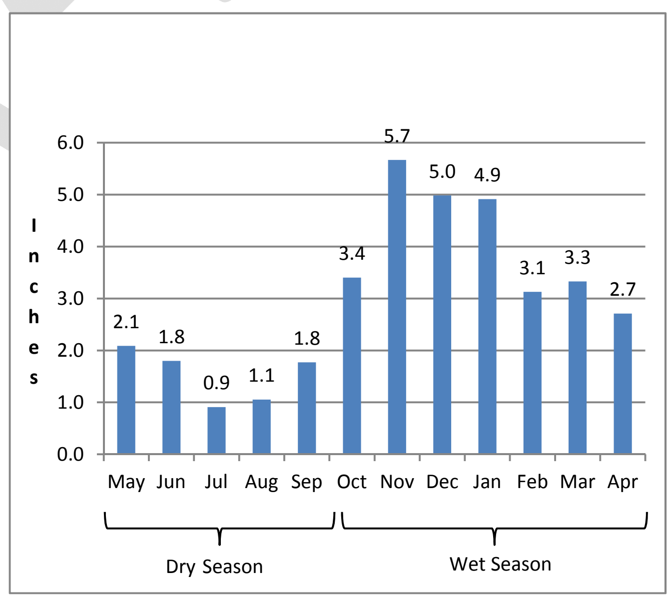


Figure 6-3. Average monthly rainfall, Bellevue, WA.

***Soils and Geology***

Soils and geology are important to surface water management because they directly affect the extent to which water soaks into the ground or runs off. The surface soils and geology in Bellevue were generally formed by glaciers, which receded approximately 10,000 years ago. Soils were originally mapped by the Soil Conservation Service (SCS) (Snyder et al. 1973). Most soils in Bellevue can be classified as glacial till, glacial outwash, or wetland soils. Till soils are generally compacted and do not readily allow water to infiltrate. Outwash soils mostly consist of sand and gravel, and tend to allow water to infiltrate. Wetland soils are generally at low elevations that receive water, and are saturated with water or ponded for most of the year.

The SCS maps provide the City with a coarse-scale soils map that helps determine locations in Bellevue where significant stormwater infiltration capacity is likely. Determining the infiltration rate for a particular location requires a more detailed soils analysis. As an example, in 2006, geotechnical engineering data were used to update the SCS soil maps in three small areas in Bellevue including the Bel-Red area (GeoMapNW 2006). The Bel-Red data changed about 36 percent of the soils map and resulted in identification of significantly more infiltration opportunities in the Bel-Red area.

The SCS categorizes soils into four hydrologic soil groups. The groups are denoted by letters A, B, C, and D with runoff potential ranging from low to high. Table 6-1 shows the existing soil conditions for Bellevue based on the hydrologic soil groups.

**Table 6-1. Hydrologic soil grouping for Bellevue**

| Hydrologic Soil Group | Description | Runoff Potential | Portion of Total Area for Bellevue |
|---|---|---|---|
| A | These soils have a high infiltration rate, deep, well-drained sands or gravels (outwash). | Low | 14.1% |
| B | These soils have a moderate infiltration rate, moderately deep, well-drained, fine to moderately coarse texture. | Low to moderate | 2.6% |
| C | Slow infiltration rate, well drained soils of moderately fine to moderately coarse texture (till). | Moderate to high | 75.7% |
| D | Very slow infiltration, chiefly clay soils with high water table, compacted or shallow soil profile (dense till). | High | 7.6% |

What is evident from Table 6-1 is that according to the SCS soils map, infiltration of stormwater is very limited, and most of the area in Bellevue has a moderate to high potential for stormwater runoff.

***Land Cover***

Impervious surfaces are any type of land surface that does not allow water to soak into the ground below. Roof tops, parking lots, and roadways act as barriers for rainfall to infiltrate the native soil profile. Because impervious surfaces block rainfall from infiltrating the soil profile, they have a negative effect on the condition of the streams receiving the runoff. The water that was once stored in the soil profile is now directed to local streams. The extra rate and volume of stormwater carries pollutants to the stream. The extra volume flowing in the stream erodes stream banks in steep sections and deposits sediment in flatter sections. As of 2008, 46 percent of the total area in Bellevue was impervious. Coal Creek basin was the least impervious (20 percent) and Sturtevant Creek basin the highest (71 percent).

For a detailed list of the impervious area organized by stormwater basins, see Appendix B-2. Figure 6-4 depicts the contrasting rainfall distributions between urban land cover and undeveloped land cover.

***Vegetative Cover***

Trees and other plants slow rainwater from reaching the storm and surface water system. Tree roots promote infiltration; their leaves act as small storage facilities allowing rain droplets to evaporate or to delay the rainwater from reaching the streams or stormwater pipes. Leaves, branches, and other vegetative detritus make the ground surface more uneven, producing small pockets where rainwater can be stored. Once delayed on the ground, rainwater can potentially infiltrate or be used by the plants. All of these functions reduce the amount of rainwater that reaches the storm and surface water system and delay the time that water reaches the system. Flood risk is diminished when excess rainfall flowing towards the stream is delayed until the rain stops. A large tract of vegetative cover can act as a large “green infrastructure” feature that provides shade and plays a significant role in reducing the rate and volume of stormwater runoff entering the storm and surface water system.

There is an inverse relationship between impervious area and vegetative cover. As of 2006, the tree canopy in Bellevue was at 36 percent of the total area. Table 6-2 shows the types of land cover area for the city of Bellevue in 2006 (American Forests 2008).

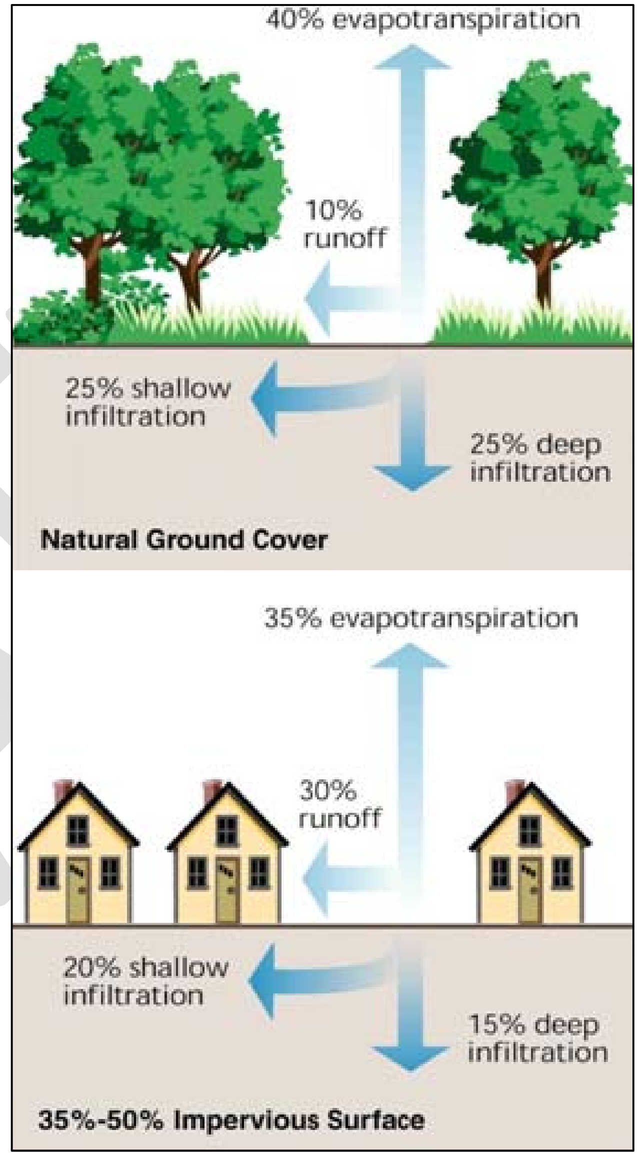


**Figure 6-4. Contrasting rainfall distributions between urban land cover and undeveloped land cover.**

**Source: Adapted from FISRWG (1998) and the LID Guidance Manual (Hinman 2005).**

***Built Environment***

The built storm and surface water system in public ownership consists of constructed pipes, catch basins, and other equipment used for conveyance, treatment, and monitoring including culverts; flow control facilities (ponds, bioretention facilities, tanks, and vaults); sediment retention basins; water quality treatment facilities; and rain, stream, and lake gauges. The City of Bellevue Utilities Department owns over 390 miles of storm drainage pipes that convey runoff to underground pipes, open channels, wetlands, streams, or lakes. Bellevue’s storm and surface water system is separate from the sanitary sewerage system; stormwater runoff is not treated at a sewage treatment plant before entering streams, wetlands, and lakes. In addition to the pipes, there are over 19,000 catch basins, 11 regional detention facilities, and hundreds of other detention and water quality facilities.

**Table 6-2. Land cover area**

| Land Cover Type | Acres | Percent of Total Area |
|---|---|---|
| Impervious Surfaces (other) | 2,131.0 | 10.0% |
| Impervious Surfaces - Buildings/Structures | 3,097.7 | 14.5% |
| Impervious Surfaces - Paved | 4,484.4 | 21.0% |
| Open Space – Grass/Scattered Trees | 3,38.8 | 15.8% |
| Shrubs | 338.6 | 1.6% |
| Trees | 7,300.2 | 34.1% |
| Trees - Impervious Understory | 408.1 | 1.9% |
| Urban Bare | 105.2 | 0.5% |
| Surface Water Area | 126.3 | 0.6% |
| Total | 21,377.4 | 100% |

The public system includes five high-flow bypass pipes that remove peak flows from stream channels that routinely flooded or had serious erosion problems. Three were built in the 1980s and two were built in the late 1990s. Most of the regional detention facilities were built in the early 1980s, except for Coal Creek, which has ponds built in the early to mid-1990s, and Lakemont Facility in the Lewis Creek basin that was built in 1991. Approximately 250 miles of privately owned stormwater pipes and numerous water quality and detention facilities built, owned, and maintained by the private sector connect to the public system. Collectively, the system of pipes and other facilities in both public and private ownership function to collect, convey, detain, treat, and monitor stormwater.

The asset management program evaluates the life span of publicly owned drainage assets (like pipes and detention vaults) to inform the Utilities Department on the timing of replacing or repairing the asset. The evaluation considers asset material, type of construction, site conditions, and other factors to determine if the asset is nearing its useful life span. The asset management program seeks to establish a savings plan that will provide the necessary resources for replacement of the drainage asset. For more information, refer to Chapter 8 Asset Management.

***Water Quality***

Clean surface water protects human health, supports a healthy aquatic ecosystem, and enables beneficial uses of streams and lakes as designated by the Clean Water Act, such as swimming and aquatic life support.

Pollutants enter surface water in a variety of ways. Pollutants are washed off natural, landscaped, and impervious surfaces during rain events, poured down storm drains (non-point pollution), and discharged from industrial sites (point pollution), for example. The term, pollution, includes not only chemicals, like pesticides or petroleum, but also sediment and temperature whose levels are changed due to human activities. During storms, pollution that has accumulated on roads and landscaped areas is washed into storm drains and streams, so water samples taken during storms characterize the mixture of pollutants contributed over the course of time. Water quality in Bellevue's lakes and streams has been monitored for over 20 years. A description of the general quality of these resources is provided in the following sections.

**Water Quality of Bellevue's Lakes**

All of Bellevue's runoff eventually goes to either Lake Washington to the west, or Lake Sammamish to the east. These two large lakes receive runoff from many other jurisdictions, and their water quality is monitored by King County.

Lake Washington has become slightly warmer over time. The temperature has increased approximately 0.98 degrees Celsius on average since 1964 (King County 2007), with warmer and colder trends occurring in some years. The warming is most significant in spring, and causes summer lake stratification to occur earlier and last longer than in the past. This trend is common across lakes in King County, and likely beyond, and is believed to be linked to climate changes rather than human activities. Lake Washington is directly connected to and at a similar pool elevation as Mercer Slough. This linkage strongly limits the movement of water in the slough, causing the slough to exhibit more lake-like water quality conditions, such as higher temperature and lower dissolved oxygen in the summer.

Of particular concern in Bellevue lakes is the sensitivity to phosphorus—a nutrient that contributes to algae growth and leads to other water quality and public safety issues. Phosphorus is present in almost all urban runoff because it occurs in naturally high concentrations in native soils. Phosphorus promotes dense algae growth and frequent cyanobacteria blooms, which can be toxic to people, pets, and wildlife. Algal blooms also result in low dissolved oxygen, which harms aquatic life and causes odors. Nutrient treatment facilities that filter phosphorus particles out of the water are required at many developing properties that drain to Lake Sammamish or Lake Bellevue. As of 2000, Bellevue's Parks Department stopped using fertilizers containing phosphates on turf at city facilities, ball fields, parks, and schools in order to minimize phosphorus input into sensitive water bodies.

Lake Sammamish, Phantom and Larsen Lakes, and Lake Bellevue have been monitored for indicators of water quality including clarity, nutrients (phosphorus), and algae (chlorophyll-a) to evaluate trends and determine whether water quality goals are being met for these parameters. All of these lakes have naturally high concentrations of phosphorus and regional goals were established to continue to meet health and recreation objectives into the future.

Lake Sammamish goals for phosphorus and transparency have been met each year between 1996 and 2006 at two stations, except in 2004 and 2006 when the phosphorus goal was not met at one of the stations (King County major lake monitoring, http://green.kingcounty.gov/lakes/map.aspx ). For Phantom Lake, goals were met for all years for clarity, 10 out of 14 years for nutrients, and 7 out of 14 years for algae; see Figure 6-5 for the Phantom Lake water quality monitoring results and goals from 1994 to 2008.

In Lake Bellevue, phosphorus, oils, water clarity, and algae growth were sampled in 2004 and 2005 to determine how to manage algae, odor, and oils in the lake (Tetra Tech, Inc. 2006). The analysis determined that only 24 percent of the phosphorus came from urban runoff to the lake; the remaining 76 percent was the result of phosphorus cycling among internal lake water, sediment, plants, and biota. Oil sheens were not attributed to stormwater runoff, but were likely from oil spills, creosote pilings, and near-shore parking lots. Water treatment best management practices (BMPs) and low impact development (LID) for redeveloping properties, education about spill prevention, lake aerators, alum treatments to reduce phosphorus, and ongoing monitoring were recommended in a 2006 Lake Bellevue Water Quality study (2006, Lake Bellevue Water Quality Study and Management Recommendations) to

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meet water quality goals for Lake Bellevue. In accordance with Bellevue policy, these recommendations would be implemented through either private actions or a lake management district.

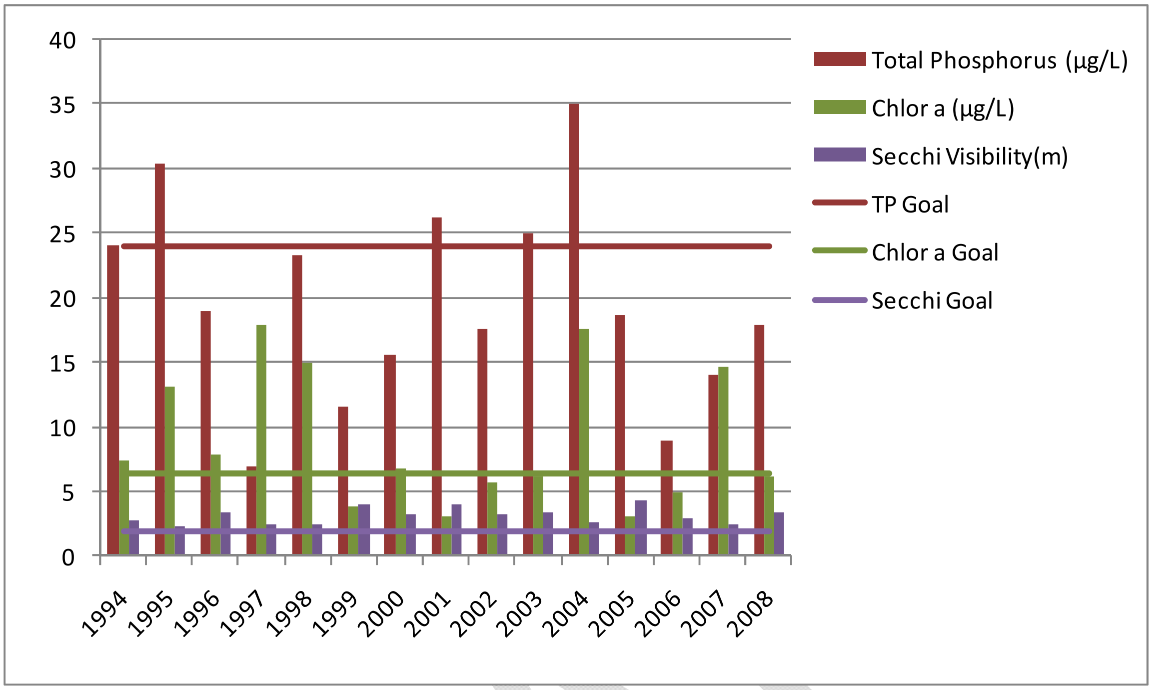


**Figure 6-5. Phantom Lake water quality monitoring results (bars) and goals (lines) from 1994 through 2008 for total phosphorus (TP), chlorophyll-a (Chlor a), and Secchi visibility.**

<u>**Water Quality of Bellevue Streams**</u>

Water quality in Bellevue streams has been characterized and evaluated through a number of different monitoring studies and ongoing efforts by multiple agencies, including the City of Bellevue. More detail can be obtained from the original sources listed below:

- Bellevue Urban Runoff Program (BURP) (City of Bellevue 1984; U.S.Environmental Protection Agency [USEPA] 1983);
- City of Bellevue Characterization and Source Control of Urban Stormwater Quality: Volume 1 Technical Report (City of Bellevue 1995);
- King County Ambient Water Quality Monitoring Program (King County 2009); and
- Various pesticide studies, including Bellevue streams (U.S. Geological Survey 1999; Evans/McDonough Company 2000; Bortleson and Davis 1997; and Voss and Embrey 2000).

Urban stormwater constituents include a variety of pollutants including sediment, nutrients, metals, oil and grease, pesticides, organics, and gross pollutants (e.g., trash and debris). Other parameters, such as temperature and pH, are also used to assess water quality and can affect aquatic life.

<u>General Stream Water Quality</u>

The general quality of stormwater and stream water quality has stayed the same or improved between 1988 and 1993, despite urban development, which is a 32 percent increase in population, and a 21 percent increase in city land area when compared to data collected before 1980 (City of Bellevue 1995). Lead concentrations have decreased (due to the phasing out of lead gasoline); however, copper, lead, and zinc still often exceed USEPA water quality criteria. Phosphates in Bellevue streams are generally

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high, and fecal coliform bacteria exceeds state standards during most storms and often during base flow conditions. New National Pollutant Discharge Elimination System (NPDES) operations and education programs, as well as emerging technologies such as rain gardens and other LID techniques, should improve water quality because they keep the pollutants from entering with surface water runoff.

Stream Temperature

In a pilot project, continuous temperature measurements were taken at nine sites along Kelsey Creek and its tributaries from mid-August through mid-October 2001 (C. Paulsen, unpublished data; Figure 6-6). Warm stream temperatures during the early fall can affect adult salmon spawning and migration. Warmer water does not hold as much dissolved oxygen, which salmon and other aquatic life breathe. Water temperature was warmest in late August, and declined at all sites over the course of the sampling period. In August, most of the sites were too warm for Chinook holding and migration, but the temperatures fell to acceptable ranges for migration by early September and for holding by late September or early October. Larsen Lake temperatures were the highest, but the next site downstream was among the lowest, likely because of the cooling influence of the wetlands and groundwater between Larsen Lake and 148th Ave NE. Temperatures became cool enough for Chinook migration by early September, which is when the first adult Chinook are generally seen during fall surveys for spawning salmon. Temperatures became cool enough for sockeye migration by late September or early October. Temperatures are influenced by land use, rainfall, and air temperatures. Since climate varies each year, in warmer years temperatures may delay Chinook and sockeye spawning runs. Reducing impervious surfaces and increasing tree canopy and infiltration sites for runoff could reduce temperatures in some areas.

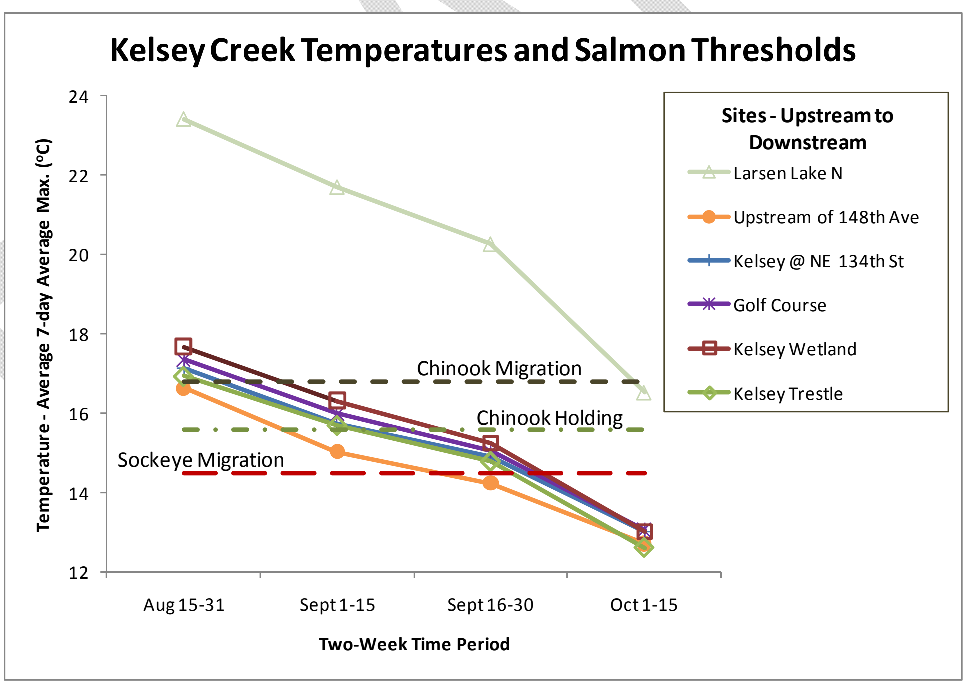


**Figure 6-6. Kelsey Creek stream temperatures ($^{o}$C) (7-day average maximum) averaged over approximately 2-week time periods during the start of the salmon spawning in 2001.**

**Note: Sites are listed in order from upstream to downstream. Upper temperature limits for Chinook holding and migration and sockeye migration are shown as dashed lines.**

Pesticides

Pesticide concentrations were measured in streams in the Puget Sound area, including streams in Bellevue, beginning in the late 1980s and early 1990s. A study by the U.S. Geological Survey found a large number of pesticides in Bellevue creeks (13 in Kelsey Creek/Mercer Creek), but mostly in very low concentrations (Bortleson and Davis 1997). As a result of concerns about pesticides, the Bellevue Parks Department initiated efforts to reduce the use of pesticides on City property. In addition, the Utilities Department began programs to proactively inform and educate residents about gardening and landscaping practices to reduce home pesticide use. Surveys of Bellevue residents conducted in 2000 and 2005 indicate that approximately 40 to 50 percent of residents use pesticides in their yards. Yard care professionals also use pesticides on residential and commercial properties in Bellevue. Comprehensive pesticide sampling in Bellevue was last conducted in 1998, so the overall effects of changed practices over the 15 years between 1995 and 2010 are unknown. The earlier studies found the following:

- Mercer Slough and Kelsey Creek were sampled for pesticides from 1987 to 1995 as part of a study of small streams in the Puget Sound basin (Bortleson and Davis 1997). This study concluded
  - Concentrations of pesticides were generally low.
  - Twenty-three different pesticides were detected in streams across Puget Sound, and a mix of pesticides was present in each creek. The effects of mixtures of pesticides on aquatic life are largely unknown.
  - Five different insecticides exceeded federal standards for maximum concentrations for the protection of aquatic life (U.S. Geological Survey 1999).
  - Stream sediments contained pesticides that were banned from use in the United States, including the fungicide pentachlorophenol (PCP), insecticides DDT and its degradation products, and chlordane (Bortleson and Davis 1997).
- Stream runoff was sampled for pesticides in Valley, Sunset, and Lewis Creeks during a storm event in 1998 (Voss and Embrey 2000). The sampling effort found
  - Seventeen pesticides or pesticide transformation products were detected in Sunset Creek, 14 in Valley Creek, and 13 in Lewis Creek.
  - None of the herbicides detected exceeded aquatic life criteria, although aquatic life criteria do not exist for many of the compounds.
  - Aquatic life criteria were exceeded for two commonly used insecticides: diazinon at all three sites, and lindane at Valley Creek.
- Surveys of Bellevue residents in 2000 and 2005 did not show a marked difference in residential pesticide use over that 5-year period. The surveys found
  - 40 percent of Bellevue residents reported using “weed and feed products, pesticides or chemical lawn fertilizers,” compared to only 29 percent county-wide in a telephone survey conducted in 2000 (Evans/McDonough Company 2000).
  - 43 percent of respondents reported using pesticides, and 50 percent reported using weed and feed type products (which contain herbicides) in a survey in 2005 (Dethman & Associates 2006).
- In the Puget Sound basin, more pounds of pesticides were applied in urban areas than in rural areas (U.S. Geological Survey 1999). This survey indicated the following
  - Some pesticides commonly found in stream runoff were those with high retail sales, such as the insecticide diazinon.

- Pesticides not sold in retail stores were also common. A wide variety of pesticide licenses allow application of pesticides not available at retail stores. These pesticides may have been applied to public and private properties by private individuals, companies, or other licensed pesticide applicators.
- Since these results were published, federal regulations restricted the use of diazinon, and Bellevue Parks and Utilities Departments changed their pesticide practices.

More recently, the Bellevue Parks Department has collected water quality data to better understand how their maintenance practices affect water quality. Grab samples were collected annually along streams both upstream and downstream of managed properties and from a golf course pond. Nutrients, pesticides, and metals were sampled between 2004 and 2010. Information from this sampling program and input from the Utilities and Development Services Departments were used to develop the Parks Department's Environmental Best Management Practices and Design Standards Manual (2006). This manual is reviewed and updated periodically, based on continued monitoring results and new BMPs.

The Parks Department also collected sediment samples over several months using filters under storm drains (The Watershed Company 2005-2009). Pesticide concentrations were rarely detected downstream of the parks, despite being present upstream in some cases. In 2005 and 2006, pesticides were detected in higher concentrations downstream, but management practices were changed, and they have not been detected since that time. Dissolved metals (zinc and manganese) were detected at one site each season since they began testing for them in spring 2008. Nutrient levels were generally lower or the same after passing through the parks, and in the two cases in which they were higher, the increase was small. The sediment and water quality tests were used to improve operations and indicated that Parks Department operations were not substantially affecting the water quality of streams.

<u>King County Ambient Water Quality Monitoring</u>

King County has an ambient water quality monitoring program at streams where major wastewater facilities are located. Several sites in Bellevue are included Kelsey Creek at the Mercer gauge, the West Tributary, Coal Creek, Ardmore (Idylwood) Creek, Yarrow Creek, and Lewis Creek downstream of Bellevue (King County 2009). Samples were collected during different time periods and for different durations at these sites, primarily between the mid-1970s and 2008. Monthly grab samples were collected during base flow and storm events. While one-time samples do not provide a true characterization of pollutant loading, they do indicate the general quality of the water. King County base flow samples appear to be generally consistent with base flow median concentrations reported by the City of Bellevue (1995) for conventional constituents, pH, bacteria, nutrients, and metals for Kelsey Creek, even though sampling methods were different.

<u>Habitat</u>

Fish and wildlife habitat protection is the third component of the Utilities Department Storm and Surface Water Mission Statement. The aquatic environment in open streams are the primary "receiving waters" of the stormwater system in Bellevue. Water quality and quantity affect fish and wildlife habitat.

Impervious surfaces such as roofs and parking lots have been directly linked to changes in flows and in pollutant loading. Trees and other vegetation slow rainwater, prevent erosion due to branches and roots, and filter and cool the water on its way to the stream. Impervious surfaces, on the other hand, do not allow water to soak into the ground. They warm the water in summer and direct it quickly to a drain or pipe, collecting pollutants on the way. Significant changes to stream habitat are generally observed when the effective impervious area (the area directly connected via pipes and conveyance systems) in a basin reaches 10 percent (Booth and Jackson 2002). Because Bellevue is well over 10 percent impervious in every drainage basin, the streams are expected to be negatively affected by urban runoff.

The amount of intact vegetation and lack of impervious surface immediately adjacent to streams, as well as throughout stream drainage basins, has been directly correlated with the health of aquatic life at individual sites within those same drainage basins (Morley and Karr 2002). Figure 6-7 shows city averages for overall impervious (light grey), percent impervious surface within 100 feet of open streams (dark grey), overall forest cover (light green), and forest cover within 100 feet of open streams (dark green).

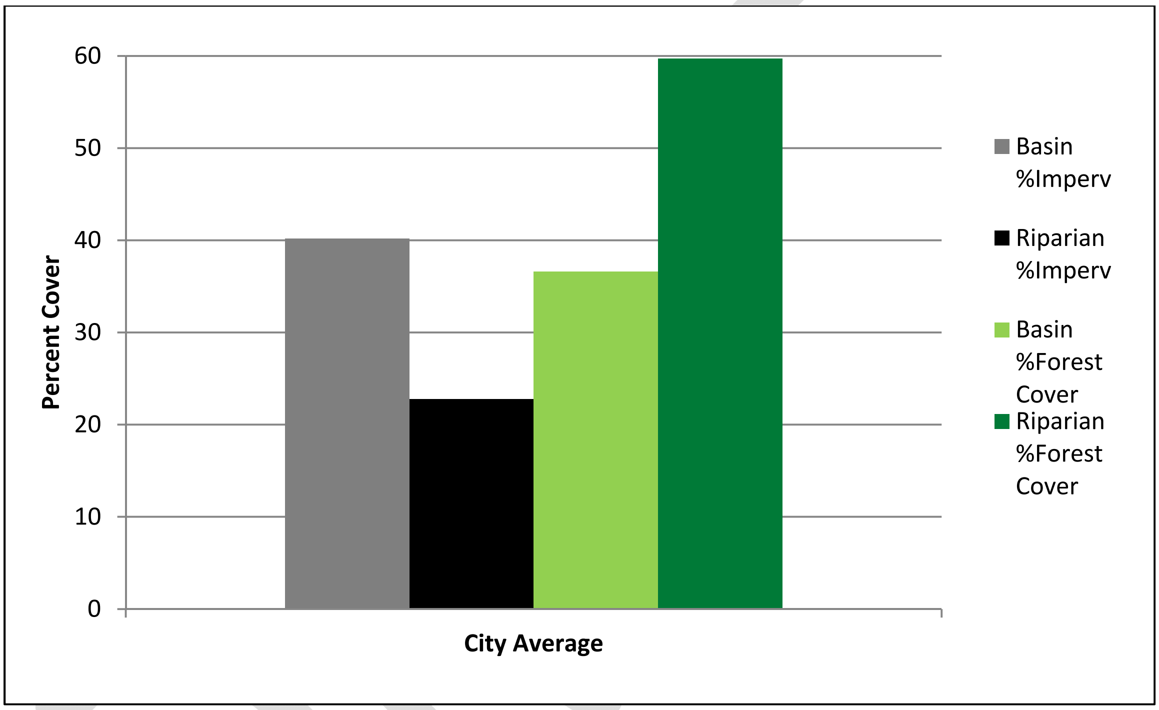


**Figure 6-7. Total impervious area and percentage within the 100-foot stream buffer and total tree canopy cover and within basin stream buffers within Bellevue city limits.**

Figure 6-7 shows that stream buffers have been more protected from urban development and tree removal than those areas of the drainage basins away from the stream corridor. In general, tree canopy is higher and impervious area lower around the streams than in the overall drainage basin. This can be attributed to stream vegetation protections afforded by the Critical Areas Ordinance (Bellevue Land Use Code 20.25H) that restrict development in streams and buffers, formerly the Sensitive Areas Ordinance.

Tree canopy cover city-wide is 36 percent based on an analysis done in 2007 (American Forests 2008). Tree canopy cover in the city decreased 20 percent between 1986 and 2006. American Forests recommends a city-wide goal in urban areas of 40 percent tree canopy to maintain environmental benefits, including carbon sequestration. While it has been shown that vegetation along streams is related to the health of aquatic invertebrates, there are currently no guidelines for urban riparian forest cover needed to sustain conditions for aquatic life.

Figure 6-8 shows impervious and forest cover for individual basins illustrating the range of conditions across basins within Bellevue. Newport, North Sammamish, Spirit Ridge, and Coal Creek have over 85 percent tree canopy in their buffers, the highest in the city. Basins that currently meet the American

Forests recommendation of 40 percent tree canopy include Beaux Arts, Coal Creek, Goff Creek, Lewis Creek, Mercer Slough, North Sammamish, Phantom Creek, South Sammamish, Vasa Creek, and Yarrow.

Rosemont, Mercer Slough, and Newport have less than 8 percent impervious in their stream buffers—the lowest city-wide.

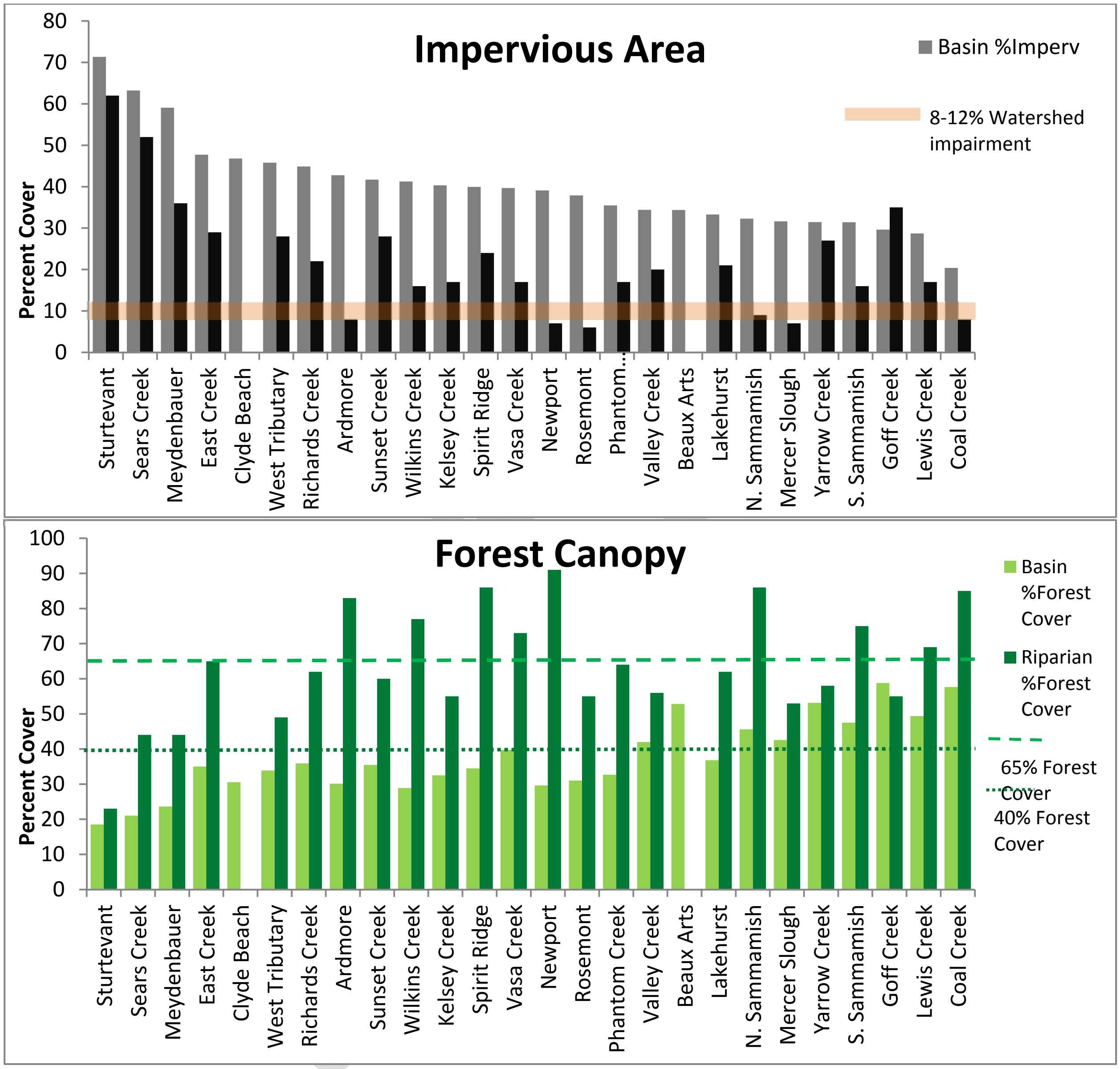


**Figure 6-8. Total impervious area percentage of each drainage basin and within the 100-foot stream buffer (upper graph), and tree canopy cover of each drainage basin and within basin stream buffers (lower graph) within Bellevue city limits.**

**Note: Beaux Arts and Clyde Beach do not have streams, so stream buffer measurements were not made.**

## Goals and Evaluation Criteria

As described in Chapter 3 Community Vision and Regulatory Framework, stormwater management is guided by the vision of the Bellevue community as well as the regulatory framework imposed by federal, state, and local regulations and requirements. Priorities include flood management, management of open streams and piped conveyances, and protection of water quality and aquatic habitat. The Storm and Surface Water Utility's Mission Statement is:

> *A surface water system that controls damage from storms, protects surface water quality, supports fish and wildlife habitat, and protects the environment.*

Achieving the goals in the Mission Statement depends on a number of factors, including the degree to which drainage basins have been affected by urbanization, the desired level of protection, the authority and influence the City has, and the resources needed to mitigate those impacts. Often in an urban environment, there is a balance of competing interests at a site, including utilization of property for other purposes, flood amelioration, salmon spawning habitat, erosion, or other needs at a particular location. Meeting multiple objectives is always desired, though it is not always attainable at a project scale.

The Utilities Department's stormwater management goals are derived directly from the Mission Statement, while also meeting regulatory obligations. The specific goals are to:

- Minimize damages from floods, including flooded buildings, street closures, and stream bank erosion;
- Improve water quality within the City's jurisdiction to meet federal and state water quality standards; and
- Improve aquatic habitat within the city's open stream channels and lakes to foster the continued existence of native fish and other aquatic organisms.

***Basin Evaluation Criteria***

Evaluation criteria and associated indicators of physical, biological, and water quality conditions were selected to evaluate whether storm and surface water management goals are being met (Table 6-3). These criteria will be used to evaluate system goals into the future, and to target actions to specific issues. The planning criteria are evaluated at the basin level because land use and other activities in each drainage basin directly affect the function of the storm and surface water system in that basin. This also allows actions to be targeted to address issues at their specific locations.

Much of the information needed to evaluate the system is currently available, but some of the specific evaluation metrics are not. For example, limiting the evaluation metric data to events larger than the 100-year, 24-hour storm severely reduced the number of data points available to analyze. Similarly, the number of secondary street closures during some large storm events since 2003 is known, but there is no record of the number of hours each street was closed. In such cases, recommendations are included to capture these data in the future. Appendix B-3 has the individual data points for all of the evaluation metrics. In addition, Appendix B-4 provides supporting information on road closures due to storm events.

In addition to the evaluation metrics, additional information was compiled to assess the overall state of the system. This includes effects of public regional stormwater detention, age of development, land cover, flow, riparian condition, sedimentation, observed stream issues, and salmon migration and spawning. The evaluation criteria does not address the constructed utility systems for connectivity, ability to meet capacity needs, or the condition of the infrastructure because those issues are determined by regulations during development of the system. The age of development and general age of the constructed system is included in this chapter to provide an indication of standards that were used for detention and conveyance capacity design, as well as an indication of areas where infrastructure may be nearing the end of its functional life span. For more information about the constructed utilities system and the results of its evaluation see Chapter 8 Asset Management.

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**Table 6-3. Planning criteria and evaluation metrics or indicators used to evaluate basins in terms of storm and surface water goals**

| Goals | Planning Criteria | Evaluation Metrics |
|---|---|---|
| Control Damage from Storms | Minimize damage from the 100-year, 24-hour storm event | 1) Flooded structures during large storms<br>2) Number of flood damage claims<br>3) Number of street closures |
| Protect Surface Water Quality | Identify pollution “hot-spots” | 1) Percent compliance with NPDES Permit<br>2) Number of Clean Water Act Violations<br>3) Number of Illicit Discharge Corrections<br>4) Number of basins classified as Impaired under Clean Water Act Section 303(d)<br>5) Number of basins classified as a high risk for water quality problems |
| Support Fish and Wildlife Habitat | Improve stream habitat conditions and biotic integrity (B-IBI) scores | 1) Large woody debris frequency per channel width<br>2) Pool frequency per channel width<br>3) B-IBI score<br>4) Number of stream reaches with hardened banks |
| Protect the Environment | Incorporated above | Combination of all categories |

## Evaluating Flow Control and Flood Protection

Bellevue does not have widespread flooding problems, but there are still recurring problems at some locations. Figure 6-9 shows the flooding problem at NE 21st Street on December 12, 2010. Flooding has the potential to threaten or damage health, safety, and property by creating hazardous conditions in streets, blocking street access, causing damage to buildings, and/or eroding streets or landscaped areas. During large storm events some flooding is expected, but smaller events can also cause flooding when debris clogs storm drains or grates, if runoff water has been redirected, or if conveyance system capacity is exceeded. As described in Table 6-3, flood control is focused on:


**Figure 6-9. NE 21st Street floods on December 12, 2010.**

1. Structural flooding. Flooding or the threat of flooding to a structure. It does not include nuisance flooding.
2. Paid damage claims. These are liability claims made against the City for storm-related damages.
3. Street closures. Primary and secondary streets closed due to flooding.

The evaluation metrics are followed by additional background information, such as the estimated age of the infrastructure and land cover, that provides context for understanding how flooding issues can arise and for identifying potential future problems.

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***Flooded Structures during Storm Events***

The number of flooded structures includes known buildings, businesses, homes, garages, basements, and crawl spaces that flooded during storm events during the evaluation period (2000 to 2009). The source of information was a database that tracked surface water work orders in response to customer requests to the Operations and Maintenance Division. If the cause of the structural flooding was due to privately owned property, these work orders were excluded. The remaining 68 work orders were included, even though it was not always possible to confirm that the cause was due to a City-owned ("public") system malfunction. Figure 6-10 highlights the stormwater basins where flooded structures were located.

For each basin, "Few" means zero to two flooded structures, "Moderate" means three or four flooded structures, and "Many" means five or more flooded structures. The number of flooded structures among basins ranged from a minimum of zero (Beaux Arts, Sears Creek, and Sturtevant Creek basins) to a maximum of 13 (Meydenbauer Creek basin) (see details in Appendix B-5). Fifteen basins had few, nine basins had moderate, and three basins had many flooded structures.

All flooding reports are investigated and actions are taken for public safety and protection of property.

Any area where recurring public maintenance issues might occur are placed on a Routine Flood Prevention Maintenance Inspection List that is frequently updated (see Appendix B-5). Flooding incidents that may require infrastructure improvements are reviewed as part of the Capital Investment Program. In two cases, affected properties have been acquired.

***Number of Flood Damage Claims***

The City maintains a database of claims brought by residents attempting to receive financial compensation for damage to private property. Claims due to flooding or other property damage were evaluated from October 1, 1996 to February 28, 2011 (Figure 6-11). Of 50 storm-related flooding claims, 14 were determined to have City liability, resulting in payment to the claimant.

***Number of Road Closures***

Primary and secondary streets are those identified in the City's emergency response plan as major routes for use during emergencies. Street closures for the period of 1996 through 2011 were used as an evaluation metric for flooding. Some of the major storms that caused street closures are reported in "Storm Reports" submitted to the City Council following major storm events. Figure 6-12 shows the street closures due to flooding. Storm Reports are prepared at the Utilities Department Director's request and are available for five major storms since November 2001. Each is summarized in Appendix B-4. These included storms on the following dates:

1. November 14–15, 2001 when 3.5 inches of rain fell in 35 hours;
2. October 20–21, 2003 when 5.1 inches of rain fell in 38 hours;
3. November 5–7, 2006 when 3.2 inches of rain fell in 59 hours;
4. December 2–4, 2007 when 6.1 inches of rain fell in 48 hours; and
5. December 11–12, 2010 when 4.6 inches of rain fell in 24 hours.

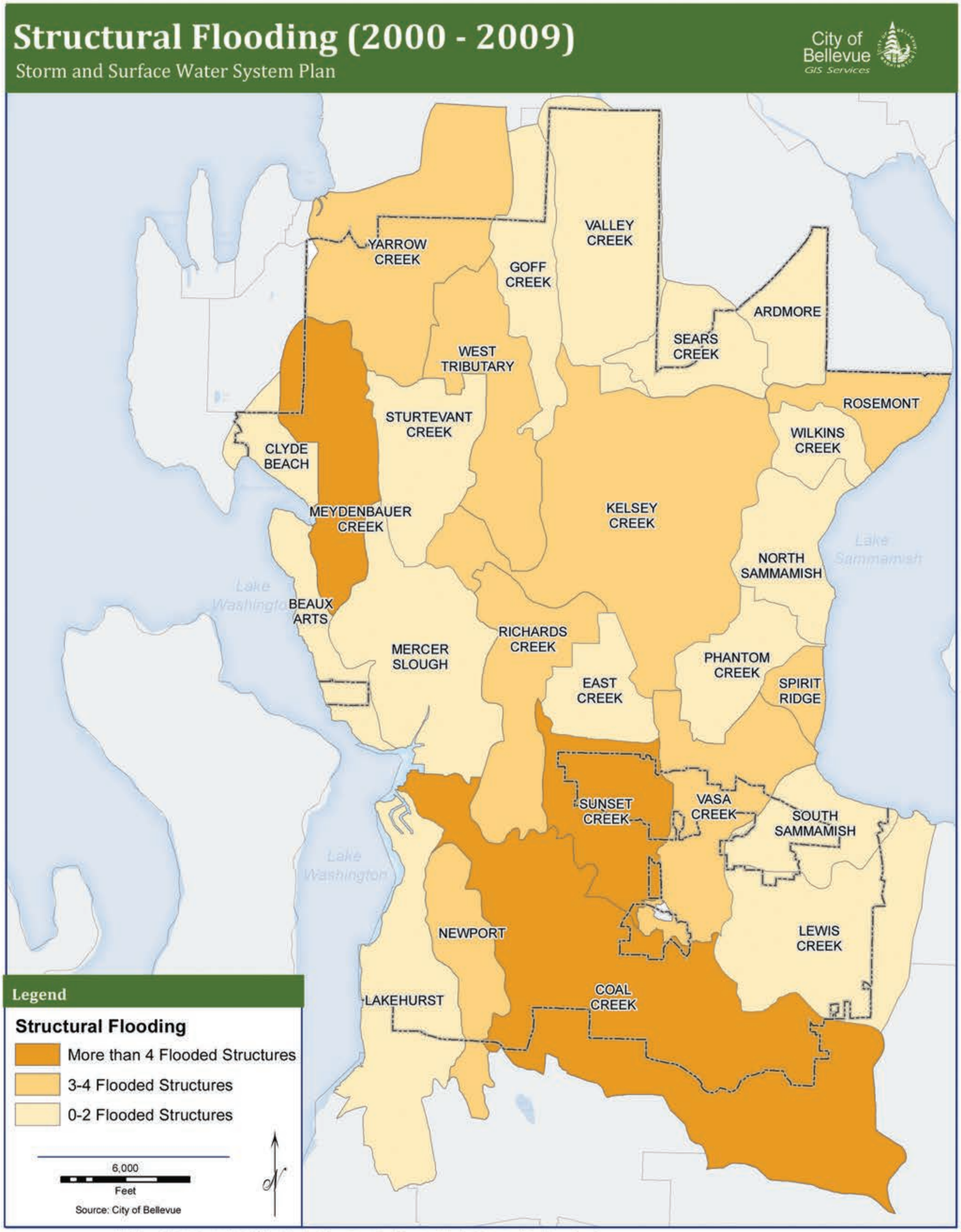


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**Figure 6-10. Structural flooding map.**

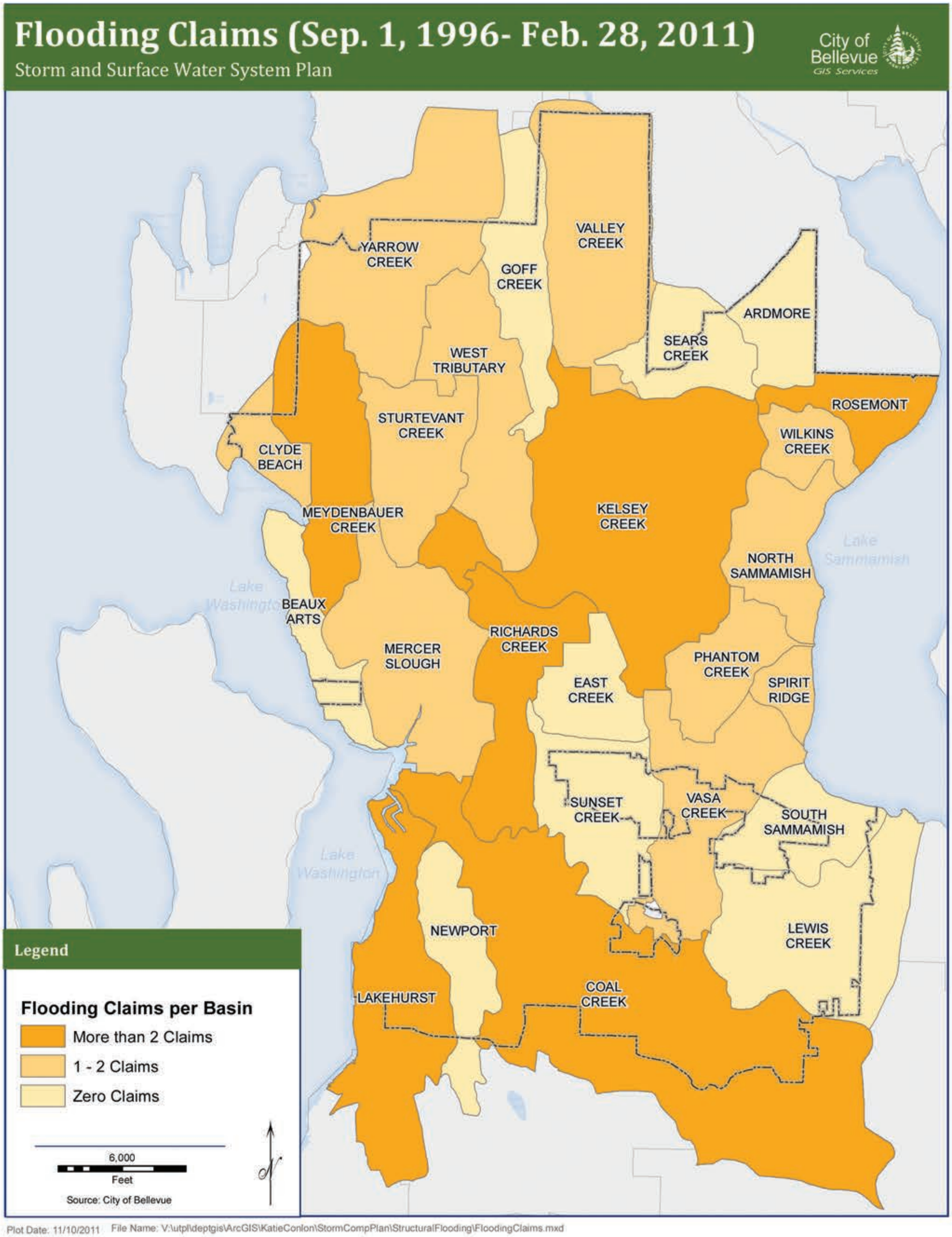


**Figure 6-11. Paid flood claims basin map.**

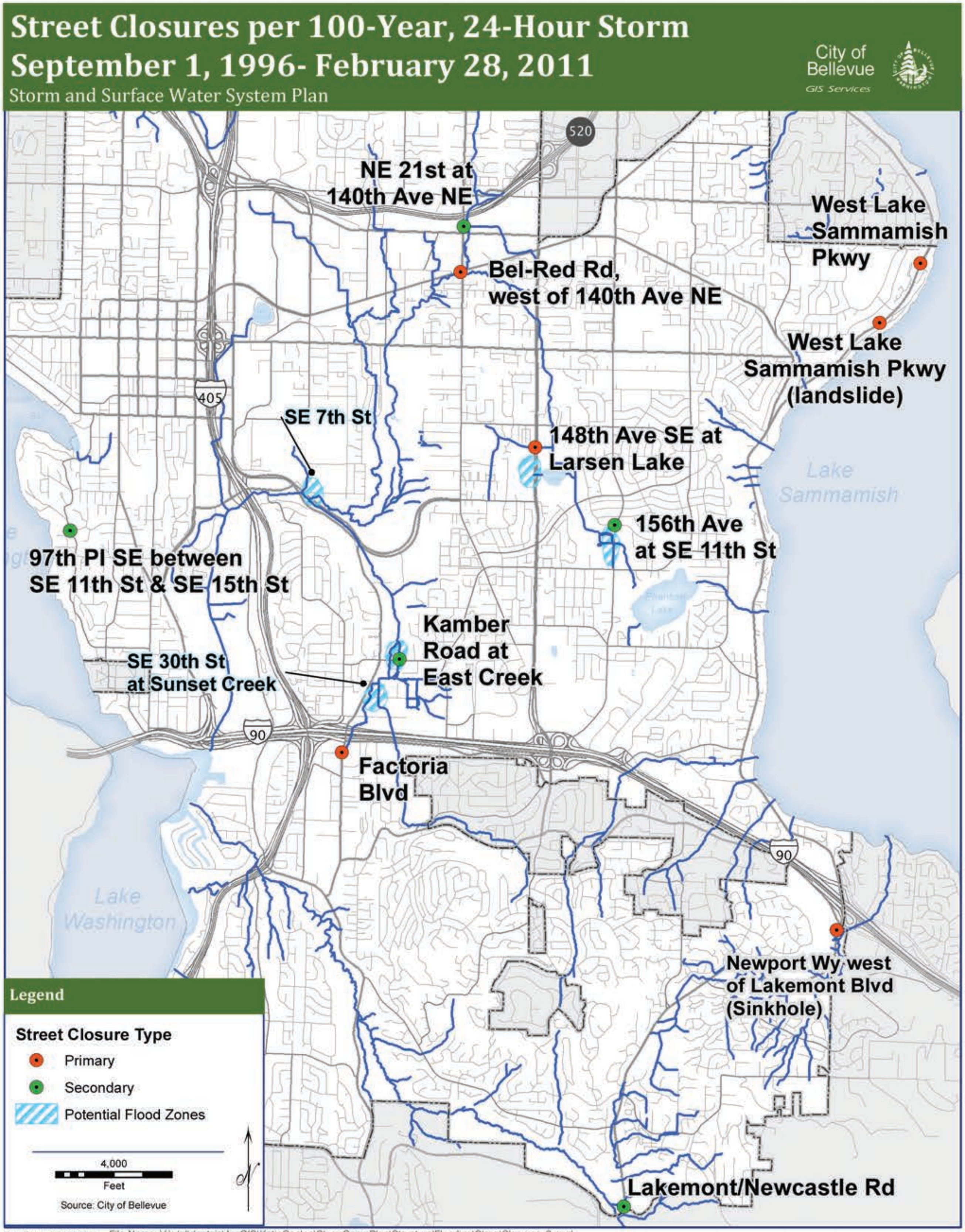

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**Figure 6-12. Street closure map due to flooding.**

Of the five storm events described in the above-mentioned Storm Reports, three of the five were considered 100-year, 24-hour storm events; one was considered a 10-year, 24-hour storm event, and one storm was less than a 10-year, 24-hour storm event (but still caused flooding). The Storm Reports did not include information about the duration of secondary road closures, so only the number of primary and secondary road closures were used as evaluation metrics. Each storm event resulted in two or three primary road closures, and one or two secondary road closures (see Appendix B-4). No other arterial or collector routes were closed. Temporary closure of collector streets due to flooding is considered acceptable, so those were not tallied.

***Background Information on Flooding***

Flood protection is a central function of the Utilities Department. The aforementioned evaluation metrics enabled a basin-scale analysis of flood protection. Additional information that was considered in the evaluation follows and is focused on the evolution of stormwater regulations, age of development, and the effects of inherited stormwater systems through annexation.

**Effects of Public Regional Stormwater Detention**

The effects of urban development on stream flow can be partially mitigated by holding water on-site or in detention facilities and releasing the stored water slowly downstream. There are 11 engineered regional stormwater detention facilities owned by the City, and their combined water storage capacity volume for the Kelsey Creek, Coal Creek, and Lewis Creek basins is estimated at over 204.8 acre-feet (regional facility locations are shown in Figure 6-13, and volume storage capacities are available in Appendix B-6). The volume of storage can also be represented as the number of inches of rain that, if it fell over that drainage basin, landed on impervious area and was directed to the regional facility for storage. The Kelsey Creek basin regional facilities could hold almost an inch of rain (0.9 inch); the Coal Creek regional facility could store less than 1/3 of an inch of rain; and the Lewis Creek regional facility could store over 4.5 inches of rain. Additional storage is provided by flow control facilities on both public and private property.

Figure 6-14 is a flow frequency graph comparing existing flow conditions that benefit from the regional detention facilities located in the Kelsey Creek basin to a hypothetical condition, one in which the detention facilities were removed (Northwest Hydraulic Consultants 2002). The graph shows that for a given flow rate (750 cubic feet per second [cfs]), the chance that such an event would happen is reduced from 20 percent (a 1-in-5 chance of occurring any year) to 10 percent (1-in-10 chance).

To completely mitigate the approximately 40 percent of impervious area across the city to the 2010 flow control standard, the system would need to store a volume over 10 times what it currently captures, approximately 2,450 acre-feet of runoff. However, as redevelopment occurs and new detention and infiltration techniques are employed, runoff should be reduced and the needed storage volume to more closely mimic natural conditions should decrease.

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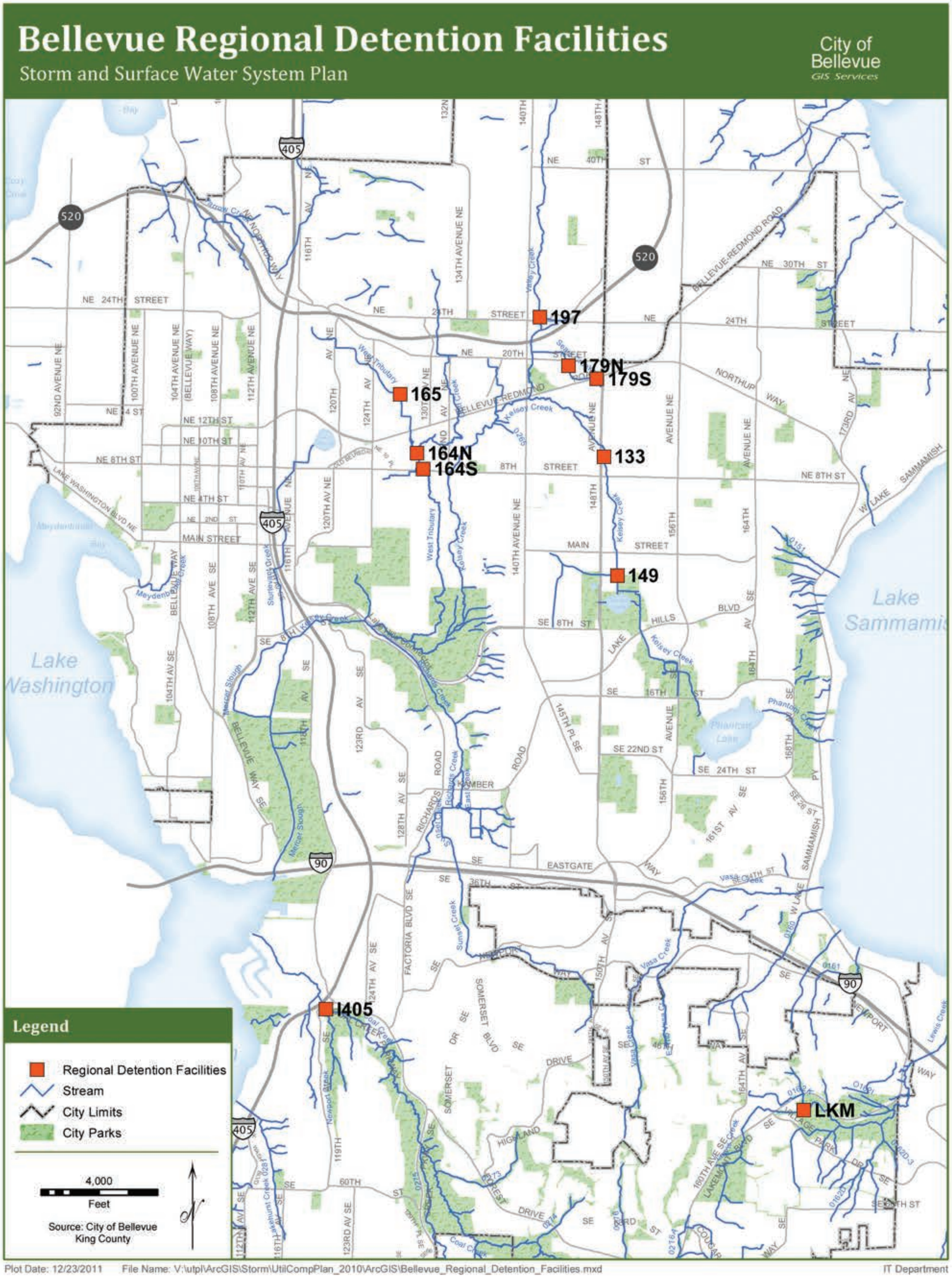



**Figure 6-13. Regional detention facilities.**

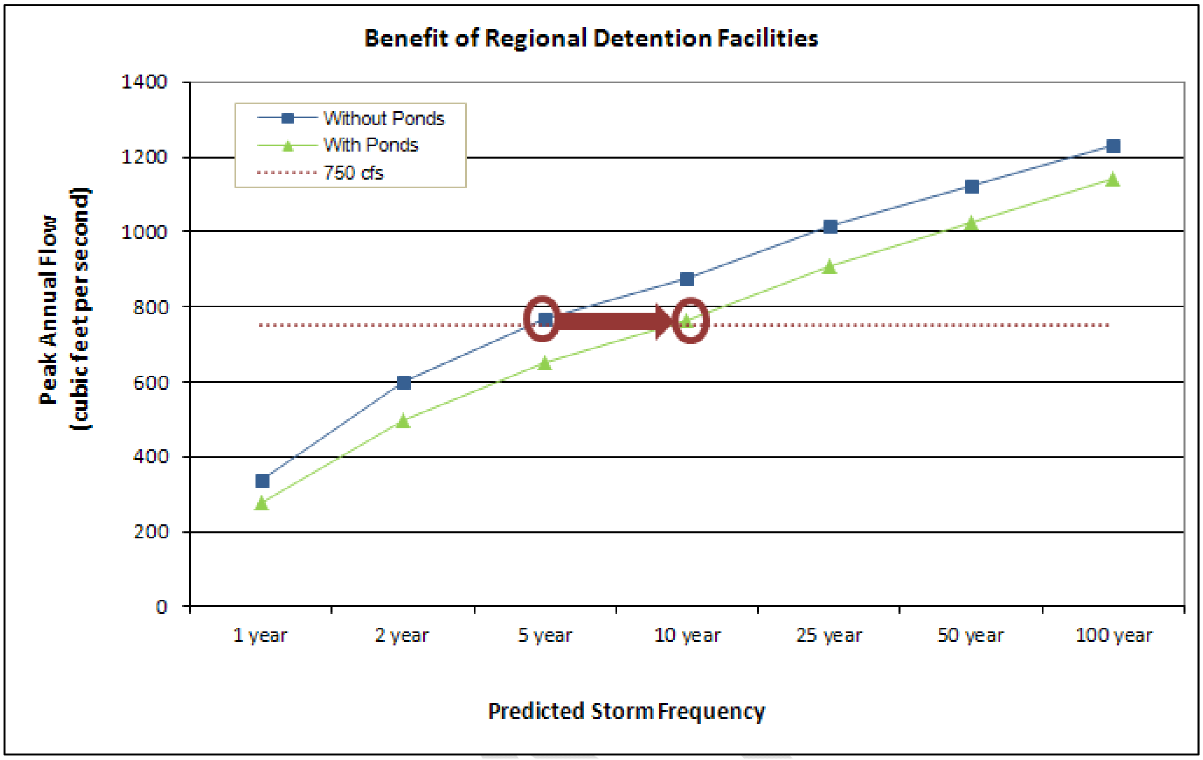



**Figure 6-14. Effect of regional detention in Kelsey Creek.**

## Age of Development

Thirty-eight percent of the city was developed prior to 1975. The King County Assessor's office provided the City with a list of parcels and the year of the most recent development on each parcel (see Figure 6-15 Parcel Development). Table 6-4 breaks out the age of development of the city with key milestone periods associated with changing stormwater design standards. The information is based on the most recent parcel development date.

As illustrated by Table 6-4, the city developed under a variety of development standards for flow control and conveyance. The descriptions of flow control and conveyance standards below are simplified, and represent only the general application of the standards.

- Prior to 1974–Flow control standards did not exist; therefore, development occurred with no appreciable flood protection.
- 1974 to 1987–Requirements were to regulate a 4-hour, 100-year storm, which was approximately 1.7 inches of rain, to a rate of 0.2 cfs per acre. To achieve this standard, new and redeveloping properties were required to provide 1 inch of detention per impervious acre and 0.5 inches of storage per pervious acre (City of Bellevue Department of Public Works 1975).
- 1988 to 1995–This standard required detention of two sizes of storm events, as follows: peak runoff from the larger 100-year, 24-hour storm event was mitigated to the pre-developed 10-year, 24-hour peak runoff rate; the post-developed 10-year, 24-hour peak flow was mitigated to the pre-developed 2-year, 24-hour peak flow event (City of Bellevue 1988).

- 1996 to 2009–Flow control was required to mitigate the post-developed runoff rates for the 100- and 10-year, 24-hour storms to their “existing” land-cover runoff rates, and the post-developed 2-year, 24-hour storm to 50 percent of the 2-year “existing” land-cover runoff rates. This code effectively limited application of runoff control to only new or added impervious area. Because the mitigation standard was “existing” land cover at the time of construction, a redevelopment project that converted one type of impervious land surface to another type, e.g., parking lot to roof top, did not need to provide mitigation of runoff from those existing impervious areas (City of Bellevue Utilities Department 1998).
- Beginning in 2010–The flow control standard required new and redeveloping properties to mitigate runoff to a pre-developed forested land-cover type, specifically by reducing the duration and peak flows from storms ranging from half of the 2-year to the 50-year storms (City of Bellevue Utilities Department 2010).

**Table 6-4. Age of built developments in Bellevue**

| Year Parcel Developed or Redeveloped | Number of Acres | Portion of 2010 City Area | Bellevue Conveyance Standard | Bellevue Flow Control Standard |
|---|---|---|---|---|
| Pre-1974 | 7,706 | 38% | None | None |
| 1974-1987 | 4,577 | 23% | 10-year event | 0.2 cfs per acre |
| 1988-1995 | 1,280 | 6% | 10-year event | 10-year to 2-year<br>and<br>100-year to 10-year |
| 1996-2009 | 1,636 | 8% | 100-year event | Developed mitigated to existing land use:<br>100-year to the 100-year<br>and<br>10-year to 10-year<br>and<br>2-year to 50% of 2-year |
| 2010 | 0 | 0% | 100-year event | Forested pre-developed runoff rates |
| Parks, Open Space | 2,895 | 14% | - | - |
| Undeveloped, Vacant | 1,272 | 6% | - | - |
| Not Classified | 910 | 5% | Unknown | - |
| Total | 20,276 | 100% | - | - |

Detention standards are intended to slow runoff from built, impervious surfaces and prevent stormwater from overwhelming the capacity of the system. These standards have changed over time to require that more volume be controlled on site to better mitigate development impacts. Developments built before flow control standards existed, or under less stringent standards, are required to upgrade to the current standards when they redevelop. Developments designed under past standards contribute higher volumes of runoff to the system immediately after each storm event.

Conveyance standards (minimum size requirements for storm drains, pipes, open channels, and other facilities that carry water from its source to the downstream receiving water) have also changed over time. Two-thirds of the city was built with storm drains sized to convey at most the 10-year rain event. It was not until 1996 that new conveyance systems were required to contain up to the 100-year storm event; only 8 percent of the city was designed to this standard as of December 2009. However, even with limited historical conveyance requirements, few of the existing flooding problems are associated with conveyance capacity.

As of 2010, Bellevue adopted the state's stormwater manual, which establishes requirements for stormwater runoff, conveyance, and water quality treatment. Bellevue enforces these requirements through Utility codes and engineering standards for new and redeveloping properties. Figure 6-15 shows the time of development and the stormwater management standard in place for most parcels in Bellevue.

**Annexation**

Much of the built system was inherited by the City through annexation. In 1953 when the City incorporated, the city area was less than 10 square miles and by 2010 the city limits expanded in area to 32 square miles. Figure 6-15 shows what areas were annexed by decade. The Bellevue Storm and Surface Water Utility was formed in 1974, so stormwater infrastructure built prior to that date was designed by King County Standards and areas developed after 1974 were either designed by City standards or the County, depending on the annexation date and the date of development.

Knowing when a parcel was developed and which jurisdictional standards were used helps with flood protection analyses and to explain why some of the stormwater infrastructure data are missing. Figure 6-16 shows the age of development for parcels in the city.

The inventory of stormwater infrastructure records is inconsistent. Often, the infrastructure location, material, size, and date of construction are missing. Prior to 1974 (when the Storm and Surface Water Utility formed), organizing and keeping detailed records of stormwater infrastructure appears to have been a low priority. It was common practice to install drainage facilities in a manner that simply removed stormwater runoff from the site as quickly as possible, often without regard to downstream impacts and with inconsistent records of the built system. The annexation areas were developed using King County standards for utility services including stormwater infrastructure design. Assessing and describing existing conditions of the built stormwater system is challenging because of the inconsistent records; therefore as a proxy, the age of the development was used.

**Ongoing Problem Flooding Locations**

Flooding happens on a recurring basis at 64 City-owned drainage facilities due to debris such as fallen leaves. These sites are routinely inspected and cleaned prior to storm events to minimize flooding (Figure 6-17). If the system is modified and results in a permanent solution, sites are removed from the preventative maintenance site list. Undersized public conveyance that causes flooding is addressed through the Capital Investment Program.

## Evaluating Water Quality Protection

Clean surface water protects human health, supports a healthy aquatic ecosystem, and enables beneficial uses of streams and lakes as designated by the Clean Water Act, such as swimming and aquatic life support.

Pollutants enter surface water in a variety of ways. Pollutants are washed off natural, landscaped, and impervious surfaces during rain events, poured down storm drains (non-point pollution), and discharged from industrial sites (point pollution), for example. During storms, pollution that has accumulated on roads and landscaped areas is washed into storm drains and streams, so water samples taken during storms characterize the mixture of pollutants contributed over the course of time. The pollutants that most affect human health and aquatic life include pesticides, temperature, heavy metals, nutrients, and other sources (Table 6-5).

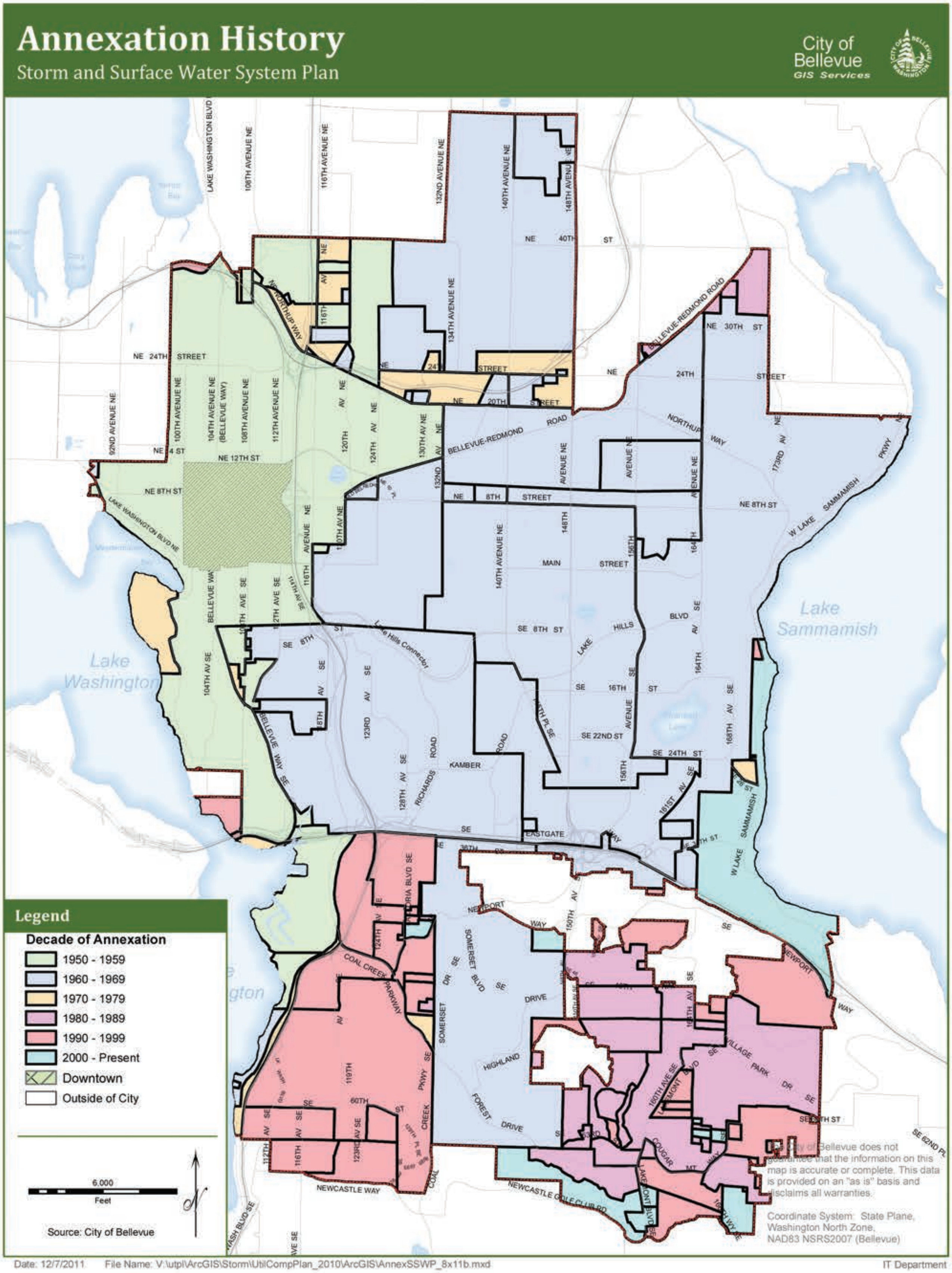



**Figure 6-15. Annexation history illustrates that much of the city was already developed prior to implementing stormwater regulations.**

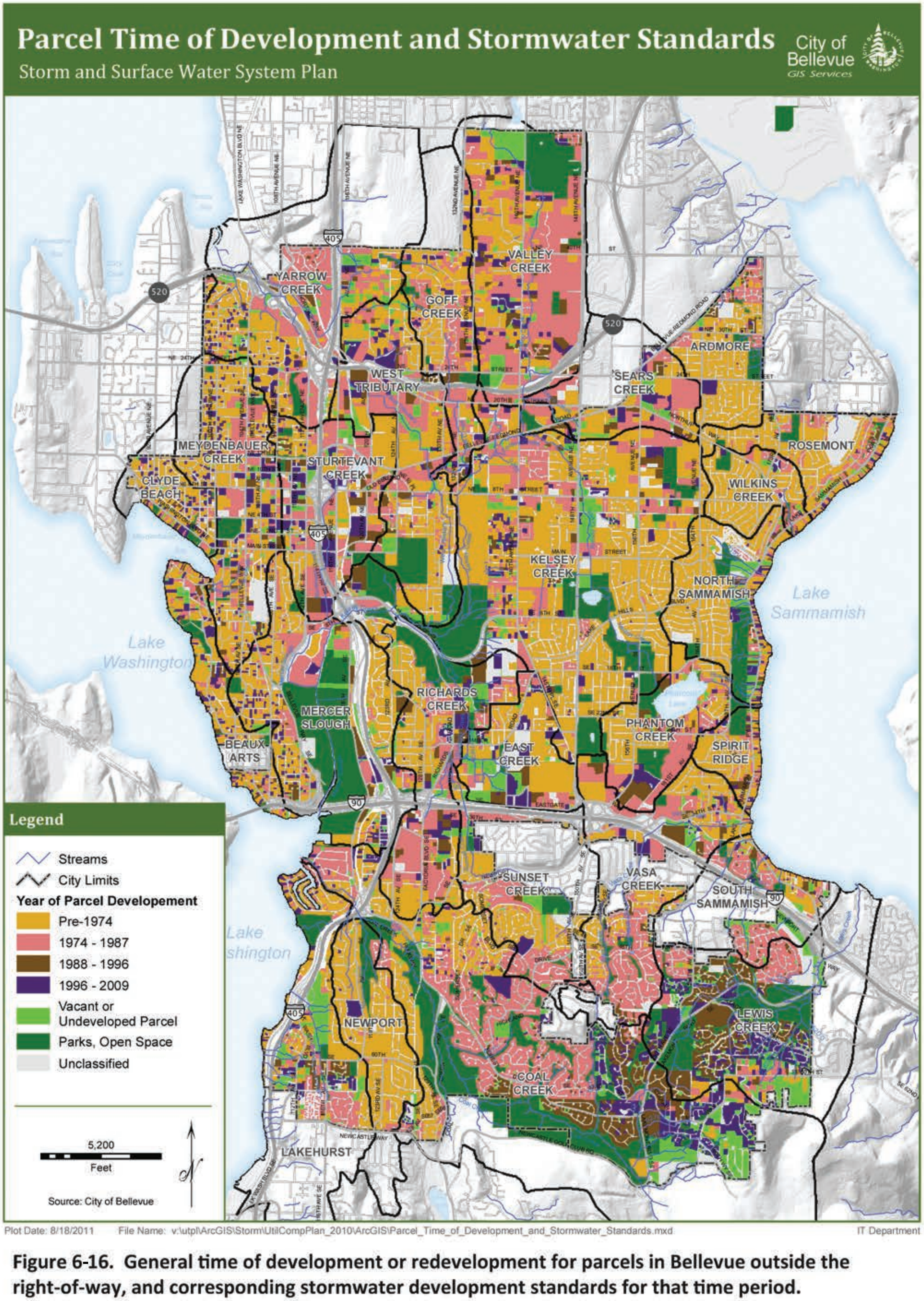
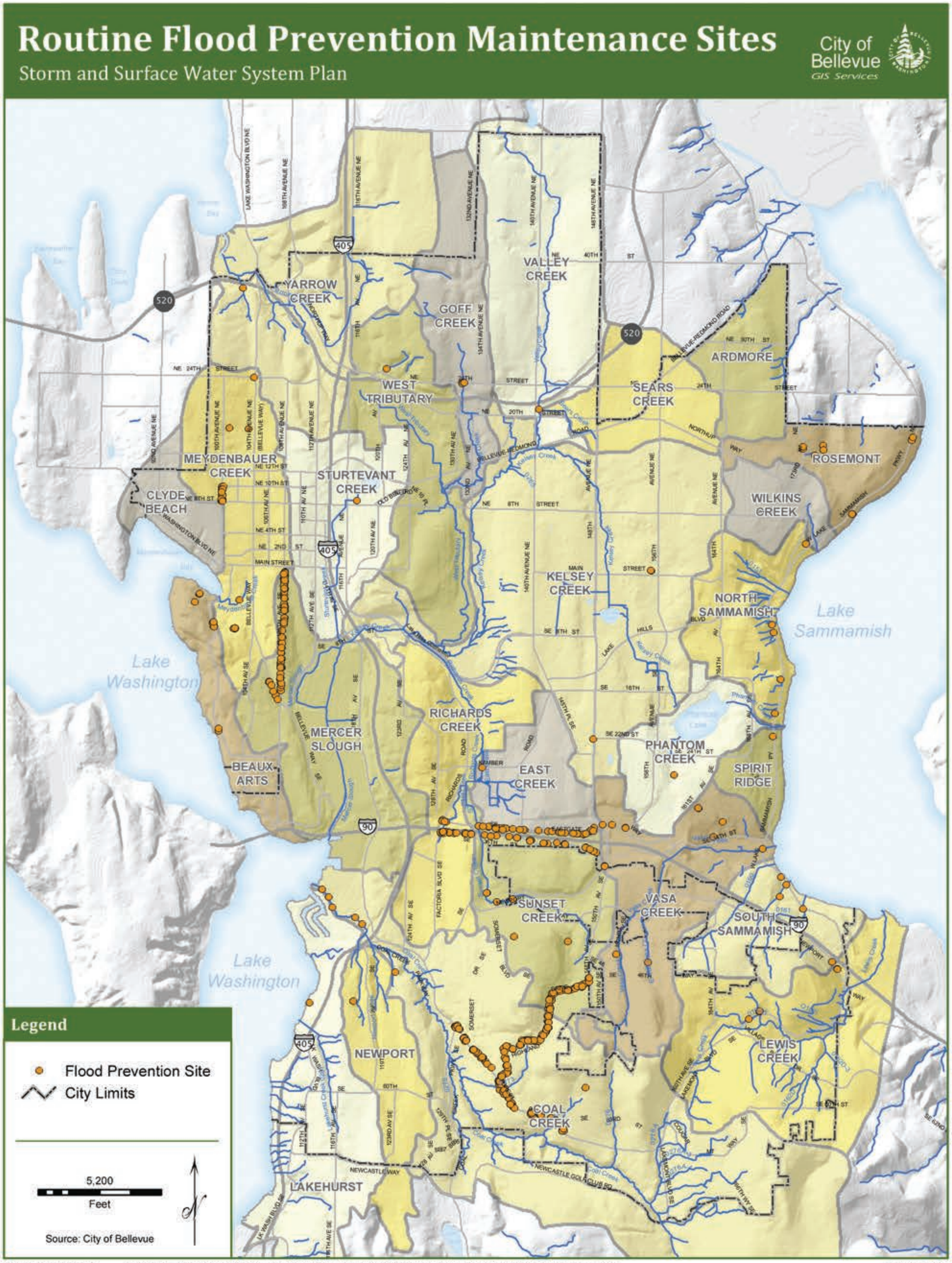



**Figure 6-16. General time of development or redevelopment for parcels in Bellevue outside the right-of-way, and corresponding stormwater development standards for that time period.**




Plot Date: 9/13/2011 File Name: V:\utpl\ArcGIS\Storm\UtilCompPlan_2010\ArcGIS\RoutineFloodPreventionMaintenanceSites.mxd IT Department

**Figure 6-17. Example of sites surveyed routinely during storm events to prevent flooding. If needed, debris is cleared from grates, or other maintenance is performed.**

**Note: This map is dynamic and constantly being revised.**

**Table 6-5. Common pollutants and their impacts on aquatic systems**

| Pollutant | Sources | Impacts |
|---|---|---|
| Sediment | Sediment is a common component of stormwater, and can be a pollutant. Sediment is the primary component of total suspended solids (TSS), a common water quality analytical parameter. | Sediment can be detrimental to aquatic life (primary producers, benthic invertebrates, and fish) by interfering with photosynthesis, respiration, growth, reproduction, and oxygen exchange in water bodies. Sediment can transport other pollutants that are attached to it including nutrients, trace metals, and hydrocarbons. |
| Nutrients | Nutrients including nitrogen and phosphorous are the major plant nutrients used for fertilizing landscapes, and are often found in stormwater. | Nutrients can result in excessive or accelerated growth of vegetation, such as algae, resulting in impaired use of water in lakes and other sources of water supply. Algae growth reduces water clarity, and when algae dies, it absorbs oxygen from the water as it decomposes. This harms fish and causes unpleasant odors. In addition, un-ionized ammonia (one of the nitrogen forms) can be toxic to fish. |
| Bacteria and Viruses | Bacteria and viruses are common contaminants of stormwater. For separate storm drain systems, sources of these contaminants include animal excrement and sanitary sewer overflow. | High levels of indicator bacteria in stormwater have led to the closure of beaches, lakes, and rivers to contact recreation such as swimming. |
| Oil and Grease | Sources of oil and grease include leakage, spills, cleaning, and sloughing associated with vehicle and equipment engines and suspensions, leaking and breaks in hydraulic systems, restaurants, and waste oil disposal. | Oil and grease includes a wide array of hydrocarbon compounds, some of which are toxic to aquatic organisms at low concentrations. |
| Metals | Metals including lead, zinc, cadmium, copper, chromium, and nickel are commonly found in stormwater. Many of the artificial surfaces of the urban environment (e.g., galvanized metal, paint, automobiles, or preserved wood) contain metals, which enter stormwater as the surfaces corrode, flake, dissolve, decay, or leach. Over half the trace metal load carried in stormwater is associated with sediments. | Metals are of concern because they are toxic to aquatic organisms, can bioaccumulate (accumulate to toxic levels in aquatic animals such as fish), and have the potential to contaminate drinking water supplies. |
| Organics | Organics may be found in stormwater in low concentrations. Often synthetic organic compounds (adhesives, cleaners, sealants, solvents, etc.) are widely applied and may be improperly stored or disposed, or deliberately dumped into storm drains and inlets. | Organics cause harm to aquatic life living in waterways. |
| Pesticides | Pesticides (including herbicides, fungicides, rodenticides, and insecticides) have been repeatedly detected in stormwater at toxic levels, even when pesticides have been applied in accordance with label instructions. | Accumulation of pesticides in simple aquatic organisms, such as plankton, provides an avenue for bio-magnification through the food web, potentially resulting in elevated levels of toxins in organisms that feed on them, such as fish and birds. |
| Gross Pollutants | Gross pollutants include trash, debris, and floatables. These items may contain heavy metals, pesticides, and bacteria. Typically resulting from an urban environment, industrial sites and construction sites, trash and floatables may create an aesthetic “eye sore” in waterways. Gross pollutants also include plant debris (such as leaves and lawn clippings from landscape maintenance), animal excrement, street litter, and other organic matter. | Gross pollutants may harbor bacteria, viruses, vectors, and depress the dissolved oxygen levels in streams, lakes, and estuaries, sometimes causing fish kills. |

**Source: Adapted from California Stormwater Quality Association. 2003. California Stormwater BMP Handbook, Municipal, Errata 9-2004. www.cabmphandbooks.com. Accessed March 2, 2010.**

Everyone has a responsibility to discharge clean water from their property. Local, state, and federal governments create rules to protect water quality and use BMPs while conducting operations. Individual actions of residents and businesses have direct impacts on surface water quality because runoff is not treated at a centralized treatment plant and there are many sources of pollution, including atmospheric deposition, byproducts of vehicle use such as gas, oil, and brake pad particles. Small actions by many people can have a large cumulative impact.

***Water Quality Evaluation***

The analysis to evaluate water quality protection looked at five measurable criteria available to the City. They are: 1) compliance with the NPDES Municipal Stormwater Permit, 2) number of Clean Water Act Violations, 3) number of illicit discharge corrections, 4) stream segments classified as being impaired water bodies, and 5) the water quality risk associated with each stormwater basin.

**Compliance with NPDES Municipal Stormwater Permit and Clean Water Act**

The City has been in 100 percent compliance with the NPDES Municipal Stormwater Permit since 2008 and has had no fines for Clean Water Act violations during the permit period. The City has only received one water quality violation—a minimum fine for a construction failure that released muddy water into Valley Creek in 2004.

**Illicit Discharge Corrections**

Illicit discharges are the release of pollutants into the storm drainage system, either through illegal connections, errors, or accidents. In 2010 and 2011, 182 illicit discharges were corrected within the city of Bellevue. As the illicit discharge detection program is new, it is anticipated to increase over the first few years as awareness increases. Over time, the numbers should decrease as problems are detected and resolved and as people have greater awareness of the impact of their actions.

**Waters Classified as Impaired**

Bellevue contributes runoff to nine stream segments, two Lake Washington sampling sites, and one Lake Sammamish sampling site that were rated as impaired in 2008 based on state criteria for water quality support of beneficial uses under the Clean Water Act; see Figure 6-18 (Ecology 2008). King County collected monthly grab samples over several years, which were used as the basis for the ratings. Streams were rated as impaired due to high fecal coliform bacteria counts, high water temperatures, and/or low dissolved oxygen; these affect their acceptability for human recreation (primary physical contact) and aquatic life support. However, two of the reaches in Mercer Slough that had high temperatures are heavily influenced by water temperatures in Lake Washington, and are unlikely to ever meet the stream temperature criteria. Fecal coliform bacteria are highly variable in the natural environment, and common sources include human septic systems, pet waste, and wildlife.

Mercer Slough, Coal Creek, Ardmore (Idylwood) Creek, Lewis Creek, and two sites along Kelsey Creek were sampled and rated as meeting tested standards (Category 1) under the Clean Water Act, Section 305(b), for pH or ammonia-nitrogen; see Figure 6-18 (U.S. Environmental Protection Agency 2010).

Statewide, less than three percent of streams and rivers were assessed, and of those, 80 percent were rated as impaired, and 20 percent were rated as meeting criteria for beneficial uses.

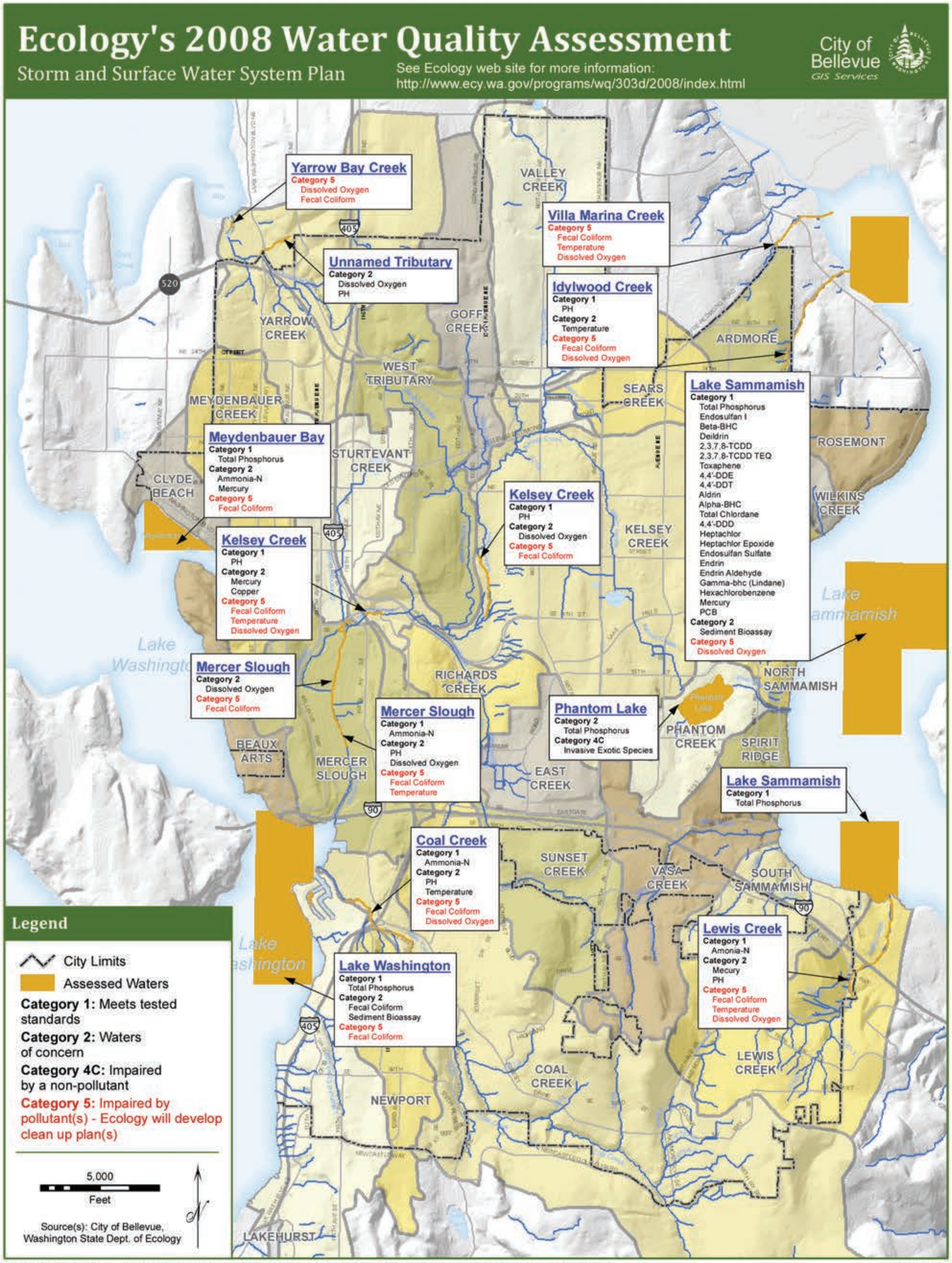



**Figure 6-18. 2008 Water Quality Assessment map showing ratings for water bodies in Bellevue and the vicinity based on state and federal water quality criteria for beneficial uses.**

**Water Quality Risk Assessment**

Stream segments were prioritized according to the likelihood of illicit discharges based on several land use and biological criteria as part of the City's NPDES program. Criteria used to rank each stream segment included:

- Fish bearing;
- Impaired water quality according to the state 303(d) list in 2009;
- Percent impervious area;
- Septic system areas;
- Density of outfall pipes greater than 24 inches directed to stream;
- Adverse history of stream water quality issues;
- Land use; and
- Industrial permits.

Each stream segment was ranked high, medium, or low water quality risk level (Figure 6-19), which corresponds to the Illicit Discharge Detection and Elimination (IDDE) program's receiving waters risk assessment, outfall reconnaissance inventory class. This classification of stream segments was used to prioritize inspections of outfalls based on the likelihood of pollutants entering the system through the outfalls. This ranking summarizes multiple factors for water quality risk in a watershed.

**Water Quality Summary of Bellevue's Streams**

Overall, Bellevue waters show similar water quality impacts as other urban streams, including increased summer temperature, lower dissolved oxygen, and increased fecal coliform bacteria—constituents identified by the Washington State Department of Ecology (Ecology). A basin-scale summary of the water quality evaluation metrics follows:

- 100 percent compliance with NPDES Municipal Stormwater Permit conditions;
- Zero Clean Water Act violations;
- 182 illicit discharge corrections; (2010)
- 5 basins with water quality impairments; and
- 10 basins with a high risk for illicit discharges.

Federal and state regulations for some widespread pollutants may be the best way to reduce their impact on water quality. For example, lead was commonly found above acutely toxic levels in Bellevue stormwater in the 1980s, when leaded gasoline was commonly used. Federal regulation restricted the use of lead in gasoline, and by 1990s, the amount of lead in Bellevue's surface runoff was dramatically reduced, from average 170 micrograms per liter (µg/L) to 10 µg/L (City of Bellevue 1995), which followed the national trend (U.S. Geological Survey 2001). Similar regulations limiting the use of toxic metals in car brake pads were recently passed. As they go into effect over the next several years, the amount of copper found in stormwater runoff should be reduced (Washington Senate Bill 6557; http://apps.leg.wa.gov/billinfo/summary.aspx?bill=6557&year=2009).

## Evaluating Stream Habitat

The evaluation criteria for stream habitat were based on standards used by NOAA Fisheries to determine potential impacts of projects on Chinook salmon or their habitat, which is protected under the Endangered Species Act (ESA). Another indicator of stream health is aquatic benthic macroinvertebrates—the small organisms that live on the stream bottom and have different sensitivity to pollutants and habitat disturbance. There is limited information about stream habitat conditions, but metrics, such as the number of large woody debris pieces per channel width and pool quality, generally indicate degraded habitat similar to other urban streams (see Figure 6-20).

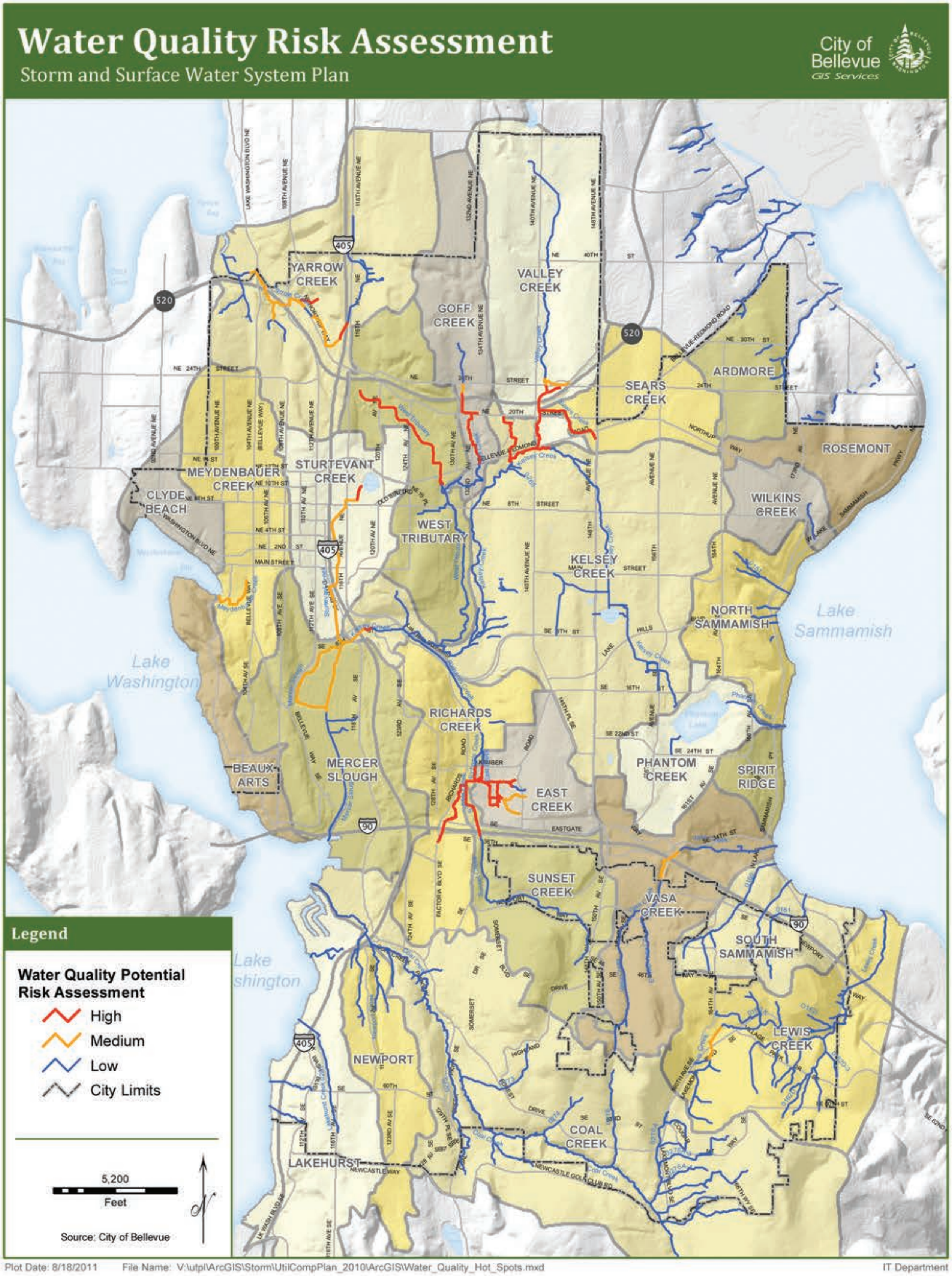



**Figure 6-19. Water quality risk assessment that identifies potential risk areas for pollution entering streams, based on land use, outfalls to streams, and fish use.**

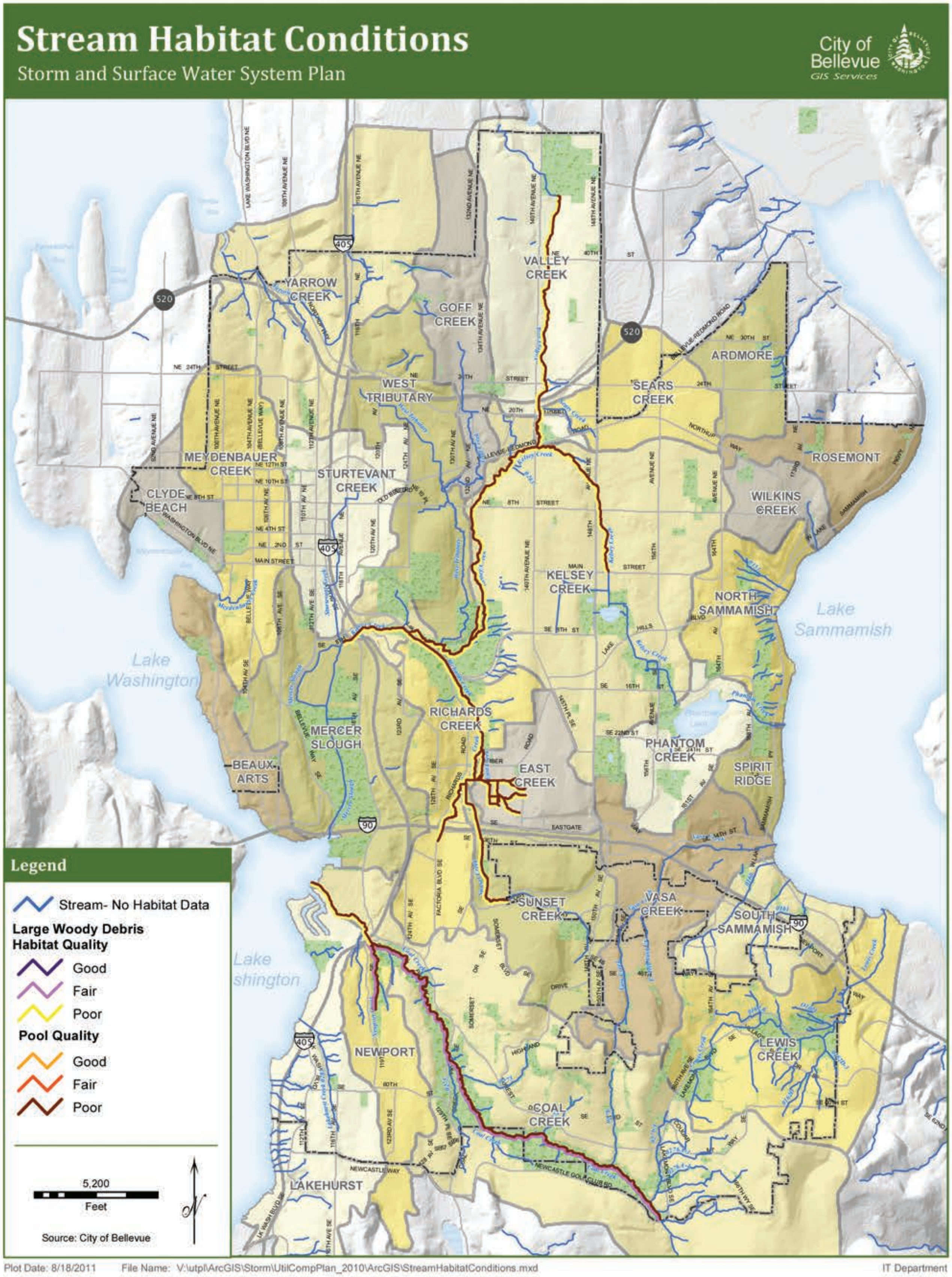



**Figure 6-20. Stream habitat conditions map.**

### *Wood Pieces per Channel Width*

Pieces of large woody debris (commonly referred to as LWD) or logs in stream channels improve stream habitat for fish and wildlife. Wood captures sediment, protects banks from erosion, shades the water, creates hiding places, forms deep pools where fish can rest and feed, and feeds invertebrates, which supports the stream food web. Wood was historically very abundant, but much of it was removed in the past two centuries for logging, and riparian trees were cut down, eliminating the source for much new wood. Current restoration efforts include placing logs directly in streams as well as planting trees near streams to supply wood in the future. The amount of wood along a stream channel per each channel width is a metric for habitat quality. Habitat quality is considered good when there are more than two pieces of large wood per channel width, fair with one to two pieces per channel width, and poor with less than one piece per channel width (Kerwin 2001). Of the few Bellevue streams that have been surveyed for wood, most are considered poor habitat quality due to a lack of wood; see Figure 6-20 (Stream Habitat Conditions). Only Coal Creek was ranked fair. Since the wood surveys, several projects were completed where wood was placed in the stream channel—these are located in Coal, Valley, Newport, Yarrow, and Sunset Creeks, and the West Tributary. Large woody debris density may have improved in Coal Creek and locally where projects have been implemented.

### *Pool Quality*

Large pools in streams provide slow-moving water that provides resting places for migrating adult salmon as well as for fish that live in the streams year-round. Deep pools with cool water and cover (an overhanging log or vegetation hanging over from the bank) provide places for fish to feed and hide from predators. Streams rate “good” for pool quality if they have frequently spaced pools over 1 meter deep with cover and cool water, and “poor” if they only have shallow pools or pools without cover or cool water, as described in Kerwin (2001). Bellevue data did not incorporate water temperature, so ratings were based on pool depth and cover. Of the five basins with data, none met standards for “good” pool quality. Sixteen basins had no data and five basins do not have perennial streams. For example, in the Kelsey Creek basin, pool frequency was less than 13 pools per mile, and the distance between pools was 22.1 bankfull widths (channel widths) on average, more than 10 times the recommended distance (Kerwin 2001).

### *Benthic Macroinvertebrates and Biotic Integrity*

Macroinvertebrates (insects, snails, worms, and other spineless creatures big enough to see with the naked eye) that live in gravel substrate of streams are sampled each year because they are a valuable indicator of stream health. These benthic macroinvertebrates are not able to move quickly to avoid undesirable conditions, and are sensitive to the following factors:

- Flow rates;
- Timing of storm flows;
- Pollutants in the water such as heavy metals and pesticides;
- Water temperature;
- Dissolved oxygen levels in the water;
- Fine sediments from upstream erosion; and
- Amount of food available in the form of leaf litter and smaller organisms.

As conditions in the streams change, the benthic macroinvertebrate community changes in predictable ways (Marangelo and Bollman 2010). Because many water quality problems are short-lived, they are difficult to measure by traditional water quality sampling. The number and diversity of benthic macroinvertebrates, on the other hand, represent a good indicator of both the water quality and habitat condition of a stream.

Scientists use a rating system to score samples based on the types of groups and number of macroinvertebrates in a sample, known as the Benthic Index of Biotic Integrity (B-IBI) (Fore et al. 1996). B-IBI scores can range from 10 (poor condition) to 50 (pristine condition). Researchers have found the B-IBI score to be significantly correlated with the amount of urbanization in a watershed, measured by percent impervious area (Alberti et al. 2007; Booth et al. 2004; Morley and Karr 2002). Generally, when a watershed becomes more than 10 percent impervious, the score is lower. Scores below 36 are currently considered biologically impaired (City of Seattle et al. 2010).

Thirty sites in 13 Bellevue drainage basins were sampled for benthic macroinvertebrates between 1998 and 2010 (Appendix B-7). Sampling sites were selected based on adequate sampling conditions for macroinvertebrates, a need for information, and available staff resources. B-IBI scores and site ratings are based on regionally accepted protocols (City of Seattle et al. 2010). Sites with at least 3 years of B-IBI sampling between 1998 and 2007 were analyzed for trends, but none were detectable with so few data points (Bollman 2009).

The most recent B-IBI scores show 56 percent of all Bellevue sites ranked in the second lowest category (poor), and 43 percent ranked in the lowest category (very poor) (see Figure 6-21). Some Lewis Creek and Coal Creek sites ranked fair between 1998 and 2006, but scored lower in more recent years. All sites in Bellevue had B-IBI scores between 10 and 32 out of a highest possible score of 50 over all the years sampled (see Appendix B-7). Bellevue site ratings are consistent with other urban sites sampled in the Puget Sound lowlands. Sites meeting the higher ratings were found in more pristine streams in the foothills of the Cascades east of Bellevue. The range of B-IBI scores for Bellevue streams from 1998 to 2010 are shown in Figure 6-22. B-IBI scores for Bellevue streams are consistent with other urbanized sites around the Puget Sound basin (see Figure 6-23).

A more detailed look at components of the scores can be helpful in diagnosing issues at each site. For example, Bellevue sites generally have low clinger richness and high numbers of tolerant invertebrate species. This generally indicates water quality issues such as elevated nutrient levels and possibly high concentrations of metals, erosion and deposition of fine sediments, or scouring flows at some sites. Streams requiring actions to improve biological communities can be identified by using B-IBI scores, along with other indicators of the stream's physical, biological, and water quality conditions.

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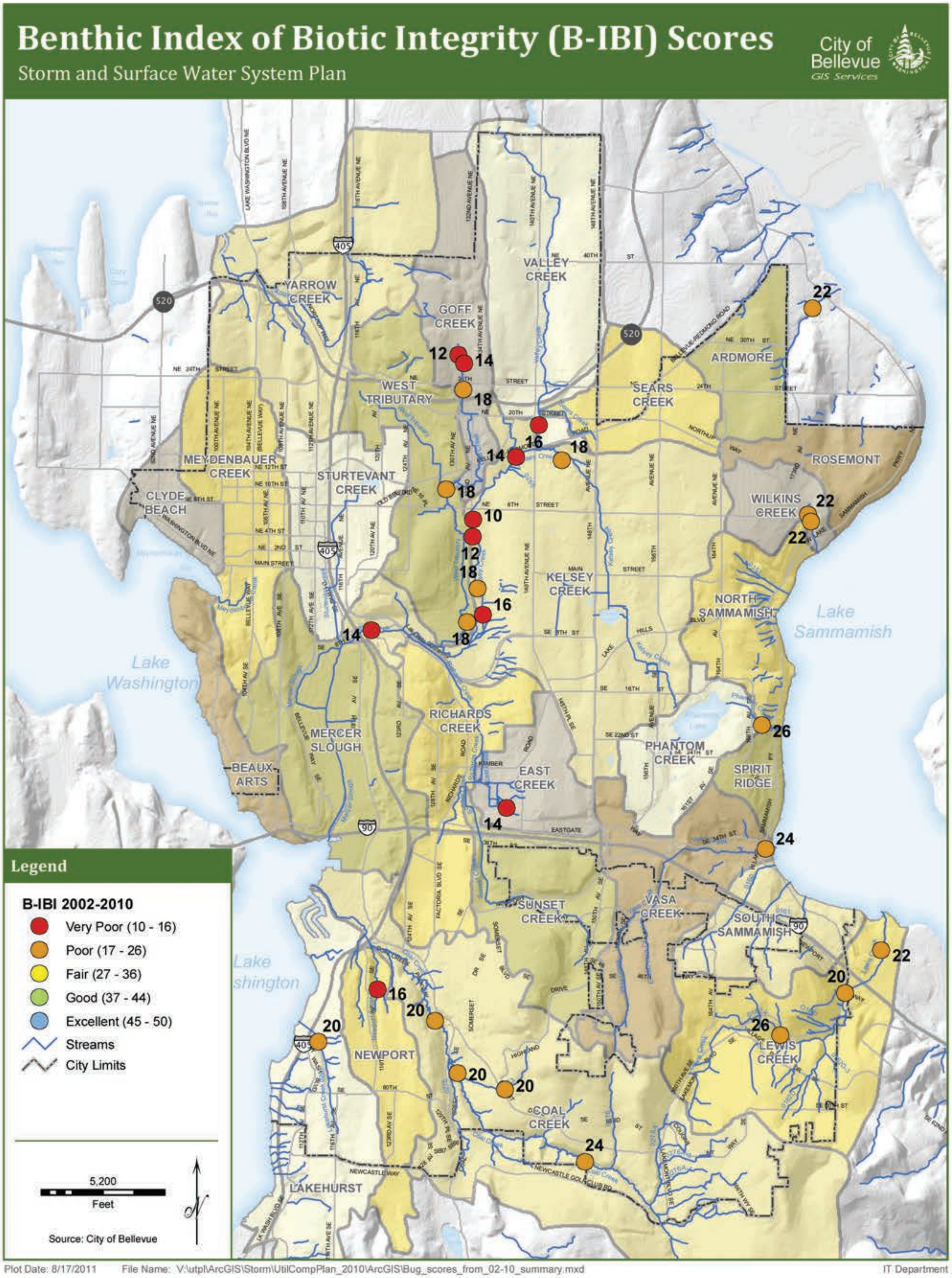



**Figure 6-21. Benthic macroinvertebrate sites sampled in Bellevue between 1998 and 2010, and the most recent B-IBI site score (2002-2010) and corresponding rating for each site.**

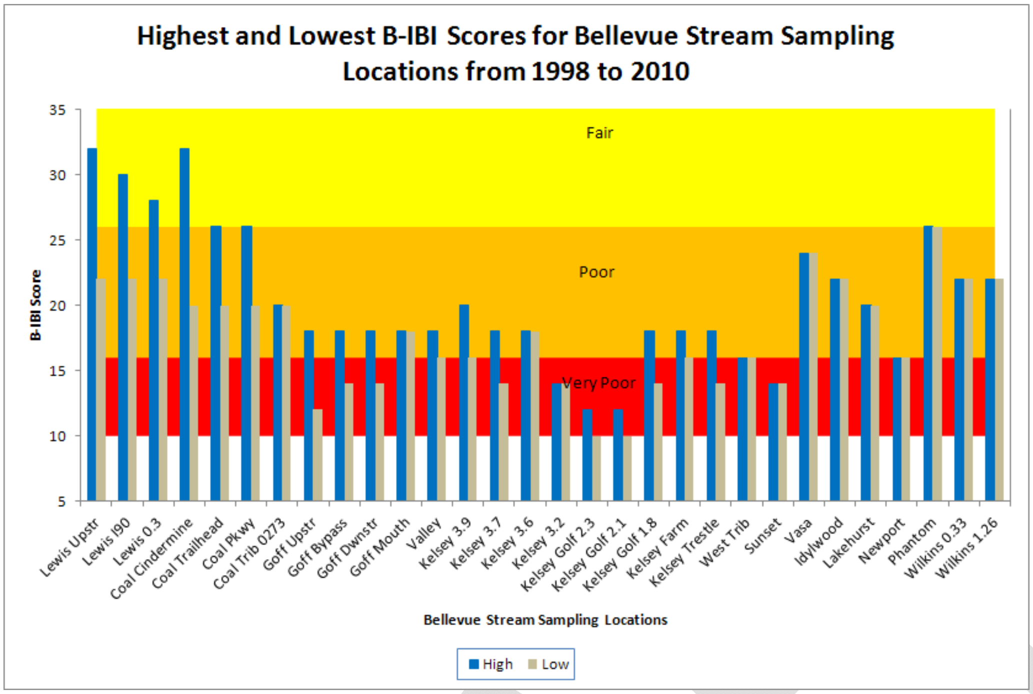


**Figure 6-22. Highest and lowest B-IBI scores for all sites sampled in and near Bellevue from 1998 through 2010.**

**Note: The scores represent the variability within the sites, not trends over time. Sites with the same high and low score were only sampled once.**

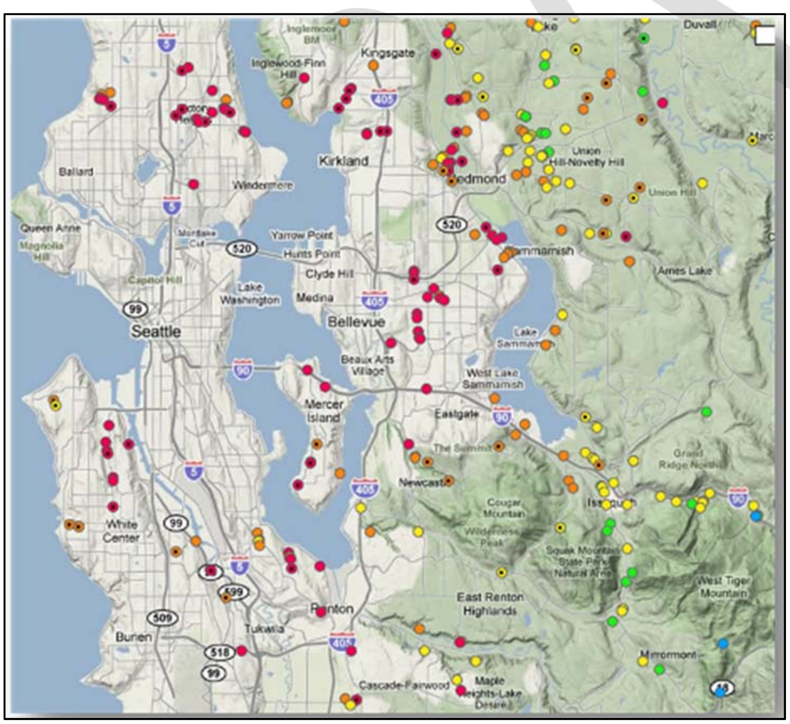


**Figure 6-23. B-IBI scores for sites in Bellevue and the greater Puget Sound region, showing that Bellevue sites are consistent with sites in nearby urbanized areas.**

**Source: Puget Sound Stream Benthos website, accessed May 27, 2010.**

**Bank Hardening**

Bank hardening is a term used to describe the condition of stream banks. NOAA Fisheries established standards for bank hardening as a measure of aquatic habitat condition. Lowland stream banks naturally consist of sandy or gravelly soils with thick native vegetation. Urbanization causes more runoff to streams, which can cause natural rates of bank erosion to increase dramatically in some places. When structures such as houses, roads, or businesses are built close to a stream, the banks are often hardened with large rocks or walls in order to prevent bank failure and protect infrastructure. This keeps streams from naturally moving and meandering back and forth within the floodplain, and can cause more erosion and flooding downstream. Bank hardening information is collected by walking the streams and measuring the extent of hardening materials present. To date, this information has not been collected in Bellevue; therefore, data are not available for this evaluation.

## Supplemental Stream Condition Information

This section of the chapter contains supplemental information used to complement the evaluation data used to assess the condition of the storm and surface water system in Bellevue. The sections that follow refer to and describe numerous data resources that are relevant to the stormwater system in Bellevue. While the data may not have been used directly for the evaluation of the system, the data provide additional supporting documentation for other metrics used in the evaluation (for instance, stream flow that affects flooding and habitat quality). The following sections provide additional information about the system captured in numerous natural resource reports prepared by the Utilities Department.

***Stream Flow***

As established earlier, the amount of surface runoff that flows into streams, lakes, and wetlands increases significantly when areas are developed. Not only is the volume increased, but it reaches the stream much faster than in an undeveloped area, and then decreases to low levels more quickly after the storm has ended. This dramatic fluctuation is due largely to changes in the infiltration rates of the soil, which is paved, covered, and compacted so that water is less able to soak in and slowly seep towards the streams after each storm (Booth and Jackson 1997). Stormwater detention requirements mitigate the increased runoff from a developed site by storing the excess stormwater in ponds or vaults and then slowly releasing the stored water over a long period of time. The mitigated peak runoff rate mimics the natural peak flow, but because of the additional quantity of water in a developed basin, the peak extends for a much longer time period than in a forested basin (Figure 6-24). This general stream response to development and stormwater detention strategies is one reason there is strong interest in implementing LID techniques that allow water to soak into the ground, rather than run off. An example from Kelsey Creek is available in Figure 6-25.

Citizens often ask whether a large rain event was a “100-year storm” or complain that, “100-year storms seem to happen every year.” This type of terminology refers to the flow frequency, or the probability that a flow of a given magnitude (or larger) will occur in a given year. For example, the 2-year flow has a 1-in-2, or 50 percent chance of occurring during a year, whereas a larger, 100-year flow has only a 1-in-100, or 1 percent chance of occurring during any particular year. Urbanization has increased flow volumes and peak flows in stream corridors that were shaped by a forested landscape; as a result, both the 2-year and 100-year flow frequencies in Bellevue have increased over time. This increase in flow frequencies directly affects the stability of stream channels, level of erosion and sedimentation, and ultimately aquatic life.

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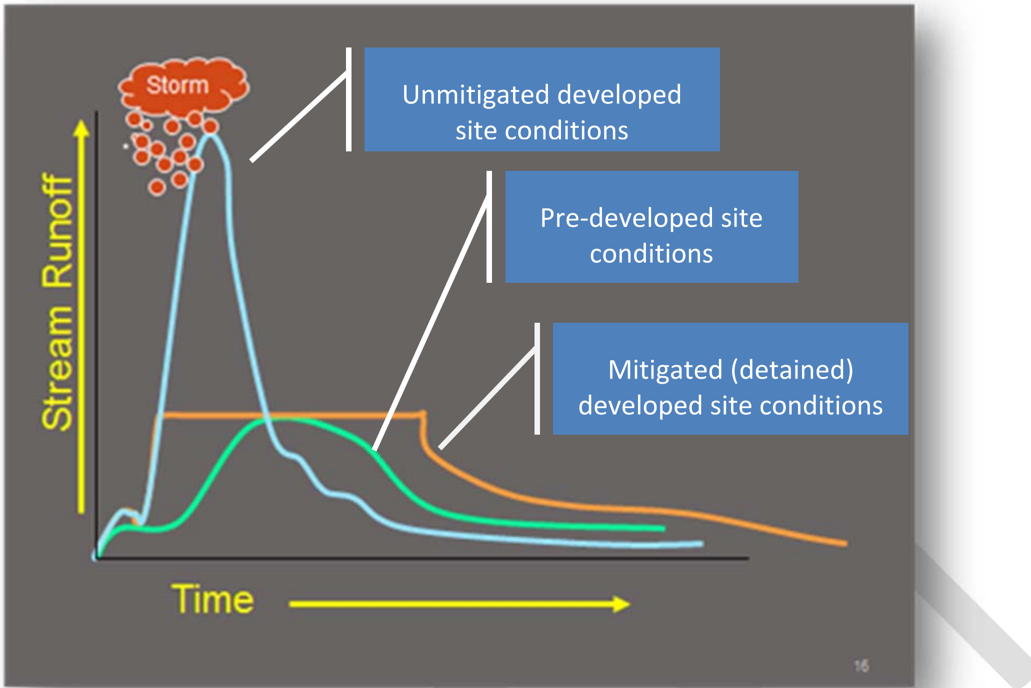


**Figure 6-24. Hypothetical runoff hydrographs illustrating effect of land use.**

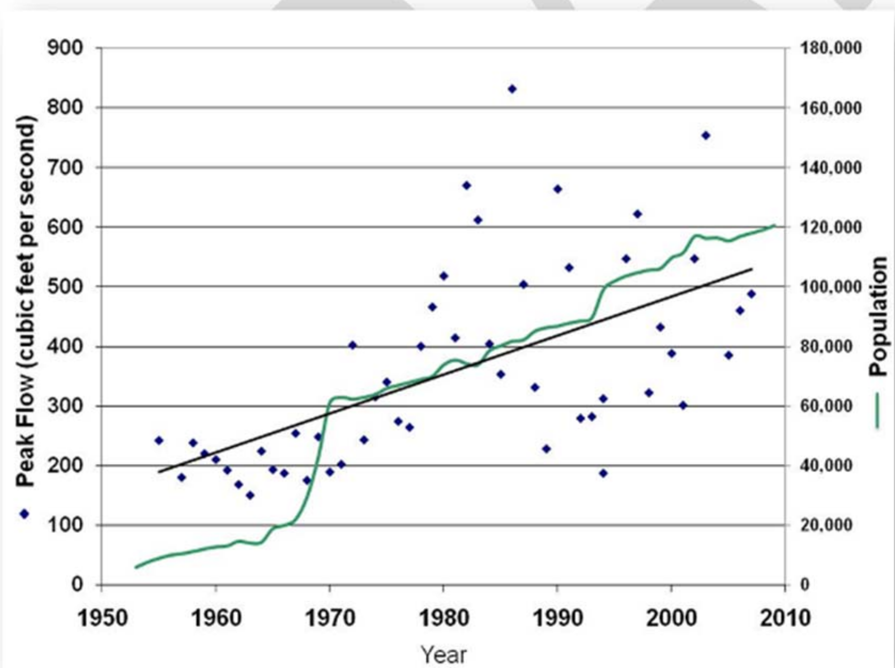


**Figure 6-25. Peak annual flow at the Mercer Gauge on Kelsey Creek compared to human population in Bellevue each year from 1953 through 2009.**

**Note: The straight black line shows the peak annual flow has an upward linear trend over time.**

Higher and more frequent peak flows in Bellevue's streams due to urbanization are evident when comparing trends in annual peak flows in Kelsey Creek between 1953 and 2009 (U.S. Geological Survey 2009) to Bellevue's human population (Bellevue Planning and Community Development 2000; State of Washington 2009). The human population increased 12 times between 1953 (when Bellevue incorporated) and 2009 (Figure 6-25). During the same period, the highest flow over the course of a year in Kelsey Creek became more erratic and trended higher. Between the 1950s and the early 1970s, the highest flow recorded was under 300 cfs. In the past 35 years, the peak annual flow has been over 600 cfs (double the highest flow before the early 1970s) six times.

According to an analysis of water quantity trends for King County completed in 2001, the peak daily flow in Kelsey Creek (measured at the USGS gauge at Mercer Slough) was increasing, and the average 7-day low flow volume was also increasing for the period between 1956 and 1996 (Wetherbee and Houck undated). In the Kelsey Creek basin, low flow volume has increased, which is unusual for urban areas, where low or base flows typically decrease because impervious land surfaces usually have a negative impact on static groundwater levels. A declining groundwater supply to streams typically results in lower base flows, but in the Kelsey Creek basin it is theorized that potable water being added to the surface water system from irrigation practices has buttressed summer stream flows in this basin. Larsen Lake at the headwaters and large wetlands along Kelsey Creek could also factor in stable low flow volumes (David Hartley, Northwest Hydraulic Consultants, pers. comm.). Maintaining natural low flow conditions is critical for sustaining aquatic life, as it maintains cooler water and a larger physical space within the wetted channel for organisms.

In a study conducted by King County in 2009, stream flow rates were found to be changing significantly over time in Kelsey Creek, in ways that are expected with increased impervious area (DeGasperi et al. 2009). This study found that eight different measures of stream flow "flashiness" are highly correlated with the quality of the aquatic macroinvertebrate community (e.g., mayflies and snails) living in the stream. Stream flow "flashiness" refers to the rate stream flows rise and fall in response to a rain event. A "flashy" stream rises quickly once rain starts and falls just as quickly once the rain stops. Flashy flows adversely affect salmon productivity because the rapid decline of stream flows can leave salmon stranded on top of beaver dams or in the floodplains next to streams.

A measure of stream flashiness, TQ mean, is the proportion (or relative amount) of time that measured flows in a given water year are above the average flow for that year. A declining TQ mean indicates a stream that is becoming increasingly flashy. The TQ mean for Kelsey Creek since 1956 has declined (Figure 6-26), indicating that storm flows in Kelsey Creek are typical of urban streams, more quickly rising above and falling below the mean annual flow.

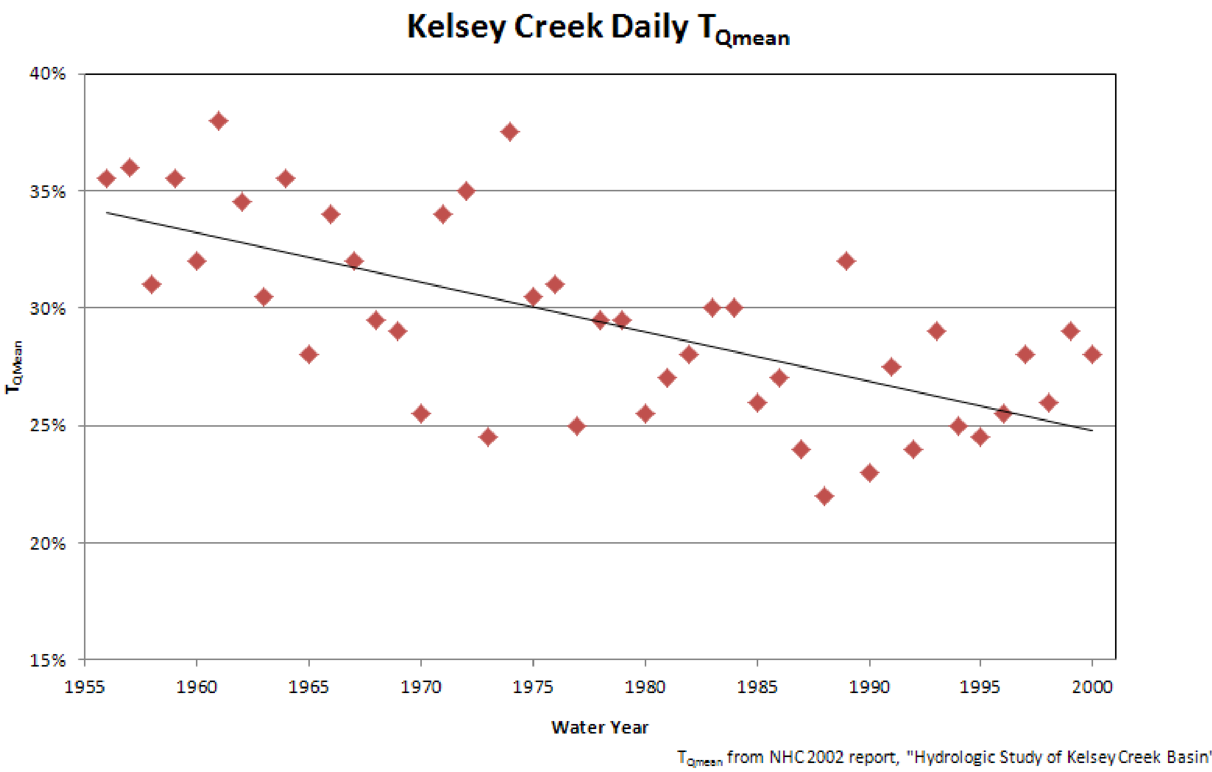


**Figure 6-26. TQ mean (proportion of time stream flow was above the mean daily flow during the water year) and linear trend in TQ mean (shown as a black line) for Kelsey Creek from 1956 to 2000.**

**Note: The decline indicates an increase in flashy stream flows, which is typical of an urban stream.**

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### *Stream Channel Condition*

Maintaining stable stream conditions in Bellevue is important to minimize streambank erosion, delta formation, flooding, and property damage as well as maintaining aquatic life in streams and lakes, including salmon listed under the ESA. There are two primary sources for current stream habitat (channel condition) information in Bellevue: 1) the Habitat Limiting Factors Report, and 2) the Citywide Streams Assessment. The descriptions of the stream channel conditions in Bellevue summarized in the sections below are from the following reports:

- The Salmon and Steelhead Habitat Limiting Factors Report (Kerwin 2001) summarized the best available science and habitat data collected in 1996 and 1997 on Kelsey Creek and its tributaries (including Richards, Valley, Sunset, and others), and in 1998 on Coal Creek. It rated the habitat condition of these basins from the perspective of salmon habitat, which can also be used as an indicator of ecological health. The Habitat Limiting Factors Report rated streams using categories of good, fair, and poor. For additional details on the basis of the ratings, see the report (Kerwin 2001).
- The City conducted a Citywide Assessment of stream channel conditions from 1998 to 2002 (City of Bellevue Utilities Department 2003). The Citywide Assessment consisted of a review of stream channel work orders and problems, a citizen survey, and visual surveys of every stream in Bellevue. Streams were mapped using Global Positioning System units, and problems that could be addressed through the Capital Investment Program were described, photographed, and ranked by severity. Land cover analyses were updated based on information collected in 2007 (Sanborn Map Company 2007).

### *Riparian Condition*

The most effective, least expensive way to maintain stable stream conditions and protect habitat for aquatic life is to maintain natural riparian zones around streams that are wider than 30 meters, continuous, and composed of wetland or mature mixed deciduous and coniferous forest canopy (May and Horner 2000). The riparian zone impervious area ranged from 6 to 62 percent along the city's streams (see black bar graph in Figure 6-7); forest canopy along streams ranged from 23 to 91 percent (see green bar graph in Figure 6-7), as described above.

Riparian condition was rated poor for all Bellevue streams in the Habitat Limiting Factors Report (Kerwin 2001) based on narrow forested buffer width and less than 30 percent cover by coniferous (evergreen) trees (Table 6-6). Restrictions on development in stream and wetland buffers and City efforts to purchase lands with important surface water functions have protected riparian zones in some basins. However, the forest canopy does not contain a high percentage of mature evergreen trees.

**Table 6-6. Stream habitat quality ratings based on habitat suitability for salmon from the Salmon and Steelhead Habitat Limiting Factors Report (Kerwin 2001)**

| Stream* | Riparian Condition | Floodplain Connectivity | LWD | Pools | Side Channel Habitat | Substrate Fines |
|---|---|---|---|---|---|---|
| Kelsey | Poor | Poor | Poor | Poor | ND | Poor |
| Mercer Slough | Poor | Poor | ND | ND | ND | ND |
| Sturtevant | Poor | ND | ND | ND | ND | ND |
| Valley | Poor | ND | Poor | Poor | ND | ND |
| West Tributary | Poor | ND | ND | ND | ND | ND |
| Goff | Poor | ND | ND | ND | ND | ND |
| Richards | Poor | ND | Poor | Poor | ND | ND |
| East | Poor | ND | Poor | Poor | ND | ND |
| Sunset | Poor | ND | Poor | Poor | ND | ND |
| Coal | Poor | Poor | Fair** | ND | Poor | ND |
| Meydenbauer | Poor | ND | ND | ND | ND | ND |
| Yarrow | Poor | ND | ND | ND | ND | ND |
| Lewis | Poor | Poor | ND | ND | ND | ND |

***Ratings were not available for Ardmore, Wilkins, Vasa, or Phantom Creeks**
****Rating based on data not included in Habitat Limiting Factors Report.**
**ND = No data available.**

### *Lake Physical Characteristics*

There are two large lakes that border Bellevue: Lake Washington to the west and Lake Sammamish to the east. In addition, Bellevue has three small lakes: Lake Bellevue, Larsen Lake, and Phantom Lake.

Lake water surface elevations affect shoreline properties. They rise and fall in response to precipitation and the hydrologic control (e.g., culvert or weir) at the outlet. Lake Washington, for example, was lowered 8 feet when the Ship Canal was completed in 1934 to allow ships access to Lake Union. The level of Lake Washington is now closely managed by the U.S. Army Corps of Engineers to stay within a 2-foot height range (U.S. Army Corps of Engineers 2004), primarily to protect floating bridges and sewer connections. Average, minimum, and maximum Lake Washington water surface elevations, averaged over 20 years, are shown in Appendix B-8.

Lake Sammamish water levels respond to precipitation amounts and inflow from many tributary streams, especially Issaquah Creek. It flows out the Sammamish River and through Lake Washington, and eventually exits to Puget Sound via the Ship Canal. In 1964, the Sammamish River was dredged and straightened by King County and the U.S. Army Corps of Engineers, and a weir was installed at the lake outlet (The Watershed Company 2004). The average daily water level on the southwest side of the lake shows fluctuations of approximately 3 to 4 feet every year, with peaks during the winter and spring, and lows in the summer and early fall (see Figure 6-27). The peak elevation observed since the gauge was installed in 1939 was 33.44 feet (NAVD88) on February 12, 1951; the lowest lake level observed was 25.13 feet (NAVD88) during August 25-27, 1951 (U.S. Geological Survey 2008).

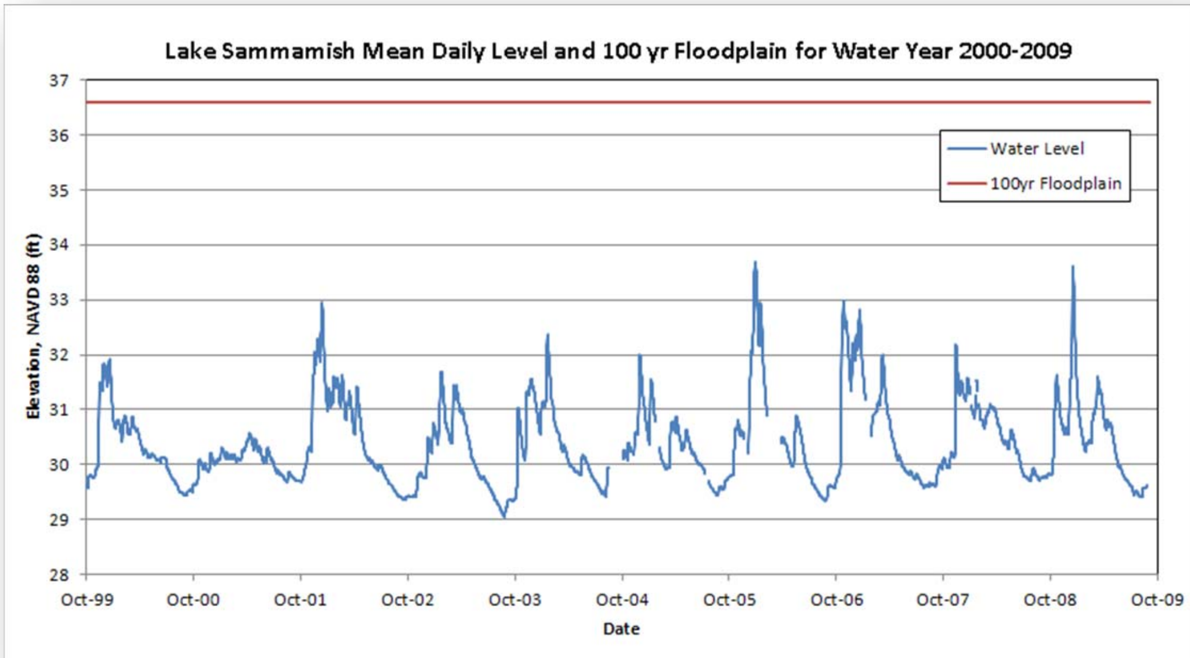


**Figure 6-27. Water level elevation of Lake Sammamish, as measured from USGS gauge 12122000, for water years 2000 through 2009.**

Larsen Lake, in the headwaters of Kelsey Creek, is part of a regional detention facility. An adjustable gate controls the outlet and helps mitigate flooding for small storm events. However, due to the flat topography in the area, heavy precipitation still results in occasional flooding of 148th Avenue NE near the lake.

Phantom Lake was historically the headwaters of Kelsey Creek, but was diverted into Lake Sammamish in the 1880s or 1890s (McDonald 1984). The lake has a weir at the outlet that can be raised or lowered to help maintain summer water levels. This is done to reduce phosphorus-laden groundwater interflow into Phantom Lake during summer months to improve water quality. The outlet control is not operated to control flooding. Phantom Lake water level generally fluctuates between 260 and 262 feet (NAVD88 datum) over the course of a year (see Figure 6-28), which is well below the 100-year floodplain elevation as shown the Flood Insurance Rate Map (Federal Emergency Management Agency 2007). Mean annual water elevation has also fluctuated by approximately 2 feet, according to the data, although the elevation gauge was not calibrated until 2007, so prior data are not reliable. These apparent fluctuations could be due to precipitation patterns, soil conditions, natural lake processes such as sediment building up in the lake bed and sediment and vegetation constricting the outlet channel, beaver activity, and/or lake outlet management activities.

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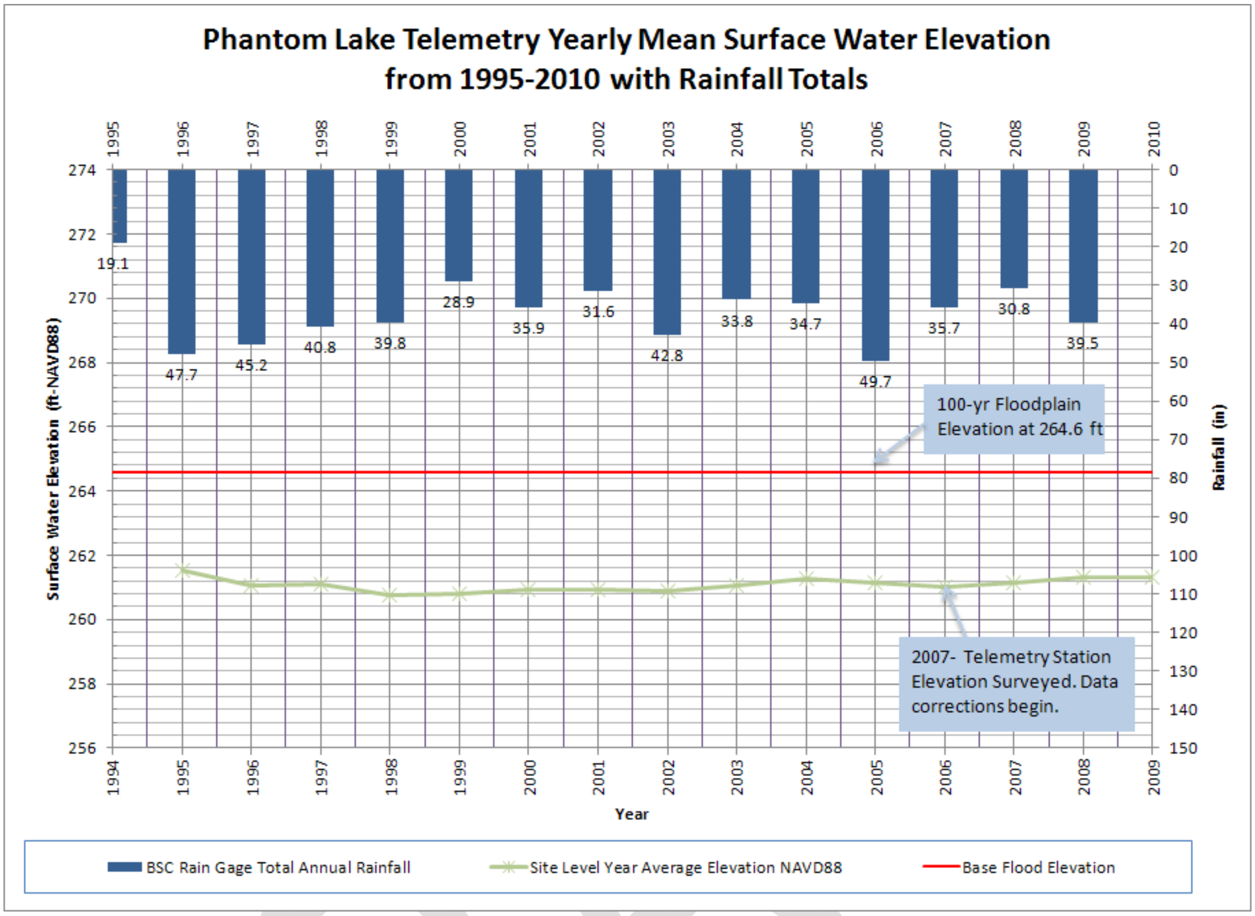


**Figure 6-28. Mean annual Phantom Lake water level elevations as measured by City of Bellevue, from 1995 through 2010, and total annual rainfall in north Bellevue.**

**(100-year floodplain Base Flood Elevation as established by FEMA in 1978, from Federal Emergency Management Agency 2007)**

Lake Bellevue does not have a continuously recording water level gauge. Vegetation removal work on the outlet channel in 2010 resulted in the water level of the lake dropping about half a foot, as recorded at a temporary staff gauge. The water level change indicates that the outlet channel is the hydraulic control for Lake Bellevue.

***Sedimentation***

Stream erosion is a natural process. The degree to which streams naturally erode depends on a number of factors such as geologic setting, stream bed material, and natural flow regime. It is well documented that with increased flows following urbanization, stream erosion increases (Hammer 1972; Leopold 1973; Booth 1990). Excessive erosion caused by urban stream flow results in fine sediments depositing in stream gravels and is known as sedimentation. Sedimentation degrades aquatic habitat by filling the void spaces in stream gravels where macroinvertebrates live, eliminating pools that provide resting areas for fish, and smothering salmon eggs after they are buried in the stream gravels to incubate.

Figure 6-29 shows fine sediment data points from Coal Creek and Kelsey Creek (Kerwin 2001) and from recent sediment monitoring for a capital project on Sunset Creek. For more information about the Sunset Creek study and the effectiveness of a capital project to reduce sediment impacts, see Appendix B-9. Fine sediments were found to be above the thresholds that impair salmon egg survival (9 percent) at all sites and above thresholds that kill salmon eggs (20 percent) in some samples. Fine sediments were also substantially above salmon thresholds in Coal Creek below I-405, but it is not clear whether the fine sediments would naturally be high in this delta depositional area.

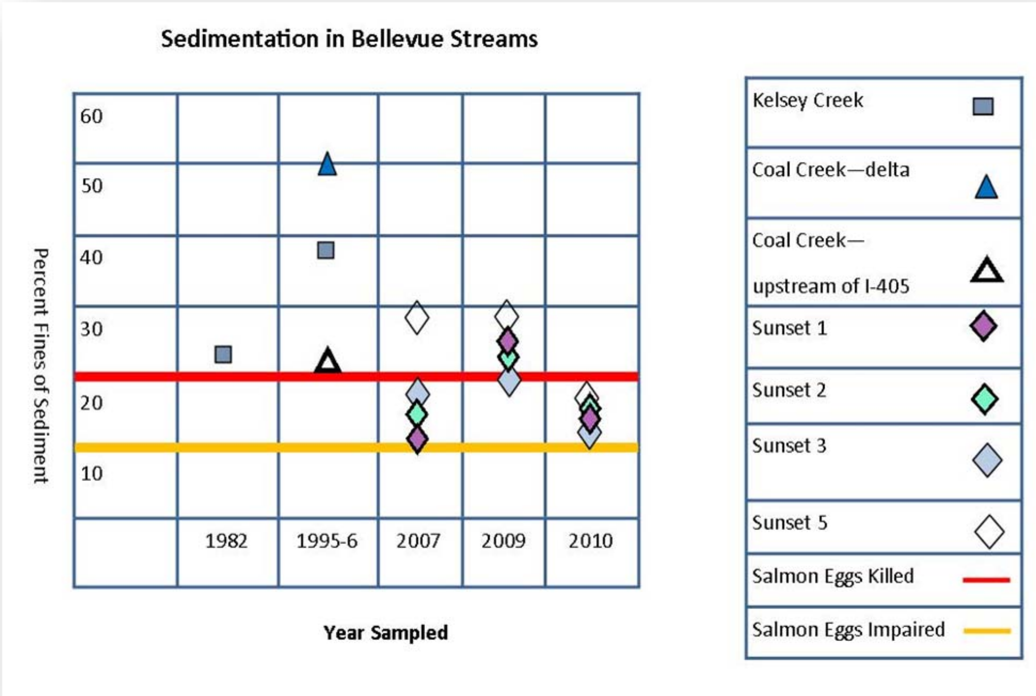


**Figure 6-29. Percent fine sediments (<0.85 mm) in stream gravels at three sites were higher than recommended for salmon habitat.**

**Note: Fine sediment levels that impair (orange line) or kill (red line) salmon eggs incubating in stream gravels are shown for comparison.**

In addition to affecting salmon egg incubation and other aquatic life, management and removal of sediment is a significant capital project and operational effort. In 2011, maintenance crews removed 5,176 cubic yards of sediment from facilities built to manage sediment loads in streams. In 2010, 990 cubic yards were removed, illustrating the variability in sediment deposition in streams and facilities maintenance needs.

**This photo shows the Coal Creek off-channel sediment pond, ready for sediment removal.**

***Observed Stream Issues***

During field surveys conducted from 1998 to 2001 of all Bellevue streams, City staff described and photographed 245 stream issues, categorized in Figure 6-30 (City of Bellevue Utilities Department 2003). Only 2 percent of these issues were ranked as severe, meaning there was a threat to life or health; 30 percent were ranked as a threat to a structure, and 68 percent were considered a threat to property or cause of minor damage. A review of 3,425 City records showed the majority of stream-related work requests from staff and residents between 1989 and 1999 primarily addressed issues with flooding (Figure 6-31).

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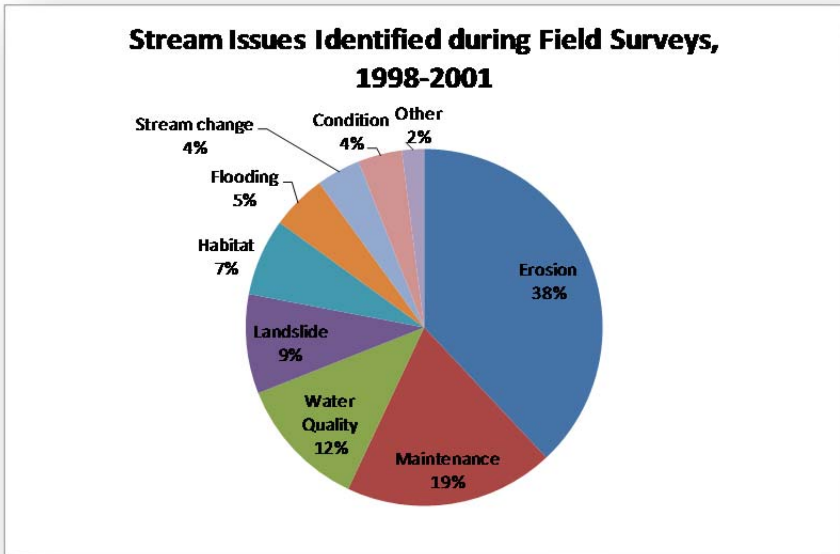


**Figure 6-30. Stream issues identified by field crews during Citywide Stream Assessment surveys between 1998 and 2001.**

**Note: Issue category terms are defined in Table 6-7.**

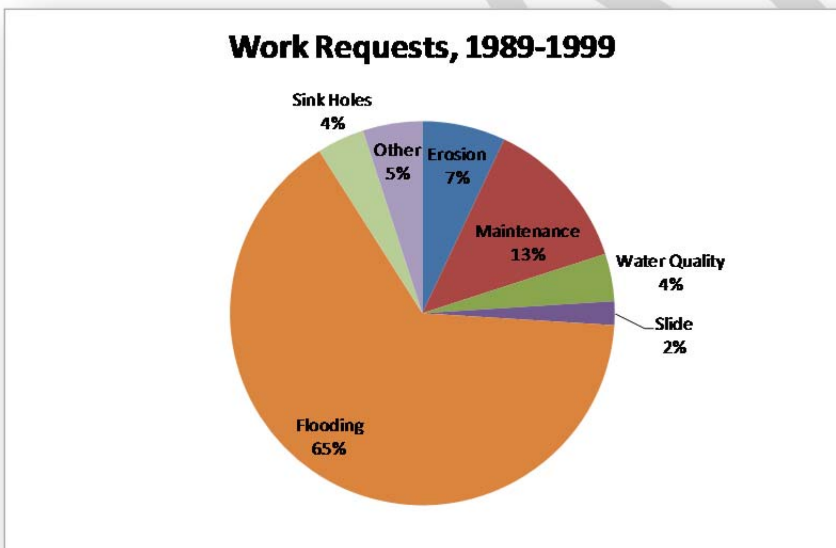


**Figure 6-31. Drainage-related issues from surface water work requests between 1989 and 1999 during a Citywide Stream Assessment.**

**Table 6-7. Definitions of stream issues identified during the 1998 to 2001 Citywide Stream Assessment**

| Category | Field Observations |
|---|---|
| Condition | Crushed culvert, abandoned pipe, collapsed structure |
| Erosion | Stream incision, deposition, stream bed or bank erosion, outfall erosion |
| Flooding | Undersized culvert, overbank flow evidence, flooded street or yard |
| Habitat | Fish migration barrier, shallow water, riparian zone lacking |
| Maintenance | Debris in channel or pipe, infrastructure failure |
| Other | Large-scale infrastructure failure, such as exposed utility pipe |
| Stream change | Avulsion, abandoned floodplain channel |
| Landslide | Large-scale bank erosion, upper slope failure |
| Water Quality | Excessive nutrients (algae growth), odor, iron bacteria, septic systems |

The 1989 to 2001 records of stream issues are based on outreach survey mailings to all Utilities Department customers, work requests, and field surveys. Most observed problems were related to stream erosion and flooding. Reported problems were most prevalent in the larger drainage basins (Kelsey Creek, Coal Creek, West Tributary, Vasa Creek, and North Sammamish), probably because of the larger area and numbers of residents (City of Bellevue Utilities Department 2003). When the numbers are adjusted for basin size, the basins with the most problems were markedly different. Clyde Beach, Meydenbauer, Rosemont, Ardmore, and Wilkins had the most drainage problems per basin area. The basins with the most stream issues per 1,000 feet of stream were Meydenbauer (3.5), Sears (3.1), Lakehurst (1.6), and North Sammamish, Sturtevant, and Vasa (each had 1.5). These streams have not been re-evaluated to see if capital projects have addressed the problems. For example, projects on Ardmore Creek and Wilkins Creek have been implemented to address erosion and bank stability issues.

***Fish Access, Passage Barriers, and Spawning Habitat***

Salmon and other fish migrate up and down streams to access food, cover, and breeding sites. Of the 79 miles of stream in the city limits, approximately 31 percent are used by salmon, and 49 percent have non-migratory fish. Fish can jump some barriers, but others are considered either partial or complete blockages to fish passage. Some fish are better at passing through barriers than others; for example, peamouth were not able to spawn in great numbers above the Mercer Slough fish ladder until it was rebuilt with smaller jumps in 2003; coho salmon are able to reach higher places than other species in some watersheds because they are well adapted to passing around or jumping over beaver dams and other barriers. Culverts often act as barriers to fish passage due to their length, slope, and resulting water velocity, and/or the vertical distance from the culvert’s downstream end to the stream below.

Fish passage was initially determined during a comprehensive city-wide survey in 1998 (Menconi and Johnson 1998) and a follow-up survey in 2001. During these surveys, 19 of 62 publicly owned culverts on 7 streams in the Kelsey Creek basin were identified as partial or complete barriers to salmonid passage; no man-made fish passage barriers were identified in Coal Creek (Kerwin 2001). Of the 19 barriers that were found, 4 have since been addressed through capital projects, and 7 projects are in the design phase as of 2010. Since those surveys, however, additional fish passage barriers have been identified, on Coal, Yarrow, and Valley Creeks. All known fish passage barriers and culverts with fish passage ratings, last updated in 2009, are shown in Figure 6-32.

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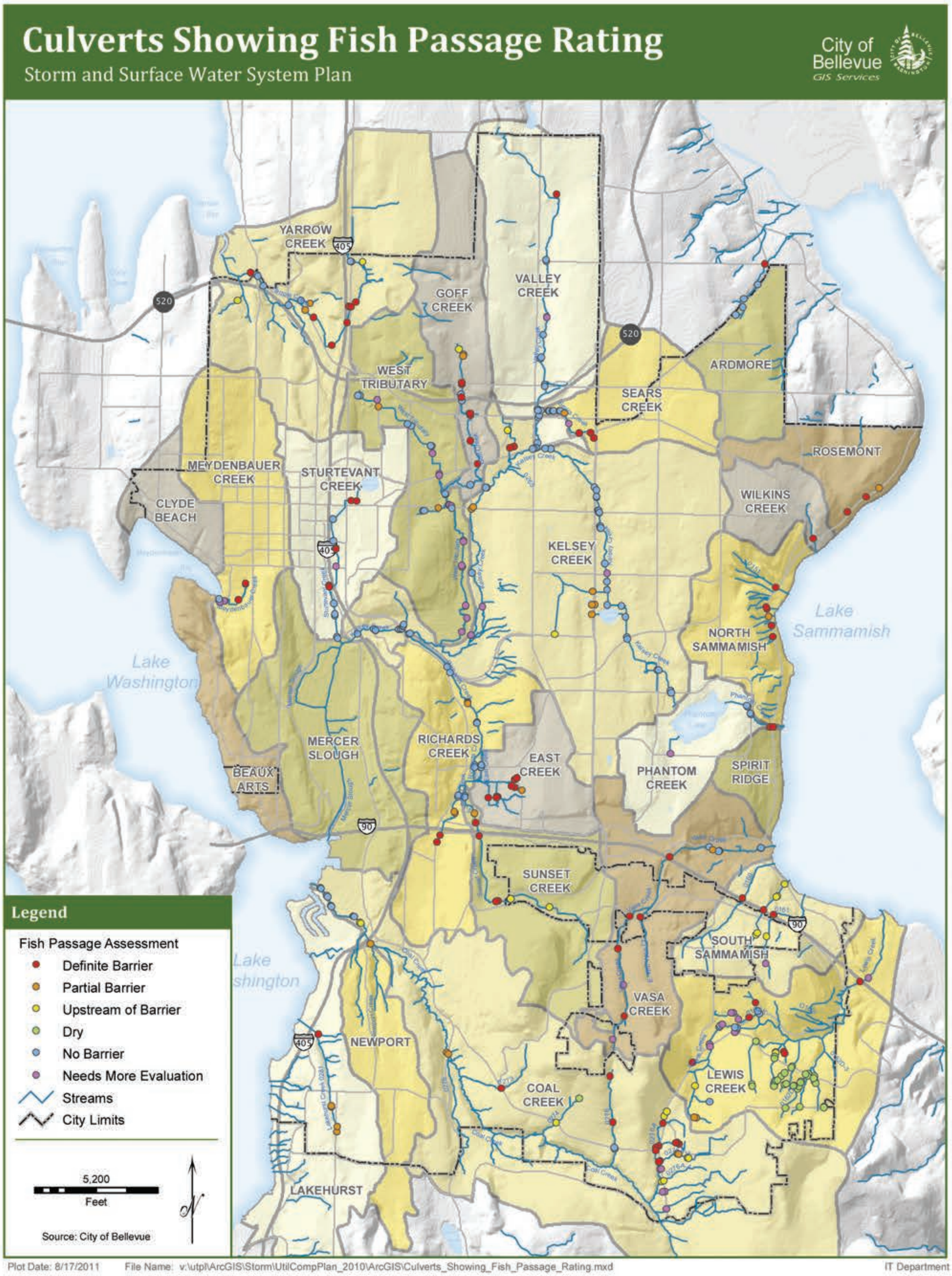


**Figure 6-32. Current or past barriers to fish migration in Bellevue streams.**

**Note: Partial barriers may be passable by some fish during low or high flows. Culverts are owned by Bellevue Utilities Department and others.**

***Available Salmon Spawning Habitat***

The availability of salmon spawning habitat is primarily determined by topography because moderate gradients are usually the location for appropriate stream velocity and gravel size to support egg incubation. Given that all basins have unique characteristics of size and gradient, there are no standards for the amount of spawning habitat that should be present in a basin. The amount of spawning habitat, though, is a primary habitat factor for maintaining salmon populations and lack of clean, stable gravel is often a limiting factor for salmon survival. City-wide, 17 percent of all the open streams have suitable spawning habitat, and 8 percent (5.1 miles) is on City-owned land, including parks and land owned by the Utilities Department (Figure 6-33). The remainder is private property. Basins with the most spawning habitat are Coal, Kelsey, Valley, and the West Tributary (see Figures 6-33 and 6-34). Coal Creek has 69 percent of the total City-owned potential spawning habitat. Unfortunately, historical land-use practices in the basin have increased the sediment transport rates and instability of the system, substantially reducing salmon spawning success. Kelsey Creek, West Tributary, and Valley Creek have the majority of successful salmon spawning reaches in the city. The small proportion of suitable habitat on City-owned property limits the City's ability to improve spawning habitat due to the limitations of working on private properties.

The amount of spawning habitat suitable for Chinook, coho, and sockeye salmon in Bellevue's streams was calculated using geographic information system (GIS) analysis (see Table 6-8). Suitable spawning habitat was defined as stream segments known to have fish, downstream of known fish barriers, without adjacent wetlands, and with gradients between 0.1 and 3 percent (Montgomery et al. 1999). Streams with adjacent wetlands are generally very low gradient, and were excluded because they generally do not have suitable spawning gravels. The resulting areas classified as suitable spawning habitat likely exclude some small areas with suitable spawning habitat, and do not include reaches that these species must pass through to reach suitable spawning habitat. Cutthroat and rainbow trout are likely to spawn in additional areas with steeper gradients.

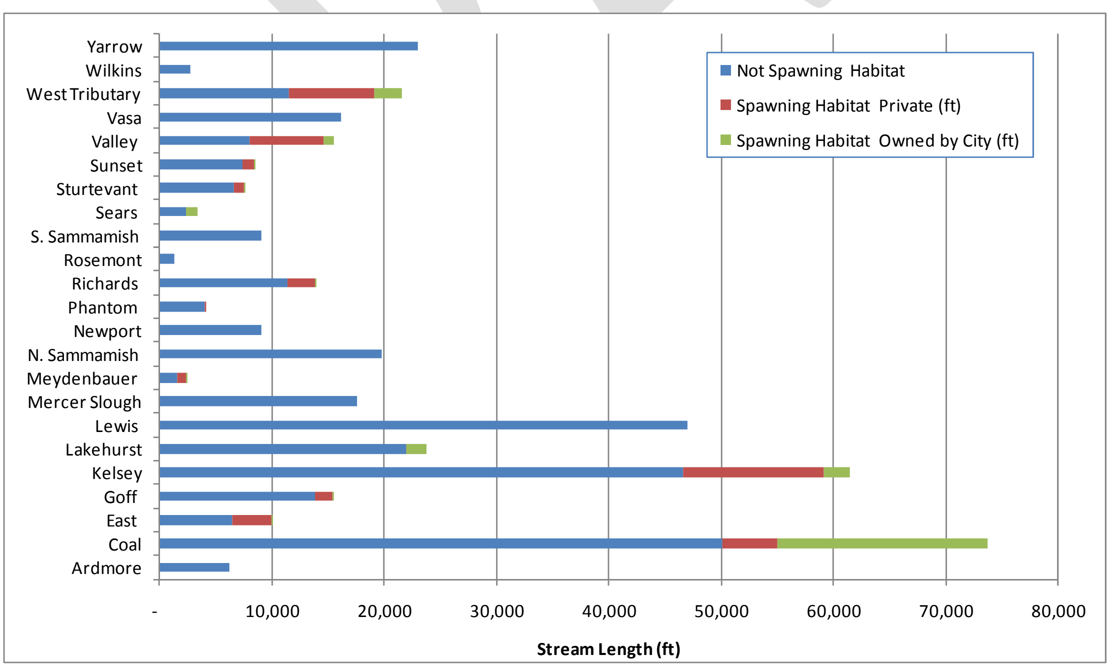


**Figure 6-33. Length of stream in each basin, with the amount suitable for salmon spawning on City-owned property and private property.**

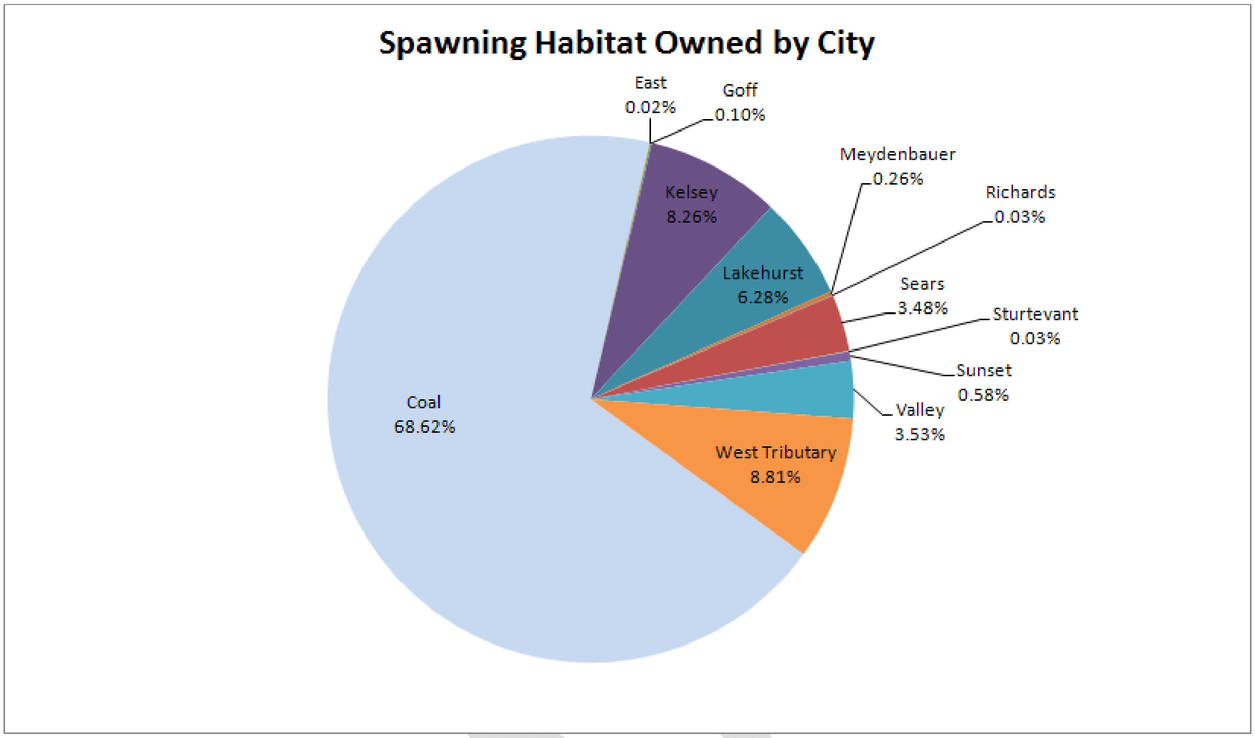


**Figure 6-34. Proportion of the 5.1 miles of City-owned suitable spawning habitat in Bellevue's drainage basins.**

**Note: Basins that are not shown do not have suitable spawning habitat on City property. Coal Creek accounts for a high proportion because a large percentage of the stream is owned by the City, compared to other streams.**

**Table 6-8. Suitable stream spawning habitat for Chinook, coho, and sockeye salmon in each drainage basin, based on a GIS analysis**

| Drainage Basin | Total Stream Length (miles) | Total Suitable Spawning Habitat (miles) | Percent Suitable Spawning Habitat |
|---|---|---|---|
| Ardmore | 1.2 | - | 0% |
| Coal Creek | 14.0 | 3.5 | 32% |
| East Creek | 1.9 | 0.001 | 36% |
| Goff Creek | 2.9 | 0.01 | 11% |
| Kelsey Creek | 11.6 | 0.4 | 24% |
| Lakehurst | 4.5 | 0.3 | 7% - Note: Over 1,000-foot blockage at Lake Washington |
| Lewis Creek | 8.9 | - | 0% |
| Mercer Slough | 3.3 | - | 0% |
| Meydenbauer Creek | 0.5 | 0.01 | 36% |
| N. Sammamish | 3.8 | - | 0% |
| Newport | 1.7 | - | 0% |
| Phantom Creek | 0.8 | - | 1% |
| Richards Creek | 2.6 | 0.001 | 18% |

**Table 6-8. Suitable stream spawning habitat for Chinook, coho, and sockeye salmon in each drainage basin, based on a GIS analysis**

| Drainage Basin | Total Stream Length (miles) | Total Suitable Spawning Habitat (miles) | Percent Suitable Spawning Habitat |
|---|---|---|---|
| Rosemont | 0.2 | - | 0% |
| S. Sammamish | 1.7 | - | 0% |
| Sears Creek | 0.6 | 0.2 | 29% |
| Sturtevant Creek | 1.4 | 0.002 | 13% |
| Sunset Creek | 1.6 | 0.03 | 13% |
| Valley Creek | 2.9 | 0.2 | 48% |
| Vasa Creek | 3.1 | - | 0% |
| West Tributary | 4.1 | 0.5 | 47% |
| Wilkins Creek | 0.5 | - | 0% |
| Yarrow Creek | 4.4 | - | 0% |
| Total City-wide | 78.2 | 5.1 | 17% |

**Note: Included are stream segments with fish use, gradients >0- 3%, and location downstream of known fish passage barriers. Stream reaches with adjacent wetlands (per Sensitive Areas Notebook [1987]) are not included.**

***Presence of Aquatic Species***

The living creatures that make up the biological component of the surface water system are an indicator of the quality of the aquatic habitat. They respond directly to both the physical and chemical environment, and those that are predators are also affected by the abundance and quality of the animals they rely upon as food. The presence and abundance of spawning and resident salmon in streams where they were historically present is a general indicator of stream health, but many salmonids also live part of their lives in lakes and the ocean.

As discussed earlier, aquatic macroinvertebrates living in the substrate of the streams are a strong indicator of the habitat's health. The B-IBI (discussed earlier) has been created to quantify the relative health of the habitat based on these animals.

**Fish**

Fish known to live or spawn in Bellevue's streams include salmonids, peamouth, three-spined stickleback, long-nosed dace, large-scale suckers, lamprey, and sculpin. Non-native fish adapted to lakes have been found in the streams as well, including sunfish and bluegill.

**Salmon Spawning**

In the Lake Washington/Cedar/Sammamish Chinook Salmon Recovery Plan, Kelsey Creek was identified as the only urban stream to have consistent annual salmon spawning populations. Salmonids in Bellevue include Chinook, coho, and sockeye salmon, cutthroat and rainbow trout, steelhead (last seen in 1996), and kokanee; their distribution is shown in Figure 6-35. The number of adults returning to spawn varied substantially between 2000 and 2009, and is dependent on previous adult spawning returns and productivity; habitat and food availability in streams, lakes and oceans; water quality; fishery harvest; and many other factors. Estimates of the number of spawners in Bellevue are important for tracking regional patterns of salmon survival and abundance, and salmon presence or absence is a good indicator of some stream conditions, especially physical barriers such as culverts and low flows, and water quality barriers such as high temperatures. Counting spawning salmon (the proportion of marked hatchery fish to unmarked native spawning fish) and redds (egg nests) provides an indication of the success of salmon, but can be confounded by changes in harvest and ocean conditions. To fully understand whether the habitat supports salmon survival, it would be necessary to count the number of salmon redds, then count the number of juvenile salmon migrating out of the stream towards marine waters. However, even though conducting both spawning and outmigrant surveys is a recommendation in the Lake Washington/Cedar/Sammamish Watershed Chinook Salmon Recovery Plan, funding has not been available.

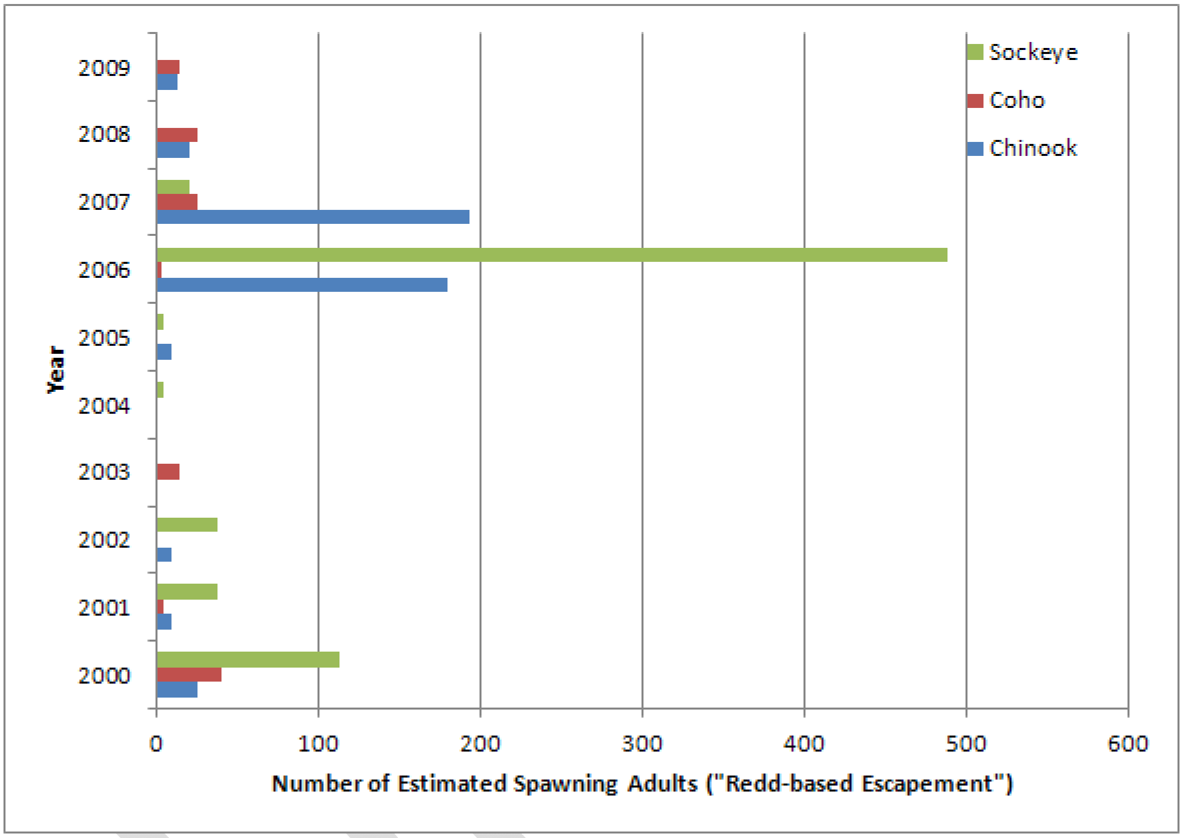


**Figure 6-35. Salmon escapement (estimated number of adults returning to spawn based on number of redds or egg nests) for Kelsey Creek from 2000 to 2009.**

Adult salmon spawn in Kelsey Creek, Goff Creek, Valley Creek, Richards Creek, West Tributary, Coal Creek, and Lewis Creek between September and early January. Wild and hatchery Chinook salmon, which are listed as endangered, continue to spawn in Kelsey Creek and its tributaries each year. Other fall spawners include coho, kokanee, and sockeye. Numbers of spawning salmon fluctuated greatly between years, as indicated by adult salmon return numbers for Kelsey Creek (see Figure 6-36). These fluctuating return numbers indicate that the populations may not be able to sustain spawning in these streams. Additional information about fall spawning salmon in Bellevue's creeks can be found in annual salmon spawner reports (e.g., The Watershed Company 2008, 2009).

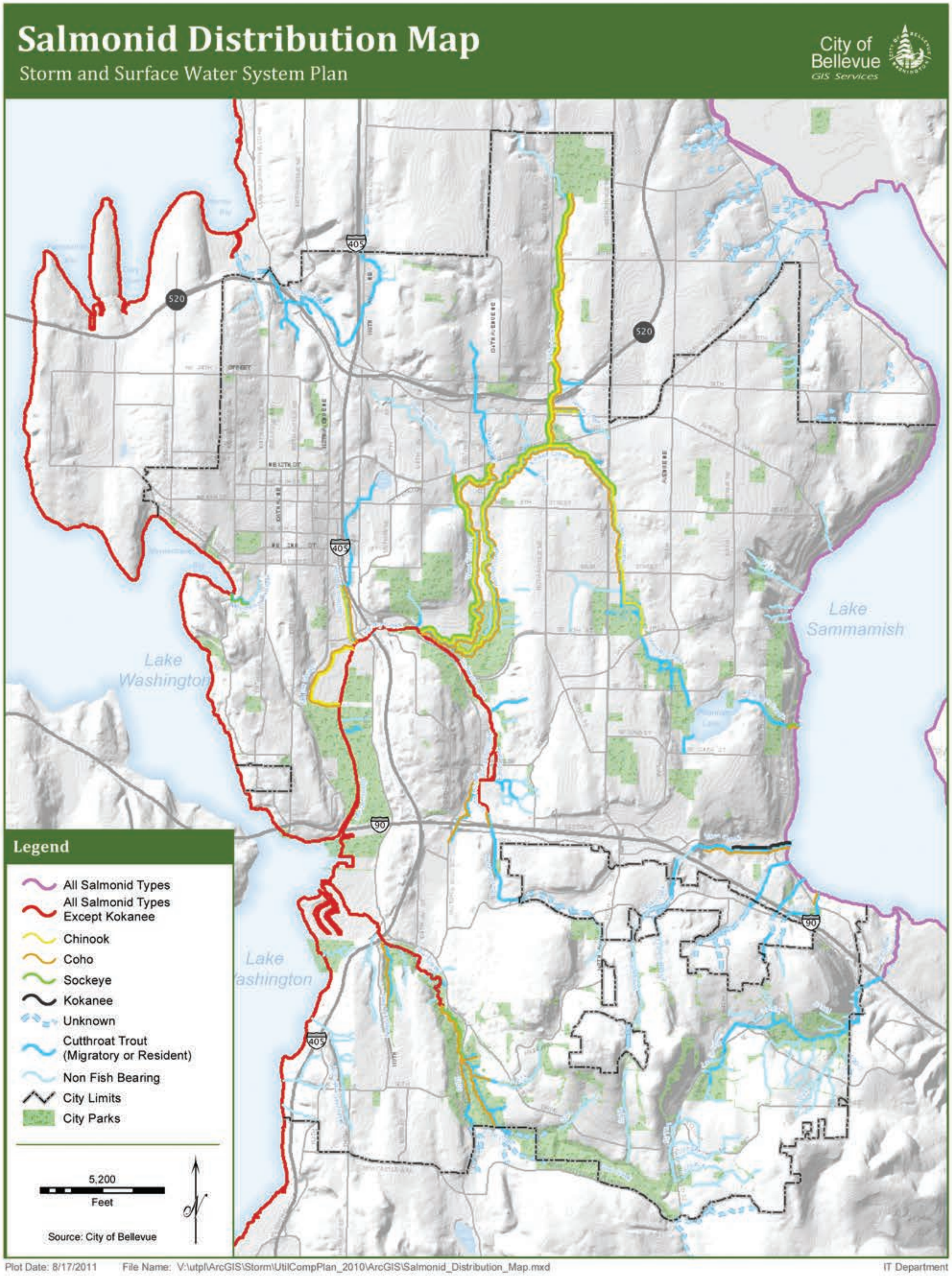


**Figure 6-36. Adult salmon and trout distribution in Bellevue streams, 1996 - 2010.**

**Peamouth**

Peamouth appear to be thriving in Bellevue streams. Peamouth, a relatively large (12-inch-long adults, on average) minnow, live most of their life in large lakes, and spawn in Kelsey Creek, West Tributary, Sturtevant Creek, and Lewis Creek between mid-April and June. For the last several years, up to three spawning events were observed in Kelsey Creek, with hundreds or thousands of fish leaving a blanket of eggs along the stream bottom; in 2010, five spring spawning events were documented by volunteers. During and after such events, wildlife such as great blue herons, wood ducks, and river otters congregated to feed on the remnant fish and eggs. Peamouth eggs incubate and hatch within 1 week, in contrast to salmon eggs, which incubate over several winter months. Likely because of the short time they are in the stream, the spring timing of their spawning, and their tolerance of warm water, peamouth do not appear to be as influenced by stream conditions as are salmon.

**Peamouth and eggs (yellow) in Kelsey Creek near 121st Avenue SE, near the Wilburton Trestle**

**Summer Fish Presence and Distribution**

Summer fish surveys were conducted to determine fish species presence and distribution in Kelsey Creek and its tributaries. These surveys provide indications of local habitat conditions, as the presence of the fish are not affected by harvest or ocean conditions. Results show that native fish diversity and abundance have been maintained in most surveyed streams, with the exception of juvenile coho, which have been decreasing over time.

Surveys were done at 10 sites in 1983, 9 sites in 1996 (Ludwa et al. 1997), 6 sites in 2002 (The Watershed Company 2002), 5 sites in 2007, and 7 sites in 2010 (Table 6-9). The 1996 study evaluated correlations between fish, habitat, and land use. Cutthroat trout juveniles were the most abundant fish, and have become more abundant in recent years as the number of coho juveniles have declined. This is consistent with studies in urban streams indicating that where fewer coho salmon juveniles were found, cutthroat trout were more abundant (Lucchetti and Fuerstenberg 1993). Regionally, sculpin were found to be more abundant in less urbanized basins in 1996, which could account for their absence from Kelsey Creek basin streams in 2002, 2007, and 2010. Sculpin rely on stream bottom habitats, which are subject to more scour in urban streams (Ludwa et al. 1997). Between two and five non-native fish species were seen each year except 2007, when non-native fish were not found. Differences between years are likely due to differences in sites surveyed, stream conditions, and other factors affecting fish distribution, including introduction of fish to new areas by local residents.

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**Table 6-9. Fish observed during summer electrofishing surveys at several sites in the Kelsey Creek basin and its tributaries, 1983, 1996, 2002, 2007, and 2010**

| Fish Observed | | Year | | | | |
|---|---|---|---|---|---|---|
| **Common Name** | **Scientific Name** | **1983** | **1996** | **2002** | **2007** | **2010** |
| Coho salmon | *Oncorhynchus kisutsch* | ● | ● | ● | ● | ● |
| Cutthroat trout | *Oncorhynchus clarki* | ● | ● | ● | ● | ● |
| Rainbow trout/Steelhead | *Oncorhynchus mykiss* | ● | ● | No data | ● | |
| Sculpin | *Cottus* spp. | ● | ● | | | |
| Brook lamprey | *Lampetra richardsoni* | | ● | ● | ● | ● |
| Dace | *Rhinichthys* spp. | | ● | ● | ● | ● |
| Sucker | *Catostomus* spp. | | ● | | ● | ● |
| Three-spine stickleback | *Gasterosteus aculeatus* | ● | ● | | ● | ● |
| Bluegill* | *Lepomis macrochirus* | | ● | ● | | ● |
| Pumpkinseed* | *Lepomis gibbosus* | | ● | ● | | |
| Green sunfish* | *Lepomis cyanellus* | | | | | ● |
| Largemouth bass* | *Micropterus salmoides* | | ● | | | |
| Smallmouth bass* | *Micropterus dolomieui* | | | | | ● |
| Yellow perch* | *Perca flavescens* | ● | | | | |
| Crappie* | *Pomoxis* spp. | ● | | | | ● |
| Catfish* | *Ictalurus* spp. | ● | | | | |
| Carp* | *Cyprinus carpio* | | | | | ● |

*Non-native species

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**<u>Salmon Pre-spawn Mortality</u>**

Beginning in the late 1990s, several jurisdictions in the greater Seattle area, including Bellevue, noticed a high rate of mortality among coho salmon females during fall surveys. Salmon were found dead and dying in the creeks before they had spawned. Adult coho from several streams had similar symptoms before death, including disorientation, lethargy, loss of equilibrium, gaping, and fin splaying (Northwest Fisheries Science Center 2007). Such pre-spawn mortality (PSM) has been observed in many lowland urban streams in the Puget Sound basin, with overall rates ranging from ~20 to 90 percent of the fall runs. By comparison, the rate of die-offs in non-urban (e.g., forested) drainages appears to be lower. The precise cause of PSM is not known. However, scientific research at the Northwest Fisheries Science Center at NOAA suggests that the coho die-offs are a consequence of non-point source water pollution; specifically, the complex mixture of metals, pesticides, and other toxic substances that are washed into streams from urban and residential areas during fall storms (e.g., Laetz et al. 2009).

**Adult female coho salmon that died before spawning; note the large quantity of eggs.**
**Source: NOAA Fisheries Service, Northwest Fisheries Science Center**

PSM was first documented in Bellevue streams in 2000. Salmon often die before spawning for reasons other than water quality; some are stranded on the banks after high flows recede, and others are eaten by predators. Rates of PSM due to unknown causes ranged from zero to 74 percent in the Kelsey Creek spawner index reaches during survey years between 2000 and 2008 (see Appendix B-10).

### *Wetlands*

Wetlands are low areas that naturally store water. They can help lessen flooding during storms by storing runoff and releasing it slowly downstream. Bellevue has approximately 860 acres of wetlands on public property. These were mapped in the 1970s and 1980s for the Sensitive Areas Notebook (City of Bellevue 1987). The survey included built detention and retention ponds, which are specifically excluded from the definition of wetlands in Bellevue's current Critical Areas Ordinance (CAO) [Land Use Code 20.25H]. As shown in Figure 6-37, the wetlands were mapped based on aerial photography, and some of them were field verified. The map likely does not include all wetlands on public property, and wetland boundaries can change over time. Wetlands on private property were not included in this document.

New wetlands or recent wetland delineation reports and maps submitted for permits are not added to the City's GIS map of wetlands, but there are plans to do so in the future. Wetlands were rated in 1987 according to size and degree of isolation from other surface water bodies. The wetland rating system was changed when the new CAO went into effect in 2006 to match Ecology's rating system, but Bellevue's wetlands have not been categorized under the new system. Bellevue does not currently have a wetland monitoring or management program.

## Summary – State of the System

Bellevue is an urban city with a mix of residential, commercial, industrial, and public land uses. Much of the storm and surface water drainage system is privately owned. The public pipes, open ditches, and other facilities that average 35 years old will eventually need to be replaced to avoid failures. Flooding concerns are limited, even though much of the city was developed prior to storm detention and conveyance standards. Tree canopy covers approximately 37 percent of the city, and impervious surfaces cover over 40 percent, which is considered urban development.

Bellevue initiated stormwater detention requirements in 1974 and has limited flooding issues. Out of 26 drainage basins, 15 basins had little to no structural flooding locations; 8 basins had 3 to 4 structural flooding locations; and 3 basins had more than 4 structural flooding locations during the period of 1996 to 2011. Six basins had more than 2 claims paid for damages (up to 8 paid claims); 11 basins had 1 to 2 paid claims, and 9 basins had no paid claims. Thirteen street locations are known to have risk of flooding. To protect public safety, the Utilities Department works closely with emergency personnel to ensure alternative routes are available.

Bellevue has lakes in which people can swim, fish, and recreate, as well as streams that provide aesthetic value and important environmental functions. The storm and surface water system is also critical for maintaining Bellevue's economy, by providing aesthetic value as well as protecting safety, mobility, and property by preventing extensive floods. Fish still live in the streams and lakes in Bellevue, even though the fish species and abundance are different than they were historically. Endangered Chinook salmon continue to spawn in Bellevue's streams each fall, although they appear to be in decline. Peamouth from Lake Washington spawn in great abundance in Kelsey Creek each spring.

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**Figure 6-37. Streams, lakes, wetlands, and currently active gauge stations in Bellevue.**

**Note: Some constructed retention/detention ponds are shown here as wetlands, but are no longer defined as wetlands according to Bellevue's Critical Areas Ordinance.**

The open streams show the impacts found in all urban areas, including lack of wood and pools, increased erosion, degraded habitat, more pollutants, impaired macroinvertebrate and fish communities, increased flooding, and flashy flows that increase quickly after a rain event, then decrease quickly when the rain subsides. Capital improvement projects provide regional detention and sediment storage, improve fish passage through culverts, stabilize stream channels, and add large wood. They also operate and maintain facilities and regulate development to slow runoff from urban areas; all these actions provide some benefits to stream channels. However, it is difficult to measure the effect of any specific stormwater management effort due to the multitude of stressors, both current and historic, and diffuse sources of pollutants. At this time, there is no standard that provides an indication of what level of habitat quality is necessary to maintain aquatic life in an urban area.

## Data Gaps and Recommendations

***Physical System***

In order to detect trends in stream habitat, it is important to have many monitoring sites and conduct surveys consistently over at least 10 to 20 years (Larsen et al. 2004). Stream flow rates can be a good indicator of the effectiveness of stormwater management practices. Currently, only the USGS station at Mercer Slough has a long enough period of record for flow data to assess change, although Bellevue has multiple sites where stream flows are measured. These data could be used if they were verified using robust quality assurance/quality control procedures, if the rating curves were applied to convert the stage readings to flow rates, and the data were analyzed appropriately to determine flow frequency probabilities and other statistics; see Appendix B-11 Hydrologic Monitoring Plan.

A program to monitor large Utilities Department capital projects to determine whether project goals are met would benefit uture project planning and prioritization. For future use of the street closure flood protection evaluation metric, work order tracking should clearly indicate whether the cause of structural flooding is due to public or private drainage system components, and street closure durations need to be recorded. The Asset Management program addresses data gaps and recommendations for the built components of the storm and surface water system in Chapter 8.

***Water Quality***

Chemical water quality data in Bellevue was characterized in the early 1990s. National efforts to characterize the water quality of urban runoff have been able to consistently characterize runoff based on land use, so additional efforts to characterize the water chemistry of the city would be expensive, and would not likely provide significant new information. King County ambient monitoring provides a snapshot of indicators of water quality, but budget cuts are reducing the number of streams being monitored. Phantom Lake and Larsen Lake phosphorus, chlorophyll-a, and water clarity sampling meet the monitoring objectives for those lakes, so no additional monitoring is recommended. Appendices 12 and 13 provide additional details on water quality and pollution export in Bellevue’s lakes. The illicit discharge outfall monitoring programs meet the requirements of the NPDES Municipal Stormwater Permit, but as the program continues, some limited additional outfall monitoring could be considered to document the effectiveness of remediation efforts.

Stream temperature is critical to spawning salmon, and the 2001 pilot temperature study showed that warm temperatures in Kelsey Creek may delay spawning salmon migration in the late summer and early fall. The rapid changes in temperature during summer rain storms may also affect juvenile coho and other aquatic life. It is recommended that water temperature be monitored at key sites along Kelsey Creek and the Mercer Slough annually from August through October using a continuous temperature gauge to identify areas that may need special consideration for reducing summer temperatures.

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Appendix B-14 shows precipitation patterns for 1962 and 1999, which were similar to the stream discharge rate at the Mercer Creek stream gauge.

***Biological***

Fish and stream macroinvertebrates are biological indicators used to assess the health of the aquatic habitat in Bellevue’s streams. Adult salmon spawning distribution and abundance is important for regional endangered salmon recovery and Kelsey Creek is the only urban stream in the watershed that has had consistent returns of adult salmon. Continued spawner surveys are recommended to determine the effectiveness of capital projects, establish long-term trends, and contribute rare data to salmon recovery efforts. To directly determine local stream condition effects on salmon spawning effectiveness, the number of young salmon produced from salmon redds can be measured. As noted in the regional salmon recovery recommendations, salmon spawning and out-migrating juveniles should be monitored, if funding can be found.

Benthic macroinvertebrates are a good indicator of stream health, but their communities and resulting scores are considered impaired, even in basins with low percentages of impervious surfaces. Bellevue has sampled five to eight sites during most years since 1998. It is recommended that samples be collected annually from up to five core sites and a rotating panel of additional sites to identify trends over time and/or responses to management changes.

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# CHAPTER 7 SUMMARY OF BASIN ISSUES AND NEEDS

The purpose of this chapter is to synthesize information from the existing conditions and state of the system, described in Chapter 6, and identify basin-scale strategies to address priority urban storm and surface water issues. Basins are grouped into similar conditions to facilitate a cohesive response for management actions to address common needs. This synthesis also clearly articulates different needs among basins; for example, there is greater need to have habitat information for salmon-bearing basins than for primarily piped basins.

## Potential Actions to Address Basin Issues

Specific recommendations for solving basin problems are not provided in this system plan because additional studies would be required to fully identify the causes and potential solutions within a site-specific context. However, examples of existing tools and strategies that could be considered to meet stormwater management goals include:

- Stormwater regulations;
- Capital projects;
- Basin planning or targeted basin studies;
- Land and easement acquisitions;
- Operations and maintenance practices;
- Customer incentives for improved stormwater management;
- Education and outreach; and
- Regional and public/private partnerships to achieve mutual goals.

Individual tools are employed in different levels based on costs, impacts, and benefits, sometimes balancing competing priorities. Some regulations, such as stormwater detention volume, are required under state permits, while other regulations, such as land clearing limits, may be independently approved by the City Council. Bellevue Utilities Department utilizes regulatory, capital project, and maintenance programs to address storm and surface water goals by targeting the most critical issues, focusing programs to address those issues, measuring progress towards those goals, and adapting the goals to changes in priorities, environmental conditions, and community values. This process is discussed in detail in Chapter 12 Adaptive Management.

Examples of actions that can address various basin issues are summarized in Appendix C-1. Some of the actions can be implemented directly by the Utilities Department, while others must be implemented through land use actions or other programs.

A summary of existing basin plan information and recommendations can be found in Appendix C-2.

## Introduction

As noted in Chapter 6, there are 26 storm and surface water drainage basins within the city. Each drainage basin has a unique combination of public and private ownership and natural and built characteristics affecting water quality, habitat functions, and stormwater conveyance system performance and operation. Some basins have long stretches of open streams that support salmon spawning; some consist largely of pipe networks that convey drainage; and others only have small streams or have predominantly steep gradients.

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As discussed in Chapter 6, evaluation criteria are based on the Utilities Department stormwater mission statement, which forms the basis for identifying system issues and needs. A summary of the findings from Chapter 6 is presented below.

## Summary of Basin Conditions

A summary table of basin evaluation results is available in Appendix C-3.

***Flooding***

There is limited structural or street flooding within the city. Increased detention regulations implemented in all basins in 2010 are expected to further reduce flooding issues as new development or redevelopment of properties occurs. Three measures were used to assess how well the system performs at reducing damage from storms: structural flooding claims, claims paid by the City for damages, and street closures. Structural flooding data are limited to information collected between 1996 and 2011. Road closures due to flooding are restricted to a few areas; some have been fixed. Most of the basins have only a few or moderate number of flooded structures reported during storms. Claims, paid and unpaid, for damages due to storm flooding are scattered across the city, but these claims are few; in many cases, the flooding is due to maintenance issues such as leaves blocking grates or private stormwater system issues.

Structural flooding is when homes, businesses, and public facilities are threatened, not the flooding of yards and landscaping. Incidents of structural flooding in the basins are as follows:

- Fifteen basins had little to no structural flooding;
- Eight basins had three or four problems; and
- Three basins had more than four structural flooding locations.

The City also has not paid many claims for stormwater damages during that time period, as indicated below:

- Nine basins had no paid claims;
- Eleven basins had one to two claims paid; and
- Six basins had more than two paid claims (up to eight).

There are 11 street locations that are commonly at risk of flooding during large storms, some of which are emergency routes. Alternative routes exist for each emergency route adversely affected by flooding. However, flooding of emergency routes does not jeopardize public safety.

***Water Quality***

Water quality is a concern in 8 out of 26 of the city's drainage basins according to the Washington State Department of Ecology (Ecology) list of impaired waters. The constituents of concern represent typical urban problems including fecal coliform bacteria, low dissolved oxygen, and elevated temperatures. Water quality risk areas that are based on percent of impervious surface areas, zoning, and other land use factors that affect water quality are of concern in 10 of the 26 drainage basins.

Five measures were used to evaluate whether the system was meeting water quality objectives: 1) compliance with the National Pollutant Discharge Elimination System (NPDES) Phase II Municipal Stormwater Permit; 2) the number of fines for Clean Water Act violations; 3) the number of illicit discharge corrections; 4) basins with water quality impairments; and 5) basins with high risk for illicit discharges. The City has been in 100 percent compliance with the NPDES Permit since 2008 and has had no fines for Clean Water Act violations during the permit period. The City has only received one water

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quality violation—a minimum fine for a construction failure that released muddy water into Valley Creek in 2004. One hundred and eighty-two illicit discharge corrections have been made to address pollutants entering the storm system. Illicit discharges range from permanent sources, such as illegal wastewater connections to the storm system, or episodic events, such as someone washing paint or commercial solvents into a storm drain. The illicit discharge correction program is new, so this number is anticipated to increase over the next few years as awareness of the issue increases.

There are currently eleven locations identified by Ecology as not meeting state water quality standards; thus, they are considered "impaired." Impaired water bodies are located in Coal, Kelsey, Lewis, Ardmore, and Yarrow Creeks; Mercer Slough; Lake Washington; Lake Sammamish; and Meydenbauer Bay.

The City has identified the basins believed to have the greatest potential for risk of pollution, by evaluating land use, density of stormwater outfalls, industrial permits, current water quality problems, septic system areas, and percentage of impervious surfaces. Based on that analysis, 10 basins were ranked as high risk, four basins were medium risk, eight basins were low risk, and four basins were not ranked because they had no streams.

***Stream Habitat***

Like other urban cities in the Puget Sound basin, Bellevue has large areas of impervious surfaces, reduced forest and vegetative cover, and pollutant loading to surface waters that affect ecosystem functions. Land use and stormwater regulations have helped to mitigate the impacts of urbanization. Even so, the state of the surface waters shows degradation in habitat quality and biota, similar to other urban areas across Puget Sound.

While there are no urban standards for aquatic habitat, three evaluation criteria were used to assess the condition of Bellevue streams: 1) the amount of wood in the stream channel; 2) the number and quality of pools; and 3) the Benthic Index of Biotic Integrity, B-IBI (which is a direct measure of the health of aquatic organisms and an indirect measure of the quality of aquatic habitat). Data to assess wood and pools were limited, but in the five basins where information was available, the streams did not meet standards set by NOAA Fisheries Service for protecting salmon. Similarly, of the 13 basins sampled for B-IBI, all showed impairment ranging from poor to very poor, consistent with other Puget Sound urban areas.

## Basin Types

Storm drainage basins have varying key needs based on physical and biological characteristics (Figure 7-1). The drainage basins have been grouped for evaluation and planning according to characteristics that could be managed using similar strategies. Each basin has been grouped into one of three categories:

1. Basins with salmon spawning streams;
2. Basins with small streams and steep slopes; and
3. Basins with predominantly closed conveyance systems.

These groupings are generalized, so there may be sections of the basin that would fit in another classification; for instance, a basin that is primarily composed of steep slopes may have a small section of salmon spawning near the mouth of the stream.

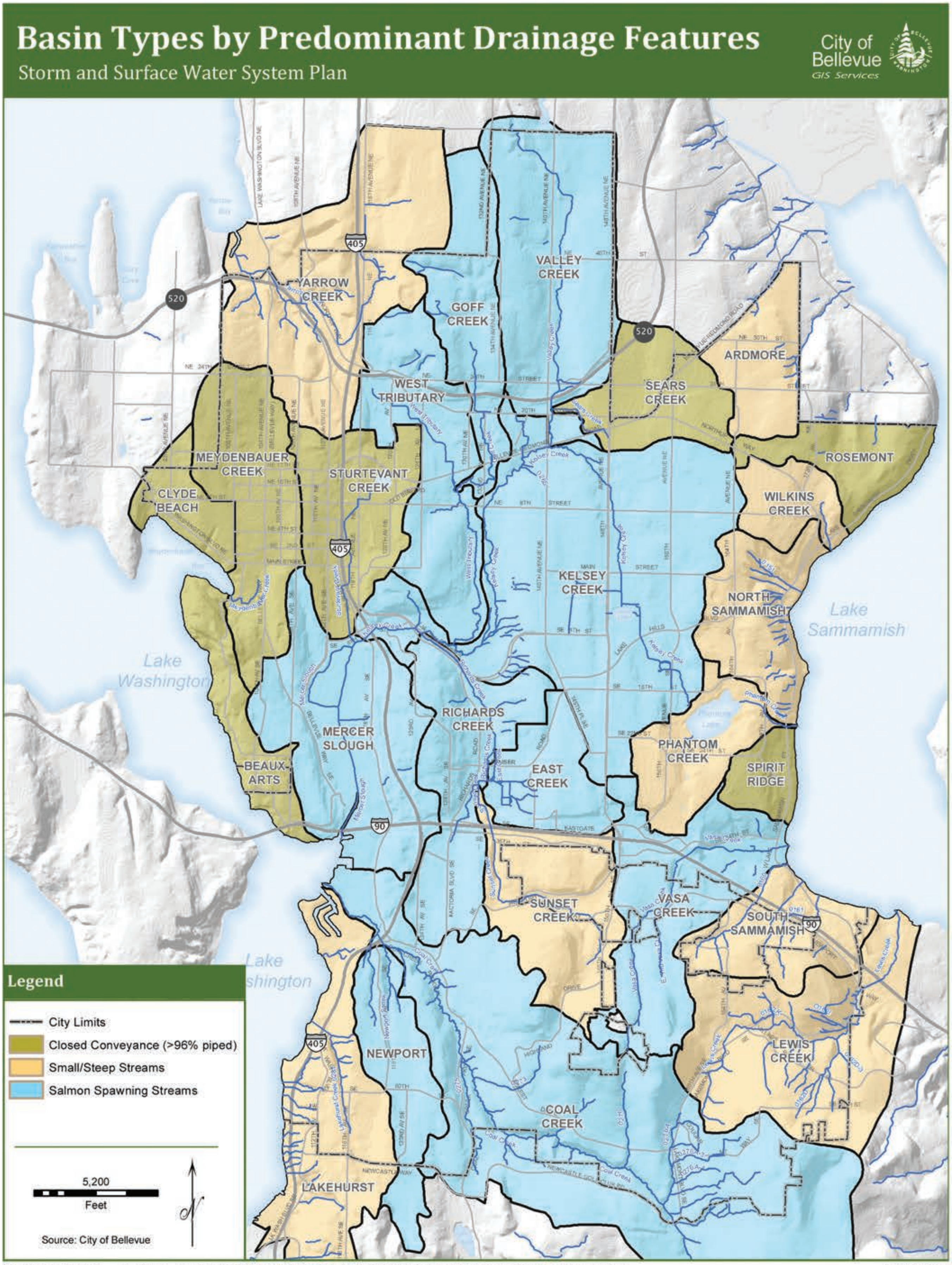


**Figure 7-1. Drainage basin types organized by those with salmon spawning, small and/or steep streams, and predominantly piped conveyance systems.**

***Basins with Salmon-spawning Streams***

These basins have predominantly open streams and support spawning salmon populations. Basins in this group include:

- Coal Creek;
- East Creek;
- Goff Creek;
- Kelsey Creek;
- Mercer Slough;
- Newport Area;
- Richards Creek;
- Valley Creek;
- Vasa Creek; and
- West Tributary.

Water quality, excessive flows, and aquatic habitat are especially important because these basins support spawning salmon. Salmon need clean water, stable stream gravels, habitat for salmon migration and rearing, and adequate food in the form of aquatic invertebrates. Aquatic habitat problems were identified in all of the basins except Mercer Slough. The B-IBI index score for Bellevue ranks in the impaired category, similar to all urban streams in the Puget Sound lowland. Water quality pollution is predominantly a medium to high-level risk, or is classified as impaired in all of these basins. The degree of water quality impairment in Bellevue is also similar to other urban streams in the Puget Sound lowland. Only two of the 11 basins in this group drain into a phosphorus-sensitive lake (Lewis Creek basin and Vasa Creek basin drain into Lake Sammamish). Land use (including percent impervious area) and the water quality risk assessment are the driving factors; four of the creeks have short segments that were found to be impaired according to the Clean Water Act Section 303(d). The total impervious area ranges from 20 to 46 percent in each of the basins, which affects stream flows, water quality, and habitat.

Flood protection is an issue in all of the salmon-spawning basins except East Creek and Goff Creek. Coal Creek and Kelsey Creek had the most flooding claims and flooded structures of all the salmon-spawning basins; these are also the largest basins in the city. Kelsey Creek, Lewis Creek, Richards Creek, and Coal Creek basins all experienced at least one road closure during a major storm event. Capital project and routine maintenance efforts to reduce structural and street flooding have been implemented in Kelsey, Richards, and Coal Creeks. Two of these recurring road closure areas have been resolved by Capital Investment Program (CIP) projects. Flood protection should be addressed first where there are recurring structural and road closures due to storm events that affect emergency routes. Other streets that flood should be addressed only after public safety issues are resolved and only when the benefit justifies the cost. Basins with many claims and flooded structures may benefit from a targeted analysis to determine which areas may need additional drainage system capacity.

Basins in this classification should employ strategies to address all three mission objectives: flooding, water quality, and habitat. Tools include regulations, capital projects, public education, and additional studies. The 2010 detention regulations are expected to help reduce high flows over time as properties are redeveloped or developed. Capital efforts for habitat should be focused on these basins. Public education programs and illicit discharge detection efforts for reducing non-point pollution is also important for protecting salmon populations. Basins within this category with flooding or other conveyance issues may benefit from new or updated hydrologic and/or hydraulic modeling to better understand the causes and potential solutions that would balance all objectives (Table 7-1). The status of projects and summary recommendations of major plans and studies as listed in Table 7-1 are provided in Appendix C-4. Fish passage barriers, although not specifically addressed here, are also a

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priority in these basins (see Chapter 6 for fish passage barrier information). These basins should have priority for assessment of basin evaluation criteria for stream habitat.

***Basins with Small Streams and/or Steep Relief***

These basins have small streams, often located in steep ravines, and are prone to erosion processes that require specific stormwater management strategies. The basins with small streams and/or steep relief include:

- Ardmore;
- Lakehurst;
- Lewis Creek ;
- North Sammamish;
- Phantom Creek;
- Sunset Creek;
- South Sammamish;
- Wilkins Creek ; and
- Yarrow Creek.

**Table 7-1. Summary of major plans and studies, and status of recommendations**

| Date | Plan Name | Focus Area | Scope of Study | | | | | | | Plans or Studies with Identified Projects and Recommendations (See Appendix C-4 for more information on the status of associated projects and recommendations) |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Conveyance Capacity | Flooding | Erosion | Sedimentation | Geology/Soil Infiltration Rates | Water Quality | Habitat/Fish | |
| 1976 | Drainage Master Plan | Entire city, except Lewis Creek, Lakehurst Area, and South Sammamish Area basins | √ | √ | √ | √ | √ | | | √ |
| 1979 | Draft Environmental Impact Statement for the 1976 Drainage Master Plan | Same as above | √ | √ | √ | √ | √ | | | |
| 1980 | Meydenbauer Basin Study | Meydenbauer Creek basin | √ | | | | | | | √ |
| 1984 | Bellevue Urban Runoff Program Summary Report | Surrey Downs and Lake Hills neighborhoods | | | | | | √ | | |
| 1987 | Coal Creek Basin Plan and Environmental Impact Statement | Coal Creek basin | | √ | √ | √ | √ | | √ | √ |
| 1987-1993 | Phantom and Larsen Lakes Restoration Reports | Phantom Lake and Larsen Lake | | | | | √ | √ | | √ |
| 1988 | Comprehensive Drainage Plan | City-wide | √ | √ | √ | √ | | √ | | √ |
| 1988 | Meydenbauer Creek Basin Study | Meydenbauer Creek basin | | | | √ | | | | √ |
| 1990 | Lewis Creek Basin Drainage Report | Lewis Creek basin | √ | √ | √ | √ | | √ | | |

**Table 7-1. Summary of major plans and studies, and status of recommendations**

| Date | Plan Name | Focus Area | Scope of Study | | | | | | | Plans or Studies with Identified Projects and Recommendations (See Appendix C-4 for more information on the status of associated projects and recommendations) |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Conveyance Capacity | Flooding | Erosion | Sedimentation | Geology/Soil Infiltration Rates | Water Quality | Habitat/Fish | |
| 1994 | Comprehensive Drainage Plan | City-wide | √ | √ | √ | √ | | √ | | √ |
| 1995 | Characterization and Source Control of Urban Stormwater Quality | City-wide | | | | | | √ | | √ |
| 1996 | Lake Sammamish Water Quality Management Plan-1996 | Lake Sammamish basins | | | | | | √ | | √ |
| 1999 | Richards Creek Basin Plan | Richards Creek basin | √ | | | √ | | | | √ |
| 2001 | City of Bellevue Stream Typing Inventory | Stream typing inventory of Bellevue streams | | | | | | | √ | |
| 2003 | Hydrologic Study of Kelsey Creek | Kelsey Creek basin and tributaries | | √ | √ | | | | √ | |
| 2005 | Coal Creek Environmental Impact Statement | Coal Creek basin | | √ | √ | √ | | | √ | √ |
| 2006 | Lake Bellevue Water Quality Study and Management Recommendations | Sturtevant Creek basin | | | | | | √ | | √ |

These streams are variable in their ability to support fish use. Lewis Creek, while identified as primarily a steep relief basin within Bellevue downstream of I-90, is the primary spawning stream for a critically declining population of late-run kokanee salmon. Some basins, such as Phantom Creek, have fish passage barriers that significantly limit the extent of salmon usage. Others, like South Sammamish, have small streams that intermittently go dry during the summer.

The structural and street flooding review indicates that flood protection is a key issue for seven of the nine basins (all but Ardmore and South Sammamish). The one recurring road closure area at Kamber Road in the East Creek basin was addressed through a CIP project in 2003. Storm-related claims and calls regarding flooded structures were common in basins with flooding issues. Many of the flooding issues were related to maintenance issues, such as leaves blocking storm drains or roots reducing the conveyance capacity of the pipes. Problem areas are incorporated into routine maintenance surveillance routes unless a structural solution, through a capital project, can correct the maintenance issue.

Aquatic habitat is an issue in six of the eight basins, but is not considered as high priority as in salmon-spawning basins. Water quality is identified as an issue in Ardmore, Sunset, and Yarrow Creek basins based primarily on the water quality risk assessment and Ecology's list of impaired waters. Most of these basins drain to phosphorus-sensitive lakes and have increased regulations limiting land clearing during the rainy season to reduce soil erosion, which is one of the largest sources of phosphorus.

Generally, basins with steep relief have retained vegetated riparian corridors because building on steep slopes is difficult or prohibited. Still, these basins are affected by stormwater runoff and typically experience erosion and sedimentation problems. Increased flows from development can result in greater channel instability in these basins than in lower gradient streams. Basins experiencing increased flows or instability would benefit from targeted studies that focus on both upland and in-stream conditions to determine causes and solutions for the symptoms. For small-stream basins with flooding or conveyance issues, new or updated hydrologic and/or hydraulic modeling may be beneficial to determine the most effective approaches to stabilize stream channels.

Basins in this category can benefit from tools that reduce stormwater runoff, including the 2010 detention regulations, capital projects that either increase storage or bypass steep slopes, and additional studies to determine whether other strategies may work to address issues within individual basins.

***Basins with Predominantly Closed Conveyance Systems***

These basins are largely piped and are most likely to have issues associated with conveyance capacity and flooding rather than habitat. Basins with predominantly closed conveyance systems are:

- Beaux Arts Area;
- Clyde Beach;
- Meydenbauer Creek;
- Rosemont Area;
- Sears Creek;
- Spirit Ridge; and
- Sturtevant Creek.

Seven basins have closed (or piped) conveyance systems that comprise most of the drainage system rather than streams or open ditches. Flood protection is a key issue for all of the closed conveyance basins except for Sears Creek. Sears Creek basin has a neighborhood street that regularly floods during storm events, but does not affect emergency routes. A capital project has addressed flooding concerns from undersized culverts in the Sturtevant Creek basin and a capital project is in design for Sears Creek. As in other basins, the increased detention regulations are expected to reduce flooding problems over time.

Water quality is identified as a key issue in four of the seven basins: Meydenbauer, Sears, Spirit Ridge, and Sturtevant. This is primarily due to high to moderate water quality risk level, but in Spirit Ridge, this is due to high impervious area and a phosphorus-sensitive lake.

In spite of being primarily closed systems, three of these basins still have open stream channels that have resident fish and limited salmon access, including Meydenbauer, Sturtevant, and Sears Creek basins. Aquatic habitat data were not available for any of these basins.

Efforts within these basins should focus on water quality and flooding. Tools include education programs to reduce non-point pollution; illicit discharge investigations and corrections; operations and maintenance activities; private system inspection and education; and capital projects to address flooding concerns.

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# CHAPTER 8 ASSET MANAGEMENT

Much of the public drainage infrastructure in Bellevue has already been built; as a result, the current management emphasis is on maintaining, repairing, rehabilitating, and replacing the existing system. An asset management program has been established, which is developing a systematic approach to the management of Bellevue's drainage infrastructure. The objective of this program is to manage Bellevue's drainage infrastructure assets in a sustainable manner through their life cycles, from planning through decommissioning, in order to meet the Utilities Department's service level goals while optimizing costs and minimizing risk.

## Asset Management Program Structure

The Utilities Department's asset management program is modeled after the asset management program framework developed by the U.S. Environmental Protection Agency (USEPA). USEPA's framework addresses five core questions:

1. What is the current condition of the assets?
2. What are the target levels of service these assets are intended to provide?
3. Which assets are critical to sustaining performance?
4. What capital investment plan and operations and maintenance strategies provide the target service levels at the lowest life cycle cost?
5. What is the best long-term funding strategy?

To address these questions, the USEPA identified the ten processes shown in Figure 8-1. These ongoing processes are not necessarily performed sequentially and involve iterating between processes. Each of these processes is described in more detail below.

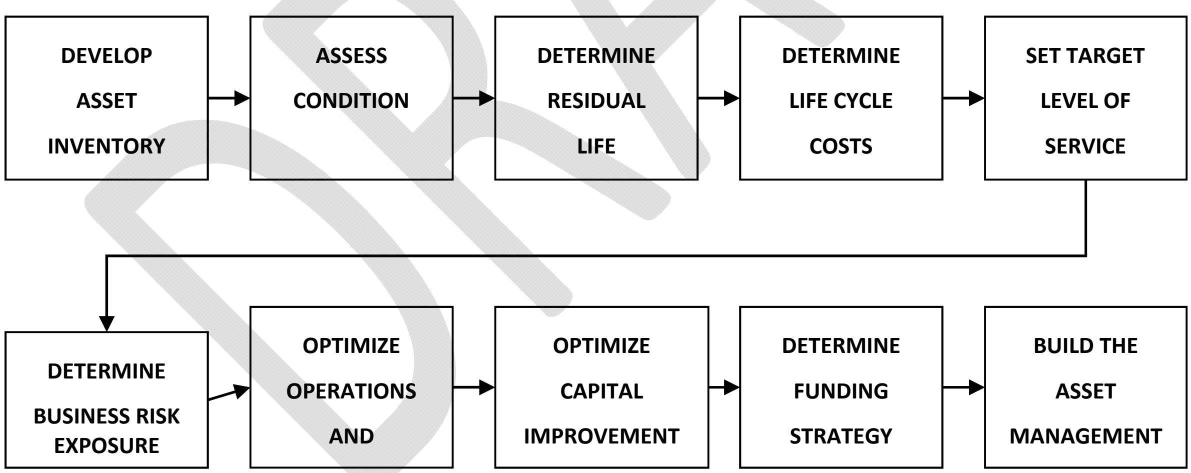


**Figure 8-1. USEPA Asset Management Program framework processes.**

### *Develop Asset Inventory*

Asset management depends on having an accurate asset inventory and knowing the characteristics of those assets. Asset characteristics such as age, size, and material are needed to plan future asset management activities and schedules. Much of Bellevue's drainage infrastructure was installed prior to Bellevue's incorporation; as a result, a large portion of the infrastructure did not have as-built drawings, either because they were never created or were no longer available to be turned over to the City when the Storm and Surface Water Utility was established in 1974. Consequently, some infrastructure asset characteristics are unknown. For example, the installation date is known for only approximately 25 percent of the drainage pipes. Because each property has an obligation to accept and convey surface water drainage to and from the property, the drainage system for the city is a mix of publicly and privately owned infrastructure. Drainage system assets outside the right-of-way are the responsibility of the property owner, unless there is legal documentation that they are the responsibility of the City.

The Utilities Department's drainage system asset databases are updated when new construction is completed, and when operations and maintenance staff notice discrepancies between asset records and their field observations. Redline drawings made by field staff are used to update the as-built record drawings. The data from the as-built record drawings are electronically pushed to Maximo, the Utilities Department asset data management system. The estimated number of known drainage utility assets owned by Bellevue Utilities is summarized in Table 8-1. Drainage pipelines are shown in Figure 8-2. As of 2010, the average public asset age is estimated to be 35 years old.

**Table 8-1. Public Drainage Asset Summary.**

| Infrastructure Asset Type | Estimated Number of Assets[2] |
|---|---|
| Drainage Pipelines[1] (miles) | 400 ± |
| Regional Detention Facilities | 11 |
| Detention Ponds | 129 |
| Detention Vaults | 189 |
| Detention Tanks | 325 |
| Oil/Water Separators (coalescing plates) | 39 |
| Water Quality Media Filters | 15 |
| Catch Basins/Inlet/Manhole Structures | 21,000 ± |
| Rain Gauges | 11 |

[1] Excludes ditches
[2] Number of assets is a raw count of individual assets determined with a Maximo database query.


**Figure 8-2. Bellevue's municipal storm and surface water conveyance system, including streams and most of the piped public drainage system.**

***Assess Condition***

Asset condition is one of the necessary pieces of information needed to make asset management decisions. Condition information is used to determine how an asset should be operated and maintained, to estimate the probability of asset failure, and to predict future resource needs for rehabilitating or replacing an asset. Condition assessment data are currently being used to identify repairs and replacements that are needed.

Drainage asset condition assessment is performed by the Utilities Department's Operations and Maintenance Division staff as part of their normal responsibilities and completed through programs dedicated to conveyance facility inspection. Closed circuit television inspection is performed for approximately 2 percent of the Utilities Department's drainage pipes each year. In 2003, a consultant recommended that 10 percent of the system should be videotaped each year. However, the Utilities Department decided that 2 percent of the system was a more appropriate target given that resources are limited and because the relatively few drainage pipe failures detected by closed circuit television inspection do not have severe failure consequences similar to those associated with pressurized water and sewer main failures.

The highest priority for inspection is given to drainage pipes in arterial streets where planned capital projects such as street overlays are anticipated, drainage pipes that are critical to system performance, and drainage pipes that are suspected of being in very poor condition. In the future, drainage pipe videotape records will be better organized so that the length is identified for critical and non-critical pipes that have been videotaped.

Additionally, a culvert inspection program is being initiated so that culverts are inspected on a regular cycle. These inspections will assess both culvert condition and potential culvert failure consequences.

***Determine Residual Life***

An estimate of each asset's remaining useful life is needed so that future resources needed to rehabilitate or replace it can be estimated. The remaining useful life estimate may also be indicative of the asset's current reliability.

For long-range planning purposes, the remaining useful life of the Utilities Department's drainage pipes is primarily based on a 2003 consultant study recommendations. This study recommended using a survival curve with a median drainage pipe life expectancy of 75 years. Although this curve may be representative of the Utilities Department's drainage pipelines as a whole, significant variation between the different types of drainage pipe is expected. Factors affecting residual life can include the asset's material, bedload, water velocity, and age. For example, many of the Utilities Department's corrugated metal drainage pipes will likely need to be rehabilitated or replaced before they are 50 years old because many have already begun to fail, while concrete and PVC pipes may last well beyond 100 years. In order to better predict drainage pipe rehabilitation and repair needs, a more detailed analysis will need to be conducted.

In the short term, significant renewal and replacement expenditures are not expected for the other public drainage assets such as detention ponds. These assets will eventually require renewal and replacement. Preliminary estimates of these resource requirements are included in the long-range financial plan.

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***Determine Life Cycle Costs***

Asset total life cycle costs, which include all costs from planning and design through decommissioning, are used to help evaluate alternative strategies for constructing, operating, maintaining, and replacing assets. The Utilities Department is currently formalizing its life cycle cost analysis procedures. Triple-bottom-line costs and benefits (economic, environmental, and social) are considered in the analysis. Life cycle cost analyses will be used to help evaluate drainage asset repair, rehabilitation, and replacement alternatives.

***Set Target Level of Service***

In order to know whether assets are performing satisfactorily, the service levels those assets are expected to provide must be defined. Asset management decisions and the resulting asset performance must be consistent with the service levels that are required by regulatory agencies and determined by the Utilities Department to be acceptable to its customers. When asset management decisions are made, only those options that would satisfy service level requirements should be further considered. Because resources are limited, it may sometimes be necessary to adjust service level goals to be compatible with resource availability.

Target service levels related to drainage assets are currently being developed based on adopted performance measures, but these have not yet been finalized. One performance measure being considered for developing target service levels is the number of claims paid each year due to drainage system failures.

***Determine Business Risk Exposure***

Risk is defined as the probability of failure multiplied by the failure consequences. Failure probability is estimated on a number of factors such as asset condition, age, type, characteristics, and failure history. Asset criticality is based on the potential adverse economic, environmental, and/or social impacts of drainage system failure.

Together with life cycle costs, the risk of asset non-performance is also needed to help evaluate asset design and construction, as well as operations, maintenance, and replacement strategies.

Risk is a function of asset condition, performance history, and asset criticality. An assessment of the risk for critical drainage pipe is underway. Critical drainage pipes will be identified by more completely incorporating all anticipated failure consequences. These consequences will be expressed in terms of expected monetary loss in order to calculate risk, prioritize asset rehabilitation and replacement needs, and quantify benefits used in life cycle cost analyses. Culvert criticality is currently being evaluated. In addition, a failures and claims analysis is completed annually to look for trends in the system that help prioritize where limited resources should be allocated. In the future, criticality will be defined for other drainage infrastructure.

***Optimize Operations and Maintenance***

Optimization of operations and maintenance programs is another activity that enables the Utilities Department to cost effectively reach service level targets. Under-expenditure of operations and maintenance resources can result in more failures and the inability to reach service level goals, while over-expenditure can result in wasteful resource allocation. In addition to developing the most appropriate levels of operations, maintenance, and repair of existing assets, operations and maintenance must be balanced against rehabilitation and replacement by considering the least overall life cycle cost.

Establishing appropriate capital projects and programs and appropriate operations and maintenance funding levels is dependent upon the following:

- Service level targets;
- Asset condition and remaining life;
- Asset criticality and failure consequences; and
- Life cycle cost comparison and available resources.

Work planning is used to estimate operations and maintenance resource investments each year. Operations and maintenance strategies are continually being evaluated and revised as appropriate. Stormwater maintenance standards were published in 2010.

***Optimize Capital Improvement Program***

Assets eventually wear out to the point where they need to be rehabilitated or replaced. Ideally, an asset should be rehabilitated or replaced when the life cycle costs for continuing to operate and maintain that asset in a condition that is consistent with the service level goals exceeds the rehabilitation or replacement life cycle costs. A capital improvement program that is consistent with these goals is necessary.

The Utilities Department's Capital Investment Program (CIP) Plan is updated every 2 years as part of the biennial budget process. The Utilities Department maintains a 75-year long-range budget forecast for the CIP Plan. Every 2 years, capital investment needs for the next 75 years are forecasted. These forecasts are based on the expected remaining useful life of the Utilities Department's assets.

The most recent emphasis has been on maintaining existing facilities and doing point repairs (repairs done at a single location as opposed to rehabilitating or replacing a continuous length of pipe) as needed. Because some drainage assets such as corrugated metal pipe and culverts can fail in as little as 25 or 30 years after they are built and the average drainage asset age in Bellevue is 35 years, rehabilitation and replacement needs are expected to start increasing in the near future.

***Determine Funding Strategy***

Financial resources are needed to design, construct, operate, maintain, and rehabilitate or replace assets. The Utilities Department operates primarily on a "pay-as-you-go" basis. Because much of the drainage system was constructed in a relatively short period of time within the past 25 or 30 years, eventual rehabilitation and replacement of the drainage system will cause resource needs to rapidly rise, peak, and then decline. The 75-year capital improvement needs forecast enables the Utilities Department to determine long-term funding needs and develop strategies for meeting those needs. A renewal and replacement fund has been established so that sudden rate spikes can be avoided when resource requirements begin to increase.

***Build the Asset Management Program***

More efficient asset management strategies and technologies are constantly being refined and developed. In order to optimize asset management, the most cost-effective strategies and technologies should be employed. Every 5 years the asset management program plan is revisited and revised, as necessary.

New technologies are evolving for drainage pipeline and structure rehabilitation and repair. These technologies and methodologies will be evaluated and incorporated, when appropriate.

## Asset Management Program Relationship to the NPDES Program

The asset management program complements Bellevue's National Pollutant Discharge Elimination System (NPDES) Municipal Stormwater Permit. NPDES permit requirements include provisions for inventorying and monitoring the operations, maintenance, and performance of stormwater assets. Consequently, the asset management program and NPDES program share many of the same goals and objectives. Additionally, the NPDES requirements stipulate stormwater collection and discharge requirements such as minimum acceptable water quality. These NPDES requirements become part of the asset management program service level requirements.

## Recommendations

To ensure resources are available for cost-effective, risk-managed asset replacement, it is recommended to:

1. Continue to visually inspect critical stormwater pipes (via closed-circuit television) at an appropriate rate, currently about 2 percent of the Utilities Department's drainage pipes each year.
2. Identify and inventory each drainage asset and estimate its remaining useful life so that future resources needed to rehabilitate or replace it can be determined.
3. Determine life cycle cost of each asset.
4. Develop short- and long-range resource needs projections based on the condition assessment program. Ensure resources are available for cost-effective, risked-based asset management and replacement by continuing to fund the renewal and replacement program at a level that is adequate to meet the Utilities Department's long-range financial goals.
5. Continue with the proactive maintenance program.
6. Continue to improve the stormwater asset management program by collecting inventory information and supporting an ongoing condition assessment program.
7. Develop the resource demand forecast to ensure that existing customer service levels are maintained as the system ages.
8. Continue to invest in capital programs and projects so critical facilities such as large diameter pipes and culverts conveying streams are repaired or replaced prior to failure (e.g., investments in the Stormwater System Conveyance Infrastructure Rehabilitation [D-64] project, and the replacement of the Coal Creek Culvert at Coal Creek Parkway [D-103] project).

# CHAPTER 9 UTILITIES OPERATIONS

This chapter discusses the Utilities Department's current operations and maintenance of the storm and surface water system. It includes descriptions of the Utilities Department's organizational structure, communications tools, system protection and maintenance, supporting programs and tools,communication tools, and preparedness and response.

The Utilities Department maintains and operates the storm and surface water system to control damage from storms, protect surface water quality, support fish and wildlife habitat, and protect the environment.

## Organizational Structure

The Utilities Department manages the storm and surface water system in accordance with the Bellevue City Code, specifically the Storm and Surface Water Utility Code (Chapter 24.06) and the Civil Violations Code (Chapter 1.18.075), the Storm and Surface Water Maintenance Standards (February 2010), a Clean Water Act permit (the National Pollutant Discharge Elimination System [NPDES] Phase II Municipal Stormwater Permit), and several other federal and state laws and regulations. The Utilities Department has responsibility for the ongoing operations and maintenance of the storm and surface water system in the city of Bellevue in conjunction with other City departments, government agencies, and private landowners. Responsibilities for drainage maintenance and operation are detailed in Chapter 3 Community Vision and Regulatory Framework, and Chapter 5 Storm and Surface Water Management Roles, Responsibilities, and Communications.

The Utilities Department is managed by the Director and Deputy Director. The Director's Office is the primary point of contact for the City Manager, City Council, and the Environmental Services Commission (ESC). The ESC is a citizen advisory committee that advises the City Council on planning, budget and rates, Capital Investment Program (CIP) Plan financing, contracts and policies related to water, wastewater, storm and surface water, and garbage programs. The Director's Office also leads intergovernmental and interagency efforts and coordinates the NPDES Municipal Stormwater Permit city-wide. Storm and surface water functions are implemented by three major divisions of the Utilities Department: Engineering, Operations and Maintenance (O&M), and Resource Management and Customer Service (RMCS). The functional organization of the Utilities Department is shown in Figure 9-1. The RMCS Division is responsible for customer service, outreach, financial management, and automation planning and implementation. The Engineering Division is responsible for development review and inspection; system analysis and comprehensive planning; asset management; systems mapping, design, and construction of the Utilities Department's capital program; and stream system management. The O&M Division is responsible for operations and maintenance of the storm and surface water and stormwater facilities associated with transportation systems including system repair and installation, emergency response, private system inspection programs, and illicit discharge response. A number of interdepartmental teams meet on a regular basis or are formed as needed to make policy recommendations and technical decisions regarding the operations and maintenance of the storm and surface water system.

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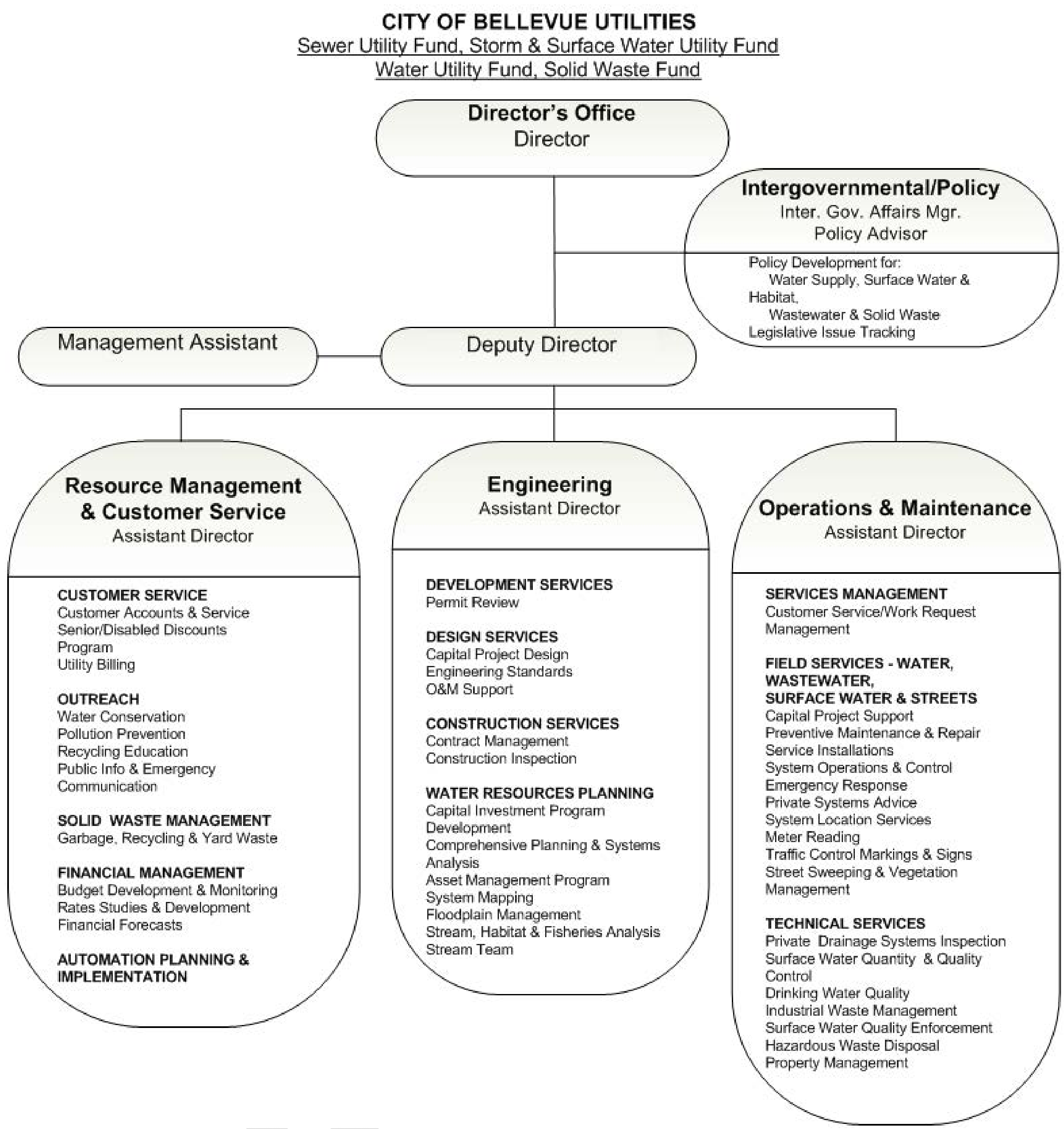


**Figure 9-1. Bellevue Utilities Department organizational chart showing division and section responsibilities and functions (updated 7/23/2010).**

## System Protection and Maintenance

### *System Components*

The storm and surface water system includes structural and natural drainage components located within Bellevue's 26 drainage basins, all of which ultimately discharge either to Lake Washington or Lake Sammamish. The structural components, both public and private, include over 35,000 catch basins and manhole structures and approximately 1,400 flow control and water quality facilities (including vaults, tanks, ponds, oil/water separators, and other structures). The natural elements include over 79 miles of streams and three small lakes. The City owns and operates 11 large regional detention facilities, almost

400 miles of underground drainage pipe, 86 miles of open ditch, approximately 21,000 storm drains and manholes, and approximately 350 water quality and/or detention facilities. Over 15 miles of streams and 864 acres of protected wetlands are on public property. A significant proportion of the system is under private ownership, including approximately 1,500 private drainage systems with over 17,000 individual flow control, water quality, and conveyance structures.

New facilities are added to the system each year. For example, 3 new miles of underground pipe, 27 flow control and water quality facilities, and 795 new catch basins, inlets, and manholes were installed in 2009 and 2010.

***Preventative Maintenance***

The final discharge locations for all drainage in Bellevue are streams and lakes. The NPDES Permit requires system maintenance to reduce the flow of sediment and pollutants into surface waters. For the constructed drainage system to function as designed and provide adequate flood control and water quality treatment, it must be kept free of excessive debris and sediment. Debris and sediment buildup in pipes, vaults, and other storage areas reduces storage capacity and can cause blockages during heavy rains leading to flooding, property damage claims, and environmental degradation. Sediment and associated pollutants are harmful to fish and other aquatic organisms. The drainage system contains a variety of water quality facilities that trap oils and other pollutants from roadways and allow for their removal during maintenance.

Preventive maintenance services are performed by the O&M Division. These include inspecting and cleaning the components of the drainage system under City responsibility according to the City's maintenance standards and schedules, which comply with the NPDES Permit, as well as performing many operations and maintenance activities necessary for optimal performance of the City's surface water system.

System inspection and cleaning operations involve measuring the amount of sediment in structures or regional ponds, then scheduling and completing cleaning based on inspection results. Cleaning of structures is typically conducted using a high-powered vacuum (eductor) truck that removes sediment from the system and transports it to an approved disposal facility. Regional ponds are generally excavated using large equipment.

Stream inspections are typically performed when a flooding, erosion, or water quality problem has been identified. Because streams in Bellevue flow through both public and privately owned properties, maintenance activities are generally limited to sections of streams on public properties or locations where a dedicated easement exists. Stream inspections and stream channel maintenance is closely coordinated with the Utilities Department water quality staff and Development Services Department staff to ensure compliance with critical areas regulations. Maintenance work includes relocating large logs, managing beaver ponds, adding rocks or erosion control fabric to stream banks, or clearing debris jams that can cause flooding.

Beaver pond management is a unique maintenance challenge for Bellevue because they yield benefits to the open stream channels provided that they do not cause flooding or block fish migration. In a benign manner, beaver ponds trap sediment, provide valuable storage of flood waters, recharge aquifers, and generally improve riparian zone habitat. However, they are also known to be barriers to fish migration and can often cause upstream flooding problems. Maintenance staff periodically dismantle beaver dams when they threaten fish passage or cause flooding. Therefore, it is recommended that the City inventory beaver problems and evaluate opportunities for beaver management that would reduce cost while maintaining the benefits offered by beaver ponds.

***Infrastructure Condition Assessment***

Storm and surface water infrastructure condition is assessed by capturing digital video images usingclosed-circuit television technology (CCTV) of the inside of drainage pipes to find deficiencies that may lead to system failures. “Critical pipes” (e.g., large diameter pipe, pipes under main arterials) and older pipes that are more likely to fail are inspected as part of this program. In addition, the Utilities Department works closely with the Transportation Department to prioritize video-inspection of pipes under streets where resurfacing is scheduled so that necessary repairs can be completed prior to paving. It is more cost-effective to repair defects before repaving than to incur costly grind and overlay expenses to repair failures that occur after roadway resurfacing. Most condition assessment work is completed by an outside contractor. A small portion of this work is done by in-house staff to investigate unanticipated, localized problems.

As the contractor performs a video-inspection review of the pipes, defects are scored in each pipe segment. In 2009, the contractor inspected 53,800 linear feet (10.2 miles out of a total of 395 miles) of underground drainage pipe and found 148 significant defects. These defects are then assessed by City staff, rated according to severity, and, if appropriate, scheduled for repair. Many of the repairs are completed by O&M Division staff, but larger, more complex repairs are referred to the Engineering Division for correction by an outside contractor as part of the CIP Plan.

***System Repair and Installation***

Repairs and installations to public storm and surface water system components are necessary to ensure that the municipal storm drainage system functions as designed to protect life, property, and the environment, and to reduce pollution entering streams and lakes. Drainage facilities are examined for cracks, loose joints, broken or missing parts, and other deficiencies during routine preventative maintenance inspections. Deficiencies found during inspections or reported to the City are scheduled for repairs or follow-up, as needed, to maintain the designed function of the system.

On average, the O&M Division repairs 172 storm structures and 502 feet of City-owned storm pipe each year; in addition, the City spends 2,650 labor hours annually repairing water quality facilities and streams. In addition, new drainage structures are installed in response to public drainage and/or flooding problems when necessary, such as catch basins and pipes. On average, 6 new structures and 430 feet of new pipe are installed annually. These installations reduce the likelihood that homes, businesses, and streets will flood.

***Private Drainage Inspection***

The Private Drainage Inspection (PDI) Program provides inspection and maintenance compliance of privately owned drainage systems to protect streams, ponds, and lakes from pollutants and minimize flooding threats to property. The list of drainage assets inspected by PDI includes assets owned by other City departments that are not part of the Utilities Department-owned assets. This program, an integral part of Bellevue’s stormwater system management since 1984, was recently mandated by the NPDES Municipal Stormwater Permit. It provides regulatory oversight of private drainage systems to ensure protection of public health and the environment, as well as protection for the public infrastructure system to which it is connected. Private drainage structures are an integral component of the drainage system.

The PDI Program implements federal and state requirements, primarily through inspection and certification services to verify proper function and maintenance. PDI activities include customer notification of inspection visits and results, facilities inspection, enforcement, database management, and regulatory compliance reporting. Specifically, the Utilities Department’s staff conduct periodic field inspections of over 1,500 privately owned storm drainage systems for compliance with required

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maintenance standards.  Private system owners are responsible for repairs and maintenance based on inspection results.  These systems are connected to the public system and represent over 17,000 individual flow control, water quality treatment, and conveyance drainage structures, which account for about half of the total constructed drainage system in Bellevue.  Source control inspections that target commercial properties (inspecting outdoor storage of potential pollution sources such as bags of fertilizer) are also conducted.

***Stormwater Pollution Prevention Plans at Public Facilities***

The NPDES Permit requires development and implementation of a Stormwater Pollution Prevention Plan (SWPPP) for City facilities, which provide heavy equipment maintenance or storage and/or material storage facilities.  In 2009, a cross-departmental team (Utilities, Civic Services, and Parks) worked with a consultant to develop and implement the SWPPPs for six City facilities that triggered this requirement. The six City facilities are:  Eastgate Yard, Bellevue Service Center, Lower Bellevue Service Center Parking Lot, Resource Management Center, Bellevue Golf Course Maintenance Facility, and Bellefields Yard.

***Regional Endangered Species Act Roads Maintenance***

The Endangered Species Act of 1973 (ESA) is a federal law designed to prevent endangered species from becoming extinct as a “consequence of economic growth and development untempered by adequate concern and conservation” (Section 2, ESA).  The ESA Roads Maintenance Program established a set of roads maintenance best management practices (BMPs) designed to protect aquatic species listed as threatened under the ESA.  This state-wide program was created regionally by the Washington State Department of Transportation (WSDOT) and 23 city and county jurisdictions; it was approved by the federal agency that administers the ESA for salmon (the National Marine Fisheries Service [now NOAA Fisheries Service]) in 2003.  Participating agencies receive protection from liability for activities that have the potential to affect species listed under the ESA. The program involves implementing BMPs, training staff, and monitoring to prevent impacts to aquatic species listed under the ESA that rely on surface waters (Regional Road Maintenance Technical Working Group 2001).  The Utilities Department and the Transportation Department signed a letter of program commitment for the National Marine Fisheries Service on November 6, 2001, and use the approved BMPs for all construction and maintenance activities.

## Supporting Programs and Tools

Various monitoring programs and analysis and communications tools support the Utilities Department in managing the storm and surface water system.  Monitoring programs involve collecting and analyzing information about stormwater system performance for efficient operations to quantify system capabilities and to identify system problems or deficiencies.  Examples of ongoing monitoring programs include the collection and analysis of regional detention pond stages, rainfall information, and stream flows.  Computer models of the storm and surface water system are developed, maintained, and used to map and predict flooding.  The models allow accurate assessment of the system’s ability to accommodate scenarios such as planned population growth or changed land uses; the data are then made available for basin or comprehensive planning.  Physical, chemical (water quality), and biological information about streams are collected for analysis of fish use, environmental health, and beneficial uses of surface waters such as fishing and swimming.  These data are used to evaluate how the storm and surface water system is performing relative to the Utilities Department’s goals, as detailed in Chapter 6.

***Physical System Monitoring***

Computer models and trend analyses rely on up-to-date, accurate information.  Data about facilities are provided by the O&M Division and analyzed by the Engineering Division staff.  Physical information about streams collected by the Utilities Department includes continuous stream flow data at critical locations, including the U.S. Geological Survey (USGS) gauges on Kelsey Creek, precipitation data, and water level data at Lake Sammamish and regional detention ponds.

***Telemetry Systems***

Telemetry and Supervisory Control and Data Acquisition (SCADA) equipment are automated systems used to remotely monitor surface water elements such as precipitation, flow rates, and water level elevations. These systems allow staff to operate and regulate the gate settings at the regional detention facilities for stormwater. Telemetry and SCADA equipment requires regular repair, replacement/upgrade, preventative maintenance, calibration, programming, and testing. Research and development are ongoing to stay current with technological advances, and to maintain effective and reliable telemetry/SCADA systems.

Telemetry and SCADA equipment warns in real time when systems are operating outside normal parameters, alerting staff so they can make manual adjustments. Currently, 12 stormwater structures and 11 rain gauges are monitored remotely using telemetry equipment. The communications and control system consists of an infrastructure of remote telemetry units at each site, fiber optics, and a leased line and network that provides data and control to and from all remote sites, Bellevue City Hall, and the Bellevue Service Center.

***Water Quality and Illicit Discharge Detection and Elimination***

The City performs water quality monitoring to detect and eliminate pollutant sources to the municipal stormwater system, to investigate water quality issues and reports of pollutant spills, to determine long-term water quality trends in a few water bodies, and, as needed, to inform management actions. The Illicit Discharge Detection and Elimination (IDDE) Program involves field assessment activities that include 1) outfall prioritization, screening, reconnaissance, discharge characterization, and sampling; 2) investigation, containment, and cleanup of illicit discharges and connections; and 3) regulatory enforcement, reporting, and program effectiveness evaluation. The IDDE Program also includes locating and mapping drainage outfalls, documentation, and City-wide support for illicit discharge training and response. The protocol for working with those responsible for illicit discharges ranges from education to fines.

The Utilities Department has conducted and/or participated in numerous storm and surface water quality monitoring studies, including comprehensive characterization studies of urban stormwater quality, monitoring studies of water bodies, and studies to assess the effectiveness of BMPs. Water quality studies are expensive. The Utilities Department uses studies strategically to identify options to address specific water quality issues and inform management actions to adaptively manage programs over time, resulting in better water quality protection, and reduced pollutant discharge to the storm and surface water system.

In the next 5-year NPDES Phase II Municipal Stormwater Permit (2012 to 2017), the City anticipates the Washington State Department of Ecology (Ecology) will require Phase II municipalities, including Bellevue, to implement storm and surface water quality monitoring. These new monitoring requirements and implementation options are still being developed.

***Aquatic Habitat and Biological Information***

The Utilities Department plays a major role in maintaining and monitoring aquatic habitat ( areas with the conditions to support aquatic life). The specific activities are detailed in Chapter 5 Storm and Surface Water Management Roles, Responsibilities, and Communications. The number and type of animals living in streams are a good indication of the relative condition of the streams. Biological information about streams collected by the Utilities Department includes surveys of spawning salmon in the fall; summer fish use of streams; annual sampling of benthic macroinvertebrates from streams; and peamouth minnow spawning surveys each spring. Staff, professional consultants, and volunteers collect biological information that is used to assess the environmental health of Bellevue's open streams.

Fall salmon spawner surveys are generally conducted on Bellevue's primary salmon streams—Kelsey Creek, West Tributary, Richards Creek, and Coal Creek—with occasional surveys and spot checks by volunteers on other streams. The surveys are normally conducted from early September through late December, during the fall spawning runs for Chinook, coho, and sockeye salmon. Summer fish use of several reaches of stream is sampled every 2 to 3 years by electrofishing. This information is used to document resident fish species present, relative abundance and ages of fish, native and non-native populations, and to document trends over time. Peamouth spawning events are monitored by volunteers who check various sites, primarily along Kelsey Creek, from April through June.

Benthic macroinvertebrates, the "bugs" that live in the stream gravels and can be seen with the naked eye, are collected each summer from multiple sites along three to five streams. Samples are collected using regionally approved protocols. Each site is assigned a score based on sampling results that indicates the relative condition compared to other streams in the region. Scores can range from pristine to heavily impacted. This score is known as the Benthic Index of Biotic Integrity, or B-IBI.

## Communications Tools

Communication within the Utilities Department and with other City departments is facilitated by automation systems and tools. These systems are described below; each work group is trained in how best to use the available tools to perform its mission. Standard operating procedures are developed and updated using an internal review process, and are centrally available to Utilities staff.

The Utilities Department uses IBM's Maximo work management database to manage daily operations and maintenance. For example, service requests are directed to managers who then schedule and assign work orders to staff. The database is also used for purchasing, work planning and scheduling, making payroll, conducting asset inventory and tracking, scheduling tools and equipment, stocking inventory, financial reporting, responding to customer requests, preparing regulatory reports, and dispatching during emergencies. The Development Services Department uses the CSDC System's Amanda database system for development permitting, tracking, and reporting. Amanda interfaces with Maximo for new service connections that originate in Development Services. A City-wide geographic information system (GIS) with a customized browser called Mapster shows Utilities infrastructure and structures on secured layers. Custom maps and geographic analyses can be created using GIS and other mapping programs, including ESRI's ArcGIS and AutoCAD. Centralized network drives and other software facilitates sharing of electronic files between the Utilities Department staff and other City departments. These automated communications applications are supported by the Information Technology Department, and Utilities staff within the RMCS Division.

### *Floodplain Management Program (FEMA's National Flood Insurance Program)*

A floodplain is the land area adjacent to a stream or lake that temporarily stores excess water during heavy rain, providing natural storage and beneficial protection of downstream properties, groundwater reservoirs, water quality, and streams. More specifically, Bellevue City Code (LUC 25.20H175) defines the floodplain as "The land in the floodplain subject to the flood having a one percent chance or greater of being equaled or exceeded in any given year as determined by customary methods of statistical analysis defined in the Utility Code, Chapter 24.06 BCC." The National Flood Insurance Program (NFIP) is a federally backed insurance program that offers flood insurance to property owners who own property in participating communities. The federal government instituted the NFIP in 1968 to provide flood insurance coverage not generally available on the private market. Bellevue voluntarily joined the NFIP in 1974, providing citizens the opportunity to purchase flood insurance.

The NFIP requires participating communities to adopt land use regulations that minimize flooding risk to new and substantially improved developments. The degree to which these regulations minimize risk is rated by the Federal Emergency Management Agency's (FEMA) Community Rating System (CRS). The CRS is a national program that recognizes and encourages community floodplain management activities that exceed minimum NFIP standards. Every 3 years, Bellevue's floodplain management program is evaluated against CRS standards that are based on a system of points awarded for floodplain management activities under the categories of Public Information, Mapping and Regulations, Flood Damage Reduction, and Flood Preparedness. Flood insurance premium rates for policyholders that live in Bellevue are dependent upon the CRS score. Bellevue's CRS score of Class 5 (last awarded in 2008) resulted in Bellevue citizens being eligible for up to a 25 percent discount on flood insurance premiums; this discount was due to floodplain management practices in Bellevue. Ongoing activities related to the CRS program include improving floodplain maps using FEMA protocols, regularly communicating with citizens regarding floodplains on their property and flood prevention activities, continuous stream flow gauging, and a suite of other activities.

FEMA publishes floodplain maps to depict the extent of the 100-year floodplain (Federal Emergency Management Agency 1995). These maps, known as Flood Insurance Rate Maps (FIRMs), help insurance agents, lending institutions, and local governmental jurisdictions understand flooding risk. The City of Bellevue uses floodplain maps to promote wise land use activities on lands prone to flooding. City floodplain management code is written to preserve floodplains in an undeveloped state so they are available to store floodwaters without damaging private property. If natural flood storage areas were allowed to develop, flood waters would be pushed downstream, causing harm to others and putting investments into private property at risk.

Floodplains in Bellevue were originally mapped by FEMA in the late 1970s and are documented in the King County Flood Insurance Study (Federal Emergency Management Agency 1995). Updates to the original floodplain maps have primarily included changes in non-technical mapping information such as jurisdictional boundary lines and new roads (Figure 9-2). With the exception of Kelsey and Meydenbauer Creeks, the FIRMs for Bellevue do not reflect changes in flood flows or flooding elevations that may have occurred due to urbanization. The Meydenbauer Creek and Kelsey Creek floodplain maps, however, have each been updated with flow rates and 100-year flooding elevations as predicted with fully built-out land use conditions (FEMA case # 98-10-131P, 03-10-0399P and 07-10-0757P).

The City's need to map floodplains is different than the needs of the NFIP. The NFIP is primarily an insurance program, and its mapping efforts are limited to stream basins that met a minimum land area threshold. Because some stream basins in Bellevue are below this threshold, the FIRMs for Bellevue do not show all of the 100-year floodplains in the city. Bellevue, on the other hand, uses floodplain maps to implement land use policies, and the City's definition of floodplains applies to every open stream within city limits. Therefore, the City's need for floodplain maps is not limited to what was mapped by FEMA.

Flooding elevations depicted on floodplain maps are affected by stream flow volumes—increased stream flow volume results in larger floodplains—and because stream flows have changed since the original FEMA floodplain maps were produced in the late 1970s, they are likely incorrect and need to be updated. Two Bellevue drainage basins have recently been remapped with updated hydrology and flooding extents (Meydenbauer Creek and Kelsey Creek), as shown on Figure 9-2. It is recommended that three additional basins (colored yellow) that were not part of the original FEMA Flood Insurance study be mapped. Many basins are not recommended for any floodplain mapping (shown in brown) because those basins do not meet the City's remapping criteria due to steep stream gradients, a poorly defined stream corridor, and/or a lack of anticipated redevelopment.

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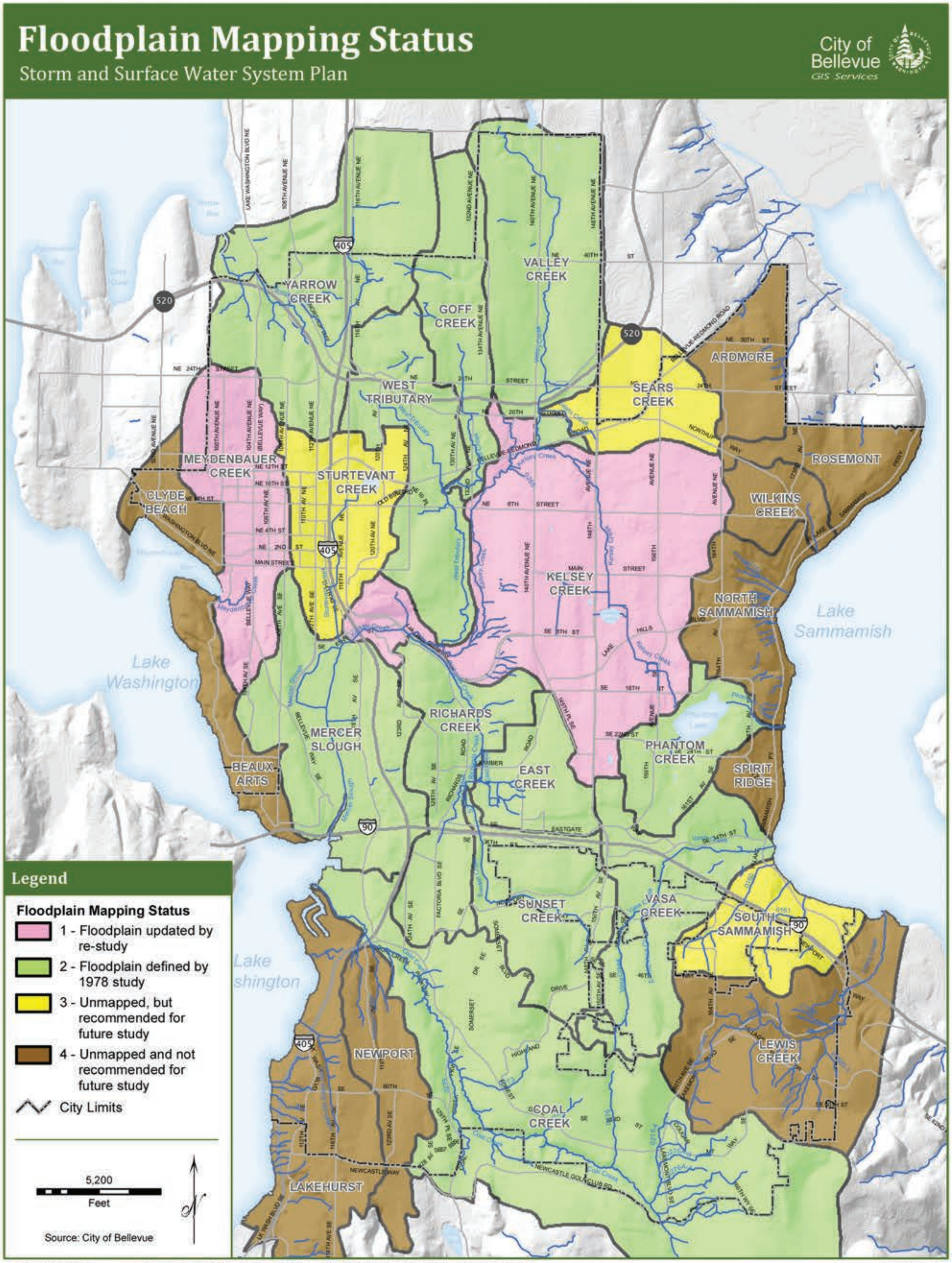


Plot Date: 8/18/2011 File Name: V:\utpl\ArcGIS\Storm\UtilCompPlan_2010\ArcGIS\Floodplain_Status_Map.mxd IT Department

**Figure 9-2. Status of floodplain mapping in each of Bellevue's drainage basins as of 2010.**

***Capital Investment Program***

The Utilities Department's Storm and Surface Water CIP Plan is a 7-year spending plan, representing a significant investment of Utilities' resources intended to further the department's mission with regards to storm and surface water. The 2011 to 2017 CIP Plan budgets approximately $4.9 million/year for projects that:

- Protect property from flooding or other stream-related damage;
- Protect or improve water quality;
- Maintain or improve the reliability, effectiveness, and/or integrity of the utility's infrastructure;
- Promote fiscal stewardship through cost savings or reduced potential liability;
- Promote resource stewardship by improving fish and/or riparian wildlife habitat; and
- Respond to regulatory requirements, settlement or easement agreements, or court orders.

The CIP Plan is updated every 2 years, as part of the City's biennial budget adoption. Changes or additions to the CIP Plan are recommended based on comprehensive plans or studies, operations or maintenance experience, asset management program recommendations, and regulatory changes. Recommended changes are developed by a diverse, multi-interest team of stakeholders including staff from all Utilities divisions and other departments. They are submitted for extensive review by the ESC, with several opportunities for review and comment by the public, before being presented to the City Council for review and adoption.

The CIP Plan includes ongoing programs with annual funding for infrastructure repair and replacement; stream channel stability; fish passage improvements; and flood control. Projects within each of these programs are prioritized and constructed based on criteria specific to each program. The CIP Plan also includes one-time projects with specific objectives, such as construction of a pond for sediment removal on Coal Creek, retrofit of an existing stormwater pond to improve water quality, and replacement of a stormwater culvert that conveys a stream under a major arterial.

Managing the CIP Plan involves ongoing monitoring and quarterly reporting (internal and to the City Council) of CIP budget and project status. Performance monitoring includes assessment of the program's planned vs. actual accomplishments.

Implementation of the CIP Plan involves selection of the optimal design alternative based on a triple-bottom-line decision model that considers economic, social, and environmental impacts. Engineering drawings, specifications, and cost estimates are developed and required permits and property rights are secured. Quality control and quality assurance is provided throughout the design process, which uses a collaborative approach involving staff from O&M, Planning, and Design and Construction sections, as well as staff from other departments depending on the nature of the project. This process results in a design that ensures a long asset life with minimal maintenance costs.

Major CIP projects will often seek public input through meetings that range in size from neighborhood groups to larger basin-wide public meetings. Property owners affected by CIP projects receive letters during the design phase that provide information about the project, including the name and contact information of the project engineer. Once projects commence construction, property owners receive advance notice that includes anticipated impacts, duration of construction work, and contact information for the City inspector assigned to the project.

CIP projects are typically constructed by private contractors obtained through a public works bidding process. This process follows Washington State public works bid laws. As prescribed by state law, construction projects are awarded to the lowest qualified bidder.

CIP projects in construction are managed and inspected by the Utilities Inspection Services staff to ensure that bidding procedures are followed; that facilities are constructed in accordance with the

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approved drawings and specifications; that all permit conditions are met; that construction impacts on residents and businesses are minimized; that the health and safety of the public is protected; and that costs are reviewed and accurately accounted to maintain budget integrity. O&M staff support CIP projects during construction, by attending pre-construction meetings, coordinating site access for contractors, and inspecting facilities before they are accepted for public ownership.

## Preparedness and Response

The Utilities Department responds to environmental and other emergencies, including flooding, snow, ice, earthquakes, and spills and pollution discharges into the storm and surface water system. The department also participates in city-wide emergency preparedness and response activities. These activities are described below.

***Environmental Response***

The Utilities Department responds to disasters and major emergency events to maintain or return utility and street systems to service. Emergency events include extreme rain and flooding, snow, ice, earthquakes, as well as other unforeseen disasters such as spills or illicit discharges of pollutants. Events that have obvious or potential wildlife impacts are reported to Washington Department of Fish and Wildlife, U.S. Fish and Wildlife Service, or NOAA Fisheries Service, as appropriate.

***Water Quality Response***

Response for surface water quality protection is conducted as required by the NPDES Permit, public health department, and/or water quality goals established for streams and lakes. O&M Division staff routinely respond to and investigate reported illicit discharges (pollutant spills). The responsible party is identified and required to perform cleanup, or is subject to enforcement, which may include cost recovery and fines. O&M and Engineering staff also respond to customer water quality concerns, help resolve crossed connections between surface water and wastewater pipes, provide city-wide technical expertise and support for water quality response issues, and oversee response planning activities for preventing and managing the West Nile virus. In 2009, Utilities staff responded to over 60 potential pollutant spills into lakes and streams and two sewage overflows that threatened Lake Washington beaches.

***Emergencies***

The City follows national Incident Command System protocols established under FEMA and Homeland Security. The Utilities Department participates in this City-wide emergency preparedness planning, coordination, and training. Activities undertaken to prepare the Utilities Department for emergency and disaster response include regular Emergency Management Plan updates, maintenance of mutual aid agreements, emergency response training, emergency management team meetings (department and city teams), disaster response exercises, and other research or activities contributing to emergency preparedness.

The Utilities Department has a key role in response to natural and human-caused disasters and major emergencies because of the critical importance of the drinking water, wastewater, and drainage systems to maintenance of public health and safety. Major wind storms may cause flooding and debris removal challenges. A strong earthquake would likely cause major damage to below-ground piped infrastructure and water detention structures. Utilities must be prepared to respond to a wide array of potential disasters, including paralyzing snowstorms, chemical spills, gas explosions, terrorist acts, volcanic activity, airplane crashes, and more. During emergency events, an Incident Command System (ICS) structure is implemented. ICS is a standardized, on-scene, all-hazards incident management approach that allows for integration of facilities, equipment, personnel, procedures, and communications operating within a common organizational structure. Following ICS protocols, resources are shared

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among the field operating sections of the O&M Division. Response, however, is only one piece of a comprehensive emergency management program as defined by FEMA and the Utilities Department. The department's emergency planning has five aspects: mitigation, preparedness, response, recovery, and review.

The steps above are detailed in the Emergency Management Plan, which the Utilities Department maintains in two volumes. Volume 1 contains information on policies and instructions regarding reporting to work; emergency response roles and responsibilities; vehicle, equipment, and emergency supplies inventories; contact information for employees, emergency operations centers, and response partners; telephone and radio communications protocols; and critical infrastructure location lists and maps to guide damage assessments. A separate Volume 2 includes scenario-based response plans for many disaster scenarios such as snow and ice events, flooding, windstorm debris removal, drinking water contamination, and West Nile virus outbreak, etc.

In addition to regularly updating the plans described above, the Utilities Department emergency preparedness includes participating on City-wide preparedness teams, maintaining a departmental emergency management team, conducting ongoing emergency response training and exercises, developing emergency messages and warning systems, and preserving mutual aid agreements with other agencies for possible lending/borrowing of critical resources. The City-wide effort produces the City of Bellevue Emergency Operations Plan (EOP), continuity of operations/continuity of government protocols, and guidance to departments on disaster response priorities.

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# CHAPTER 10 PUBLIC EDUCATION AND OUTREACH

## Introduction

The Utilities Department has developed numerous programs to educate citizens, protect local natural resources, and meet federal requirements. Bellevue citizens have been working with the City to protect water quality and aquatic habitat since the 1970s.

Program elements have evolved over time based on current needs and best available science, but the goals and objectives of education and outreach programs have generally remained the same. Surveys, focus groups, regional recommendations, and state and federal mandates help determine which programs are needed and are adapted over time based on requirements and evaluations.

State and federal regulations include requirements for stormwater outreach. Those requirements are implemented in Bellevue as follows:

- **City's National Pollutant Discharge Elimination System and State Waste Discharge General Permit for Discharges from Small Municipal Separate Storm Sewers in Western Washington (the NPDES Permit), issued in January 2007.** The City provides public education and outreach aimed at a variety of customer classes, including residents, businesses, industries, elected officials, policy makers, planning staff, and other employees. The goal is to reduce or eliminate behaviors and practices that cause or contribute to adverse stormwater impacts; to that end, programs are designed to achieve measurable improvements in the targeted audience's understanding of the problem and what they can do to solve it.
- **Revised Code of Washington (RCW) 90.48 (State's Water Pollution Control Law).** The City works to maintain the highest possible standards to ensure the purity of all waters of the state consistent with public health and public enjoyment, including the protection of wildlife, birds, game, fish, and other aquatic life. The goal is to educate the general public that it is unlawful to throw, drain, pour, or otherwise discharge pollutants into any of the waters of this state, or to cause, permit, or suffer to be thrown, poured, drained, allowed to seep or otherwise discharged into the state's waters any organic or inorganic matter that causes or tends to cause pollution of such waters.
- **Federal Water Pollution Control Act (the Federal Clean Water Act), Title 33 United States Code, Section 1251 et seq.** The City's goal is to educate the general public and raise awareness to eliminate the discharge of pollutants of any kind into the nation's waters and to improve water quality in order to provide protection of fish, shellfish, and wildlife, and for recreation in and on the water.
- **Local Hazardous Waste Management Program Grant.** Every year the City enters a contract with the Seattle-King County Department of Public Health where they return funds collected from Bellevue solid waste customers to the City to be used for hazardous waste prevention outreach, education, and technical assistance. While the specifics of each annual grant contract vary somewhat, the City provides targeted programs similar to the following
    - Pollution Prevention Outreach and Technical Assistance. A variety of outreach and technical assistance methods are used to encourage Bellevue area residents and businesses to seek appropriate alternatives to, and/or proper handling and disposal of, hazardous waste, including the purchase and placement of storm drain markers to encourage residents to protect lakes, streams, and wetlands from pollutants.

- Used Motor Oil and Household Hazardous Waste Research, Outreach, and Technical Assistance. Used motor oil generated in the City is tracked, and do-it-yourself motor oil changers are educated about options for recycling used motor oil and reasons not to dump it down neighborhood storm drains. This project also includes determining the recycling and proper disposal options available to local residents for household hazardous waste, as well as educating residents and working to expand these options, so that household hazardous waste do not end up in the surface or waste water system.

- **Public Outreach Actions.** The Cedar/Sammamish/Lake Washington Watershed (Water Resource Inventory Area [WRIA] 8) team recommends public outreach actions including increasing public involvement in stewardship activities, providing information to streamside landowners, and raising awareness about pollution prevention. The City adopted the Cedar/Sammamish/Lake Washington Watershed (WRIA 8) Salmon Recovery Plan in 2005 as a response to the Endangered Species Act (ESA).

## Goals and Objectives

There has not been a formal process for identifying the Utilities Department goals and objectives for public education and outreach. The following goals and objectives were developed to address regional and local issues, including NPDES and other requirements.

**Goals**

- Teach every citizen that runoff in storm drains flows directly into local water bodies;
- Help citizens understand that stormwater is not treated before being released into open water, like wastewater is;
- Educate every citizen on choices and tools that can be used to prevent stormwater pollution; and
- Increase community involvement in activities that help protect habitat and water quality.

**Objectives**

- See “Stream Team” and “Pollution Prevention” Performance Measures for specific objectives that are being measured regarding the goals stated above;
- Comply with state and federal requirements;
- Work in partnership with regional groups to foster consistent messages and leverage time and funding; and
- Engage residents in habitat restoration, monitoring, and stewardship through volunteer and educational programs.

## Current Programs

Current programs include a variety of forums and topics, from general messages about storm drains and the stormwater system, to more in-depth programs where citizens attend classes or participate in field projects to learn about topics such as natural yard care practices and local salmon.

Education and outreach on stormwater issues is vital to protecting and improving water quality. Everyone has a role and responsibility for keeping stormwater clean. Bellevue’s programs reach a variety of audiences including single-family, multi-family, businesses, and schools. Outreach topics focus on the behaviors that citizens can adopt to protect water quality and prevent pollution. Key behaviors and messages include:

- Nothing but rain down the storm drain;
- Pet waste—scoop the poop, bag it, and place it in the trash;
- Car washing—use a commercial car wash or waterless car wash product;
- Natural yard care—use fewer lawn and garden chemicals; and
- Proper storage and disposal of hazardous materials.

Table 10-1 provides examples of current Utilities Department programs to achieve stormwater outreach goals and objectives.

**Table 10-1. Current Utilities Department programs to achieve the City's stormwater goals**

| Program | Audience | Description |
|---|---|---|
| Stream Team | Schools, volunteers, streamside property owners, general public | • Restoration projects and educational programs and workshops, which include volunteer programs, such as Salmon Watchers, Peamouth Patrol, Arbor/Earth Day habitat restoration, and macroinvertebrate collections.<br>• Targeted outreach to streamside property owners and residents within specific watersheds.<br>• Presentations to school groups in the classroom, at science fairs and at community events.<br>• Presentations to community groups such as Rotary and Bellevue Downtown Association.<br>• General outreach activities, such as the Stream Team newsletter, brochures, displays, and signage. |
| Storm Drain Marker Program | General public | Storm drain markers are brightly colored plates with the message "nothing but rain down the storm drain" to prevent people from discharging pollutants into storm drains. Interns and volunteers have marked all public storm drains and are now filling in missing markers and reaching out to private property owners and managers to mark storm drains on their property. |
| Natural Yard Care Programs | Single-family residences | Includes workshops and provides educational resources to teach residents about natural yard care practices such as natural pest, weed, and disease control, which reduces the amount of toxics used in landscape management. |
| Fundraising Car Wash Program | Businesses where car washes are held, groups that commonly hold fundraising car washes | Educates businesses where car washes are commonly held, along with schools and groups that hold car washes, on alternative options to raise money and prevent pollution. Informs groups about the opportunity to sell car wash coupons from local vendors. Provides car wash kits to groups holding fundraising car washes. The kits collect and redirect the wastewater from the car wash to a drain connected to the sanitary sewer system or a location where the wastewater will soak into the ground and not flow into the local storm drains. |
| Used Motor Oil Recycling Program | Do-it-yourself oil changers | Promotes the proper management and recycling of used motor oil and used oil filters by residents who change their own motor oil, and educates residents on reasons not to dump motor oil down the neighborhood storm drains. |
| School Programs | 4th grade biology and AP environmental science classes | Provides a pollution prevention workshop entitled "Be the Solution" that is integrated into all high school-level biology classes, and works with high school environmental science teachers to integrate pollution prevention messaging and information into their courses. Classes on salmon, pollution prevention, and macroinvertebrates offered to Advanced Placement environmental science. Salmon cycles class available to all 4th grade classes, which includes pollution prevention messages. |

**Table 10-1. Current Utilities Department programs to achieve the City's stormwater goals**

| Program | Audience | Description |
|---|---|---|
| Commercial Source Control Technical Assistance | Local businesses | Provides educational materials and on-site technical assistance to commercial and industrial customers on best management practices (BMPs) to keep pollutants from the storm drainage system. |
| Posters, Displays, Outreach Materials, such as Brochures, Theater Ads, and Newspaper Ads | General public | Promotes BMPs for vehicle washing; cleaning up spills; properly disposing of wastewater; natural pest, weed, and disease control; and other current pollution prevention measures. |
| News Stories | General public | Developed for inclusion in the City's newsletter "It's Your City" and the Bellevue Reporter to help readers identify the issues and what they can do to help prevent pollution. |
| Interpretive Signs | General public | Provide stormwater outreach at various City facility and community park sites. |
| Public Service Announcements | General public | Produced for use on the City's website, BTV Channel 21, and used on the internet to help viewers visibly understand the issues involved with pollution of City waterways and the ways they can prevent pollution. |
| STORM (Stormwater Outreach for Regional Municipalities) | General public | Multi-jurisdictional stormwater public education campaign that the City actively participates in to support regional messages, leverage time and money, and meet NPDES requirements. The website pugetsoundstartshere.org is the major effort of STORM. |
| SOGgies (Stormwater Outreach Group) | General public | Small multi-jurisdictional stormwater outreach group comprising east and north King County cities that collaborate on projects such as surveys, focus groups, and bus ads in order to leverage time, funding, and reach of messages. |
| Floodplain Outreach | Residents and businesses within floodplains | Outreach including website, city newspaper, and targeted mailings provided to meet Community Rating System (CRS) protocols to make residents in floodplains eligible for insurance discounts. |
| Private Drainage Inspection | Businesses with private storm drain systems | Outreach is one-on-one with businesses when assistance is requested or concerns are observed on site by staff. Education is always the first step to helping solve pollution concerns. Businesses receive follow-up letters and appropriate brochures. |
| Private Drainage Assistance | Property owners with drainage concerns | Outreach is one-on-one with private property owners when assistance is requested. "Drainage Around Your Home" brochure is commonly provided. |

## Recommendations

Outreach efforts should evolve over time to meet needs, mandates, and most current issues that need to be communicated based on science, program evaluations, and research. The program must be tailored to available staff time and budget. Recommended efforts for the future include the following measures:

- Develop a current “Stormwater Outreach Guide” that explains key messages, identifies sources of facts, summarizes research, and details the programs, audiences, and level of effort.
- Identify outreach opportunities and local demonstration sites for natural drainage practices that encourage stormwater retrofit and the implementation of low impact development (LID) techniques.
- Continue ongoing survey and evaluation efforts to maintain the efficiency and effectiveness of outreach efforts.
- Research barriers, motivations, and incentives for streamside landowners to be better stewards of their properties to create effective targeted outreach material.
- Develop regional outreach to mobile businesses such as landscapers, carpet cleaners, and other contractors who work throughout the region.
- Continue to educate customers about the difference between public and private drainage systems, legal aspects, and private property owners’ responsibilities.
- Educate stakeholders to view stormwater as a resource to address climate change and promote reuse technologies.
- Continue monitoring public attitudes and knowledge about stormwater and stormwater management. Target messages to address shortcomings and meet goals through surveys and other techniques.

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# CHAPTER 11 FINANCIAL INFORMATION

This chapter summarizes the current and forecasted financial strength of Bellevue's Storm and Surface Water Utility and its funding strategy for recommended investments through the 20-year planning period.

## Current Financial Status

Table 11-1 summarizes actual cash-basis revenues, expenses, and fund balances for the Storm and Surface Water Utility for the most recent 4-year period. Over this period, the Storm and Surface Water Utility's fund balance, which represents total unexpended resources carried forward to future years, increased from $4.5 million at the beginning of 2007 to a current balance of $6.3 million at the end of 2010. From 2007 through 2010, a total of $20.2 million was transferred to the Utility Capital Improvement Fund to finance budgeted capital project expenses. These transfers represent approximately 34 percent of total Storm and Surface Water Utility expenses for the 4-year period.

**Table 11-1. Current financial status of the Storm and Surface Water Utility, 2007 through 2010.**

| | Storm and Surface Water Utility Revenues, Expenses, and Reserve Balances by Year | | | |
|---|---|---|---|---|
| | 2007 | 2008 | 2009 | 2010 |
| **BEGINNING FUND BALANCE** | $ 4,478,846 | $ 5,632,163 | $ 6,850,853 | $ 7,019,340 |
| **ANNUAL REVENUES** | | | | |
| Storm Rate Revenues | $ 12,559,724 | $ 13,908,507 | $ 14,392,891 | $ 15,541,959 |
| Interest Earnings | 259,119 | 226,405 | 131,258 | 84,675 |
| Other Revenues | 1,197,154 | 1,143,426 | 909,196 | 960,792 |
| Sub-Total | $ 14,015,997 | $ 15,278,338 | $ 15,433,345 | $ 16,587,426 |
| **ANNUAL EXPENDITURES** | | | | |
| Personnel Expense | $ 4,203,392 | $ 4,334,199 | $ 4,535,404 | $ 4,606,455 |
| Other O&M Expense | 3,861,308 | 3,900,253 | 4,280,101 | 5,986,433 |
| Capital Outlay | 15,957 | 521,184 | 174,569 | 140,239 |
| Transfers to Capital Project Fund | 3,758,844 | 4,412,944 | 5,605,006 | 6,434,100 |
| Debt Service Expense | 1,023,179 | 891,067 | 638,190 | 96,379 |
| Sub-Total | $ 12,862,680 | $ 14,059,648 | $ 15,233,270 | $ 17,263,606 |
| **ENDING FUND BALANCE** | $ 5,632,163 | $ 6,850,853 | $ 7,050,928 | $ 6,343,160 |

Note: The difference between the 2009 Ending Fund Balance and the 2010 Beginning Fund Balance is due to an accounting adjustment of investment value to current market value.

As of March 2011, there were 30,681 storm and surface water accounts. Accounts are billed at different rates depending on the intensity of development on the lot (Table 11-2). Some lots have more than one intensity type. Therefore, the total number of accounts when listed by intensity type, as in Table 11-2, is higher than the actual number of storm accounts.

**Table 11-2. Number of customer accounts receiving storm and service water services.**

| Intensity Type | Developed Surface Area | Number of Accounts by Intensity Type[1] |
|---|---|---|
| Undeveloped | 0% | 1,983 |
| Lightly Developed | 0-20% | 10,403 |
| Moderately Developed | >20-40% | 17,410 |
| Heavily Developed | >40-70% | 1,430 |
| Very Heavily Developed | Over 70% | 917 |
| Wetlands | Not developable | 431 |

[1] The total number of accounts is 30,681, but some accounts have more than one intensity type on the same account.

## Current Debt Status

As listed in Table 11-3, the Utilities Department currently has two outstanding Public Works Trust Fund Loans. The Utilities Department does not have any outstanding bonds as of December 31, 2010.

**Table 11-3. Outstanding State Public Works Trust Fund Loans**

| | Storm and Surface Water Utility Debt Outstanding as of December 31, 2010 | | | |
|---|---|---|---|---|
| | Issue Date | Original Debt Issued | Debt Outstanding 12/31/2010 | Final Maturity Date |
| DCTED P/W Trust Fund Loan #91-011 | 8/6/1991 | $377,100 | $39,915 | 8/6/2011 |
| DCTED P/W Trust Fund Loan #91-005 | 7/1/1993 | $135,172 | $28,043 | 7/1/2013 |

## Credit Worthiness

While they operate independently, the City’s water, sewer, and storm and surface water utilities officially merged in 1980 into one combined “Waterworks Utility” for financial reporting purposes. This action has allowed the individual utilities to issue bonds at more favorable interest rates by presenting their combined financial resources and revenue generating capability as related debt security. Bonds issued by the Waterworks Utility, although primarily related to storm and surface water capital financing needs in recent years, have earned very positive evaluation of credit worthiness by bond rating agencies. This credit rating was based on factors that include the financial position, reserve levels, and ratio of net annual operating revenues to annual debt service payments (that is, debt service coverage) for the three utilities as a whole. The Waterworks Utility currently has a bond rating of “Aa2” from Moody's Investors Service. Ratings at this level indicate a strong degree of confidence by the rating agencies in the ability of the City’s utilities to repay related debt obligations. The Waterworks Utility has no immediate plans to issue additional debt. However, if this action becomes necessary, the Utility can expect a proposed bond issue to receive a similarly favorable credit rating and, therefore, to sell at lower interest rates than would otherwise be possible.

A comparative balance sheet and operating statement for the Waterworks Utility for the 8-year period from 2003 through 2010 is provided in Table 11-4.

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**Table 11-4. Combined financial information for 2003 through 2010 for the Waterworks Utility, which includes Water, Wastewater, and Storm and Surface Water.**

| | Waterworks Utility Combined Operating Statement (Years Ending December 31) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
| **REVENUES** | | | | | | | | |
| Service Revenues | $60,533,156 | $64,129,713 | $67,862,886 | $77,344,598 | $78,128,024 | $80,030,441 | $86,860,520 | $91,483,907 |
| Interest/Other Revenues | 6,406,069 | 4,168,085 | 3,649,460 | 4,779,771 | 6,261,777 | 5,675,437 | 4,716,818 | 6,411,782 |
| Total Revenue and Income | $66,939,225 | $68,297,798 | $71,512,346 | $82,124,368 | $84,389,801 | $85,705,877 | $91,577,338 | $97,895,689 |
| **OPERATING EXPENSES** | | | | | | | | |
| Personnel Expense | $10,168,027 | $10,954,580 | $11,121,520 | $12,267,628 | $13,040,665 | $13,911,686 | $14,980,544 | $15,322,746 |
| Other O&M Expenses | 44,506,204 | 44,883,523 | 46,372,261 | 53,997,330 | 51,659,904 | 50,910,233 | 55,374,568 | 64,672,609 |
| Capital Outlay | 995,171 | 594,264 | 541,132 | 532,069 | 56,765 | 1,114,231 | 545,612 | 642,214 |
| Transfers to Capital Project Fund | 6,642,400 | 8,079,632 | 10,888,285 | 11,703,928 | 12,681,468 | 18,055,863 | 22,523,603 | 20,923,164 |
| Debt Service Expense | 1,411,090 | 1,364,773 | 1,441,147 | 1,292,783 | 1,055,039 | 922,632 | 669,460 | 127,354 |
| Total Operating Expenses | $63,722,891 | $65,876,772 | $70,364,346 | $79,793,738 | $78,493,841 | $84,914,645 | $94,093,789 | $101,688,088 |
| **AVAILABLE FOR DEBT SERVICE** | $14,836,535 | $15,673,013 | $17,287,901 | $19,174,611 | $23,565,028 | $24,664,270 | $25,466,211 | $23,856,286 |
| **ACTUAL DEBT SERVICE** | $1,411,090 | $1,364,773 | $1,441,147 | $1,292,783 | $1,055,039 | $922,632 | $669,460 | $127,354 |
| **DEBT SERVICE COVERAGE** | 10.51 | 11.48 | 12.00 | 14.83 | 26.73 | 0.86 | 38.04 | 187.32 |

## Financial Outlook

Table 11-5 presents a projection of annual Utilities Department revenues, expenses, and fund balances for the next 8 years, based on the 2010 amended budget amounts and changes expected to occur in various categories over the subsequent 7-year period as a result of new customers, general inflation, and other related factors. This type of forecast is routinely used by utility staff to develop rate adjustment proposals and to assess the impact of changing budget assumptions on future rate requirements.

Some key assumptions used to forecast future annual revenues and expenses that appear in Table 11-5 are outlined below:

1. Growth in total Storm and Surface Water Utility customers will average 0.2 percent per year in 2011 through 2018, based on historical averages.
2. Interest and other revenue sources will grow by an average of 2.4 percent per year, based on historical trends and projected fund balances.
3. Personnel costs will increase annually by 3.6 percent per year, based on average historical trends and projected increases in benefit costs.
4. Other operations and maintenance and capital outlay expenses will increase annually by 3.3 percent, based on historical trends and projected increases in the Seattle Consumer Price Index for All Urban Consumers (CPI-U).
5. Annual debt service expense will equal scheduled payments for current outstanding loans.
6. Storm and Surface Water Utility rate increases are projected each year from 2013 through 2018 to cover the cost of local program operations.

## Funding Plan For The Capital Investment Program

Table 11-1 and Table 11-4 showed the estimated funding needs of capital improvement activity recommended in this Storm and Surface Water System Plan. Transfers to the capital improvement fund included in Table 11-5 and Table 11-6 represent anticipated funding needs and projected expenses for projects in the current (2011 through 2017) Capital Investment Program (CIP) Plan, and they will be updated to reflect the recommendations cited in this plan for future budget and rate projections. Potential means of funding these recommendations include reallocating funds from other lower priority projects identified in the CIP Plan, obtaining low-interest public works trust fund loans for projects satisfying necessary eligibility requirements, obtaining grants, adopting additional Storm and Surface Water Utility rate increases to provide additional resources for capital project support, or using funds from the Renewal and Replacement Account for eligible projects (see next section).

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**Table 11-5. Financial forecast information for the Storm and Surface Water Utility.**

| | Storm and Surface Water Utility Forecasted Revenues, Expenses, and Fund Balances by Year | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 2010 Amended Budget | 2011 Forecast [1] | 2012 Forecast | 2013 Forecast [2] | 2014 Forecast | 2015 Forecast | 2016 Forecast | 2017 Forecast |
| **BEGINNING FUND BALANCE** | $6,023,682 | $5,060,360 | $4,690,358 | $3,922,969 | $3,838,230 | $3,926,702 | $3,431,019 | $3,530,848 |
| **ANNUAL REVENUES** | | | | | | | | |
| Storm Rate Revenues | $15,241,988 | $15,769,280 | $16,309,776 | $18,226,450 | $19,966,164 | $21,537,084 | $23,206,476 | $25,481,540 |
| Interest/Other Revenues | 1,744,624 | 1,150,268 | 1,164,322 | 1,167,400 | 1,200,487 | 1,240,899 | 1,262,171 | 1,305,639 |
| Subtotal | $23,010,294 | $21,979,908 | $22,164,456 | $23,316,818 | $25,004,882 | $26,704,685 | $27,899,666 | $30,318,026 |
| **ANNUAL EXPENDITURES** | | | | | | | | |
| Personnel Expense | $5,019,689 | $5,126,075 | $5,305,546 | $5,494,619 | $5,690,436 | $5,893,239 | $6,103,276 | $6,320,805 |
| Other O&M Expenses | 4,596,059 | 4,695,896 | 4,766,203 | 4,880,608 | 5,132,724 | 5,379,700 | 5,639,174 | 5,944,390 |
| Capital Outlay | 1,005,028 | 660,691 | 895,149 | 303,088 | 277,786 | 871,192 | 256,340 | 239,645 |
| Transfers to Capital Project Fund | 6,434,100 | 6,779,101 | 7,550,636 | 8,793,123 | 9,977,234 | 11,129,534 | 12,370,029 | 13,793,819 |
| Debt Service Expense | 92,827 | 27,787 | 7,291 | 7,151 | - | - | - | - |
| Subtotal | $17,147,703 | $17,289,550 | $18,524,825 | $19,478,588 | $21,078,180 | $23,273,666 | $24,368,818 | $26,298,659 |
| **ENDING FUND BALANCE** | $5,862,591 | $4,690,358 | $3,639,631 | $3,838,230 | $3,926,702 | $3,431,019 | $3,530,848 | $4,019,367 |

[1] The beginning fund balance in 2011 does not equal the budgeted ending fund balance in 2010 because of higher than budgeted revenues and/or savings during the last biennium and 2010 capital expenditures delayed until 2011.

[2] The beginning fund balance in 2013 does not equal the budgeted ending fund balance in 2012 because it includes projected 3% under-expenditures for other operating expenses less capital for 2011 and 2012. Not recognizing this historical under-expenditure percentage would cause future rate projections to be overstated.

**Table 11-6. Capital Investment Program (CIP) funding status for storm and surface water projects, 2011 through 2017.**

| | Storm and Surface Water Utility CIP Funding Status | | | | | | |
|---|---|---|---|---|---|---|---|
| | **2011** | **2012** | **2013** | **2014** | **2015** | **2016** | **2017** |
| **RESOURCES** | | | | | | | |
| Transfers from Operating Budget | $3,407,964 | $5,707,154 | $6,140,460 | $3,639,477 | $3,957,547 | $4,306,818 | $4,779,045 |
| Grants | 836,000 | 345,000 | 345,000 | 345,000 | 345,000 | 345,000 | 345,000 |
| Interest Earned | 14,891 | 6,145 | 6,145 | 6,145 | 6,145 | 6,145 | 6,145 |
| **TOTAL RESOURCES** | $4,258,855 | $6,058,299 | $6,491,605 | $3,990,622 | $4,308,692 | $4,657,963 | $5,130,190 |
| **APPROVED PROJECTS BY CATEGORY** | | | | | | | |
| Flood Hazard | $833,027 | $850,454 | $870,329 | $890,484 | $903,465 | $925,773 | $948,998 |
| Drainage System Rehabilitation | 1,321,840 | 3,649,318 | 3,797,662 | 1,027,172 | 1,071,913 | 1,114,729 | 1,159,308 |
| Water Quality | 1,092,894 | 436,712 | 550,901 | 656,630 | 761,705 | 881,876 | 1,061,037 |
| Resource Habitat Management | 981,094 | 1,091,814 | 1,242,713 | 1,386,336 | 1,541,609 | 1,705,586 | 1,930,847 |
| Other | 30,000 | 30,000 | 30,000 | 30,000 | 30,000 | 30,000 | 30,000 |
| **SUBTOTAL COMMITTED EXPENSES** | $4,258,855 | $6,058,299 | $6,491,605 | $3,990,622 | $4,308,692 | $4,657,963 | $5,130,190 |

**Funding for the Infrastructure Renewal and Replacement Program**

The Renewal and Replacement (R&R) reserves were established by the City Council in 1995 to better position the City for the future by planning for the inevitable replacement of the constructed utility systems basic to the City's health and economy.

- The Utilities Department has assets with a replacement value of over $3.5 billion in 2010 dollars, and about half of this aging infrastructure is past mid-life.
- Aging infrastructure is one of the biggest drivers of utility costs; reactive response to aging infrastructure is expensive and very disruptive to customers.
- Accumulating R&R reserves in a measured way to pay for the proactive replacement of aging systems before they fail ensures that customers would continue to enjoy reliable, unobtrusive delivery of the most basic and critical services, protects customers from rate spikes, preserves financial flexibility and credit worthiness, and ensures each generation of customers pays for the utility systems they will use.
- Reliable infrastructure is one of the foundations of economic competitiveness and growth. Managing reserves that fund the replacement of that infrastructure in a deliberate, fiscally prudent manner supports continued economic viability and creates financial sustainability.
- R&R reserves ensure that the Utilities Department is financially prepared to respond to emergency events.
- Use of R&R reserves is governed by state law and the Utilities financial policies (established by City Council resolution in 1995; see Chapter 4 Policies).

R&R needs are projected using asset management data to determine the timing and estimated cost of replacing systems over time. Annual revenues set aside for infrastructure replacement are based on projected replacement cash flow needs over a 75-year forecast period less projected interest earnings. In early years, annual contributions from rates are somewhat higher than projected annual capital replacements, thereby building up capital reserves. Contributions from rates continue at a fairly smooth pace, essentially increasing to cover inflation such that all ratepayers are paying roughly the same amount in today's dollars. On or about 2040, when annual capital replacement costs are expected to exceed the annual rate of contributions, sufficient reserve balances will have accumulated to cover the gap between revenues and expenses (Table 11-7).

**Table 11-7. Current and projected renewal and replacement (R&R) fund balances for replacement of aging infrastructure.**

| R&R Fund | Current Balance in 2011 | Projected Balance in 2040 |
|---|---|---|
| Storm and Surface Water | $16.2 Million | $305 Million |
| Water | $24.4 Million | $113 Million |
| Sewer | $38.8 Million | $462 Million |

Money is contributed to the R&R fund each year through rates, interest earnings, connection charges, and unplanned revenues. Like a retirement account, the interest earnings that will accumulate over time are significant, and are a key part of the planned funding for renewal and replacement of infrastructure. For example, as shown in Figure 11-1, in the Storm and Surface Water R&R fund over 30 years, 78.3 percent will be funded by rates, 21.0 percent by interest, and 0.7 percent by connection charges.

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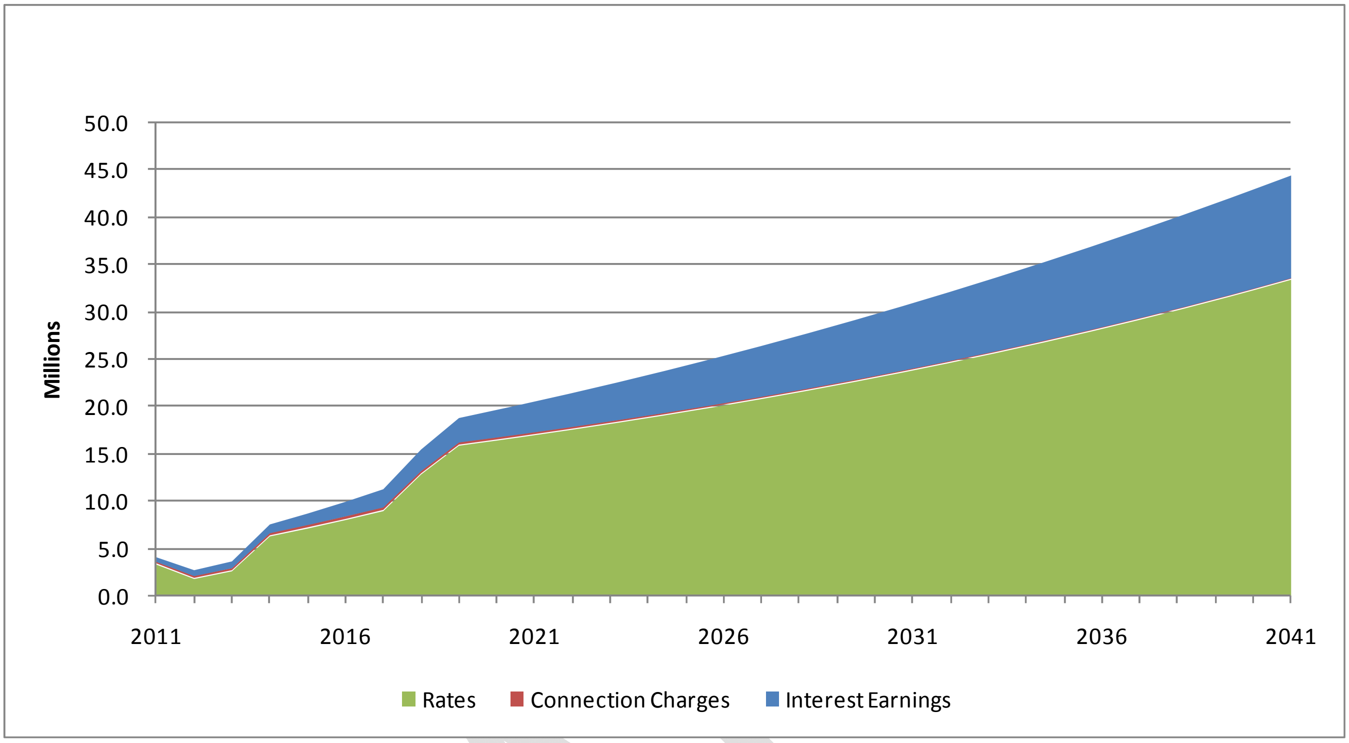


**Figure 11-1. Storm and Surface Water Utility R&R Funding**

The use of R&R funds are restricted by law. By state law, utility funds must be used for utility purposes. In accordance with the City Council-adopted financial policies (see Chapter 4 Policies), the funds accumulated in the R&R Account must be used for system renewal and replacement as identified in the CIP Plan. Because these funds are invested, they may be loaned for other purposes provided repayment is made consistent with the needs for those funds and at appropriate interest rates.

Bellevue's R&R approach ensures rate stability, inter-generational equity, and the ability to minimize debt. Bellevue's utility rates, which include annual contributions to the R&R fund, are competitive with those of neighboring jurisdictions that do not have comparable R&R funding plans in place. In the future, Bellevue's rates will be even more competitive as its neighbors' capital needs grow and their rates increase or they rely more heavily on debt. Bellevue's R&R reserves ensure that the City is prepared to meet the high cost of infrastructure replacement as the system continues to age.

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# CHAPTER 12 ADAPTIVE MANAGEMENT

The Bellevue Utilities Department is an enterprise utility committed to providing excellent customer service in a timely manner at a reasonable cost. To achieve this goal requires employing continual improvement processes on a wide range of information and data management, and evaluating fiscal, operational, and environmental processes.

Adaptive management is the systematic use of information to improve operations, especially in the face of uncertainty. The concept is common in business practices, such as General Electric's "Six Sigma," as well as conservation planning, such as The Nature Conservancy's "Open Source." These two examples have been used by multiple governments, businesses, and non-profit organizations. While most business sectors use some type of system to determine actions, adaptive management is a focused, systematic approach to improve future work by learning from the outcomes of implemented actions. Establishing an intentional learning environment allows an organization to move forward in an uncertain environment, establish reasonable expectations and timeframes, as well as reduce the risk of misdirected actions and funding.

In a 2002 National Association of Flood and Stormwater Management Agencies (NAFSMA) discussion paper about a National Academy of Sciences (NAS) report, the uncertain nature of stormwater management was articulated.

> The NAS report states that this "reality of uncertainty in water quality management" is a fact that must be acknowledged and addressed. It derives from "our incomplete (system) knowledge or lack of sufficient data to estimate probabilities," and the "inherent variability of natural processes." As noted in the NAS report, "we are limited by incomplete conceptual understanding of the systems under study, by models that are necessarily simplified representations of the complexity of the natural and socioeconomic systems, as well as by limited data." Further that "not only are waterbodies, watersheds, and their inhabitants characterized by randomness, but they are also open systems in which we cannot know in advance what the boundaries of possible (biological, for example) outcomes will be."

The key elements are usually condensed into an ongoing, cyclical process, as illustrated in Figure 12-1. Adaptive Management Concept.

An example to illustrate the adaptive management concept follows. A utility company has a goal of no street flooding of primary emergency routes. An assessment might find that flooding existed at one location. Staff would identify (hypothesize) whether the flooding was due to conveyance capacity, insufficient upstream detention, frequently obstructed storm drains, or other causes. If there was not a clear answer to the question, multiple options, including additional studies, would be considered. There are many factors in choosing the appropriate action plan, including the relative cost, likelihood of success, and other elements (economic, social, environmental) of a triple-bottom-line analysis, as discussed in Chapter 8 Asset Management. Action plans would then be designed towards the most likely stressor, such as re-engineering a storm drain to reduce leaf blockages or installing a high-flow bypass system. The chosen action would be implemented and street flooding would be monitored. An evaluation would determine if the chosen action resolved the problem. If the primary street flooding was resolved, then the goal may be reviewed and could be maintained or revised to include no street flooding of secondary emergency routes, depending on the desired level of service. Then the process would start again.

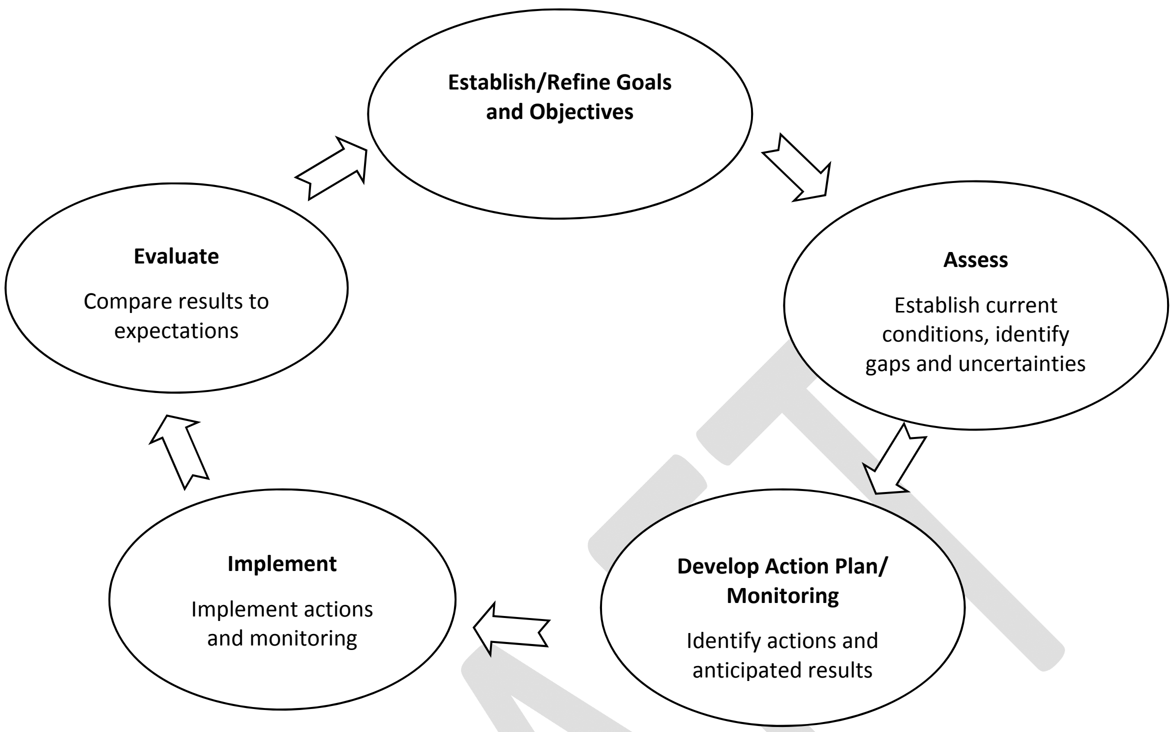


**Figure 12-1. Adaptive Management Concept.**

The adaptive management process can be applied at any scale from budget processes to individual projects to overall stormwater management programs. Adaptive management is a systematic process that identifies uncertainties, monitors results, and informs actions. A formalized program that clearly articulates the uncertainties and monitors results reduces the risk of errors and allows programs to move forward in the face of uncertainty.

## Bellevue Utilities Department Monitoring and Adaptive Management Programs

The Bellevue Utilities Department is an entrepreneurial institution that expects staff at all levels to review and evaluate data for program effectiveness and efficiency on a regular basis. Some of these adaptive management programs are briefly described below.

### *APWA Accreditation Process*

The Utilities Department voluntarily participates in a review and accreditation process for public works programs by the American Public Works Association (APWA); it received its first certification in 2004, demonstrating that the Utilities was compliant with industry best practices. The department was reviewed and recertified in 2007 and 2011.

#### Financial Review and Bond Ratings

As described in Chapter 11 Financial Information, the stormwater management financial program undergoes rigorous reviews every 2 years as part of the City's budget process. The Utilities Department has financial reviews through Moody's Investors Service, which establishes bond ratings. Customer views of the quality and value of the Utilities services are also rated during the budget process to ensure that the types of services and costs are meeting customer expectations.

**Capital Investment Program Plan Biennial Review Process**

The Capital Investment Program (CIP) Plan (see Chapter 9 Utilities Operations) comprises individual projects and programs that are identified through system evaluations related to the public stormwater system operations regarding flooding, water quality, and habitat. These programs are operated on a 7-year basis with capital program review occurring every 2 years in off-budget years to inform the budget process. The capital programs review the goals and objectives of each program, evaluate current conditions and needs, develop project lists and preliminary budgets, and then review the action plan with the Environmental Services Commission (ESC) for recommendation for approval to the City Council as part of the budget process. Individual project designs utilize a team approach for triple-bottom-line evaluation of best solutions. CIP projects for streams typically have permit conditions requiring a 5-year monitoring plan for plant survivability. While the effectiveness of individual projects is evaluated in the larger system assessment for flooding, water quality, and stream habitat, there is currently no formal process for adaptive management for specific capital project design elements, such as which plants have the best survival rate or which design for improving fish passage has the least impact for maintenance. An adaptive process to evaluate individual design elements should be considered to improve success and reduce the application of ineffective designs.

**Asset Management Program**

As described in Chapter 8 Asset Management, Bellevue's asset management program is a formalized adaptive management program that is reviewed every 5 years. The program acknowledges that the assessment phase of adaptive management is currently a challenge because only approximately 25 percent of the piped system's installation date is known and about 2 percent of the pipes is inspected annually. However, the asset management approach utilizes all available information to make recommendations for capital projects and funding; moreover, it works to gather the more critical information based on known conditions of different types of materials, clearly articulated assumptions of life cycle expectations, and risks of catastrophic pipe failure. As additional information is gathered, the assumptions are reviewed and inspection rates or replacement expectations can be changed.

**Program Evaluation**

Performance measures have been developed to formally set goals and evaluate the effectiveness and efficiency of individual programs throughout the Utilities Department. Performance measures are used for operational decision-making, evaluating whether program objectives are being achieved, helping plan the priorities and best uses of resources, aligning budgets with program needs, providing accountability about how well a program is operating over time, facilitating communication among different levels of management, and providing a framework for the Utilities Department's strategic planning and goal-setting processes. Each program administrator is responsible for maintaining records and reviewing data against program goals. Program evaluation processes occur at different time scales depending on the program, though many measures are reviewed annually.

Each of the adaptive management programs within the Utilities Department described above are designed to promote ongoing improvements in services and a general atmosphere of engaged learning by staff at all levels in the department.

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## Bellevue Monitoring Programs

In addition to the formal adaptive management programs, there are monitoring programs in place to provide information to guide these larger adaptive management programs.

Various monitoring programs and analysis and communications tools support the Utilities Department in managing the storm and surface water system (see Chapter 9 Utilities Operations). Monitoring programs involve collecting and analyzing information about stormwater system performance for efficient operations, to quantify system capabilities, and to identify system problems or deficiencies. Computer models of the storm and surface water system are developed, maintained, and used to map and predict flooding. The models allow accurate assessment of the system's ability to accommodate scenarios such as planned population growth or changed land uses; these data are then made available for basin or comprehensive planning. Computer models and trend analyses rely on up-to-date, accurate information. Data about facilities are provided by the Operations and Maintenance Division and analyzed by Engineering Division staff. Physical, chemical (water quality), and biological information about streams are collected for analysis of fish use, environmental health, and beneficial uses of surface waters such as fishing and swimming.

***Telemetry and Hydrologic Systems***

As discussed in Chapter 9, the Telemetry and Supervisory Control and Data Acquisition (SCADA) equipment are automated systems used to remotely monitor surface water elements such as precipitation, flow rates, and water level elevations. These systems allow staff to operate and regulate the gate settings at the regional detention facilities for stormwater based on current conditions. Telemetry and SCADA equipment warns in real time when systems are operating outside normal parameters, alerting staff so they can make manual adjustments. Currently, 12 stormwater structures and 11 rain gauges are monitored remotely using telemetry equipment.

Monitoring of rainfall and stream flows is critical to stormwater management and is used to inform emergency response, facilities operations, system evaluation, and capital investments. The hydrologic monitoring program serves both long-term and short-term objectives of the Utilities Department. Long-term hydrologic monitoring needs include planning, conducting ongoing operations, evaluating field safety, and monitoring trends such as climate change. Generally, a record of up to 50 years or more is needed for effective long-term hydrologic monitoring. Long-term records are often used for calibrating models for specific projects, such as basin studies or CIP Plans, and for providing data for statistical stream flow forecasting. Short-term needs generally encompass less than 5 years, which include using temporary flow gauges to plan and design CIP projects or guide operation of facilities with adjustable outlets. Short-term monitoring systems may be moved or abandoned depending on project need. The complete Hydrologic Monitoring Plan is provided in Appendix B-11.

Rainfall and flow monitoring is done at multiple sites across the city to address differences in elevation, stream size, and land use, as well as to facilitate operational needs. These data are also important when combined with other regionally collected data to recognize data trends, such as increased intensity of rainfall. If long-term climate change impacts are anticipated, the Utilities Department could consider changing development standards or constructing capital projects to reduce flooding risks.

The Water Supply Forum of Snohomish, King and Pierce Counties comprises regional public water systems purveyors, including the Cascade Water Alliance. In 2009, the Forum published the Water Supply Outlook report that evaluated municipal water demand through 2060. The report also considered uncertainties associated with water supply, including the implications of Climate Change on snow pack, stream flows, and precipitation intensity (Water Supply Forum 2009). The Utilities

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Department will monitor information provided by the Forum as a basis for adapting its stormwater management program in response to climate change.

***Operations and Maintenance***

Maintenance programs monitor many facilities for improved operations and maintenance, such as the sediment levels of catch basins or flood storage capacity at regional detention facilities. These are project-specific efforts that are reviewed and modified as part of a continual improvement process for both effectiveness and efficiency of field operations. Many of these monitoring efforts are articulated in performance measures and some are required through the National Pollutant Discharge Elimination System (NPDES) Permit. These monitoring efforts are anticipated to increase in response to future permits. New technology, such as rain gardens or pervious pavement, currently has limited information on maintenance requirements. It is recommended that ongoing monitoring programs that evaluate these new technologies be implemented to inform future maintenance practices and design considerations.

**Illicit Discharge Detection and Elimination and Water Quality**

As discussed in Chapter 9, the Utilities Department performs water quality monitoring to detect and eliminate pollutant sources discharging to the municipal stormwater system; to investigate water quality issues and reports of pollutant spills; to determine long-term water quality trends in a few water bodies; and, as needed, to inform management actions. The IDDE Program also includes locating and mapping drainage outfalls, preparing documentation, and providing City-wide support for illicit discharge training and response.

The Utilities Department has conducted and/or participated in numerous storm and surface water quality monitoring studies. These studies have included comprehensive characterization investigations of urban stormwater quality, water body-specific monitoring studies, and assessments of effective best management practices (BMPs). Water quality studies are expensive. The Utilities Department uses studies strategically to identify options to address specific water quality issues and inform management actions to adaptively manage programs over time, resulting in improved water quality protection and reduced pollutant discharge to the storm and surface water system.

The Utilities Department conducts summer nutrient and water clarity monitoring in Phantom and Larsen Lakes to determine the continued effectiveness of a reduction in phosphorus. This information is incorporated into systems analyses and capital program reviews, but stable conditions over the last 10 years have not indicated a need for management changes.

In the next 5-year NPDES Phase II Municipal Stormwater Permit (2012 to 2017), the City anticipates the Washington State Department of Ecology (Ecology) will require Phase II municipalities, including Bellevue, to implement storm and surface water quality monitoring. These new monitoring requirements and implementation options are still being developed with the sponsorship of Ecology.

The Puget Sound Partnership and Ecology recommend three types of regionally coordinated monitoring efforts be included in municipal NPDES permits to assist with stormwater adaptive management:

1. Status and trends monitoring to identify changes that affect beneficial uses of surface water over time;
2. Effectiveness monitoring to determine improvements in municipal stormwater management activities; and
3. Source control monitoring to determine more efficient and effective methods of detecting and eliminating pollution.

Each of these monitoring components is anticipated to be formally incorporated into adaptive management programs in local management efforts and into future municipal NPDES permits.

**Environmental Indicators**

Monitoring streams, small lakes, and aquatic life provide data to determine progress towards the overall stormwater vision and help guide or evaluate capital investment projects that affect stream habitat and fish passage.

The Utilities Department plays a major role in maintaining and monitoring aquatic habitat in areas with the conditions to support aquatic life, as discussed in Chapter 5. The number and type of animals living in streams are a good indication of the relative condition of the streams. Biological information about streams collected by the Utilities Department includes surveys of spawning salmon in the fall; summer fish use of streams; annual sampling of benthic macroinvertebrates (the "bugs" that live in the stream gravels and can be seen with the naked eye) from streams; and peamouth minnow spawning surveys each spring. Staff, professional consultants, and volunteers collect biological information that is used to assess the environmental health of Bellevue's open streams.

Aquatic benthic macroinvertebrates, resident fish, and spawning salmon populations are considered an indicator of aquatic health because the diversity and types of organisms reflect the water quality and physical habitat conditions of the stream over the course of their life span. Water quality samples can reflect the condition of the water only at the time of sampling and for the pollutants that were analyzed. While aquatic benthic macroinvertebrates cannot provide specific information on the types of pollutants that may be present, they can indicate general influences, such as toxics, sediment, or water temperature that have biological significance over the course of their aquatic life.

Summer fish populations provide indications of water temperature and physical habitat conditions typically relating to spring and summer conditions. Decreased or absent trout, sculpin, or juvenile coho populations in summer sampling can indicate increased temperature, loss of in-stream pool habitat, increased heavy metals, or significant water quality concerns. Both aquatic macroinvertebrate and summer fish populations respond to local habitat conditions and are not directly linked to outside influences such as harvest or ocean conditions.

Spawning salmon surveys, while influenced by outside influences, provide direct information about fish passage through culverts, as well as indications of physical habitat conditions. Salmon spawning surveys provide information about habitat conditions during the fall and winter, including late summer water temperature, flows, fine sediment, and stream stability. Using the aquatic indicator information as a whole helps to determine the types of projects and sequencing of stream projects that would best support aquatic life. For instance, increasing the complexity of habitat with large woody debris could help areas that spawning salmon or aquatic macroinvertebrates indicate have been affected by fine sediment. Salmon spawning surveys provide direct evidence whether salmon are utilizing habitat created through CIP or basin improvements in flow or sediment. While monitoring the number of successful juveniles from those spawning adults would provide a direct measure of habitat health and the success of salmon habitat improvements, aquatic benthic macroinvertebrates have been used as a less expensive surrogate.

Because environmental indicators are instrumental in evaluating aquatic habitat conditions and informing where stream CIP projects should be constructed, it is recommended that the Utilities Department do the following:

- Continue to conduct salmon spawning surveys;
- Continue to collect macroinvertebrate data;

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- Start to collect in-stream habitat data for large woody debris structures and in-stream pools;
- Stay current on research evaluating the effectiveness of stream habitat standards that guide CIP Plan design; and
- Develop a program for ongoing review of previously constructed CIP open-stream projects to inform future design strategies.

***Monitoring Data from Outside Entities***

Information collected and analyzed by outside entities is also used for adaptive management programs within Bellevue.

**King County**

City of Bellevue swimming beaches are monitored by King County. If bacteria are detected above certain levels, the information is used to close beaches for public safety and initiate source control investigations. Beaches are reopened after King County monitoring shows improved water quality and public safety is ensured.

King County has conducted water quality monitoring in a number of Bellevue streams for status and trends of surface waters. These data are incorporated into systems analyses, such as the state of the system, and county performance measures for environmental quality (see Chapter 6 Current Conditions – State of the Storm and Surface Water System).

**Lake Washington/Cedar/Sammamish Watershed (WRIA 8) Salmon Recovery Program**

The regional salmon recovery program in Water Resource Inventory Area (WRIA) 8 began conducting status and trends sampling in Kelsey and Coal Creeks for aquatic macro-invertebrates, summer fish populations, and physical habitat conditions in 2009. Bellevue uses these regional data sets for environmental indicator analyses rather than conducting local monitoring in those major stream reaches.

**Washington State Department of Ecology**

Ecology works with local governments to conduct special investigations into water quality related to streams and lakes that have been identified as having impaired water quality. This monitoring is associated with establishing Total Maximum Daily Load (TMDL) allocations as directed under the Clean Water Act. Currently, Bellevue is not engaged in any TMDL investigations, but Ecology has stated that investigations may be required within the next several years for at least one and maybe more of the five drainage basins identified in 2008 as having some water quality impairments (see Chapter 6).

Ecology also manages the Technology Assessment Protocol - Ecology (TAPE) program that screens and evaluates new technologies for stormwater management. This program provides research and monitoring of best management techniques for approved use in stormwater management and land use development activities.

## Future Direction

Adaptive and data-driven management is gaining greater momentum at all levels of government to show the responsible use of public funds and that the funds are being used efficiently and effectively. Bellevue continues to develop city-wide programs for more data-driven management as part of its continual improvement processes.

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***Regional and State Initiatives***

State and federal funding sources are increasingly requiring proof that anticipated outcomes are actually occurring. Regional monitoring programs coordinated through the Puget Sound Partnership, Ecology, U.S. Environmental Protection Agency (USEPA), U.S. Geological Survey (USGS), NOAA Fisheries, local governments, and others will provide data to determine whether action plans for cleaning up Puget Sound, recovering endangered species, and reducing impacts from stormwater are working. As previously noted, Ecology and the Puget Sound Partnership have encouraged the development of a regional stormwater monitoring program for Puget Sound. Regional stormwater monitoring can be incorporated into a larger regional ecosystem monitoring program evaluating the health and recovery of Puget Sound.

***Other Drivers for Monitoring and Information***

As technology improvements allow greater opportunities for data sharing, there will likely be increasing demand for increased access to information, such as stream flows, salmon returns, or water quality. The City is currently investigating development of a Sustainable Eastside Web Portal to make environmental information more accessible to the public.

In state and federal processes, such as USEPA standards and rule-making, there has been increasing public demand for transparency of data and decision-making information. It is likely that increasing public disclosure of information and greater ease of access will become part of local government processes as a general protocol to maintain public trust.

The City of Bellevue is developing methods for increased communication among departments. As noted in Chapter 5 Storm and Surface Water Management Roles, Responsibilities, and Communications, there are numerous departments within the City that may want access to data collected by the Utilities Department regarding rainfall, stream flows, salmon utilization, water quality, or surface water.

## Summary

The Utilities Department is committed to continual improvement processes at all levels of operations. As the internal and regional adaptive management programs mature and improve, data needs will be modified and refined. Continued review and evaluation of processes and projects to provide opportunities for increased learning, efficiency, and effectiveness will be an operational expectation. Data and summary information will likely have more broad application and interest in access to information will likely continue to increase.

# CHAPTER 13 EMERGING ISSUES AND PLAN RECOMMENDATIONS

This chapter summarizes storm and surface water emerging issues and major plan recommendations. These recommendations are the result of evaluating the drainage basins using the criteria described in Chapter 7 Summary of Basin Issues and Needs and acknowledging that regional, state, and federal initiatives affect how local jurisdictions implement their stormwater management programs. The approaches to responding and implementing these recommendations are separated into two organizational categories: 1) emerging issues, including regulatory drivers, and 2) the Capital Investment Program (CIP) Plan.

## Plan Recommendations

In general, the programs, policies, and practices implemented since the last systematic review of the Storm and Surface Water Utility, such as new detention regulations or asset management strategies, were aligned with the needs of the system. Recommendations in this chapter represent these higher level recommendations. Recommendations affecting technical projects or programs are included within individual chapters where they are discussed.

## Capital Investment Program

The Utilities Department's Storm and Surface Water CIP Plan is a 7-year spending plan, representing a significant investment of the Utilities' resources to further its mission regarding storm and surface water. The CIP Plan recommendations are organized into four distinct categories for flood control, water quality, fish and wildlife habitat, and asset management.

### *Flood Control*

Bellevue does not have widespread flooding problems, although a few areas of flooding concern remain. Established level of service goals are intended to prevent flooding of structures, flooding that restricts access to residences or businesses, or street flooding, particularly on primary emergency routes. Such flooding events affect public safety and cause property damage. Proposed flood control projects are prioritized based on risk (frequency and consequence of flooding) and are completed as resources are available.

The King County Flood Control District (District) is a special governmental body created to provide funding and policy oversight for flood protection projects and programs in King County. The District is funded by an assessed value tax (11 cent per $1,000) on each parcel in King County. It is charged with providing comprehensive flood protection and provides funding to improve the County's aging and inadequate flood protection facilities. The District has on its CIP list a project to replace five culverts and increase conveyance capacity of Coal Creek in the Newport Shores neighborhood. That project is scheduled to receive District funding beginning in 2014. In addition to its CIP program, the District redirects 1 percent of its funding back to local jurisdictions for sub-regional flood control capital projects. Bellevue uses this funding to supplement local rates to fund its Flood Control Capital Program.

**Flood Control Program Recommendations**

1. Continue investing in the Flood Control Capital Program (D-94). This ongoing program constructs improvements to reduce or eliminate local flooding caused by insufficient public drainage system capacity. Projects involve enlarging pipes or culverts to convey more stormwater, re-routing drainage to pipes with more capacity, adding detention or infiltration facilities, or implementing other runoff control strategies. Areas where levels of service for flood protection are not met are considered candidate sites. Appropriate annual

funding levels should be re-evaluated during each budget update, based on known flooding problems and needs and acceptable risk.

2. Continue to use King County Flood Control Zone District Sub-Regional Opportunity funds to supplement local rates that partially fund projects in the City's Flood Control Capital Program.

***Water Quality***

Water quality concerns identified in the Washington State Department of Ecology (Ecology) list of impaired water bodies (see Chapter 6 Current Conditions - State of the Storm and Surface Water System) are common non-point source pollution issues that are better addressed through programs, such as source control investigations or focused outreach, rather than capital projects. However, capital investments have been made at existing stormwater facilities to improve water quality. For example, at the Valley Creek regional detention facility, a stream diversion was installed to increase the travel time of stream flow through the regional detention facility. Because the facility is also a wetland, the increased travel time allows plants to uptake nutrients and for sediment to be deposited in the detention pond. Another project is a pilot project to determine whether converting a standard detention pond to one with a sand filter bottom would reduce the temperature of water leaving the pond, which flows to Lewis Creek. New technologies are being developed and evaluated at the state and regional levels that may provide additional opportunities for site-specific projects that could improve water quality in areas of concern.

**Water Quality CIP Recommendations**

1. Invest in cost-effective water quality projects, where appropriate.
2. Consider emerging technologies and techniques that improve water quality for pilot projects.

***Fish and Wildlife Habitat***

Aquatic habitat and biological data indicate that streams in Bellevue, like most urban streams in the Puget Sound, are impaired and lack quality habitat (see Chapter 7 Basin Issues and Needs). There is insufficient wood in the streams and there are not enough deep, in-channel pools where fish forage and seek refuge. Macroinvertebrate data also showed impacts of urban impairment.

Barriers to fish migration also exist. The City is required by state law to maintain fish passage at all road crossings (Revised Code of Washington [RCW] 77.57.030). Culverts that are perched high above the stream channel or culverts where the water is too shallow or too fast are examples of fish passage barriers. Removing fish barriers supports the community's vision for fishable waters, and regional efforts to protect and enhance salmon populations.

New urban residential neighborhoods planned for the Bel-Red Corridor require investments in stream restoration and open spaces that support high quality, livable places. Public investment in these improvements will pave the way for pioneer housing development in the transitioning area. Most streams in this historically industrial part of Bellevue flow through pipes under parking lots, roads, and even buildings. Stormwater support from the City's Mobility and Infrastructure Initiative provides funds for restoration of the West Tributary and Goff Creeks (property acquisition by others) and replacement of the fish-blocking culverts on those creeks under Bel-Red Road. The City Council-endorsed Mobility and Infrastructure Initiative provides CIP funds to improve transportation mobility while meeting City goals for a healthy and sustainable environment. The replaced culverts will allow fish access to the newly opened habitat upstream.

The following CIP Plan recommendations are meant to address these issues.

**Fish and Wildlife Habitat CIP Recommendations**

1. Continue to invest in D-81 Fish Passage Improvement Program to remove fish passage barriers created by impassable culverts, debris jams, or accumulated sediment, which opens spawning and rearing habitat for salmon populations. Typical projects include culvert replacement or modification, debris removal, or installation of logs and boulders to channelize low stream flows.

2. Continue to invest in D-86 Stream Channel Modification Program to construct habitat improvements on stream channels. The program increases opportunities for citizens to enjoy fish and other riparian species and reduces the likelihood of localized erosion that can jeopardize structures, cause flooding, and block fish access.

3. Invest in D-104 Stream Restoration for Mobility and Infrastructure Initiative to implement the stormwater improvements associated with this initiative (a city-wide initiative that seeks to address high priority mobility and infrastructure needs in downtown Bellevue and the Bel-Red corridor). Storm funds will be used to open and restore streams for passive recreation and environmental health through the Bel-Red corridor and to encourage redevelopment of the area.

***Asset Management***

Much of the constructed drainage system in Bellevue was built before standards for storm pipe material and construction were in place, so the City has only limited information about when pipes were installed, their size, and composition. The City owns almost 400 miles of stormwater conveyance pipe. Because the attribute data for the conveyance pipeline are so limited, predicting its remaining life is particularly challenging. It is a fundamental assumption of the stormwater asset management program that significant investments will be needed to maintain the system and replace components that are reaching the end of their useful life. In its assessment program, Bellevue uses video technology to assess the condition of the pipeline and to evaluate the constructed elements of the stormwater system; in addition, the City prioritizes where renewal and replacement funds are spent.

The CIP Plan includes several investments identified as necessary to meet critical system infrastructure renewal requirements. It focuses on critical pipes where the consequences of failure would be significant.

The following CIP program recommendations are meant to address aging infrastructure:

**Asset Management Program Recommendations**

1. **Critical Facility Failure**. Continue to invest in capital programs and projects so that critical facilities (e.g., large diameter pipes and culverts) are repaired or replaced prior to failure.
2. **D-64 Stormwater System Conveyance Infrastructure Rehabilitation**. This ongoing program rehabilitates or replaces defective storm drainage pipelines and ditches identified in the condition assessment program or by other means. Projects are prioritized based on the severity of deterioration, the risk and consequence of failure, and coordination with planned street improvement projects. This program provides for repair or replacement of defective stormwater conveyance pipes, culverts, and ditches. It proactively repairs pipes under arterials in advance of street resurfacing, thereby saving costs and minimizing disruption.
3. **D-103 Replace Coal Creek Parkway Culvert at Coal Creek**. Recent inspections revealed the pipe is heavily corroded, with limited remaining structural integrity. Holes in the bottom of the culvert allow water to leak through, threatening the integrity of Coal Creek Parkway and two high-pressure fuel pipelines that are located near the pipe. Engineers estimate the

two high-pressure fuel pipelines that are located near the pipe. Engineers estimate the remaining culvert life at less than 5 years. This project will pre-empt eventual culvert collapse, which would have catastrophic consequences to Coal Creek Parkway and Coal Creek, as well as having a ripple effect throughout the region due to disruption of the fuel pipelines.

4. **D-59 Minor (Small) Storm and Surface Water Capital Improvement Projects**. This ongoing program is for conducting small improvements to Bellevue's surface water system to resolve deficiencies, improve efficiencies, or resolve maintenance problems, often in conjunction with other Bellevue programs such as the transportation overlay program. Projects are prioritized based on criteria including public safety, property damage, maintenance frequency, flooding history, operator safety, environmental risk, coordination with other City or development activity, and level of service impact. The program allows the City to efficiently maintain and upgrade its storm system by coordinating minor improvements with other City projects and maintenance activities.

## Storm and Surface Water Emerging Issues

### ***Management of Stormwater***

As discussed in Chapter 2 Stormwater Management Challenges and Opportunities, Bellevue's management of the storm and surface water system must balance the demand for economic sustainability along with environmental protection. A number of emerging stormwater issues will continue to shape how the resource is managed. As an example, Ecology is proposing to use updates to its Stormwater Management Manual and reissuance of the National Pollutant Discharge Elimination System (NPDES) Permit to require rather than promote, where feasible, on-site stormwater management practices that infiltrate stormwater at its source. Infiltration of stormwater is not a new approach to stormwater management; however, applying the technique at a regional scale (via the NPDES Permit) is, so monitoring its effectiveness and being prepared to make necessary adjustments is the basis of the this Plan's recommendations.

Ongoing stormwater education and outreach informs citizens about stormwater issues and encourages behaviors that protect water quality and reduce runoff. Because most of the land in Bellevue is private property, citizens play a pivotal role in stormwater protection. Education and outreach is needed for common behaviors, such as car washing, yard care, and disposing of pet waste, which can affect water quality as well as natural drainage practices that help control stormwater flow. A variety of outreach methods is needed to reach the general community as well as target audiences depending on the messages and goals.

The following recommendations are in response to the emerging issues related to the management of stormwater.

**<u>Recommendations for Emerging Stormwater Management Issues</u>**

1. Continue to encourage use of emerging low impact development (LID) technologies and collect data on their effectiveness.
2. Continue to educate the public on how to optimize on-site stormwater runoff management.
3. Monitor the effectiveness of structural and outreach programs over time.

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***Puget Sound Partnership***

The Puget Sound Partnership is a community effort of citizens, governments, tribes, scientists, and businesses working together to restore and protect Puget Sound. Governor Gregoire and the Legislature tasked the Partnership with creating an Action Agenda to clean up Puget Sound by 2020. The Legislature intends that all government entities within Puget Sound will exercise their existing authority to implement the applicable provisions of the Action Agenda (RCW 90.71.350). The major focal areas for the Action Agenda are land development, shoreline alteration, runoff from the built environment, wastewater, and loss of floodplain function. The applicable draft Action Agenda items for stormwater management are as follows:

- *Sustain freshwater availability for instream and human uses*.
- *Protect and recover salmon.* Implement the regional salmon recovery plan.
- *Prevent and reduce toxic loadings into Puget Sound.* Work with local governments and others to implement toxic chemical and pollution policy and programs to reduce release of chemicals, provide education and technical assistance, and strengthen authorities and policies to deal with toxic chemicals.
- *Control and manage stormwater.* Use a comprehensive approach to manage urban stormwater runoff at the site and landscape scales; control sources of pollutants; provide focused stormwater-related education and training; and assess the effectiveness of actions and effects on the environment.
- *Issue awareness and understanding.* Implement a regional communications effort to increase public understanding of Puget Sound for local communications efforts; and implement a locally based communications effort to increase public understanding of Puget Sound for local recovery efforts and other social media and school-based awareness campaigns.
- *Changing practices and behaviors.* Provide a science-based foundation for targeted communications and behavior change approaches. Sustain and expand proven and effective local volunteer and stewardship programs that target Action Agenda priorities. Stimulate broad-scale individual stewardship behaviors by integrating messages and technical assistance into existing programs, youth education, adult education, volunteer opportunities, and other programs.
- *Build and use a performance management system.*

<u>**Recommendation for Support of Regional Planning Efforts**</u>

Continue to support regional planning efforts and activities related to water quality, quantity, and habitat consistent with community values and resources.

***Regulatory Drivers***

The NPDES Permit, issued by Ecology, is the basis for regulatory compliance for operating the City's municipal storm and surface water system (MS-4). Ecology will implement the conditions of the permit using a phased approach, which involves using 5-year permit cycles to slowly ramp-up the permit requirements. The City received its first NPDES Permit in 2007; in 2012, Ecology is scheduled to reissue the next 5-year Municipal Stormwater General permit. These permits are anticipated to continue to increase in complexity, cost, and responsibilities.

<u>**Regulatory Driver Recommendation**</u>

Continue to implement the planned NPDES activities described in the City's annual Stormwater Management Program report.

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***Water Quality Improvement Project Process***

Ecology may require projects and programs to improve surface water quality for water bodies identified on the state's list of impaired water bodies (the 303(d) list). The Total Maximum Daily Load (TMDL) or Water Quality Improvement Project process establishes limits on pollutants that can be discharged to a listed water body and still allow state standards to be met. The state's 303(d) list identifies the impaired water bodies located in Bellevue.

**Water Quality Improvement Project Process Recommendation**

Verify the state's list of water quality impairments in Bellevue (303(d) listed water bodies) to determine if existing programs will address identified water quality impairments.

***Regional Water Quality Monitoring***

The City's first NPDES municipal stormwater permit (issued in 2007) requires Bellevue to prepare a comprehensive long-term monitoring program (NPDES Stormwater Management Program, 2011). The permit requirements focus on the characterization of outfall water quality and effectiveness of best management practices required by the permit in improving water quality; however, these requirements will likely be replaced in the second NPDES municipal stormwater permit (anticipated 2013 issuance date) by a regional stormwater monitoring program being developed by the Stormwater Work Group (SWG).

The SWG is a coalition of federal, tribal, state, and local governments, as well as business, environmental, agriculture, and research interests, that was convened at the request of the Puget Sound Partnership and Ecology to develop a Stormwater Monitoring and Assessment Strategy for the Puget Sound Region (including Bellevue). The coalition strategy is to provide a coordinated, integrated approach to quantifying the stormwater problem in Puget Sound and to help stakeholders efficiently and effectively manage stormwater to reduce harm to the ecosystem. The strategy is focused on pollutant source identification, effectiveness of municipal activities and practices, and monitoring the status and trends of receiving water conditions and biota. This regional monitoring program recommended by the SWG would meet individual permit requirements while establishing a comprehensive long-term monitoring program.

**Regional Water Quality Monitoring Recommendation**

Continue to participate in and support the recommendations of the SWG, which provide more meaningful and useful results, are less expensive to implement, and meet multiple objectives, such as Chinook salmon recovery or Growth Management Act directives.

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# APPENDIX A. OVERVIEW OF CURRENT UTILITIES ACTIVITIES IN AQUATIC HABITAT

***City-Wide Leadership Roles***

- **National Pollutant Discharge Elimination System (NPDES) Municipal Stormwater Permit**
  - Coordinate a City-wide organizational structure
  - Implement program and projects associated with the Utilities Department's implementation responsibilities
- **Salmon Recovery**
  - Participating in regional planning efforts
  - Lead City efforts for Endangered Species Act response and planning

***Lakes Washington/Sammamish***

- **Water Quality**
  - City watershed-based water quality programs/NPDES
  - Illicit discharge detection and elimination
    - Spill response
    - Outreach/education on non-point pollution
    - Construction management requirements
    - Development standards
    - Operations and maintenance (treatment and flow control facilities)
    - Private system inspection/maintenance (treatment and flow control)
    - Pollution prevention plans for public facilities
  - Regional Planning—Lake Washington and Sammamish Forums (1995 to 1999) Regional needs assessment process for water quality, flooding, and fisheries issues. The Sammamish Forum was combined into the Lake Washington/Cedar/Sammamish Forum, focused on Chinook salmon recovery.
  - Regional agreement for phosphorus control (Lake Sammamish jurisdictions)
    - Instituted local regulations on erosion control limits
    - Partnered on Lakemont treatment facility
    - Conducted outreach and education
- **Flooding**
  - Emergency response for structural flooding
  - New/redevelopment flow control (watershed based)
  - Monitoring (Lake Sammamish)
  - Floodplain management regulations
- **Habitat/Shorelines**
  - Shoreline vegetation and condition
    - Homeowner native plant and shoreline vegetation workshops and technical assistance (Lake Sammamish)
    - Mercer Slough revegetation volunteer projects
    - Technical assistance and outreach for shoreline vegetation templates
    - Outreach and volunteer efforts for salmon and aquatic habitat (Mercer Slough)
    - Initiator and technical assistance for shoreline armoring GPS inventory

Sockeye studies (Lake Washington jurisdictions)

Funding for research and technical studies

Staff support for technical committees and reporting

Chinook salmon recovery (WRIA 8 jurisdictions)

Implemented local 4(d) rule for roads maintenance

Developed and adopted recovery plan, including capital projects

Kokanee recovery (Lake Sammamish jurisdictions)

Contributed funding and staff for status report

Staff support for technical, management, and workgroup committees

Funding for hatchery incubation project

***Small Lakes (Bellevue, Phantom, Larsen)***

**Water Quality**

Watershed-based water quality programs/NPDES

Illicit discharge detection and elimination

Spill response

Outreach/education on non-point pollution

Construction management requirements

Development standards

Operations and maintenance (treatment and flow control facilities)

Private system inspection/maintenance (treatment and flow control)

Pollution prevention plans for public facilities

Capital projects—Installed water quality facilities/BMPs (for Phantom/Larsen Lakes over $2 million spent)

Facilitated resolution of private and private/public disputes

Provided technical support

Monitoring (Phantom/Larsen Lakes)

Capital projects—Ecology grants project examples

**Flooding**

Emergency response for structural flooding

New/redevelopment flow control (watershed based)

Floodplain management regulations

**Habitat**

Watershed-level educational programs

***Streams***

**Water Quality**

Watershed-based water quality programs/NPDES

Illicit discharge detection and elimination

Spill response

Outreach/education on non-point pollution

Construction management requirements

Development standards

Operations and maintenance (treatment and flow control facilities)

Private system inspection/maintenance (treatment and flow control)

Pollution prevention plans for public facilities

Monitoring (water chemistry [periodic], environmental indicators)

Water quality facilities, sediment ponds (public), stability facilities (weirs, armoring)—construction, operations, maintenance

Capital projects (e.g., 2010 Kelsey Creek bank stabilization, 2005 to 2010 Coal Creek bank stabilization and sediment pond; over $1,600,000 spent)

**Flooding**

Emergency response for structural flooding

New/redevelopment flow control (watershed based)

Regional detention facilities—maintenance, operations

Floodplain management regulations

Capital projects (e.g., East Creek at Kamber Road culvert replacement; over $1,500,000 spent)

**Habitat**

Capital projects (public lands)

Fish passage (required by law)

Stream stability and habitat for water quality and salmon, e.g., 1995 Kelsey Creek channel stabilization, 2006 Richards Creek habitat improvements at Kamber Road; over $700,000 spent

Basin-scale knotweed/invasive weed management; upstream of capital projects

Monitoring

City-wide stream assessment

1996 to 1997 habitat (Kelsey, Valley, Richards, Coal, Newport Tributary)

Macroinvertebrates

Summer resident fish

Salmon spawning

Technical assistance for remote sensing (impervious surface, vegetation)

Planning

Local basin plans

Inter-local plans (Coal Creek)

Endangered Species Act (Chinook, bull trout, kokanee)

City lead for programmatic, capital, education, monitoring

Volunteer restoration activities

Education and outreach— general public, riparian property owners, schools

Technical assistance—Parks, Transportation, Planning and Community Development, Development Services, City Manager’s Office Departments

Technical assistance—streamside private property owners, native plants/erosion/code compliance

***Wetlands***

**Water Quality**

Watershed-based water quality programs/NPDES

Illicit discharge detection and elimination

Spill response

Outreach/education on non-point pollution

Construction management requirements

Development standards

Operations and maintenance (treatment and flow control facilities)

Private system inspection/maintenance (treatment and flow control)

Pollution prevention plans for public facilities

**Flooding**

New/redevelopment flow control (watershed based)

Floodplain management regulations

**Habitat**

Native plant revegetation; general outreach and education

Native plant revegetation; private homeowner technical assistance

**Property Owner**

Invasive weeds management, riparian corridor improvements, etc.

# APPENDIX B. SUPPORTING INFORMATION USED IN THE STATE OF THE SYSTEM EVALUATION

- B-1. Bellevue Stormwater Basin Fact Sheets
- B-2. Impervious Area and Tree Canopy Cover for Drainage Basins and their Stream Buffers in Bellevue, 2007
- B-3. Basin Evaluation by Available Evaluation Criteria
- B-4. Information used to Evaluate Basins, Evaluation Metrics, and Results
- B-5. Count of Flooded Structures from Historic Work Order Database
- B-6. Volume of Storage and Other Characteristics of Bellevue's Public Regional Detention Ponds, Updated in 2009
- B-7. B-IBI Scores at Bellevue Sites in all Sampled Years
- B-8. Lake Washington Average Water Levels Over a Year Based on Daily Measurements (collected at 8:00 a.m.) at the Ship Canal, Measured between 1979 and 1999
- B-9. Sunset Creek Sedimentation Study
- B-10. Rates of Pre-spawn Mortality (PSM) in Kelsey Creek Index Reaches (Kelsey Creek, West Tributary, and Richards Creek) from Fall Salmon Spawner Surveys
- B-11. Hydrologic Monitoring Plan
- B-12. Water Quality in Bellevue's Lakes
- B-13. Pollution Export Coefficients for Bellevue Runoff Based on Samples Collected from 1989 to 1993
- B-14. Total Monthly Rainfall for 1962 and 1999 Measured at Sea-Tac Airport

## Appendix B-1. Bellevue Stormwater Basin Fact Sheets

DRAFT

# Ardmore Area
Lake Washington Watershed (WRIA 8)
State Stream #08-0143

## LAND CHARACTERISTICS
Basin Area: 451 Total Acres ( 2% of the City)
Drainage Jurisdiction(s):
450.4 Acres - in Bellevue
1.0 Acres - in Redmond

Highest Elevation: 442 Ft
Lowest Elevation: 122 Ft

Total Length of Open Channel: 6,132 Ft
Total Length of Storm Drainage Pipes: 67,485 Ft
Built Rain Storage Volume per Acre of Impervious Surface:
Less than 0.5 Inches

## SALMON PRESENT in BASIN
None known

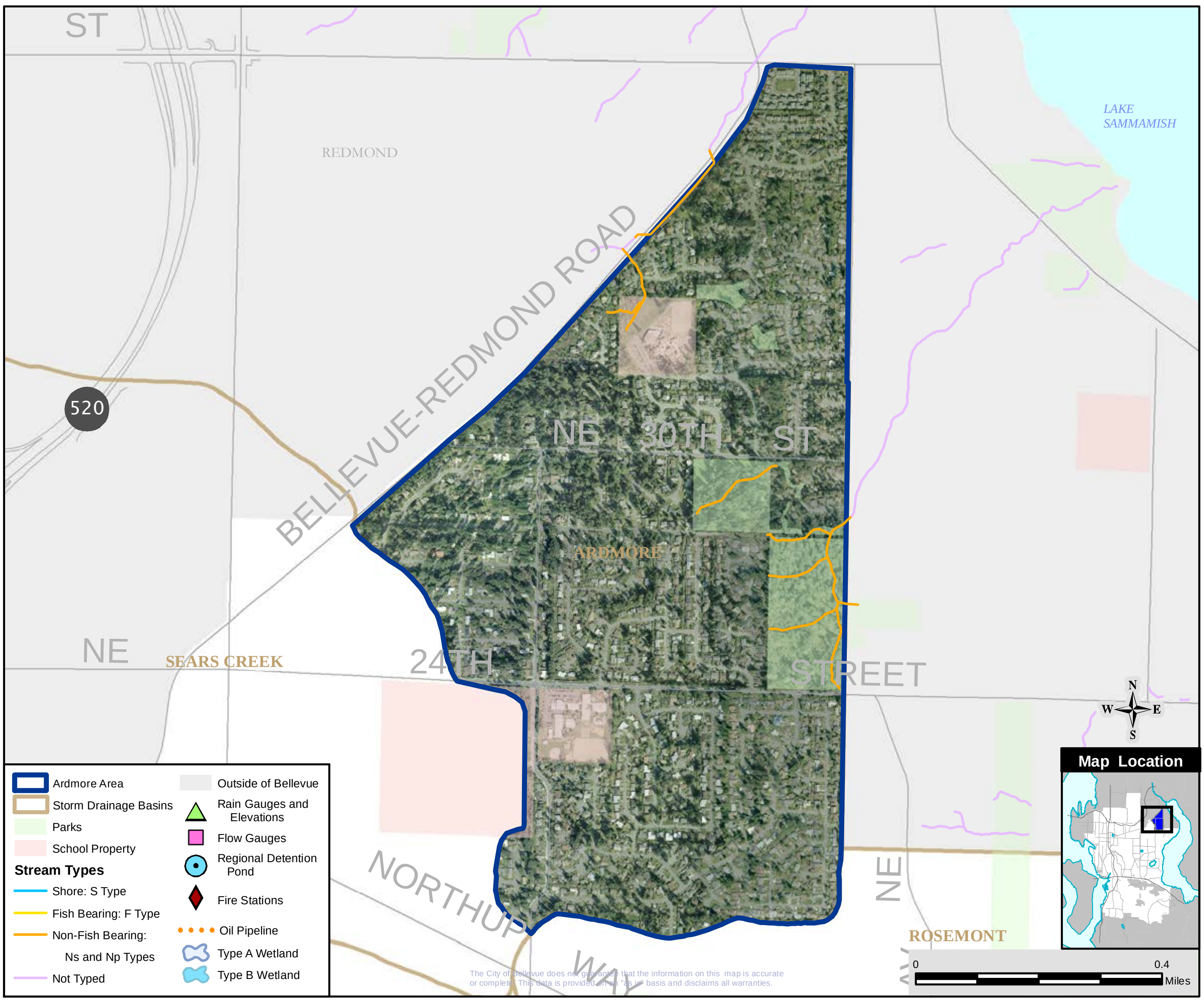
## POPULATION
City Basin Population (2000): 3,803 ( 3.4% of the City)
Basin Population Density: 5,405 People/Square Mile
Number 26 of 26 Basins (One is the lowest density)

## LAND USE (within Bellevue city limits)

| | | |
|---|---|---|
| Public Right of Way: | 20.24% | 91.39 Acres |
| Institutional/Government: | 5.02% | 22.6 Acres |
| Open Space/Park: | 6.76% | 30.4 Acres |
| Single Family Residential: | 65.15% | 293.5 Acres |
| Mixed Use/Misc: | 1.15% | 5.2 Acres |

## LAND COVER

| | |
|---|---|
| Impervious: | 43% |
| Tree Canopy: | 30% |
| Impervious in 100 Ft Stream Buffer: | 8% |
| Tree Canopy in 100 Ft Stream Buffer: | 83% |

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Plot Date: 8/9/2011

# Beaux Arts Area
Lake Washington Watershed (WRIA 8)

## LAND CHARACTERISTICS
Basin Area: 419 Total Acres ( 2% of the City)
Drainage Jurisdiction(s):
52.2 Acres - in Beaux Arts
365.6 Acres - in Bellevue

Highest Elevation: 280 Ft
Lowest Elevation: 18 Ft

Total Length of Open Channel: 0 Ft
Total Length of Storm Drainage Pipes: 26,702 Ft
Built Rain Storage Volume per Acre of Impervious Surface:
Less than 0.5 Inches

## SALMON PRESENT in BASIN
Lake only: Chinook*+, Coho+, Sockeye
Rainbow & cutthroat trout (Lake only)
Steelhead (Lake only)

* Listed Federal Endangered Species
\+ City Species of Local Importance (Bellevue Land Use Code 20.25H.150A)

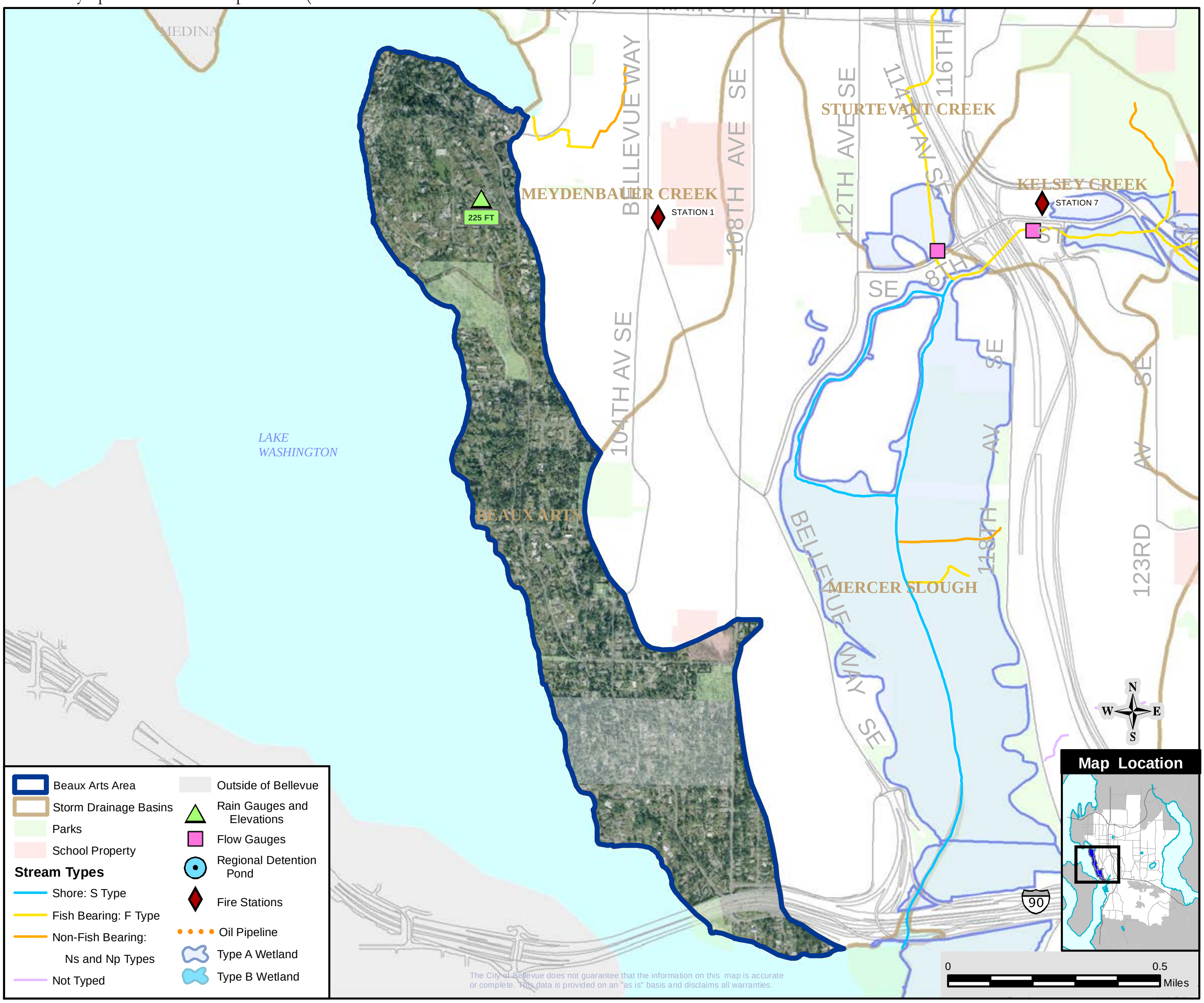
## POPULATION
City Basin Population (2000): 1,520 ( 1.4% of the City)
Basin Population Density: 2,732 People/Square Mile
Number 10 of 26 Basins (One is the lowest density)

## LAND USE (within Bellevue city limits)

| | | |
|---|---|---|
| Public Right of Way: | 14.31% | 59.92 Acres |
| Institutional/Government: | 2.19% | 8.0 Acres |
| Multi-Family Residential: | 0.19% | 0.7 Acres |
| Open Space/Park: | 5.33% | 19.5 Acres |
| Single Family Residential: | 66.74% | 244.0 Acres |

## LAND COVER

| | |
|---|---|
| Impervious: | 34% |
| Tree Canopy: | 53% |
| Impervious in 100 Ft Stream Buffer: | NA |
| Tree Canopy in 100 Ft Stream Buffer: | NA |



# Clyde Beach Area
Lake Washington Watershed (WRIA 8)

## LAND CHARACTERISTICS

Basin Area: 292 Total Acres ( 1% of the City)

Drainage Jurisdiction(s):
219.5 Acres - in Bellevue
40.4 Acres - in Clyde Hill
32.2 Acres - in Medina

Highest Elevation: 362 Ft
Lowest Elevation: 18 Ft

Total Length of Open Channel: 0 Ft
Total Length of Storm Drainage Pipes: 35,932 Ft
Built Rain Storage Volume per Acre of Impervious Surface: Less than 0.5 Inches

## SALMON PRESENT in BASIN

Lake only: Chinook*+, Coho+, Sockeye
Rainbow & cutthroat trout (Lake only)
Steelhead (Lake only)

* Listed Federal Endangered Species
+ City Species of Local Importance (Bellevue Land Use Code 20.25H.150A)

## POPULATION

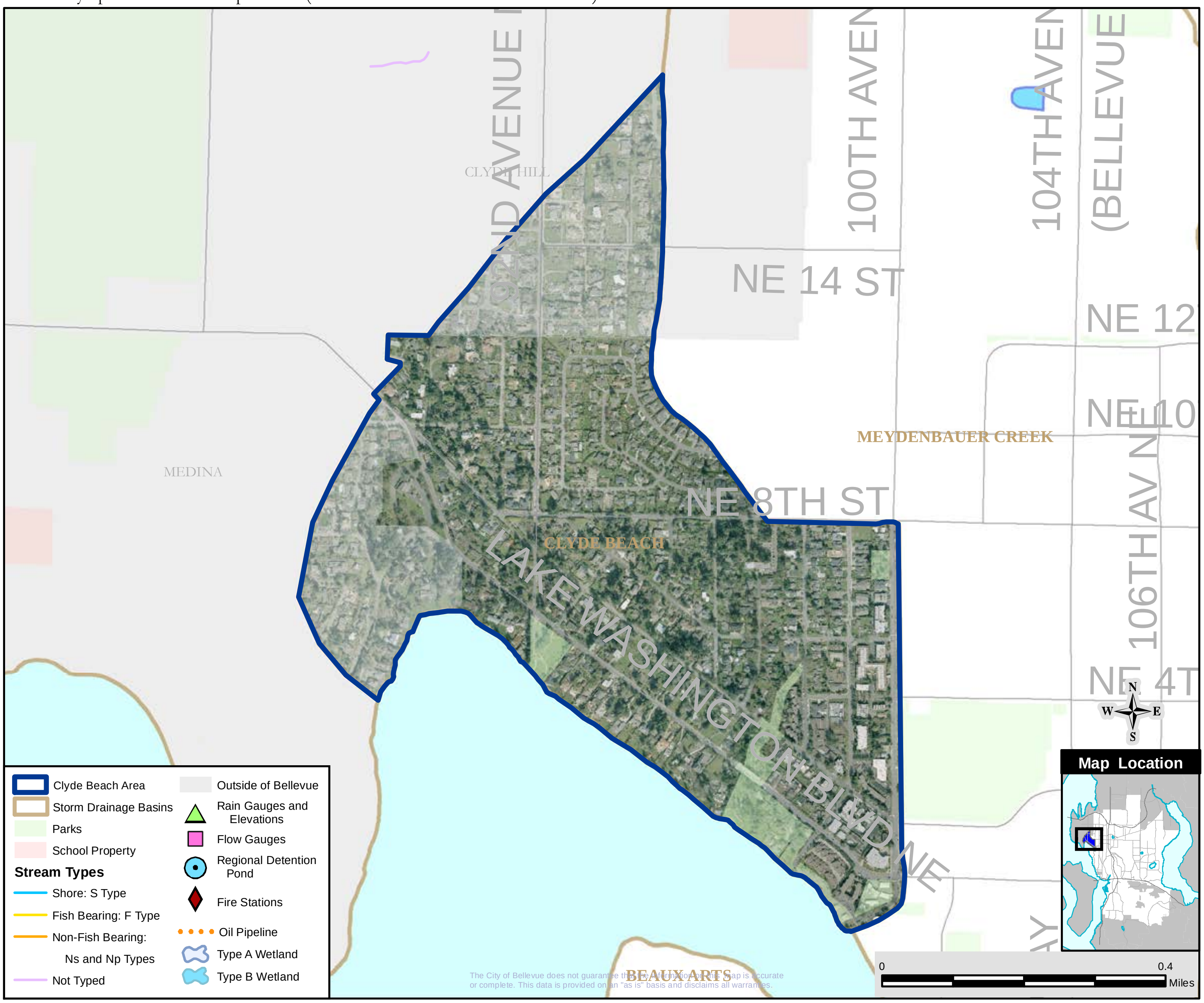
City Basin Population (2000): 1,668 ( 1.5% of the City)
Basin Population Density: 4,293 People/Square Mile
Number 20 of 26 Basins (One is the lowest density)

## LAND USE (within Bellevue city limits)

| | | |
|---|---|---|
| Public Right of Way: | 17.42% | 50.95 Acres |
| Commercial/Office: | 0.66% | 1.5 Acres |
| Institutional/Government: | 3.12% | 6.9 Acres |
| Mixed Use/Misc: | 1.93% | 4.2 Acres |
| Multi-Family Residential: | 8.47% | 18.6 Acres |
| Open Space/Park: | 1.91% | 4.2 Acres |
| Single Family Residential: | 58.33% | 128.1 Acres |

## LAND COVER

| | |
|---|---|
| Impervious: | 47% |
| Tree Canopy: | 31% |
| Impervious in 100 Ft Stream Buffer: | NA |
| Tree Canopy in 100 Ft Stream Buffer: | NA |

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Plot Date: 8/9/2011

# Coal Creek Basin

Lake Washington Watershed (WRIA 8)

State Stream #08-0268

## LAND CHARACTERISTICS

Basin Area: 3,990 Total Acres ( 11% of the City)

Drainage Jurisdiction(s):

2,329.1 Acres - in Bellevue

1,128.3 Acres - in King County

532.1 Acres - in Newcastle

Highest Elevation: 1,561 Ft

Lowest Elevation: 18 Ft

Total Length of Open Channel: 97,099 Ft

Total Length of Storm Drainage Pipes: 266,341 Ft

Built Rain Storage Volume per Acre of Impervious Surface: Less than 0.5 Inches

## SALMON PRESENT in BASIN

Chinook*+

Rainbow & cutthroat trout

Coho+

Sockeye

Steelhead

* Listed Federal Endangered Species

\+ City Species of Local Importance (Bellevue Land Use Code 20.25H.150A)

## POPULATION

City Basin Population (2000): 10,144 ( 9.1% of the City)

Basin Population Density: 1,852 People/Square Mile

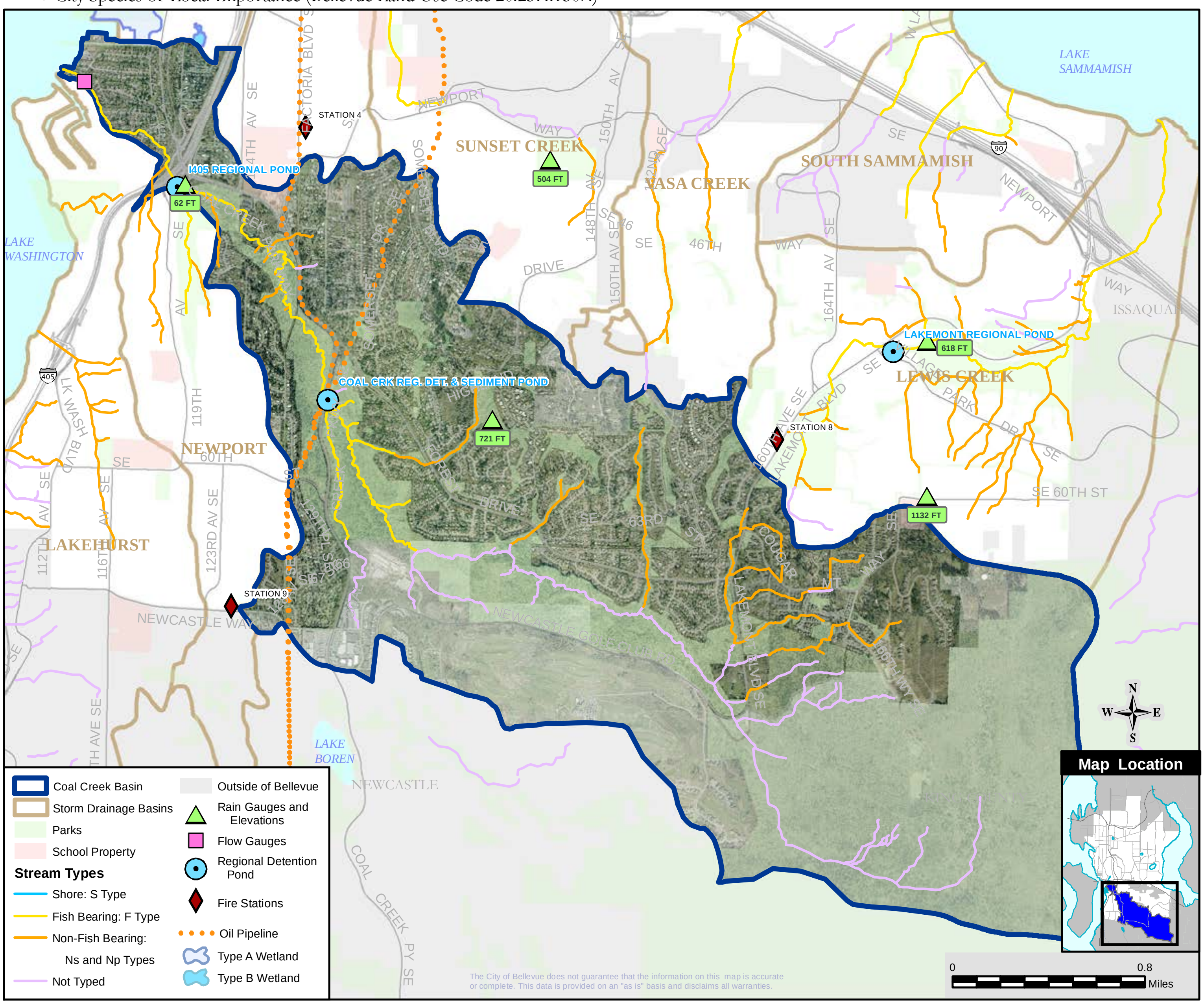
Number 3 of 26 Basins (One is the lowest density)

## LAND USE (within Bellevue city limits)

| | | |
|---|---|---|
| Public Right of Way: | 9.16% | 365.38 Acres |
| Commercial/Office: | 0.03% | 0.6 Acres |
| Industrial: | 0.01% | 0.3 Acres |
| Institutional/Government: | 3.06% | 66.8 Acres |
| Mixed Use/Misc: | 3.77% | 82.2 Acres |
| Multi-Family Residential: | 1.44% | 31.4 Acres |
| Open Space/Park: | 10.89% | 237.7 Acres |
| Single Family Residential: | 50.14% | 1,093.9 Acres |

## LAND COVER

| | |
|---|---|
| Impervious: | 20% |
| Tree Canopy: | 58% |
| Impervious in 100 Ft Stream Buffer: | 8% |
| Tree Canopy in 100 Ft Stream Buffer: | 85% |

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Plot Date: 8/9/2011

# East Creek Basin
Lake Washington Watershed (WRIA 8)

## LAND CHARACTERISTICS
Basin Area: 462 Total Acres ( 2% of the City)
Drainage Jurisdiction(s):
461.6 Acres - in Bellevue

Highest Elevation: 435 Ft
Lowest Elevation: 49 Ft

Total Length of Open Channel: 8,866 Ft
Total Length of Storm Drainage Pipes: 40,913 Ft
Built Rain Storage Volume per Acre of Impervious Surface:
1.1 Inches

## SALMON PRESENT in BASIN
Chinook*+
Cutthroat trout
Coho+
Sockeye

* Listed Federal Endangered Species
+ City Species of Local Importance (Bellevue Land Use Code 20.25H.150A)

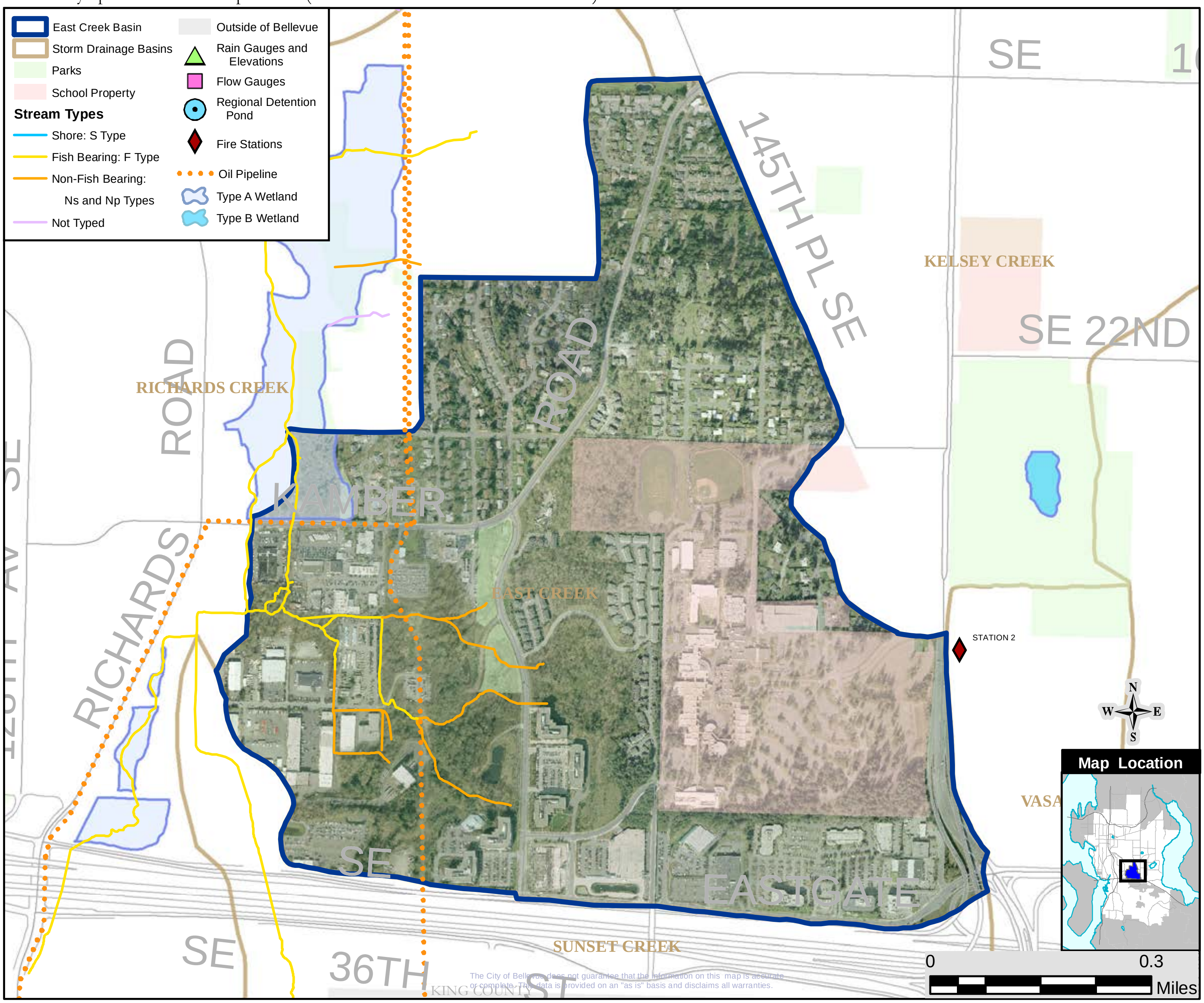
## POPULATION
City Basin Population (2000): 1,498 ( 1.3% of the City)
Basin Population Density: 2,076 People/Square Mile
Number 6 of 26 Basins (One is the lowest density)

## LAND USE (within Bellevue city limits)

| | | |
|---|---|---|
| Public Right of Way: | 10.87% | 50.17 Acres |
| Commercial/Office: | 12.70% | 58.6 Acres |
| Industrial: | 6.64% | 30.7 Acres |
| Institutional/Government: | 20.31% | 93.8 Acres |
| Mixed Use/Misc: | 11.37% | 52.5 Acres |
| Multi-Family Residential: | 6.03% | 27.8 Acres |
| Open Space/Park: | 0.47% | 2.2 Acres |
| Single Family Residential: | 20.79% | 96.0 Acres |

## LAND COVER

| | |
|---|---|
| Impervious: | 48% |
| Tree Canopy: | 35% |
| Impervious in 100 Ft Stream Buffer: | 29% |
| Tree Canopy in 100 Ft Stream Buffer: | 65% |



# Goff Creek Basin

Lake Washington Watershed (WRIA 8)

## LAND CHARACTERISTICS

Basin Area: 674 Total Acres ( 2% of the City)

Drainage Jurisdiction(s):

508.0 Acres - in Bellevue
162.6 Acres - in King County
3.8 Acres - in Kirkland

Highest Elevation: 541 Ft
Lowest Elevation: 111 Ft

Total Length of Open Channel: 10,164 Ft
Total Length of Storm Drainage Pipes: 45,962 Ft
Built Rain Storage Volume per Acre of Impervious Surface: 0.7 Inches

## SALMON PRESENT in BASIN

Chinook*+
Rainbow & cutthroat trout
Coho+
Sockeye

* Listed Federal Endangered Species
\+ City Species of Local Importance (Bellevue Land Use Code 20.25H.150A)

## POPULATION

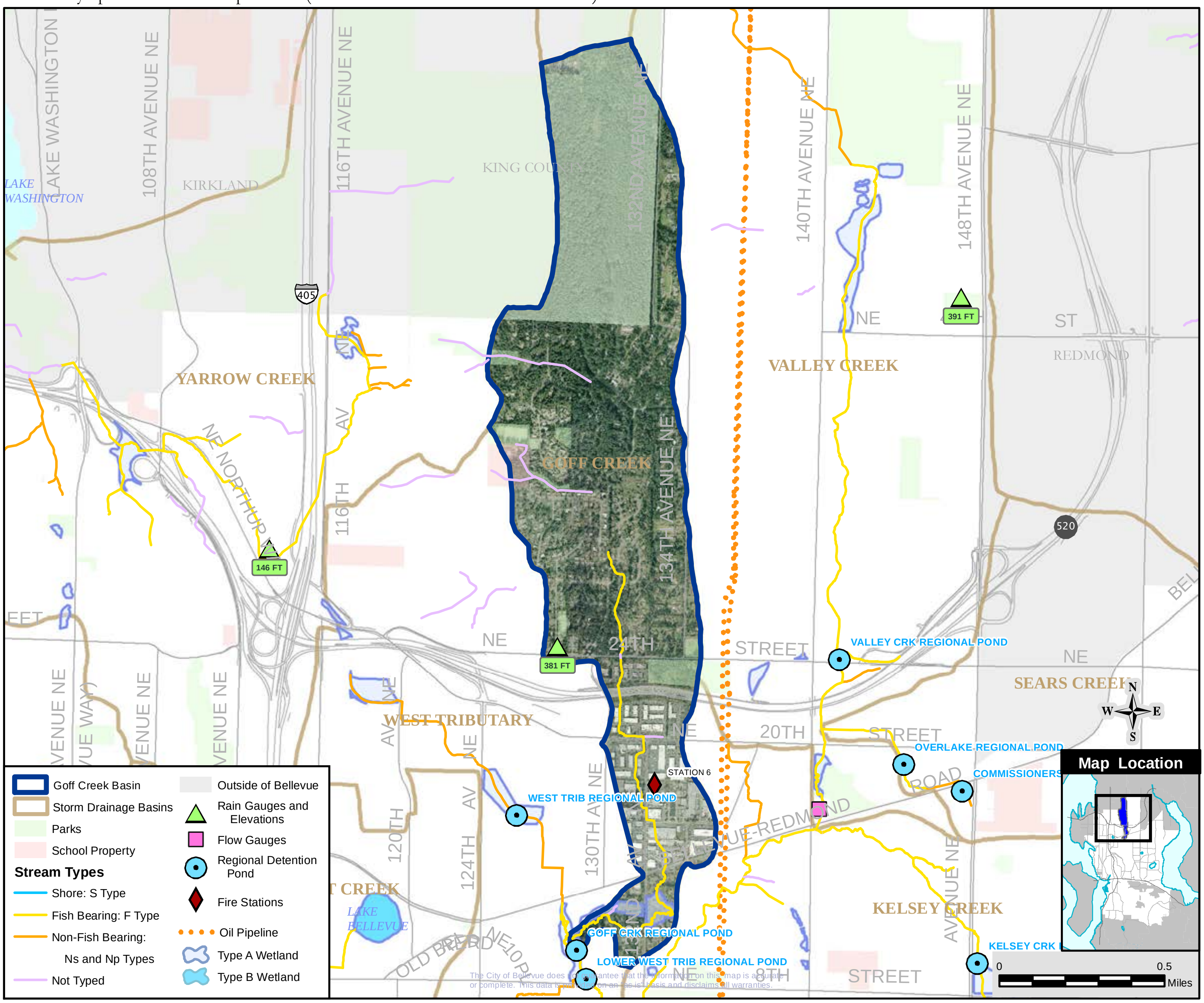
City Basin Population (2000): 1,675 ( 1.5% of the City)
Basin Population Density: 1,599 People/Square Mile
Number 1 of 26 Basins (One is the lowest density)

## LAND USE (within Bellevue city limits)

| | | |
|---|---|---|
| Public Right of Way: | 10.77% | 72.63 Acres |
| Commercial/Office: | 7.07% | 35.9 Acres |
| Industrial: | 2.63% | 13.4 Acres |
| Institutional/Government: | 1.24% | 6.3 Acres |
| Mixed Use/Misc: | 6.05% | 30.7 Acres |
| Multi-Family Residential: | 0.26% | 1.3 Acres |
| Open Space/Park: | 3.06% | 15.6 Acres |
| Single Family Residential: | 59.98% | 304.7 Acres |

## LAND COVER

| | |
|---|---|
| Impervious: | 30% |
| Tree Canopy: | 59% |
| Impervious in 100 Ft Stream Buffer: | 35% |
| Tree Canopy in 100 Ft Stream Buffer: | 55% |

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Plot Date: 8/9/2011

# Kelsey Creek Basin

Lake Washington Watershed (WRIA 8)

State Stream #08-0259

## LAND CHARACTERISTICS

Basin Area: 2,822 Total Acres ( 14% of the City)

Drainage Jurisdiction(s):

2,822.4 Acres - in Bellevue

Highest Elevation: 449 Ft

Lowest Elevation: 19 Ft

Total Length of Open Channel: 54,606 Ft

Total Length of Storm Drainage Pipes: 264,467 Ft

Built Rain Storage Volume per Acre of Impervious Surface: 1.2 Inches

## SALMON PRESENT in BASIN

Chinook*+

Chum

Coho+

Cutthroat trout

Sockeye

* Listed Federal Endangered Species

+ City Species of Local Importance (Bellevue Land Use Code 20.25H.150A)

## POPULATION

City Basin Population (2000): 22,494 ( 20.1% of the City)

Basin Population Density: 5,101 People/Square Mile

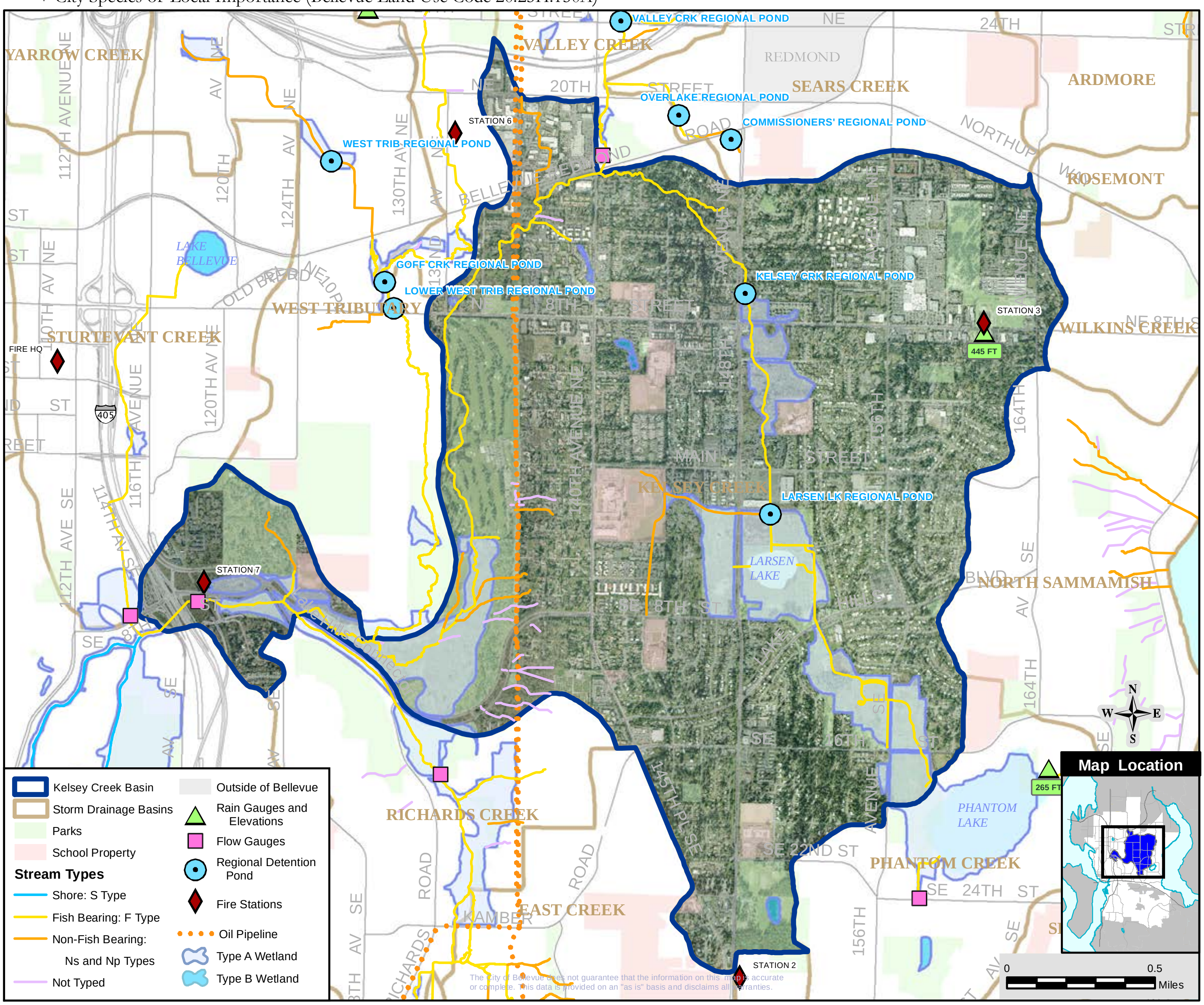
Number 24 of 26 Basins (One is the lowest density)

## LAND USE (within Bellevue city limits)

| | | |
|---|---|---|
| Public Right of Way: | 14.89% | 420.32 Acres |
| Commercial/Office: | 6.18% | 174.4 Acres |
| Industrial: | 0.86% | 24.4 Acres |
| Institutional/Government: | 6.24% | 176.2 Acres |
| Mixed Use/Misc: | 3.42% | 96.5 Acres |
| Multi-Family Residential: | 13.34% | 376.5 Acres |
| Open Space/Park: | 16.75% | 472.9 Acres |
| Single Family Residential: | 32.92% | 929.1 Acres |

## LAND COVER

| | |
|---|---|
| Impervious: | 40% |
| Tree Canopy: | 33% |
| Impervious in 100 Ft Stream Buffer: | 17% |
| Tree Canopy in 100 Ft Stream Buffer: | 55% |

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Plot Date: 8/9/2011

# Lakehurst Area

Lake Washington Watershed (WRIA 8)
State Stream #08-0281

## LAND CHARACTERISTICS

Basin Area: 1,284 Total Acres ( 3% of the City)
Drainage Jurisdiction(s):
651.0 Acres - in Bellevue
23.2 Acres - in King County
445.5 Acres - in Newcastle
163.6 Acres - in Renton

Highest Elevation: 568 Ft
Lowest Elevation: 17 Ft

Total Length of Open Channel: 34,651 Ft
Total Length of Storm Drainage Pipes: 57,587 Ft
Built Rain Storage Volume per Acre of Impervious Surface:
Less than 0.5 Inches

## SALMON PRESENT in BASIN

Lake only: Chinook*+, Coho+, Sockeye
Rainbow & cutthroat trout (Lake only)
Steelhead (Lake only)

* Listed Federal Endangered Species
\+ City Species of Local Importance (Bellevue Land Use Code 20.25H.150A)

## POPULATION

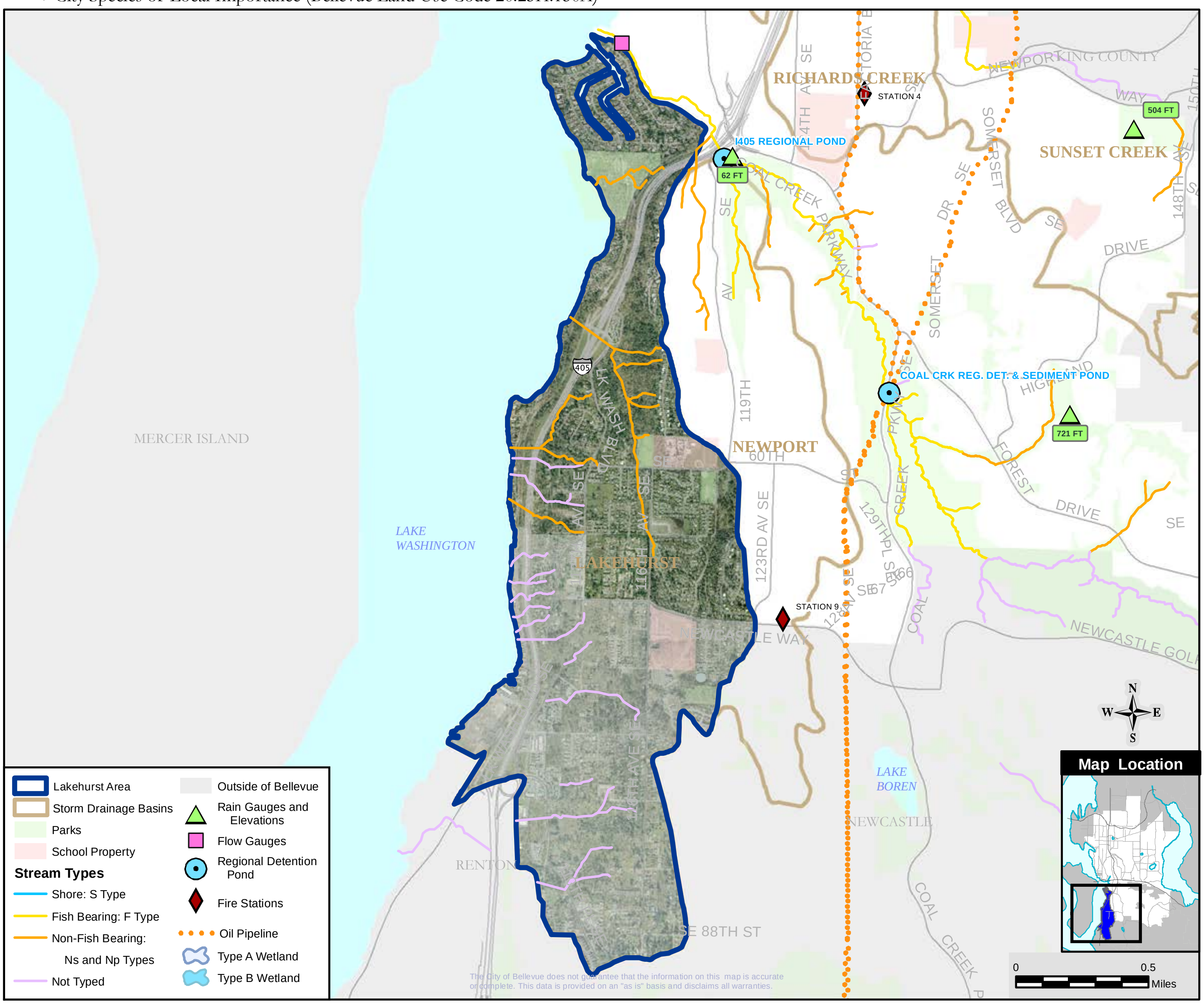
City Basin Population (2000): 2,828 ( 2.5% of the City)
Basin Population Density: 2,371 People/Square Mile
Number 9 of 26 Basins (One is the lowest density)

## LAND USE (within Bellevue city limits)

| | | |
|---|---|---|
| Public Right of Way: | 12.58% | 161.45 Acres |
| Industrial: | 0.42% | 2.7 Acres |
| Institutional/Government: | 3.47% | 22.6 Acres |
| Multi-Family Residential: | 0.12% | 0.8 Acres |
| Commercial/Office: | 0.08% | 0.5 Acres |
| Open Space/Park: | 4.35% | 28.3 Acres |
| Single Family Residential: | 44.38% | 288.9 Acres |
| Mixed Use/Misc: | 10.56% | 68.8 Acres |

## LAND COVER

| | |
|---|---|
| Impervious: | 33% |
| Tree Canopy: | 37% |
| Impervious in 100 Ft Stream Buffer: | 21% |
| Tree Canopy in 100 Ft Stream Buffer: | 62% |

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Plot Date: 8/9/2011

# Lewis Creek Basin

Lake Washington Watershed (WRIA 8)

State Stream #08-0162

## LAND CHARACTERISTICS

Basin Area: 1,451 Total Acres ( 5% of the City)

Drainage Jurisdiction(s):

1,003.6 Acres - in Bellevue

355.1 Acres - in Issaquah

91.4 Acres - in King County

Highest Elevation: 1,425 Ft

Lowest Elevation: 30 Ft

Total Length of Open Channel: 50,666 Ft

Total Length of Storm Drainage Pipes: 118,442 Ft

Built Rain Storage Volume per Acre of Impervious Surface: 1.2 Inches

## SALMON PRESENT in BASIN

Chinook*+

Rainbow & cutthroat trout

Coho+

Sockeye

Kokanee+

Steelhead (Lake only)

* Listed Federal Endangered Species

\+ City Species of Local Importance (Bellevue Land Use Code 20.25H.150A)

## POPULATION

City Basin Population (2000): 4,886 ( 4.4% of the City)

Basin Population Density: 2,995 People/Square Mile

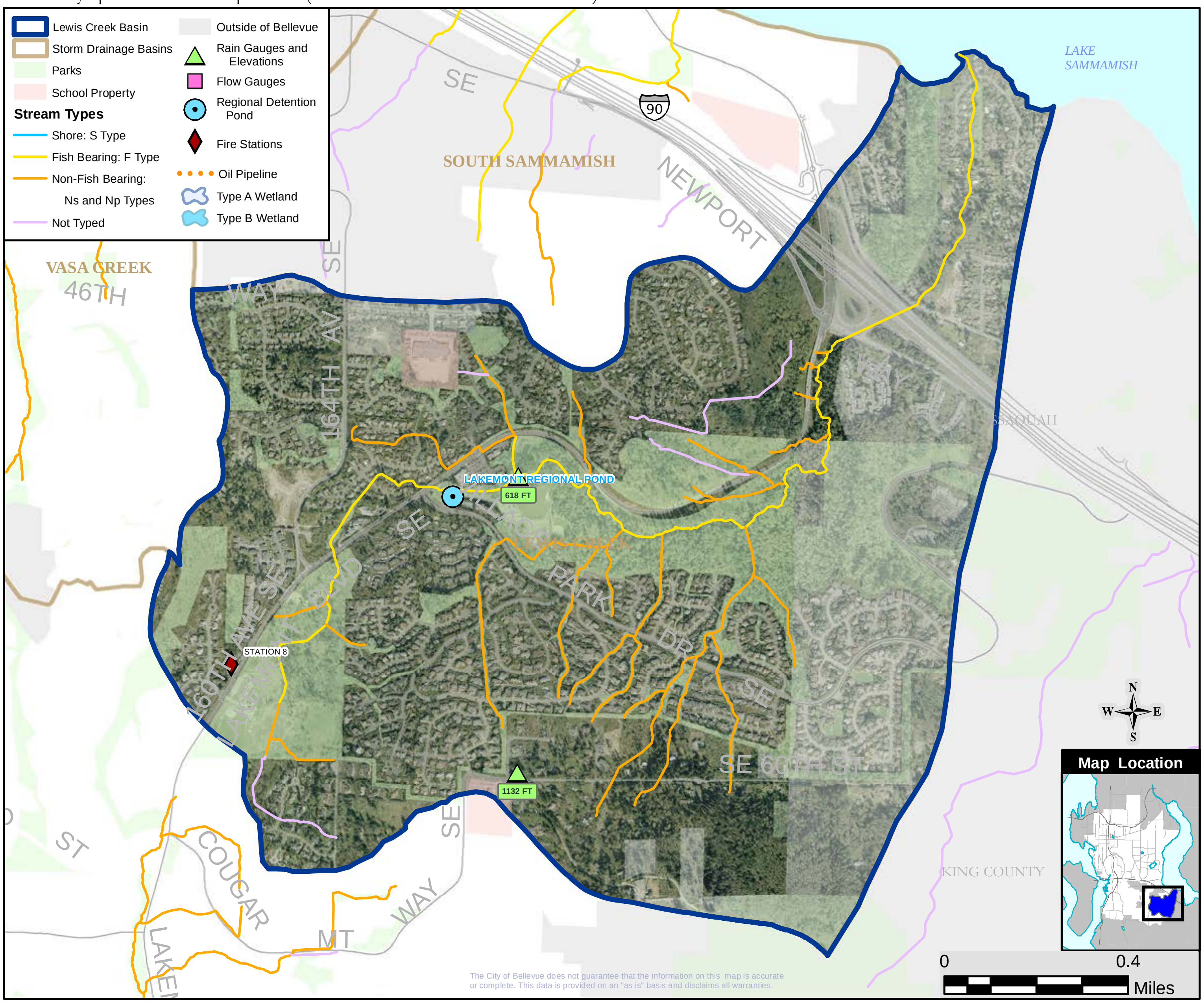
Number 12 of 26 Basins (One is the lowest density)

## LAND USE (within Bellevue city limits)

| | | |
|---|---|---|
| Public Right of Way: | 10.15% | 147.26 Acres |
| Commercial/Office: | 3.36% | 33.7 Acres |
| Institutional/Government: | 0.86% | 8.6 Acres |
| Multi-Family Residential: | 4.44% | 44.6 Acres |
| Mixed Use/Misc: | 9.33% | 93.7 Acres |
| Open Space/Park: | 3.28% | 32.9 Acres |
| Single Family Residential: | 41.86% | 420.1 Acres |

## LAND COVER

| | |
|---|---|
| Impervious: | 29% |
| Tree Canopy: | 49% |
| Impervious in 100 Ft Stream Buffer: | 17% |
| Tree Canopy in 100 Ft Stream Buffer: | 69% |

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Plot Date: 8/9/2011

# Mercer Slough Basin
Lake Washington Watershed (WRIA 8)
State Stream #08-0259

## LAND CHARACTERISTICS
Basin Area: 1,327 Total Acres ( 6% of the City)
Drainage Jurisdiction(s):
1,327.0 Acres - in Bellevue

Highest Elevation: 339 Ft
Lowest Elevation: 16 Ft

Total Length of Open Channel: 15,533 Ft
Total Length of Storm Drainage Pipes: 96,145 Ft
Built Rain Storage Volume per Acre of Impervious Surface:
Less than 0.5 Inches

## SALMON PRESENT in BASIN
Chinook*+
Rainbow & cutthroat trout
Coho+
Sockeye
Steelhead (Lake only)

* Listed Federal Endangered Species
\+ City Species of Local Importance (Bellevue Land Use Code 20.25H.150A)

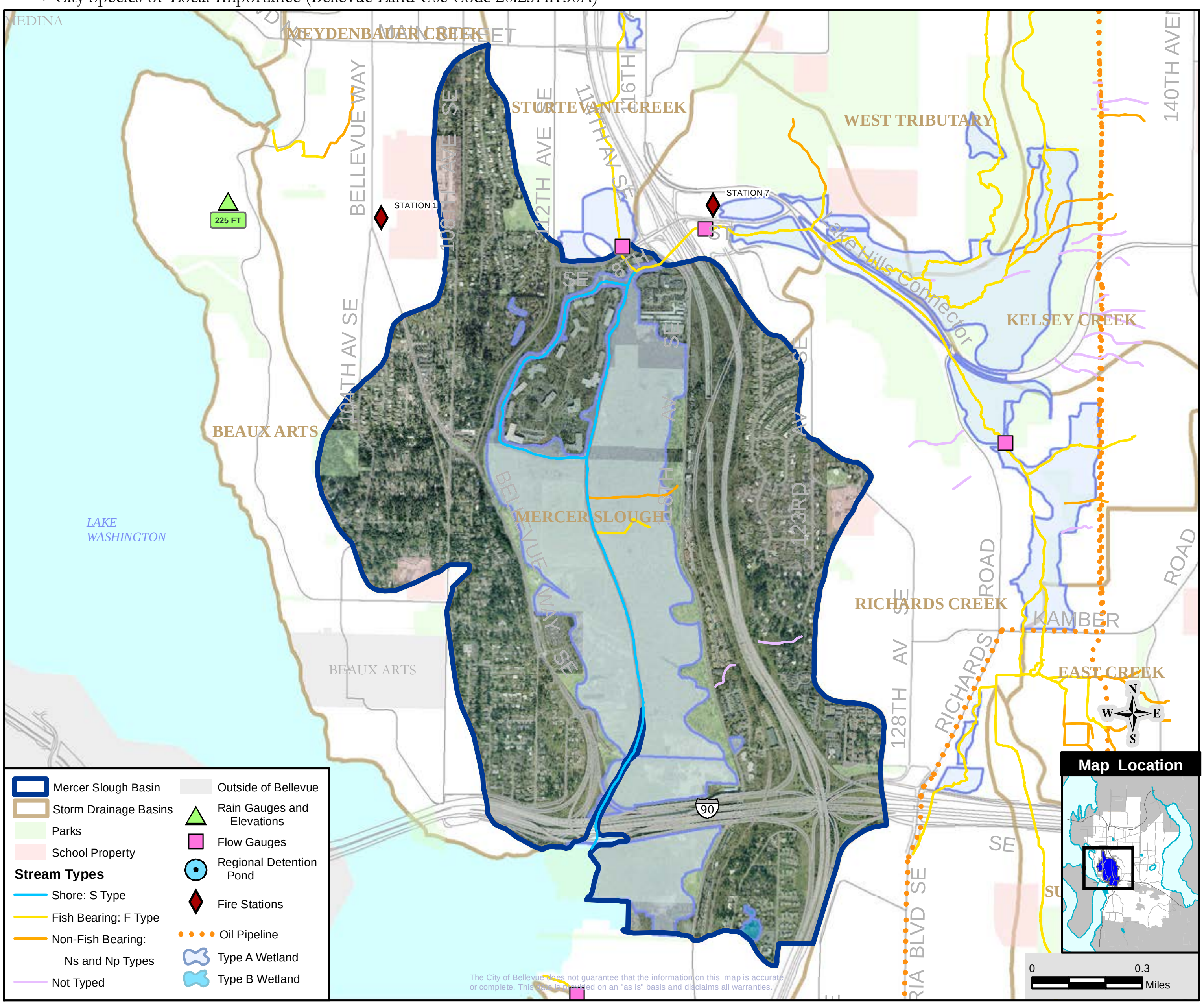
## POPULATION
City Basin Population (2000): 4,546 ( 4.1% of the City)
Basin Population Density: 2,192 People/Square Mile
Number 8 of 26 Basins (One is the lowest density)

## LAND USE (within Bellevue city limits)

| | | |
|---|---|---|
| Public Right of Way: | 27.08% | 359.33 Acres |
| Commercial/Office: | 5.87% | 77.9 Acres |
| Industrial: | 2.86% | 38.0 Acres |
| Institutional/Government: | 4.55% | 60.3 Acres |
| Mixed Use/Misc: | 2.20% | 29.2 Acres |
| Multi-Family Residential: | 4.69% | 62.2 Acres |
| Open Space/Park: | 18.14% | 240.7 Acres |
| Single Family Residential: | 27.68% | 367.4 Acres |

## LAND COVER

| | |
|---|---|
| Impervious: | 32% |
| Tree Canopy: | 43% |
| Impervious in 100 Ft Stream Buffer: | 7% |
| Tree Canopy in 100 Ft Stream Buffer: | 53% |

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Plot Date: 8/9/2011

# Meydenbauer Creek Basin

Lake Washington Watershed (WRIA 8)
State Stream #08-0258

## LAND CHARACTERISTICS

Basin Area: 927 Total Acres ( 4% of the City)
Drainage Jurisdiction(s):
833.2 Acres - in Bellevue
94.2 Acres - in Clyde Hill

Highest Elevation: 391 Ft
Lowest Elevation: 18 Ft

Total Length of Open Channel: 1,773 Ft
Total Length of Storm Drainage Pipes: 142,906 Ft
Built Rain Storage Volume per Acre of Impervious Surface:
Less than 0.5 Inches

## SALMON PRESENT in BASIN

Chinook*+ (Lake only)
Coho+ (Lake only)
Cutthroat trout (Lake only)
Rainbow trout (Lake only)
Sockeye

* Listed Federal Endangered Species
\+ City Species of Local Importance (Bellevue Land Use Code 20.25H.150A)

## POPULATION

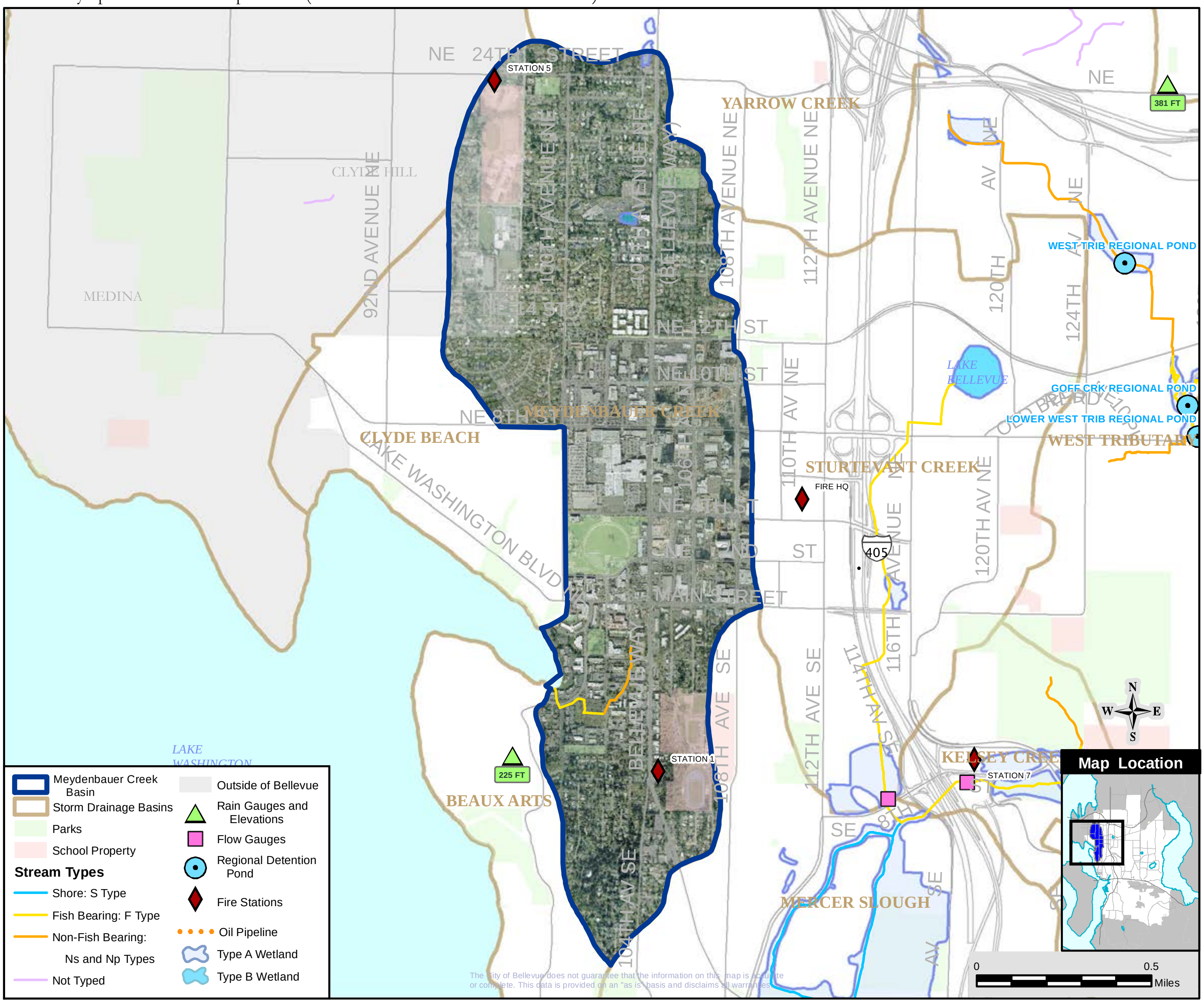
City Basin Population (2000): 6,700 ( 6.0% of the City)
Basin Population Density: 4,833 People/Square Mile
Number 23 of 26 Basins (One is the lowest density)

## LAND USE (within Bellevue city limits)

| | | |
|---|---|---|
| Public Right of Way: | 16.60% | 153.95 Acres |
| Commercial/Office: | 15.23% | 126.9 Acres |
| Industrial: | 0.20% | 1.7 Acres |
| Institutional/Government: | 5.67% | 47.3 Acres |
| Mixed Use/Misc: | 7.70% | 64.2 Acres |
| Multi-Family Residential: | 15.03% | 125.2 Acres |
| Open Space/Park: | 3.61% | 30.1 Acres |
| Single Family Residential: | 31.61% | 263.4 Acres |

## LAND COVER

| | |
|---|---|
| Impervious: | 59% |
| Tree Canopy: | 24% |
| Impervious in 100 Ft Stream Buffer: | 36% |
| Tree Canopy in 100 Ft Stream Buffer: | 44% |



# Newport Area

Lake Washington Watershed (WRIA 8)
State Stream #08-0269

## LAND CHARACTERISTICS

Basin Area: 573 Total Acres ( 2% of the City)
Drainage Jurisdiction(s):
469.8 Acres - in Bellevue
103.2 Acres - in Newcastle

Highest Elevation: 571 Ft
Lowest Elevation: 51 Ft

Total Length of Open Channel: 8,845 Ft
Total Length of Storm Drainage Pipes: 62,013 Ft
Built Rain Storage Volume per Acre of Impervious Surface:
Less than 0.5 Inches

## SALMON PRESENT in BASIN

Coho+ (juveniles)
Cutthroat trout

+ City Species of Local Importance (Bellevue Land Use Code 20.25H.150A)

## POPULATION

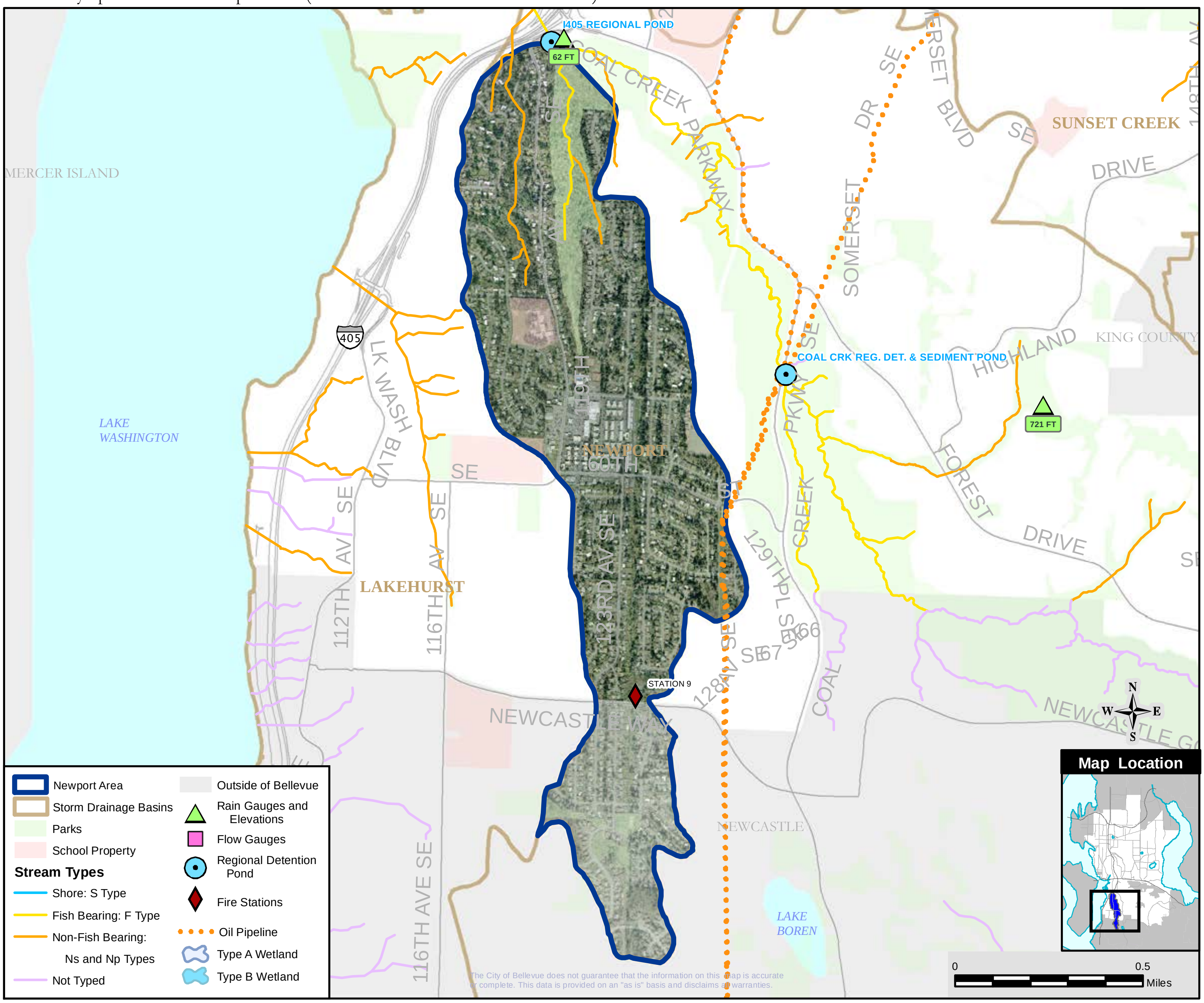
City Basin Population (2000): 3,588 ( 3.2% of the City)
Basin Population Density: 4,700 People/Square Mile
Number 22 of 26 Basins (One is the lowest density)

## LAND USE (within Bellevue city limits)

| | | |
|---|---|---|
| Public Right of Way: | 14.37% | 82.38 Acres |
| Commercial/Office: | 1.94% | 9.1 Acres |
| Institutional/Government: | 4.35% | 20.5 Acres |
| Multi-Family Residential: | 3.25% | 15.3 Acres |
| Open Space/Park: | 8.61% | 40.5 Acres |
| Single Family Residential: | 60.46% | 284.1 Acres |
| Mixed Use/Misc: | 0.32% | 1.5 Acres |

## LAND COVER

| | |
|---|---|
| Impervious: | 39% |
| Tree Canopy: | 30% |
| Impervious in 100 Ft Stream Buffer: | 7% |
| Tree Canopy in 100 Ft Stream Buffer: | 91% |

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Plot Date: 8/9/2011

# North Sammamish Area
Lake Washington Watershed (WRIA 8)

## LAND CHARACTERISTICS

Basin Area: 621 Total Acres ( 3% of the City)
Drainage Jurisdiction(s):
618.5 Acres - in Bellevue

Highest Elevation: 443 Ft
Lowest Elevation: 30 Ft

Total Length of Open Channel: 19,713 Ft
Total Length of Storm Drainage Pipes: 59,355 Ft
Built Rain Storage Volume per Acre of Impervious Surface:
Less than 0.5 Inches

## SALMON PRESENT in BASIN

Lake only: Chinook*+, Coho+ , Kokanee+, Sockeye
Rainbow & cutthroat trout (Lake only)
Steelhead (Lake only)

* Listed Federal Endangered Species
\+ City Species of Local Importance (Bellevue Land Use Code 20.25H.150A)

## POPULATION

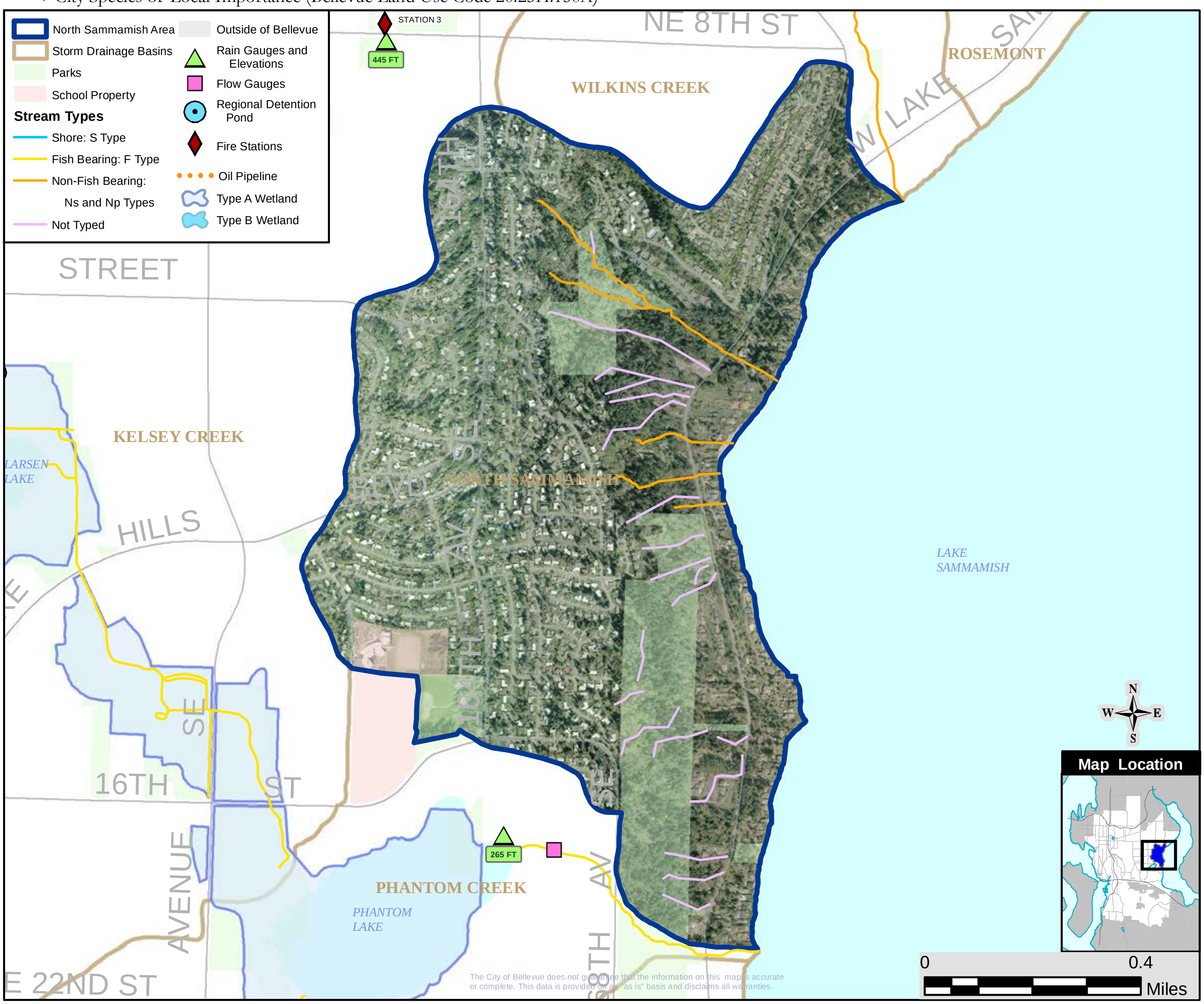
City Basin Population (2000): 3,789 ( 3.4% of the City)
Basin Population Density: 3,916 People/Square Mile
Number 16 of 26 Basins (One is the lowest density)

## LAND USE (within Bellevue city limits)

| | | |
|---|---|---|
| Public Right of Way: | 15.67% | 97.25 Acres |
| Institutional/Government: | 1.78% | 11.0 Acres |
| Multi-Family Residential: | 0.05% | 0.3 Acres |
| Open Space/Park: | 14.63% | 90.5 Acres |
| Single Family Residential: | 54.10% | 334.6 Acres |
| Mixed Use/Misc: | 5.70% | 35.3 Acres |

## LAND COVER

| | |
|---|---|
| Impervious: | 32% |
| Tree Canopy: | 46% |
| Impervious in 100 Ft Stream Buffer: | 9% |
| Tree Canopy in 100 Ft Stream Buffer: | 86% |

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Plot Date: 8/9/2011

# Richards Creek Basin

Lake Washington Watershed (WRIA 8)
State Stream #08-0261

## LAND CHARACTERISTICS

Basin Area: 901 Total Acres ( 4% of the City)
Drainage Jurisdiction(s):
901.5 Acres - in Bellevue

Highest Elevation: 397 Ft
Lowest Elevation: 23 Ft

Total Length of Open Channel: 14,561 Ft
Total Length of Storm Drainage Pipes: 99,331 Ft
Built Rain Storage Volume per Acre of Impervious Surface:
Less than 0.5 Inches

## SALMON PRESENT in BASIN

Chinook*+
Coho+
Cutthroat trout
Sockeye

* Listed Federal Endangered Species
\+ City Species of Local Importance (Bellevue Land Use Code 20.25H.150A)

## POPULATION

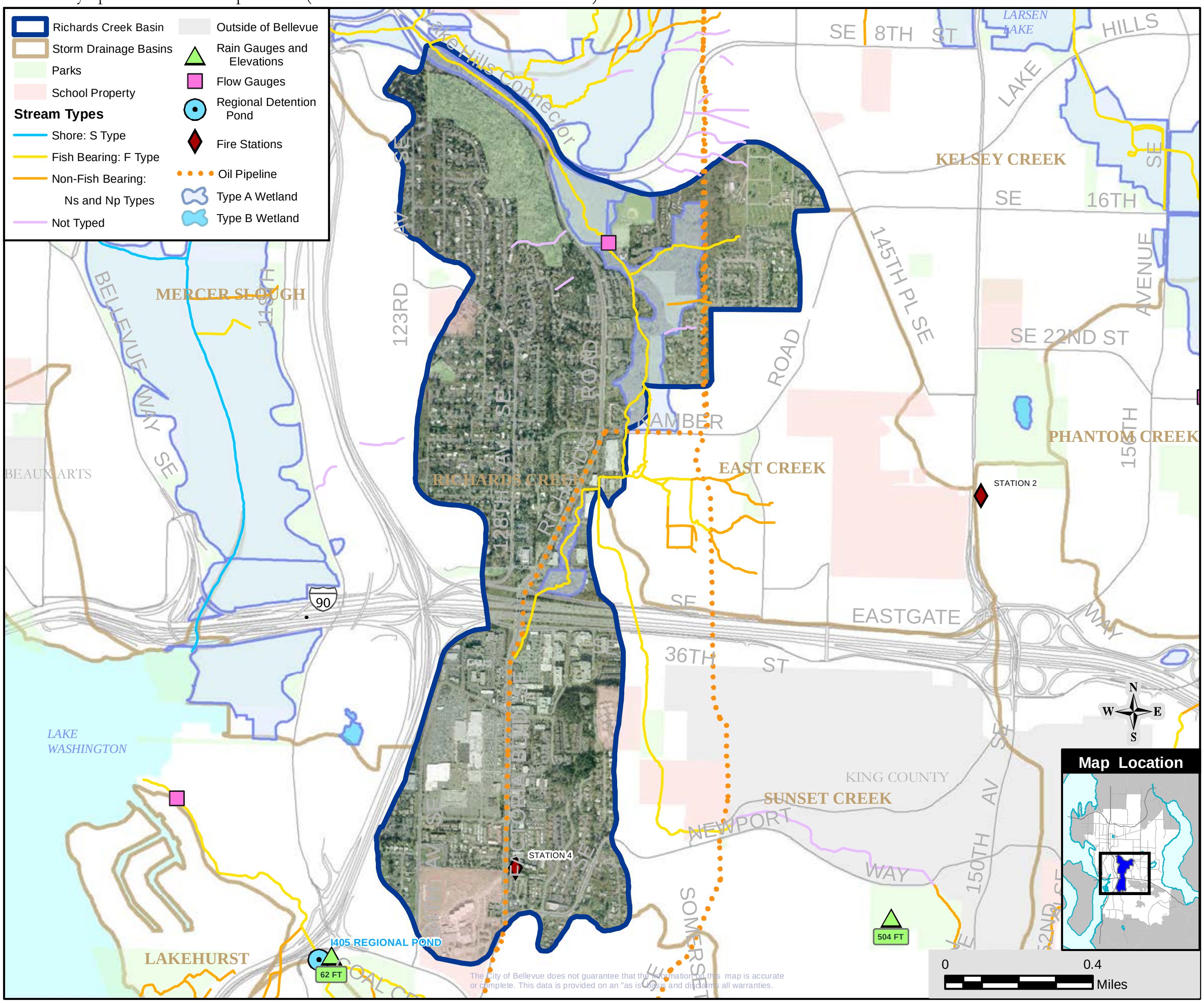
City Basin Population (2000): 5,660 ( 5.1% of the City)
Basin Population Density: 4,018 People/Square Mile
Number 17 of 26 Basins (One is the lowest density)

## LAND USE (within Bellevue city limits)

| | | |
|---|---|---|
| Public Right of Way: | 16.96% | 152.88 Acres |
| Commercial/Office: | 10.79% | 97.2 Acres |
| Industrial: | 1.63% | 14.7 Acres |
| Institutional/Government: | 10.59% | 95.5 Acres |
| Mixed Use/Misc: | 7.20% | 64.9 Acres |
| Multi-Family Residential: | 12.23% | 110.3 Acres |
| Open Space/Park: | 4.50% | 40.6 Acres |
| Single Family Residential: | 27.41% | 247.1 Acres |

## LAND COVER

| | |
|---|---|
| Impervious: | 45% |
| Tree Canopy: | 36% |
| Impervious in 100 Ft Stream Buffer: | 22% |
| Tree Canopy in 100 Ft Stream Buffer: | 62% |

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Plot Date: 8/4/2011

# Rosemont Area
Lake Washington Watershed (WRIA 8)

## LAND CHARACTERISTICS

Basin Area: 432 Total Acres ( 2% of the City)
Drainage Jurisdiction(s):
431.4 Acres - in Bellevue
0.2 Acres - in Redmond

Highest Elevation: 444 Ft
Lowest Elevation: 30 Ft

Total Length of Open Channel: 1,436 Ft
Total Length of Storm Drainage Pipes: 47,399 Ft
Built Rain Storage Volume per Acre of Impervious Surface:
Less than 0.5 Inches

## SALMON PRESENT in BASIN

Lake only: Chinook*+, Coho+ , Kokanee+, Sockeye
Rainbow & cutthroat trout (Lake only)
Steelhead (Lake only)

* Listed Federal Endangered Species
\+ City Species of Local Importance (Bellevue Land Use Code 20.25H.150A)

## POPULATION

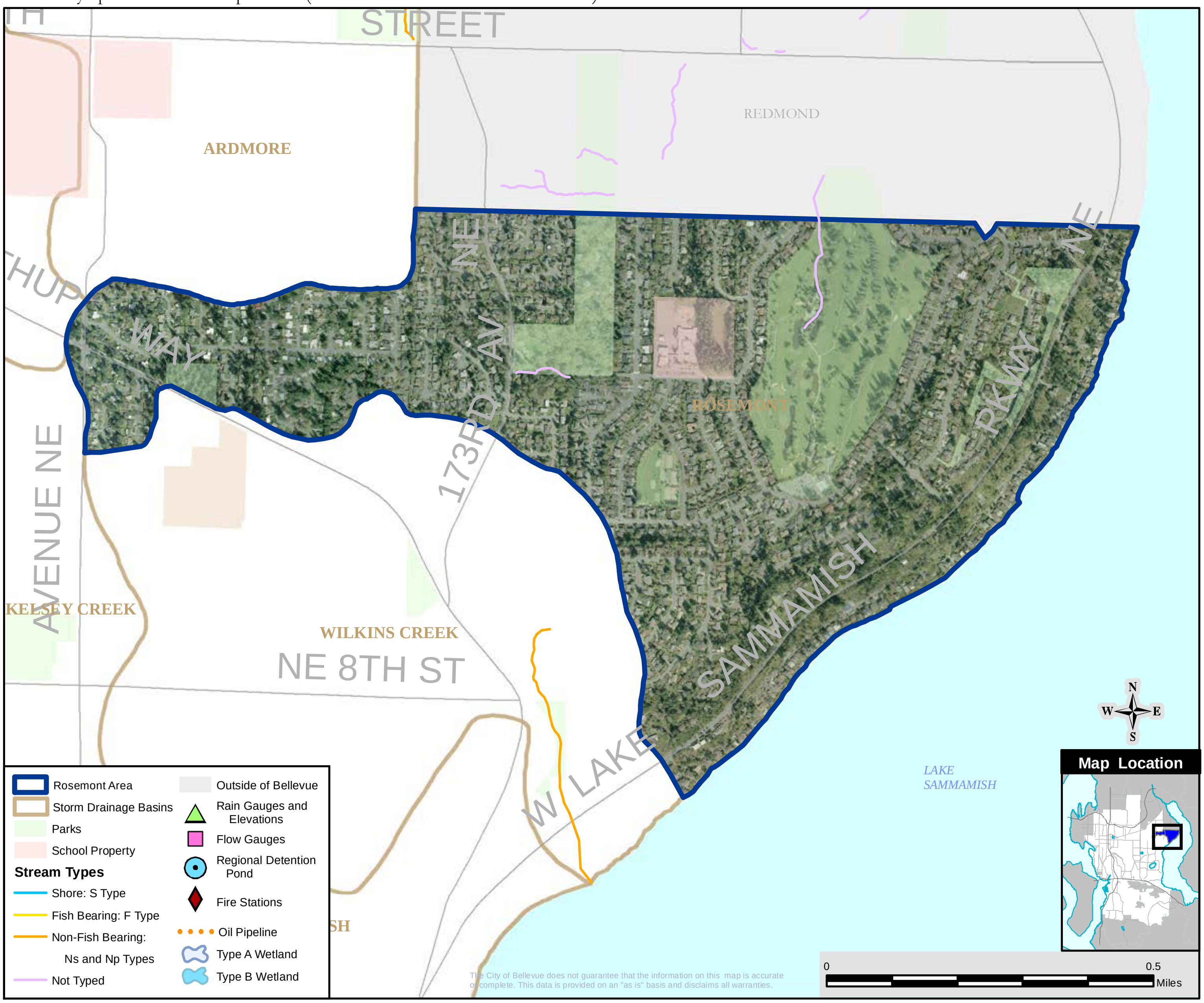
City Basin Population (2000): 2,939 ( 2.6% of the City)
Basin Population Density: 4,354 People/Square Mile
Number 21 of 26 Basins (One is the lowest density)

## LAND USE (within Bellevue city limits)

| | | |
|---|---|---|
| Public Right of Way: | 16.06% | 69.45 Acres |
| Commercial/Office: | 0.09% | 0.4 Acres |
| Institutional/Government: | 2.27% | 9.8 Acres |
| Multi-Family Residential: | 0.16% | 0.7 Acres |
| Open Space/Park: | 4.21% | 18.2 Acres |
| Single Family Residential: | 60.71% | 261.9 Acres |
| Mixed Use/Misc: | 2.08% | 9.0 Acres |

## LAND COVER

| | |
|---|---|
| Impervious: | 38% |
| Tree Canopy: | 31% |
| Impervious in 100 Ft Stream Buffer: | 6% |
| Tree Canopy in 100 Ft Stream Buffer: | 55% |



# South Sammamish Area

Lake Washington Watershed (WRIA 8)

State Stream #08-0160, 08-0161

## LAND CHARACTERISTICS

Basin Area: 593 Total Acres ( 2% of the City)

Drainage Jurisdiction(s):

336.9 Acres - in Bellevue
16.4 Acres - in Issaquah
238.5 Acres - in King County

Highest Elevation: 799 Ft
Lowest Elevation: 30 Ft

Total Length of Open Channel: 17,488 Ft
Total Length of Storm Drainage Pipes: 28,395 Ft
Built Rain Storage Volume per Acre of Impervious Surface:
Less than 0.5 Inches

## SALMON PRESENT in BASIN

Lake only: Chinook*+, Coho+ , Kokanee+, Sockeye
Rainbow & cutthroat trout
Steelhead (Lake only)

* Listed Federal Endangered Species
\+ City Species of Local Importance (Bellevue Land Use Code 20.25H.150A)

## POPULATION

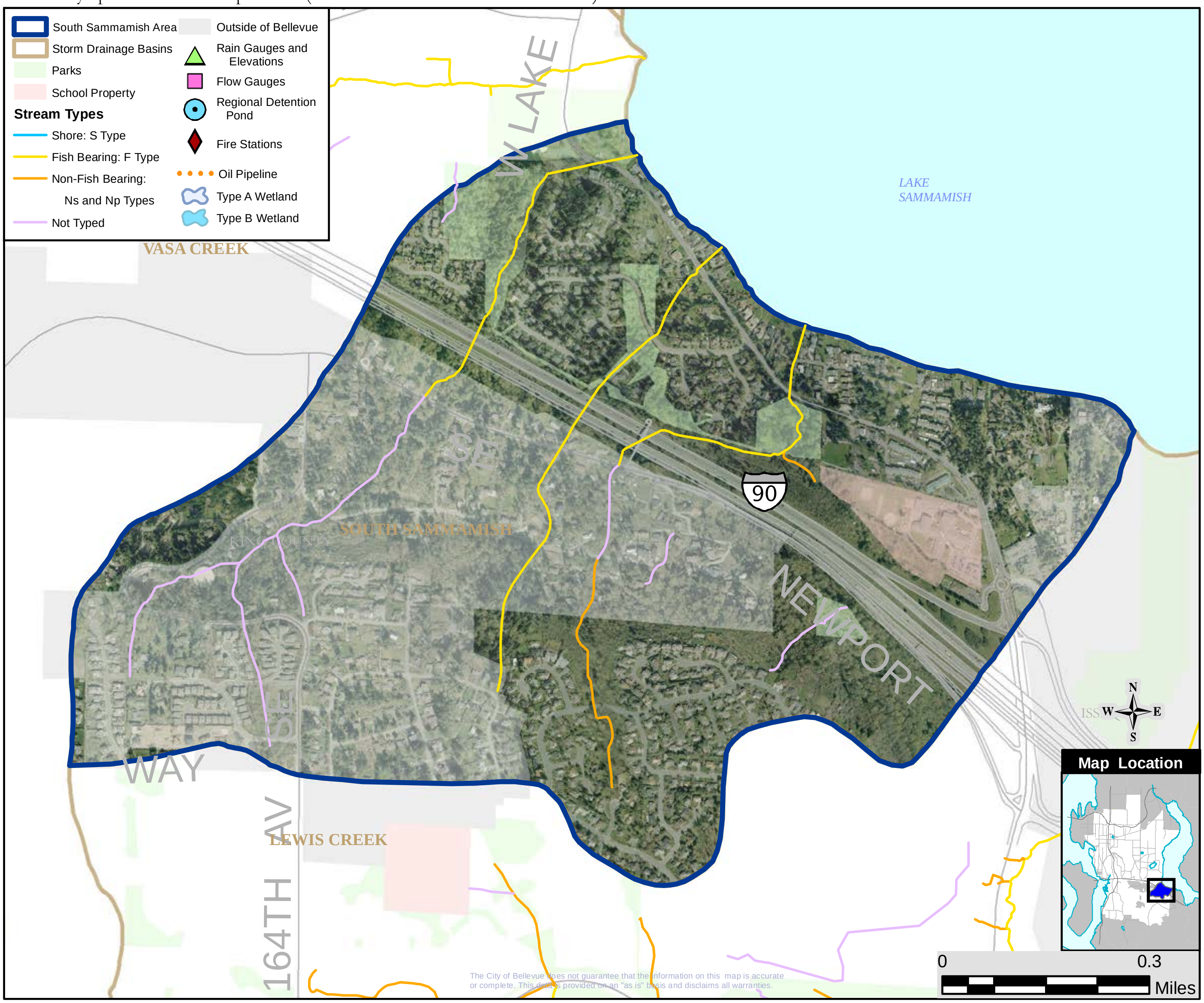
City Basin Population (2000): 1,689 ( 1.5% of the City)
Basin Population Density: 2,755 People/Square Mile
Number 11 of 26 Basins (One is the lowest density)

## LAND USE (within Bellevue city limits)

| | | |
|---|---|---|
| Public Right of Way: | 22.48% | 133.32 Acres |
| Institutional/Government: | 3.65% | 12.3 Acres |
| Multi-Family Residential: | 1.53% | 5.2 Acres |
| Open Space/Park: | 5.69% | 19.2 Acres |
| Single Family Residential: | 41.65% | 140.3 Acres |
| Mixed Use/Misc: | 2.80% | 9.4 Acres |

## LAND COVER

| | |
|---|---|
| Impervious: | 31% |
| Tree Canopy: | 48% |
| Impervious in 100 Ft Stream Buffer: | 16% |
| Tree Canopy in 100 Ft Stream Buffer: | 75% |

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Plot Date: 8/9/2011

# Spirit Ridge Area

Lake Washington Watershed (WRIA 8)

## LAND CHARACTERISTICS

Basin Area: 193 Total Acres ( 1% of the City)

Drainage Jurisdiction(s):
192.1 Acres - in Bellevue

Highest Elevation: 350 Ft
Lowest Elevation: 31 Ft

Total Length of Open Channel: 0 Ft
Total Length of Storm Drainage Pipes: 20,544 Ft
Built Rain Storage Volume per Acre of Impervious Surface:
Less than 0.5 Inches

## SALMON PRESENT in BASIN

Lake only: Chinook*+, Coho+ , Kokanee+, Sockeye
Rainbow & cutthroat trout (Lake only)
Steelhead (Lake only)

* Listed Federal Endangered Species
\+ City Species of Local Importance (Bellevue Land Use Code 20.25H.150A)

## POPULATION

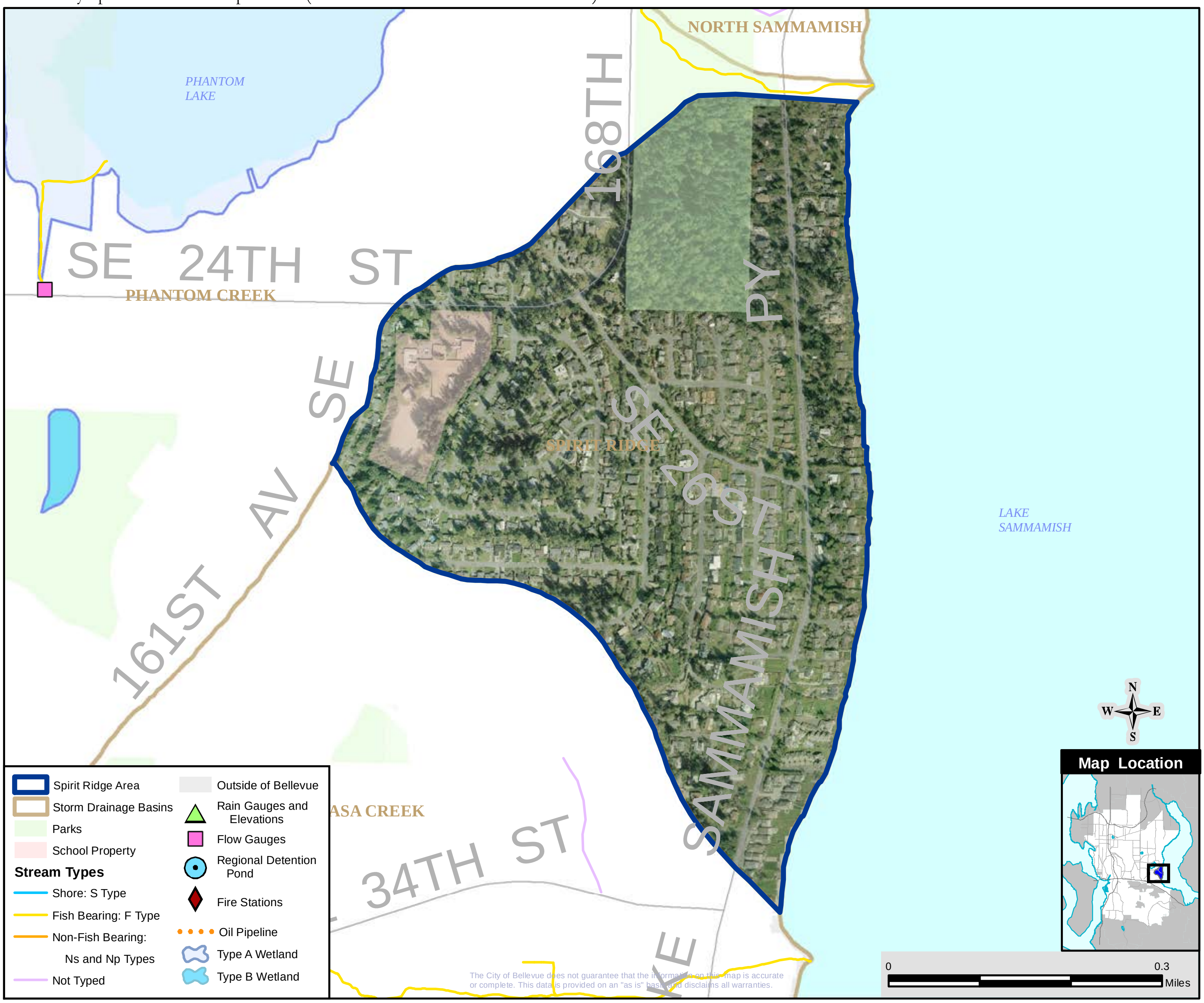
City Basin Population (2000): 1,274 ( 1.1% of the City)
Basin Population Density: 4,230 People/Square Mile
Number 19 of 26 Basins (One is the lowest density)

## LAND USE (within Bellevue city limits)

| | | |
|---|---|---|
| Public Right of Way: | 15.89% | 30.68 Acres |
| Institutional/Government: | 4.30% | 8.3 Acres |
| Multi-Family Residential: | 1.32% | 2.5 Acres |
| Commercial/Office: | 0.03% | 0.1 Acres |
| Open Space/Park: | 10.06% | 19.3 Acres |
| Single Family Residential: | 65.45% | 125.8 Acres |
| Mixed Use/Misc: | 0.54% | 1.0 Acres |

## LAND COVER

| | |
|---|---|
| Impervious: | 40% |
| Tree Canopy: | 34% |
| Impervious in 100 Ft Stream Buffer: | 24% |
| Tree Canopy in 100 Ft Stream Buffer: | 86% |

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Plot Date: 8/4/2011

# Sturtevant Creek Basin

Lake Washington Watershed (WRIA 8)
State Stream #08-0260

## LAND CHARACTERISTICS

Basin Area: 773 Total Acres ( 4% of the City)
Drainage Jurisdiction(s):
773.0 Acres - in Bellevue

Highest Elevation: 248 Ft
Lowest Elevation: 19 Ft

Total Length of Open Channel: 4,038 Ft
Total Length of Storm Drainage Pipes: 90,833 Ft
Built Rain Storage Volume per Acre of Impervious Surface:
Less than 0.5 Inches

## SALMON PRESENT in BASIN

Chinook*+
Coho+
Cutthroat trout
Sockeye

* Listed Federal Endangered Species
\+ City Species of Local Importance (Bellevue Land Use Code 20.25H.150A)

## POPULATION

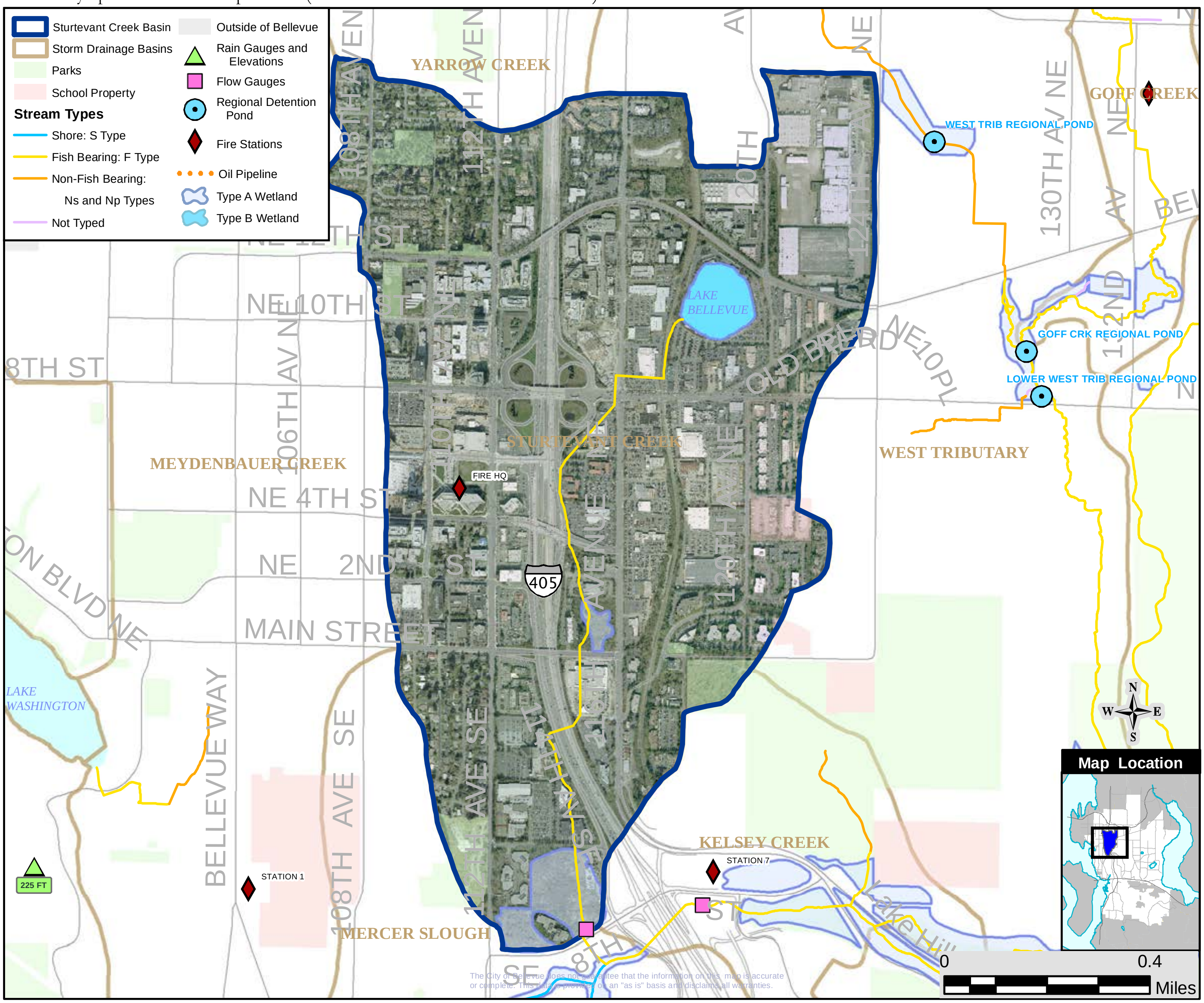
City Basin Population (2000): 2,182 ( 1.9% of the City)
Basin Population Density: 1,806 People/Square Mile
Number 2 of 26 Basins (One is the lowest density)

## LAND USE (within Bellevue city limits)

| | | |
|---|---|---|
| Public Right of Way: | 24.80% | 191.68 Acres |
| Commercial/Office: | 35.64% | 275.5 Acres |
| Mixed Use/Misc: | 8.21% | 63.5 Acres |
| Industrial: | 7.19% | 55.6 Acres |
| Institutional/Government: | 4.04% | 31.2 Acres |
| Multi-Family Residential: | 2.71% | 20.9 Acres |
| Open Space/Park: | 3.34% | 25.8 Acres |
| Single Family Residential: | 8.02% | 62.0 Acres |

## LAND COVER

| | |
|---|---|
| Impervious: | 71% |
| Tree Canopy: | 18% |
| Impervious in 100 Ft Stream Buffer: | 62% |
| Tree Canopy in 100 Ft Stream Buffer: | 23% |

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Plot Date: 8/9/2011

# Sunset Creek Basin

Lake Washington Watershed (WRIA 8)
State Stream #08-0262

## LAND CHARACTERISTICS

Basin Area: 890 Total Acres (3% of the City)
Drainage Jurisdiction(s):
536.6 Acres - in Bellevue
353.8 Acres - in King County

Highest Elevation: 1,059 Ft
Lowest Elevation: 63 Ft

Total Length of Open Channel: 9,830 Ft
Total Length of Storm Drainage Pipes: 87,054 Ft
Built Rain Storage Volume per Acre of Impervious Surface:
Less than 0.5 inches

## SALMON PRESENT in BASIN

| | |
|---|---|
| Chinook*+ | Sockeye |
| Coho+ | Steelhead |
| Cutthroat Trout | |

* Listed Federal Endangered Species
+ City Species of Local Importance (Bellevue Land Use Code 20.25H.150A)

## POPULATION

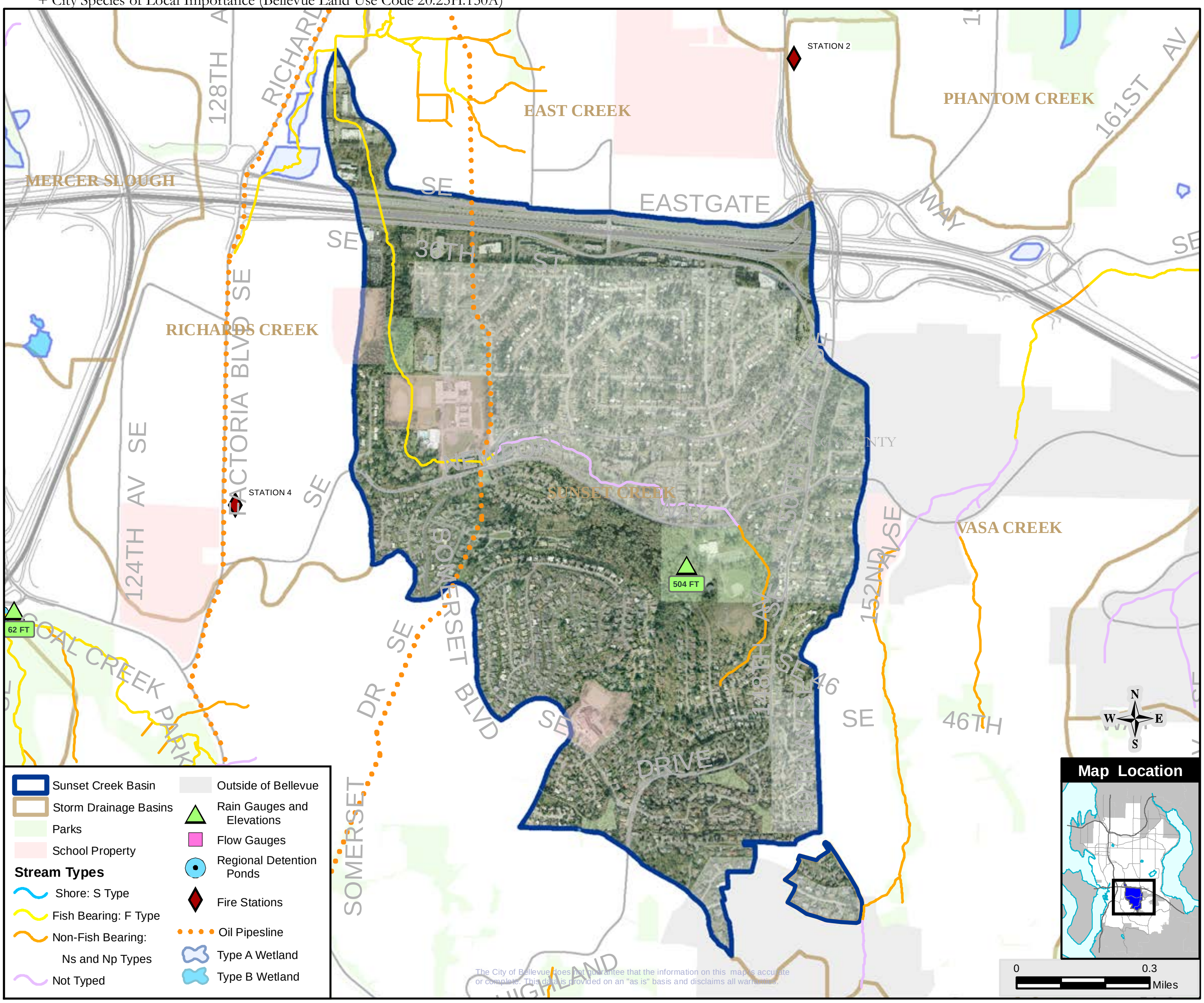
City Basin Population (2000): 3,174 ( 2.8% of the City)
Basin Population Density: 4,126 People/Square Mile
Number 18 of 26 Basins (One is the lowest density)

## LAND USE (within Bellevue city limits)

| | | |
|---|---|---|
| Public Right of Way: | 25.87% | 216.5 Acres |
| Commercial/Office: | 4.39% | 23.3 Acres |
| Industrial: | 0.98% | 5.2 Acres |
| Institutional/Government: | 14.77% | 78.6 Acres |
| Mixed Use/Misc: | 4.05% | 21.7 Acres |
| Multi-Family Residential: | 0.38% | 2.0 Acres |
| Open Space/Park: | 2.89% | 15.4 Acres |
| Single Family Residential: | 44.2% | 237.1 Acres |

## LAND COVER

| | |
|---|---|
| Impervious: | 42% |
| Tree Canopy: | 35% |
| Impervious in 100 Ft Stream Buffer: | 28% |
| Tree Canopy in 100 Ft Stream Buffer: | 60% |

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Updated: 8/4/2009

# Valley Creek Basin

Lake Washington Watershed (WRIA 8)
State Stream #08-0266

## LAND CHARACTERISTICS

Basin Area: 1,391 Total Acres ( 6% of the City)
Drainage Jurisdiction(s):
1,307.0 Acres - in Bellevue
29.4 Acres - in King County
3.1 Acres - in Kirkland
51.4 Acres - in Redmond

Highest Elevation: 529 Ft
Lowest Elevation: 182 Ft

Total Length of Open Channel: 17,290 Ft
Total Length of Storm Drainage Pipes: 76,677 Ft
Built Rain Storage Volume per Acre of Impervious Surface:
0.8 Inches

## SALMON PRESENT in BASIN

Chinook*+
Coho+
Cutthroat trout
Sockeye

* Listed Federal Endangered Species
\+ City Species of Local Importance (Bellevue Land Use Code 20.25H.150A)

## POPULATION

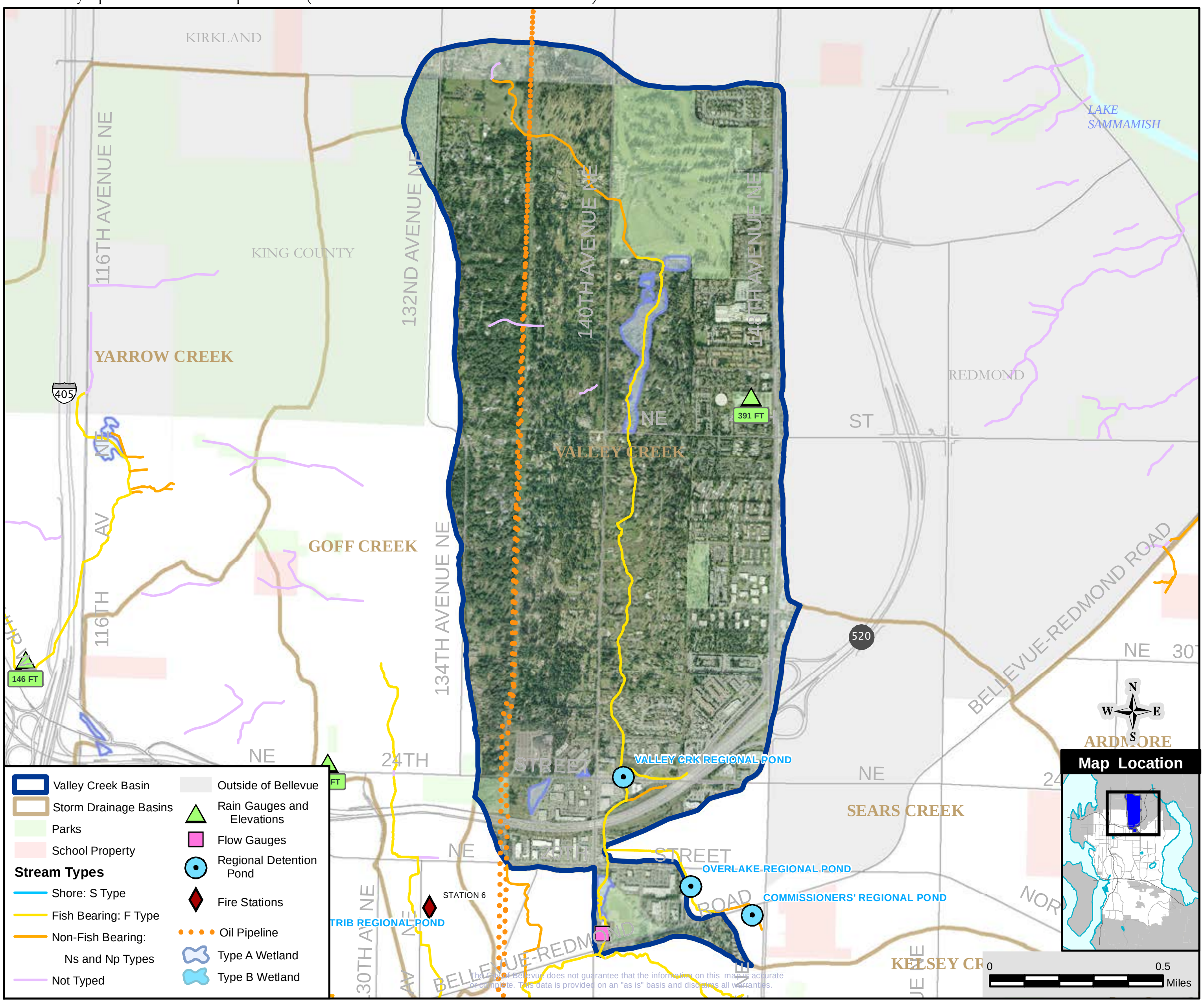
City Basin Population (2000): 7,605 ( 6.8% of the City)
Basin Population Density: 3,683 People/Square Mile
Number 15 of 26 Basins (One is the lowest density)

## LAND USE (within Bellevue city limits)

| | | |
|---|---|---|
| Public Right of Way: | 9.34% | 129.89 Acres |
| Commercial/Office: | 6.19% | 81.0 Acres |
| Industrial: | 0.22% | 2.9 Acres |
| Institutional/Government: | 0.83% | 10.9 Acres |
| Mixed Use/Misc: | 2.56% | 33.5 Acres |
| Multi-Family Residential: | 11.35% | 148.3 Acres |
| Open Space/Park: | 14.67% | 191.7 Acres |
| Single Family Residential: | 46.50% | 607.7 Acres |

## LAND COVER

| | |
|---|---|
| Impervious: | 34% |
| Tree Canopy: | 42% |
| Impervious in 100 Ft Stream Buffer: | 20% |
| Tree Canopy in 100 Ft Stream Buffer: | 56% |



# Vasa Creek Basin

Lake Washington Watershed (WRIA 8)
State Stream #08-0156

## LAND CHARACTERISTICS

Basin Area: 1,085 Total Acres ( 4% of the City)
Drainage Jurisdiction(s):
841.0 Acres - in Bellevue
243.9 Acres - in King County

Highest Elevation: 1,195 Ft
Lowest Elevation: 31 Ft

Total Length of Open Channel: 18,002 Ft
Total Length of Storm Drainage Pipes: 103,034 Ft
Built Rain Storage Volume per Acre of Impervious Surface:
Less than 0.5 Inches

## SALMON PRESENT in BASIN

Chinook*+ (Lake only)
Rainbow & cutthroat trout
Coho+
Sockeye (Lake only)
Kokanee+
Steelhead (Lake only)

* Listed Federal Endangered Species
+ City Species of Local Importance (Bellevue Land Use Code 20.25H.150A)

## POPULATION

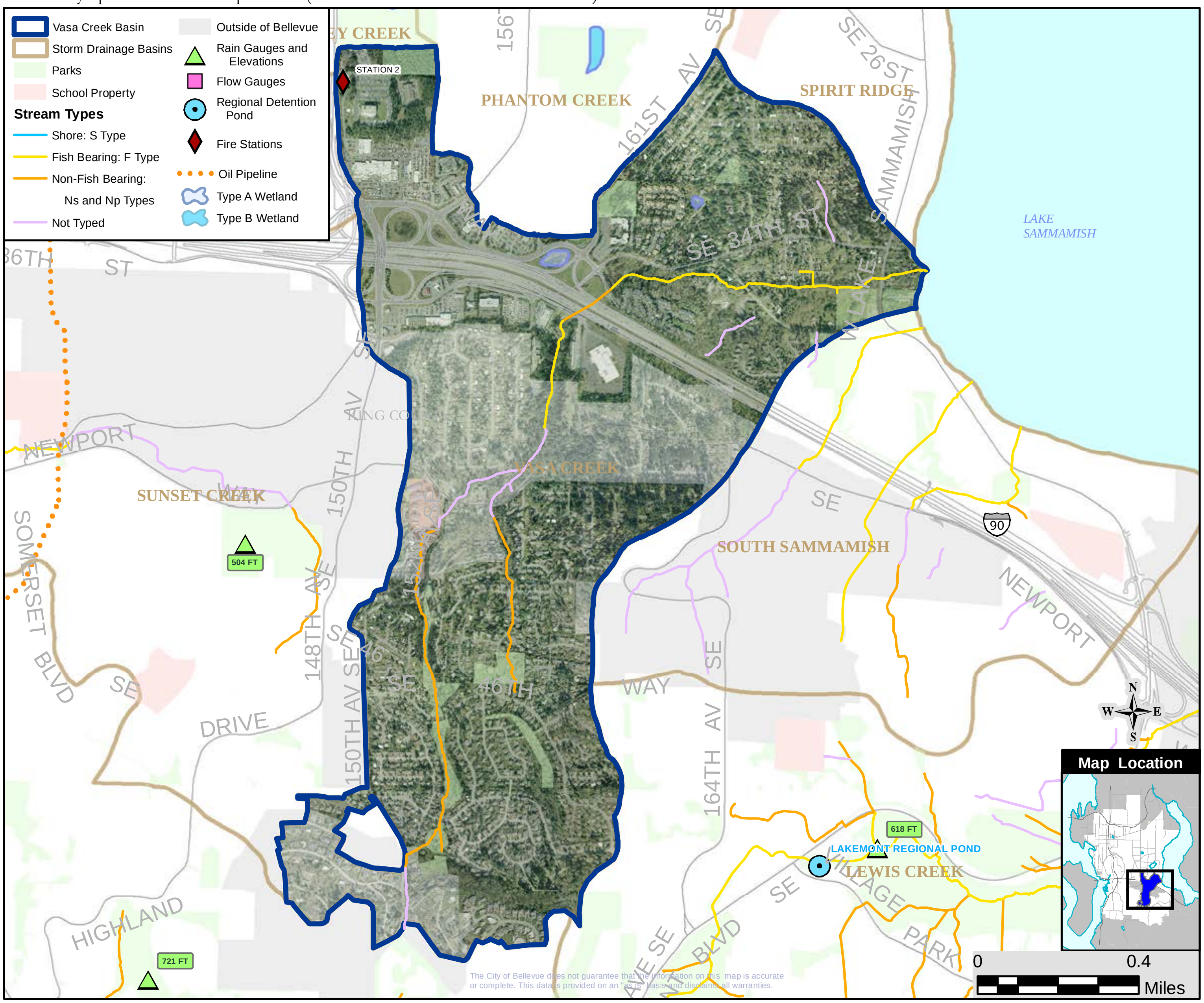
City Basin Population (2000): 4,586 ( 4.1% of the City)
Basin Population Density: 3,504 People/Square Mile
Number 14 of 26 Basins (One is the lowest density)

## LAND USE (within Bellevue city limits)

| | | |
|---|---|---|
| Public Right of Way: | 23.12% | 250.97 Acres |
| Commercial/Office: | 8.12% | 68.3 Acres |
| Mixed Use/Misc: | 2.94% | 24.7 Acres |
| Industrial: | 0.43% | 3.6 Acres |
| Institutional/Government: | 5.48% | 46.1 Acres |
| Multi-Family Residential: | 3.77% | 31.7 Acres |
| Open Space/Park: | 2.43% | 20.5 Acres |
| Single Family Residential: | 46.13% | 387.9 Acres |

## LAND COVER

| | |
|---|---|
| Impervious: | 40% |
| Tree Canopy: | 40% |
| Impervious in 100 Ft Stream Buffer: | 17% |
| Tree Canopy in 100 Ft Stream Buffer: | 73% |

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Plot Date: 8/9/2011

# West Tributary Basin

Lake Washington Watershed (WRIA 8)

State Stream #08-0264

## LAND CHARACTERISTICS

Basin Area: 1,006 Total Acres ( 5% of the City)

Drainage Jurisdiction(s):

1,005.8 Acres - in Bellevue

Highest Elevation: 496 Ft

Lowest Elevation: 26 Ft

Total Length of Open Channel: 18,121 Ft

Total Length of Storm Drainage Pipes: 86,842 Ft

Built Rain Storage Volume per Acre of Impervious Surface: 1.2 Inches

## SALMON PRESENT in BASIN

Chinook*+

Sockeye

Migratory & resident cutthroat trout

Coho+

* Listed Federal Endangered Species

\+ City Species of Local Importance (Bellevue Land Use Code 20.25H.150A)

## POPULATION

City Basin Population (2000): 3,329 ( 3.0% of the City)

Basin Population Density: 2,118 People/Square Mile

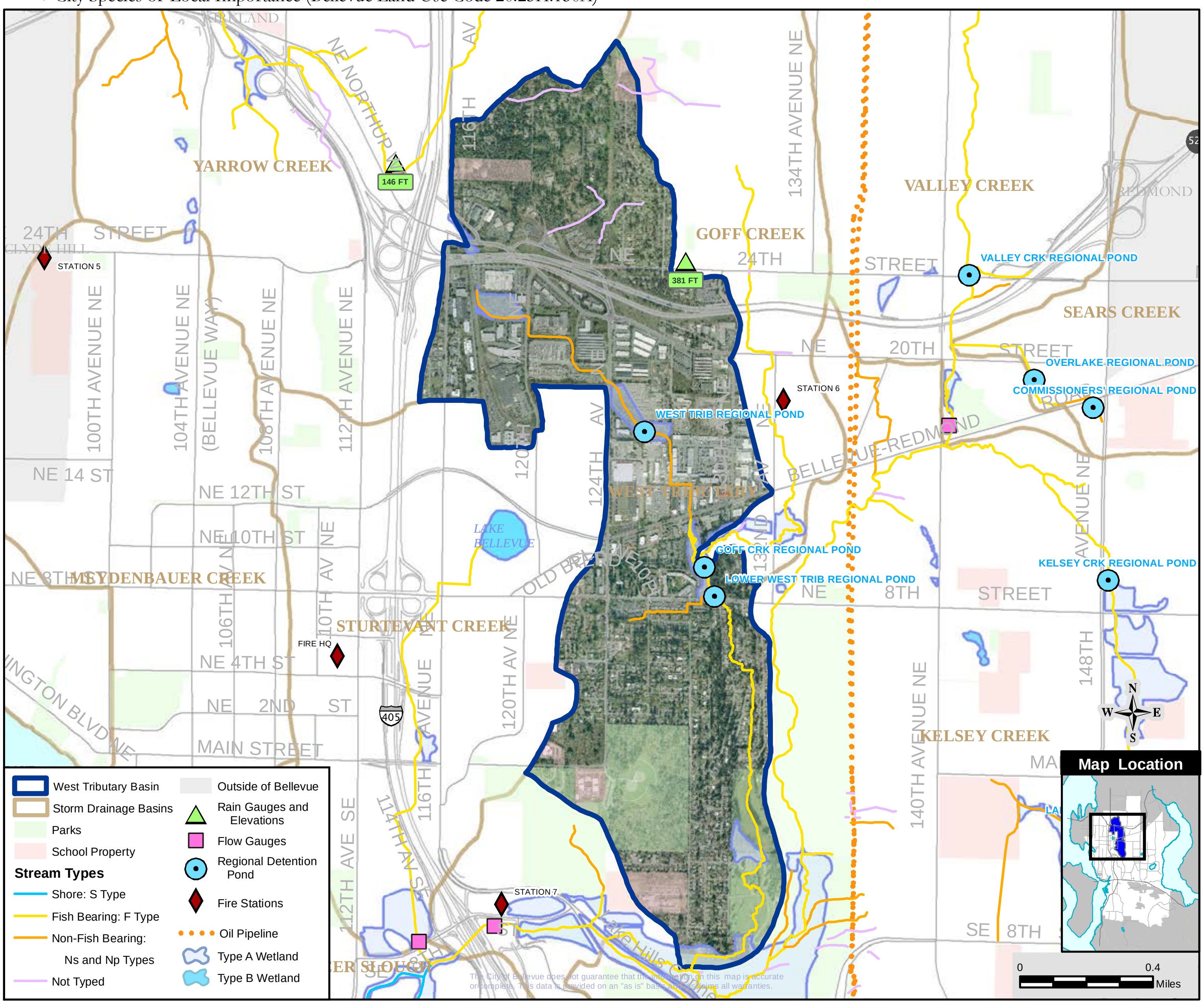
Number 7 of 26 Basins (One is the lowest density)

## LAND USE (within Bellevue city limits)

| | | |
|---|---|---|
| Public Right of Way: | 16.18% | 162.73 Acres |
| Commercial/Office: | 9.03% | 90.9 Acres |
| Industrial: | 15.09% | 151.8 Acres |
| Institutional/Government: | 4.62% | 46.5 Acres |
| Mixed Use/Misc: | 4.54% | 45.7 Acres |
| Multi-Family Residential: | 4.84% | 48.7 Acres |
| Open Space/Park: | 12.46% | 125.3 Acres |
| Single Family Residential: | 29.34% | 295.1 Acres |

## LAND COVER

| | |
|---|---|
| Impervious: | 46% |
| Tree Canopy: | 34% |
| Impervious in 100 Ft Stream Buffer: | 28% |
| Tree Canopy in 100 Ft Stream Buffer: | 49% |

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Plot Date: 8/9/2011

# Wilkins Creek Basin

Lake Washington Watershed (WRIA 8)
State Stream #08-0151

## LAND CHARACTERISTICS

Basin Area: 306 Total Acres ( 1% of the City)
Drainage Jurisdiction(s):
305.4 Acres - in Bellevue

Highest Elevation: 446 Ft
Lowest Elevation: 31 Ft

Total Length of Open Channel: 1,654 Ft
Total Length of Storm Drainage Pipes: 43,625 Ft
Built Rain Storage Volume per Acre of Impervious Surface:
0 Inches

## SALMON PRESENT in BASIN

Lake only: Chinook*+, Coho+ , Kokanee+, Sockeye
Rainbow & cutthroat trout (Lake only)
Steelhead (Lake only)

* Listed Federal Endangered Species
\+ City Species of Local Importance (Bellevue Land Use Code 20.25H.150A)

## POPULATION

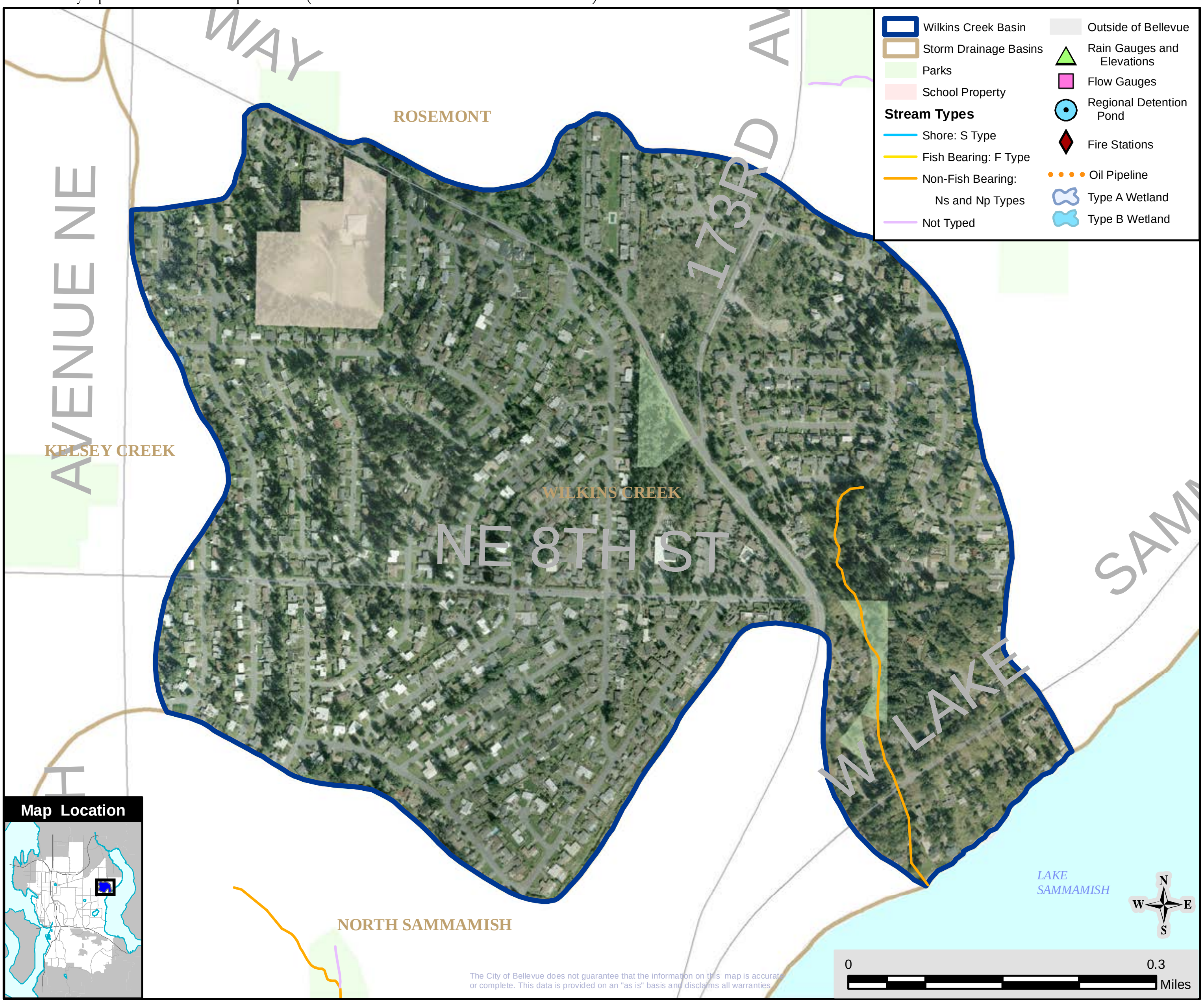
City Basin Population (2000): 2,560 ( 2.3% of the City)
Basin Population Density: 5,363 People/Square Mile
Number 25 of 26 Basins (One is the lowest density)

## LAND USE (within Bellevue city limits)

| | | |
|---|---|---|
| Public Right of Way: | 21.24% | 64.91 Acres |
| Institutional/Government: | 2.84% | 8.7 Acres |
| Mixed Use/Misc: | 0.86% | 2.6 Acres |
| Multi-Family Residential: | 3.60% | 11.0 Acres |
| Open Space/Park: | 3.81% | 11.6 Acres |
| Single Family Residential: | 65.23% | 199.2 Acres |

## LAND COVER

| | |
|---|---|
| Impervious: | 41% |
| Tree Canopy: | 29% |
| Impervious in 100 Ft Stream Buffer: | 16% |
| Tree Canopy in 100 Ft Stream Buffer: | 77% |



# Yarrow Creek Basin
Lake Washington Watershed (WRIA 8)
State Stream #08-0252

## LAND CHARACTERISTICS
Basin Area: 1,667 Total Acres ( 5% of the City)
Drainage Jurisdiction(s):
926.4 Acres - in Bellevue
0.8 Acres - in Clyde Hill
281.2 Acres - in King County
457.1 Acres - in Kirkland

Highest Elevation: 534 Ft
Lowest Elevation: 9 Ft

Total Length of Open Channel: 25,143 Ft
Total Length of Storm Drainage Pipes: 78,411 Ft
Built Rain Storage Volume per Acre of Impervious Surface:
Less than 0.5 Inches

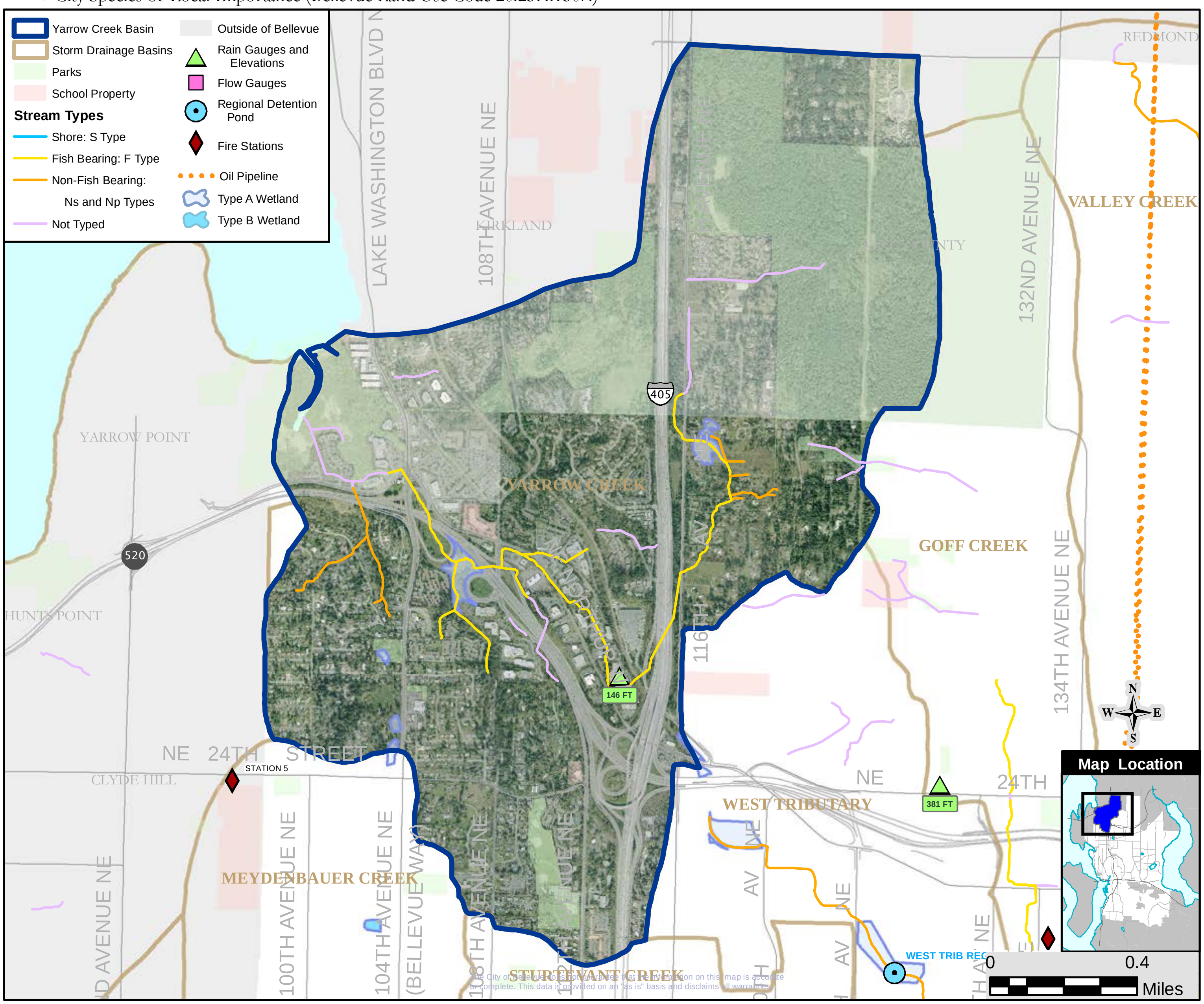
## SALMON PRESENT in BASIN
| | |
|---|---|
| Chinook*+ (Lake only) | Sockeye (Lake only) |
| Rainbow trout (Lake only) | Cutthroat trout |
| Coho+ (Lake only) | Steelhead (Lake only) |

* Listed Federal Endangered Species
\+ City Species of Local Importance (Bellevue Land Use Code 20.25H.150A)

## POPULATION
City Basin Population (2000): 3,772 ( 3.4% of the City)
Basin Population Density: 1,911 People/Square Mile
Number 4 of 26 Basins (One is the lowest density)

## LAND USE (within Bellevue city limits)
| | | |
|---|---|---|
| Public Right of Way: | 16.49% | 274.94 Acres |
| Commercial/Office: | 10.23% | 94.8 Acres |
| Industrial: | 1.73% | 16.0 Acres |
| Institutional/Government: | 2.25% | 20.9 Acres |
| Mixed Use/Misc: | 5.49% | 50.9 Acres |
| Multi-Family Residential: | 6.87% | 63.6 Acres |
| Open Space/Park: | 2.52% | 23.3 Acres |
| Single Family Residential: | 39.36% | 364.6 Acres |

## LAND COVER
| | |
|---|---|
| Impervious: | 31% |
| Tree Canopy: | 53% |
| Impervious in 100 Ft Stream Buffer: | 27% |
| Tree Canopy in 100 Ft Stream Buffer: | 58% |




V:\utpl\ArcGIS\Storm\BasinFactSheets2010\MapBkPLTS\StormBasinFactSht27Jul2011_LegNW.mxd

Plot Date: 8/9/2011

# Sears Creek Basin

Lake Washington Watershed (WRIA 8)
State Stream #08-0267

## LAND CHARACTERISTICS

Basin Area: 577 Total Acres ( 2% of the City)
Drainage Jurisdiction(s):
357.5 Acres - in Bellevue
219.9 Acres - in Redmond

Highest Elevation: 444 Ft
Lowest Elevation: 190 Ft

Total Length of Open Channel: 1,878 Ft
Total Length of Storm Drainage Pipes: 43,564 Ft
Built Rain Storage Volume per Acre of Impervious Surface:
0.9 Inches

## SALMON PRESENT in BASIN

Chinook*+
Coho+
Cutthroat trout
Sockeye

* Listed Federal Endangered Species
\+ City Species of Local Importance (Bellevue Land Use Code 20.25H.150A)

## POPULATION

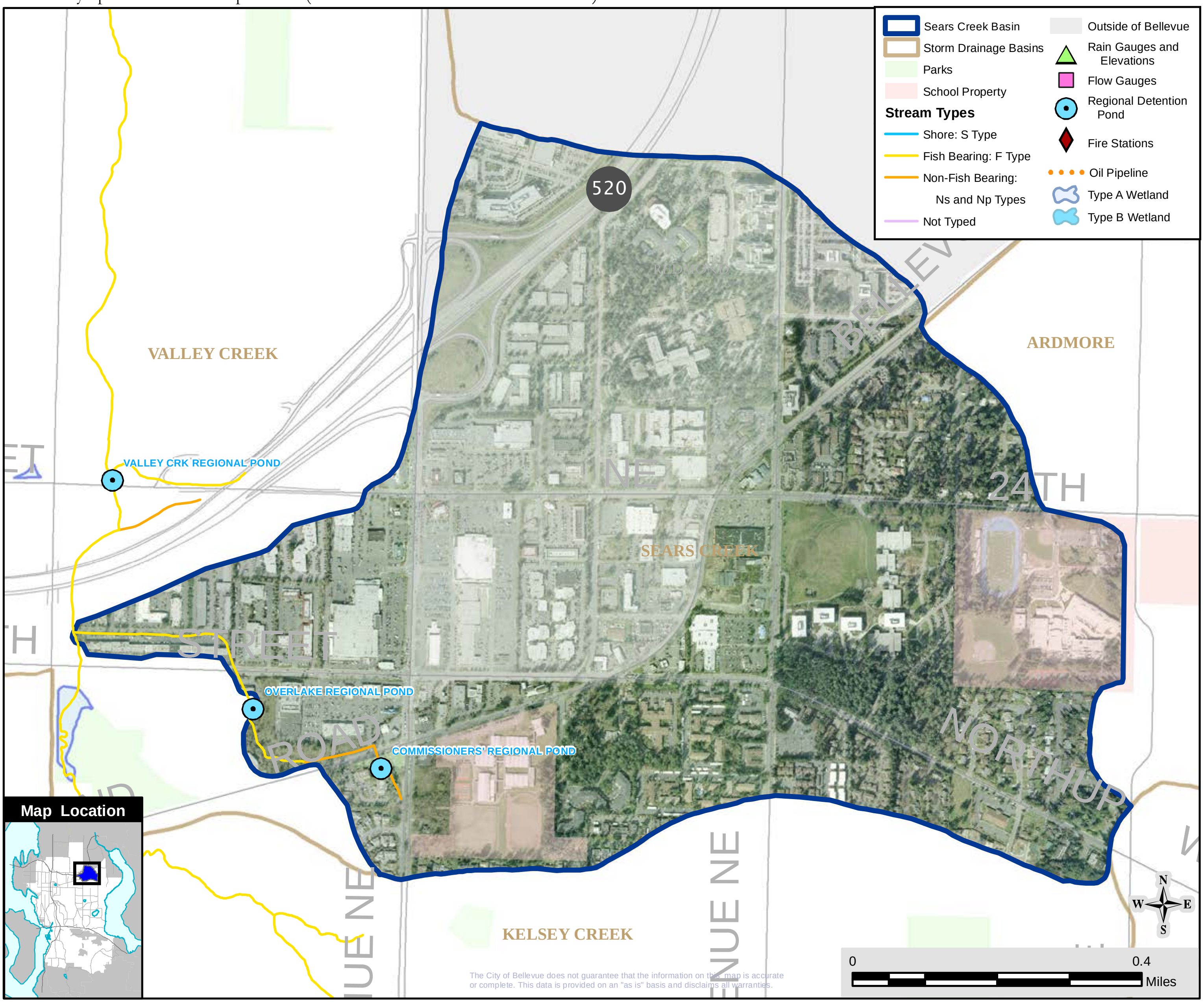
City Basin Population (2000): 2,391 ( 2.1% of the City)
Basin Population Density: 3,156 People/Square Mile
Number 13 of 26 Basins (One is the lowest density)

## LAND USE (within Bellevue city limits)

| | | |
|---|---|---|
| Public Right of Way: | 7.27% | 42.00 Acres |
| Commercial/Office: | 22.21% | 79.4 Acres |
| Mixed Use/Misc: | 12.02% | 43.0 Acres |
| Industrial: | 1.10% | 3.9 Acres |
| Institutional/Government: | 18.37% | 65.7 Acres |
| Multi-Family Residential: | 10.64% | 38.0 Acres |
| Open Space/Park: | 0.54% | 1.9 Acres |
| Single Family Residential: | 12.58% | 45.0 Acres |

## LAND COVER

| | |
|---|---|
| Impervious: | 63% |
| Tree Canopy: | 21% |
| Impervious in 100 Ft Stream Buffer: | 52% |
| Tree Canopy in 100 Ft Stream Buffer: | 44% |




The City of Bellevue does not guarantee that the information on this map is accurate or complete. This data is provided on an "as is" basis and disclaims all warranties.

# Phantom Creek Basin

Lake Washington Watershed (WRIA 8)
State Stream #08-0154

## LAND CHARACTERISTICS

Basin Area: 537 Total Acres ( 3% of the City)
Drainage Jurisdiction(s):
536.5 Acres - in Bellevue

Highest Elevation: 425 Ft
Lowest Elevation: 31 Ft

Total Length of Open Channel: 3,755 Ft
Total Length of Storm Drainage Pipes: 36,058 Ft
Built Rain Storage Volume per Acre of Impervious Surface:
Less than 0.5 Inches

## SALMON PRESENT in BASIN

Lake Sammamish only: Chinook*+, Coho+ , Kokanee+, Sockeye
Rainbow & cutthroat trout
Steelhead (Lake Sammamish only)

* Listed Federal Endangered Species
\+ City Species of Local Importance (Bellevue Land Use Code 20.25H.150A)

## POPULATION

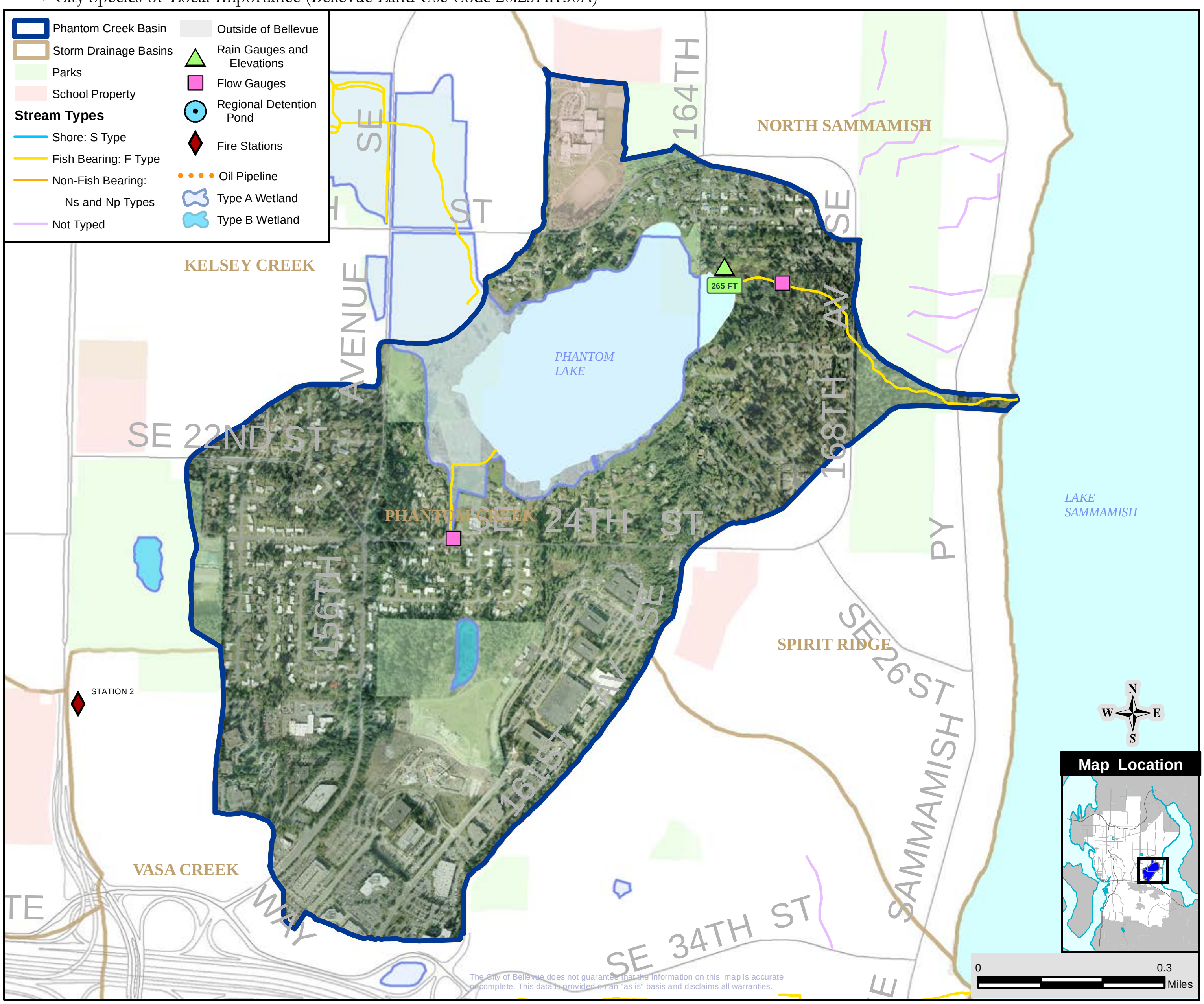
City Basin Population (2000): 1,606 ( 1.4% of the City)
Basin Population Density: 1,915 People/Square Mile
Number 5 of 26 Basins (One is the lowest density)

## LAND USE (within Bellevue city limits)

| | | |
|---|---|---|
| Public Right of Way: | 10.37% | 55.66 Acres |
| Commercial/Office: | 17.72% | 95.1 Acres |
| Mixed Use/Misc: | 0.70% | 3.8 Acres |
| Industrial: | 3.71% | 19.9 Acres |
| Institutional/Government: | 4.68% | 25.1 Acres |
| Multi-Family Residential: | 0.09% | 0.5 Acres |
| Open Space/Park: | 12.29% | 66.0 Acres |
| Single Family Residential: | 42.88% | 230.1 Acres |

## LAND COVER

| | |
|---|---|
| Impervious: | 35% |
| Tree Canopy: | 33% |
| Impervious in 100 Ft Stream Buffer: | 17% |
| Tree Canopy in 100 Ft Stream Buffer: | 64% |



## Appendix B-2. Impervious Area and Tree Canopy Cover for Drainage Basins and their Stream Buffers in Bellevue, 2007.

| Basin | % Impervious | % Tree Canopy | % Impervious in 100-foot Stream Buffers | % Tree Canopy in 100-foot Stream Buffers |
|---|---|---|---|---|
| Ardmore Area | 43 | 30 | 8 | 83 |
| Beaux Arts Area | 34 | 53 | * | * |
| Clyde Beach Area | 47 | 31 | * | * |
| Coal Creek Basin | 20 | 58 | 8 | 85 |
| East Creek Basin | 48 | 35 | 29 | 65 |
| Goff Creek Basin | 30 | 59 | 35 | 55 |
| Kelsey Creek Basin | 40 | 33 | 17 | 55 |
| Lakehurst Area | 33 | 37 | 21 | 62 |
| Lewis Creek Basin | 29 | 49 | 17 | 69 |
| Mercer Slough Basin | 32 | 43 | 7 | 53 |
| Meydenbauer Creek Basin | 59 | 24 | 36 | 44 |
| Newport Area | 39 | 30 | 7 | 91 |
| North Sammamish Area | 32 | 46 | 9 | 86 |
| Phantom Creek Basin | 35 | 33 | 17 | 64 |
| Richards Creek Basin | 45 | 36 | 22 | 62 |
| Rosemont Area | 38 | 31 | 6 | 55 |
| Sears Creek Basin | 63 | 21 | 52 | 44 |
| South Sammamish Area | 31 | 48 | 16 | 75 |
| Spirit Ridge Area | 40 | 34 | 24 | 86 |
| Sturtevant Creek Basin | 71 | 18 | 62 | 23 |
| Sunset Creek Basin | 42 | 35 | 28 | 60 |
| Valley Creek Basin | 34 | 42 | 20 | 56 |
| Vasa Creek Basin | 40 | 40 | 17 | 73 |
| West Tributary Basin | 46 | 34 | 28 | 49 |
| Wilkins Creek Basin | 41 | 29 | 16 | 77 |
| Yarrow Creek Basin | 31 | 53 | 27 | 58 |
| City-wide | 46 | 36.2 | Not available | Not available |

***No streams in this basin.**

**Appendix B-3. Basin Evaluation by Available Evaluation Criteria.**

| | Flood Protection | | | | Water Quality | | | | | Aquatic Habitat | | | Presence or Absence of Key Basin Issues | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Basin | Primary Street Closures per 100-year, 24-hour Storm | Secondary Street Closures per 100-year, 24-hour Storm | Flooded Structures (2000-2009) Note: >4 years less than claims | Flooding Claims (10/1/96-2/28/11) | Area Built prior to Stormwater Control Standards (%) | Total Impervious Area (%) | Phosphorus-sensitive Lake | Impaired Water Body (Ecology 303(d) list 2008) | Water Quality Risk Level (IDDE) | LWD Pieces per Channel Width | Pool Frequency and Quality (deep and cool with cover) | B-IBI Score (most recent) | Flood Protection | Water Quality | Aquatic Habitat |
| **Salmon Spawning Stream Basins** | | | | | | | | | | | | | | | |
| Coal Creek | 0 | 1 | >5 | 6 | 16 | 20 | No | Yes | Low | Fair | ND | 20 | √ | √ | √ |
| East Creek | 0 | 0* | <2 | | 45 | 48 | No | No | High | Poor | Poor | ND | | √ | √ |
| Goff Creek | 0 | 0 | <2 | | 46 | 30 | No | No | High | ND | ND | 18 | | √ | √ |
| Kelsey Creek | 2 | 1 | 3-4 | 7 | 57 | 40 | No | Yes | High | Poor | Poor | 18 | √ | √ | √ |
| Lewis Creek | 1 | 0 | <2 | | 4 | 29 | Yes | Yes | Medium | ND | ND | 20 | √ | √ | √ |
| Mercer Slough | 0 | 0 | <2 | 2 | 38 | 32 | No | Yes | Medium | ND | ND | NA | √ | √ | |
| Newport Area | 0 | 0 | 3-4 | | 82 | 39 | No | No | Low | ND | ND | 16 | √ | √ | √ |
| Richards Creek | 1* | 0 | 3-4 | 4 | 32 | 45 | No | No | High | Poor | Poor | ND | √ | √ | √ |
| Valley Creek | 0 | 0 | <2 | 1 | 36 | 34 | No | No | High | Poor | Poor | 16 | √ | √ | √ |
| Vasa Creek | 0 | 0 | 3-4 | 1 | 36 | 40 | Yes | No | Medium | ND | ND | 24 | √ | √ | √ |
| West Tributary | 0 | 0 | 3-4 | 2 | 51 | 46 | No | No | High | ND | ND | 18 | √ | √ | √ |
| **Small and Steep Stream Basins** | | | | | | | | | | | | | | | |
| Ardmore | 0 | 0 | <2 | | 63 | 43 | Yes | Yes | Low | ND | ND | 22 | | √ | √ |
| Lakehurst | 0 | 0 | <2 | 3 | 37 | 33 | No | No | Low | ND | ND | 20 | √ | | √ |
| North Sammamish | 0 | 0 | <2 | 2 | 56 | 32 | Yes | No | Low | NA | NA | NA | √ | | |
| Phantom Creek | 0 | 0 | <2 | 1 | 35 | 35 | Yes | No | Low | ND | ND | 26 | √ | | √ |
| Sunset Creek | 0 | 1 | >5 | | 47 | 42 | No | No | High | Poor | Poor | 14 | √ | √ | √ |
| South Sammamish | 0 | 0 | <2 | | 22 | 31 | Yes | No | Low | ND | ND | ND | | | |
| Wilkins Creek | 0 | 0 | <2 | 2 | 76 | 41 | Yes | No | Low | ND | ND | 22 | √ | | √ |
| Yarrow Creek | 0 | 0 | 3-4 | 2 | 40 | 31 | No | Yes | High | ND | ND | ND | √ | √ | √ |
| **Closed Conveyance System Basins (>96% piped storm drainage system)** | | | | | | | | | | | | | | | |
| Beaux Arts Area | 0 | 1 | <2 | | 53 | 34 | No | No | NA | NA | NA | NA | √ | | |
| Clyde Beach | 0 | 0 | <2 | 1 | 62 | 47 | No | No | NA | NA | NA | NA | √ | | |
| Meydenbauer Creek | 0 | 0 | >5 | 4 | 48 | 59 | No | Yes (Bay) | Medium | ND | ND | ND | √ | √ | |
| Rosemont Area | 1 | 0 | 3-4 | 8 | 55 | 38 | Yes | No | NA | NA | NA | NA | √ | | |
| Sears Creek | 0 | 0 | <2 | | 32 | 63 | No | No | High | ND | ND | ND | | √ | |
| Spirit Ridge | 0 | 0 | 3-4 | 2 | 65 | 40 | Yes | No | NA | NA | NA | NA | √ | √ | |
| Sturtevant Creek | 0 | 0 | <2 | 2 | 34 | 71 | Yes | No | High | ND | ND | ND | √ | √ | |

Note: See Appendices B-1, B-2, and B-4 through B-14 for additional details and supporting information of the evaluation data.

## Appendix B-4. Information used to Evaluate Basins, and for the Evaluation Metrics and Results

### *Road Closures Due to Storms*

Road closures during the five storm events reported below are due to flooding unless otherwise indicated. Other storm-related causes of road closures include landslides and sink holes. The amount of rainfall reported below is the total amount of rain for the duration of the storm event, and the frequency applies to the maximum amount of rain that fell during a consecutive 24-hour period during the storm event. For purposes of evaluating the basins, the range in the number of road closures during an individual storm event are reported by road type, only for primary and secondary roads. Arterial/collector streets and neighborhood streets are included here because they may be addressed after the highest priority recurring road closures are fixed. The following recurring road closures reported for the 2001 and 2003 storm events have been resolved by flood control projects through the Capital Investment Program, and have not been closed during any storms that have occurred since the project was built:

- Kamber Road at East Creek (2004—culvert replacement)
- SE 30th Street at East Creek (2010 to 2011—culvert replacement)

A project to reduce flooding at Factoria Boulevard was constructed in 2003, but this road flooded in a large storm in 2006. It is possible that regular maintenance since that time has prevented flooding in subsequent large storms. A project to evaluate flooding and capacity issues and determine steps to resolve the flooding at 156th Avenue SE at SE 11th Street is in progress as of 2011.

| Storm Event | | | Road Closures (Drainage Basin) | | | |
|---|---|---|---|---|---|---|
| Date(s) | Rainfall (inches) | Storm Frequency | Primary* | Secondary* | Arterial/Collector Streets* | Neighborhood Streets* |
| Nov. 14-15, 2001 | 3.5 | >10-year, 24-hour | 1) West Lake Sammamish Parkway (Rosemont)<br>2) Factoria Blvd. (Richards)<br>3) 148th Avenue SE at Larsen Lake (Kelsey) | 1) Kamber Road at East Creek (Sunset)<br>2) 156th Avenue at SE 11th St. (Kelsey) | none | 1) NE 21st St. at 140th Avenue NE (Sears)<br>2) SE 7th Place near Lake Hills Connector (Kelsey)<br>3) SE 30th at Sunset Creek (Sunset) |
| Oct. 20-21, 2003 | 5.1 | >100-year, 24-hour | 1) Bel-Red Road at 140th Avenue NE (Kelsey)<br>2) Factoria Blvd. (Richards)<br>3) 148th Avenue SE at Larsen Lake (Kelsey) | 1) Kamber Road at East Creek (Sunset) | none | 1) SE 7th Place near Lake Hills Connector (Kelsey) |

| Storm Event | | | Road Closures (Drainage Basin) | | | |
|---|---|---|---|---|---|---|
| Date(s) | Rainfall (inches) | Storm Frequency | Primary* | Secondary* | Arterial/Collector Streets* | Neighborhood Streets* |
| Nov. 5-7, 2006 | 3.2 | <10-year, 24-hour | 1) West Lake Sammamish Parkway (Rosemont)<br>2) Factoria Blvd. (Richards) | none | none | 1) NE 21st St. at 140th Avenue NE (Sears)<br>2) SE 7th Place near Lake Hills Connector (Kelsey)<br>3) SE 30th at Sunset Creek (Sunset) |
| Dec. 2-4, 2007 | 6.1 | >100-year, 24-hour | 1) Newport Way near Lakemont Blvd. - sinkhole (Lewis)<br>2) 148th Avenue SE at Larsen Lake (Kelsey) | 1) 97th Place SE between SE 11th and SE 15th St. - landslide (Beaux Arts) | none | 1) NE 21st St. at 140th Avenue NE (Sears)<br>2) SE 7th Place near Lake Hills Connector (Kelsey) |
| Dec. 11-12, 2010 | 4.6 | >100-year, 24-hour | 1) West Lake Sammamish Parkway-landslide (Rosemont)<br>2) 148th Avenue SE at Larsen Lake (Kelsey) | 1) 97th Place SE between SE 11th and SE 15th St. - landslide (Beaux Arts)<br>2) Lakemont/Newcastle Road-landslide (Coal) | none | 1) NE 21st St. at 140th Ave NE (Sears)<br>2) SE 7th Place near Lake Hills Connector (Kelsey) |

***Primary and secondary roads are priority routes during emergencies, and are priority areas for preventing closures due to storms where it is not cost-prohibitive. Arterial/collector streets and neighborhood streets are lower priorities for preventing closures during storms.**

**Appendix B-5. Count of Flooded Structures from Historic Work Order Database.**

Note: Includes flood records from 1/1/2000 to 9/30/2009 that were not coded as having a private cause/remedy.

These report numbers may include multiple calls for the same incident, maintenance issues (e.g., leaves blocking catch basins), and other issues involving the public storm system. All reports are investigated and actions taken for public safety and protection of property.

Any areas where recurring maintenance issues might occur are placed on the Routine Flood Prevention Maintenance Inspection List. Flooding incidents that may require infrastructure changes are reviewed as part of the Capital Investment Program. In rare cases, affected properties may be acquired, especially if the property could provide multiple benefits.

| Basin | Number of Flooded Structures | Flooded Structure Evaluation* | Paid Claims (*=Yes) | Additional Actions in Basin |
|---|---|---|---|---|
| Ardmore | 2 | Few | | |
| Beaux Arts | 0 | Few | | |
| Clyde Beach | 2 | Few | * | |
| Coal Creek | 5 | Many | * | Maintenance surveillance; Capital Investment Program (CIP) flood control projects |
| East Creek | 1 | Few | | CIP flood control projects |
| Goff Creek | 1 | Few | | |
| Kelsey Creek | 4 | Moderate | * | Maintenance surveillance; CIP flood control projects; acquisition |
| Lakehurst | 1 | Few | * | Maintenance surveillance |
| Lewis Creek | 2 | Few | | Maintenance surveillance; acquisition |
| Mercer Slough | 2 | Few | * | |
| Meydenbauer Creek | 13 | Many | * | Maintenance surveillance |
| Newport | 3 | Moderate | | Maintenance surveillance |
| North Sammamish | 1 | Few | * | Maintenance surveillance |
| Rosemont | 4 | Moderate | * | Maintenance surveillance |
| Sears Creek | 0 | Few | | |
| South Sammamish | 2 | Few | | |
| Spirit Ridge | 3 | Moderate | * | Maintenance surveillance |
| Sturtevant Creek | 0 | Few | * | Maintenance surveillance |
| Sunset Creek | 5 | Many | | Maintenance surveillance; CIP flood control projects |
| Valley Creek | 1 | Few | * | |
| West Tributary | 3 | Moderate | * | |
| Wilkins Creek | 1 | Few | * | |
| Yarrow Creek | 3 | Moderate | * | Maintenance surveillance; CIP flood control projects |
| Total | 68 | | | |

***Few (0-2); Moderate (3-4); Many ($\geq$5)**

# Appendix B-6. Volume of Storage and other Characteristics of Bellevue's Public Regional Detention Ponds (updated 2009).

| Regional Pond | Volume at Overflow (ac-ft) | Tributary Area (ac) | Tributary EIA (ac) | Total Volume/Acre Tributary EIA 1 (ft) | Stage at Overflow (ft, NGVD) | Q at Overflow (cfs) | Overflow Return Period (yrs) | Notes |
|---|---|---|---|---|---|---|---|---|
| Kelsey Creek Pond 2 (133) | 32.0 | 1594 | 476 | 0.18 | 247.9 | 110.0 | 20.0 | Larsen Lake is upstream |
| Larsen Lake Pond 2 (149) | 54.0 | 833 | 207 | 0.26 | 253.4 | 23.0 | 1.5 | |
| Lower West Tributary Pond 2 (164S) | 8.0 | 1423 | 517 | 0.07 | 109.2 | 85.0 | 5.0 | Goff Creek and Upper West Tributary ponds are upstream |
| Goff Creek Pond 2 (164N) | 8.0 | 1268 | 427 | 0.07 | 113.4 | 53.0 | 2.0 | Upper West Tributary pond is upstream |
| Upper West Tributary Pond 2 (165) | 22.0 | 463 | 238 | 0.09 | 131.2 | 39.0 | 10.0 | |
| Valley Creek Pond 2 (197) | 15.0 | 1298 | 288 | 0.05 | 198.5 | 37.0 | 5.0 | |
| Overlake Pond 2 (179N) | 12.0 | 514 | 312 | 0.05 | 246.6 | 55.0 | 25.0 | Commissioners Pond upstream |
| Commissioners Pond 2 (179S) | 2.7 | 269 | 116 | 0.02 | 282.4 | 37.0 | 5.0 | |
| Total Kelsey Basin 2 | 153.7 | 6470 | 2040 | 0.08 | | | | |
| I-405 Pond (Coal Creek Basin) 3 | 19.5 | 4550 | | | 72.5 | 585 | | |
| Lakemont (Lewis Creek Basin) 4 | 31.6 | 252.4 | 85.1 | 0.37 | 634.6 5 | | | |

[1] **From Northwest Hydraulic Consultants. 2002. Hydrologic Study of Kelsey Creek Basin, Bellevue, WA.**
[2] **Volume includes all upstream regional pond storage. EIA = Effective Impervious Area, or impervious area that drains directly to the storm drain system and streams.**
[3] **From Jensen, Bruce. 2004. I-405 Rating Curve Development, Entranco, Inc., Bellevue, WA.**
[4] **From City of Bellevue. 2002. Lakemont Stormwater Filtration Facility, Operations and Maintenance Manual, Volume 1: Procedures Manual.**
[5] **Emergency spillway overflow elevation.**

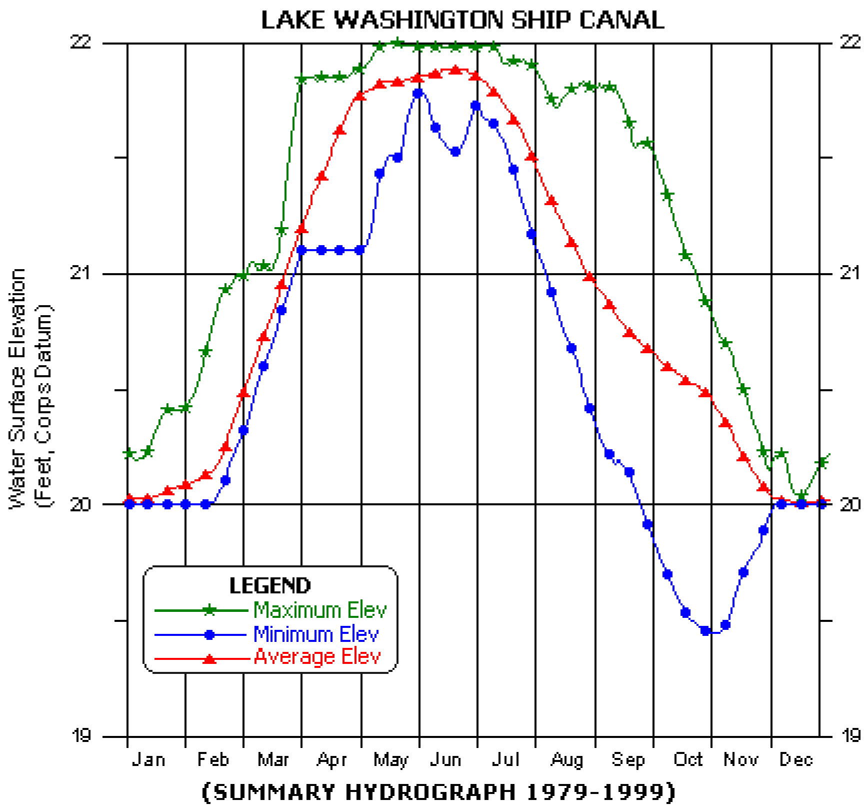
## Appendix B-7. B-IBI Scores at Bellevue Sites in all Sampled Years.

Note: Replicate scores are given, as well as mean B-IBI site scores. To obtain B-IBI site scores, metric values were individually averaged and scored; scores of averaged metric values were summed. Bold B-IBI scores indicate samples collected by King County; others were collected by Bellevue staff.

| Stream | River Mile | Site Code | Location | 1998 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lewis | 1.8 | LewisUS/ravine | Lewis upstream of I-90 | | | | 30 | | 32 | | 22 | 24 | 26 | |
| Lewis | 0.8 | LewisI90 | Lewis on Lakemont Blvd. at I-90 | 28 | 26 | 24 | 30 | | 24 | 26 | 24 | 22 | | 20 |
| Lewis | 0.3 | LewisElliot | Lewis downstream of I-90 | | | | | | 24 | 28 | 22 | | 22 | |
| Coal | 4.0 | Cindermines | Coal off Newcastle Road at cinder mine detention site | 32 | 20 | 22 | | | 30 | 30 | 24 | 24 | | |
| Coal | 2.3 | Trailhead | Coal above Coal Creek Parkway | 26 | 22 | 22 | | | 22 | 26 | 22 | 22 | 20 | |
| Coal | 1.8 | CoalPkwy | Coal below Coal Creek Parkway | 26 | 22 | 20 | | | | | | 20 | | |
| Trib 0273 | 0.3 | 08EAS2540 | Trib. 0273, upstream of Forest Dr. SE, trib. to Coal Creek | | | | | | | | | | 20 | |
| Goff | 1.7 | GoffUsBp | Goff upstream of bypass | 18 | 16 | 12 | | | | | | | | |
| Goff | 1.6 | GoffInBp | Goff in bypass area | 18 | 18 | 14 | | | | | | | | |
| Goff | 1.5 | GoffDsBp | Goff downstream of bypass | 18 | 14 | 18 | | | | | | | | |
| Goff | 0.1 | GoffMouth | Just upstream of confluence with West Trib. | | | | | | | | | | | 18 |
| Valley | 0.2 | Valley | Valley at Highland Park | | | | | | 18 | 16 | | | | |
| Kelsey | 3.9 | KelByrne | Kelsey upstream of Glendale Country Club (GCC) (1400 block 143rd Place NE) | 20 | 18 | 16 | | | | | | | | |
| Kelsey | 3.7 | Peltzer | Upstream of Glendale 14434 NE 14th Bellevue | | | | | | 18 | 18 | | 18 | 14 | |
| Kelsey | 3.6 | WAM06600-038087 | Kelsey downstream of Peltzer | | | | | | | | | | 18 | |
| Kelsey | 3.2 | 08EAS2272 | Kelsey downstream of 140th Avenue NE near NE 15th St. | | | | | | | | | | 14 | |
| Kelsey | 2.3 | KelWeirs | Kelsey at GCC within step weirs | 12 | 10 | 10 | | | | | | | | |
| Kelsey | 2.1 | KelGCfb | Kelsey at GCC below step weirs | 12 | 10 | 12 | | | | | | | | |
| Kelsey | 1.8 | Glendale | Kelsey at GCC wooded area | 18 | 16 | 16 | | 15 | 14 | 18 | | 16 | 18 | |
| Kelsey | 1.6 | KelFarm | Kelsey Farm | | | | | | 18 | | | | 16 | |
| Kelsey | 0.2 | KelTrstl | Kelsey under trestle and below culvert | 16 | 18 | 14 | | | | | | | | |
| West Trib | 0.4 | WTribFarm | West Trib. in Kelsey Farm, restored reach | | | | | | | | | | 16 | 18 |
| Sunset | 0.3 | 08EAS2546 | Sunset near SE 32nd St. | | | | | | | | | 14 | | |
| Vasa | 0.1 | 08LAK2827 | Vasa between West Lake Sammamish Parkway and Lake Sammamish | | | | | | | | | | 24 | |
| Idylwood | 0.3 | 08LAK3121 | Idylwood in Redmond, near 175th and NE 34th St. | | | | | | | | | | 22 | |
| Lakehurst | 0.3 | Lkhrst405 | Just upstream of pond, east of I-405 | | | | | | | | | | | 20 |

| Stream | River Mile | Site Code | Location | 1998 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Newport | 0.4 | NewpStab | Stabilized reach downstream of swim club on 119th | | | | | | | | | | | 16 |
| Phantom | 0.2 | PhanWeowna | Lower Phantom Lake, just upstream of West Lake Sammamish in Weowna Park | | | | | | | | | | | 26 |
| Wilkins | 0.33 | WilkUpstr | Upstream of Bypass, at NE 8th and Northup Way | | | | | | | | | | | 22 |
| Wilkins | 0.26 | WilkBypass | In bypass reach, near NE 8th and Northup Way | | | | | | | | | | | 22 |

**Appendix B-8. Lake Washington Average Water Levels over a Year based on Daily Measurements (collected at 8:00 a.m.) at the Ship Canal, Measured between 1979 and 1999.**




**Notes:**

1. The Lake Washington Ship Canal is operated primarily as a navigation facility connecting Puget Sound and Lakes Union and Washington. Project authorization documents state that under normal operation the Lake Washington Ship Canal should be maintained within a 2-foot range between 20.0 feet and 22.0 feet (U.S. Army Corps of Engineers Datum), respectively. The minimum elevation is maintained during the winter months to allow for annual maintenance on docks, walls, etc., by businesses and lakeside residents, minimize wave and erosion damage during winter storms, and provide storage space for high inflow. The storage between 20 and 22 feet is used to augment Lake Washington Ship Canal inflows for use in operating the locks, the saltwater return system, the smolt passage flume, and the fish ladder facility.
2. The locks and spillway dam regulate the elevation of Salmon Bay, Lake Union, Lake Washington, and the Lake Washington Ship Canal. The level of Lake Washington was lowered about 8 feet by the construction of the Lake Washington Ship Canal, but it is still the second largest natural lake in the state, with a surface area of 22,138 acres and shoreline of about 91 miles at elevation 22 feet.

Source: U.S. Army Corps of Engineers (2004)

**Appendix B-9. Sunset Creek Sedimentation Study**

Stream sediment samples have been collected for a number of years along Sunset Creek at SE 30th Street. Sample locations are shown in Figure B-9A below. This particular segment of Sunset Creek, at SE 30th Street, is the site of a recently constructed sediment trap and culvert replacement. The area has experienced periodic flooding and is a location where the City, with appropriate permits, has been removing builtup sediment directly from the stream. Samples were taken at the same key locations before and after installation of the new culvert and sediment trap.

As discussed in Chapter 6 of the Storm and Surface Water System Plan, too much fine sediment can smother salmon eggs laid in a stream. Table B-9A, taken from the Post Construction/2010 Conditions Report prepared by Herrera Environmental, shows changes in fine sediment content from year to year (pre-project 2007 and 2009 baseline) even before construction. Note that the table not only provides year-to-year direct comparison of fine sediment, it also shows changes in the sediment conditions for salmon spawning with readings of Good, Fair, and Poor.

Table B-9A shows a reduction in fine sediment post-construction. This is generally seen as improving salmon spawning conditions in three of the four sample sites from PoortoFair. However, proper management of the new sediment trap requires many years of sampling data. Permit conditions from local, state, and federal agencies require that sediment sampling, stream cross-section survey, and a variety of other stream features be monitored for a period of 15 years. Additional downstream projects are planned as part of a comprehensive approach to flood control and stream enhancement along this segment of Sunset Creek, Richards Creek, and East Creek. Data will be collected and reports will be available as construction and monitoring continues.

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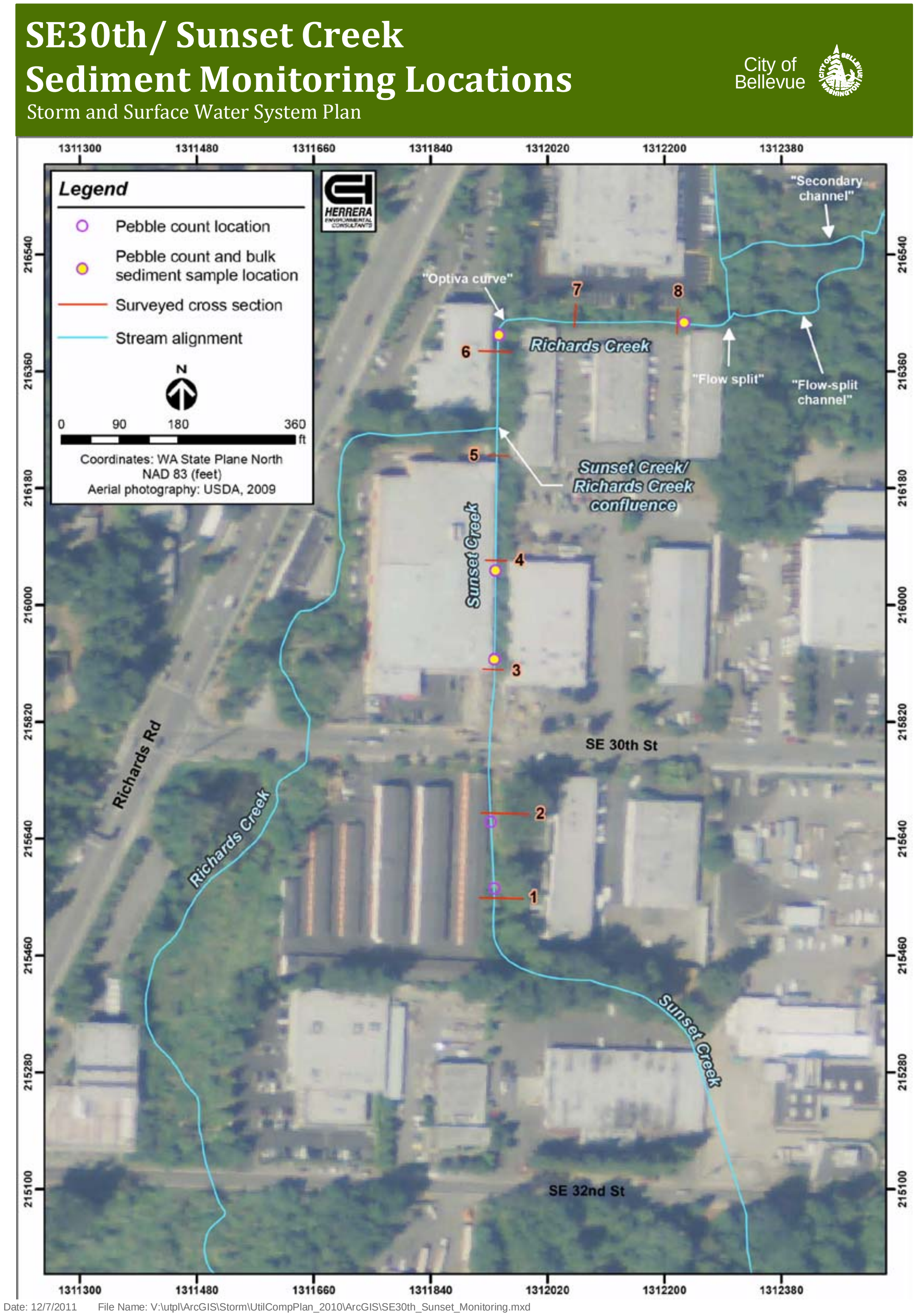


**Figure B-9A. Sampling data taken in Sunset Creek.**

**Table B-9A. Table taken from the Sunset Creek and Richards Creek Channel Monitoring Report, Post-Construction / 2010 Conditions prepared by Herrera Environmental Consultants, dated December 2010.**

**A comparison of pre-project 2007, baseline, and post-construction / 2010 bulk sediment sample monitoring results according to the City of Bellevue's Monitoring Protocol standards (2009), 1 of 3.**

| Cross-section Location | | % Finer than 0.85 mm | | | Condition | | |
|---|---|---|---|---|---|---|---|
| Pre-project (2007) | Monitoring | Pre-project (2007) | Baseline (2009) | Post-con (2010) | Pre-project (2007) | Baseline (2009) | Post-con (2010) |
| SS-1 | 3 | 12.0 | 24.2 | 14.7 | Good | Poor | Fair |
| SS-2 | 4 | 14.5 | 21.1 | 15.4 | Fair | Poor | Fair |
| SS-3 | 6 | 18.5 | 19.8 | 13.5 | Poor | Poor | Fair |
| SS-5 | 8 | 28.0 | 28.6 | 18.8 | Poor | Poor | Poor |

[a] Grain size condition is judged as:
Good is <12% finer than 0.85 mm (per Schuett-Hames et al. 1999)
Fair is 12 - 17% finer than 0.85 mm
Poor is >17% finer than 0.85 mm

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## Appendix B-10. Rates of Pre-spawn Mortality (PSM) in Kelsey Creek Index Reaches (Kelsey Creek, West Tributary, and Richards Creek) from Fall Salmon Spawner Surveys.

| Year | Percent Pre-Spawn Mortality Rate (female carcasses only) | Total Number of Adult Spawners | Species |
|---|---|---|---|
| 2000-2001 | 74 | 35 (female) | coho |
| 2002 | 0 | 11 (male and female) | Chinook |
| 2003 | 0 | 1 (female) | Chinook |
| 2006 | 7 | 200 (male and female) | Chinook |
| 2007 | 15 | 193 (male and female) | Chinook |
| 2008 | 6 | 16 (female) | coho |

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## Appendix B-11. Hydrologic Monitoring Plan

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## Executive Summary

Hydrologic monitoring data are used by stormwater managers during flood emergency responses for watershed planning, operations, trend assessment, educational needs, and project design. The current array of rain and flow monitoring stations meet the operational needs of the Bellevue Utilities Department.

The Utilities Department currently operates 29 hydrologic monitoring gauges throughout the city. Ten regional detention facilities gauges provide real-time stage readings, six in-stream gauges measure the depth of flow, and two lake gauges measure water levels. Additionally, 11 rain gauges stationed throughout the city measure precipitation.

Bellevue's hydrologic monitoring network evolved based on program and project needs. This monitoring plan recommends the following:

1. Continue monitoring rainfall and water levels at all gauges on Bellevue's telemetry system; and
2. Continue partnerships with the U.S. Geological Survey (USGS) and King County to meet shared hydrologic monitoring needs.

There are outstanding gaps and opportunities to gain efficiency and effectiveness with operating and maintaining the monitoring network. The following recommendations will improve the effectiveness and efficiency of current activities:

3. Reevaluate the need for the Pinewood Apartment (PNW) staff gauge on Kelsey Creek if a volunteer is no longer available to monitor the gauge.
4. Conduct quality assurance/quality control reviews of data that are downloaded.
5. Create and post annual summarized rainfall data online for efficient public access.
6. Maintain and validate flow discharge measurements and rating curves at three stream gauging sites (CCF, KCF, and VCF) and one facility gauge site (133).
7. Upgrade the Coal Creek Flow (CCF) gauge at Newport Shores to connect to the Bellevue telemetry system for improved data accessibility for emergency response.
8. Re-activate the Valley Creek Flow (VCF) gauge telemetry system to provide greater operational capabilities for the Valley, Sears, and Overlake regional facilities.
9. Conduct a 2-year overflow study of the outlet gate settings for two regional facilities (197 and 179N) to evaluate non-structural approaches for solving downstream flooding.
10. Relocate the Richards Creek Flow (RCF) gauge to avoid backwater conditions.
11. Conduct and maintain storm event-stage relationship analyses for five chronic flooding sites.
12. Install a new, long-term manual download gauge at Vasa Creek near Lake Sammamish to improve information for basin planning, stormwater management, and project design.

If all proposed recommendations were implemented, hydrologic monitoring labor hours are estimated to require 301 hours per year (0.15 FTE). Additional one-time costs of recommendations are estimated to total $10,500 for gauge upgrade, replacement, and installation, and 55 hours per year for a 2-year regional facility overflow analysis (0.03 FTE).

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# 1 Introduction

The Bellevue Utilities Department is responsible for coordinating the management of the storm and surface water system in the city. Bellevue's storm and surface water system consists of a combined network of public and private open streams, natural features, pipe systems, constructed drainage facilities, and lakes. Hydrologic monitoring activities are necessary to help the Utilities Department meet its storm and surface water mission, which is to control damage from storms, protect surface water quality, support fish and wildlife habitat, and protect the environment. Hydrologic monitoring provides essential data for operations and assessing the overall functioning of the storm and surface water system.

This hydrologic monitoring plan (Flow Plan) is a comprehensive analysis of the priorities and criteria for the gauge network; the existing hydrologic monitoring network; issues and gaps; and recommendations for improvement. This Flow Plan was developed following a 10-step iterative hydrologic monitoring review process established by the World Meteorological Organization (1994). A description of the review process is available in Attachment A.

The Flow Plan was developed with input from stakeholders within the Utilities Department and other partners. Stakeholders include Engineering Division staff involved with project design, planning, and development inspection, as well as Operations and Maintenance (O&M) staff involved with operating and maintaining the storm and surface water system. The Utilities Department is also partnered with the U.S. Geological Survey (USGS) and King County in response to the Water Resource Inventory Area 8 (WRIA 8) Lake Washington/Cedar/Sammamish Watershed Chinook Salmon Recovery Program.

# 2 Flow Plan Purpose and Objectives

The purpose of this Flow Plan is to assess the existing hydrologic monitoring network, and to provide a comprehensive strategy for current and future hydrologic monitoring activities. Hydrologic monitoring is currently conducted by the Utilities Department on a widespread but informal basis. This Flow Plan is designed to establish a formal hydrologic monitoring program that can be used to guide stormwater management staff to perform hydrologic monitoring activities in an organized, coordinated, and systematic way.

The Utilities Department uses hydrologic monitoring data to:

- Respond to emergency flooding events and road closures;
- Guide operations of regional detention facilities;
- Guide staff safety for in-stream field work;
- Minimize flooding through planning and capital investments;
- Plan for future drainage needs, including Capital Investment Program (CIP) projects;
- Support hydrologic and hydraulic design criteria, facilitate basin planning (model calibration/verification), and analyze pipe capacity;
- Determine the effectiveness of stormwater management strategies;
- Evaluate long-term trends such as climate change or hydrologic variability;

- Support regional monitoring efforts/partnerships, e.g., WRIA 8 salmon recovery efforts;
- Respond to hydrologic information requests from the public, neighboring jurisdictions, and City staff; and
- Provide information for education and outreach.

The Flow Plan is intended to provide staff with the necessary tools to evaluate the effectiveness of stormwater management activities for both long-term and short-term needs. A detailed discussion of the long-term and short-term needs for a hydrologic monitoring plan is provided in Attachment B.

# 3 Existing Hydrologic Monitoring Network

Bellevue's storm and surface water system consists of a network of public and private open streams, natural features, pipe systems, and constructed drainage facilities. The network covers 31 square miles, with 79 miles of open and piped stream length within the city limits. The original hydrologic gauge network was established in the late 1970s and early 1980s. The network has since evolved based on program and project needs, improved technology, and as available staffing and financial resources permitted.

The existing network of active and inactive gauges and their functions are described below. Rain gauges are included as part of the existing network of hydrologic monitoring activities. Other hydrologic monitoring activities include variably maintaining flow rating curves and conducting a quality assurance/quality control review on preliminary data for specific projects.

## 3.1 Active Gauges

There are 29 hydrologic monitoring gauges currently in operation in Bellevue (shown in Figure 3-1 and listed in Table 3-1). Of these, 10 regional detention facilities gauges, 6 stream gauges, and 2 lake gauges measure water levels, and 11 rain gauge stations measure precipitation.

In Table 3-1, gauge data collection equipment has evolved over time with advancements in technology or changes in available resources. The Coal Creek Flow (CCF) station, the Mercer Creek Flow (MCF) station, the Richards Creek Flow (RCF) station, and the Valley Creek Flow (VCF) station show two periods of data before and after gauge equipment was upgraded. For example, the CCF, RCF, and VCF gauges previously collected stage height by chart equipment. Currently, the data are collected by manual download from data loggers.

### *3.1.1 Regional Detention Facilities and Stream Gauges*

The regional detention facility gauge stations and stream gauge stations measure stage height using continuous or instantaneous recording gauge equipment and data collection methods described below.

#### ***3.1.1.1 Telemetry-Bellevue Service Center***

Ten regional detention facility gauges and one stream gauge (Kelsey Creek Flow [KCF]) are monitored and operated remotely by a continuous recording telemetry system from the Bellevue

Service Center (BSC). The telemetry system automatically records the 'real time' stage heights for these stations every 15 minutes.

The supervisory control and data acquisition (SCADA) system includes an automated alarm system that alerts BSC staff when water levels meet or exceed pre-determined thresholds, acting as a flood warning alarm system.

The telemetry system at the Kelsey Creek Flow (KCF) gauge was re-activated in March 2011 after partnering with King County as part of the Lake Washington/Cedar/Sammamish Watershed (WRIA 8) Chinook Salmon Recovery Program. The WRIA 8 Chinook Salmon Recovery Plan was adopted by the Bellevue City Council in 2005, and is funded from Bellevue and other local governments. The City agreed to collect telemetry stage height data while King County agreed to collect stream discharge data at the station. Together, these data can be used to develop a stage-discharge flow rating curve. King County agreed to create and maintain the KCF flow-rating curve for 3 years, beginning in 2011 to 2014. These data, along with data from other participating local governments, will be used by the WRIA 8 Chinook Salmon Recovery Program to evaluate the status and trends of salmon habitat in freshwater streams.

#### 3.1.1.2 Telemetry - USGS

The stream gauge known as Mercer Creek Flow (MCF) gauge, located on lower Kelsey Creek beneath the Wilburton railroad trestle, is jointly funded by the USGS and City of Bellevue, and is solely operated and maintained by the USGS. This telemetry system automatically records discharge and stage, with a web interface that is updated hourly. The data are available on the USGS Real-Time Water Data for Washington website (referred to as USGS 12120000 MERCER CREEK by the USGS).

#### 3.1.1.3 Manually Download

Three stream gauges (Valley Creek Flow [VCF], Coal Creek Flow [CCF], and Richards Creek Flow [RCF]) are equipped with data loggers that continuously record stage heights every 15 minutes. The battery-operated data loggers are capable of storing several months of data. Staff manually download data at these sites three or more times per year.

#### 3.1.1.4 Staff Gauge

One stream gauge (Pinewood Apartments/148th Avenue NE [PNW]) is equipped with a staff gauge, which provides an instantaneous water level reading. A volunteer collects these data one to two times per week, and submits it to the City on a monthly basis.

### 3.1.2 Lakes Gauges

Bellevue has two lake gauges. The Lake Sammamish (LSAMM) gauge is maintained and operated by the USGS with funding support from the Cities of Bellevue, Sammamish, and Issaquah, and King County. The gauge is operated automatically using a telemetry system that reports lake water level data hourly, and is also available on the USGS Real-Time Water Data for Washington website (referred to as USGS 12122000 SAMMAMISH LAKE by the USGS).

The Phantom Lake (PLG) gauge is located on City-owned lakefront property at Heintze Point on Phantom Lake. The real-time gauge monitors water levels and reports the data via a telemetry



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connection port to the BSC. The data are used for operations with the water quality weir at the outlet.

Larsen Lake and the surrounding areas are owned by the City and used for recreation, wildlife, and as a regional detention facility. Water levels at Larsen Lake are monitored through the regional detention facility telemetry gauge station (No. 149) located at the flow control structure for Larsen Lake.

#### *3.1.3 Rain Gauges*

Eleven rain gauges measure precipitation throughout Bellevue. These gauges are monitored by the BSC telemetry system. The data for these gauges are updated every 15 minutes.

## 3.2 Inactive Gauges

Bellevue has 38 inactive gauges (shown in Figure 3-2 and listed in Table B.11-3-2): 30 stream gauges, 7 groundwater gauges, and 1 lake gauge all measured water levels. These gauges were de-activated for various reasons, whether there was a lack of resources to continue operations or the project need no longer existed. Table 3-2 identifies which gauges have equipment and housing remaining in place. Equipment was not removed to save costs associated with decommissioning the gauge and/or provide a cost-saving opportunity if the gauge were re-activated.

## 3.3 Flow Rating Curves

Flow rating curves graphically relate stage height data to a volume of water flowing in the stream (discharge) for a station. In order to maintain a flow rating curve, stream discharge measurements must be collected at a different stage height ranges to verify the correlation. Once established, a flow rating curve reduces or eliminates the need for stream discharge measurements to determine the volume of flow.

Currently, 13 active stream gauges have flow rating curves (see Table 3-1 for gauges). These rating curves are not regularly maintained or verified due to limited staffing resources. Rating curve data are stored electronically and updated per project need or as staff resources permit.

## 3.4 Data Quality Assurance/Quality Control

Hydrologic monitoring data are considered preliminary until a quality assurance/quality control (QA/QC) review of the data is conducted. Typically, this is done before the data are used for specific projects.

Hydrologic data from the two USGS-operated gauges (Mercer and Lake Sammamish) are QA/QC reviewed by the USGS annually. Final water reports for these gauges are available on the USGS website.

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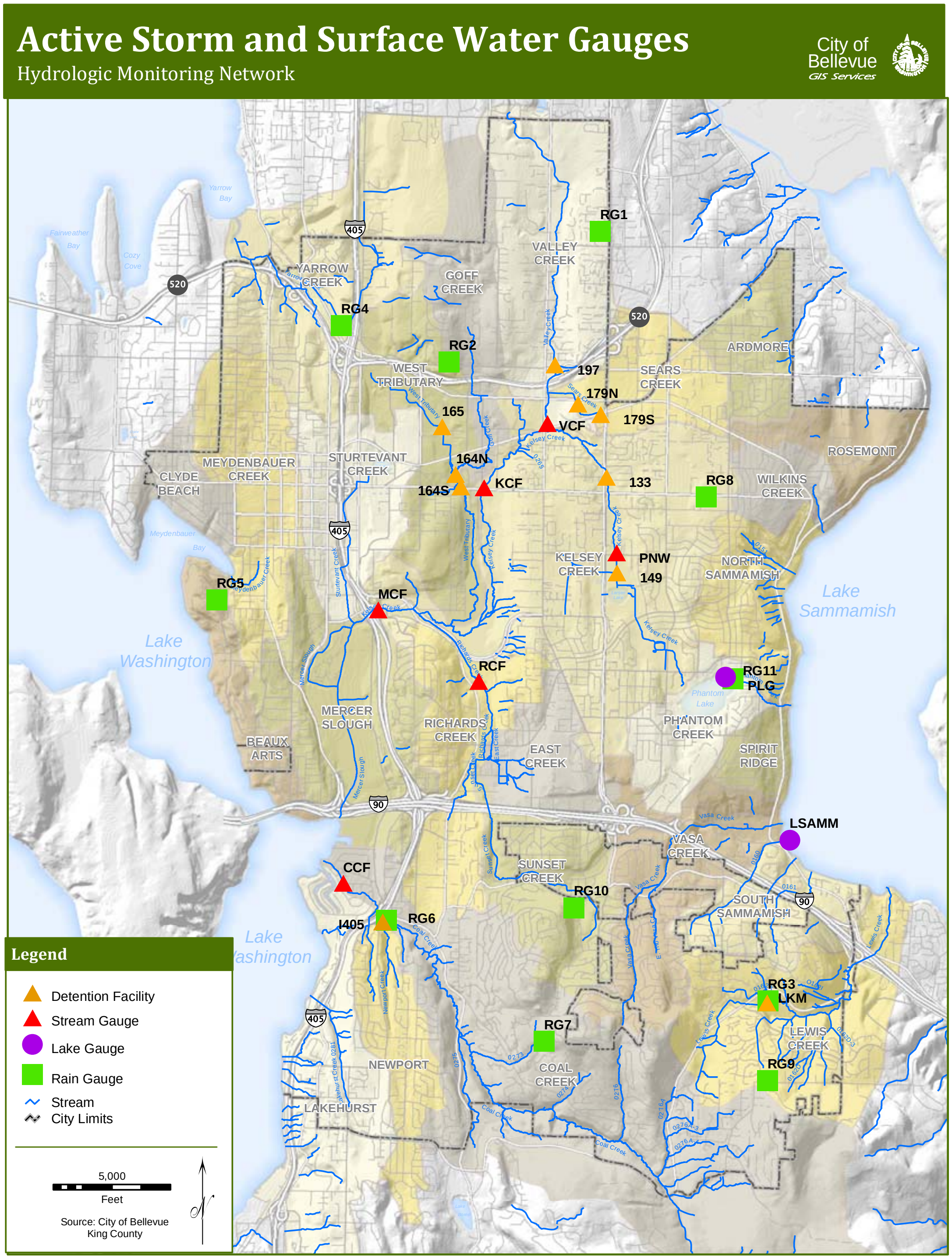


**Figure B.11-3-1. Stream, facility, lake, and rain gauges in Bellevue that are actively in use as of December 2011.**

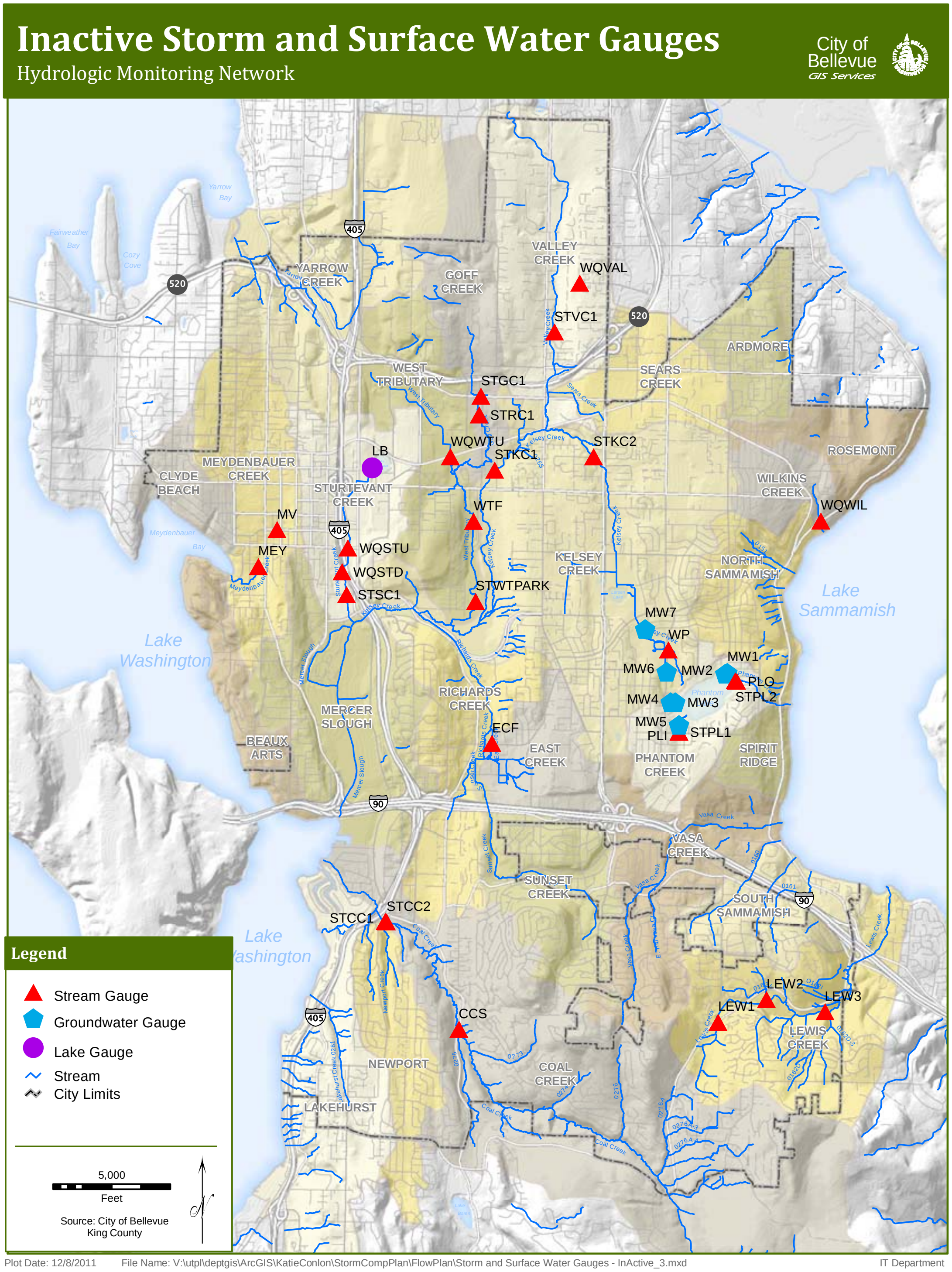


**Figure B.11-3-2 Inactive hydrologic monitoring stations or gauge equipment in Bellevue as of December 2011.**

**Table B.11-3-1. Active Gauges in the Existing Hydrologic Monitoring Network**

| Basin | Station ID | Station Name(s) | Station Type | Gauge/ Equipment Type[1] | Data Collection[2] | Purpose: Trend | Purpose: Project | Purpose: Operations | Purpose: Effectiveness | Period of Record: Start | Period of Record: End | Flow Rating Curve Available |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Coal Creek | I405 | I-405 Regional Detention Facility | Facility | DF | T | • | o | • | • | 1998 | Present | Yes |
| | CCF | Coal Creek Flow | Stream | SG | SC | • | o | • | • | 1989 | 2003 | -- |
| | | | | | MD | • | o | • | • | 2004 | Present | Yes |
| | RG6 | Coal Creek/ I-405 Regional Detention Facility | Rain | RG | T | • | o | • | • | 1992 | Present | -- |
| | RG7 | Forest Hills | Rain | RG | T | • | o | • | • | 1992 | Present | -- |
| Goff Creek | RG2 | Cherry Crest | Rain | RG | T | • | o | • | • | 1992 | Present | -- |
| Kelsey Creek | 133 | Kelsey Creek/148th/Piano Ranch | Facility | DF | T | o | o | • | o | 1988 | Present | Yes |
| | 149 | Larsen Lake/Kmart | Facility | DF | T | o | o | • | o | 1988 | Present | Yes |
| | MCF | Mercer Creek Flow- Bellevue Historic Site | Stream | SG | SC | • | o | • | • | 1989 | 2003 | No |
| | | Mercer Creek - USGS 12120000 | | | T-USGS | | | | | 1956 | Present | Yes |
| | KCF | NE 8th/ Fucheck/Fish Ladder | Stream | SG | T | • | • | o | • | 1988 | 1998 | No |
| | | | | | | | | | | 2011 | Present | Yes |
| | PNW | Pinewood Apartments | Stream | SF | S | o | o | • | o | 1983 | Present | No |
| | RG8 | Crossroads | Rain | RG | T | • | o | • | • | 1994 | Present | -- |
| Lewis Creek | LKM | Lakemont | Facility | DF | T | o | o | • | • | 1992 | Present | No |
| | RG3 | Lakemont | Rain | RG | T | • | o | • | • | 1992 | Present | -- |
| | RG9 | Cougar Mt. #2 | Rain | RG | T | • | o | • | • | 1994 | Present | -- |
| Meydenbauer Creek | RG5 | Meydenbauer | Rain | RG | T | • | o | • | • | 1992 | Present | -- |
| Phantom Creek | PLG | Phantom Lake | Lake | LG | T | o | o | • | o | 2000 | Present | |
| | RG11 | Phantom Lake | Rain | RG | T | • | o | • | • | 1996 | Present | -- |

| Basin | Station ID | Station Name(s) | Station Type | Gauge/ Equipment Type[1] | Data Collection[2] | Purpose: Trend | Purpose: Project | Purpose: Operations | Purpose: Effectiveness | Period of Record: Start | Period of Record: End | Flow Rating Curve Available |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Phantom Creek** | PLG | Phantom Lake | Lake | LG | T | o | o | • | o | 2000 | Present | -- |
| | RG11 | Phantom Lake | Rain | RG | T | • | o | • | • | 1996 | Present | -- |
| **Richards Creek** | RCF | Bannerwood Park/Pardee Lumber | Stream | SG | SC | • | o | o | • | 1996 | 1998 | Yes |
| | | | | | MD | | | | | 2007 | Present | No |
| **South Sammamish** | LSAMM | Lake Sammamish – USGS 12122000 | Lake | LG | T-USGS | • | o | • | • | 1939 | Present | -- |
| **Sears Creek** | 179N | Overlake/Sears Creek | Facility | DF | T | o | o | • | • | 1988 | Present | Yes |
| | 179S | Commissioners | Facility | DF | T | o | o | • | • | 1998 | Present | No |
| **Sunset Creek** | RG10 | Parksite | Rain | RG | T | • | o | • | • | 1995 | Present | -- |
| **Valley Creek** | 197 | North Valley Creek/ Valley Creek/Henry Bacon | Facility | DF | T | o | o | • | • | 1988 | Present | Yes |
| | VCF | Valley Creek Flow | Stream | SG | SC | o | o | • | • | 1988 | 2004 | Yes |
| | | | | | MD | o | o | • | • | 2007 | Present | Yes |
| | RG1 | NE 40th | Rain | RG | T | • | o | • | • | 1992 | Present | -- |
| **West Tributary** | 165 | West Tributary/ Metro Base/Safeway | Facility | DF | T | o | o | • | • | 1988 | Present | Yes |
| | 164N | Goff Creek/West Tributary Upstream | Facility | DF | T | o | o | • | • | 1988 | Present | Yes |
| | 164S | LW Tributary/ NE 8th, West Tributary Down | Facility | DF | T | o | o | • | • | 1988 | Present | Yes |
| **Yarrow Creek** | RG4 | BSC/Previously at MSC (1989) | Rain | RG | T | • | o | • | • | 1980 | Present | -- |

[1] **Gauge/Equipment Type:**
DF = Detention facility gauge
SG = Stream gauge
LG = Lake gauge
SF = Staff gauge
RG = Rain gauge

[2] **Data Collection:**
MD = Manual download
S = Site visit - Instantaneous readings only
T = Bellevue BSC Telemetry
T – USGS = Telemetry, in partnership with USGS

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**Table B.11-3-2. Historic hydrologic monitoring stations and equipment in Bellevue.**

**Note: These stations are currently inactive, or in some cases, the data collection equipment is retired.**

| Basin | Station ID | Station Type | Gauge/ Equipment Type[1] | Data Collection[2] | Period of Record | | Housing Equipment Left in Place |
|---|---|---|---|---|---|---|---|
| | | | | | Start | End | |
| Coal Creek | CCS | Stream | SF | S | 1995 | 2000 | No |
| | STCC2 | Stream | SF | S | 1989 | 1992 | No |
| | STCC1 | Stream | SF | S | 1989 | 1992 | No |
| East Creek | ECF | Stream | SG | MD | 2005 | 2010 | Unknown |
| Goff Creek | STGC1 | Stream | SF | S | 1989 | 1993 | No |
| Kelsey Creek | WP | Stream | SF | S | 1995 | 1998 (est.) | Unknown |
| | STKC2 | Stream | SF | S | 1989 | 1993 | No |
| | STKC1 | Stream | SF | S | 1989 | 1990 | No |
| Lewis Creek | LEW1 | Stream | SG | MD | 1991 | 1995 | No |
| | LEW2 | Stream | SG | MD | 1991 | 1995 | No |
| | LEW3 | Stream | SG | MD | 1991 | 1995 | Unknown |
| Meydenbauer Creek | MEY | Stream | SC | CH | 1989 | 1996 | Unknown |
| | MV | Stream | SG | MD | 2006 | 2011 | No |
| Phantom Creek | PLI | Stream | SC | CH | 1989 | 2003 | Yes |
| | PLO | Stream | SC | CH | 1989 | 2003 | Yes |
| | STPL2 | Stream | SF | S | 1988 | 1989 | No |
| | STPL1 | Stream | SF | S | 1989 | 1989 | No |
| | MW1 | Groundwater | P | MD | 1985 | 1986 | Yes |
| | MW2 | Groundwater | P | MD | 1985 | 1986 | Yes |
| | MW3 | Groundwater | P | MD | 1985 | 1986 | Yes |
| | MW4 | Groundwater | P | MD | 1985 | 1986 | Yes |
| | MW5 | Groundwater | P | MD | 1985 | 1986 | Yes |
| | MW6 | Groundwater | P | MD | 1985 | 1986 | Yes |
| | MW7 | Groundwater | P | MD | 1985 | 1986 | Yes |
| Richards Creek | STRC1 | Stream | SF | S | 1988 | 1992 | No |
| Sturtevant Creek | WQSTU | Stream | SG | CH | 1989 | 1992 | No |
| | WQSTD | Stream | SG | CH | 1989 | 1992 | No |
| | STSC1 | Stream | SF | S | 1988 | 1992 | No |
| | LB | Lake | SF | S | 2009 | 2011 | Yes |
| Valley Creek | STVC1 | Stream | SF | S | 1988 | 1995 | No |
| | WQVAL | Stream | SG | CH | 1989 | 1992 | No |
| West Tributary | WTF | Stream | SG | T | 1988 | 1989 | Yes |
| | STWTPark | Stream | SF | S | 1993 | 1994 | No |
| Wilkins Creek | WQWIL | Stream | SG | CH | 1989 | 1992 | No |

[1]Gauge/Equipment Type:
SC = Strip Chart
SF= Staff Gauge
SG = Stream Gauge
P = Piezometer

[2]Data Collection:
CH = Chart
MD = Manual download
S = Site visit - Instantaneous readings only
T = Bellevue BSC Telemetry

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# 4 Priorities and Criteria for Gauge Network

This Flow Plan evaluates and prioritizes the existing hydrologic monitoring gauge network using criteria that represent how the hydrologic data are used for stormwater management. Rain gauges and temporary, short-term gauges were not included in this evaluation. The current network of rain gauges is meeting staff needs. Temporary gauges are installed and removed based on specific project need.

Installation of new, long-term gauges for geographic coverage require additional consideration and recognition that they would need ongoing resources for equipment maintenance and labor. If representative hydrologic data are not available for a stream and/or drainage basin and the data are necessary for operations and planning purposes, a monitoring gauge may be warranted.

Removal of long-term gauges may be recommended based on the value of the data provided. If a long-term gauge is determined not to add value to the hydrologic monitoring network and no longer meets the needs of the Utilities Department, then removing the gauge may be warranted.

Six criteria were developed for evaluating the value of the City's existing long-term stream, facility, and lake monitoring gauges. Each gauge was subjectively scored from 1 to 5, lowest to highest in importance. Evaluation results are shown in Table 4-1. The following criteria and assumptions were made:

1. **Flood Response, Operations, and Flood Reporting:** Flooding poses potential risks to public and staff safety and personal property. O&M directly uses real-time gauge data for responding to flooding, operations, and flood reporting. Gauges used directly by O&M score highest (5). Other gauges, those not equipped to report real-time data, may be used by O&M for these purposes. Those gauges were given an intermediate score (3). All other gauges not used for flooding risks were scored with the lowest score (1).
2. **Multi-purpose:** Gauges with more than three purposes scored highest (5). Gauges with two purposes were moderately important (3), and gauges with only a single purpose scored low (1).
3. **Period of Record:** Gauges with a long period of record can be used for long-term trend and hydrologic variability analyses. Gauges with more than 20 years of record score the highest (5). Gauges with a period of record between 5 to 20 years are moderately important (3), and gauges with less than 5 years of record scored low (1).
4. **Partnerships:** Collaborating with other agencies on hydrologic monitoring needs is encouraged, where feasible. Coordinated partnerships are a more cost-effective use of limited hydrologic monitoring funds and staffing resources; thus, they score higher (5) than gauges funded solely by Bellevue (1).
5. **Type of Data Collection:** The type of data collection equipment and technology used may provide value and efficiencies for limited staff resources. Gauges with a telemetry system score highest (5), gauges that require manual downloads score moderately (3), and gauges with a staff gauge scored low (1).
6. **Opportunity to Increase Value:** The value of a gauge may be increased based on the opportunity to upgrade the gauge to telemetry (5), develop a rating curve (3), maintain an existing rating curve (1), or no additional opportunity exists (e.g., the USGS maintains the gauge and rating curve for MCF).

These criteria were further prioritized, by a weighted value, which were determined based on prioritization of categories to operational needs.  Criteria scores were multiplied by the weighted value to determine a weighted score.  Weighted scores were then totaled for each gauge, and sorted by the highest weighted score to lowest (shown in the last column in Table 4-1).

The results of the evaluation can be summarized as follows:

- The USGS partnered gauges at Kelsey Creek and Lake Sammamish rank highest among the existing network of facility, stream, and lake gauges.  The result of the ranking supports current activities to contract with USGS for operating these gauges.
- The I-405 gauge ranks highest among facility gauges that report real-time data.  This gauge is a vital gauge for O&M responding to flooding in the Newport Shores community and its other operations.
- The Coal Creek in-stream gauge (CCF) at Newport Shores ranks highest among gauges that are not equipped to report real-time data.  This gauge ranks higher than two facility gauges (133 and 149), because it complements the I-405 gauge on Coal Creek for emergency response.  This gauge would be more efficient and valuable if equipment was upgraded so that it can report real-time data (via a telemetry data-port connection) during rain events.

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**Table B.11-4-1. Hydrologic monitoring gauges (shown in order of importance based on evaluation).**

| *Criterion weight* | *Total:* | *100* | | *30* | | *25* | | *17* | | *13* | | *10* | | *5* | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Basin** | **Station Type** | **Station ID** | **Flooding Response, Operations, Flood Reporting[1]** | | **Multi-Purpose[2]** | | **Period of Record[3]** | | **Partnership[4]** | | **Type of Gauge[5]** | | **Opportunity to Increase Value[6]** | | **Gauge Total Weighted Score by Rank** |
| | | | **Score** | **Weighted Score** | **Score** | **Weighted Score** | **Score** | **Weighted Score** | **Score** | **Weighted Score** | **Score** | **Weighted Score** | **Score** | **Weighted Score** | |
| **Mercer Slough** | Stream | MCF | 5 | 150 | 5 | 125 | 5 | 85 | 5 | 65 | 5 | 50 | 0 | 0 | 475 |
| **South Sammamish** | Lake | LSAMM | 3 | 90 | 5 | 125 | 5 | 85 | 5 | 65 | 5 | 50 | 0 | 0 | 415 |
| **Coal Creek** | Facility | I405 | 5 | 150 | 5 | 125 | 3 | 51 | 1 | 13 | 5 | 50 | 1 | 5 | 394 |
| **Kelsey Creek** | Stream | KCF | 3 | 90 | 5 | 125 | 3 | 51 | 5 | 65 | 5 | 50 | 0 | 0 | 381 |
| **Sears Creek** | Facility | 179N | 5 | 150 | 3 | 75 | 5 | 85 | 1 | 13 | 5 | 50 | 1 | 5 | 378 |
| **Sears Creek** | Facility | 179S | 5 | 150 | 3 | 75 | 5 | 85 | 1 | 13 | 5 | 50 | 1 | 5 | 378 |
| **Valley Creek** | Facility | 197 | 5 | 150 | 3 | 75 | 5 | 85 | 1 | 13 | 5 | 50 | 1 | 5 | 378 |
| **West Tributary** | Facility | 165 | 5 | 150 | 3 | 75 | 5 | 85 | 1 | 13 | 5 | 50 | 1 | 5 | 378 |
| **West Tributary** | Facility | 164N | 5 | 150 | 3 | 75 | 5 | 85 | 1 | 13 | 5 | 50 | 1 | 5 | 378 |
| **West Tributary** | Facility | 164S | 5 | 150 | 3 | 75 | 5 | 85 | 1 | 13 | 5 | 50 | 1 | 5 | 378 |
| **Coal Creek** | Stream | CCF | 3 | 90 | 5 | 125 | 5 | 85 | 1 | 13 | 3 | 30 | 5 | 25 | 368 |
| **Lewis Creek** | Facility | LKM | 5 | 150 | 3 | 75 | 3 | 51 | 1 | 13 | 5 | 50 | 0 | 0 | 339 |
| **Kelsey Creek** | Facility | 133 | 5 | 150 | 1 | 25 | 5 | 85 | 1 | 13 | 5 | 50 | 1 | 5 | 328 |
| **Kelsey Creek** | Facility | 149 | 5 | 150 | 1 | 25 | 5 | 85 | 1 | 13 | 5 | 50 | 1 | 5 | 328 |
| **Valley Creek** | Stream | VCF | 3 | 90 | 3 | 75 | 5 | 85 | 1 | 13 | 3 | 30 | 5 | 25 | 318 |
| **Richards Creek** | Stream | RCF | 3 | 90 | 3 | 75 | 3 | 51 | 1 | 13 | 3 | 30 | 5 | 25 | 284 |
| **Phantom Creek** | Lake | PLG | 3 | 90 | 1 | 25 | 3 | 51 | 1 | 13 | 5 | 50 | 0 | 0 | 229 |
| **Kelsey Creek** | Stream | PNW | 1 | 30 | 1 | 25 | 5 | 85 | 5 | 65 | 1 | 10 | 0 | 0 | 215 |

**Criterion Scoring:**
**Low to High Importance = 1 to 5**
**Not Applicable = 0**

1. **Flooding Response, Operations, Flood Reporting (30%):**
(5) Regional facilities are directly used for flooding response, operations, and flood reporting.
(3) Gauge is indirectly used for this criterion.
(1) Gauge not used for this criterion.

2. **Multi-Purpose* (25%):**
(5) Three or more purposes
(3) Two purposes
(1) Single purpose

*Data for multi-purpose determined from Table 3-1.

3. **Period of Record (17%):**
(5) More than 20 years of records
(3) Between 5 and 20 years of record
(1) Less than 5 years of record

4. **Partnership (13%):**
(5) Shared costs (labor and/or financial assistance) with other agency
(1) Bellevue only

5. **Type of Gauge (10%):**
(5) Telemetry
(3) Manual download
(1) Staff gauge

6. **Opportunity to Increase Value (5%):**
(5) Upgrade to telemetry
(3) Develop rating curve
(1) Maintain rating curve
(0) No opportunity

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# 5 Hydrologic Monitoring Network Issues and Gaps

Engineering and O&M staff identified several issues and gaps during this evaluation of Bellevue's hydrologic monitoring network. The issues and gaps identified include:

1. A QA/QC review of the data is not conducted on a consistent and systematic basis. The data are collected and stored electronically, but generally are not analyzed or reviewed for quality until needed for a specific project. This has resulted in duplication of efforts for multiple projects, and sometimes data quality problems are not found in a timely manner.
2. Public records requests (PRR) for rainfall data are frequently made by consultants, residents, and students. Because there is no systematic process to check the data as it is collected, efforts to fulfill the PRR can result in significant and duplicated efforts over time.
3. Flow rating curves are not regularly maintained and validated, which reduces the confidence in accuracy of the relationship between stage height and discharge data. For example, Richards Creek flow site (RCF) at Bannerwood Park is ineffective due to frequent backwater inundation as a result from downstream constraints (e.g., beaver dams).
4. Regional detention facility outlet gate settings are based on design recommendations, and most are functioning as expected by preventing downstream flooding. Based on field observations by O&M staff during storms in late 2010, two regional detention facilities (Station IDs 179N and 197) were frequently overflowing, posing flooding concerns downstream.
5. O&M staff have a number of chronic flooding sites to respond to during storm events. Developing a flood response time for flooding sites would provide valuable information for operations and planning purposes.
6. No data are available for any Bellevue salmon spawning streams that flow into Lake Sammamish. Vasa Creek is of particular concern because it flows through a steep ravine and is subject to erosion and sedimentation problems.
7. Some existing data are not being used because it is not accessible electronically. For example, some older stream stage height data were recorded and archived on paper charts. Converting these data to electronic format would be too costly, unless specifically requested.

# 6 Recommendations

Recommendations for increasing efficiency and effectiveness within the hydrologic monitoring network and activities include non-action and action items. Non-action recommendations do not have additional labor hours or costs associated. Action recommendations include an estimate of number of hours per year and/or associated cost.

Estimates include time for downloading data, data QA/QC, reporting, equipment repair, telemetry programming, maintenance, and calibration that are in addition to current monitoring activities. Where applicable, estimates are based on staff time spent in 2010. Estimates do not include time and costs required to set up or take down sites because very few new sites are

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proposed. New equipment costs will vary depending on equipment vendors, site access, and the availability of electricity and telephone utilities. Equipment costs for new gauge sites should therefore be considered planning estimates.

**Non-action recommendations**:

1. Continue to collect real-time rainfall and water level data at all gauges linked to Bellevue's BSC telemetry system. No additional cost or labor is required.
2. Continue to partner with USGS and King County to meet shared hydrologic monitoring needs. Where appropriate, seek opportunities for additional partnerships similar to these for additional cost savings and expertise. No additional cost or labor is required.
3. Re-evaluate the need for the Pinewood Apartments (PNW) gauge on Kelsey Creek if a volunteer is no longer available to monitor the gauge. No additional cost/labor required.

**Action recommendations**:

4. Conduct a systematic QA/QC review of data per download transmittal. This includes rainfall data, manual downloaded stream gauges, and BSC telemetry gauges.
    a. Rainfall data are currently collected from the BSC telemetry each month. An estimated 22 hours per year would be required to QA/QC these data.
    b. Data are collected from manual downloaded stream gauges about five times a year. Fifteen hours per year would be needed to QA/QC these data.
    c. Bellevue BSC telemetry gauge data are not downloaded regularly. Downloading the data monthly along with rainfall data, plus conducting a QA/QC of the data, would require an estimated 90 hours per year.
5. Create an annual summary report for rainfall data and post on the Utilities Department's website for public use. This would reduce the time spent responding to data requests. An estimated 16 hours per year will be required to complete this task.
6. Maintain and validate flow rating curves at three stream gauging sites (CCF, KCF, and VCF) and one facility gauge (133) on an annual basis. Use flow rating curves to create tables and charts of stream discharge rates, and generate summary statistics annually. Maintaining the flow rating curves would validate the accuracy in the data, and increase efficiency and cost-effectiveness for the department. An estimated 48 hours per year would be required to maintain, validate, and summarize rating curve data.
7. Upgrade the stream gauge equipment at the Coal Creek Flow (CCF) from manual download equipment to the BSC telemetry system to help O&M staff respond to flooding emergencies and reduce potential loss of data from undetected equipment failure. Upgrading the gauge equipment is estimated to cost $5,000. Equipment stand and housing is currently in place. Costs associated reflect a one-time installation cost for a probe, electricity, and telephone line. Labor hours associated with data download transmittal and data QA/QC are estimated at 28 hours per year.
8. Re-activate the BSC telemetry system and maintain the flow rating curve at Valley Creek Flow (VCF), near the confluence with Kelsey Creek, in order to monitor system response from regional facilities 197, 179N, and 179S located upstream. Reactivating the telemetry connection would require an estimated 10 hours per year for data download transmittal and QA/QC.
9. Conduct a short-term (approximately 2 years) analysis to determine if changing the outlet gate settings would reduce flooding at Valley Creek at NE 21st Street and the Sears

Creek Overlake regional detention facilities. The analysis would require monitoring at two facility gauges (179N and 197) and one downstream gauge (VCF), and developing two short-term flow rating curves for the facilities. Modify operation plans based on results of the analysis. The labor associated with this study is estimated at 55 hours per year for 2 years.

10. Relocate Richards Creek Flow (RCF) station at Bannerwood Park to a site not influenced by beaver activity. Potential new locations are upstream at Kamber Road on the upstream side of the culvert or at the intersection of Richards Road and Lake Hills Connector. Costs are estimated at $3,000 for demolition of the existing gauge and relocation of the new gauge. Costs do not include permitting fees.
11. Conduct a storm event-stage response analysis at five chronic flooding sites, including Richards Creek at Kamber Road, Valley Creek at NE 21st Street, Larsen Lake at 148th Avenue, Kelsey Creek near SE 7th Street and Lake Hills Connector, and Coal Creek at Newport Shores. Analyze the relationship between the 24-hour rain event, antecedent conditions, and the extent of flooding. The analysis was calculated for Coal Creek between the I-405 gauge and the gauge at Newport Shores in December 2010 at O&M’s request. This analysis provided a flood response time for crews. The analysis and maintaining the relational data for these sites would require an approximately 10 hours per year.
12. Add a new, long-term manual download flow station on Vasa Creek near West Lake Sammamish Parkway to meet multi-purpose objectives identified within the basin needs discussion (planning, stormwater management, and CIP). This small stream on the east side of Bellevue flows into Lake Sammamish. It is in a steep ravine and is subject to erosion and sedimentation issues. Gauges are not recommended for similar streams that drain to Lake Sammamish (Ardmore or Wilkins) because they do not have spawning kokanee, and projects to stabilize them have already been completed. Adding this gauge is estimated to cost $2,500 for installation (not including permitting fees) and an estimated 15 hours per year for data download and QA/QC.

If all proposed recommendations were implemented, hydrologic monitoring labor hours are estimated at 301 hours per year (0.15 FTE). Additional one-time costs are estimated to total $10,500 for gauge equipment upgrade and/or replacement, and installation. The estimate for the 2-year overflow study is 55 hours per year (0.03 FTE).

# 7 Conclusion

Adequate hydrologic monitoring is critical for providing information for flood emergency response, health and safety, stormwater management, and the environmental and financial sustainability for Bellevue residents and businesses. Bellevue’s monitoring network, with proposed modifications, meets World Meteorological Organization recommendations and will meet Bellevue’s needs with a predictable level of effort for many years.

# 8 References

World Meteorological Organization. 1994. Guide to Hydrological Practices—Data Acquisitions and Processing, Analysis, Forecasting and Processing. *In*: Chapter 20 *Design and Evaluation of Hydrological Networks*.

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# Attachment A. World Meteorological Organization's Process for Conducting a Hydrologic Network Review and Redesign

The World Meteorological Organization (1994) lays out a 10-step iterative process for conducting a review and/or redesign of an existing hydrological network. The Utilities Department is generally following a similar process for this review of the hydrologic monitoring system. A short description of each step and how it pertains to Bellevue stream gauging needs follows.

## Institutional Set-up

The various stakeholders from the Engineering and Operations and Maintenance Divisions and any potential partner organizations and regulatory requirements should be identified. NPDES requirements are currently being defined by a regional monitoring consortium in which Bellevue participates.

## Purposes of the Network

The purposes of the network in terms of users and uses of the data should be identified. Data users and uses can vary temporally and spatially. Debate must occur with the stakeholders to ensure the purposes for the existing network gauges are still valid. For Bellevue to develop a plan, present-day needs and purposes for the gauge network must be discussed so that an appropriate network design can be proposed for approval.

## Objectives of the Networks

Based upon the purposes established above, a set of objectives can be established in terms of the information required. An indication of the consequences of not being able to provide this information should be documented.

## Establish Priorities

Priorities among objectives should be identified. Priorities will change over time, and some stations or needs will be short term. Current priorities should be assessed, and a plan for revisiting these priorities should be created, possibly aligned with the budget and work planning cycle.

## Assess Existing Networks

Existing networks will be tabulated and assessed, and a determination made of the adequacy to meet current objectives.

## Network Design

Depending upon the available information and the reviewed objectives, a proposal with options to meet these objectives will be prepared.
According to the World Meteorological Organization, the design of a hydrologic network answers the following questions pertaining to the collection of hydrologic data:

1. What hydrologic variables need to be observed?
2. Where do they need to be observed?
3. How often do they need to be observed?

4. What is the duration of the observation program?
5. How accurate should the observations be?

Technical criteria used to choose a particular site will include:

- Accessibility—The station should be accessible during all weather conditions, particularly during floods.
- Adequacy—The station must be able to measure the full range of flows.
- Stability—The stage-discharge relationship must be stable or with little variation over time, otherwise regular verification measurements should be made.
- Permanency—For long-term stations, the station must remain undisturbed.

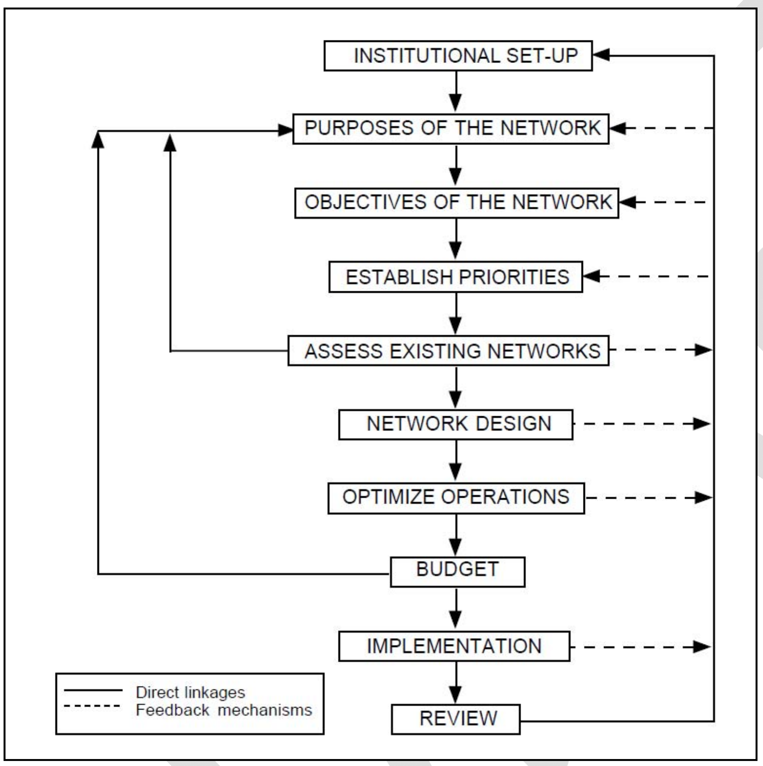


**Figure A-1. A framework for network analysis and redesign of a hydrologic monitoring program (World Meteorological Organization 1994).**

## Operations

An optimization process will be conducted to minimize the cost of the data collection. This includes strategically locating monitoring stations to meet multiple needs, and partnering with other organizations when possible.

## Determine Costs

The cost to implement the recommended network will be estimated, and operational costs will be determined separately (e.g., maintaining rating curves). Estimated costs will be compared to the current budget. If the budget is too low, the plan will investigate additional funding approaches or reduced monitoring.

## Implementation

The redesigned network will be implemented.  If a phased approach is required, both short- and long-term plans may be developed.

## Review Networks

Reviews will occur in the future to make sure the plan is working.  These reviews should occur in the off-budget year so that if changes are necessary, the redesigned network can be implemented in the next budget.

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# Attachment B. Business Case in Support of a Hydrologic Monitoring Plan

## Long-Term Needs

Long-term hydrologic monitoring generally requires a record of several decades, depending on the objective. Long-term data can provide information on hydrologic variability and the overall condition of the storm and surface water system; changes in the system due to land use and natural storm events; and information for flood frequency and forecast modeling.

The Utilities Department uses long-term data for purposes that include planning, operations, stormwater evaluation and effectiveness, trend analysis, and education and outreach needs.

*Planning*

Flood prediction statistics are used for storm response and for studies in basins prone to flooding. This includes determining the frequency and intensity of rain events and correlating those events to discharge rates that result in street or structural flooding. Such information can help Operations and Maintenance staff plan for flood response, including issuing warnings, distributing sand bags and pumps, and closing streets. Planning to resolve recurring erosion, flooding, or sedimentation issues also requires long-term flow and precipitation records. Planning efforts that require hydrologic monitoring data include:

- Basin studies;
- Identifying basins to target for specific stormwater management programs, e.g., low impact development opportunities;
- Flood prevention and drainage system capacity analysis;
- Floodplain mapping;
- CIP projects;
- Emergency storm response; and
- Climate change impacts.

*Operations*

Operating the City's storm and surface water system requires ongoing, real-time data as well as periodic short-term, intensive monitoring that lead to improved operations. Regional stormwater facilities such as regional detention facilities, sand filters, and other facilities with gates or weirs require ongoing data collected by telemetry to efficiently verify that the system is operating as designed, and to check system status remotely during storm events. Periodically, long-term data may be used to verify effectiveness or determine when to make adjustments to reduce flooding and/or improve water quality conditions.

*Stormwater Management Evaluation and Program Effectiveness*

Hydrologic monitoring is used to assess the long-term effectiveness of stormwater management practices. Stormwater management practices include on-site detention or infiltration of water, regional detention facilities, and water quality treatment facilities designed to reduce the speed, quantity and duration of stormwater runoff and associated pollutants. Effectiveness can be evaluated by using hydrologic measurements, including direct measurements of stream flows in response to storms and during base flow conditions, as a surrogate to indicate the condition of physical, water quality, and biological systems.

Hydrologic flow monitoring is critical for water quality analysis because the amount and concentration of pollutants are dependent on the amount of flow. The next NPDES Phase II Municipal Stormwater Permit (2012–2017) will require Bellevue to participate in regional storm and surface water quality and quantity monitoring. These new regional monitoring requirements and implementation options are currently under development. Local monitoring can both contribute to and benefit from the effort.

Biological indicators of stream health, such as fish and benthic macroinvertebrates, are dependent on seasonally appropriate flow regimes. The relationship between flow monitoring and ecological indicators can be used to help stormwater managers evaluate basin issues and needs, prioritize and sequence programs, and determine program success. Long-term hydrologic monitoring is useful to interpret how biological indicators are responding to stormwater management activities.

In addition, the Utilities Department may, as part of an adaptive management program, evaluate various low impact development techniques to determine which are most effective for managing stormwater. Both long- and short-term hydrologic monitoring may be required for evaluating the effectiveness of these techniques. The Utilities Department will coordinate with regional efforts to avoid duplication of effort.

*Long-Term Trends and Climate Change*

Long-term rainfall and stream discharge records will be useful to determine the effects of climate change. Climate change research suggests that given the uncertainties, it is premature for resource managers to make changes to stormwater design standards, but recommend building resiliency into the stormwater system. Changes in precipitation patterns may in turn alter the flow regimes and capacity thresholds of Bellevue's storm and surface water system. Multiple monitored sites with long-term records would be useful for comparing trends between drainage basins; targeting areas for projects to address runoff capacity, flooding, or habitat; and modifying operations. This information, linked with regional efforts, will help inform future stormwater management approaches.

*Education and Outreach*

Long-term stream flow, precipitation, and various hydrologic summary statistics are presented in the Utilities Department's Basin Fact Sheets, which are used by students, teachers, interested citizens, consultants, and staff. The Basin Fact Sheets are available in Appendix B-1 of the Storm and Surface Water System Plan and on the City's website.

## Short-Term Needs

Short-term hydrologic monitoring generally involves a period of record of less than 5 years. Short-term monitoring may be conducted at permanent or temporary gauges. The need for short-term monitoring is determined on a project-by-project basis. Occasional special projects may require that discharge and/or precipitation data be collected over short time periods. Once a project is completed, short-term monitoring systems may be discontinued or moved to address another need.



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The Utilities Department uses short-term hydrologic data for purposes that include operations, stormwater evaluation and effectiveness, CIP design and evaluation, and customer request needs.

*Operations*

In some cases Operations and Maintenance require intensive, short-term monitoring for adjusting the operations of regional facilities. The regional detention facilities have adjustable outlets, which can be changed to modify the amount of storm and surface water detained to prevent downstream flooding during high flows or to help sufficient flow to support fish during summer months. In many cases the outlet structure settings were designed to contain the 100-year, 24-hour rain event, and the facility performs well without adjustments. In other cases, regional detention facility water levels may need to be adjusted seasonally or periodically to compensate for storage limitations such as sedimentation or other changes.

Some gauges are used to guide staff for when stream water levels are safe to perform in-stream fieldwork. For instance, prior to conducting in-stream activities, staff will check the USGS Mercer Creek stream gauge to determine if stream flow is too high to safely walk and work in the streams.

*Stormwater Management Evaluation and Effectiveness*

In addition, the Utilities Department may, as part of an adaptive management program, evaluate various low impact development techniques to determine which are most effective for managing stormwater. Both long- and short-term hydrologic monitoring may be required for evaluating the effectiveness of these techniques. The Utilities Department will coordinate with regional efforts to avoid duplication of effort.

*Capital Investment Program Design and Evaluation*

The Utilities Department's Storm and Surface Water CIP represents a significant investment of resources for infrastructure repair and replacement, habitat improvements, flood control, water quality, and meeting regulatory requirements, settlement and easement agreements, and court orders. Projects are prioritized and constructed based on criteria specific to each program. In addition to the long-term data and modeling information, the CIP also includes short term, one-time projects with specific objectives.

Short-term flow monitoring can provide calibration and verification data for the hydrologic and hydraulic computer models that are used to identify solutions and properly size each project, thus making the CIP and investments more effective and the system more efficient in the long term.

*Customer Requests*

The Utilities Department will provide collected hydrologic monitoring data to customers, internal and external to the City, upon request. Customers include consultants, agencies, institutions, and residents. Consultants periodically request hydrologic data, including precipitation and discharge rates, for engineering design and hydrologic modeling calibration for both private and public contracts. Customer requests include both long-term and short-term data ranges.

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## Appendix B-12. Water Quality in Bellevue's Lakes

Lake Sammamish water contains high concentrations of phosphorus, a nutrient which can cause algae blooms and die-offs that reduce the oxygen in the water available for fish and other aquatic life, and reduces water clarity. In 1996, Bellevue, King County, the City of Redmond and the City of Issaquah set a goal of protecting the "ecological health and public benefits of Lake Sammamish." Water quality indicator goals were set at 4.0 meters Secchi disk transparency, 2.8 micrograms per liter chlorophyll-a, and 22 micrograms per liter total phosphorus (Entranco et al. 1996). Since 1997, King County has collected water quality samples of Lake Sammamish in two locations to evaluate whether or not the water quality goals are being met. As of 2006, goals for phosphorus and transparency have been met each year for both stations except in 2004 and 2006 when the phosphorus goal was not met at one of the stations. The goal for chlorophyll-a has consistently not been met at both sampling stations. For more details, see http://green.kingcounty.gov/lakes/LakeSammamish.aspx.

Phantom and Larsen Lakes are much smaller than Lake Sammamish, and are also sensitive to phosphorus input. Phantom Lake is 63 acres, and has 7,392 feet of shoreline. The maximum water depth is 54 feet, and the mean water depth is 21 feet. It holds a volume of 1,450 acre-feet of water. The outlet of Phantom Lake was altered in approximately 1890, when a farmer diverted it from Kelsey Creek (and Lake Washington) by creating a new channel to the east, to Lake Sammamish. Bellevue has monitored the summer (June through September) water quality of Phantom Lake since 1991 for water clarity (Secchi visibility depth), nutrients (phosphorus), and algae (chlorophyll-a). From 1994 through 2008, goals set for the three measures were met for all years for clarity, 10 out of 14 years for nutrients, and 7 out of 14 years for algae; see Figure 6-5 for the Phantom Lake water quality monitoring results and goals from 1994 to 2008. Zooplankton and phytoplankton were monitored in Phantom Lake for over 10 years, beginning in 1997. The goal of the monitoring was to determine if overall aquatic biological conditions in Phantom Lake had improved, declined, or not changed since water quality improvements were implemented in 1990. Based on over 10 years of data, lake plankton conditions have generally improved.

Larsen Lake is near Phantom Lake, and forms the headwaters of Kelsey Creek. It is approximately 10.5 acres in surface area (Huitt-Zollars 2008), and averages about 9 feet deep. Water quality data, similar to Phantom Lake information, have been collected, but not yet analyzed.

Lake Bellevue is a small lake (approximately 10.4 acres) at the headwaters of Sturtevant Creek, which drains into Mercer Slough and ultimately into Lake Washington. The lake is on average 8 feet deep, with a maximum depth of approximately 11 feet. Lake Bellevue is situated within a densely urban (the Sturtevant Creek basin is on average 71 percent impervious surface area) drainage area, with development over the wetlands around the lake, including structures built over the lake itself. There are high phosphorus concentrations in the lake. Phosphorus, oils, water clarity and algae growth were sampled in 2004 and 2005 to determine how to manage algae, odor, and oils in the lake (Tetra Tech 2006). The analysis determined that only 24 percent of the phosphorus came from urban runoff to the lake; the remaining 76 percent was the result of phosphorus cycling among internal lake water, sediment, plants, and biota. Oil sheens were not attributed to stormwater runoff, but were likely from oil spills, creosote pilings, and nearshore parking lots. Water treatment best management practices and low impact development for redeveloping properties, education about spill prevention, lake aerators, alum treatments to reduce phosphorus, and ongoing monitoring were recommended in a 2006 Lake Bellevue water quality study (2006 Lake Bellevue Water Quality Study and Management Recommendations) to meet water quality goals for Lake Bellevue.

**Appendix B-13. Pollution Export Coefficients for Bellevue Runoff based on Samples Collected from 1989 to 1993.**

Note: Values presented are modified direct averages, estimated based on flow volumes and sampled concentrations during storm events (Storm) and between storm events (Base). Confidence limits, site descriptions, methods and additional analysis can be found in the original report (City of Bellevue 1995).

| Land Use Type | % Impervious | Site | TSS (kg/ha-yr) | | FC (no./ha-yr) | | TP (kg/ha-yr) | | Ortho-P (kg/ha-yr) | | $NO_3$+$NO_2$-N (kg/ha-yr) | | $NH_3$-N (kg/ha-yr) | | COD (kg/ha-yr) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Storm | Base | Storm | Base | Storm | Base | Storm | Base | Storm | Base | Storm | Base | Storm | Base |
| New MFR | 79 | Goldsmith Park | 21.6 | ND | ND | 9.55E+08 | 0.096 | 0.235 | 0.03 | 0.171 | 0.276 | 0.706 | 0.33 | 0.377 | 32.7 | ND |
| Food Distribution (Industrial) | | Grocery Warehouse | 194 | 33 | 2.07E+10 | 2.73E+09 | 2.19 | 3.45 | 0.652 | 6.76 | 2.15 | 0.818 | 775 | 1.1 | 375 | 58 |
| Comm, Indust, MFR, SFR | 50 | Meydenbauer Creek | 190 | 6.25 | 3.71E+10 | 2.35E+10 | 0.625 | 0.176 | 0.199 | 0.126 | 1.93 | 3.27 | 1.82 | 0.126 | 191 | 43.9 |
| Comm, Indust, Service, Residential | 72 | Sturtevant Creek Downstream | 340 | 11.8 | 2.17E+10 | 1.21E+10 | 1.39 | 0.485 | 0.301 | 0.373 | 2.02 | 1.86 | 1.99 | 0.41 | 151 | 37.9 |
| Comm, Indust | 71 | Sturtevant Creek Upstream | 303 | 14.4 | 1.34E+10 | 1.13E+10 | 1.15 | 0.422 | 0.295 | 0.281 | 2.28 | 2.39 | 2.66 | 0.597 | 196 | ND |
| SFR, Light Indust, Service | 37 | West Tributary Downstream | 79.6 | 16.5 | 1.99E+10 | 1.45E+11 | 0.26 | 0.46 | 0.079 | 0.368 | 0.656 | 6.72 | 0.283 | 2.85 | 28 | ND |
| Indust, SFR | 50 | West Tributary Upstream | 288 | 18.7 | 4.76E+10 | 3.15E+10 | 0.623 | 0.48 | 0.189 | 0.36 | 0.887 | 2.76 | 0.755 | 4.38 | 67.7 | ND |

## Appendix B-13, continued.

| | Surfactants (kg/ha-yr) | | Oil and Grease (kg/ha-yr) | | Total Petroleum Hydrocarbons | | Cadmium (kg/ha-yr) | | Chromium (kg/ha-yr) | | Copper (kg/ha-yr) | | Nickel (kg/ha-yr) | | Lead (kg/ha-yr) | | Zinc (kg/ha-yr) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Site | Storm | Base | Storm | Base | Storm | Base | Storm | Base | Storm | Base | Storm | Base | Storm | Base | Storm | Base | Storm | Base |
| Goldsmith Park | ND | ND | 1.3 | ND | 0.943 | ND | 0.0005 | 1.789 | ND | ND | 0.0153 | ND | 0.0044 | ND | 0.0066 | 11.02 | 0.104 | 0.3605 |
| Grocery Warehouse | 2.72 | ND | 135 | ND | 90.2 | ND | ND | ND | 0.0483 | ND | 0.1393 | ND | ND | ND | ND | 0.0285 | 2.362 | 0.3275 |
| Meydenbauer Creek | 0.881 | ND | 53.3 | ND | 36.9 | ND | 0.0024 | ND | 0.0247 | ND | 0.12 | 0.0452 | 0.0218 | 0.0062 | 0.0829 | 0.012 | 0.5845 | 0.1103 |
| Sturtevant Creek Downstream | ND | 0.3727 | 14.6 | ND | 11.6 | ND | 0.0035 | 0.001 | 0.0273 | ND | 0.1153 | 0.0361 | 0.0384 | ND | 0.1064 | 0.0228 | 0.5993 | 0.3118 |
| Sturtevant Creek Upstream | ND | 0.2811 | 42.9 | ND | 35.9 | ND | 0.0031 | ND | 0.0269 | ND | 0.1348 | 0.0228 | 0.0532 | ND | 0.1301 | ND | 0.6062 | 0.1861 |
| West Tributary Downstream | ND | ND | 3.03 | ND | 2.54 | ND | 0.0006 | 0.0032 | ND | ND | 0.452 | ND | 0.0063 | ND | 0.0286 | 0.0311 | 0.1547 | 0.4068 |
| West Tributary Upstream | ND | ND | 7.33 | ND | 6.19 | ND | 0.0016 | 0.0017 | ND | ND | 0.153 | 0.1475 | 0.0219 | ND | 0.1312 | 0.0392 | 0.5661 | 0.4055 |

Values are Modified Daily Averages, which is the total discharge volume for the study period multiplied by the mean pollutant concentration, calculated appropriately for a log normal distribution.

Abbreviations used:

| | | | |
|---|---|---|---|
| TSS | Total suspended solids | kg/ha-yr | kilograms per hectare per year (annual loading) |
| FC | Fecal coliform bacteria | ND | Not detected in any samples |
| TP | Total phosphorus | Comm | Commercial |
| Ortho-P | Orthophosphorus | Indust | Industrial |
| COD | Chemical Oxygen Demand | MFR | Multi-family Residential |
| $NO_3$+$NO_2$-N | Nitrate-Nitrite | SFR | Single-family Residential |
| $NH_3$-N | Ammonia | | |

Dissolved metals were detected at all sites during storm events (see Table B-13A). Dissolved metals concentrations were generally higher for all metals sampled in basins with more impervious surface area. For example, zinc was highest in Sturtevant Creek, West Kelsey Creek, and Meydenbauer Creek drainage basins. Metal toxicity levels change with the hardness of the water, so determining whether concentrations in samples exceed state standards involves separate calculations for each sample. Additionally, state standards for metals have changed since the 1995 water quality report, so locations and numbers of exceedences were not available for this report.

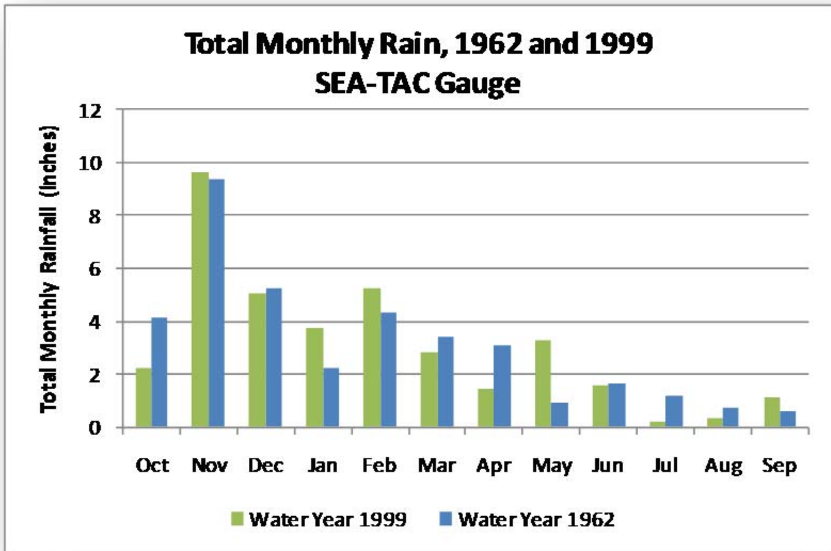
**Table B-13A. Median concentrations (µg/L) and annual yields (kg/ha-yr) for various metals analyzed at Bellevue monitoring locations during the first 6 hours of storm events, 1988-1993, as calculated by Whiley (2009).**

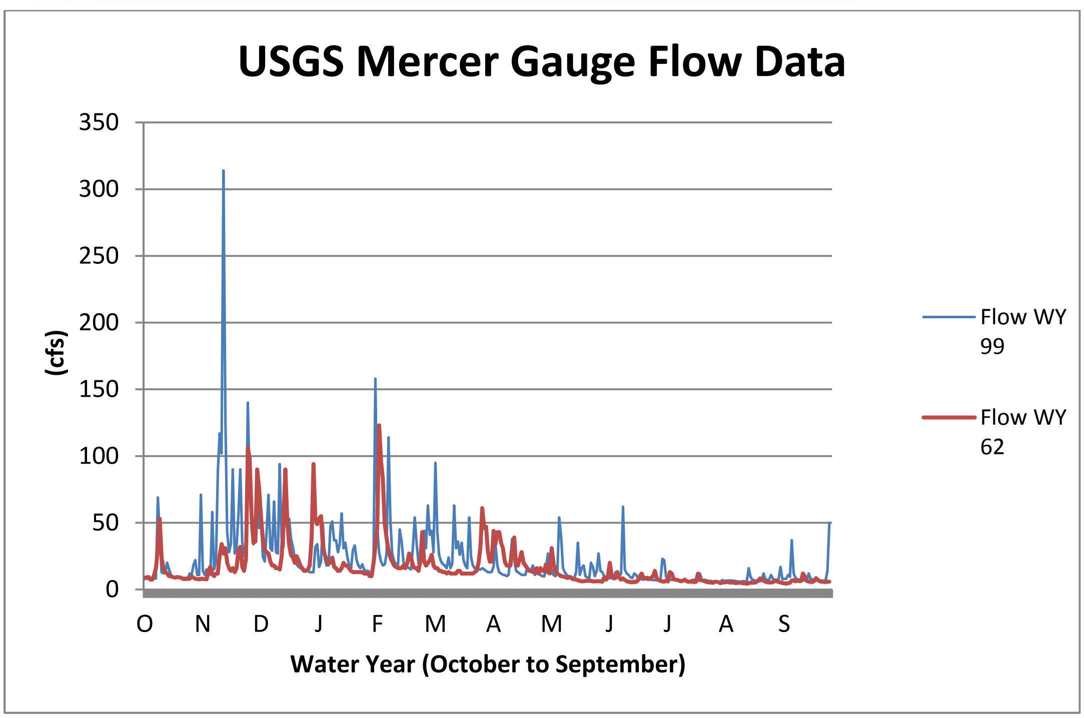
| Stations | Lead | | Cadmium | | Zinc | | Nickel | | Chromium | | Copper | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Median Conc. | Yield | Median Conc. | Yield | Median Conc. | Yield | Median Conc. | Yield | Median Conc. | Yield | Median Conc. | Yield |
| W. Kelsey Creek Upstream | 35.0 | 0.062 | 0.70 | 0.0012 | 179 | 0.318 | 11.0 | 0.020 | >30% nd | == | 33.5 | 0.06 |
| W. Kelsey Creek Downstream | 14.0 | 0.017 | 0.67 | 0.0008 | 84 | 0.101 | 5.5 | 0.007 | >30% nd | == | 22.0 | 0.026 |
| Mercer Slough | >30% nd | == | >30% nd | == | 46 | 0.041 | >30% nd | == | >30% nd | == | 15.0 | 0.013 |
| Coal Creek | >30% nd | == | >30% nd | == | 54 | 0.097 | >30% nd | == | >30% nd | == | 20.5 | 0.037 |
| Meydenbauer Creek | >30% nd | == | >30% nd | == | 170 | 0.394 | >30% nd | == | >30% nd | == | 28.0 | 0.065 |
| Sturtevant Creek Upstream | 23.0 | 0.089 | >30% nd | == | 127 | 0.492 | >30% nd | == | >30% nd | == | 23.0 | 0.089 |
| Sturtevant Creek Downstream | 27.5 | 0.076 | 0.85 | 0.0023 | 140 | 0.386 | 9.0 | 0.025 | >30% nd | == | 20.0 | 0.055 |
| Wilkins Creek | >30% nd | == | n<4 | == | 49 | == | >30% nd | == | 12.5 | == | 15.5 | == |
| Phantom Lake | n<4 | == | n<4 | == | 15 | 0.009 | n<4 | == | >30% nd | == | 10.0 | 0.006 |

**Shaded data: >30% of reported observations less than detection limit; table value is median of concentrations above detection limit.**
**<4: Reported observations number less than 4.**
**= = Yield not calculated.**

## Appendix B-14. Total Monthly Rainfall for 1962 and 1999 Measured at Sea-Tac Airport.

Precipitation patterns were similar in 1962 and 1999. Total annual rainfall in water year 1962 (October 1, 1962 to September 30, 1963) was 36.2 inches. Total annual rainfall during water year 1999 was 36.8 inches. Daily rainfall records were not available, but monthly rainfall totals indicate that the overall monthly amount of precipitation was similar for most months. Because the rainfall patterns were similar for these 2 years, the stream discharge rate at the Mercer Creek stream gauge was compared in order to analyze differences in stream flow in the same stream before and after urbanization occurred. See the graph below.



# APPENDIX C. SUPPORTING INFORMATION ADDRESSING BASIN ISSUES AND NEEDS

- C-1. Summary of Physical, Water Quality, and Biological Issues Resulting from Urbanization, and Evaluation Criteria
- C-2. Existing Basin Plans and Information
- C-3. Basin Evaluation by Available Evaluation Criteria
- C-4. Status of Projects and Recommendations of Major Plans and Studies

**Appendix C-1.** Summary of Physical, Water Quality, and Biological Issues Resulting from Urbanization, and Evaluation Criteria.

Source: Adapted from *A Science Framework for Ecological Health in Seattle's Streams* (Seattle Public Utilities and Stillwater Sciences 2007)

| Urban Stressors | | Metric | Impacts: Direct | Impacts: Primary Indirect | Impacts: Secondary Indirect | Natural Influencing Factors | Mitigators/Corrective Actions |
|---|---|---|---|---|---|---|---|
| Physical | Impervious Surfaces | Area of impervious surface | Reduced aquifer recharge | Reduced summer baseflow | Warmer stream temperatures | Geology | Reduce impervious surface areas, use infiltration, install flow control and water quality facilities |
| | | | Increased surface water runoff | Flooding | Property Damage | Location of floodplain areas, wetlands | Preserve floodplains and wetlands, install flow control and water quality facilities |
| | | | | Channel erosion | Sedimen-tation | Geology, topography, vegetation | Maintain streambank vegetation, detain flows to more natural hydrologic conditions, install flow control and water quality facilities |
| | | | | Conveyance system deficiencies | Infrastructure damage and increased maintenance | Geology (infiltration potential) | Upgrade pipe system, install natural drainage practices (e.g., rain gardens, pervious pavement), install flow control and water quality facilities |
| | | | Land conversion-vegetation to impervious surface | Heat island effect | Warmer temperatures | Vegetation | Preserve forest property, use pervious pavement, install flow control and water quality facilities |
| | | | | Loss of evapo-transpiration (ET) | More runoff from ET loss | Vegetation, water table | Minimize impervious surfaces, use bioretention, install flow control and water quality facilities |

| Urban Stressors | | Metric | Impacts: Direct | Impacts: Primary Indirect | Impacts: Secondary Indirect | Natural Influencing Factors | Mitigators/Corrective Actions |
|---|---|---|---|---|---|---|---|
| | Channel Hardening | Miles of modifications | Channel Incision | Disconnection of floodplain from stream channel | | Geology, topography, vegetation | Channel restoration, grade control, reconstructed floodplain terraces, install flow control and water quality facilities |
| | | | | Downstream sedimentation | Downstream flooding | Topography | Upstream channel restoration, channel or conveyance system maintenance (including dredging), culvert upgrades. |
| Water Quality | Pollution-generating surfaces | Area of pollution-generating surfaces, Ecology 303(d) list | Pollutants in runoff | Adsorbs to sediment | Biological uptake by aquatic organisms, plants | Groundwater- surface water connections, geology, wildlife, vegetation | Water quality treatment of runoff prior to release into environment, catch basin cleaning/maintenance |
| | | | | Discharge to surface water | Decreased dissolved oxygen | | Prevention and source control of pollutants |
| Biological | Loss of Open Space | Acres of Open Space/Parks | Land conversion | Reduced carbon sequestration, heat islands, loss of ET | More runoff from ET loss | | Preserve mature forests or neighborhood trees where possible, flow control and water quality facilities, and water quality BMPs. |
| | Loss of Tree Canopy | % Tree Canopy | Modified forest structure (younger vs. | Lost interflow in duff layer | More runoff from lost soil retention capacity | | Soil amendments for new plantings, flow control and water quality facilities, and water quality BMPs |

| Urban Stressors | Metric | Impacts: Direct | Impacts: Primary Indirect | Impacts: Secondary Indirect | Natural Influencing Factors | Mitigators/Corrective Actions |
|---|---|---|---|---|---|---|
| | | mature forests) | | | | |
| | | Modified soil structure | Higher stream temperatures in summer months | Different, more tolerant aquatic communities | Groundwater connection, baseflow conditions | Protect riparian areas, flow control and water quality facilities, and water quality BMPs. |
| Riparian Encroachment | % Tree Canopy in Stream Buffers | Reduced shade | Higher stream temperatures in summer months<br>Simplified ecological food chain | Different, more tolerant aquatic communities | Groundwater connection, baseflow conditions<br>Transport of leaf litter, detritus from upstream and upland | Protect aquifer recharge areas that supply baseflow to affected streams<br>Protect and restore riparian areas, flow control and water quality facilities, and water quality BMPs |

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**Appendix C-2. Existing Basin Plans and Information**

Whenever studies or projects are to be initiated within a basin, previous studies should be reviewed to avoid duplication of efforts. Basins with multiple issues that have not received basin studies should have higher consideration for future basin studies. Early basin-level plans and studies focused on primary conveyance capacity, flooding, erosion, sedimentation, and geology or soil infiltration rates. Over time, the scope of basin studies have expanded to include water quality and habitat/fish criteria. A review of major plans and studies conducted in previous years, as well as the status of their associated recommendations are listed in Appendix C-4. Plans completed between 1987 and 1999 for Phantom Lake, Larsen Lake, Meydenbauer Creek, and Richards Creek basins primarily addressed water quality and sedimentation issues. However, Richards Creek also had conveyance issues that were addressed. Many of the projects recommended in these plans have been completed. Some of the recommended projects from these older plans are no longer a priority, and will not be built (see Appendix C-4 for a review of previously proposed projects and reasons why these projects were not carried out).

These basin plans and status of recommendations are summarized to provide greater understanding of the level of effort that has occurred for individual basins and are recommended for review for any future basin studies.

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**Appendix C-3. Basin Evaluation by Available Evaluation Criteria.**

| Basin | Flood Protection | | | | | Water Quality | | | | Aquatic Habitat | | | Presence or Absence of Key Basin Issues | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Primary Street Closures per 100-year, 24-hour Storm | Secondary Street Closures per 100-year, 24-hour Storm | Flooded Structures (2000-2009) ***Note: 4+ years less than claims*** | Flooding Claims (10/1/96 to 2/28/11) | Area Built prior to Stormwater Control Standards (%) | Total Impervious Area (%) | Phosphorus-sensitive Lake | Impaired Water Body (Ecology 303(d) list 2008) | Water Quality Risk Level (IDDE) | LWD Pieces per Channel Width | Pool Frequency and Quality (deep and cool with cover) | B-IBI Score (most recent) | Flood Protection | Water Quality | Aquatic Habitat |
| Salmon Spawning Stream Basins | | | | | | | | | | | | | | | |
| Coal Creek | 0 | 1 | ≥5 | 6 | 16 | 20 | No | Yes | Low | Fair | ND | 20 | √ | √ | √ |
| East Creek | 0 | 0* | ≤2 | | 45 | 48 | No | No | High | Poor | Poor | ND | | √ | √ |
| Goff Creek | 0 | 0 | ≤2 | | 46 | 30 | No | No | High | ND | ND | 18 | | √ | √ |
| Kelsey Creek | 2 | 1 | 3-4 | 7 | 57 | 40 | No | Yes | High | Poor | Poor | 18 | √ | √ | √ |
| Mercer Slough | 0 | 0 | ≤2 | 2 | 38 | 32 | No | Yes | Medium | ND | ND | NA | √ | √ | |
| Newport Area | 0 | 0 | 3-4 | | 82 | 39 | No | No | Low | ND | ND | 16 | √ | √ | √ |
| Richards Creek | 1* | 0 | 3-4 | 4 | 32 | 45 | No | No | High | Poor | Poor | ND | √ | √ | √ |
| Valley Creek | 0 | 0 | ≤2 | 1 | 36 | 34 | No | No | High | Poor | Poor | 16 | √ | √ | √ |
| Vasa Creek | 0 | 0 | 3-4 | 1 | 36 | 40 | Yes | No | Medium | ND | ND | 24 | √ | √ | √ |
| West Tributary | 0 | 0 | 3-4 | 2 | 51 | 46 | No | No | High | ND | ND | 18 | √ | √ | √ |
| Small and Steep Stream Basins | | | | | | | | | | | | | | | |
| Ardmore | 0 | 0 | ≤2 | | 63 | 43 | Yes | Yes | Low | ND | ND | 22 | | √ | √ |
| Lakehurst | 0 | 0 | ≤2 | 3 | 37 | 33 | No | No | Low | ND | ND | 20 | √ | | √ |
| Lewis Creek | 1 | 0 | ≤2 | | 4 | 29 | Yes | Yes | Medium | ND | ND | 20 | √ | √ | √ |
| North Sammamish | 0 | 0 | ≤2 | 2 | 56 | 32 | Yes | No | Low | NA | NA | NA | √ | | |

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| | Flood Protection | | | | | Water Quality | | | | Aquatic Habitat | | | Presence or Absence of Key Basin Issues | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Basin | Primary Street Closures per 100-year, 24-hour Storm | Secondary Street Closures per 100-year, 24-hour Storm | Flooded Structures (2000-2009) ***Note: 4+ years less than claims*** | Flooding Claims (10/1/96 to 2/28/11) | Area Built prior to Stormwater Control Standards (%) | Total Impervious Area (%) | Phosphorus-sensitive Lake | Impaired Water Body (Ecology 303(d) list 2008) | Water Quality Risk Level (IDDE) | LWD Pieces per Channel Width | Pool Frequency and Quality (deep and cool with cover) | B-IBI Score (most recent) | Flood Protection | Water Quality | Aquatic Habitat |
| Phantom Creek | 0 | 0 | ≤2 | 1 | 35 | 35 | Yes | No | Low | ND | ND | 26 | √ | | √ |
| Sunset Creek | 0 | 1 | ≥5 | | 47 | 42 | No | No | High | Poor | Poor | 14 | √ | √ | √ |
| South Sammamish | 0 | 0 | ≤2 | | 22 | 31 | Yes | No | Low | ND | ND | ND | | | |
| Wilkins Creek | 0 | 0 | ≤2 | 2 | 76 | 41 | Yes | No | Low | ND | ND | 22 | √ | | √ |
| Yarrow Creek | 0 | 0 | 3-4 | 2 | 40 | 31 | No | Yes | High | ND | ND | ND | √ | √ | √ |
| Closed Conveyance System Basins (>96% piped storm drainage system) | | | | | | | | | | | | | | | |
| Beaux Arts Area | 0 | 1 | ≤2 | | 53 | 34 | No | No | NA | NA | NA | NA | √ | | |
| Clyde Beach | 0 | 0 | ≤2 | 1 | 62 | 47 | No | No | NA | NA | NA | NA | √ | | |
| Meydenbauer Creek | 0 | 0 | ≥5 | 4 | 48 | 59 | No | Yes (Bay) | Medium | ND | ND | ND | √ | √ | |
| Rosemont Area | 1 | 0 | 3-4 | 8 | 55 | 38 | Yes | No | NA | NA | NA | NA | √ | | |
| Sears Creek | 0 | 0 | ≤2 | | 32 | 63 | No | No | High | ND | ND | ND | | √ | |
| Spirit Ridge | 0 | 0 | 3-4 | 2 | 65 | 40 | Yes | No | NA | NA | NA | NA | √ | √ | |
| Sturtevant Creek | 0 | 0 | ≤2 | 2 | 34 | 71 | Yes | No | High | ND | ND | ND | √ | √ | |

NA = Not applicable; ND = no data available; *= Flooding problem corrected by 2004 culvert replacement. Street closures prior to this date were not included in total.

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**Appendix C-4. Status of Projects and Recommendations of Major Plans and Studies as Listed in Table 7-1.**

| Date | Plan Name | Focus Area | Status of Recommendations |
|---|---|---|---|
| 1976 | Drainage Master Plan | Entire city, except Lewis Creek, Lakehurst Area, and South Sammamish Area basins | Many of the recommended actions in this plan were completed in the early 1980s, including acquisition of property for regional detention, and capital construction of infrastructure. |
| 1979 | Draft Environmental Impact Statement for the 1976 Drainage Master Plan | Same as above | Same as above. |
| 1980 | Meydenbauer Basin Study | Meydenbauer Basin | Recommendations related to modify the diversion vault to send more flow into the bypass line were completed. Recommendations for flow and sedimentation monitoring were also implemented. Other projects related to conveyance upgrade were not implemented because they were based on predicted flooding, not actual flooding events |
| 1984 | Bellevue Urban Runoff Program Summary Report | Surrey Downs and Lake Hills neighborhoods | No recommendation. This study characterized the beneficial uses and the water quality problems of an urban stream compared to a pristine reach. |

| Date | Plan Name | Focus Area | Status of Recommendations |
|---|---|---|---|
| 1987 | Coal Creek Basin Plan and Environmental Impact Statement | Coal Creek Basin | King County established Cougar Mountain Regional Wildland Park, and I-405 regional detention pond and Coal Creek sediment pond were built. |
| 1987-1993 | Phantom and Larsen Lakes Restoration Reports | Phantom Lake and Larsen Lake | Completed. |
| 1988 | Comprehensive Drainage Plan | City-wide | Approximately 60% of the recommended capital improvements have been constructed. The remainder are no longer recommended for construction due to inability to obtain property rights, changed policies, or low ranking of project. |
| 1988 | Meydenbauer Creek Basin Study | Meydenbauer Creek basin | Completed or ongoing. |
| 1990 | Lewis Creek Basin Drainage Report | Lewis Creek basin | A compilation of pre-1990 reports, agreements, design data, plat history, water quality information, Lakemont pond performance during storm events, and policies prepared for the storm and surface water commission to address surface water policies being discussed in 1990. |
| 1994 | Comprehensive Drainage Plan | City-wide | |

| Date | Plan Name | Focus Area | Status of Recommendations |
|---|---|---|---|
| 1995 | Characterization and Source Control of Urban Stormwater Quality | City-wide | A 4 ½-year water quality study to support NPDES processes. The report recommended using a watershed-based approach to characterize stormwater, to use source control programs to improve water quality, and revisions to water quality criteria. |
| 1996 | Lake Sammamish Water Quality Management Plan, 1996 | Lake Sammamish basins | This plan made recommendations on how the neighboring jurisdictions could protect the water quality of Lake Sammamish through a combination of phosphorus control practices including source control, retrofit, forest management, and regional treatment technologies. |
| 1999 | Richards Creek Basin Plan | Richards Creek basin | Two culvert enlargement projects to improve fish passage and flood flow conveyance. |
| 2001 | City of Bellevue Stream Typing Inventory | Stream typing inventory of Bellevue streams | |
| 2003 | Hydrologic Study of Kelsey Creek | Kelsey Creek basin and tributaries | Analysis to evaluate operation of regional detention facilities to reduce erosive flows, improve aquatic habitat, and maintain existing flood control. |

| Date | Plan Name | Focus Area | Status of Recommendations |
|---|---|---|---|
| 2005 | Coal Creek Environmental Impact Statement | Coal Creek basin | All identified projects built, including numerous streambank stabilization projects, and off-channel sedimentation pond. |
| 2006 | Lake Bellevue Water Quality Study and Management Recommendations | Sturtevant Creek basin | This study addressed current and future developments and land uses and their impact on water quality; current nutrient dynamics and their impact upon algal blooms; sources of petroleum products; and made management recommendations on achievable lake water quality goals. |

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