Joan Kersnar
SPU Water System Plan 2013 ORD
June 25, 2012
Version #2

CITY OF SEATTLE

ORDINANCE _____

COUNCIL BILL 117589

AN ORDINANCE relating to Seattle Public Utilities; adopting the 2013 Water System Plan.

WHEREAS, the 2013 Water System Plan provides guidance for planning and managing Seattle Public Utilities' water system and capital facilities in coordination with growth management planning by the City of Seattle and other planning agencies in the Puget Sound Basin; and

WHEREAS, Seattle Public Utilities prepared its 2013 Water System Plan to meet Washington Department of Health requirements for water system plans and King County requirements for franchises and permits; and

WHEREAS, the 2013 Water System Plan sets a regional water use efficiency goal to reduce per capita water use from current levels so that total average annual retail water use of members of the Saving Water Partnership is less than 105 million gallons per day from 2013 through 2018 despite forecasted population growth; and

WHEREAS, Seattle Public Utilities has prepared a Determination of Nonsignificance for the 2013 Water System Plan which has been submitted to Council; NOW, THEREFORE,

BE IT ORDAINED BY THE CITY OF SEATTLE AS FOLLOWS:

Section 1. The City of Seattle hereby adopts the *2013 Water System Plan*, a copy of which is included as Attachments 1 and 2.

Section 2. This ordinance shall take effect and be in force 30 days after its approval by the Mayor, but if not approved and returned by the Mayor within ten days after presentation, it shall take effect as provided by Seattle Municipal Code Section 1.04.020.

Passed by the City Council the ____ day of _____, 2012, and signed by me in open session in authentication of its passage this _____ day of _____, 2012.

_____

President _____of the City Council

Approved by me this ____ day of _____, 2012.

_____

Michael McGinn, Mayor

Filed by me this ____ day of _____, 2012.

_____

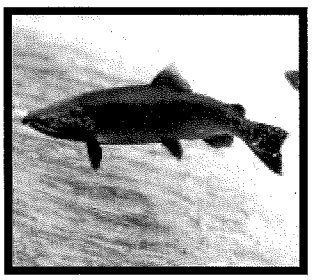
Monica Martinez Simmons, City Clerk

(Seal)

ATTACHMENT 1 – 2013 Water System Plan, Volume I, July 2012
ATTACHMENT 2 – 2013 Water System Plan, Volume II, Appendices, July 2012

Attachment 1

Seattle Public Utilities



2013 Water System Plan

Our Water. Our Future.

Volume I
July 2012

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Seattle Public Utilities

Seattle Public Utilities

2013 Water System Plan

July 2012

VOLUME I

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Acknowledgements

The following have contributed to the preparation of this *2013 Water System Plan*:

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Special appreciation is extended to members of the Seattle Water Supply Operating Board and the Water System Advisory Committee who provided input and comments on preliminary work products for this Water System Plan.

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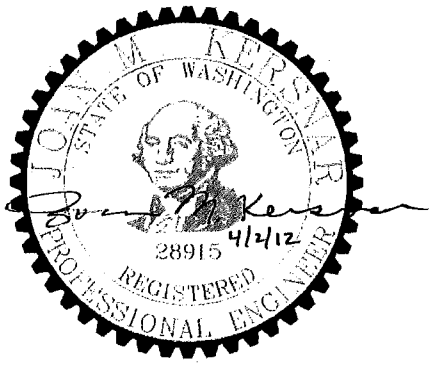
Certification

Seattle Public Utilities
2013 Water System Plan

This 2013 Water System Plan for Seattle Public Utilities has been prepared under the direction of the following Registered Professional Engineers:



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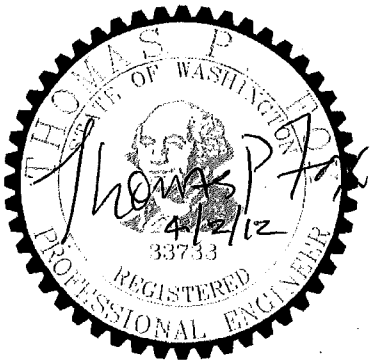

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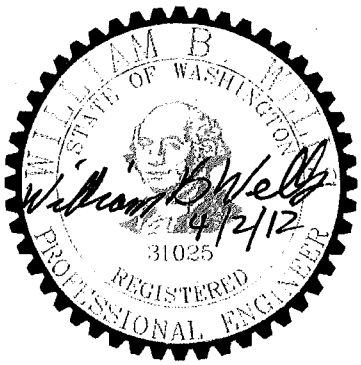

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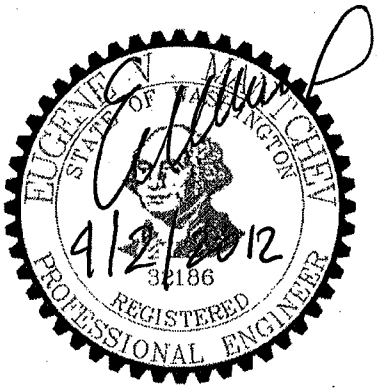

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Abbreviations

AMC	Asset Management Committee
AMR	Automated Meter Reading equipment
ASR	Aquifer Storage and Recovery
AWWA	American Water Works Association
BPA	Bonneville Power Administration
CCF	hundred cubic feet
CCL	Contaminant Candidate List
CCP	Concrete cylinder pipe
CCR	Consumer Confidence Report
cfs	Cubic feet per second
CFP	Capital Facilities Plan
CI	cast iron
CIP	Capital Improvement Program
COEHHA	California Office of Environmental Health Hazard Assessment
CRPL	Cedar River Pipeline
CUE	Conjunctive Use Evaluation
CWSP	Coordinated Water System Plan
DBP	Disinfection By-Products
DI	ductile iron
DNS	Determination of Nonsignificance
DSL	Distribution System Leakage
EDC	Endocrine Disrupting Compounds
EIS	Environmental Impact Statement
EPA	Environmental Protection Agency
ESA	Endangered Species Act
F	Fahrenheit
FCF	Flow Control Facilities
FERC	Federal Energy Regulatory Commission
FWP	Finished Water Pipeline
GIS	Geographic Information System
GMA	Growth Management Act
HCP	Habitat Conservation Plan
HISB	High Impact Shutdown Block
I-63 SO	Initiative 63 Settlement Ordinance (Seattle Ordinance 120532)
IDSE	Initial Distribution System Evaluation
IFA	Instream Flow Agreement
IWA	International Water Association
LAF	Limited Alternative to Filtration
LEED	Leadership in Energy and Environmental Design
LIMS	Laboratory Information System

LT2ESWTR	Long Term 2 Enhanced Surface Water Treatment Rule
LT2SWTR	Long Term 2 Surface Water Treatment Rule
MAC	Mycobacterium Avium Complex
MCL	Maximum Contaminant Level
MDL	Minimum Detection Limit
mgd	million gallons per day
MIT	Muckleshoot Indian Tribe
MTBE	methyl tertiary butyl ether
MWL	Municipal Water Law
NZMS	New Zealand mud snail
O&M	Operation and Maintenance
OFM	Washington State Office of Financial Management
PHSKC	Public Health Seattle and King County
PPCP	Pharmaceuticals and Personal Care Products
PRV	Pressure regulating valve
psi	pounds per square inch
PSRC	Puget Sound Regional Council
PUMA	Piloting Utility Modeling Applications
RCM	Reliability Centered Maintenance
RWSP	Regional Wastewater Services Plan
SAMP	Strategic Asset Management Plan
SBS	Standby Storage
SCADA	Supervisory Control and Data Acquisition
SDOT	Seattle Department of Transportation
SFD	Seattle Fire Department
SPU	Seattle Public Utilities
SRES	Special Report on Emission Scenarios
SWTR	Surface Water Treatment Rule
TESS	Tolt Eastside Supply
TESSL	Tolt Eastside Supply Line
TPL	Tolt Pipeline
UCMR	Unregulated Contaminant Monitoring Rule
UV	Ultraviolet
UW-CIG	University of Washington Climate Impacts Group
VOC	Volatile Organic Compounds
WAC	Washington Administrative Code
W.D.	Water District
WDOH	Washington State Department of Health
WSDOT	Washington Department of Transportation
WSP	Water System Plan
WTF	Water Treatment Facility
WUE	Water Use Efficiency

2013 Water System Plan
Plan Summary

Seattle Public Utilities (SPU) manages and operates the water system serving Seattle retail customers and wholesale customers in nearby cities and water districts. This *2013 Water System Plan* describes how SPU meets current and future water demands, ensures high quality drinking water, and invests in and maintains its water system at the lowest life-cycle cost. While the plan focuses on the 2013-2018 time period, longer term outlooks to 2040 and beyond are also discussed.

SPU prepared the plan under regulations adopted by the Washington State Department of Health (WDOH) for public drinking water suppliers. The plan is also consistent with the WDOH Water Use Efficiency Rule, requirements of the Growth Management Act, and local and regional land use plans.

Key findings and implementation actions are highlighted below, with more detail provided in the chapters that correspond to the headings.

Drinking Water System

- SPU provides drinking water to a service area population of 1.3 million within the greater Seattle metropolitan region of King County and portions of southern Snohomish County. See map of SPU's service area on page S-9.
- Recent surveys of residential and commercial customers indicate that SPU's retail customers continue to be very satisfied with water system reliability and drinking water quality.

Water Resources

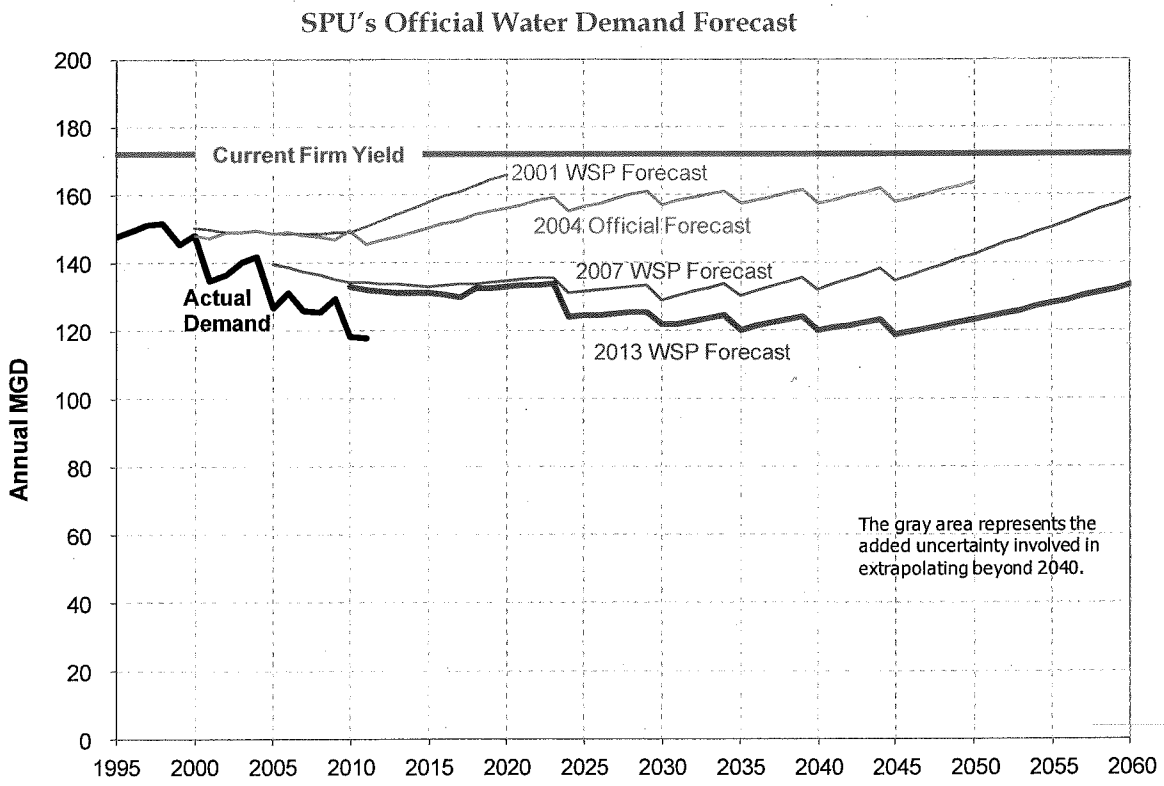
SPU's water supply system consists of surface water reservoirs on the Cedar River and South Fork Tolt River and two wellfields providing groundwater. The system is operated primarily for water supply and protection of instream flows, but also used for hydroelectric power generation and flood management.

Water Use

- Approximately one-half of SPU's water is used by SPU's retail customers and one-half is sold through wholesale contracts to 19 municipalities and special purpose districts, plus Cascade

Water Alliance, who in turn provide the water to their own retail customers.

- Since 1990, consumption has decreased about 30 percent while population has increased by 15 percent.
- From 2010 to 2040, population is forecast to increase by 21 percent in SPU's retail service area and by 25 percent in the service area of SPU's full and partial wholesale water contract holders. Employment is forecast to grow by 54 and 46 percent, respectively, over the same period.
- Total average annual demand is forecast to remain at or below current levels of approximately 133 million gallons per day through 2060, significantly lower than what was forecasted in the *2007 Water System Plan*. See graph below.
- The primary factors that influence the demand forecast consist of the declining block contract with Cascade Water Alliance and continued reductions in water use by customers.



Conservation

- SPU achieved a greater than 30 million gallons per day (mgd), or 20 percent, reduction in water use on an average annual basis from 2000 through 2010 from the combined effect of the Regional 1% Conservation Program, SPU's "Everyone Can Conserve" Program, system operation improvements, and other changes in water use by customers due to rates and codes.
- This plan sets a goal to reduce per capita water use from current levels so that total average annual retail water use of members of the Saving Water Partnership[1] is less than 105 mgd from 2013 through 2018 despite forecasted population growth.

Water Supply

- The current firm yield estimate for SPU's water supply system is 172 mgd, which is an increase of one mgd reflecting recent demand patterns and a recently approved higher refill level in Chester Morse Lake.
- Through this plan, SPU is modifying its service area for its water rights place of use so as to clarify that the service area includes small areas in Snohomish County currently served by Northshore Utility District, the City of Woodinville, and the City of Bothell, as well as potential service area additions proposed by Water District 119. For these areas, see the map on page S-9.
- Given the new demand forecast and current firm yield estimate for SPU's existing supply resources, no new source of supply is needed before 2060.

Climate Change and Future Supply Outlook

- Updated analyses indicate that under the warmest climate change scenario analyzed, available supply is estimated to be reduced by as much as 4 percent in 2025, 6 percent in 2050, and 13 percent in 2075. Even so, the reduced supply would exceed climate-impacted demands for all years except 2075, in which demand would exceed supply by approximately 3 percent. Low or no cost system modifications could be made to meet demands in this case.

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[1] Members of the Saving Water Partnership include Seattle, Northshore Utility District and SPU's 17 full and partial wholesale water contract holders.

Planned Infrastructure and Operational Improvements

- SPU identified infrastructure improvement needs for the water supply system that include Morse Lake Pump Plant, Overflow Dike Replacement, and Landsburg Dam Flood Passage Improvements projects.
- SPU plans to complete investigations that support water resources operations including refill of Chester Morse Lake to elevation 1566 feet, potential impact on water quality that could be caused by failure of Lake Youngs Cascades Dam, and potential additional drawdown of South Fork Tolt Reservoir.

Water Quality and Treatment

SPU's water system includes state-of-the-art water treatment facilities for the Cedar and South Fork Tolt source waters, in-town disinfection facilities at reservoirs and well sites, and a state-certified water quality laboratory.

Drinking Water Quality

- SPU continues to meet drinking water quality regulations and other aesthetic criteria (i.e., taste and odor).
- SPU's source protection practices, water treatment facilities, and distribution system practices have provided excellent quality water that ensures compliance with current and future regulations.
- Results of testing in 2008 for pharmaceuticals and personal care products (PPCPs) and endocrine disrupting compounds (EDCs) in SPU's source water confirms the absence of these emerging contaminants of concern.
- SPU plans to review distribution system flushing practices and the level of resources allocated to flushing of the distribution system through fire hydrants.
- SPU will conduct a risk-cost analysis of public access on the Kerriston Road to determine if additional land acquisition is the preferred approach for mitigating the risk of impairing Cedar source water quality.
- SPU will continue to monitor and characterize limnological conditions in Lake Youngs as it affects Cedar supply operations and treated water quality.
- SPU will operate the water supply system to bypass Lake Youngs to avoid problematic algae from entering the water system.

- SPU will continue efforts to prevent aquatic nuisance and invasive species from being introduced into SPU's drinking water supplies.

Reservoir Covering/Burying

- SPU has covered eight of the ten reservoirs that were previously uncovered, with six of these buried to increase security and create new public open space opportunities.
- The plan for the remaining two open reservoirs is to test-decommission Roosevelt Reservoir and Volunteer Reservoir.
- In about 2020, the floating covers on Bitter Lake and Lake Forest Park Reservoirs will be evaluated for their remaining service life and possible replacement.

Water Treatment Facilities

- SPU will be evaluating contract extension options for the Tolt and Cedar Water Treatment Facilities that are in long-term Design-Build-Operate (DBO) contracts.
- SPU plans to replace the existing gas chlorine feed system at Landsburg with sodium hypochlorite to reduce safety risks.

WATER TRANSMISSION SYSTEM

The regional and sub-regional water transmission systems include approximately 193 miles of pipeline, seven covered reservoirs, 15 pump stations, six elevated tanks and standpipes, and 129 wholesale customer taps with meters.

Transmission Infrastructure

- SPU has met the wholesale contract requirements for pressure and flow, and there have been no unplanned outages of the transmission pipelines that have exceeded SPU's service level for maximum outage durations.
- SPU plans to mitigate the risk of pipe failure in the slide area between the Regulating Basin and Tolt Water Treatment Facility through continued slope monitoring, additional geotechnical data collection, periodic internal inspections, biannual leak testing, and by taking such actions as acquiring ownership of the land in the slide area and implementing pipeline stress relief measures when necessary.
- SPU will implement cost-effective cathodic protection projects as needed for the concrete cylinder and steel transmission

pipelines to protect these from corrosion and extend their service lives.

System Storage Level of Reliability

- SPU has defined its system storage level of reliability that is based on outage scenarios of major system components and of power supply. These scenarios form the basis for downsizing or retiring certain treated water reservoirs, for decommissioning certain tanks and standpipes, and for making targeted improvements to pump stations.

Water Distribution System

The distribution system contains more than 1,680 miles of watermains, two open reservoirs, six covered reservoirs, 16 pump stations, six elevated tanks and standpipes, 21,000 valves, and 18,920 fire hydrants, as well as more than 188,000 service lines and meters serving individual residential and non-residential properties in the retail service area.

Service Delivery

- Since completion of the pressure improvement projects in early 2009, pressures at all retail service connections are greater than 20 pounds per square inch during normal operations.
- SPU consistently responded to reported distribution system problems within one hour more than 90 percent of the time.
- While SPU's distribution system leakage has increased from less than 3 percent in 2006 and 2007 to more than 6 percent in 2010 and 2011, the 3-year rolling average has remained below the WDOH standard of 10 percent.
- The rate of watermain leaks and breaks remains low, averaging less than 10 reported leaks or breaks per 100 miles per year in the distribution system.
- From 2006 through 2010, fewer than 2 percent of all retail customers experienced water service delivery outages of more than 4 hours per year from all planned and unplanned events.

Distribution Infrastructure

- SPU plans to assess, in a pilot effort, the condition of a portion of the most critical watermain segments and, if needed and supported by analysis, to repair, rehabilitate or replace the pipe prior to anticipated failure.

- SPU will improve operational response and customer service by using information from the watermain shutdown block analysis for project and emergency shutdown plans.
- SPU plans to complete the remaining seismic backbone upgrades in the Duwamish River Valley.
- SPU will consider the use of cleaning and cement-mortar lining as an alternative to replacement of deteriorated unlined, cast iron pipe to address pipeline life, fire flow, water quality, and pressure issues in the distribution system.
- SPU will continue to work with the Seattle Fire Department to improve fire hydrant maintenance and testing practices, to better coordinate communication between SFD and SPU's water system control center and emergency crews just prior to and during fire fighting, and to prioritize and implement fire flow improvement projects.
- SPU plans to use SPU's Watermain Replacement Opportunity Model to determine whether to protect or replace existing watermains impacted by transportation projects.
- SPU will continue working with developers where watermain replacements or upgrades in redevelopment areas are required to meet current fire flow requirements and watermain standards.

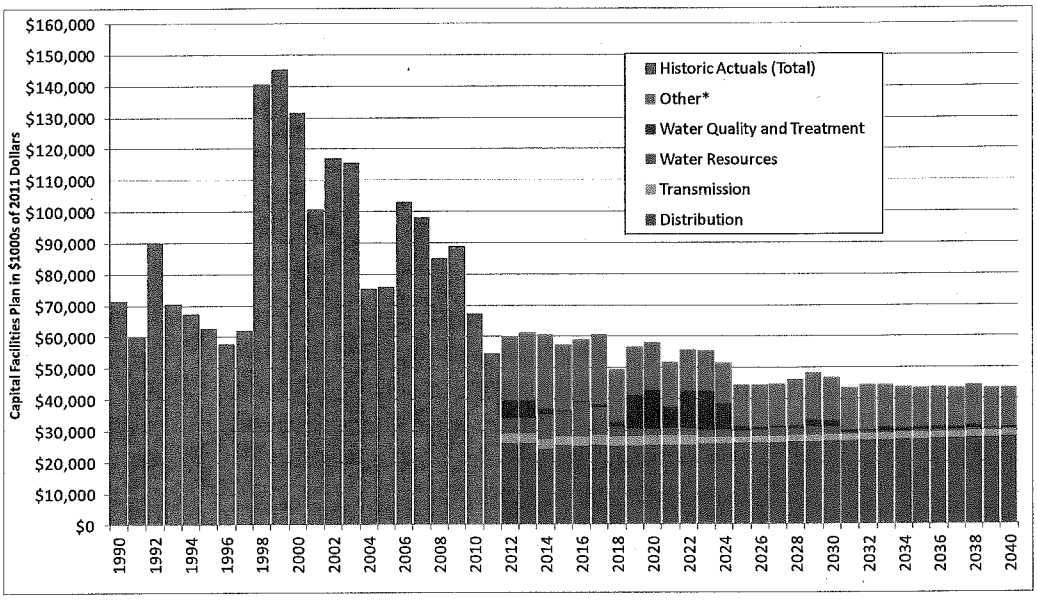
Plan Implementation

Implementation of this plan requires completion of capital projects, programs, and operations and maintenance (O&M) activities.

Capital Facilities Budget

- Over the past decades, SPU has invested in several major new capital projects, including the two new water treatment facilities and Tolt Pipeline 2.
- SPU anticipates its capital improvement budget needs to be much lower than in the past decades, and will decline from $62 million in 2013 to less than $45 million by 2025, and remain at approximately that level through 2040 (in 2011 dollars). See the graph on page S-8 for historic and proposed capital expenditures.
- SPU's draft Capital Facilities Plan totals to $1.4 billion from 2013 through 2040, which is 64 percent of what was spent in the previous 28-year period (in 2011 dollars).

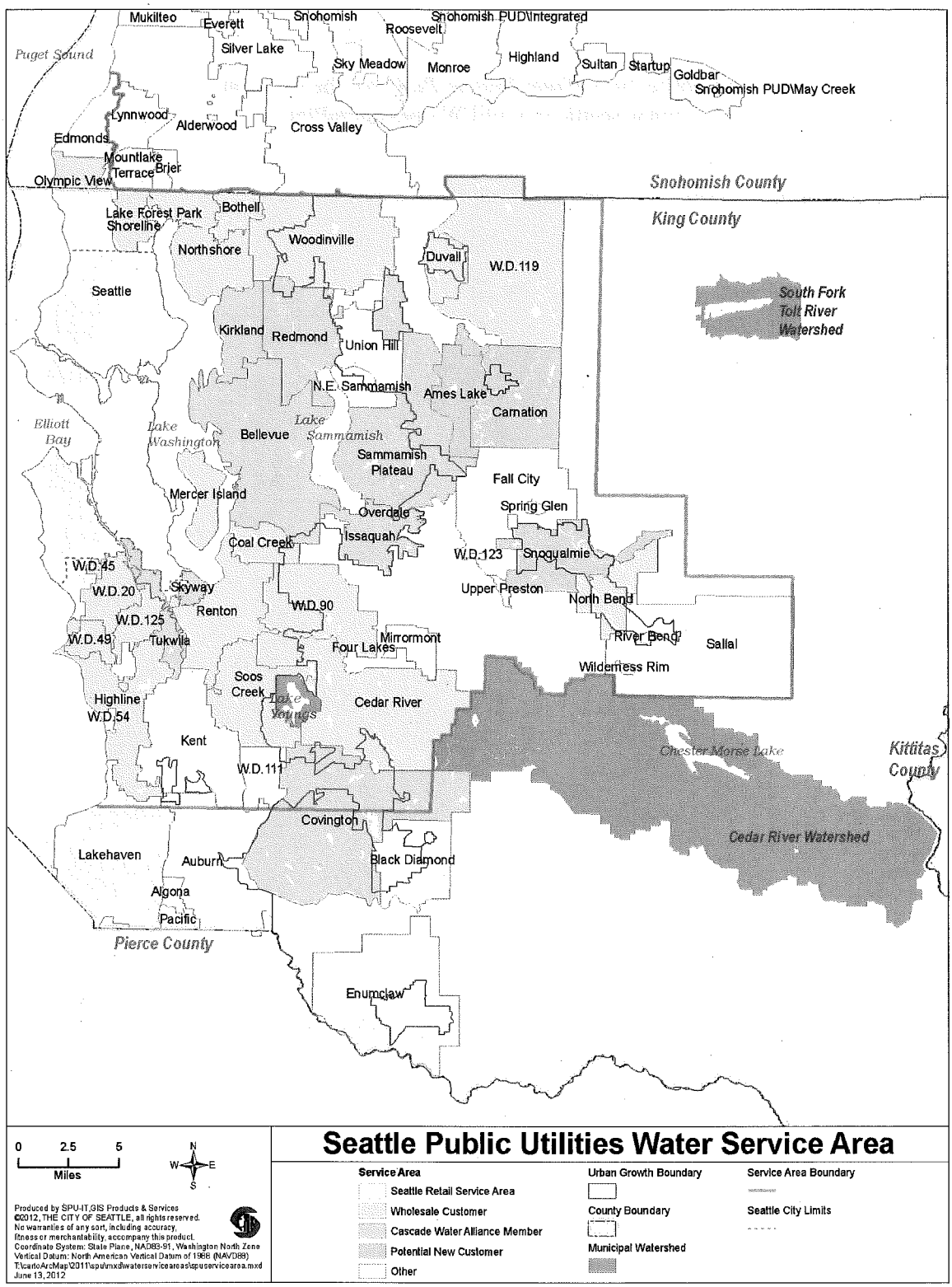
Historic and Proposed Capital Facilities Plan Spending through 2040
(2012-2017 Adopted CIP, plus 2018-2040 Estimates, in thousands of 2011 dollars)



* Other includes Major Watersheds, Fleets, Facilities, Security, Information Technology, SCADA and other miscellaneous projects.

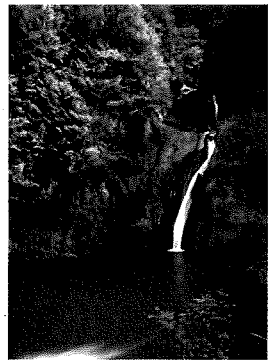
CONCLUSION

SPU has been making, and continues to make, significant investments to protect public health, comply with federal and state regulations, and replace aging infrastructure. While SPU has invested in major regional facilities in the past decades, the need is now shifting to significant capital investments to rehabilitate and improve the distribution system. Implementation of this water system plan will help to ensure that SPU meets its mission to provide reliable, efficient and environmentally conscious water utility services to enhance the quality of life and livability in all communities we serve.


Seattle Public Utilities Water Service Area
Mukilteo
Everett
Snohomish
Snohomish PUD\Integrated
Roosevelt
Silver Lake
Sky Meadow
Monroe
Highland
Sultan
Startup
Goldbar
Snohomish PUD\May Creek
Puget Sound
Lynnwood
Alderwood
Cross Valley
Edmonds
Mountlake Terrace
Brier
Olympic View
Snohomish County
King County
Lake Forest Park
Shoreline
Bothell
Woodinville
Northshore
Duvall
W.D.119
Seattle
South Fork Tolt River Watershed
Kirkland
Redmond
Union Hill
N.E. Sammamish
Ames Lake
Carnation
Elliott Bay
Lake Washington
Bellevue
Lake Sammamish
Sammamish Plateau
Fall City
Mercer Island
Spring Glen
Overdale
Issaquah
Coal Creek
W.D.123
Snoqualmie
W.D.45
W.D.20
Skyway
Upper Preston
North Bend
Renton
W.D.90
W.D.125
W.D.49
Tukwila
Mirrormont
River Bend
Sallal
Four Lakes
Wilderness Rim
Soos Creek
Highline
W.D.54
Lake Youngs
Cedar River
Kent
Chester Morse Lake
Kittitas County
W.D.111
Covington
Cedar River Watershed
Lakehaven
Auburn
Black Diamond
Algona
Pacific
Pierce County
Enumclaw
0 2.5 5
Miles
N
W
E
S
Service Area
Seattle Retail Service Area
Wholesale Customer
Cascade Water Alliance Member
Potential New Customer
Other
Urban Growth Boundary
County Boundary
Municipal Watershed
Service Area Boundary
Seattle City Limits
Produced by SPU-IT,GIS Products & Services
©2012, THE CITY OF SEATTLE, all rights reserved.
No warranties of any sort, including accuracy, fitness or merchantability, accompany this product.
Coordinate System: State Plane, NAD83-91, Washington North Zone
Vertical Datum: North American Vertical Datum of 1988 (NAVD88)
T:\carto\ArcMap\2011\spu\mxd\waterserviceareas\spuservicearea.mxd
June 13, 2012

The entire *2013 Water System Plan* may be found at:
www.seattle.gov/util/WaterSystemPlan

Part I: Direction for Business Areas



Part I of this *2013 Water System Plan* presents SPU's water system capital facilities and operation and maintenance "roadmap" for the next 20 years and beyond. After an introductory chapter to establish context for this updated plan, the balance of Part I presents the substance of that roadmap for each business area of SPU's water line of business. Part II focuses on the anticipated costs of implementing that roadmap over the next six years and through 2040.

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Chapter 1
Introduction

Seattle Public Utilities (SPU) provides drinking water to a service area population of 1.3 million within the greater Seattle metropolitan region of King County and portions of southern Snohomish County. This *2013 Water System Plan* describes the near- and long-term plans for the regional water system in accordance with Washington State Department of Health (WDOH) requirements. The focus of this plan is on updates to the water system and programs since completion of the *2007 Water System Plan*. To provide context for this plan, this introductory chapter includes a brief history and description of the existing water system and of five core business areas that comprise SPU's water line of business.

In addition, this chapter presents an overview of SPU's policies that guide activities for the water system. A summary is provided of SPU's customer service levels for the water system. Also provided are the results of recent customer surveys regarding their views on the quality of services provided by SPU. The chapter also contains a description of the current planning environment, including how this plan is consistent with other relevant planning efforts. Finally, the introduction summarizes the organization of this plan and describes how it meets the requirements of the Washington Administrative Code (WAC).

1.1 SPU's Drinking Water Line of Business

SPU's mission is to provide reliable, efficient and environmentally conscious utility services to enhance the quality of life and livability in all communities we serve.

The overarching mission for SPU is to provide reliable, efficient and environmentally conscious utility services to enhance the quality of life and livability in all communities we serve. In addition to operating Seattle's regional drinking water system, SPU also provides surface water drainage, wastewater, solid waste, and engineering services to residents of Seattle. This plan covers SPU's drinking water line of business. This section provides background on the water system and the water utility's organizational structure.

1.1.1 History of Water Business

Since 1901, the Cedar River has provided water for Seattle. Initially, there was a diversion dam and transmission pipeline on the lower Cedar River at Landsburg and a timber crib dam at Cedar Lake–later renamed Chester Morse Lake. In 1914, a higher

masonry dam was constructed to create storage for Seattle's water supply. Additional pipelines were added between 1909 and 1954 to meet growing demands for water. Today, the Cedar River supplies 60 to 70 percent of SPU's customer demand for water.

In the late 1950s, several King County suburban communities began to look to Seattle as a source of their drinking water. In response, Seattle began selling water wholesale to these communities, who, in turn, supply it to their own customers.

Although the City began developing its water rights on the Tolt River in 1936, the source was first put to use in 1964. The first phase of the Tolt development was on the South Fork Tolt River, where a reservoir and pipelines were built to increase Seattle's water supply. The South Fork Tolt now provides approximately 30 to 40 percent of the City's water supply.

In 1987, the City began development of two well fields near the Highline area, subsequently renamed the "Seattle Well Fields". These well fields are available to supplement Seattle's surface water supplies, especially during the summer peak demand season and emergencies.

1.1.2 System Description

Today, SPU's regional water system is the largest in Washington State. SPU serves 664,000 people in its retail service area and provides water to 20 wholesale customers, including Cascade Water Alliance, who together deliver SPU water to an additional residential population of over 629,000. The water from the Cedar and South Fork Tolt Rivers is treated by ozonation/ultraviolet light and ozonation/filtration respectively. The Seattle Well Fields are available to supplement the South Fork Tolt and Cedar supply sources during peak demand seasons and during emergencies. SPU's water is delivered to Seattle retail service connections and to SPU wholesale customers through a network of approximately 1,880 miles of transmission and distribution system pipelines. SPU also provides untreated water from the Cedar River Watershed to North Bend to mitigate streamflow impacts to their water supplies. SPU is not a Satellite System Management Agency, and will not operate nor be responsible for Group A water systems owned by other parties, even if these are within the City of Seattle. Figure 1-1 shows the major components of the Seattle Regional Water Supply System and the areas currently served by SPU and its wholesale customers.

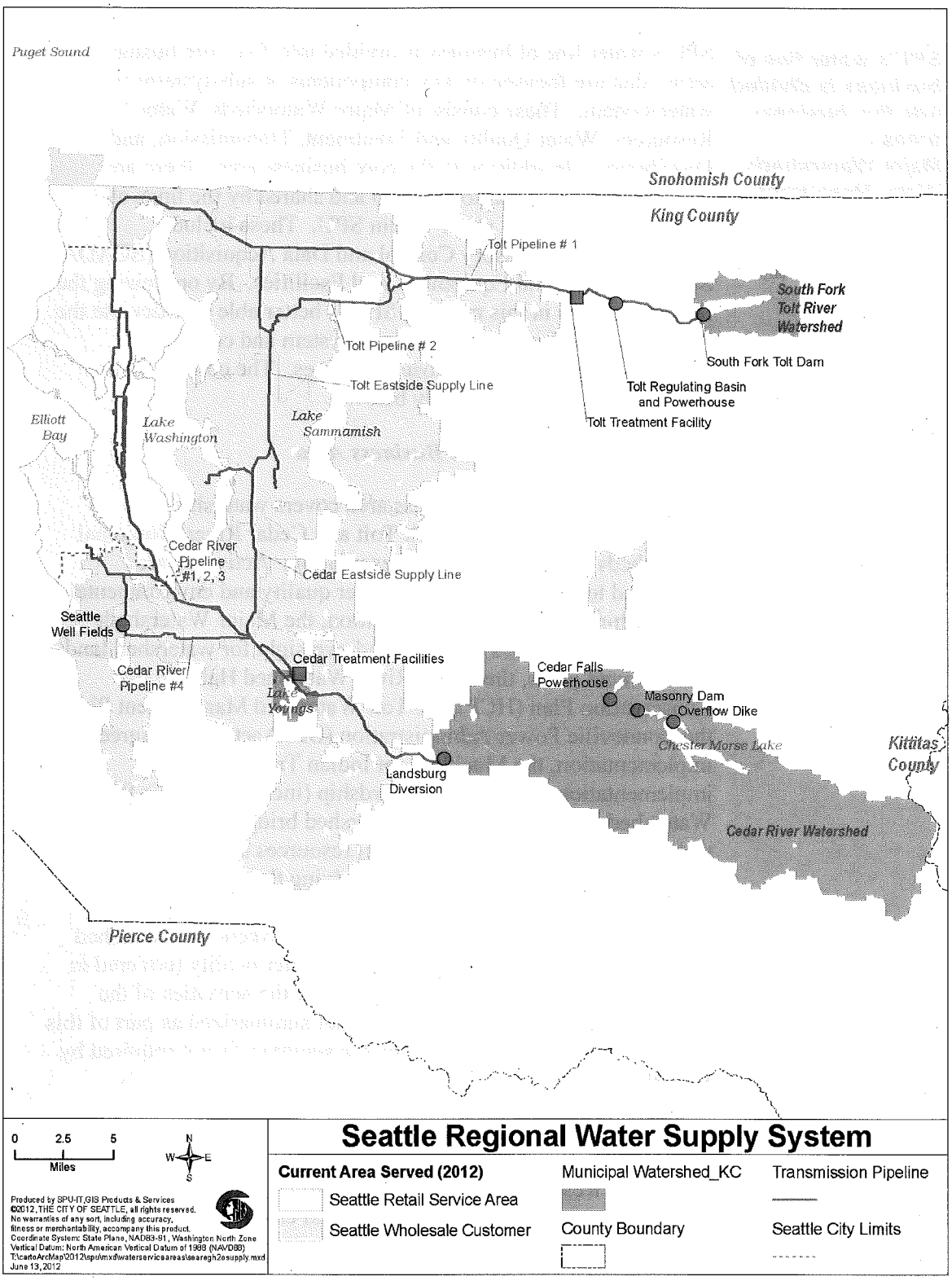

Figure 1-1. Seattle Regional Water Supply System

1.1.3 Business Areas

SPU's water line of business is divided into five business areas: Major Watersheds, Water Resources, Water Quality and Treatment, Transmission and Distribution.

SPU's water line of business is divided into five core business areas[1] that are focused on key components or sub-systems of its water system. These consist of Major Watersheds, Water Resources, Water Quality and Treatment, Transmission, and Distribution. In addition to the core business areas, there are business areas that are common to and shared by the lines of businesses other than water within SPU. These include Technology, Supervisory Control and Data Acquisition (SCADA), Security, Fleets and Equipment, and Facilities. By organizing the line of business in this manner, SPU is better able to articulate the performance objectives of each sub-system and create accountability in meeting those objectives. The core business areas are described more fully below.

1.1.3.1 Major Watersheds Business Area

The Major Watersheds business area covers watershed management of the South Fork Tolt and Cedar River Municipal Watersheds and Lake Youngs Reservation. Activities are conducted to ensure that source water quality and environmental stewardship goals are met. In addition, the Major Watersheds business area includes planning and oversight for watershed land management plans, the Cedar River Watershed Habitat Conservation Plan (HCP), the Tolt Watershed Management Plan, the Bonneville Power Administration (BPA) settlement agreement implementation, the Muckleshoot Indian Tribe agreement implementation, watershed stewardship (including Cedar River Watershed Education Center), watershed bridges and roads, watershed protection plans, cultural resources management plans, and other programs and projects involving the watersheds for the surface water supplies. The business area also provides coordination with salmon recovery plans. Except for watershed programs and plans to protect drinking water quality (covered in Chapter 3, Water Quality and Treatment), the activities of the Major Watersheds business area are not summarized as part of this *2013 Water System Plan* since such a summary is not required by WDOH.

1.1.3.2 Water Resources Business Area

The Water Resources business area consists of the programs and projects whose purpose is to plan for and ensure sufficient water is

[1] The *2007 Water System Plan* listed four business areas, but the Transmission and Distribution business areas has been split in two since then.

available to meet anticipated demands. One critical function of this business area is real-time management and operation of mountain reservoir and river facilities for water supply, instream resource protection, and flood management, as well as hydropower generation. The programs of the Water Resources business area include instream resource management, water conservation, dam safety, and water rights. The Water Resources business area also performs water supply and demand forecasting, conservation potential assessments, reclaimed water/water reuse analysis, development of new sources of supply when needed, and infrastructure planning for water supplies.

1.1.3.3 Water Quality and Treatment Business Area

The Water Quality and Treatment business area covers SPU's drinking water quality and treatment programs, projects, services, and capital assets from the source to customer taps. Key functions of this business area include managing SPU's drinking water regulatory compliance, oversight of the Tolt and Cedar Water Treatment Facilities and their contract operations, and overseeing water quality and treatment programs and capital projects. Critical water quality monitoring and regulatory compliance services are provided to the Water Quality and Treatment business area by SPU Laboratory Services Division. Infrastructure in this business area includes the Tolt and Cedar Water Treatment Facilities and ancillary facilities, Landsburg treatment and intake screening facilities, and in-town water treatment facilities at reservoirs and well sites. Key Operations Programs in the Water Quality and Treatment business area include water treatment facility operations, cross-connection control, and storage facility cleaning.

1.1.3.4 Transmission Business Area

The Transmission business area is comprised of programs and projects affecting the regional and sub-regional transmission systems, which serve both SPU and its wholesale customers. Business area activities include policy development, planning and oversight for transmission pipelines, and operation and maintenance of the transmission headworks and pipelines, storage facilities, pump stations, wholesale customer taps, and appurtenances. The Transmission business area provides oversight for and coordination with related programs, such as seismic analysis and cathodic protection. Billing meter and transportation-related projects that impact both the water transmission and distribution systems are overseen by the Transmission business area manager.

1.1.3.5 Distribution Business Area

The Distribution business area is comprised of programs and projects affecting the distribution system, which serves SPU's own retail customers within and outside the City of Seattle. Business area activities include policy development, planning and oversight for distribution pipelines, and operation and maintenance of distribution pipelines, storage facilities, pump stations, hydrants, valves, services and miscellaneous appurtenances.

1.2 GUIDING POLICIES

Revised and updated polices for SPU's water business areas were developed and adopted for the *2007 Water System Plan*, and are being carried forward in this plan. These policies are summarized in the table below.

Table 1-1. Policies to Guide SPU's Water System Activities

Policy	Policy Statement
Asset Management	Use Asset Management principles to guide all capital and O&M financial decisions to deliver services effectively and efficiently.
Environmental Stewardship	Protect and enhance the environment affected by the utility as it carries out its responsibilities to provide drinking water.
Security and Emergency Preparedness	Institute and maintain appropriate safeguards to protect against security risks and sustain emergency response readiness to ensure the continuity of drinking water services, including fire protection service.
Meeting Customer Expectations	Provide retail and wholesale drinking water service that responds to changing customer expectations centered on providing reliable, high-quality water, and guided by asset management principles.
Service Area	Continue providing service within the service area boundary as defined in the most recent *Water System Plan*, allowing for new wholesale customers within that area at SPU's discretion.
Regional Role and Partnerships	Be a leader in seeking regional cooperation and efficiencies that benefit the customers of SPU, other water utilities, and the environment.
Planning for Uncertainty	Base supply investment strategies on future outlooks for supply and demand that incorporate an evaluation of uncertainties using the best available analytical tools.
Supply Reliability	Plan to meet full water demands of "people and fish" under all but the most extreme or unusual conditions, when demands can only be partially met.
Resource Selection	In planning to meet future customer demand, select new sources of supply from all viable options, including conservation programs, improvements to system efficiencies, use of reclaimed water, and conventional supply sources, based on triple-bottom-line analysis.
High-Quality Drinking Water Provision	Manage drinking water quality from the water source to the customer taps in coordination with wholesale customers to protect public health, comply with drinking water quality regulations, and maintain and improve public confidence in the drinking water quality.
Watershed Protection	Control human activity and be prepared to respond to emergencies in the municipal watersheds to maximize protection of drinking water source quality.
Transmission System Redundancy	Consider redundancy in the transmission system on a case-by-case basis, with decisions based on an evaluation of net present value.
Access to Seattle Regional Water System	Evaluate requests for access to the Seattle regional water system using the *Access to Seattle Water System Guidelines*, based on the unique characteristics of the water that would be moved through the system.
Distribution System Redundancy	Consider redundancy for the distribution system on a case-by-case basis, with decisions based on an evaluation of net present value.

1.3 Customer Service Levels and Survey Results

SPU first documented its service levels objectives and targets in its *2007 Water System Plan*. Since then, SPU has tracked its performance relative to those targets. These efforts are part of SPU's asset management initiative as outlined in the *2007 Water System Plan*.

In addition, SPU has completed a series of surveys of its residential and commercial customers to get feedback on the services SPU provides.

1.3.1 Service Levels

SPU also participates in benchmarking studies in which it compares its performance with that of other utilities around the world.

Service levels are statements of desired performance outcome that are high priority to SPU's customers or required by regulators. Often these service levels go beyond minimum regulatory requirements. Service levels are largely within the control of SPU and have performance level data that can be accurately and consistently collected and audited. SPU utilizes service level objectives – broad statements of intent – to establish the direction of each of its business areas while using service level targets to establish annual or longer term goals which can be measured through performance outcomes. Service levels are used by SPU to manage its assets, including making decisions on renewal/ replacement and O&M practices.

The *2007 Water System Plan* provided levels of service targets to achieve the following objectives:

- Meet the environmental requirements of our water rights and water supply operations.
- Meet water use efficiency goals to ensure wise use and demonstrate good stewardship of limited resource.
- Promote a high level of public health protection and customer satisfaction with drinking water quality.
- Provide agreed-upon service to wholesale customers.
- Provide adequate pressure for drinking water supplies.
- Respond quickly and effectively to water distribution system problems.

For the most part, SPU has been meeting the service level targets since 2006. More information is provided in the chapters that follow.

1.3.2 Customer Surveys

Survey results indicate that SPU's customers are very satisfied with water system reliability and drinking water quality.

SPU conducts periodic surveys of its residential and business customers to gather their opinions and views of the utility services it provides within the City of Seattle. These surveys provide performance measurements which are used as part of SPU's performance management program. They also provide information on how well the utility is meeting customers' utility needs and on special topics of particular relevance in the survey year.

SPU surveyed residential customers within the City in 2001, 2003, 2005, 2007 and 2011. In these surveys, a random sampling of residential customers was selected to represent the City's residential demographic profile. These customers were asked to rate their level of satisfaction with the City's water supply and with drinking water quality on a seven-point scale, where "1" means "not at all satisfied" and "7" means "very satisfied." Most respondents rated these services as "6" or "7 - very satisfied." The mean satisfaction scores for each year are shown in Figure 1-2 and indicate a high and generally increasing level of satisfaction with both of these utility services.

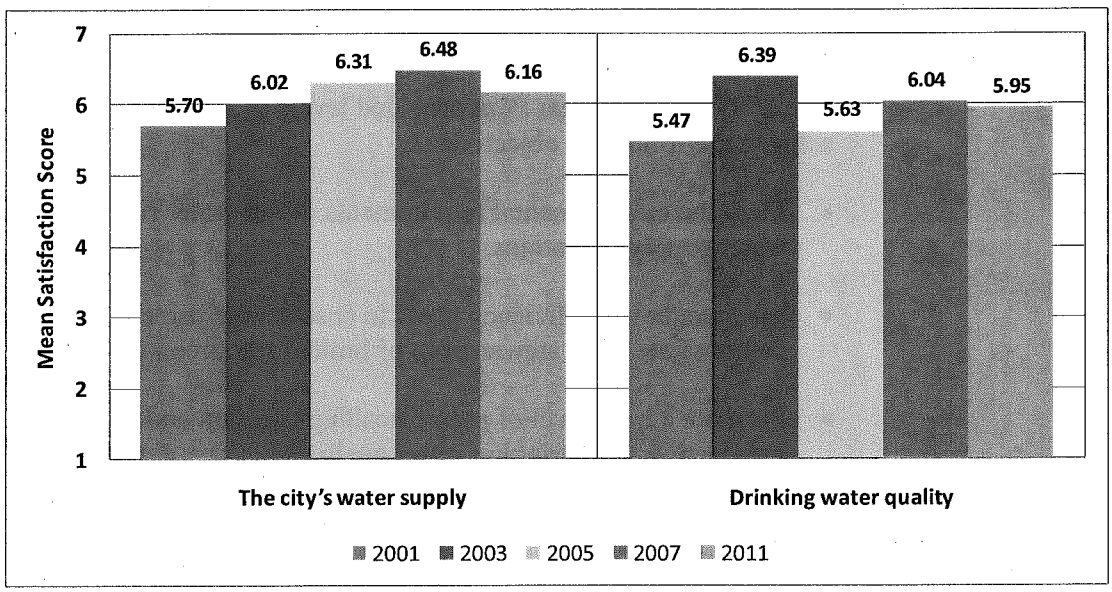

Figure 1-2. Residential Customer Survey Results for Water Supply and Quality

Surveys of SPU's business customers within the City – both small and large – were conducted in 2004, 2006, 2008 and 2011. These

customers were asked to rate their satisfaction with the reliability of water service and drinking water quality, using the same seven-point scale as residential customers. The mean satisfaction scores for each year are shown in Figure 1-3 and indicate a high and generally increasing level of satisfaction with both of these utility services.

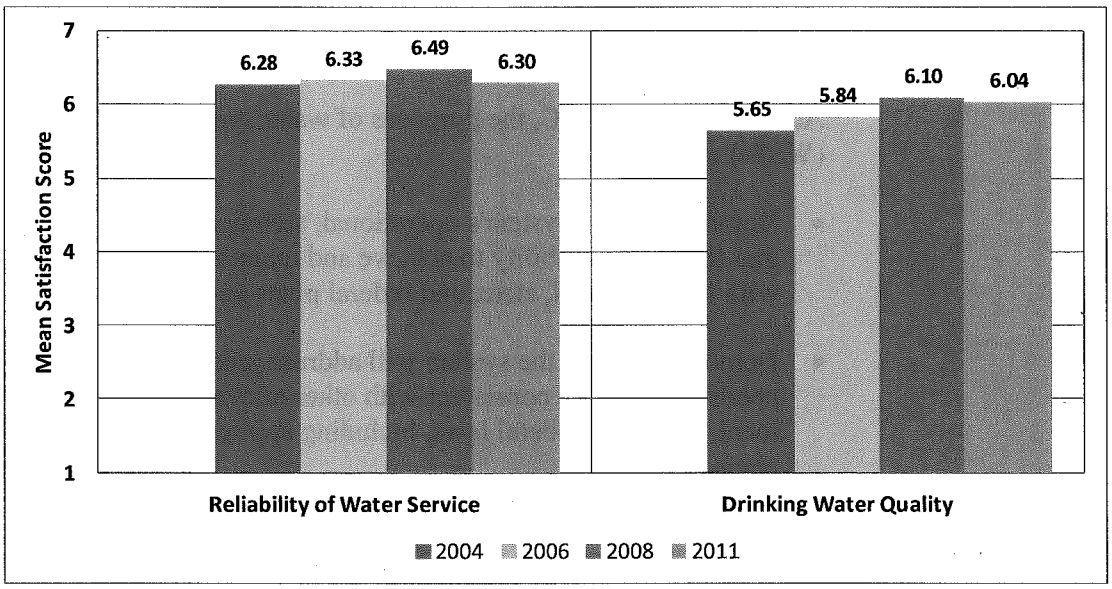

Figure 1-3. Business Customer Survey Results for Water Supply and Quality

In 2011, residential customers were also asked a series of questions regarding the taste of Seattle's drinking water and their water drinking habits. Fifty-two percent of all respondents report their tap water tastes "excellent" or "very good," and only five percent reported it tastes "poor." For those who drink tap water that they do not filter in their home, most (44 percent of all respondents) rate the taste of their tap water even higher: 63 percent rated their water as "excellent" or "very good," and only one percent as "poor."

These survey results indicate that SPU's customers are very satisfied with water system reliability and drinking water quality.

1.4 Planning Requirements

The SPU regional water system is categorized as a Group A community water system with 1,000 or more services and must prepare a water system plan for Washington State Department of Health review and approval per Chapter 246-290-100 of the Washington Administrative Code (WAC). These plans must be updated and submitted every six years. This section describes the

planning requirements, as well as how this plan is consistent with other plans.

Note that this water system plan does not cover the Group A water system at Seattle's Cedar Falls Headquarters. That system, as well as other water systems serving outlying SPU facilities, has a separate operating permit and different planning requirements.

1.4.1 WSP Requirements

According to the WAC, the purposes of water system plans (WSPs) are to:

- Demonstrate the system's operational, technical, managerial, and financial capability to achieve and maintain compliance with relevant local, state, and federal plans and regulations.
- Demonstrate how the system will address present and future needs in a manner consistent with other relevant plans and local, state, and federal laws, including applicable land use plans.

The contents of a water system plan are governed by WAC 246-290-100(4). A checklist provided as an appendix lists the plan contents required by the WAC and identifies the specific chapters or appendices of this plan where that required information can be found.

The WAC also provides for a "document submittal exception" process that allows a purveyor to proceed with new distribution mains without submitting construction documents to WDOH for review. This process requires a WDOH-approved water system plan that includes standard construction specifications for these types of projects. SPU is requesting such an exception for new distribution mains. Information needed to support this request is provided in the appendices, including SPU's design and construction guidelines.

WAC 246-290-108 requires that this *Water System Plan* be consistent with local plans and regulations. Consistency review and certification have been obtained from those local governments with jurisdiction over areas where SPU provides retail water service, which includes the cities of Seattle, Shoreline, Lake Forest Park and Burien (see appendix). This consistency review covers:

(a) Land use and zoning within the applicable service area;

(b) Six-year growth projections used in the demand forecast;

(c) Utility service extension ordinances of a city or town when water service is provided by the water utility of the city or town;

(d) Provisions of water service for new service connections; and

(e) Other relevant elements related to water supply planning as determined by WDOH.

King County has its own consistency review process.

1.4.2 Consistency with Other Plans

SPU is committed to working together with other water providers and regional jurisdictions to address water issues.

In planning to meet future demand, it is necessary to coordinate with other planning efforts to ensure consistency. WDOH has determined that plans that may contain elements requiring local government consistency review include Coordinated Water System plans, Regional Wastewater Plans, Reclaimed Water Plans, Groundwater Area Management Plans, and Capital Facilities Elements of Comprehensive Plans. Other plans that SPU coordinates with include the water system plans of SPU's wholesale customers and adjacent water purveyors, watershed plans and salmon recovery plans. Each of these plans and their relevance to SPU's water resources and water system planning is described below.

1.4.2.1 Coordinated Water System Plans

Three of the four coordinated water system plans (CWSPs) in King County are for areas served by the SPU regional water system, including east King County, south King County, and Skyway/Bryn Mawr. (The fourth CWSP is for Vashon.) A small portion of SPU's retail service area lies within the Skyway/Bryn Mawr Critical Water Service Area. SPU worked with the regional water associations responsible for developing those plans to ensure coordination with SPU planning. SPU participates in the development and updates of these plans to varying degrees, depending on the extent to which SPU's service area overlaps with the CWSP area. SPU staff also maintains regular contact with regional water associations on issues related to SPU's water system plan.

1.4.2.2 Wholesale Customers' Individual Water System Plans

As SPU's wholesale customers update their water system plans for their own water supply and distribution systems, SPU staff coordinates with them so that their water system plans maintain consistency with SPU's *Water System Plan*. For most customers,

this includes SPU review of their draft plans in the following key areas:

- Assumptions about the quantities and pressures available from SPU transmission lines.
- Demand forecasts to ensure consistency of population forecasts among Seattle and its wholesale customers.
- Responsibilities that the customer shares with SPU, such as distribution system water quality monitoring.
- Conservation programs.

SPU does not comment on water system plan demand forecast and conservation elements for wholesale customers now purchasing water through the Cascade Water Alliance because SPU is not involved with Cascade planning in these areas.

Since the *2007 Water System Plan*, SPU has reviewed or provided input and comments on water system plans from Bothell, Cedar River, Duvall, Edmonds, Highline, North Bend, Northshore, Olympic View, Redmond, Shoreline Water District, Woodinville, and Water Districts 20, 45, 49, 90, and 125. SPU will continue working closely with wholesale customers to coordinate regional water supply planning activities.

1.4.2.3 King County Comprehensive Plan

Most of SPU's service area is within incorporated areas of King County. A very small part of its retail service area is in unincorporated King County. These areas are located south of the City of Seattle boundary and form portions of the North Highline and West Hill Potential Annexation Areas. In total, fewer than 4,800 customers are located in unincorporated King County.

SPU's *2013 Water System Plan* aims to be consistent with the *King County Comprehensive Plan* (*KCCP*) to be sure that growth targets within the SPU service area match the availability of water supply to serve related demand. In addition, SPU's *2013 Water System Plan* is consistent with the policies in the *KCCP* relevant to water supply.

1.4.2.4 City of Seattle's Comprehensive Plan

Seattle's *Comprehensive Plan* relates to this water system plan in regard to water distribution issues. Planned population increases

and changes in land uses are important to how SPU conveys water throughout the distribution system.

Although minor changes have occurred more often, the last major update to the *Comprehensive Plan* was in 2004, as a result of the 10-year review required by the Growth Management Act. The *Comprehensive Plan* is undergoing a major review to reflect a 20-year vision for the Seattle community. Part of the review will be to ensure that Seattle's *Comprehensive Plan* remains consistent with the regional growth management strategy (Vision 2040) and the King County Countywide Planning Policies which were recently revised. As with the *KCCP*, SPU has closely monitored development of the Seattle's *Comprehensive Plan* to ensure that this water system plan will be consistent with it.

1.4.2.5 Adjacent Purveyors

A number of water purveyors within SPU's water service area and adjacent to existing SPU wholesale customers are not themselves current SPU customers. These include Water District No. 54, Lakehaven Utility District, City of Kent, City of Auburn, Water District No. 111, Mirrormont, Northeast Sammamish Water District, Union Hill, Ames Lake, Carnation, Fall City, and several other smaller purveyors. When water system plans for these systems are received, SPU reviews them for compatibility and consistency in areas such as assumptions about water demand forecasts, transmission needs, and water quality issues. None have been received since 2006.

1.4.2.6 Purveyors Beyond the Boundaries of SPU's Service Area

As a regional water supplier, SPU was an active participant in the *2009 Water Supply Outlook*, produced by the Water Supply Forum for the three-county region of Snohomish, King, and Pierce Counties. SPU continues to be an active member on the Forum, which helps ensure coordinated water supply planning throughout the region and between the three major utilities in central Puget Sound: Everett, Tacoma, and Seattle. It also highlights opportunities for efficiencies that can help to reduce impacts from utilities.

1.4.2.7 Regional Wastewater and Reclaimed Water Plans

In 2004, King County published an update to its *Regional Wastewater Services Plan* (*RWSP*). The *RWSP* contains proposals for disposal of the region's wastewater, including using reclaimed water as a new source of water supply. Several possible uses for

reclaimed water to offset demand for potable water are identified in the *RWSP*. SPU participated in the development of the *RWSP* and has been actively involved in the development of the King County Reclaimed Water Comprehensive Plan.

King County has indicated that completion of their Reclaimed Water Checklist suffices to meet consistency with these plans. This checklist is included in the appendices.

1.4.2.8 Groundwater Area Management Plans

The Seattle Well Fields and a portion of SPU's retail service area lie within the South King County Groundwater Management Area. However, there are no approved groundwater area management plans applicable to SPU.

1.4.2.9 Watershed Plans

SPU is dedicated to being a leader in protection of the environment.

Watershed plans in the SPU retail service area are the Chinook Salmon Conservation Plans for the Cedar River/Lake Washington/Lake Sammamish Watershed (WRIA 8) and the Green/Duwamish and Central Puget Sound Watershed (WRIA 9), which were adopted as part of the Puget Sound Salmon Recovery Plan, approved by the federal government in 2007. This watershed planning occurred within the framework of RCW 77.85, Salmon Recovery. This is not one of the types of plans for which a water system plan must meet WDOH consistency requirements.

The 50-year Cedar River Watershed HCP that SPU developed was agreed to by federal and state resource agencies in 2000 and is now being implemented. SPU continues to be in compliance with the HCP.

1.4.2.10 Salmon Recovery Plans

Seattle participates in salmon recovery processes conducted under the framework of RCW 77.85 in the Water Resource Inventory Areas (WRIA) associated with its water supply and service area: WRIAs 7 (Snohomish River Basin), 8 (Cedar River/Lake Washington Basin), and 9 (Green River/Duwamish Basin). The WRIA 7, 8, and 9 salmon recovery plans recognize that salmon recovery is a long-term effort and include a scientific framework, lists of priority actions, comprehensive action lists, adaptive management approaches, and funding strategies. The City of Seattle has supported salmon recovery through primary sponsorship and implementation of significant habitat restoration and protection projects, and has also addressed salmon habitat

protection through its land use and public outreach policies and programs.

As part of WRIA 7, 8, and 9 salmon recovery efforts, Seattle has been a leader in implementing a number of actions. Examples of these efforts include:

- Lower Cedar River habitat acquisition and restoration projects.
- Shoreline and wetland restoration projects along the south shoreline of Lake Washington.
- Development and distribution of a Green Shorelines Guidebook for Lake Washington property owners.
- Receipt of an EPA grant in 2010 to develop Green Shorelines Incentives.
- Receipt of an EPA grant in 2010, partnering with Cascade Land Conservancy and Friends of Cedar River Watershed to eradicate knotweed and replant native plants on public and private property in lower Cedar River; and conduct community outreach and education on river and stream restoration.
- Purchase and restoration of the Salmon Bay Natural Area downstream of the Locks for habitat benefits.
- Participation in many research efforts with the goal of ensuring effectiveness of restoration projects in Lake Washington and on the Duwamish River.
- Acquisition of habitat lands on the Tolt River by Seattle City Light.
- Implementation and primary fiscal sponsorship of the Tolt River Floodplain Reconnection Project, in partnership with King County and multiple grant funders.
- Funding over several years to Tulalip Tribes for juvenile salmon research on the Snoqualmie River.
- Protective land management practices in the Seattle-owned, Cedar River Municipal Watershed to preserve water quality and the natural ecological processes that promote healthy river conditions throughout the Cedar River Basin.

- Fish passage facilities at the Landsburg Dam that reopen over 20 miles of stream habitat for salmon in the protected Cedar River Municipal Watershed.

- Protective stream flow management practices that provide beneficial stream flows for all salmon and steelhead life stages in the Cedar and South Fork Tolt rivers.

- Implementation of the new Cedar River Sockeye Salmon Hatchery Program and associated Adaptive Management Plan guided by oversight bodies composed of representatives from federal, state, tribal and local natural resource agencies, academic experts and citizen stakeholders.

The Cedar River Watershed HCP covers many of the costs for the projects recommended in the WRIA 8 plan for the Upper and Lower Cedar River. Staff has successfully leveraged other funding so more can be accomplished. The HCP also provided funding for improving fish passage at the Hiram Chittendon Locks.

1.5 PLAN ORGANIZATION

SPU has organized its water utility into the five business areas described previously. This plan is organized similar to the *2007 Water System Plan*, with the remaining chapters of Part I focused on each of those business areas. Since most of the Major Watersheds business area activities are not required to appear in water system plans, it does not have its own chapter. Each of the chapters in Part I are divided into the following sections:

- A section summarizing SPU's accomplishments since completion of the *2007 Water System Plan.*

- A service level section that describes SPU's performance in meeting the service levels for that business area.

- A description of the facilities that the business area manages, and the practices it follows in operating and maintaining those facilities. This section focuses on changes since the *2007 Water System Plan.*

- A summary of needs, gaps, and issues that face that business area in the next 20 years and beyond, but with a focus on the 2013-2018 planning period.

- A summary of the plans and actions the business area will be undertaking or continuing as it moves forward to address the needs, gaps, and issues in the next 20 years and beyond.

Part II describes the plan for implementing the actions described in Part I, including details on the costs and financing approach for plan implementation.

Appendices to this plan are contained in a separate volume as listed in the Table of Contents and should be considered part of this *2013 Water System Plan.*

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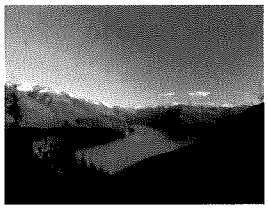
Chapter 2
Water Resources



Chester Morse Reservoir

SPU's Water Resources business area focuses on the programs and projects that ensure SPU's customers and instream resources will have sufficient water to meet their needs, both in the present and for the foreseeable future. One important function of the business area is the real-time management and operation of mountain reservoir and river facilities for municipal use while meeting instream flow requirements supporting hydropower production, and managing floods. Water resource concerns also include forecasting future water demands, and evaluating current supply capacity and the need for future additional supply sources and new water rights. The business area also addresses issues related to dam safety and infrastructure maintenance and improvements.

SPU has the water supply necessary to meet needs now and well into the future.

Chapter 2 describes how SPU is prepared to meet water demands in the foreseeable future even with the uncertainties surrounding the potential impacts of future climate change and population growth.

2.1 Accomplishments Since 2007 WSP

Since completion of the *2007 Water System Plan*, SPU has accomplished the following activities in the water resources business area:

- Water Conservation: Completed the 2000-2010 Regional 1% Conservation Program, Seattle's additional conservation requirements of the Initiative 63 Settlement Ordinance, and the first 6-Year Water Use Efficiency Goal. More information on past conservation program savings is provided in Section 2.3.3 below.

- North Bend Mitigation Water: Per an agreement signed in 2008, began delivering untreated water from Hobo Springs via Boxley Creek to the city of North Bend to mitigate the use of their municipal water wells on the Snoqualmie River (2009).

- New Wholesale Contracts: Signed new wholesale contracts with the six remaining 1982 wholesale contract holders, the city of Renton, and Cascade Water Alliance. More information is provided in Section 2.3.1 below.

- Cedar Moraine Improvements: Installed a horizontal drainage system in the West Boxley area of Cedar Moraine to partially dewater the moraine embankment, reducing the risk of a groundwater-blowout event flooding downstream properties along Boxley Creek. Completion of the project was a key factor in gaining approval to refill Chester Morse Lake to elevation 1563 feet (2008).

- Tolt Reservoir Temperature Management: Completed an interactive reservoir water quality computer model that enhances water managers' ability to manage the South Fork Tolt Reservoir and installed equipment throughout the entire vertical water column for real-time temperature monitoring and management (2009).

2.2 SERVICE LEVEL PERFORMANCE

In managing its water resources, SPU has established service levels that are consistent with its regulatory requirements and environmental commitments. In particular, SPU's water resources service levels give emphasis to instream flows and conservation. By meeting these service levels, SPU has high confidence in having adequate water supply to meet all customer demands. Table 2-1 summarizes these service levels.

Table 2-1. SPU's Service Levels for Managing Water Resources

Service Level Objective	Service Level Target
Meet the environmental requirements of our water rights and water supply operations.	Meet instream flow requirements and performance commitments in tribal, regional, state, and federal agreements and permits.
Meet water use efficiency goals to ensure wise use and demonstrate good stewardship of limited resource.	Achieve water conservation goals: - Save 14.5 mgd peak season (11 mgd annual average) from 2000 to 2010. - Save additional 15 mgd (average annual) from 2011 to 2030. - Meet the Initiative 63 Settlement Ordinance requirements.

Since 2006, SPU has been in compliance with all minimum flow specifications and supplemental flow targets for its Cedar and South Fork Tolt River water supplies. Since 2006, there have been a few downramping events on the Cedar River, in which water levels fell more quickly than prescribed by the Cedar River Watershed Habitat Conservation Plan (HCP). All events have been reported to the Instream Flow Commission and corrective action described and taken. To date, SPU has also met other performance commitments of the Cedar River Watershed HCP and

Muckleshoot Indian Tribe (MIT) Settlement Agreement that do not involve instream flows, including limits on diversions from the Cedar River.

In addition, SPU has achieved its water conservation goals through 2010. Additional information on these achievements is provided in Section 2.3.3. The service level targets for water use efficiency will be updated with the Water Use Efficiency Goal described in Section 2.4.1.1 of this plan.

2.3 Existing System and Practices

The total population currently served by SPU and its wholesale customers in King and south Snohomish County is about 1.3 million.

The total population currently served by SPU and its wholesale customers in King and south Snohomish County is about 1.3 million. To provide water to the people and businesses in its service area, SPU operates and maintains supply facilities associated with its surface water sources and well fields. This section provides an overview of the area to which SPU provides water service. The section also summarizes the City's water rights and the quantity of water that can be reliably provided to the service area, or the firm yield of its supply sources. SPU's water demands, including the non-revenue component of demand, are then summarized. The City's water conservation programs are described, and the section concludes by describing the operations activities employed to manage instream flows and the maintenance activities for the water supply facilities.

2.3.1 Service Area Characteristics

SPU's retail service area includes the City of Seattle and portions of the cities of Shoreline, Lake Forest Park and Burien, as well as portions of unincorporated King County south of the City of Seattle. SPU also provides retail water service to Shorewood Apartments on Mercer Island and SeaTac Airport. The SPU retail service area reflects the proposed annexation of the area known as the Greenbridge Notch (Wind Rose) by Water District 45. Also, the area served in the City of Shoreline may become a wholesale area in 2020 if current efforts by the City of Shoreline are successful in creating a new utility.

Besides serving retail customers, SPU provides wholesale water to area cities and water districts, who in turn deliver water to their customers' taps. Figure 2-1 shows these different customer types and service area boundaries, which, in general, includes the City of Seattle, the suburban areas immediately to the north and south, and similar areas extending east of Lake Washington to slightly beyond North Bend.

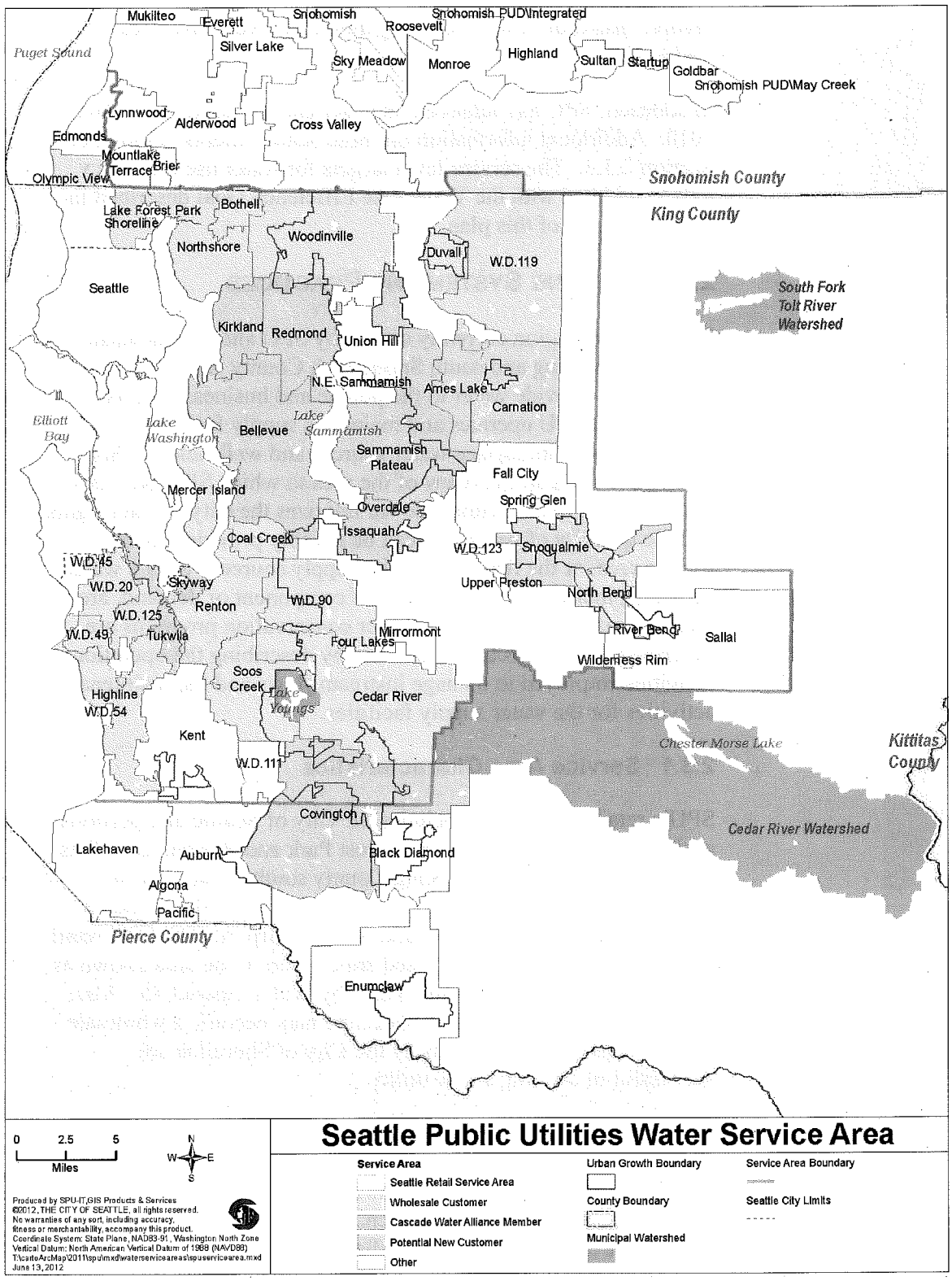


Figure 2-1. SPU's Water Service Area

2.3.1.1 Changes in Demographics

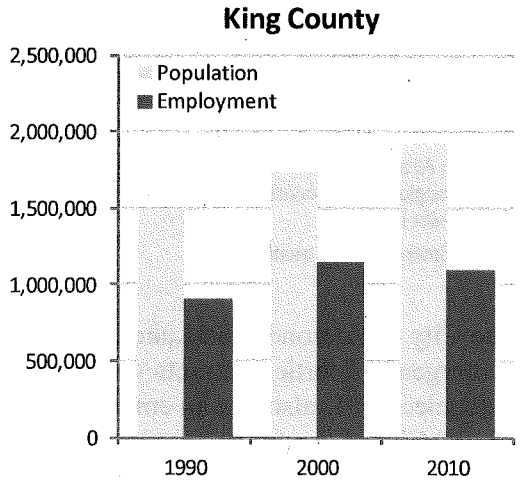
Since 2000, there have been significant changes in demographics that were influenced by the economy. Following the 1990 recession, King County employment grew much faster than population, 27 percent compared to 15 percent, from 1990 to 2000. In the last decade, population grew a little slower at 11 percent, but employment shrank so that 4 percent fewer people were employed in 2010 than in 2000. Table 2-2 and the figures below show the changes in population, households and employment in King County and Seattle.

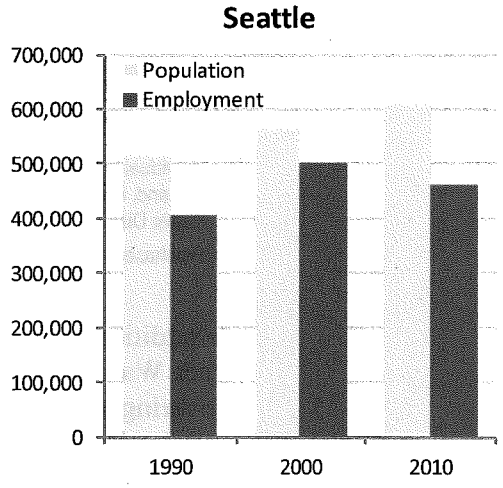
Table 2-2. Demographic Changes

	Population[1]		Households[1]		Employment[2]	
	King County	Seattle	King County	Seattle	King County	Seattle
1990	1,507,319	516,290	615,792	236,715	907,753	407,862
2000	1,737,034	563,374	710,916	258,510	1,149,642	502,835
2010	1,931,249	608,660	789,232	283,510	1,099,639	462,180
Change						
1990-2000	229,715	47,084	95,124	21,795	241,889	94,973
2000-2010	194,215	45,286	78,316	25,000	-50,003	-40,655
% Change						
1990-2000	15.2%	9.1%	15.4%	9.2%	26.6%	23.3%
2000-2010	11.2%	8.0%	11.0%	9.7%	-4.3%	-8.1%
Annual %						
1990-2000	1.4%	0.9%	1.4%	0.9%	2.4%	2.1%
2000-2010	1.1%	0.8%	1.1%	0.9%	-0.4%	-0.8%

[1] U.S. Census: 1990, 2000 and 2010

[2] Puget Sound Regional Council covered employment estimates





2.3.1.2 Retail Customers

SPU delivers water directly to a population in its retail service area of more than 664,000 through more than 188,000 service connections, approximately 36,000 more people than indicated in the *2007 Water System Plan*. This increase has resulted from increased population density from development of vacant property and redevelopment of property to higher densities.

2.3.1.3 Wholesale Customers

SPU's wholesale customers, excluding North Bend, provide SPU water to a resident population of about 629,000. Current Seattle wholesale customers, listed in Table 2-3, include 19 municipalities and special purpose districts, plus Cascade Water Alliance.

Table 2-3. SPU Wholesale Water Customers

Full Requirements Contract Holders	
• Bothell, City of	• Water District No. 20
• Cedar River Water and Sewer District	• Water District No. 45
• Coal Creek Utility District	• Water District No. 49
• Duvall, City of	• Water District No.119
• Mercer Island, City of	• Water District No.125
• Shoreline Water District	• Woodinville Water District
• Soos Creek Water and Sewer District	
Partial Requirements Contract Holders	
• Highline Water District	• Renton, City of
• Olympic View Water and Sewer District	• Water District No. 90
Block Contract Holders	
• Cascade Water Alliance (Cascade)[1]	• Northshore Utility District
Mitigation Water	
• North Bend, City of[2]	

[1] Individual members of the Cascade Water Alliance are the cities of Bellevue, Issaquah, Kirkland, Redmond, and Tukwila, and Covington Water District, Sammamish Plateau Water and Sewer District, and Skyway Water and Sewer District.

[2] Purchases mitigation water from Boxley Creek that is not treated.

In addition to the above, the City of Edmonds and Lake Forest Park Water District have emergency intertie contracts with SPU covering all types of emergencies. SPU also has an emergency water sales agreement with the City of Renton to provide water to the Seattle Regional Water Supply System from Renton.

Since the last of the 1982 contract holders signed new contracts in 2011, SPU now provides regular municipal water service to its wholesale customers under three contract types:

- Full Requirements Contracts. Thirteen of SPU's wholesale customers, as shown in Table 2-3, now receive all of their water supply under full-requirements contracts. These contracts extend to 2060, establish wholesale water rates, and include a provision for an operating board to address issues related to the Seattle water supply system.

- Partial Requirements Contracts. As shown in Table 2-3, four of SPU's wholesale customers purchase water from SPU under a partial requirements contract. These utilities have their own sources of supply with which they meet a portion of their demand and depend on Seattle for the rest. Contract provisions pertaining to expiration dates, wholesale rates, Operating Board membership, etc., are identical to the full requirements contracts.

- Block Contracts. In 2003, SPU signed long-term contracts for specified amounts of water ("block contracts") with the Cascade Water Alliance (Cascade), whose members are listed above in a footnote to Table 2-3, and Northshore Utility District (Northshore).

    - SPU's contract with Cascade is a declining block contract that limits annual Cascade purchases from SPU to an average 30.3 million gallons per day (mgd) through 2023, after which the block volume begins to decline. The block will be reduced by 5 mgd in 2024 and by another 5 mgd in 2030. Additional 5-mgd reductions will occur every 5 years thereafter through 2045, leaving a final block of 5.3 mgd. A contract amendment in 2008 provides for supplemental blocks of water of 3 mgd from 2009 through 2017 and 5 mgd from 2018 through 2023 that are in addition to the blocks specified in the first contract. Cascade chose to not participate on the Operating Board and the regional conservation program.

    - Northshore's block contract is for 8.55 mgd on an average annual basis for the duration of the contract, which is expected to meet all the district's water supply needs into the future. Northshore provides water directly to its retail customers and participates on the Operating Board and in the regional conservation program.

2.3.2 Water Demand

For most of Seattle's history, water consumption increased along with its population. However, that link was broken around 1990

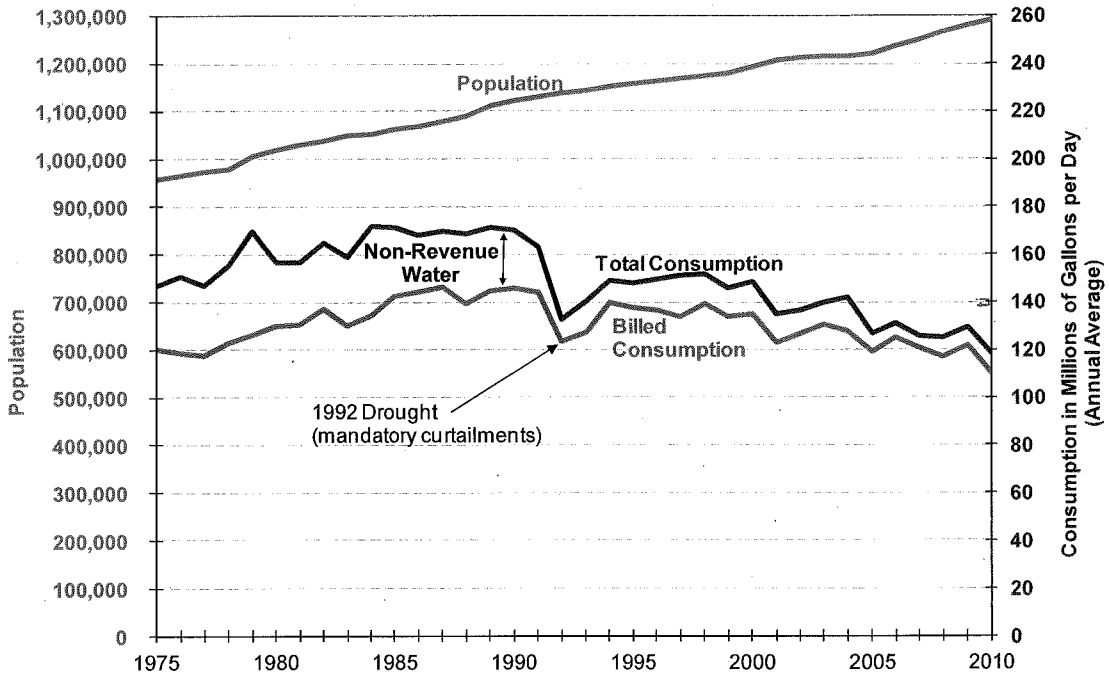
when consumption reached its highest level. Since then, water consumption has steadily declined despite continued population growth. By 2010, consumption was lower than it had been since 1957 when the regional service area was smaller.

2.3.2.1 Historical Water Consumption

Are people using less water?

Yes! Today, people in SPU's regional water supply system use 30% less water than they did In 1990. Total water consumption is now lower than it was in 1957, despite population growth.

Figure 2-2 displays Seattle system water consumption and service population since 1975. While population has steadily risen since 1975, water demand leveled off during the 1980's before dropping off sharply in 1992 due to a severe drought and mandatory curtailment measures. Since then, the combined effects of higher water and sewer rates[1], new federal and state plumbing codes, utility conservation programs, and improved system operations kept both billed and total consumption significantly below pre-1992 drought levels. Also, water consumption in recent years has also been impacted by the ongoing economic recession. Between 1990 and 2010, consumption has decreased about 30 percent (50 mgd) while population increased by 15 percent.



Note: Population is adjusted to reflect the proportion of resident service area population actually using SPU water (i.e., excludes those that receive water from other sources).

Figure 2-2. Population Growth and Water Consumption from SPU Sources

[1] Seattle's sewer rates are based, in part, on water use, so that using less water may result in a lower sewer bill, thereby increasing a retail customer's incentive to conserve water.

One benefit of the lower demand is a reduced need for treated water storage and their associated costs and water quality impacts.

Peak water demand has fallen even more than annual average demand since the 1980's when hot summer weather could produce peak day consumption of over 330 mgd. In the last ten years however, peak day consumption has stayed below 250 mgd even on the hottest days. Recent years with cool summers, peak day consumption has been below 200 mgd. Peak month and peak week consumption have also been trending downwards over the past twenty plus years, though not as steeply as peak day consumption.

2.3.2.2 Non-Revenue Water

SPU's system non-revenue water is calculated by subtracting total metered water sales, both retail and wholesale, from total water production. Distribution System Leakage, as reported to the state, is a component of non-revenue water. Since the *2007 Water System Plan*, the amount of non-revenue water has declined due to reduced use of water for system operations. As the remaining open reservoirs have been covered and buried, overflowing for water quality reasons has been substantially reduced, as has the need to empty the reservoirs for cleaning. Table 2-4 reflects SPU's best estimates of the components of non-revenue water for 2010.

Table 2-4. Components of Non-Revenue Water and Estimated Magnitudes

Total Non-Revenue Water	8.0 mgd
System Operations	**0.3 mgd**
Reservoir Overflowing	<0.1 mgd
Reservoir Draining/Cleaning	0.2 mgd
Water Main Flushing	<0.1 mgd
Public Uses	**0.3 mgd**
Sewer flushing, fire fighting, etc.	0.3 mgd
System Losses	**7.4 mgd**
Measured Losses (Reservoir Leaks/ Net Evaporation)	0.3 mgd
Unmeasured Losses (Pipeline Leaks and Other)	3.7 mgd
Meter Inaccuracies[a]	3.4 mgd

Note: All the above categories except meter inaccuracies were estimated by water planning and operations staff. Meter inaccuracies were calculated by subtracting the estimates for all other types of non-revenue water from total non-revenue water. To the extent the estimates for all other types of non-revenue water are (on average) too low, the estimate of unmeasured losses will be too high, and vice versa.

2.3.3 Water Conservation Programs

Passive Savings are reductions in water use that occur as customers, without SPU intervention, purchase new plumbing fixtures and water-using appliances that meet, or in many cases exceed federal and state codes.

SPU's water conservation strategy includes a comprehensive regional program for Seattle and participating wholesale customers, as well as a targeted effort for Seattle's low-income residents. Savings also come from water rates designed to promote conservation, passive savings, and system efficiencies.

2.3.3.1 Regional Conservation 2000-2010

In 1999, SPU took on an ambitious goal: keep water demand from increasing over the next ten years, despite projected regional population and economic growth. At the time, Seattle was one of the few large cities in the country attempting to manage expected growth in water demand through conservation.

A key component of SPU's water conservation approach was achieved by its Saving Water Partnership – a collaborative program run by Seattle and 17 of SPU's wholesale customers[1]. The program emphasized long-term water use efficiency without customer sacrifice. The regional program set a savings target of about 1 mgd per year, or a cumulative average annual total savings of 11 mgd.

Conservation measures promoted by the program eliminated unnecessary, wasteful use of water while customers and the community continued to enjoy high-quality drinking water.

With support of residential, commercial and institutional customers, the Saving Water Partnership achieved a cumulative savings total of 9.6 mgd from the year 2000 through 2010, at a cost to the participating utilities of $35 million. Highlights of the measures implemented during the program are shown in Table 2-5. The *Saving Water Partnership 2010 Annual Report and Ten Year Program Review* provides additional detail on the program's accomplishments and is available on the Saving Water Partnership web-site.[2]

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[1] The City of Renton joined the Saving Water Partnership in 2011, bringing the total number of participating wholesale customers to 18. As of January 2012, Saving Water Partnership members include SPU along with Northshore Utility District, and all Full and Partial Requirements Contract utilities: Cedar River Water & Sewer District, City of Bothell, City of Duvall, City of Mercer Island, City of Renton, Coal Creek Utility District, Highline W.D., Olympic View Water & Sewer District, Shoreline W.D., Soos Creek Water & Sewer District, W.D. 20, W.D. 45, W.D. 49, W.D. 90, W.D. 119, W.D. 125, and Woodinville W.D.

[2] http://www.savingwater.org/docs/2010_Annual_Report.pdf

Table 2-5. Summary of Regional 1% Program Accomplishments 2000-2010

Measures Implemented	Strategies Implemented
RESIDENTIAL INDOOR	
• Replace washing machines • Replace toilets, showerheads & faucets (multifamily) • Fix leaks (toilets) • Change behaviors (faucet use, shower time, full loads)	• 180,392 showerheads distributed to single-family residents • 78,770 washing machine rebates and 1,073 multi-family coin-op rebates • 32,838 multifamily and 5,773 single family toilet rebates • 36,693 showerheads and aerators distributed to multifamily properties • Behavior messaging • Collaboration with energy utilities • Program recruiting through retailers, radio, TV and print ads, ads in property manager trade publications, website • Promotion of Flush Star and Water Sense toilet performance
RESIDENTIAL LANDSCAPE	
• Improve irrigation system performance • Change landscape watering behaviors • Encourage practices that affect watering (e.g. mulch, soil prep and plant selection)	• 1,015 Irrigation system efficiency rebates • Right Plant, Right Place promotion via retailer partnerships (nurseries, home and garden centers) • Savvy Gardener e-newsletter and classes – 3,451 subscribers; 4,149 class attendees • The Garden Hotline – 134,152 questions answered • Natural Lawn & Garden Guides (how-to materials) – 590,440 distributed • Training for irrigation professionals • Develop irrigation technology performance testing through Irrigation Association Smart Water Application Technologies Initiative • Online weather data, watering index, water budgeting and irrigation scheduling tools
COMMERCIAL PROCESS/DOMESTIC	
• Upgrade toilets and other domestic water use fixtures • Upgrade industrial and commercial water-using equipment • Improve building cooling performance • Upgrade efficiency of specific water consuming medical and lab equipment • Outreach to ethnic businesses	• Financial incentives (723 custom projects & standard rebates) • Targeted promotion through vendors, trade groups, agencies with focus on Mexican and Korean businesses • Restaurant targeting – Commercial Kitchen Equipment Partnership with multiple energy and water utilities • Outreach to business groups through Resource Venture (www.resourceventure.org) • Technical assistance, assessments, workshops • End-use metering to build cost-effective conservation recommendations
COMMERCIAL LANDSCAPE	
• Upgrade irrigation equipment (controllers, rain sensors, drip) • Improve scheduling and maintenance • Train irrigation contractors and installers	• Targeted outreach to large commercial customers • Site-specific recommendations and technical assistance • Financial incentives (custom projects and set rebates) – 375 businesses and institutions • Targeted recruiting and promotion to large commercial customers • Market transformation by establishing and building vendor and contractor relationships • Online weather data, watering index, water budgeting and irrigation scheduling tools • Training for irrigation professionals – 500 attendees
YOUTH EDUCATION	
• Build conservation awareness and residential measures	• Educator resources – teacher trainings and materials online • Classroom and take-home materials – 43,660 conservation kits distributed; 12,900 water system posters distributed; 9,000 activity books distributed • Web-based interactive activities – 44,911 Water Buster game players • Support of water festivals and events
OVERALL MESSAGING	
• Conservation awareness supporting recruitment of residential and commercial customers	• Market EPAWaterSense labeled products • Promote regional website: www.savingwater.org • Water conservation hotline: 684-SAVE • Collaboration with Partnership for Water Conservation • Festivals, utility open house events • Radio, TV, public transit, and print advertising

After ten years, the overall goal of keeping demand flat was not only achieved, but exceeded. The programmatic savings were complimented by additional savings from standards, codes, rates, and system operation changes. Average annual demand was lower in 2010 than in 2000. Figure 2-3 illustrates the components that have contributed to a greater than 30 mgd reduction in water use since 2000.

While population has steadily increased, water consumption has decreased by over 30 mgd since 2000.

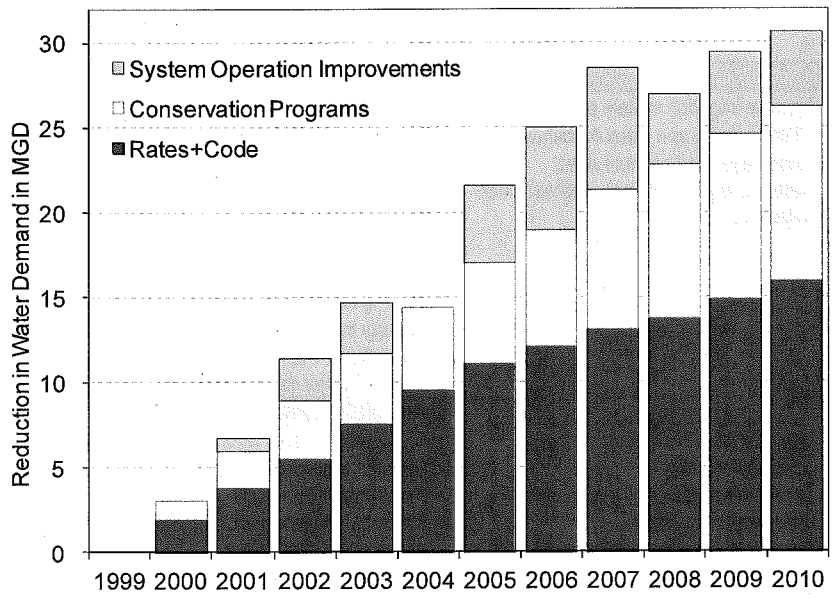


Figure 2-3. Cumulative Water Savings from Conservation, in Average Annual mgd, 1999-2010

2.3.3.2 Seattle-Only Conservation 2003-2010

In addition to the regional program, SPU has implemented a water conservation program exclusively for low-income customers in Seattle. The City of Seattle adopted the I-63 Settlement Ordinance in 2001 (Ordinance 120532), which committed the City to pursue conservation beyond the Regional Program in the SPU direct service area and to focus on low-income housing conservation assistance by establishing the "Everyone Can Conserve Program." From 2002 through 2010, the program retrofitted over 20,000 income-qualified housing units with water conservation fixtures and equipment. A similar but modified Program continues post-2010 as part of the City's efforts to help low-income customers manage their water bills.

Ordinance 120532 directed SPU to provide 3 mgd of water savings in the Seattle retail service area by 2010 through the low-income conservation program, rate structures that provide conservation

incentives, increased system efficiencies resulting from the accelerated in-town reservoir replacement program, and other cost-effective measures. SPU has met these requirements.

2.3.3.3 Water Use Efficiency Goal and Program 2007-2012

As part of the process to comply with the WDOH Water Use Efficiency Rule, the Saving Water Partnership utilities updated regional policy objectives for water conservation and set a six-year regional goal. These goals were described in SPU's *2007 Water System Plan.* For the Saving Water Partnership, the 2007-2012 regional water conservation objectives were to provide:

- Low-cost insurance for meeting potential future challenges from climate change;
- Efficient management of water resources; and
- Assistance to customers with managing their bills.

For its 2007-2012 Water Use Efficiency Goal, the Saving Water Partnership adopted cumulative average annual regional programmatic water saving targets of 11 million gallons per day from 2000 through 2010 and 15 mgd of both price and programmatic savings from 2011 through 2030. The six-year portion of these two regional targets, from 2007 through 2012, is estimated to total 5.98 mgd. As with earlier programs, the range of services for customers remains a mix of education as well as financial rebates for water saving equipment.

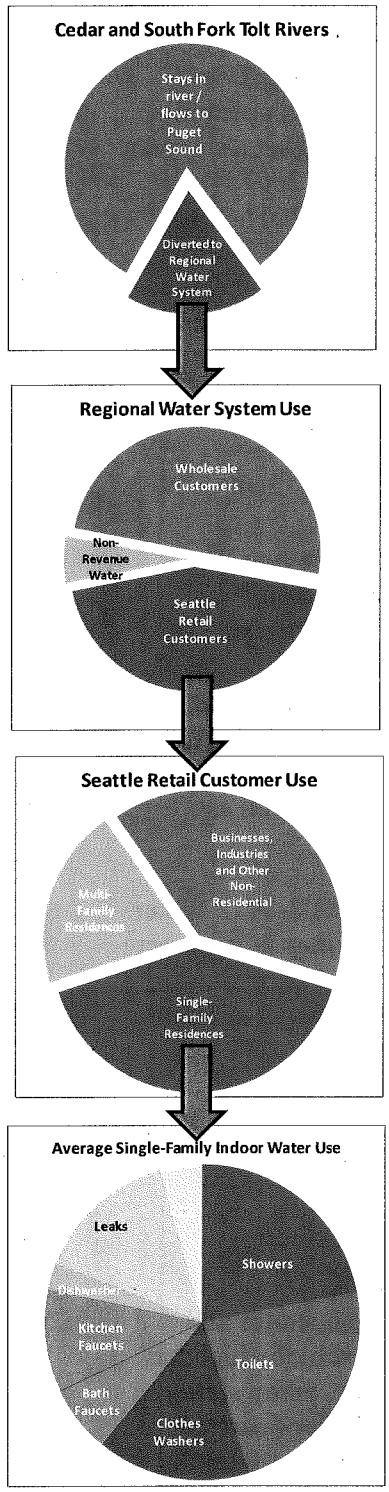
Note that in addition to the regional goal, SPU's 2007-2012 Water Use Efficiency Goal includes additional water savings in its direct service area. Additional water savings of 2.57 mgd are estimated to be achieved from implementation of the requirements of Seattle Ordinance 120532.

SPU's Water Use Efficiency annual reports are available on the WDOH web-site and are reported to SPU's customers in the annual Drinking Water Quality Report.

2.3.4 Existing Water Supply

To meet the water demand of its customers, SPU operates and maintains two surface water sources of supply, each of which has associated infrastructure (such as reservoirs, dams, pump stations, and pipelines). This section describes the capacities of each of Seattle's water sources and provides information concerning the City's water rights and firm yield.

Where is all of the water from the Cedar and Tolt used?



2.3.4.1 Supply Sources

Seattle obtains approximately 70 percent of its raw drinking water supply from the Cedar River and most of the remaining 30 percent from the South Fork Tolt River. Seattle's two well fields are available to provide drought and emergency supply. Additional information about each supply source is included below. The few changes that have occurred since the *2007 Water System Plan* are noted.

Cedar River. The Cedar River Municipal Watershed is located in the Cascade Range within southeast King County. The watershed contains the 1,680-acre Chester Morse Lake, formed behind Masonry Dam. The reservoir stores 13 billion gallons (40,000 acre-feet) between elevations 1563 and 1538 feet.

The Chester Morse Lake pumping plants, two sets of barge-mounted pumps, each with the capacity to pump 120 mgd, are stationed year-round on the lake and can be anchored near its outlet to draw additional water from below the outlet level and discharge dike during low reservoir conditions (below approximately elevation 1538 feet). Use of the pumping plants requires rental and installation of mobile diesel generators, installation of flashboards at the Discharge Dike, and other set up activities which necessitate a lead-time of up to two months prior to actually needing to pump.

Water stored in Chester Morse Lake flows downstream to the Landsburg Diversion Dam and fish passage facility, which is located about 14 miles downstream from the Masonry Dam. Here, water is diverted through pipelines to Lake Youngs Reservoir. Lake Youngs Reservoir, with a useable storage capacity of approximately 1.5 billion gallons (4,600 acre-feet), provides additional storage and regulates flows to the Cedar Water Treatment Facility.

Some of the Cedar River source water is lost from Masonry Pool, the portion of the reservoir between the Overflow Dike and Masonry Dam, via seepage into a moraine on the Pool's northern bank. Water leaks out of the Masonry Pool mostly in the spring and early summer, when water is relatively abundant, fills an underground "reservoir" or aquifer, then a portion returns to the river in the summer, when it provides a water supply benefit in the critical fall season, before the fall rains return. About 75 to 80 percent of the water that leaks from Masonry Pool is "stored" in this way and finds its way back to the Cedar River, while the remainder ends up in the Snoqualmie River basin. Some of this

seepage is discharged through Hobo Springs. In 2009, piping was installed to divert water from Hobo Springs to Boxley Creek for the city of North Bend to mitigate use of their wells on the Snoqualmie River. The amount of water provided was 0.09 mgd in 2009 and 0.05 mgd in 2010.

The Cedar Moraine Safety Study identified that the West Boxley area of the Cedar Moraine could result in a groundwater burst failure under seismic conditions when steady-state groundwater levels reach those associated with Masonry Pool elevation 1555 feet and above. The flood resulting from the groundwater burst failure could impact people downstream. The annual probability of failure for the seismically-induced groundwater burst was estimated at 1 chance in 2,400. This annual probability of failure does not meet Department of Ecology Dam Safety Office requirements of a less than one in 10,000 year probability of failure.

In order to meet Ecology requirements, SPU constructed a subsurface drainage system into the face of the moraine hillside embankment. The purpose of the drainage system is to capture groundwater prior to reaching the slope face, thereby reducing the potential for a groundwater burst flow event. An additional result of the installation of the drains is that SPU received Ecology authorization to officially have a normal permanent refill level of elevation 1563 feet in Chester Morse Lake.

South Fork Tolt River. The South Fork Tolt River Municipal Watershed is located about 13 miles east of Duvall in King County. The South Fork Tolt Reservoir, which went online in 1964, provides 18.3 billion gallons (56,160 acre-feet) of storage. Water from this reservoir is conveyed to the Tolt Regulating Basin and the Tolt Water Treatment Facility.

Seattle Well Fields. In addition to the major surface water supplies, Seattle operates two small well fields in the City of SeaTac to provide additional drought capacity and emergency supply, as needed. The Riverton well field has two wells, and the Boulevard Park well field has one well. In total, the three wells can supply up to 10 mgd for approximately four months. The well fields are naturally recharged, but the wells can also be artificially recharged using a method known as aquifer storage and recovery (ASR), if needed. When used, ASR injects treated water from the Cedar River into the production wells to supplement natural recharge into the aquifer.

2.3.4.2 Water Rights

Seattle holds various water rights for use of water from the Cedar River, South Fork Tolt River, and Seattle Well Fields. Also, Seattle has water right applications on file with the Washington State Department of Ecology (Ecology) for potential future sources of supply, as indicated by the Water Rights Evaluation contained in the appendices. One change in status of these water rights is that the term permit for the Cedar River (Morse Lake) Pumping Plant has expired. Since SPU's Cedar River claim includes the use of this water, it is not necessary to renew the permit.

Also, SPU received a water right permit in 2007 to capture and put to use rainwater that falls on rooftops of structures in the combined and partially separated sewer basins of the City of Seattle. This permit includes a map for areas covered. Under this permit, Seattle would authorize, with conditions, individuals, businesses and other entities within the mapped area to collect and use rainwater. After receiving the permit, Ecology released in 2009 Interpretative Statement / Policy 1017 regarding collection of rainwater for beneficial use to clarify that a water right is not required for on-site storage and use of rooftop-collected rainwater.

SPU is requesting its water rights place of use be changed to include small portions of southern Snohomish County.

Through the *2007 Water System Plan*, SPU changed its place of use for the Cedar River and Lake Youngs claims to be the service area described in that plan as allowed by the 2003 Municipal Water Law (WAC 246-290-107). Through this water system plan and the State review process, SPU is modifying its service area so as to clarify that the service area includes small areas in Snohomish County currently served by Northshore Utility District, the City of Woodinville, and the City of Bothell, as well as potential service area additions proposed by Water District 119. These areas are shown in Figure 2-1 and are based on the following:

- Northshore Utility District, Water System Comprehensive Plan, December 2006, retail service area, including retail service area by Agreement, as shown in Figure 3-1 of that document.
- Woodinville Water District, 2008 Comprehensive Water System Plan, water service area, including interim service, as shown in Figure 2-1 of that document.
- City of Bothell, Water System Plan, February 2011, water system retail service area, as shown in Figure 1-2 of that document.

- Proposed service area additions as indicated by Water District 119, which consist of Snohomish County Sections 31, 32, 33, and 34 of Township 27 North, Range 7 East, east of Highway 203. This area includes properties for which Water District 119 has received requests for service in the recent past due to poor groundwater conditions and the lack of other nearby water purveyors. Any new service to this area is subject to approval by SPU, Snohomish County, King County, WDOH and other jurisdictions.

An evaluation of specific Seattle water right claims, permits, and applications as called for in WDOH planning guidelines is included as an appendix. Forecasts indicate that Seattle does not need to apply for any new water rights within the 20-year planning horizon.

2.3.4.3 Firm Yield and Supply Reliability

Firm yield of SPU's water supply has been updated to 172 mgd, an increase of 1 mgd.

Firm yield is the amount of water that SPU is able to supply system-wide at a given delivery pattern while meeting the supply reliability standard, instream flow requirements, treatment and transmission capacity, and other system constraints, including diversion limits for the Cedar River as set forth in the 2006 Agreement with the Muckleshoot Indian Tribe. Firm yield is expressed as an average annual delivery rate in mgd from all sources operating conjunctively. Calculating firm yield for SPU's existing supply sources is critical to ensuring that SPU can meet existing and future demands reliably. The firm yield can be compared to long-term forecasts of water demand to determine when new sources or additional conservation programs need to be online to maintain the desired level of supply reliability. Firm yield calculations are also useful in determining the quantity of water that can be expected from a potential new source of supply.

SPU uses a computer simulation model to calculate the firm yield from its existing water supply sources and potential new water sources. This model is known as the Conjunctive Use Evaluation (CUE) model. The model is used with 81 years of reconstructed historic flow records that takes into account past weather and hydrologic variability to produce a system-wide firm yield estimate. SPU's supply reliability standard is 98 percent. Therefore, SPU's firm yield is the amount of water that is assured for delivery in all but the driest 2 percent of years without lowering reservoirs below normal minimum operating levels. The firm yield calculation was updated in 2011 to include inflow dataset through 2009 and to represent current operating conditions, namely the use of the current spring refill target of elevation 1563 feet for Chester

Morse Lake and the use of a revised monthly demand distribution based upon the actual demand of 2005 through 2009. The result was that the firm yield increased by one mgd. The combined firm yield of all SPU supplies is currently estimated to be 172 mgd.

2.3.5 Operations

The surface water supply facilities on the South Fork Tolt and Cedar Rivers are operated primarily for water supply and protection of instream flows, but are also used for hydroelectric power generation and flood management. The reservoirs are drawn down and refilled each year. The groundwater supply facilities at the Seattle Well Fields supplement these sources, if needed. Should a drought or other water supply emergency occur, SPU would activate the Water Shortage Contingency Plan (WSCP) contained in the *2007 Water System Plan*. Since the *2007 Water System Plan*, the WSCP has not been activated, and the only time that these wells were used was in 2008. Groundwater elevations during this period are provided in the appendices. Water resource management and operations have changed since the *2007 Water System Plan*. The changes include the following and are described more fully below:

- Installation of the moraine drains resulting in Chester Morse Lake refill elevation of 1563 feet being authorized and changes to seepage from Masonry Pool.
- Operations intended to maintain higher pool levels to better avoid the use of the floating pumps in Chester Morse Lake.
- Management of outlet water temperatures at South Tolt Reservoir in support of South Fork Tolt River fisheries.
- Adjustments to the instream flow requirements for the Cedar River due to the change in hydrology when Walsh Lake Ditch was disconnected and became a tributary to flows above Landsburg on the Cedar River.

2.3.5.1 Chester Morse Lake Refill and Masonry Pool Seepage

As noted previously, some of the Cedar River source water can be lost as a result of seepage through the porous soils of the Cedar moraine on the northern bank of Masonry Pool. The losses are directly proportional to Masonry Pool Reservoir level.

The authorization to allow refill to an elevation of 1563 feet does result in more storage but also leads to increased loss to the

Installation of the drains in Cedar Moraine has allowed refill of Chester Morse Lake to elevation 1563 feet.

moraine. With installation of the moraine drains, some increase in loss to the Snoqualmie Basin has been observed, but the magnitude and timing of this increase is still under evaluation. However, past studies have shown that the seepage provides an overall net benefit to water supply because of the additional storage provided by the moraine aquifer and the timing of water returning to the Cedar River. As noted in the *2007 Water System Plan*, analysis conducted by SPU found that if seepage from Masonry Pool were completely eliminated, an estimated 24 mgd of firm yield would be lost.

Presently, water levels in the lake and pool are managed to minimize moraine embankment instability and the potential loss in water supply yield. These management practices are focused on manipulating the water surface elevation in the Masonry Pool to selectively manage seepage to the moraine.

2.3.5.2 Operational Changes to Avoid Use of Floating Pumps

Surveys in 2002 and in subsequent years have revealed that a portion of the Outlet Channel between Chester Morse Lake and Masonry Pool had filled in with sediment resulting in a diminished capacity to convey a sufficient volume of water to meet water supply and instream flow objectives. The channel was dredged in 2002 and 2010, which partially restored the flow capacity. In addition, the Discharge Dike crest elevation was raised in 2002 to 1538 feet, and effectively moved up the minimum elevation at which gravity flow can be maintained and established a new elevation below which pumping is required. This has led to a need to activate the pumps sooner, and consequently more frequently, than what would have occurred in the past. In addition, the existing floating barge system has numerous mechanical and electrical components that are in need of replacement.

Water resource operations in recent years have taken into consideration the condition of the existing floating pumps and channel. The current operational goal is, to the maximum extent practicable, reduce the likelihood that the floating barge system would need to be mobilized during the fall or winter by keeping as much water as practical in Chester Morse Lake. To meet this objective, the river and reservoir system is managed to maximize refill during the spring, maintain the level as long as possible, avoid releases when possible during the summer and early fall, reduce seepage losses in the summer and fall, use more Tolt water, optimize use of Lake Youngs, and use the wells if necessary. While the Morse Lake Pump Plant Project, described below, will improve the floating pump system, SPU intends to continue

operating the reservoir in this same manner so as to reduce the likelihood of needing to pump.

2.3.5.3 Temperature Management at South Fork Tolt Reservoir

SPU has been successful at meeting water temperature objectives in the South Fork Tolt River.

SPU uses existing reservoir intake gates to release water from different water depths in the South Fork Tolt Reservoir to provide beneficial water temperatures for instream resources in the river downstream of the reservoir. Specific objectives of this program are to maintain water temperatures throughout the lower South Fork Tolt River within Washington Department of Ecology Standards and at levels that are similar in pattern to temperatures in the unregulated North Fork Tolt River. Since implementation of this program began in 2004, SPU has been successful at meeting these objectives without compromising water supply.

2.3.5.4 Walsh Lake Ditch Disconnect

From 1904 to about 1947, the town of Taylor, Washington, was a large mining and manufacturing community in the western Cedar River Municipal Watershed. In the 1930's, the City of Seattle constructed the Walsh Lake Diversion Ditch (Ditch) to divert the water contaminated by this community. The water was diverted just above the natural confluence with Rock Creek, a tributary of the Cedar River in the Municipal Watershed, and conveyed 1.7 miles to a discharge point on the Cedar River downstream of the Landsburg Diversion Dam (the diversion point for Seattle's Cedar River municipal water supply). Following abandonment and decommissioning of the Taylor townsite in 1947, water quality impairment in the 4.3 sq mi Walsh Lake Basin naturally recovered, making the Ditch obsolete. The Ditch—contained by a constructed earthen levee—is located in a steep ravine above Rock Creek. During a January 2009 storm event, a 300-foot section of the Ditch catastrophically failed, resulting in the natural reconnection of the Walsh Lake sub-basin to its historic tributary flow into Rock Creek—effectively disconnecting and largely dewatering the downstream section of the Ditch.

To account for this change in hydrology with regards to Seattle's water supply and instream flow management, SPU in consultation with the Cedar River Instream Flow Commission adjusted the instream flow requirements in the river by the mean weekly flow contribution from the Ditch (annual mean of 8.6 cfs). In 2012, SPU plans to improve the now-reconnected confluence of Rock Creek and Walsh Lake Ditch, to stabilize the area, and to make long term improvements to stream habitat at the confluence. This work includes the removal of the former concrete diversion weir

structure, and breaching of the remnant section of the earthen Ditch levee to stabilize the hillslopes in the area adjacent to the former Ditch.

2.3.6 Maintenance

SPU's water resource maintenance activities focus on the City's watershed dams and particularly on dam safety. The water system includes seven dams located in the Cedar and Tolt water supply systems that are owned by SPU. These dams are maintained to ensure operability and safeguard against damage or failure in large floods, earthquakes, malevolent acts, and general deterioration from aging. The Dam Safety Section of the Washington State Department of Ecology (Ecology) and Federal Energy Regulatory Commission (FERC) regulate the maintenance of SPU's dams to ensure continued safe performance. Both Ecology and FERC require regular inspections of these dams and related infrastructure, such as spillway gates and dam failure warning systems; inspections that can result in requirements for maintenance work or major capital improvements.

SPU is developing a strategic asset management plan (SAMP) for the major dams that are part of the water supply system. A SAMP for Lake Youngs has been completed and one for the Tolt is expected to be completed in 2012. These SAMPs will analyze how SPU should maintain and repair the dams and make recommendations as to any renewals of the existing dams or their components. They will also include recommendations regarding elements such as the mechanical and electrical equipment associated with the dams, including the dam failure warning systems. The key result from the Lake Youngs SAMP is the recommendation to begin analysis of the eastern Cascades Dam for ways to reduce impacts of a seismic induced failure on water quality (see Section 2.4.2.5 for more information).

2.4 Needs, Gaps, and Issues

Needs, gaps, and issues facing the Water Resources business area include appropriately planning for water supply in the face of uncertainty and potential climate change impacts and improving water supply infrastructure and operational practices to make the best use of existing supplies. The Water Use Efficiency Goal and program for the 2013-2018 time period is also described, along with an updated water demand forecast. Each of these specific issues is discussed in the following section, along with how SPU plans to address them.

2.4.1 Future Water Demand and Supply

There are uncertainties affecting both future water demand and future water supply. Future water demand is dependent on population growth, income, conservation, climate, weather, and other factors, such as changes in water appliance efficiency standards. Future water supply depends on the condition of water supply infrastructure, new operating constraints, climate, the feasibility of developing new supplies as needed, and other factors, such as legal and regulatory issues. SPU has developed water demand forecasts and analyzed future water supply using frameworks that incorporate these relative uncertainties. The results of SPU's analyses are described in the following sections.

2.4.1.1 Water Use Efficiency Goal and Program 2013-2018

For over twenty years, SPU and its wholesale utility customers have successfully designed and delivered water conservation programs for residents, businesses and institutions throughout the regional service area. Conservation has proven to be an effective and flexible strategy. In the early years, conservation programs helped educate customers about the efficient use of water and successfully built an ethic of stewardship. Having an established program was a key response strategy during droughts when voluntary and mandatory customer water curtailment was needed. Later, conservation programs helped to decrease per capita water use when the need for a new source of supply was forecast.

Experience has demonstrated the value of periodically assessing the reasons for and role of customer-based conservation programs in water system planning -- to ensure that the program emphasis supports utility needs, reflects customer preferences, and recognizes changing regulatory and market factors that affect water use efficiency.

As of January 2012, in the Seattle water system, SPU and 18 of its wholesale utility customers operate regional conservation programs collaboratively as the Saving Water Partnership[1]. Utility members set and oversee conservation goals, objectives, and program intensity through the Operating Board. Staff from the utilities comprise the Water Conservation Technical Forum, which is tasked with designing programs within parameters defined by the Operating Board. In SPU's retail area, a customer-based Water

[1] For Saving Water Partnership member listing and website, and regional conservation goals, programs, and accomplishments through 2012, see Sections 2.3.3.1 and 2.3.3.3.

System Advisory Committee provides additional customer input and feedback on conservation goals, objectives, and programs.

To scope and scale regional conservation initiatives for the 6-year planning timeframe required by the Washington State Water Use Efficiency (WUE) Rule, the Saving Water Partnership reviewed the current water demand forecast, which is described in the next section, prior to adopting a Water Use Efficiency Goal and Program. The demand forecast indicates that a new source of supply is not needed before 2060 despite continued growth in regional population. This is, in part, due to increased attribution of passive conservation savings as a factor in reducing per capita demand.

Conservation prepares the region for potential water supply challenges, helps customers use water wisely, and preserves the ethic of stewarding natural resources.

The Saving Water Partnership recognizes that the utilities and their customers benefit from a regional conservation program that ensures staff expertise and strong industry partnerships are available to meet a variety of water system needs. This "conservation infrastructure" prepares the region for potential water supply challenges, helps customers use water wisely, and preserves the ethic of stewarding natural resources.

As a statement of objectives for its regional conservation efforts from 2013-2018, the Saving Water Partnership will:

- Ensure core capacity is available to deliver conservation programs that prepare the utility to be resilient for curtailment events and future supply challenges from climate change, as well as help customers use water wisely;
- Preserve customers' ethic of conservation as one element of stewarding our water resources and the environment; and
- Meet regulatory and contractual requirements.

The Saving Water Partnership utilities set a regional combined conservation goal that reflects a reduction in per capita water demand – for residents, businesses, and institutions throughout the regional service area – and holds total water use below a specified level despite population growth being forecasted to increase by 3.9 percent over the six-year period. The goal is formally adopted by each utility's governing body and is reported on annually by each utility. The goal for the Saving Water Partnership service area captures the cumulative effect of all demand-side conservation indicated in the water demand forecast including water savings from utility funded customer-based programs, price-induced

conservation from customer response to water and sewer rate increases, and passive savings.

The Saving Water Partnership's regional 2013-2018 Water Use Efficiency Goal is to:

Reduce per capita water use from current levels so that total average annual retail water use of members of the Saving Water Partnership is less than 105 mgd from 2013 through 2018 despite forecasted population growth.

The metric for determining success of the Water Use Efficiency Program measures reductions in metered retail water consumption in the Saving Water Partnership members' service areas, regardless of whether the water is supplied by SPU or a member's own source of supply.

The Saving Water Partnership defined the regional utility-funded customer-based program in its 2013-2018 Water Use Efficiency Program to support its objectives and 6-year goal. The customer-based conservation program is one component of demand management included in the regional 2013-2018 Water Use Efficiency Goal. Selection of measures for the customer-based conservation program is based on an understanding of national appliance and fixture codes, estimates of sales in the market that exceed code, reviews of regional conservation potential analysis and Saving Water Partnership program impact evaluations, market research with utility customers to assess program acceptance and effectiveness, and opportunities for partnerships to leverage water utility funds. Considerations also include ensuring balanced service across customer classes, providing conservation services across utility member service areas, and opportunities to reach traditionally under-served populations. Because the current demand forecast does not indicate that a new source of water supply is needed until sometime after 2060, a set level of avoided water supply cost with which to compare conservation measures is not available.

The 2013-2018 Water Use Efficiency Program renews emphasis on consumer and youth education along with a priority to benchmark customer attitudes about water conservation. It also includes educational campaigns for leak prevention and water use in the landscape. Additionally, the program continues to share costs with customers who retrofit old water-using equipment with new equipment that is more efficient than national and State

appliance and fixture codes. Conservation measures for the 2013-2018 Water Use Efficiency Program are summarized in Table 2-6.

Table 2-6. Summary of Saving Water Partnership 2013-2018 Water Use Efficiency Program

General Activities	Specific Measures
CUSTOMER BEHAVIOR CHANGE	
• Community events, schools support, customer education	• Schools outreach • Festivals, shows and fairs • Customer technical assistance • Regional phone hotline: 684-SAVE • Tips on Tap articles for utility newsletters • Media promotion and advertising • Customer mailings • Regional web site: www.savingwater.org • Partnerships with vendors, trade groups, agencies and energy utilities • Awards and recognition • Education on water pricing and conservation rates • Equitable customer access to conservation messages and services
• Leaks and indoor water use education	• Find and fix leaks instructional videos and information on web and in print • Leak detection dye strips distributed via direct mailings
• Landscape water use education	• Landscape classes for residential gardeners • Irrigation scheduling and maintenance • Expert one-on-one advice through the Garden Hotline • Natural Lawn & Garden Guides (how-to materials) and other brochures • Online weather data, watering index, water budgeting and irrigation scheduling tools • Irrigation training in multiple languages for professionals • Smart Water Application Technologies testing
• Benchmarking customer behavior	• Customer research including identification of traditionally underserved populations and program design options to meet their needs • Technical studies and end-use metering • Conservation measure evaluation
WATER EFFICIENT EQUIPMENT UPGRADES	
• Residential indoor water use	• Single-family toilet rebates • Multi-family toilet rebates
• Residential and Commercial irrigation systems	• Weather-based irrigation controllers • Pressure regulating and efficient spray heads • Drip irrigation and micro sprays • Seasonal adjust (percentage) controllers • Irrigation system leak monitoring alarms
• Businesses and institutions	• Technical assessments and outreach • End use metering and monitoring • Plumbing fixture rebates for toilets, urinals, showerheads, aerators, etc. • Cooling and process water rebates • Food service equipment rebates • Medical and lab equipment rebates • Laundry equipment rebates • Steam condensate equipment rebates • Partnerships with energy utilities • Evaluation of reclaimed water opportunities

The Saving Water Partnership estimates the average savings from the 2013-2018 Water Use Efficiency Program will be 0.3 to 0.4 mgd of annual savings at an estimated annual utility cost of $2,150,000 (2011 dollars). The estimated annual mgd savings from the Water Use Efficiency Program are one component of the 6-year regional Water Use Efficiency Goal, which captures all sources of demand reductions.

2.4.1.2 Water Demand Forecast

The new water demand forecast includes passive conservation savings and is lower than the last forecast – and still indicates that no new supply needed before 2060.

Long-term water demand forecasting is critical for water system planning. SPU has updated and improved the Demand Forecast Model developed for the *2007 Water System Plan*. This new model incorporates the best features of various model types found in applicable literature. Like simple "fixed flow factor" models, the new SPU model is easy to understand and has relatively modest data requirements. However, like more complex econometric models, the model reflects the impacts of variables such as price, income, and conservation on water use factors over time. This approach takes advantage of past econometric analysis to provide estimates of how price and income can affect demand. The model incorporates estimates of the impacts of passive savings on the water use factors over time, as described below. More information on the model, data sources and assumptions are provided in an appendix.

SPU's official water demand forecast is presented in Figure 2-4, and the various components that add up to the total demand forecast are shown in Figure 2-5. The demand forecast is considerably lower than the *2007 Water System Plan* forecast, particularly in the outer years, and remains considerably below SPU's current firm yield of 172 mgd until well after 2060. Total demand is forecast to remain relatively flat through 2023, at which point the Cascade block begins to step down. Over the two decades that follow, water demand is forecast to decline as the periodic reductions in Cascade's block more than offset what would otherwise be a modest amount of growth in demand. Once the Cascade block has been reduced to its minimum level in 2045, water demand is forecast to begin rising again, finally reaching 132 mgd – back to current levels – by 2060. Peak demands are also forecasted to remain below historic high levels. Given the current firm yield estimate for SPU's existing supply resources, this forecast indicates that no new source of supply is needed before 2060.

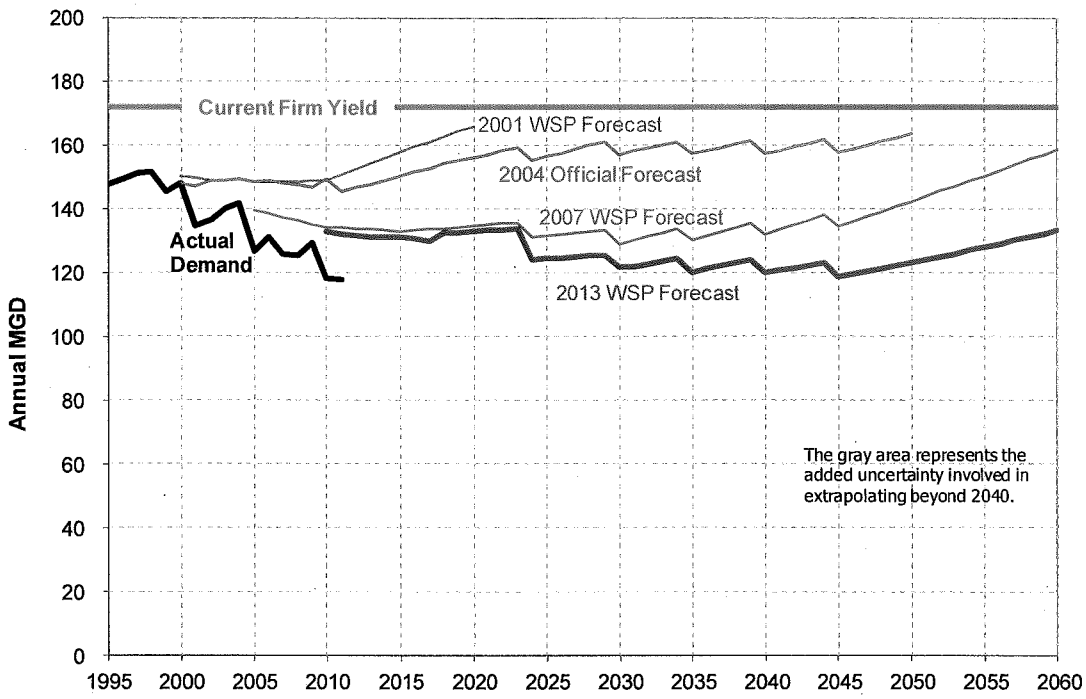


Figure 2-4. SPU's Official Water Demand Forecast

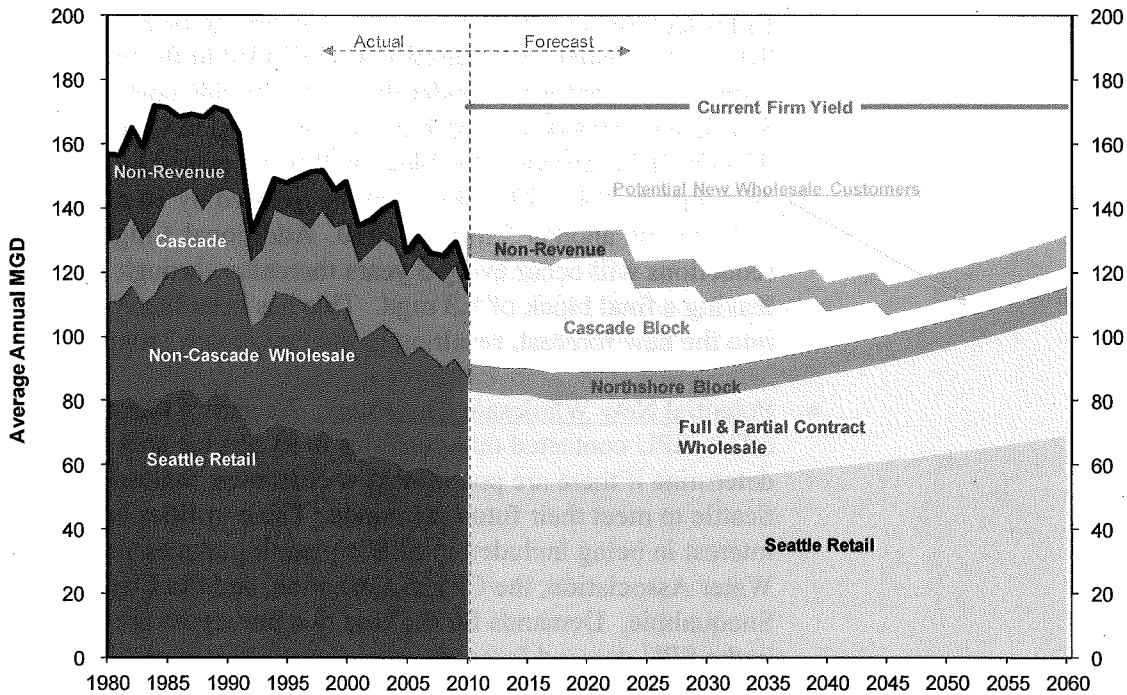


Figure 2-5. Components of Actual and Forecasted Demand

Note: Forecast demand is higher than actual demand in 2010 because the forecast includes all block contract amounts, whereas the actual demand by Cascade and Northshore has been less than their block contract amounts. Additionally, the forecast is for average weather conditions, whereas 2010 and 2011 were wetter and cooler than average, resulting in lower actual demand.

SPU's new official water demand forecast is based on a number of changes, particularly in the following key areas:

- Future Conservation Goals and Programs. The forecast includes the impact of the 2013-2018 Water Use Efficiency Goal and Program, described in the previous section, and the commitment made in the *2007 Water System Plan* for 15 mgd of cumulative savings from 2011 through 2030.

- Passive Savings. The forecast includes reductions in water use due to passive savings, which are those savings resulting from actions taken by customers without SPU intervention. These include purchases of new plumbing fixtures and appliances that meet federal codes adopted in 1992, 2001 and 2002. In addition, the impact of new clothes washer codes scheduled for adoption in 2011and to become effective in 2015[1] are also included. Passive savings in the forecast also reflect the current proportion of fixtures and appliances sold in the market that exceed code, meeting the more stringent Energy Star, Water Sense, and Consortium for Energy Efficiency (CEE) standards, as well as how those proportions are expected to continue shifting in the direction of higher efficiency over time.

- Block Contracts. The block supply amounts to be provided by SPU to Northshore and Cascade are included in the forecast as stated in the contracts. Under the 2008 Cascade contract, Seattle will provide a fixed block of 33.3 mgd to Cascade through 2017, and then the block will be increased by 2 mgd to 35.3 mgd in 2018. The block will be reduced by 10 mgd in 2024 and by another 5 mgd in 2030. Additional 5 mgd reductions will occur every 5 years thereafter through 2045, leaving a final block of 5.3 mgd. This has been incorporated into the new forecast, resulting in the "saw tooth" shape.

- Potential New Wholesale Customers. As part of this planning effort, SPU contacted other utilities in its service area to determine if there are potential new customers that may turn to Seattle to meet their future demands. Three utilities indicated interest in being included in SPU's planning: Ames Lake Water Association, the City of Carnation, and the City of Snoqualmie. Demands for the first two purveyors are included in the SPU demand forecast.

1 The US Department of Energy has proposed a two phase clothes washer efficiency standard with the first phase effective March 7, 2015, and the second, more stringent phase, effective for Janunary 1, 2018. This federal proposal has yet to be adopted as a final rule..

- Non-Revenue Water. Combined transmission and Seattle distribution system non-revenue water is assumed to increase from 8 mgd in 2010 to 10 mgd by 2060. This increase is expected to be caused by the increasing number of leaks that are likely to occur as the distribution system ages.

Forecasting future water demand with certainty is virtually impossible. The official water demand forecast is based on forecasts of income, water prices, households, and employment, all of which are subject to uncertainty. Additional uncertainty surrounds the forecast model's assumptions about price elasticity, income elasticity, and future conservation (the model assumes no programmatic conservation past 2030). These uncertainties were modeled by estimating probability distributions for each source of uncertainty. These distributions became inputs to an aggregate uncertainty model employing a Monte Carlo simulation[1] to characterize uncertainty associated with the official demand forecast.

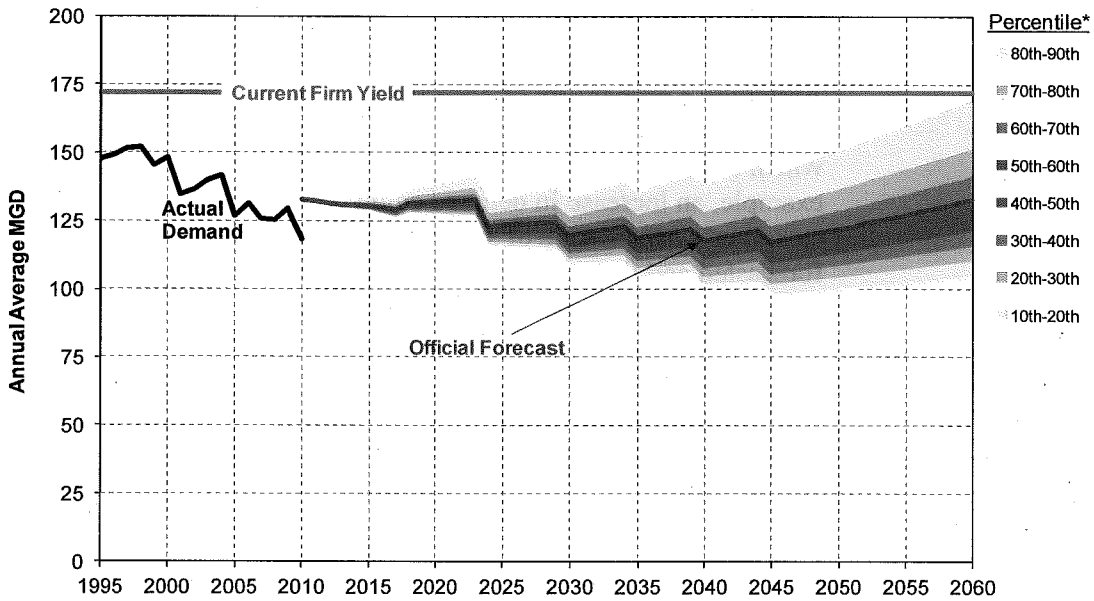


Figure 2-6. Uncertainty in Water Demand Forecast[2]

[1] A Monte Carlo simulation calculates multiple scenarios of a model by repeatedly sampling values from the probability distributions for the uncertain variables. The data generated from the simulation can be represented as probability distributions or confidence intervals. Because the method is based on random chance, it was named after the city of Monte Carlo which is known for its gambling.

[2] Percentiles represent the probability that actual demand will be less than the value shown. Ranges reflect uncertainty in projected household, employment, price and income growth, price elasticity, income elasticity, and conservation. Note that the official forecast is at about the 58th percentile.

The results of the Monte Carlo simulation are displayed in Figure 2-6. The green bands indicate the range of uncertainty associated with the official forecast. Each band represents a 10 percent increase (from the band immediately below it) in the probability that actual demand will be equal to or less than the level shown. For example, the bottom of the lowest band represents the 10th percentile, meaning that there is an estimated 10 percent chance that actual demand will be at or below that level (i.e., 104 mgd in 2060) and, thus, a 90 percent chance it will be above. The top of the uppermost band is the 90th percentile, corresponding to an estimated 90 percent probability that actual demand will be at or below that level (i.e., 169 mgd in 2060).

This type of analysis provides insight into the uncertainty that surrounds the various inputs to the demand forecast model. It estimates a more than 90 percent probability that a new source will not be necessary before 2060 given the range of uncertainty in demand that was tested.

SPU also considers the uncertainty of discrete events that produce significant and sometimes abrupt changes in customer demand. Assigning a probability of occurrence to these events is difficult. These uncertainties are examined through scenario planning in which the outcome of those events occurring is considered. For example, an increase in demand could occur if a wholesale customer's own source of supply is significantly less than forecasted and the wholesale customer chooses to have SPU provide for its additional needs. SPU monitors such developments so that adjustments to the forecast can be made when appropriate.

2.4.1.3 Climate Change and Future Supply Outlook

Climate variability and climate change are uncertainties that SPU considers in ensuring that current and future water demands for people and fish are met. Having managed the water supply system for the past century, SPU is accustomed to providing an essential and reliable service in the face of climate variability. In the Pacific Northwest, two major drivers of climate variability are El Nino Southern Oscillation (ENSO) and the Pacific Decadal Oscillation (PDO), both of which are natural phenomena that affect meteorological conditions and in turn SPU's water supply and demand. Climate change is caused by an increase in heat-trapping atmospheric gases, known as greenhouse gases. Climate change can also alter weather patterns and affect air temperatures, humidity, evaporation, cloud cover, rainfall, snowfall, snowpack, and runoff, in terms of averages, extremes, timing and distribution. The timing and magnitude of these changes and their affect on

SPU's water supply and demand is uncertain but better understanding of the implications of climate change for SPU is a programmatic area of focus within SPU. Climate variability and climate change are often used interchangeably but, for purposes of distinction, in this document when SPU refers to climate variability SPU is referring to a phenomenon that is cyclical and natural in nature, while references to climate change denote persistent change that is largely human induced. SPU's policies for Supply Reliability and Planning for Uncertainty require that the potential impacts of long-term climate change on water supply and demand be addressed in developing supply investment strategies based on the most current knowledge and a wide range of climatic conditions.

The *2007 Water System Plan* presented the results of a University of Washington Climate Impacts Group (UW-CIG) study initiated in 2002 on the potential impacts of climate change on SPU's water supply. Since then, and as part of the process that resulted in the Water Supply Forum's *2009 Regional Water Supply Outlook*, SPU evaluated the potential impact of climate change on the future availability of its water supply as well as future water demands using information from a second study conducted by UW-CIG. This evaluation was further updated in developing the *2013 Water System Plan.*

The recent work builds off of a downscaling study[1] completed in 2007 by UW-CIG that explored a range of climate change scenarios produced by model runs that coupled three different global climate models with two different emissions scenarios[2]. UW-CIG used these model runs to create meteorologic datasets for the Central Puget Sound region at four different 31-year time periods centered around 2000, 2025, 2050 and 2075. Individual model projections of average daily air temperature for 2075 produced increases above the 1928-2004 historic period that range from 3.8°F to 9.0°F for summer and from 1.4°F to 8.1°F for winter, when averaged across the stations in the study area. Precipitation changes were less consistent for each model and between models, with changes in seasonal precipitation in 2075

[1] Palmer, R.N. 2007. "Final Report of the Climate Change Technical Committee." A report prepared by the Climate Change Technical Subcommittee of the Regional Water Supply Planning Process, Seattle, WA.

[2] The three global climate models used are the GISS model from the Goddard Institute for Space Studies coupled with Special Report on Emissions Scenarios (SRES) emission scenario B1 ("warm" scenario), the ECHAM model from the Max Planck Institute for Meteorology coupled with SRES emission scenario A2 ("warmer" scenario), and the IPSL model from Institute Pierre Simon Laplace coupled with SRES emission scenario A2 ("warmest" scenario).

relative to the historic period ranging from -29 percent to +11 percent in summer and -6 percent to +48 percent in winter.

Using these datasets, UW-CIG ran hydrologic models that simulate snow accumulation, snow melt and runoff to create streamflow datasets for the major water supply drainage basins in the region. For the primary sites used to characterize inflows into the reservoirs, by 2075 the average of all models across all five basins compared to historic flows decrease by 37 percent during the summer and increase by 48 percent during the winter. SPU used the inflow data from these models to assess the impacts on available supply. In addition, SPU used the temperature and precipitation data to determine how peak season and annual water demands could change in the future under these scenarios.

The results of this assessment indicated that climate change could lead to reductions in supply ranging from 6 percent to 21 percent in 2050 and a possible 4 percent increase in demand under the warmest scenario. SPU identified a series of adaptation options and modeled how effective they would be in offsetting the reductions of supply. In two of the three scenarios in 2050, the adaptation offsets would fully compensate for the reductions in supply. In all of the scenarios there would be sufficient supply to meet demand if adaptation options were deployed.

Updated climate change analyses show less of an impact on water supply availability than previous studies because of the updates to assumptions to the firm yield estimates and lower forecasted water demands.

SPU's analysis was updated in 2011 to include the same assumptions used in the latest firm yield estimate, including the recently authorized higher refill level of 1563 feet for Chester Morse Lake, as well as the latest water demand forecast. This analysis is based on meeting water demands at 98 percent reliability after satisfying instream flow requirements and limiting diversions from the Cedar River according to the MIT Agreement, as described in the *2007 Water System Plan*. The analysis also assumes that an improved Chester Morse Lake Pump Plant and associated facilities would allow normal access to water stored between elevations 1538 and 1532 feet in Chester Morse Lake.

Under the three model scenarios, the impact of climate change on supply and demand would increase over time, with the greatest impact occurring with the warmest scenario. Assuming no change in system operations, available supply under the warmest scenario is estimated to be reduced by as much as 4 percent in 2025, 6 percent in 2050, and 13 percent in 2075. The reduced supply would exceed forecasted demand for all years. However, under the warmest scenario, average annual demand is estimated to increase by 1 percent in 2025, 2 percent in 2050, and 5 percent in 2075, assuming no change in forecasted demographics and no new

conservation programs to reduce this increase. Even so, the reduced supply would still exceed climate-impacted demands for all years except 2075, in which demand would exceed supply by approximately 3 percent.

For this scenario, SPU identified system modifications that could be pursued to mitigate the reductions in supply from climate change. These modifications are no or low cost options that would increase useable storage to capture more of winter runoff for release during the summer. These options include:

- Chester Morse Lake refilled to 1566 feet: current refill is to 1563 feet; adds more than 6,000 acre-feet or 11 percent more storage in the Cedar system with no new infrastructure and no change to water rights.

- South Fork Tolt Reservoir drawdown to 1690 feet: current minimum is 1710 feet; adds 7,500 acre-feet or 18 percent more storage in the Tolt system with no new infrastructure and no change to water rights.

- Overflow Dike at 1554 feet: crest is currently at 1550 feet; change would store 6,500 acre-feet in Chester Morse Lake, reducing seepage to the moraine and loss to the Snoqualmie River Basin. This option is under study as a repair alternative and would require modifications of existing infrastructure and amendments to the Cedar River Habitat Conservation Plan.

These system modifications would essentially restore supply to historic levels. Under the warmest scenario in 2075, the available supply with these system modifications would exceed forecasted climate-impacted demands by almost 10 percent if all modifications are made. Additional options to manage the impacts on supply may be possible through optimization of system operations.

The results of this analysis indicate that no new source of supply is needed before 2060 (the ending year of the official demand forecast) even when potential climate change impacts are considered. This updated evaluation shows less of an impact on water supply availability than previous studies because of the updates to assumptions to the firm yield estimates and lower forecasted water demands. Even so, future climate change could potentially increase the frequency of low reservoir levels and for requests to customers to curtail water use, depending on the system modifications that are implemented and the timing and magnitude of climate change impacts.

The above analysis does not assess the effect of climate change on several key factors that influence water resources and supply operations. For example, climate change impacts on water quality, particularly the frequency of high turbidity events and algal blooms that can be disruptive to supply operations, have not been evaluated but can reduce supply availability. Also, changes to the watershed forests and potential increases in fires have not been assessed, but could have a significant impact on hydrology and water quality. SPU's water supply could also be affected if climate change were to significantly delay the return of fall rains or lead to sustained droughts of longer duration than those experienced in the past. These issues are a sampling of topics for further research and analysis.

It is anticipated that some of these issues will be considered through SPU's next impacts assessment, which SPU will initiate in 2012. SPU is participating in a collaborative venture between Water Utility Climate Alliance members and climate researchers called Piloting Utility Modeling Applications (PUMA[1]). PUMA is intended to identify state of the art climate modeling tools and techniques to generate climate data that utilities can use to conduct impacts assessments and inform the development of adaptation strategies. In conducting its assessment through PUMA, SPU intends to use the next generation of climate data and will share the results of this assessment when it is finalized. Given the dynamic nature of climate research, SPU is committed to remaining engaged in future research, conducting new assessments on a periodic basis to identify potential impacts and system vulnerabilities, and planning for adequate water supply while ensuring that decisions do not result in unnecessary or premature financial and environmental costs for the region.

2.4.1.4 Future Supply Opportunities

While both the firm yield update and climate change analysis indicate that no new supply is needed well into this century to meet forecasted demand, the supply alternatives identified in the *2007 Water System Plan* remain as opportunities for SPU to consider should future forecasts indicate the need to develop a new supply source. Included in the list of alternatives is reclaimed water, and because new information is available, that alternative is discussed more fully here.

[1] For additional information about PUMA see: http://www.wucaonline.org/html/actions_puma.html

Over the past decade, SPU has engaged in several evaluations of providing reclaimed water as an alternative to its potable supply. None were implemented, however, because projects were either not cost-effective or not welcomed by the potential user.

With the Brightwater Treatment Plant, there is an opportunity for large volumes of reclaimed water to be distributed in the north part of the SPU service area. The Brightwater Reclaimed Water Backbone Project will be able to carry up to up to 9 mgd south to large non-potable water users in the Sammamish River valley, and about 12 mgd west to northern King County to the Ballinger Way portal. The Ballinger portal is at the very northern end of SPU's retail service area.

Knowing that King County is interested only in selling reclaimed water wholesale to potential retail distributors such as SPU, SPU conducted an economic analysis of the potential use and cost-effectiveness of distributing reclaimed water from the Brightwater portal to large irrigators and other potential users of non-potable water in the north part of SPU's retail service area. The analysis is summarized in *An Economic Analysis of the North Seattle Reclaimed Water Project* completed by SPU in 2010.

For the analysis, a total of 50 potential customers with 1.7 mgd of potential use were identified. Distribution of the reclaimed water would require 27 miles of pipeline plus pumping facilities at a cost of $87 million in initial capital improvements and $109 million in total life-cycle costs, as well as any on-property improvements. Both the supply and environmental benefits of this project were determined to be minimal.

The overall conclusion of the analysis was that the proposed North Seattle Reclaimed Water Project would not be a sound investment for the region due to high costs, a low level of benefits, and the availability of lower-cost alternatives for achieving comparable benefits.

2.4.2 Infrastructure Needs and Improvements

SPU maintains its water resources facilities for safe and reliable operation to ensure water supply is available for its customers. Several infrastructure improvement projects and operational studies have been identified to improve the reliability and flexibility of the existing water supply system. These projects and studies are described below.

2.4.2.1 Morse Lake Pump Plant Project

The Chester Morse Lake floating barge pump system is intended to be used to access water in storage when levels in the lake are below elevation 1538 feet. Pumping provides additional flow to the Masonry Pool and the Cedar River to meet customer needs and instream flow requirements.

The Morse Lake Pump Plant option selected for further analysis, design and implementation is a new floating pump system using purchased mobile diesel generators and additional channel improvements.

In recent years, maintenance work has been completed in an attempt to achieve operability and restore flow capacity of the pumping plants and associated facilities. This work included maintenance dredging of the channel, testing and replacing electrical cable, and making electrical mechanical safety improvements and repairs. Even with these improvements and repairs, concerns remain over the reliability and readiness of these facilities. Of particular concern is the long-term stability of the outlet channel and its flow capacity. Infilling of the outlet channel has resulted in the need to begin pumping operations sooner to supplement gravity flow to the Masonry Pool. Also of concern is the long lead-time needed to mobilize the pumping plants prior to actual use due to the need to rent and install mobile diesel generators that power the pumps. Up to two months are needed to ready the plants, which can lead to costly efforts that later prove to be unnecessary when the plants are then not subsequently needed or put to use.

SPU completed preliminary engineering and value engineering studies to evaluate options for repairing or replacing the current floating barge pump system. The Morse Lake Pump Plant option selected for further analysis, design and implementation is a new floating pump system using purchased mobile diesel generators and additional channel improvements. This project is currently in the implementation phase.

2.4.2.2 Overflow Dike Replacement

The existing Overflow Dike used to separate Cedar Lake from Masonry Pool has wooden flashboards with the tops at elevation 1550 feet. The top of the Overflow Dike structure is at elevation 1555 feet, with the invert of the dike notch at 1546 feet. The wooden flashboards were damaged in 2008 during a flood event. SPU will conduct an analysis to determine if a variable crest dam replacement for the flashboards would be beneficial. One benefit of a variable crest dam would be improved flood management by allowing a faster flood pocket recovery. A part of this analysis will include the evaluation of the potential benefits of having a higher elevation for the top of the flashboards, up to elevation 1554

feet. The additional four feet of elevation would be useful in allowing an earlier pool split, saving water in Cedar Lake and reducing seepage at Masonry Pool. The analysis will also include the environmental impacts of higher pool levels during the pool split period.

2.4.2.3 Refill of Chester Morse Lake to 1566

One of the projects evaluated as a part of the Operations and Optimization Study was raising the refill level of Chester Morse Lake to elevation 1566 feet. This analysis will be continued to further determine feasibility and costs. Just as raising the refill level to elevation 1563 feet added storage and resulted in an increase to firm yield, raising the refill level to 1566 is expected to do the same. The benefits of the higher refill could be optimized in conjunction with an increase in the Overflow Dike as described above. The feasibility analysis will also preliminarily investigate the impacts of the higher refill level on tributary habitat, flood management issues, moraine seepage and dam safety.

2.4.2.4 Landsburg Flood Passage Improvements

Since the Cedar River flooded in fall 1990, there have been concerns about flood debris, such as large trees uprooted during high flows, blocking the spillway gates at Landsburg Diversion Dam during major floods. SPU has completed new studies of large woody debris management since completion of the *2007 Water System Plan*, and this information will be used to update the evaluation of flood passage at the Landsburg Diversion Dam. SPU is in the process of reviewing the options for structural modifications of the Landsburg Dam and non-structural approaches that include increased log handling during storm events. Analyses have been completed on preliminary engineering and life-cycle cost analyses to improve the flood passage capabilities at the dam using modifications to existing spill gates, large woody debris handling upstream, and modifications to the south abutment to allow passage of the 500-year design storm. These approaches reduce the risk of overtopping of the dam during large flood events, which could potentially cause severe erosion of the embankments and place the dam at risk of failure and impede the delivery of water.

2.4.2.5 Lake Youngs Cascades Dam

Water stored in Lake Youngs is impounded by two earth embankments, the Outlet Dam to the south and Cascades Dam to the east, and the perimeter dikes around the lake. A third dam,

Inlet Dam, east of Cascades Dam, normally does not store water and was constructed as a backup embankment to retain the reservoir water in case of a failure of Cascades Dam, which shows signs of movement and is considered to be somewhat unstable. As noted previously, SPU plans to conduct further investigations and studies to determine the potential impact on water quality that could be caused by failure of Cascades Dam, particularly with respect to material existing in the area between Cascades Dam and the Inlet Dam.

2.4.2.6 South Fork Tolt Reservoir Studies

As noted in the *2007 Water System Plan*, there is potentially significant benefit to expanding the historical operating range of the South Fork Tolt Reservoir. SPU plans to conduct studies and analyses to increase the understanding of the constraints and environmental issues associated with South Fork Tolt Reservoir operations to support drawdown below elevation 1710 feet.

2.5 IMPLEMENTATION/ACTION PLAN

In the absence of a need to develop new water supplies for several decades, SPU's implementation/action plans in the Water Resources business area will focus on continuing conservation efforts, improving infrastructure reliability and operational flexibility to optimize existing supply, and pursuing additional work to assess climate change impacts. A summary of the implementation/action plan for the Water Resources business area is as follows:

- Reduce per capita water use from current levels so that total average annual retail water use of members of the Saving Water Partnership is less than 105 mgd from 2013 through 2018 despite forecasted population growth.
- Continue to implement water conservation efforts that help low-income customers in Seattle manage their water bills.
- Complete infrastructure and operational improvements:
  - Implement the Morse Lake Pump Plant Project to recover water from Chester Morse Lake during low water level conditions and other emergencies.
  - Investigate raising the Overflow Dike to elevation 1554 feet and using a variable crest dam for that purpose.

- Complete investigations that are required to determine if the Chester Morse Lake refill elevation can be raised to elevation 1566 feet.
- Implement the Landsburg Dam Flood Passage Improvements.
- Conduct further investigations to determine the potential impact on water quality that could be caused by failure of Lake Youngs Cascades Dam and potential improvements to mitigate this risk.
- Learn more about what level of additional drawdown the South Fork Tolt Reservoir can accommodate to support additional future supply.

- Remain engaged in future research on climate change by participating in the PUMA project, conducting new assessments on a periodic basis to identify potential impacts and system vulnerabilities, and planning for adequate water supply while ensuring that decisions do not result in unnecessary or premature financial and environmental costs for the region.

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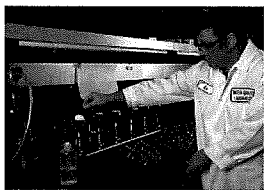
Chapter 3
Water Quality and Treatment



This chapter of the *2013 Water System Plan* focuses on the Water Quality and Treatment Business Area, which administers SPU's drinking water quality and treatment programs, projects, services, and capital assets from the supply source to the customers' taps. Key functions of this business area include managing SPU's drinking water regulatory compliance, oversight of the Tolt and Cedar Water Treatment Facilities and their contract operations, ensuring appropriate monitoring of water quality for regulatory and operational purposes, managing distribution system water quality, overseeing water quality and treatment related capital improvement projects, and participating in other water system projects that have the potential to impact water quality. The Water Quality and Treatment business area is unlike other business areas in that its programs affect infrastructure and practices in the Major Watersheds, Water Resources, Transmission and Distribution business areas. This chapter also includes descriptions of the drinking water regulatory requirements SPU must meet or exceed, as well as SPU's history of compliance.

SPU's water system includes two state-of-the-art water treatment facilities for the Cedar and Tolt source waters. The treatment facilities provide multiple barrier treatment processes to offer high levels of treatment prior to transmission and distribution.

3.1 Accomplishments Since 2007 WSP

Since completion of the *2007 Water System Plan*, SPU has implemented the following major improvements in the Water Quality and Treatment business area:

- Reservoir Covering/Burying: Reconstructed the following from open reservoirs to covered reservoirs to improve water quality, increase security, and create new public open space opportunities:
    - Myrtle Reservoir (2008)
    - Beacon Reservoir (2009)
    - West Seattle Reservoir (2010)
    - Maple Leaf Reservoir (2012)
- Kerriston Road: Purchased approximately 148 acres to increase control of lands accessed by Kerriston Road through the lower Cedar River Watershed, avoid future risk and costs associated with illegal trespass in and around the Cedar River Watershed, and reduce risk and liability costs associated with continuing residential build-out of the Kerriston community (2011).

- Laboratory Information Management System (LIMS): Implemented an updated LIMS system at SPU's Water Quality Laboratory to allow for efficient sample scheduling, coordination of analyses, recording of results, quality assurance/quality control tracking, and data retrieval (2007).
- Cross-Connection Control: Set up and installed a database for management of the cross-connection control program, which includes the oversight of over 20,000 backflow assemblies in the city (2009). The database made possible a new enforcement strategy implemented in 2011 which greatly improved compliance with backflow assembly testing requirements. The backlog of assemblies overdue for testing was reduced from fifteen percent down to four percent.

3.2 SERVICE LEVEL PERFORMANCE

SPU's service level in the Water Quality and Treatment business area focuses on meeting federal and state regulatory requirements. This is captured in a single service level objective and target for drinking water quality as shown in Table 3-1.

Table 3-1. SPU's Service Level for Managing Water Quality and Treatment Assets

Service Level Objective	Service Level Target
Promote a high level of public health protection and customer satisfaction with drinking water quality.	Meet all health-related and aesthetic regulations administered by the WDOH Drinking Water Program for the Seattle regional water system.

SPU's service level target is to meet health-related regulations (i.e., primary maximum contaminant levels and treatment requirements), aesthetic regulations (i.e., secondary maximum contaminant levels), and other aesthetic criteria (i.e., taste, and odor). SPU has been successful in meeting this service level. Since the *2007 Water System Plan* was developed, SPU met all drinking water regulatory requirements. SPU has a Reservoir Covering Plan approved by Washington State Department of Health (WDOH) that is being implemented ahead of schedule (see Section 3.3.6.1). More information on how SPU is meeting regulations is provided in the remainder of this chapter.

3.3 EXISTING FACILITIES AND PRACTICES

SPU's water system includes state-of-the-art water treatment facilities for the Cedar and South Fork Tolt source waters,

treatment and intake screening facilities at Landsburg, intake screening facilities at the Tolt Regulating Basin, and in-town disinfection facilities at reservoirs and well sites. Each of these facilities is operated and maintained to ensure that the potable water SPU delivers to its customers meets high public health and aesthetic standards.

To achieve its water quality and treatment service level, SPU has expended a great deal of effort over the past decades and continues to make concerted efforts in order to ensure compliance with WDOH drinking water regulations. SPU operates its facilities, monitors water quality at those facilities, and engages in a number of practices designed to bring safe, high-quality drinking water to its customers. This section summarizes SPU's record of regulatory compliance, identifies SPU's treatment facilities, and summarizes its operation and maintenance practices to ensure excellent water quality and a high level of customer satisfaction.

3.3.1 Regulatory Requirements and Compliance

Federal and state statutes and administrative regulations require the utility to meet certain water quality criteria and performance standards. The following subsections identify the standards and requirements that SPU must achieve and summarize SPU's performance in meeting those standards and requirements.

3.3.1.1 Total Coliform Rule

SPU has been well within regulatory requirements for coliform since the startup of the Cedar Water Treatment Facility in 2004.

The Total Coliform Rule requires monitoring to demonstrate that a water system is operating and maintaining its distribution system in a way that minimizes the risk of bacterial intrusion or regrowth. SPU collects required monthly samples from its retail service area distribution system and tests for coliforms, which are naturally present in the environment and are used as an indicator of whether other, potentially harmful, bacteria may be present. As system improvements, especially better disinfection facilities and covered reservoirs, have been implemented over recent years, Seattle's success in meeting the total coliform rule requirements have improved greatly.

As indicated by Figure 3-1, SPU has been continuously in compliance with the Total Coliform Rule. Since the startup of the Cedar Water Treatment Facility in August 2004, SPU has been well within the regulatory requirement of less than 5 percent of samples with detectable total coliform. The highest detection month since August 2004 was 2.1 percent, which occurred in July 2008.

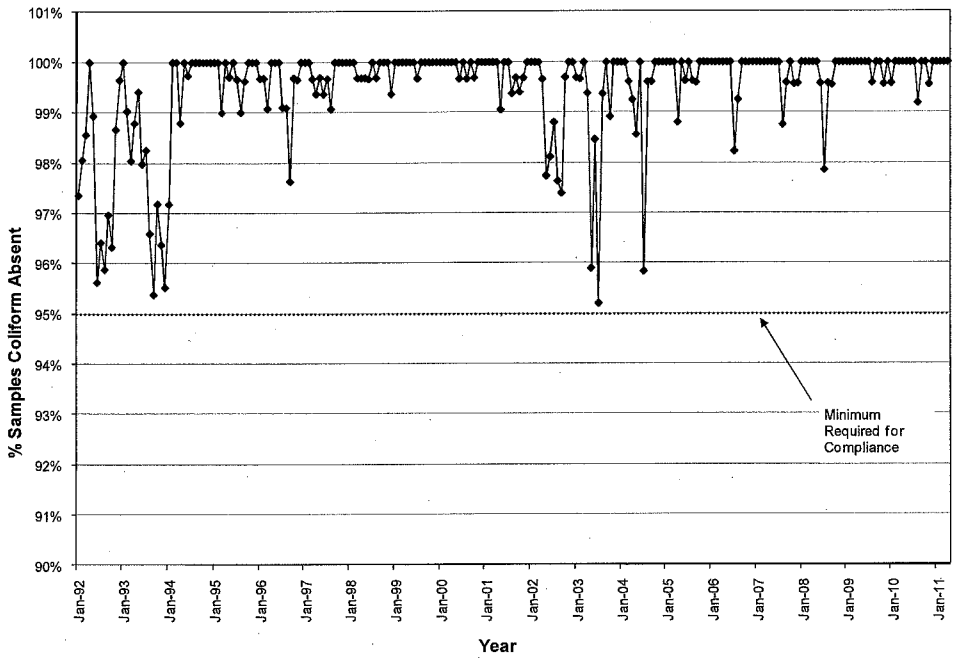


Figure 3-1. Monthly Coliform Data from SPU Water Distribution System

There have been over 15,000 coliform samples collected since January 2006. Of those 15,000 distribution samples, 27 have been positive for total coliform, and two have been positive for *E. Coli*. All follow-up sampling for the *E. Coli* positive samples showed no indication of contamination, and compliance with the Total Coliform Rule was met. Public notification was not required.

3.3.1.2 Surface Water Treatment Rule

The Surface Water Treatment Rule (SWTR) contains disinfection and filtration requirements for all public water systems that use surface water supplies. Several revisions to the original rule have been made since 1989, with the latest revision being the Long Term 2 Enhanced Surface Water Treatment Rule (LT2ESWTR).

Tolt Supply. With completion of the Tolt Water Treatment Facility in 2001, the supply from South Fork Tolt River must meet all the requirements of a surface supply using filtration and disinfection. The Tolt Water Treatment Facility operations contract includes water quality performance requirements that meet and, in most cases, exceed the regulatory filtration and disinfection requirements. The Tolt Water Treatment Facility has had no treatment violations since startup.

Cedar Supply. Construction of the Cedar Water Treatment Facility was completed in 2004. The Cedar River supply has a

regulatory designation known as a "Limited Alternative to Filtration" (LAF), which authorizes SPU to operate the Cedar source without filtration treatment. LAF status is granted because Cedar source water is produced from a watershed that is 100 percent in public ownership, with no residential, commercial or industrial development, and the treatment system employs a multi-stage disinfection process that provides greater protection against microbial contamination than can be provided by traditional filtration and chlorine disinfection. The Cedar supply continues to operate in compliance with the LAF criteria.

Like the Tolt Water Treatment Facility, the Cedar Water Treatment Facility operations contract includes water quality performance requirements that meet and, in most cases, exceed regulatory requirements. Since it began operating in 2004, the Cedar Water Treatment Facility has experienced no treatment violations.

Long Term 2 Enhanced Surface Water Treatment Rule. The LT2SWTR, focuses on controlling *Giardia* and *Cryptosporidium* in surface water supplies. This rule affects the Seattle water system in two ways: source monitoring for *Cryptosporidium* and covering of open distribution reservoirs. The source monitoring for *Cryptosporidium* is now complete. The results for both the Cedar and Tolt were in the lowest category (highest quality), so no changes are needed to the existing treatment provided.

The LT2ESWTR also requires that open, treated-water reservoirs be covered or provided with treatment on the outlet. SPU already had a reservoir covering plan approved by WDOH when the LT2EWTR was issued. SPU reaffirmed its covering plan with DOH in 2009. SPU's reservoir covering program is described in further detail later in this chapter.

3.3.1.3 Groundwater Rule

The Groundwater Rule was issued in November of 2006 and went into effect in 2009. SPU has not used its wells for production purposes since the rule has been in effect. SPU's wells draw from a deep aquifer that is well protected from contamination. When the Seattle Wells are next used, SPU's plan for compliance is to conduct triggered source water monitoring as necessary. While not part of the current regulatory compliance strategy, chlorine contact time for disinfection of viruses is achieved in the pipelines a short distance from the wells.

3.3.1.4 Disinfection By-Products Rule

In general, Seattle's high quality source water and upgraded treatment result in low concentrations of disinfection by-products (DBPs), such as trihalomethanes and haloacetic acids, by-products that can result from reactions between chlorine and natural organic matter. Trihalomethane and haloacetic acid monitoring results since 2006 are presented in Figure 3-2 and Figure 3-3. The results are all well below the regulatory limits. Historically, disinfection by-product levels have been relatively low in the Cedar River water. Disinfection by-product levels in the South Fork Tolt River water decreased substantially with startup of the Tolt Water Treatment Facility and are now comparable to those of the Cedar source.

SPU has completed the Stage 2 DBP Rule Initial Distribution System Evaluation (IDSE) sampling program that identified sites in the distribution system where the highest disinfection by-product levels were likely to be found. Based on IDSE testing results, SPU does not anticipate any difficulty meeting the by-product limits under the new rule.

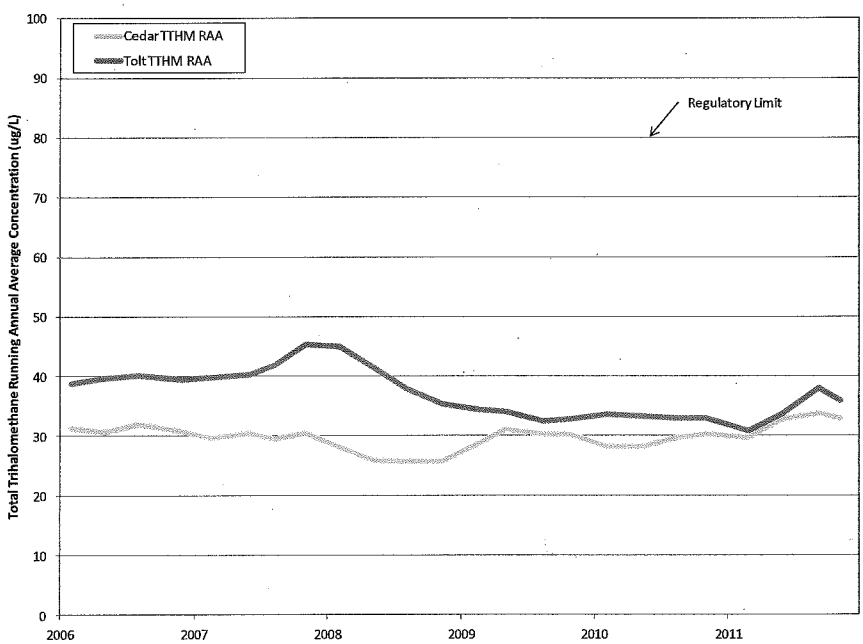


Figure 3-2. Trihalomethane Concentrations, 2006 to 2011

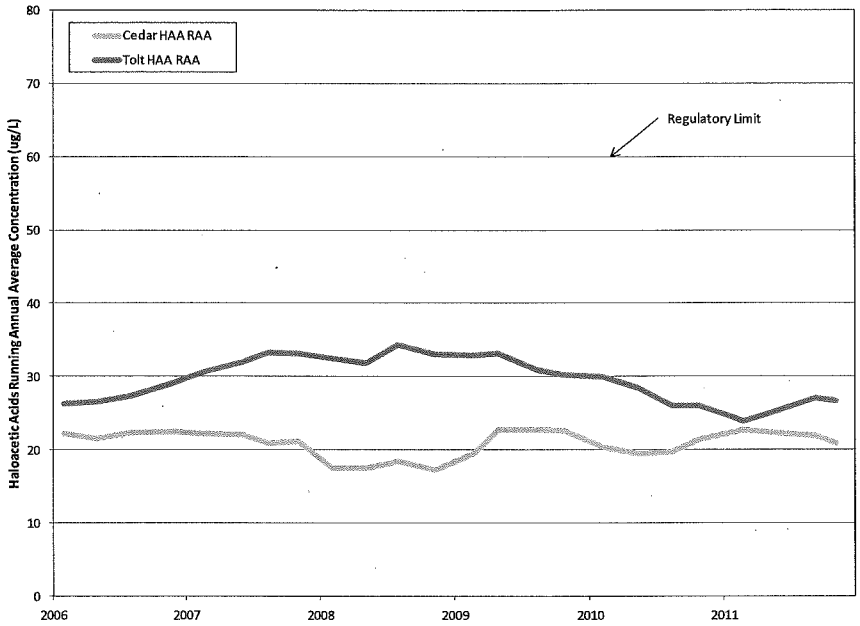


Figure 3-3. Haloacetic Acid Concentrations, 2006 to 2011

3.3.1.5 Lead and Copper Rule

Seattle's source and distribution water contains no significant amounts of lead or copper. Household plumbing, however, is often made of copper, and household systems can include components containing lead, such as lead-tin solder and leaded-brass fixtures. These components can leach lead and copper into the water.

Beginning in 2005, compliance for Seattle's Regional Lead and Copper Monitoring Program was divided into sub-regions. Compliance for Seattle has been based on samples collected from the Seattle direct service area only since 2005. Compliance for the other sub-regions (Bellevue, Tolt Wholesale, and Cedar Wholesale) is based on results from those sub-regions.

The Lead and Copper Rule requirement is to be below 15 ug/L for lead, and below 1,300 ug/L for copper, with both at the 90th percentile. Seattle's 90th percentile lead levels since 2005 have been between 5.0 to 6.4 ug/L, well below the lead action level. For copper, Seattle's 90th percentile levels have been between 120 to 160 ug/L. These levels have allowed Seattle to conduct reduced monitoring for lead and copper. Fifty samples are now collected once every three years from qualified homes in the Seattle direct service area. The next sampling period for the Seattle subregion will occur in 2013.

3.3.2 Other Water Quality Monitoring

SPU conducts a range of other regulatory and non-regulatory water quality monitoring throughout the water system.

Source Monitoring. SPU conducts source monitoring for hundreds of potential contaminants, including inorganic chemicals, volatile organic chemicals, synthetic organic chemicals, and radionuclides. None of the Seattle water sources have had chemical concentrations near the compliance limits for any of these contaminants.

Open Reservoir Monitoring. SPU operates, maintains, and monitors its open reservoirs in accordance with a WDOH-approved open reservoir protection plan, discussed later in this chapter.

Closed Storage Monitoring. Throughout the year, SPU monitors the quality of water within covered storage facilities as part of its routine water quality monitoring program. The information guides system operations, reservoir turnover, spot disinfection, and decisions about when to take facilities out of service for cleaning or other actions.

Taste and Odor Sampling. Taste and odor testing is conducted at least bi-weekly by a trained flavor profile analysis panel at SPU. The testing monitors and characterizes changes in tastes and odors associated with the source waters and distribution reservoirs, especially the open reservoirs. The test data are used to ensure source treatment performance criteria are met and to inform operators about the need to take reservoirs out of service, increase reservoir turnover, overflow reservoirs, or blend sources of supply.

Emerging Contaminants. Emerging contaminants are not regulated, they are generally new to drinking water scientists, and there is typically limited information about their occurrence and health effects. EPA requires water systems to perform monitoring for some of these contaminants in order to learn about their occurrence. In addition, SPU has chosen to test for other emerging contaminants for its own information and to inform the public. Details of this monitoring are described later in this chapter.

Miscellaneous Monitoring. SPU also conducts extensive water quality monitoring at the Landsburg Diversion on the Cedar River, Chester Morse Lake, Lake Youngs, the Tolt Reservoir, and the Tolt Regulating Basin. Nutrients, algae, and other basic chemical and physical parameters such as pH, temperature, total organic

carbon, ultraviolet absorbance, dissolved oxygen, reservoir stratification, and visibility throughout the water column are monitored. This water quality information is used to better understand the conditions in the water bodies, to learn about potential shifts or changes with significance to the drinking water supply, and to inform decisions about water treatment and other system operations.

3.3.3 Source Water Protection Programs

SPU's finished water quality is excellent, in part, because of SPU's substantial efforts to protect its water sources. Those source protection efforts are described below.

3.3.3.1 Watershed Protection

By owning almost all of the land in the Cedar Watershed and 70% of the Tolt Watershed, SPU maximizes source water protection.

The primary tool for maintaining source water quality is Seattle's extensive watershed ownership, which allows SPU to restrict human access and activities within the watersheds. SPU has adopted watershed protection programs for the Cedar River and South Fork Tolt River Municipal Watersheds, including the Lake Youngs Reservation, to ensure that SPU's source water remains of high quality and free from contamination. These programs are described in SPU's *Watershed Protection Plan*, which details SPU's ongoing efforts to control activities that have the potential to adversely affect water quality in both of its surface water supplies. The latest Plan was approved by WDOH in 2011.

3.3.3.2 Wellhead Protection

While the two municipal watersheds supply nearly all of Seattle's raw drinking water, Seattle supplements its drinking water supplies with groundwater from the Riverton well field and the Boulevard Park well, located in SeaTac. As part of the *2001 Water System Plan*, SPU prepared and WDOH approved a wellhead protection program, including an inventory of potential contaminants. The program has not changed since 2001, except for the updates to the potential contaminant inventory completed every other year. After each update is completed, notification letters are sent to businesses handling or storing potential contaminants within or near the wellhead protection area, as well as to agencies that have influence over activities in the wellhead protection area, including King County Department of Natural Resources and Parks, Groundwater Protection Program. These letters contain maps of the wellhead protection area boundaries and steps that businesses can take to protect the groundwater supply from contamination.

3.3.4 Source Water Quality Summary

Water quality characteristics of the raw water from each of SPU's sources, including its three wells, are shown in Table 3-2.

Table 3-2. Water Quality Characteristics of SPU's Source Water 2007-2011

Surface Water Sources	Cedar River/Landsburg		Cedar River/Lake Youngs Outlet		South Fork Tolt River/Regulating Basin	
Parameter and Unit	Average	Typical Range	Average	Typical Range	Average	Typical Range
Turbidity, NTU	0.8	0.2 – 2.0	0.4	0.2 – 1.0	0.7	0.2 – 2.2
Temperature, °C	9	5 - 13	12.4	6 - 20	8.7	3 - 14
pH	7.6	7.3 – 7.9	7.7	7.1 – 8.5	7.4	7.0 – 7.8
Alkalinity, mg/L as $CaCO_3$	22	14 - 30	19	16 - 25	6.6	5.0 – 7.0
Conductivity, umhos/cm	55	36 - 75	57	48 - 70	23	20 - 25
UVA (@254 nm), cm-1	0.025	0.01 – 0.05	0.017	0.01 – 0.023	0.05	0.04 – 0.06
Total Organic Carbon, mg/L	0.75	0.4 – 1.1	0.8	0.6 – 1.0	1.3	1.1 – 1.6
Total coliform, per 100 mL	310	40 - 700	660	0 - 2400	53	1 - 225
Fecal coliform, per 100 mL	10	0 - 23	<1	0 - 3	<1	0 - 2

Groundwater Sources	Boulevard Well		Riverton Wells	
Parameter and Unit	Average	Typical Range	Average	Typical Range
Temperature, °C	11	10 - 12	10	9 - 11
pH	7.0	6.8 – 7.1	7.8	7.7 – 7.9
Alkalinity, mg/L as $CaCO_3$	143		85	83 - 87
Hardness, mg/L as $CaCO_3$	148		107	
Conductivity, umhos/cm	313		243	241 - 245

Contaminants of concern that have been identified in the wells include radon in all of the wells and trace levels of dacthal mono- and di-acid degradates in the Riverton Wells. Radon is a naturally-occurring element found in groundwater sources. Dacthal is an active ingredient in herbicides and is found in soils wherever it is used. These contaminants are currently not regulated by the EPA.

3.3.5 Source Treatment Facilities

As described below, treatment facilities located at both surface water sources and at the well locations are operated to provide high-quality finished water to the regional system.

3.3.5.1 Cedar Supply Treatment Facilities

SPU operates two facilities to treat Cedar River source water, the Landsburg Water Treatment Facility and the Cedar Water Treatment Facility.

Landsburg Water Treatment. At the Landsburg Water Treatment Facility, SPU fluoridates and chlorinates the Cedar

supply. Prior to the construction of the Cedar Water Treatment Facility at Lake Youngs in 2004, the Landsburg Water Treatment Facility was the primary disinfection site for water from the Cedar River watershed. The chlorine addition at Landsburg now serves to minimize microbial growth in the transmission pipeline between Landsburg and Lake Youngs and to aid in the control of new organisms (e.g., algae from Chester Morse Lake) entering Lake Youngs.

The Cedar Water Treatment Facility uses ozone, UV, and chlorine applied in series to ensure inactivation of Giardia, Cryptosporidium, and viruses.

Cedar Water Treatment Facility. The Cedar Water Treatment Facility uses ozone, UV, and chlorine applied in series to ensure inactivation of *Giardia*, *Cryptosporidium*, and viruses. The ozone process also improves the taste and odor of the water from this source. Lime is added at the facility in order to reduce the corrosivity of the water to in-premise plumbing. The new facility has a capacity of 180 mgd.

The Cedar Water Treatment Facility is operated under contract by CH2M HILL OMI with oversight from SPU. The operations contract began in late 2004. In both 2019 and 2024, the 15- and 20-year marks of the contract, SPU will have the option to renew the existing contract for 5 more years, hire another operations contractor, or use SPU staff to operate the treatment facility.

3.3.5.2 Tolt Water Treatment Facility

A 120-mgd ozonation and direct filtration treatment facility for the South Fork Tolt River water began operation in 2001. The facility also provides fluoridation, chlorination, and adjustment of pH and alkalinity for corrosion control.

The Tolt Water Treatment Facility is operated by American Water / Camp Dresser & McKee with oversight from SPU. The 15-year operations contract began in 2001. In 2016 and 2021, SPU will have the same 5-year contract renewal options as it has for the Cedar Water Treatment Facility.

3.3.5.3 Well Field Treatment Facilities

Both well locations include sodium hypochlorite disinfection to provide chlorine residual in the distribution system, fluoridation, and sodium hydroxide addition for corrosion control. Although sodium hydroxide addition is not required, it makes the well water quality more consistent with that of treated water from the Cedar River, with which it is normally blended before delivery to SPU customers. Treatment of well water is maintained under normal circumstances, though for emergency supply the wells could be

started and run for a short period of time prior to startup of the treatment systems.

3.3.5.4 Condition of Source Treatment Facilities

The Tolt Water Treatment Facility produces water comparable in quality to that of the Cedar.

Because of their recent construction, the Cedar and Tolt Water Treatment Facilities are both in excellent condition. Condition assessment of the major equipment is performed on an annual basis and preventative maintenance is ongoing. No major equipment replacement is currently planned. Equipment at the well treatment sites is generally in very good condition. Some components with shorter lifespan have been replaced as needed, but no major replacements are planned.

The older Landsburg Water Treatment Facility is outdated, and SPU is in the process of implementing an alternative to replace the building and upgrade the SCADA systems. In addition, the decision has been made to replace the existing chlorine feed system with sodium hypochlorite for risk management purposes.

3.3.5.5 Overall Finished Water Quality

The water quality characteristics of treated water as it enters SPU's transmission system are shown in Table 3-3.

Table 3-3. SPU's Finished Water Quality Characteristics

Surface Water Sources	Cedar/Lake Youngs (2007-2010)		Tolt River (2007-2010)	
Parameter and Unit	Average	Typical Range	Average	Typical Range
Turbidity, NTU	0.4	0.2 – 0.9	0.06	0.04 – 0.10
Temperature, °C	12.7	5 – 22	9	3.5 – 15
pH	8.2[a]	8.0 – 8.4	8.2[a]	8.0 – 8.4
Alkalinity, mg/L as $CaCO_3$			19[a]	18 – 20
Conductivity, umhos/cm	67	55-77	61	56-66
UVA (@254 nm), cm^{-1}	0.010	0.007-0.013	0.012	0.010-0.014
Chlorine residual, mg/L	1.5[a]	1.4 – 1.7	1.5[a]	1.4 – 1.6

Groundwater Sources	Boulevard Park Well (2000-2010)[b]		Riverton Wells (2000-2010)[b]	
Parameter and Unit	Average	Typical Range	Average	Typical Range
Temperature, °C	12	10 - 14	11	9 - 12
pH	8.25[a]		8.25[a]	
Alkalinity, mg/L as $CaCO_3$	112		80	
Conductivity, umhos/cm	330	285 - 362	218	206 - 255
Chlorine residual, mg/L	1.0[1]		1.0[a]	

[a] Treatment target or criterion

[b] Wells are used infrequently, so data set is relatively small.

3.3.6 In-Town Storage Facilities

SPU operates several water storage facilities downstream of its Cedar and Tolt Water Treatment Facilities, including open reservoirs, covered reservoirs, and standpipes and elevated tanks. SPU operates these facilities to ensure that water quality within the distribution system is protected. SPU has established a regular program of inspections for the open and closed reservoirs and reports the results of the surveys to WDOH upon request.

3.3.6.1 Reservoir Covering/Burying

SPU is nearing completion of its open reservoir covering program. The approach for covering the open reservoirs has remained closely on track with that outlined in the *2007 Water System Plan,* and has focused on replacing SPU's open reservoirs with new buried structures to improve water quality, increase security, and create new public open space opportunities. Although new park space will be a feature at many of the new buried reservoir sites, the paramount purpose of these sites remains as the storage and distribution of city water supplies and the safety of the drinking water. The replacement projects represent a significant amount of work. Table 3-4 summarizes the covering program and completion dates.

Table 3-4. Schedule for Covering or Upgrading In-Town Open Reservoirs

Reservoir	Open Reservoir Size (million gallons)	Covered Reservoir Size (million gallons)	Completion
Bitter Lake	21.5	21.3	2001[a]
Lake Forest Park	60	60	2003[a]
Lincoln	20	12.7	2006
Myrtle	7	5	2008
Beacon	61	50	2009
Roosevelt	50	0[b]	2015[b]
West Seattle	68	30	2010
Maple Leaf	60	60	2012
Volunteer	20	0 or 10[b]	2015[b]
Total	**367.5**	**239 (or 249)**	

[a] Floating cover replacement options, including buried storage, will be evaluated at end of useful life of floating cover (i.e., in about 10-15 years).

[b] Roosevelt and Volunteer Reservoirs are planned to be removed from service following the completion of the new buried Maple Leaf Reservoir—see text below for more information. Roosevelt is shown here as decommissioned, and Volunteer is shown as either decommissioned or downsized to 10 MG.

Construction of the new buried Maple Leaf Reservoir is planned to reach substantial completion in 2012. The only two remaining open reservoirs (Roosevelt and Volunteer) are planned to be removed from service following the completion of Maple Leaf Reservoir. They will remain out of service for several years to gain operational experience, and to confirm analytical conclusions that system reliability will not be affected by their decommissioning.

Why did we have to cover the reservoirs?

Federal regulations require that all treated drinking water reservoirs be covered. SPU installed floating covers on two reservoirs, and is replacing its other open reservoirs with underground structures that both improve the quality and security of our water system and provide 76 acres of new open space for everyone to enjoy.

3.3.6.2 Open Reservoir Protection Plan

In order to ensure that the quality of treated water is not diminished during its residence in open reservoirs, SPU operates and maintains its open reservoirs in accordance with a WDOH-approved, open reservoir protection plan. This plan includes provisions for reservoir maintenance and operation, security, water quality monitoring at locations within the reservoir itself and just downstream of the chlorine addition, follow-up actions, and emergency response.

3.3.6.3 Water Quality Enhancements at Storage Facilities

Some of SPU's enclosed storage facilities were constructed with a common inlet and outlet, or were otherwise designed without considering the optimal water flow conditions needed to maintain water quality by avoiding stagnant conditions. When major maintenance or upgrades are performed on tanks and standpipes, such as interior painting, SPU has been making modifications to improve water-quality management. Upgrade methods include separation of inlets and outlets, installation of mixing systems, multiple level sample taps, and sodium hypochlorite injection points. The completed Myrtle Tank project included separation of the inlet and outlet piping as well as sample taps at multiple levels. The ongoing Richmond Highlands Tank project has a mixing system and multiple sample taps as part of the design.

3.3.6.4 In-Town Reservoir Treatment

Additional chlorination is provided at some of SPU's in-town storage reservoirs to ensure that chlorine residual is maintained in the drinking water supply until it reaches customer taps. SPU's addition of filtration treatment on the Tolt supply back in 2001 along with the reservoir covering program that is now nearing completion have reduced the amount of chlorine addition in the distribution system previously necessary. In most cases, the treatment involves addition of sodium hypochlorite to increase the residual chlorine. At some reservoirs, hypochlorite is generated

on-site, while at other reservoirs it is delivered to the reservoir site. Open reservoirs that were using chlorine gas have been converted to sodium hypochlorite, except in one case where the facility is scheduled for decommissioning. All of the hypochlorite and chlorine gas equipment is in good condition. A list of the chlorination facilities is provided in the treatment facilities inventory in the appendices.

3.3.7 Operations

SPU operations ensure that its customers receive high-quality drinking water.

SPU undertakes a number of activities to ensure that its customers receive high-quality drinking water. Operations activities include water quality monitoring, preventing or eliminating cross connections, responding to customer complaints, storage reservoir cleaning, testing and flushing watermains, and maintaining transmission pipeline water quality. Each activity is summarized below.

3.3.7.1 Comprehensive Water Quality Monitoring Plan

A comprehensive monitoring plan was updated in 2011 and is included as an appendix. The Comprehensive Water Quality Monitoring Plan covers the entire water system, from the watersheds through the transmission and distribution systems to the customer taps. The monitoring plan addresses the following:

- Monitoring requirements under state and federal drinking water regulations.
- Future regulations, which are currently under development at the federal level.
- Non-regulatory monitoring, which SPU conducts for informational purposes and to assist in operating the water system.
- Sampling procedures.
- Managing laboratory information.
- All parameters, locations, and frequency of monitoring conducted by SPU.

3.3.7.2 Cross-Connection Control Program

SPU implements a cross-connection control program in order to protect the quality of the water supply from cross connections. Within Seattle and the retail service area south of Seattle, SPU's

cross-connection program is a joint undertaking with Public Health Seattle-King County (PHSKC). Within the City of Shoreline, SPU works with Shoreline city staff members. The program includes elements to isolate and disconnect cross-connections both within the customer's premises and at the service connection. The cross-connection control policy and procedures were included with the *2007 Water System Plan.*

Under the cross-connection control program, SPU oversees more than 20,000 backflow assemblies owned by customers within SPU's retail service area. In 2009, SPU implemented a new database for management of the cross-connection control program. This database has enabled staff to more efficiently and more accurately ensure that these backflow assemblies are protecting the drinking water supply. The database made possible a new enforcement strategy implemented in 2011 which greatly improved compliance with backflow assembly testing requirements. The backlog of assemblies overdue for testing was reduced from fifteen percent down to four percent

3.3.7.3 Customer Complaint Response

SPU has procedures for responding to complaints and problems reported by its retail customers about drinking water quality. The vast majority of complaints concern discolored water. Discolored water comes from internal pipe rust and sediment getting stirred up. It is an inconvenience, but does not represent contamination of the water supply. From 2006 to 2010, an average 1,500 water quality complaints were received per year. This is for a customer base of 188,000 connections. Figure 3-4 shows the breakdown of the types of complaints for that period.

SPU retail customers with water quality concerns, water service problems, or questions contact the SPU Call Center during normal business hours and the SPU Operations Response Center after hours and on the weekends. Calls that involve water quality concerns or that identify high priority problems–calls that concern public health issues or safety risks–are passed on to an inspector who will investigate the problem until it is resolved.

The process for receiving complaints puts the customer in immediate contact with SPU staff and provides SPU with up-to-date knowledge of where the complaints are coming from, the nature of the complaints or problems, and how many calls are being received from a given area of Seattle. SPU logs the complaint information in a computer system and is able to bring these complaints up on a map for further analysis. Because the

cause of a problem is usually not known at the time a complaint is called in, improvements are planned to allow revision of complaint data after follow up with the customer so that if the probable cause of the problem is determined, it can be noted and tracked.

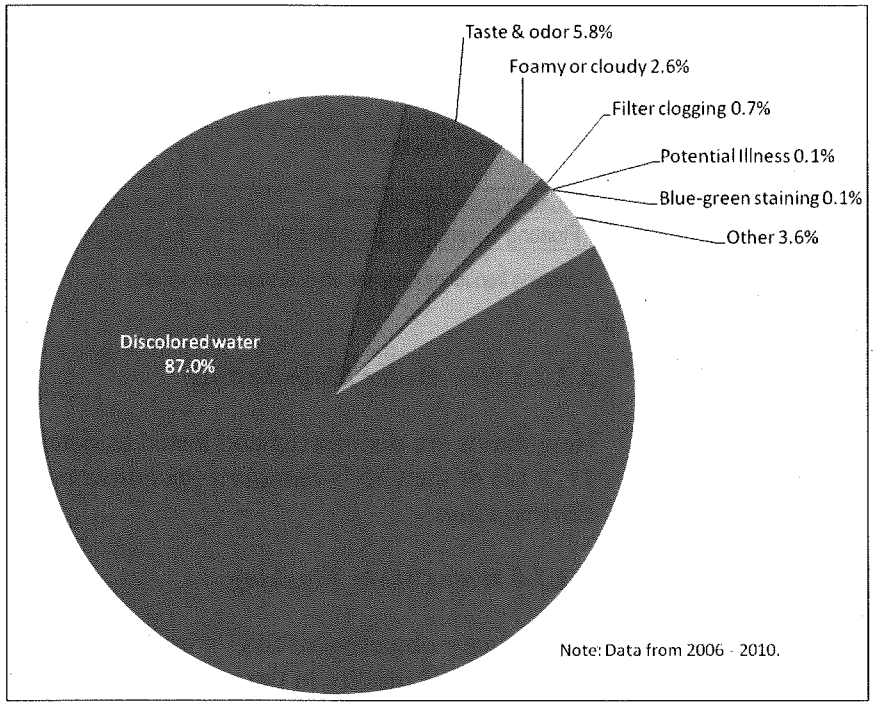


Figure 3-4. Types of Water Quality Complaints

3.3.7.4 Transmission and Distribution Storage Facility Cleaning

A key to maintaining water quality after the treated water enters the transmission and distribution system is making sure that storage facilities are regularly cleaned. SPU ensures its in-town, open reservoirs are drained and cleaned at least annually. SPU monitors water quality analytical results and customer complaints to identify trends that would indicate more frequent cleaning is necessary. Currently, Roosevelt Reservoir is scheduled for cleaning in the spring, and Volunteer Reservoir is scheduled for cleaning in the fall. Cleaning employs high-pressure washing equipment to remove algae and debris buildup; then the facilities are disinfected and sampled before they are put back into service.

SPU also ensures that its enclosed storage facilities are regularly cleaned to ensure water quality protection. SPU's approximate cleaning frequency for closed storage facilities is shown in Table 3-5. These cleaning frequencies may be adjusted based on inspections. Facilities that store Cedar water are on a more

frequent cleaning schedule than those that receive Tolt water because the Cedar supply is not filtered.

Table 3-5. Closed Storage Cleaning Schedule

Type of Reservoir	Frequency of Cleaning
Elevated tanks or standpipes	3-5 years - Cedar supply and/or if interior coating is in poor condition 10-15 years - Tolt supply
Hard-covered reservoirs	3 -5 years - Cedar supply Variable - Tolt supply[1]
Floating covered reservoirs	Variable – Tolt supply[1]
Floating covers (top of cover only)	1 time per year

[1]Cleaning frequency depends on dive inspection results.

3.3.7.5 New Water Main Testing

New mains are disinfected and tested as detailed in Section 7-11.3(12) of the City's *Standard Specifications for Municipal Construction.*

3.3.7.6 Water Main Flushing

The primary objective of SPU's water main flushing program is to improve water quality in the water distribution system and to reduce customer complaints regarding discolored water and unacceptable taste and odor. There is currently a two-person crew dedicated to water main flushing. SPU is planning to review its flushing practices and its level of resources allocated to flushing.

3.3.7.7 Water Quality in Transmission Lines

Large-diameter transmission pipelines composed of metal (e.g., steel, ductile iron, cast iron) are often lined with cement mortar to prevent corrosion and deterioration of the metal pipe wall. Cement lining of pipelines can cause the pH in the water to increase (i.e. the water to become more alkaline or basic) when a section of pipeline is taken out of service for repair or maintenance but kept full of water. Although pH is typically not a health issue, unless it becomes extremely low or extremely high, customers may find that water with moderately elevated pH tastes or feels different than that to which they are accustomed. Higher pH can also decrease the effectiveness of chlorine for disinfection. Additional customer concerns could include loss of aquarium fish or adverse impacts on commercial and industrial facilities.

The EPA-recommended lower and upper values for pH are 6.5 and 8.5, respectively. For the temporary situations where water in transmission lines exhibits elevated pH, SPU established the following guidance:

- Water with pH up to 9.5 can be sent to the distribution system.
- If water in the pipeline has pH above 9.5, the pipeline will be flushed.
- In emergency circumstances, the SPU Director may allow the pH 9.5 limit to be exceeded.

If future experience shows that the upper pH limit of 9.5 is inappropriate, this guideline will be revised.

3.3.8 Water Treatment Infrastructure SAMP

SPU has developed a strategic asset management plan (SAMP) for its water treatment facilities, including in-town disinfection facilities. This SAMP describes the infrastructure, their operations and maintenance, relevant service levels, repair and replacement needs, data needs, and other relevant asset information. Relevant information from the SAMP has been included in this chapter.

3.4 Needs, Gaps, and Issues

In the past decades, SPU has made significant strides towards ensuring that its water is of the highest quality while meeting current and future regulations. In particular, SPU's recent completion of the Tolt and Cedar Water Treatment Facilities has significantly improved SPU's water quality. In addition, SPU's recent and planned activities to cover, bury, or decommission its open reservoirs also demonstrate SPU's efforts towards ensuring excellent water quality in its system.

There are always new challenges for SPU to confront as it strives to meet its high standards for drinking water quality. The following sections summarize the needs, gaps, and issues facing the Water Quality and Treatment business area and describe SPU's plans to address them.

3.4.1 Future Regulatory Changes

The federal government is expected to pass a number of new water quality regulations over the next several years. These include the revised total coliform rule, the radon rule, and revisions to the lead

and copper rule. These future regulations and their expected impacts on SPU are summarized in Table 3-6.

As noted in Table 3-6, the proposed radon rule and the revisions to the total coliform rule and lead and copper rule could have minimal to moderate impacts on SPU's infrastructure and practices. Since the final form of the proposed rules and revisions and their impacts are still unclear, SPU plans to stay informed on the status of the rules. As the rules become clearer, SPU will develop comprehensive action plans to address any potential issues that arise.

Table 3-6. Future Regulations and Impact on SPU

Regulation or Issue	Provisions	Impact or Consideration
Total Coliform Rule Revisions/ Distribution System Rule	Proposed rule would change the MCL for total coliform to a trigger level for follow up investigation and action. Other distribution water quality issues are further out on the regulatory horizon.	Existing SPU practices generally address the proposed approach regarding coliform.
Radon Rule	Proposed both an MCL of 300 pCi/L and Alternative MCL of 4,000 pCi/L. Proposal was made in 1999 with little known action since that time.	Seattle wells would require treatment or blending prior to supplying customers to comply with MCL, but they are currently below Alternative MCL. Blending would likely be the more economical alternative, but a final decision would need to be supported by a more detailed analysis. No radon detected in Tolt or Cedar.
Lead and Copper Rule: Long-Term Revisions	Likely to address lead service lines. Possible changes to optimal water quality parameters and sampling sites. May include schools.	Full impact of revisions not clear at this time. Some adjustment may be needed to monitoring plan and schedule. Lead service lines not used in Seattle.

3.4.2 Emerging Contaminants of Concern

Emerging contaminants are not regulated, they are generally new to drinking water scientists, and there is typically limited information about their occurrence and health effects. Understanding the significance of emerging contaminants can be difficult and complex given that lack of clear data. EPA takes on emerging contaminants primarily through the Contaminant Candidate List and the Unregulated Contaminant Monitoring Rule. In addition, SPU has made its own efforts in regard to some

emerging contaminants in order to better understand the quality of SPU's water supply.

3.4.2.1 Contaminant Candidate List

The majority of the CCL contaminants present relatively low concern to SPU.

The Safe Drinking Water Act directs EPA to publish a Contaminant Candidate List (CCL) every 5 years and EPA finalized the third list (CCL3) in 2009. It includes 104 chemicals or chemical groups and 12 microbiological contaminants. These contaminants occur or are anticipated to occur in public water systems. Contaminants on the CCL3 are not currently regulated and the list does not impose requirements on public water systems. EPA uses the list to prioritize research and data collection efforts to help determine if a contaminant should be regulated. Regulatory determinations must be made on at least 5 of the contaminants every 5 years.

Since SPU published its *2007 Water System Plan*, EPA determined in July 2008 that no regulatory action was necessary for eleven of the CCL2 contaminants, including the dacthal mono- and di-acid degradates, which had been detected previously at very low levels in the Riverton Wells. One microbial contaminant Mycobacterium Avium Complex (MAC) was listed on CCL2 and remains on CCL3.

Over the past several years endocrine disrupting chemicals (EDCs) and pharmaceuticals and personal care products (PPCPs) have been of concern nationally and are included on CCL3. EDCs and PPCPs include prescription drugs, hormones, preservatives in cosmetics, and other personal care product chemicals that have been detected in water supplies located downstream of wastewater discharges. None of SPU's water sources are downstream of any wastewater discharges, so these contaminants are not of concern to SPU drinking water quality. More information on PPCPs is provided below.

The majority of the CCL3 contaminants present relatively low concern to SPU because of its excellent source protection practices, state-of-the-art water treatment facilities, and distribution system practices. SPU will continue to stay up to date on EPA regulatory determinations as well as participate in or stay informed on related studies and national occurrence of emerging contaminants.

3.4.2.2 Unregulated Contaminant Monitoring Rule

The Unregulated Contaminant Monitoring Rule (UCMR) is EPA's program for gathering public water system data on contaminants without current health based standards. Monitoring results are used for determination of future drinking water regulations. EPA requests or requires participation from a utility, depending on its size.

The UCMR monitoring rounds occur on a 5-year cycle, is largely based on the CCL, and the list may contain no more than 30 contaminants. SPU participated in UCMR 1 (conducted 2001-2005) and UCMR 2 (conducted 2007-2010). As a system serving more than 10,000 people, SPU and its wholesale customers are required to participate in UCMR 3 as well. The list of contaminants for UCMR 3 contains several categories of compounds that are unlikely to occur in our system given our protected source water. This includes seven hormones, six perfluorinated compounds, five metals, and seven VOCs.

For UCMR 3, SPU will collect quarterly samples at entries to the distribution system (treated Tolt and Cedar water) for a 12-month period sometime between 2013 and 2015. Distribution system samples are also required for UCMR 3 at the same frequency.

3.4.2.3 Chromium

SPU has routinely tested for total chromium (the combined total of chromium-0, chromium-3 and chromium-6) at the source and in the distribution system. In the past, SPU has not tested specifically for chromium-6, because there is no maximum contaminant level (MCL) for chromium-6, SPU's source waters have no adjacent industrial activities that would introduce chromium-6, and no reportable levels of total chromium have been found in SPU's water. The current MCL for total chromium is 100 ug/L. The naturally occurring background levels of total chromium in SPU's water range from non-detectable to 1.0 ug/L, with average results near our minimum detection limit (MDL) of 0.2 ug/L using EPA Method 200.8.

In March 2010, EPA announced that it had initiated a reassessment of chromium and published a draft human health assessment for chromium-6 in September 2010. The risk assessment should be finalized in 2011. On a related note, the California Office of Environmental Health Hazard Assessment (COEHHA) proposed a health goal for chromium-6 of 0.06 ug/L in August 2010 and

subsequently proposed an even lower health goal of 0.02 ug/L on December 31, 2010.

Given the current level of review and discussion for potentially revising the chromium standard, EPA has provided guidance on voluntary, though strongly encouraged, monitoring for chromium-6. Recommendations included sampling quarterly at source and distribution locations currently sampled for Disinfection By-products Rule (DBP) Stage 1 and 2 testing. This would be approximately 8 quarterly samples for SPU.

With respect to testing, the standard method for total chromium analysis in drinking water has MDL's that are well above the potentially low-level (COEHHA) goal. The SPU laboratory MDL for total chromium using EPA Method 200.8 is 0.2 ug/L. EPA method 218.6 has a more sensitive detection limit and, depending on the laboratory, can measure chromium-6 at levels approaching 0.02 ug/L.

Based on SPU source water quality and lack of potential sources of chromium-6, the background total chromium level is presumably from naturally occurring chromium-3. It is possible for chromium-3 to convert to chromium-6 in treated drinking water depending on pH and disinfection treatment processes. To better quantify the low chromium levels in SPU's water, SPU began following the EPA recommended quarterly monitoring in 2011.

3.4.2.4 Pharmaceutical/Personal Care Products

Testing has confirmed the absence of PPCPs and EDCs in SPU's source water.

SPU conducted three rounds of testing in 2008 for pharmaceuticals and personal care products (PPCPs) and endocrine disrupting compounds (EDCs) in our source water. Results confirmed the absence of PPCPs or EDCs in SPU's source water, which was not surprising considering SPU's exceptional source water protection efforts.

Prior to 2008, SPU conducted regulatory monitoring of its source water for synthetic organic compounds (SOCs) and for unregulated compounds, as part of UCMR 2. The sampling panels included some EDCs. Samples were collected from only the finished water for the Cedar and Tolt supplies. The analyses were conducted using a certified lab, following accepted field sampling procedures, and included QA/QC procedures. Historical results showed no detections of any suspected EDCs, including Atrazine, Butylbenzyl phthalate, Diazinon, Linuron, Methoxychlor, and bisphenol A.

Because prior UCMR testing did not include any PPCPs and samples were collected from locations following treatment, SPU conducted additional more extensive testing of source water and treated water beginning in April 2008. SPU conducted two rounds of sampling from Tolt and Cedar supplies at locations before and after treatment. SPU collected a third set of samples from Riverton and Boulevard Park wells in December 2008. SPU detected none of the PPPCPs and EDCs tested.

3.4.3 Kerriston Road in the Cedar River Watershed

Kerriston Road is a King County road that has more than two miles lying within the hydrographic boundary of the Cedar River watershed in the vicinity of Brew Hill. The road provides the only existing access to 322 acres of privately-owned property located outside of the municipal watershed hydrographic boundary. WDOH has expressed concern about the potential public health and water quality impacts that could result from public use of the road. The 2009 acquisition of the 4,000 acres by King County and the Washington Department of Natural Resources in the Raging River area reduced the total area of privately-owned property accessed by the Kerriston Road by 84 percent, significantly reducing the scale of the potential future development threat and investment to acquire remaining properties. In 2008 SPU conducted a feasibility study and cost estimates for acquiring the private properties accessed by the Kerriston Road. A portion of the property, about 148 acres, has been purchased. Before proceeding with further acquisitions, SPU is conducting a risk-cost analysis of public access on the Kerriston Road to determine if additional land acquisition is the preferred approach for mitigating risk.

3.4.4 Lake Youngs Water Quality

Lake Youngs is a high quality, oligotrophic lake, meaning it has low nutrient content and low biological productivity. In recent years, SPU has observed some changes in Lake Youngs' water quality, particularly some new dominant algal species and less predictability in the timing of algal blooms. SPU held a workshop of limnology experts in 2009 to look more closely at the water quality data and determine if these changes in algae are indicative of more fundamental or permanent changes in the lake. The expert panel concluded that the types of changes observed are well within normal ranges and do not suggest any significant degradation of the lake.

Algal blooms have been observed in Lake Youngs since the 1920s. Prior to the startup of the Cedar Water Treatment Facility, these algal blooms would cause undesirable tastes and odors in the drinking water. The new treatment facility has eliminated nearly all these effects. Another effect of algae has been that over time it can accumulate on water filters used in homes and businesses. One of the new dominant types of algae in the lake, *Cyclotella*, has been found to produce fine filaments that not only clog filters, but accumulate on screens used in the water system. Because of the more problematic nature of these filaments, SPU strives to avoid this algae by bypassing Lake Youngs during a bloom.

SPU has an extensive lake monitoring program. In response to the changes in the lake and recommendations of the expert panel, SPU has added to that program in order to better characterize the lake. Water quality monitoring has been improved with the addition of some sampling and the installation of a remote floating water quality monitoring station on the lake. A water quality modeling effort has also been taken on in order to better understand the lake and to look at the impacts of operational changes and potential improvement projects.

3.4.5 Aquatic Nuisance and Invasive Species

Several aquatic organisms currently create or have the potential to create nuisance conditions in Washington state waters, including SPU's drinking water supplies. Once established in an aquatic system, infestations of these nuisance organisms can be difficult to control and impossible to eradicate, resulting in deleterious effects on water quality and water system operations.

Several aquatic nuisance species are specific targets of SPU's prevention program because of their proximity to the Cedar River, ease of invasion, or significance of impact. The invasive aquatic plant species include: *Eurasian milfoil*, parrotfeather, *Hydrilla*, *Brazilian elodea*, fanwort, water hyacinth, and others. The microorganism species include *Didymosphenia geminate* (didymo), Whirling Disease, and others. The animal species include the zebra mussel, quagga mussel, New Zealand mud snail (NZMS), Chinese mitten crab, and others. All of the aquatic nuisance plant species listed here have been positively documented in freshwaters of Washington State, including NZMS in Seattle's Thorton Creek.

SPU's "Prevention of Aquatic Nuisance Species Plan" outlines general responsibilities of field personnel working in any of the water supply reservoirs and watersheds. A detailed equipment

decontamination procedure is included in the plan. In addition to preventing the introduction of aquatic nuisance species, the decontamination procedure is designed to prevent contamination by any biological organism (i.e., plant, animal, or microbe) that is either a native or exotic species and may be terrestrial or aquatic in origin, and by any chemical or petroleum product.

3.5 IMPLEMENTATION/ACTION PLAN

With the construction of four new buried reservoirs to replace the pre-existing Beacon, Myrtle, West Seattle, and Maple Leaf open reservoirs, SPU has accomplished a great deal since the *2007 Water System Plan*. These actions have supported SPU in meeting drinking water quality regulations and have placed SPU in position to continue to meet water quality requirements in the future. In addition, SPU has a list of important upcoming projects and actions in the Water Quality and Treatment business area that include the following:

- Remove Roosevelt and Volunteer Reservoirs from service following the completion of the Maple Leaf reservoir burying project. Evaluate water system operation without Roosevelt and Volunteer Reservoirs and confirm a decision on how to go about the decommissioning of Roosevelt and whether to decommission or cover Volunteer Reservoir.

- In about 2020, evaluate options for replacing the floating covers at Bitter Lake and Lake Forest Park Reservoirs, given that the covers at these sites will reach the end of their useful life within the next 10 to 15 years

- Complete the conversion from chlorine gas to sodium hypochlorite at Landsburg.

- Evaluate contract extension options for the Tolt and Cedar Water Treatment Facilities.

- Review distribution system flushing practices and the level of resources allocated to flushing.

- Stay abreast of EPA and WDOH regulatory development efforts and make adjustments as necessary to ensure that SPU's water quality service level is always met.

- Continue monitoring the science regarding new or emerging contaminants of concern, and continue to monitor source and

finished drinking water to determine whether these contaminants are at levels of concern in SPU's supplies.

- Conduct a risk-cost analysis of public access on the Kerriston Road to determine if additional land acquisition is the preferred approach for mitigating the risk of impairing Cedar source water quality.
- Continue to monitor and characterize limnological conditions in Lake Youngs as it affects Cedar supply operations and treated water quality.
- Bypass Lake Youngs to avoid problematic algae from entering the water system.
- Continue efforts to prevent aquatic nuisance and invasive species from being introduced into SPU's drinking water supplies.

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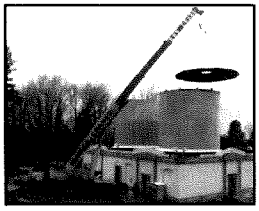
Chapter 4
Water Transmission System



SPU's water transmission system consists of the large diameter pipelines, storage facilities, pump stations, and related infrastructure that convey raw water to the treatment facilities and treated water to the distribution systems of SPU's wholesale customers and its own retail service area. The water transmission system consists of both regional and sub-regional facilities, as defined in the wholesale water contracts.

4.1 Accomplishments Since 2007 WSP

Since completion of the *2007 Water System Plan*, SPU has implemented the following improvements to the water transmission system:

- Control Works Surge Tanks: Installed painted, welded mild steel structural covers on these tanks to protect drinking water quality (2010).
- Lake Youngs Supply Lines Standpipes: Extended open air standpipe air vents to prevent or reduce occasional overflows when Lake Youngs is bypassed (gravity operation from Landsburg to Cedar Treatment).
- Cedar/Tolt Transfer Improvements: In Seattle, installed a modulating valve at Maple Leaf Gatehouse to allow the Tolt source to supply farther south into areas normally supplied from the Cedar source. On the Eastside (Woodinville), upgraded the diesel backup pump at TESS Junction that delivers Cedar water into the upper reaches of Tolt Pipeline No. 1 at times of Tolt source outage (2010).
- Cedar River Pipeline Improvements and Upgrades:
    - Slip-lined portions of Cedar River Pipeline 4 (CRPL4) where it crosses I-405 in Tukwila and protected the segment of CRPL4 where it crosses SR-167 in Renton to prevent this major transmission pipeline from potential damage during widening of both highways by the State of Washington, as well as to extend its useful life (2010).

- Completed a sonic leakage test of Cedar River Pipeline 2 from Volunteer Reservoir to Maple Leaf Reservoir (also known as the 430 Pipeline) using "smart ball" technology to assess its condition and found no leaks (2007).
- Improved the supports under above-ground sections of Cedar River Pipelines 1, 2, and 3 in Tiffany Park in Renton to increase the likelihood of the pipelines remaining operational after a larger earthquake.
- Replaced sections of Cedar River Pipelines 1, 2 and 3 where they cross the Sound Transit Light Rail at Martin Luther King Way in Seattle, to protect these transmission pipelines.

- Cathodic Protection Program: Installed cathodic protection on a concrete cylinder pipe section of CRPL4 near South Center in conjunction with the I-405 widening improvements discussed above.
- Tolt Slide Monitoring: After ground movement in 2009 and subsequently finding that Tolt Pipelines No. 1 and No. 2 both cross an ancient slide located between the Regulating Basin and Tolt Water Treatment Facility, installed a 48-inch double ball joint expansion sleeve on TPL2 to allow the pipeline to better conform to the creeping slide. Also initiated an on-going survey and inclinometer monitoring program to monitor slide movement.
- Wholesale Customer Meters: Added several new wholesale services as requested by its whole sale customers primarily to improve retail service reliability within the wholesale customers' service areas.

In addition, Maple Leaf and West Seattle Reservoirs, which are part of the transmission system, were replaced with buried reinforced concrete tanks as described in Part I, Chapter 3.

4.2 SERVICE LEVEL PERFORMANCE

SPU has developed service levels that deal with the water service SPU provides to its wholesale customers. From a wholesale customer's perspective, the quality of water service can be measured by the amount of water flow provided, the pressure of that water, and the duration of any water system outages. Many of the drinking water quality service levels, as stated in the Water

Quality and Treatment chapter, also apply to the transmission system. Table 4-1 summarizes SPU's service levels concerning service provision to wholesale customers.

Table 4-1. SPU's Service Levels for Managing Transmission System Assets

Service Level Objective	Service Level Target
Provide agreed-upon service to wholesale customers.	• Meet wholesale contract requirements for pressure and flow. • Limit each unplanned outage in the transmission system to be within the maximum outage duration set for each pipe segment (24, 48 or 72 hours).

These service level targets have been met since 2006. SPU's wholesale contracts require SPU to provide a minimum pressure and maximum flow rate at each wholesale service connection, with contingencies for emergency or unusual conditions. There have been no contractual compliance issues in recent years. Additionally, there have been no unplanned outages of the transmission pipelines that have exceeded SPU's service level for maximum outage durations.

4.3 Existing System and Practices

SPU's regional and sub-regional water transmission systems include 193 miles of pipeline, 7 covered reservoirs, 15 pump stations, 6 elevated tanks and standpipes, and 129 wholesale customer taps with meters.

SPU's transmission system consists of the facilities that convey bulk water to wholesale customers throughout the regional service area, as well as to SPU's own retail service area distribution system. SPU's transmission system facilities include the large-diameter transmission pipelines, storage facilities, pump stations, wholesale customer meters, and other appurtenances that are used in conveying water from SPU supply sources to its wholesale customers and the SPU retail service area.

4.3.1 Existing Infrastructure

The regional and sub-regional water transmission systems include approximately 193 miles of pipeline, seven covered reservoirs, 15 pump stations, and six elevated tanks and standpipes. Taps off of the major supply transmission pipelines from the Cedar and Tolt sources deliver water to 129 wholesale customer master meters and intertie locations. Wholesale customers operate their own distribution systems serving their own retail customers. Brief descriptions of the elements that comprise transmission system infrastructure are presented below, along with assessments of the

condition of related assets. Inventories of the primary transmission system facilities are provided in the appendices.

4.3.1.1 Pipelines

SPU's transmission system contains approximately 193 miles of large-diameter pipelines. These pipelines convey untreated water from the supply sources to the treatment facilities and treated water from the treatment facilities to the wholesale and retail service areas. These pipes vary in size from 16 to 96 inches in diameter, with some connections and bypasses being smaller. The bulk of these pipelines are made of steel and concrete, with a small portion consisting of ductile or cast iron, as shown in Figure 4-1.

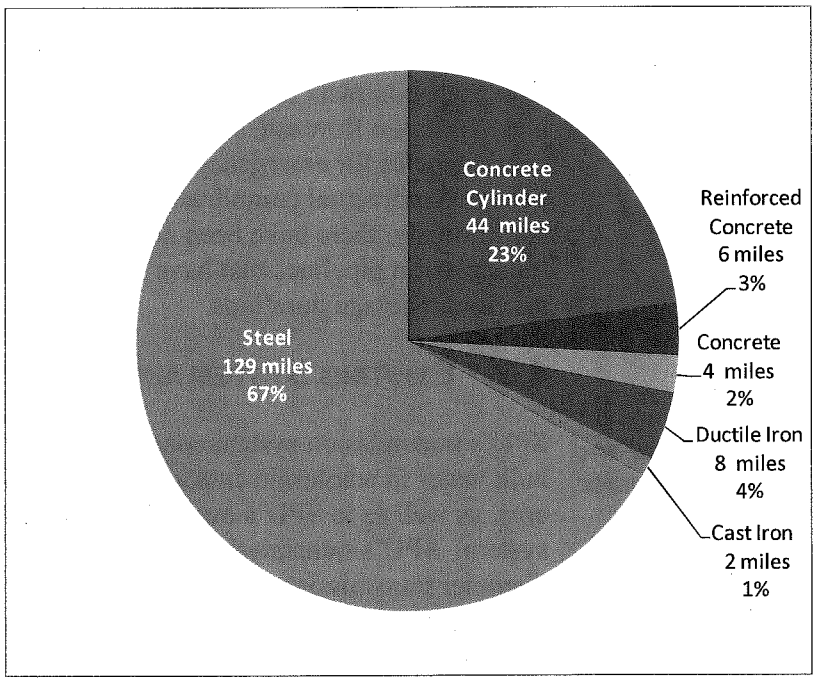


Figure 4-1 Breakdown of Transmission Pipeline Material

SPU relies on the leakage history and visual inspections of its transmission pipes to provide an indication of condition. Leaks are identified by SPU crews that drive along the alignments of the transmission pipes weekly to look for water ponding on the surface.

4.3.1.2 Storage

SPU owns, operates, and maintains 15 storage facilities in its transmission system. All store treated water. An assessment of the condition of these facilities is described below.

Reservoirs. With completion of the Maple Leaf and West Seattle reservoir burying projects in 2010, all seven of SPU's treated transmission system reservoirs are covered. With the exception of Lake Forest Park Reservoir, these reservoirs are pre-stressed or reinforced concrete tanks. Lake Forest Park Reservoir was constructed in 1961-62, and its structure consists of a hypalon-lined, reinforced concrete slab with a floating cover that was added in 2003.

The condition of the reservoirs is typically assessed by inspecting the structures, the embankment stability, the valves and piping, and any internal lining, and measuring the leakage rate from the reservoirs. When evaluating leakage rates, SPU looks for increasing trends and anomalies that could indicate deteriorating conditions at the reservoir. SPU performs routine structural inspections of the tanks during cleaning activities to assess their condition and ensure that they meet regulatory requirements. Minor and major deficiencies are addressed through capital programs when they are identified.

Inspections revealed that the storage reservoirs are in good condition.

Inspections conducted since 2005 reveal that the storage reservoirs are in good condition. The leakage rates from Soos North and Soos South Reservoirs are low, 0.11 gallons per minute per million gallons (gpm/MG) and 0.04 gpm/MG, respectively, when tested in 2006-2007. Riverton Heights Reservoir was last tested in 2007 and had negligible leakage. The leakage rates for Lake Forest Park and Eastside Reservoirs are 1 and 2 gpm/MG, respectively, which has been typical for these reservoirs since 1994.

In 2008 and 2009, a detailed condition assessment was performed by a consultant for the Eastside Reservoir, and its inlet-outlet pipeline up to its connection to the Tolt Eastside Supply Line at SE 16th Street in Bellevue. The effort was intended to provide information to the Cascade Water Alliance on the condition of these facilities for a possible acquisition. The work included inspection of the pre-tensioning wire of the reservoir, internal inspection of the pipeline at two locations, and soil corrosivity assessment along the pipeline. Both the reservoir and the pipeline were found to be in good condition; however, Cascade has since decided not to pursue acquisition of these facilities for other reasons.

Standpipes and Elevated Tanks. The SPU water transmission system includes five elevated tanks, one standpipe, and two control works surge tanks to provide drinking water storage. The elevated tanks and standpipes were constructed between 1925 and 1959. They range in capacity from 0.3 to 2 MG. Richmond Highlands #1

Tank and Foy Standpipe are to be removed from service and decommissioned. Decommissioning of Myrtle #1 Tank is also proposed, but approval by WDOH is pending. More information on system performance without these facilities is provided in the appendix on System Storage Level of Reliability.

Tanks, including standpipes, are expected to have a service life of approximately 100 years with regular maintenance. SPU inspects the tanks visually to evaluate their condition and appearance. Structural inspections are conducted when tanks are drained for cleaning. Exterior sanitary inspections are conducted quarterly. The condition of the tanks is evaluated for the condition of interior and exterior coatings, as well as its valves and pipes. The condition of each tank varies, depending on its year of construction and the year the last interior and exterior coatings were applied.

SPU has an on-going tank and standpipe recoating program. The program involves safety modifications at tank sites, minor structural repairs, and interior and exterior surface preparation and coating following a regular maintenance cycle. Tank painting generally follows an approximate 20-25 year cycle. The timing will vary with need as shown by inspections and economic analysis. Myrtle Tank #2 was recoated in 2010, and Richmond Highlands Tank #2 is scheduled for recoating in 2012.

4.3.1.3 Pump Stations

SPU operates 15 transmission system pump stations. These pump stations are inspected regularly and equipment is repaired or replaced as needed. The only significant modification to the pump stations was the upgrade of the diesel pump at the Tolt Eastside Supply (TESS) Junction Pump Station to provide for improved delivery of water from the Cedar system to the upper reaches of TPL1 and the Tolt Water Treatment Facility clearwells in the event of a Tolt source outage.

The condition of SPU's pump stations varies depending on the age and condition of their components, their usage, past maintenance or rehabilitation activities, and other factors. Recently, SPU has begun implementing a Reliability Centered Maintenance (RCM) program for its pump stations, which is described more fully in Section 4.3.3.3. Since it will take several years to complete RCM on all active pump stations, the current practice is to determine replacement/upgrade schedules according to the expertise of SPU Maintenance Division staff. Pumps are monitored for efficiency and overhauled every 5 to 7 years.

4.3.2 Operations

Since completion of the Cedar Water Treatment Facility in 2004, water from the Cedar source is pumped from Lake Youngs into the treatment facility and flows through the treatment processes by gravity to the clearwells. From the clearwells, flow to Control Works is through two finished water pipelines (FWP) and flow control facilities (FCF). FWP No. 4 and FCF No. 4 deliver water directly to Control Works through the former Lake Youngs Bypass No. 4 pipeline. FWP No. 5 and FCF No. 5 deliver water to the Lake Youngs tunnel through the former Lake Youngs Bypass No. 5 pipeline. From the Control Works, water flows to the four Cedar River Pipelines (CRPLs) for transport to wholesale customers generally east and south of Lake Washington, and to SPU's retail service area. A maximum of 200 mgd of treated water can be transmitted from the Cedar Water Treatment Facility clearwells through the Cedar River pipelines, but flow is constrained by the Cedar Water Treatment Facility treatment capacity of 180 mgd.

How long does it take the water to get to my house?

It typically takes about two weeks for the water to get from the treatment plants to your faucet.

For the Tolt source, raw water is delivered from the South Fork Tolt Reservoir to the Regulating Basin either through the original South Fork Tolt Pipeline or through the Seattle City Light penstock pipeline installed in 1995. From the Regulating Basin, which serves as a break in the hydraulic grade line and as regulating storage for hydropower production, the raw water moves through a screenhouse and then into Tolt Pipelines Nos. 1 and 2 to the inlet of the Tolt Water Treatment Facility. Treated water from the clearwells of the Tolt Water Treatment Facility flows west in the original and, in some places, replaced Tolt Pipeline No. 1 (TPL1) to the Duvall area where TPL1 bifurcates into TPL1 and Tolt Pipeline No. 2 (TPL2). TPL2 follows a separate southwesterly alignment and connects to the Tolt Eastside Supply Line in Kirkland. TPL1 runs west and connects to the north end of the Tolt Eastside Supply Line (TESSL) in Woodinville. West from the Woodinville area TPL1 and TPL2 follow the same original right-of-way to Lake Forest Park Reservoir. TPL2 is in active mode along this stretch whereas TPL1 is in standby mode at lower pressure. TPL1 is kept fresh by maintaining a low level continuous discharge directly into Lake Forest Park Reservoir whereas the main supply to the reservoir comes from TPL2. The Tolt transmission facilities are capable of hydraulically delivering 135 mgd through the treatment facility and downstream transmission pipelines; the treatment capacity is 120 mgd.

SPU has performed extensive hydraulic modeling analysis, and has implemented capital improvements to reduce the likelihood of water service interruption in case of unplanned source outage. As

a result, the SPU system is expected to be able to meet indoor and off-peak season water use of the entire service area, most likely including the wholesale customer demand, for at least seven days with only one of its two main sources available. In case of an unexpected source outage during higher demand periods, SPU plans to reduce water demand to indoor levels through aggressive public messaging in the media. More information on system performance under these scenarios is provided in the appendix on System Storage and Reliability Standard. Such responses to emergency outages are covered in the Water Shortage Contingency Plan contained in the *2007 Water System Plan.*

4.3.3 Maintenance

Proper maintenance of SPU's transmission system components ensures that SPU will be able to deliver reliable water service, reduce the risk of unexpected failures, and provide safe drinking water quality to its wholesale and retail customers. SPU has prepared a number of strategic asset management plans (SAMPs) for each major class of transmission system infrastructure components. The SAMPs outline maintenance strategies for each asset. Summaries of those maintenance strategies are provided in this section.

4.3.3.1 Pipelines

Maintenance activities for water transmission pipelines include cleaning of exposed pipes and periodic inspections of pipelines. Moss and dirt are cleaned from exposed transmission pipes at least once every three years. Internal inspections are performed when pipes are emptied and out of service for repairs or maintenance, allowing inspectors to enter the pipe. External inspections are typically performed only when opportunities present themselves, such as when a pipeline is exposed for other work. However, since the *2007 Water System Plan*, SPU performed five dig-up inspections on Cedar River Pipeline No. 4, a reinforced concrete pipeline, to confirm that it was in good structural condition. Earlier, dig-up inspections were done on the Tolt Pipeline between the Tolt Water Treatment Facility and Kelly Road where the original 66-inch concrete cylinder pipe is still in service.

4.3.3.2 Reservoirs and Tanks

Storage facility cleaning is performed to remove sediment, debris, and/or microbial growth. Cleaning is done on a scheduled basis or when water quality inside the storage has declined, as evidenced

by regular water quality monitoring. The cleaning schedule is explained in the Water Quality and Treatment chapter.

4.3.3.3 Pump Stations

In 2007, SPU piloted a Reliability Centered Maintenance (RCM) program and brought in a consultant to train in-house staff. RCM is a major shift from traditional maintenance programs that primarily apply time-based maintenance on system components, in this case, components of pump stations. Instead, RCM focuses on the function, failure mode, and criticality of a component to determine the frequency and type (i.e., preventive, predictive, or corrective) of maintenance to perform.

SPU adopted RCM as the core of our maintenance program and has analyzed Burien Pump Station and implemented changes to maintenance tasks and frequency in Maximo (SPU's computerized maintenance management system).

Maintenance activities at water pump stations ensure that the stations continue to operate with minimal loss of function, thereby reducing the likelihood of customer outage, loss of pressure, and potential introduction of pathogens into the distribution systems. SPU performs three types of maintenance activities for its pump stations as described below.

Preventative Maintenance. Preventative maintenance is maintenance which is carried out on a routine basis on elapsed time schedules or equipment run-time hours. Preventative maintenance is designed to eliminate routine failures. Table 4-2 lists typical preventive maintenance activities, the craft responsible for performing them, and the normal frequency at which those activities are performed.

Table 4-2. Typical Pump Station Maintenance Activities

Craft	Task	Approximate Frequency
Carpenter	Building inspection	Annually
Electrician	Generator exercising	Monthly
Electrician	Pump motor starter maintenance	Annually
Electrician	Valve operator	Annually
Mechanics	Overhaul pressure regulator	2 to 5 years
Mechanics	Flow meter inspect/overhaul	2 to 5 years
Mechanics	Diesel engine exercising	Every 2 months
Mechanics	HVAC filter change	Every 2 to 3 months
Mechanics	Air conditioner inspection	Annually
Mechanics	Pump station check	Weekly
Grounds	Basic site check	Weekly

Corrective Maintenance. When preventative maintenance tasks or other data indicate minor equipment malfunctions, corrective maintenance is performed. This type of equipment malfunction does not restrict normal operation of the pump station.

Emergency/Reactive Maintenance. Emergency maintenance is generally carried out when a piece of equipment has failed and the need to restore its performance is critical. The criticality of each pump has been predetermined and incorporated into SPU's computerized work management system to ensure that repair of these facilities receives higher priority than other, non-critical repairs and that critical facilities are quickly put back into service.

4.3.3.4 Wholesale Customer Meters

Wholesale customer meters are tested annually and maintained to meet accuracy standards.

SPU owns and maintains 129 wholesale water meters at intertie locations with wholesale customer systems that measure usage and provide a basis for billing wholesale customers. The most significant change to SPU's wholesale meters since the *2007 Water System Plan* has been the installation of radio frequency modules on almost all of the wholesale meter registers, which allow safer and faster meter reading by enabling the meters to be read without requiring personnel to enter the meter chamber. Meter installations that raise safety concerns, cannot be tested on site, or have older meters that are difficult to maintain are being replaced.

Wholesale customer meters are 3 to 24 inches in diameter and classified as "large meters." SPU's policy is to install, test, and maintain all customer service water meters in such a way as to meet the accuracy standards of the American Water Works Association (AWWA). SPU's meter testing and maintenance practices are described below.

Meter Testing. SPU's approach to field testing of wholesale meters varies with the type of the meter. There are three types of meters: compound, turbine and electronic. Typically, compound meters are field tested annually. Based on operational experience, SPU recently extended the period between tests for turbine meters to once every three years. First, the measuring element is replaced in the field with a measuring element that has been bench tested and known to be accurate. The removed measuring element is then tested on the bench, and repaired as needed. Electronic meters, which are mostly magnetic flow meters, are tested once a year for accuracy of the zero set point and for other applicable electronic settings; due to their size they cannot be typically tested by the

conventional method of flowing water and comparing to a reference meter.

Meter Maintenance. SPU performs scheduled maintenance activities on large meters based on a variety of criteria including manufacturer recommendations, AWWA standards and consumption history. Unscheduled maintenance activities are performed in response to billing questions and customer requests. Typically maintenance is performed at the time of testing.

Meter Replacement. Meter replacement includes pipe work and vault modification necessary to bring meter installations up to current standards for accuracy, safety, and maintenance access, and to ensure that the impacts of supply interruptions due to meter maintenance and testing are maintained at levels that are acceptable to customers. Some upgrades may include relocation of the meter installation. Meter replacements are discussed with the customer prior to scheduling to ensure current and future customer needs are met, as well as to ensure proper meter application and coordination to limit customer impacts. Reasonable efforts are made to coordinate meter upgrade work with local street improvement projects to minimize street cuts.

4.4 Needs, Gaps, and Issues

SPU has identified several needs, gaps, and issues in regards to the transmission system. Needs include mitigating the risk of pipeline failure in the Tolt slide area and extending the life of transmission pipe using cathodic protection. The following subsections summarize these issues and SPU's approach to addressing them.

4.4.1 Tolt Slide Monitoring

In 2009, Tolt Pipelines 1 and 2 were found to cross a historic slide located between the Regulating Basin and Tolt Water Treatment Facility. The slide had been dormant, and therefore unknown, since the pipelines were installed in the 1960s and late 1990s, but has become more active apparently due to a combination of logging in upland area and erosion by the North Fork Tolt River. This slope movement has affected both pipelines: the ground in the vicinity of TPL2 has moved up to 6 inches, or about 3 inches per year, and near TPL1 it is about one-half of that rate. Since discovery of the slide, TPL1 has been kept empty most of the time to reduce the risk of new small joint leaks triggered by the ground movement and aggravating slope stability. A 48-inch double ball joint expansion sleeve was installed on the newer steel TPL2 to allow the pipeline to better conform to the creeping slide. The ball

joint can elongate up to 18 inches, and has moved about 0.8 inches since installation. In addition, SPU initiated an on-going survey and inclinometer monitoring program to track the slide and pipeline movement.

SPU plans on performing the following analysis and actions to gain a better understanding of the situation and mitigate the risk of pipeline failure:

- Continue to collect geotechnical data to better understand the causes behind ground movement.
- Acquire ownership of the slide area to preclude future logging and deforestation, and to gradually reduce the water load on the slide through re-vegetation.
- Perform periodic internal inspections of the Tolt pipelines when monitoring indicates possible stress buildup at certain locations, and implement stress relief measures when necessary, such as cutting and re-welding the pipe, and/or installing additional expansion couplings.
- Perform biannual leak testing of Tolt Pipeline No. 1 to monitor for new small joint leaks that would further aggravate slope stability.
- If and when necessary, implement stress relief or other measures to mitigate the risk of pipe failure.

Cathodic protection is a method used to minimize the rate of electrochemical corrosion of metallic materials, such as pipes, by shifting the corrosion process away from the metal to be protected and onto other more easily corroded "sacrificial" pieces of metal.

4.4.2 Cathodic Protection Program

SPU's transmission system consists primarily of two types of pipe, distinguished by their material and their distinct modes of failure:

- Concrete cylinder pipe can have sudden, unexpected, and oftentimes very destructive failures.
- Steel and ductile iron pipelines usually develop increasing numbers of leaks that are detectable and repairable well before catastrophic failure.

Failure issues associated with each type of pipeline differ because of their different failure modes and risks. Cathodic protection systems have been shown to extend the life of pipe and reduce the risk of failures for both types of pipes, as described below.

4.4.2.1 Concrete Cylinder Pipe

Concrete cylinder pipe (CCP) is manufactured by lining the interior of a thin-walled, steel cylinder with concrete mortar, then wrapping the exterior of the steel cylinder with steel reinforcing rod under slight tension. The entire exterior is then coated with concrete mortar to provide additional stiffness and corrosion protection. CCP derives its strength from the combined strength of the steel cylinder and the pretensioned rod reinforcing. However, should the tensioning rods corrode or deteriorate to the point where they no longer provide sufficient tension to hold the pipe together, the pipe cylinder can fail, sometimes producing explosive bursts of water.

SPU's only sudden CCP failure due to pipe deterioration occurred in 1987 on the TPL1. The failure caused significant flooding and property damage. Detailed investigations revealed that the failure was caused by a particular type of corrosion known as hydrogen embrittlement, where chemical reactions with hydrogen ions in the soil cause the steel to turn brittle and lose its strength. The chemical process is irreversible, and the only remedy is to replace the pipe or to use it as a casing and to install new, smaller-diameter, fully competent pipe inside. Only the steel that was used for the spiral wrap by one particular pipe manufacturer (United Pipe) was found to be susceptible to hydrogen embrittlement. In SPU's system, all pipe made by United and prone to hydrogen embrittlement has been either replaced or slip-lined with new steel or ductile iron pipe.

Investigations in the early 1990s through dig-up inspections revealed some deterioration of the rest of the CCP lines but that these lines are still in serviceable condition. In an effort to mitigate further deterioration of CCP, SPU piloted a cathodic protection project. Cathodic protection has the effect of reducing the rate of metal corrosion in pipelines. The pilot installation proved successful and showed that a single deep cathodic protection well can protect one to three miles of concrete cylinder pipe with fairly even electric potential distribution.

The likelihood of catastrophic failure varies across pipeline sections. In some places the steel cylinder is thick enough to withstand normal working pressure even if the entire rod corrodes away. SPU is in the process of developing a comprehensive strategy to identify where it would be cost-effective to install cathodic protection. Cost effectiveness is generally defined as the avoided risk costs being higher than the costs to install and operate a cathodic protection system. Pipeline segments that are likely to

fail catastrophically, and are located in urban areas where consequences of failure would be significant, are likely to qualify for cathodic protection installation.

In addition to the cathodic protection program, SPU plans to reduce of risks of failure in its CCP lines using the following strategies, which were identified in the *2007 Water System Plan*:

- In the unlikely event that a failure does occur, plans are in place to respond expeditiously and repair the pipe and place it back on line, as provided in the outage service levels.
- Stay current on new pipeline inspection technologies. When high tech tools and methods for non-destructive, no-dig condition assessment for this particular type of concrete cylinder become available, they could be used to inspect pipe sections. After such inspections, SPU can apply asset management principles to decide if any should be replaced.

4.4.2.2 Steel and Ductile Iron Pipe

Steel and ductile iron pipelines differ significantly from CCP in that they develop increasing numbers of leaks well before catastrophic failure. In most cases, leaks can be repaired without depressurizing or taking the pipeline out of service. An aging steel pipeline is more likely to present an economic concern due to its increasing repair costs well before its structural strength is imperiled.

When the incidence of leaks on a steel pipeline starts to increase, installing cathodic protection can stop further increases. SPU has used cathodic protection, coupled with internal cement mortar relining, on numerous sections of steel pipelines where either significant leaks have been experienced in the past or may be expected in the future due to corrosive soils. Cathodic protection is a viable alternative to replacement along higher risk areas, like steep slopes or near critical utilities and transportation corridors where an undetected leak may result in high damage costs and where replacement costs are high.

4.5 IMPLEMENTATION/ACTION PLAN

As described earlier, the primary issues facing the transmission system include mitigating risks in the Tolt slide area and extending the life of existing pipelines through continued deployment of cost-effective cathodic protection systems, especially for concrete cylinder pipe. To address those and other issues discussed in this

chapter, SPU has identified the following major implementation and action plan items:

- Mitigate the risk of pipe failure in the Tolt slide area through continued slope monitoring, geotechnical data collection, periodic internal inspections, and biannual leak testing, and by taking such actions as acquiring ownership of the slide area and implementing stress relief measures when necessary.

- Continue to implement cost-effective cathodic protection projects for the concrete cylinder and steel transmission pipelines to protect these from corrosion and extend their service lives well into the future.

- Continue to operate the regional water system and manage outage durations for transmission pipelines to meet service level targets.

- Decommission Foy Standpipe and Richmond Highlands Tank #1, as well as Myrtle #1 Tank if approved by WDOH.

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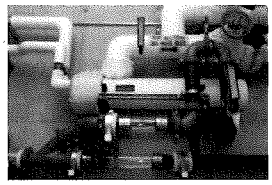
Chapter 5
Water Distribution System



This chapter focuses on the SPU water distribution system, the business area that involves delivery of water for retail use and for fire flow. SPU's water distribution system consists of watermains, distribution storage facilities and pump stations, and related appurtenances such as valves, hydrants, service connections, and retail billing meters. The supervisory control and data acquisition (SCADA) system used to monitor and control the water system is also discussed in this chapter. Proper management of the distribution system ensures that SPU meets its service levels for retail customers.

5.1 Accomplishments Since 2007 WSP

Since completion of the *2007 Water System Plan*, SPU has implemented the following improvements to the water distribution system:

- Pressure Improvements: Completed improvements to raise pressure in areas where services had less than 20 psi on Queen Anne Hill, in the lower Queen Anne 326 pressure zone, and in the Maple Leaf 530 pressure zone (2009).
- Queen Anne Pipe Replacement: Replaced watermain to withstand increased pressure associated with the new Queen Anne tank and pump station projects (2008).
- Backbone Pipeline System Seismic Upgrades:
  - Upgraded the seismic backbone along South Spokane Street from west of 1st Ave South to the Burlington Railroad tracks just east of Airport Way South.
  - Upgraded the seismic backbone along 1st Avenue South between South Stacy Street and South Spokane Street.
- New Taps: Installed over 5,300 new customer taps from 2007 through 2010.
- Service Renewals: Renewed or replaced over 3,400 services, primarily those made of plastic tubing, from 2007 through 2010.

- Water system improvements and watermain replacement associated with third-party projects:
  - Hidden Lakes Combined Sewer Overflow Betterments: Replaced approximately 1,100 feet of sub-standard watermain and associated fire hydrants to improve fire flow in the Shoreline service area (2007).
  - State Highway 99 (Aurora Avenue): Made various water system improvements along this highway between 145th Street to 192nd Street in the City of Shoreline.
- Steel Tank Recoating: Recoated Myrtle Tank #2 (2010).
- Tank Decommissioning: Decommissioned, but did not demolish, Maple Leaf Tank and Woodland Park Standpipe based on asset management business cases and to avoid the costs needed to upgrade the facilities (2009).

Additionally, Beacon and Myrtle Reservoirs, which are part of the distribution system, were replaced with below-grade reinforced concrete tanks, as described in Part I, Chapter 3.

5.2 SERVICE LEVEL PERFORMANCE

SPU consistently responds to reported distribution system problems within one hour more than 90 percent of the time.

SPU developed service levels to manage its water distribution system assets and describe what retail customers can expect of SPU in terms of water pressure and problem response. Also, a service level was developed to limit the amount of water lost to leakage. Many of the drinking water quality service levels, as stated in Chapter 3, also apply to the distribution system. Table 5-1 summarizes the distribution system service level objectives and targets used by SPU to manage its distribution system assets.

SPU has been meeting these service level targets. Since completion of the pressure improvement projects in early 2009, pressures at all retail service connections are greater than 20 pounds per square inch (psi) during normal operations. SPU also designs new or expanded parts of the distribution system to deliver a minimum of 30 psi during peak hour demand.

For each year since 2006, SPU consistently responded to reported distribution system problems within one hour more than 90 percent of the time. Because of this high level of performance, SPU raised the service level target in 2009 to 90 percent from the minimum of 80 percent that was documented in the *2007 Water System Plan.*

Table 5-1. SPU's Service Levels for Managing Distribution System Assets

Service Level Objective	Service Level Target
Provide adequate pressure for drinking water supplies.	• New or expanded parts of the distribution system designed to deliver peak hour demand at a minimum of 30 pounds per square inch (psi) at the meter. • No retail customers with less than 20 psi during normal operations.
Respond quickly and effectively to water distribution system problems.	• 90 percent of distribution system problems (emergency situations such as a pipe break; potential contamination of water supply; hydrant damage) responded to within 1 hour.
Meet water use efficiency goals to ensure wise use and demonstrate good stewardship of limited resource.	• Distribution system leakage losses of no more than 10 percent of total supplied, as defined by Washington Department of Health guidelines.

Distribution system leakage (DSL) has been reported to WDOH since 2006, as required by the 2003 Municipal Water Law (WAC 246-290-820). By definition, DSL is the difference between the total amount of water produced and the amount authorized for consumption. DSL includes water lost from pipe and service line breaks, as well as from storage facilities. It also includes metering inaccuracies and unauthorized uses. Due to the location of SPU's meters, losses in the transmission system are included in the reported DSL figures.

SPU's estimate of authorized consumption consists of water sold to retail and wholesale customers based on metering data, and estimates of water used to drain and clean treated water storage reservoirs and in overflowing of open reservoirs for water quality management. Small amounts of water used for authorized purposes such as firefighting, hydrant testing, watermain flushing, sample stand usage, and permitted hydrant usage (e.g., for building construction) have not been included in the estimate of authorized consumption because it would be costly to meter the use, compute an estimate, or determine the amount used in a calendar year. Exclusion of these authorized uses increases the amount of reported distribution system leakage. As shown in Figure 5-1, SPU's DSL has increased from less than 3 percent in 2006 and 2007 to more than 6 percent in 2010 and 2011. However, the 3-year rolling average has remained below the WDOH standard of 10 percent.

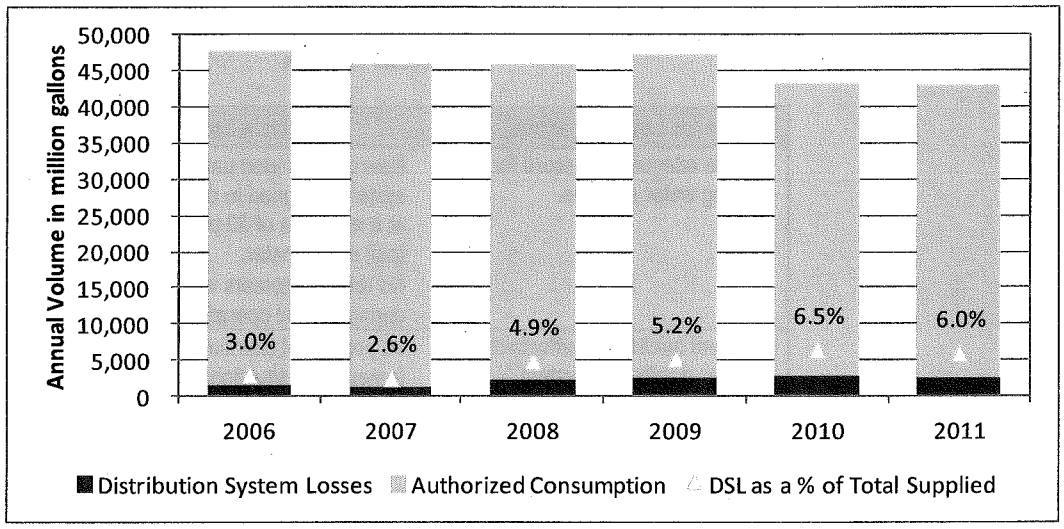


Figure 5-1. Distribution System Leakage

5.3 EXISTING SYSTEM AND PRACTICES

SPU's distribution system contains more than 1,680 miles of watermains, 2 open reservoirs, 6 covered reservoirs, 16 pump stations, 6 elevated tanks and standpipes, 21,000 valves, and 18,920 fire hydrants, as well as more than 188,000 retail service connections.

The water distribution system consists of the facilities that deliver treated water to SPU's retail water customers. Distribution system facilities include watermains, storage facilities, pump stations, retail customer meters, and other appurtenances. The water distribution system contains more than 1,680 miles of watermains, most of them 6 to 12 inches in diameter. Seattle's water distribution system also includes two open reservoirs, six covered reservoirs, 16 pump stations, and six elevated tanks and standpipes. In addition, the City has more than 21,000 valves, 18,920 fire hydrants and 188,000 service lines and meters serving individual residential and non-residential properties.

The following sections provide a description of the major classes of distribution system assets and a brief summary of their condition. The distribution system facilities O&M practices are also described, with attention given to changes in these practices or facilities since the *2007 Water System Plan*.

5.3.1 Existing Infrastructure

A description of the major components of SPU's water distribution system, a summary of their condition, and SPU's replacement/ renewal strategy is summarized below. A detailed inventory of the major asset classes is provided as an appendix.

5.3.1.1 Watermains

Seattle owns a network of more than 1,680 miles of watermains within its retail service area. Since the *2007 Water System Plan*, many watermain improvement projects have been completed, with a number completed in conjunction with re-development and other agency projects, such as transportation projects within the City limits and in Shoreline. However, the overall configuration of the distribution system remains unchanged since 2007.

The condition of SPU's watermains varies based on a number of factors including age, material, size, date of installation, and site specific conditions such as soil type and water table depth. The year of installation by decade and material type of distribution watermains is shown in Figure 5-2. Mainly unlined cast iron pipe was installed through the 1930s, followed by lined cast iron pipe. Since the 1970s, ductile iron pipe has been installed in almost all instances.

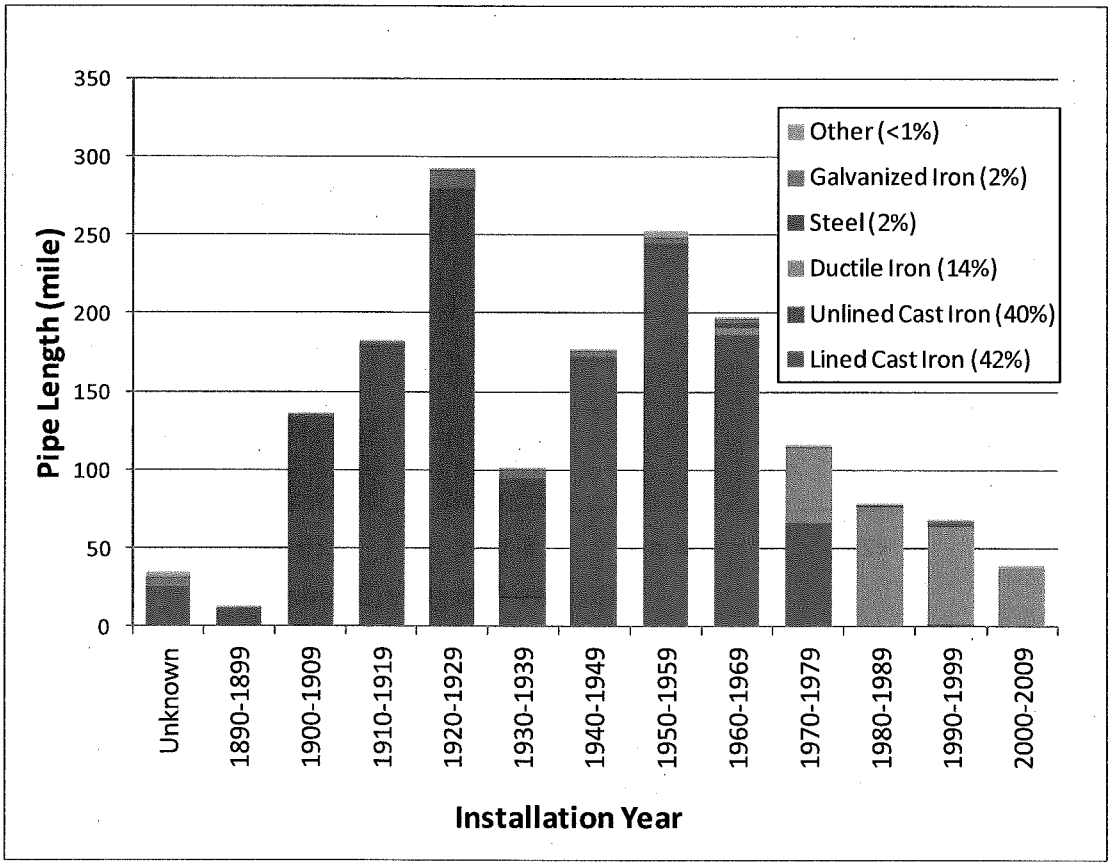


Figure 5-2. Type of Material and Decade of Installation for SPU's Distribution System Watermains

Currently, cast iron pipe is the most common type of pipe material used in SPU's distribution system. More than 80 percent of the pipes are cast iron, with roughly one-half of that unlined and one-half lined. Ductile iron pipe, the current standard and most common pipe material installed since the 1970s, is the third largest material type, at 14 percent. Galvanized iron and steel each make up about 2 percent of the system. The remaining pipe is made of other materials, including concrete cylinder (0.3 percent), polyvinylchloride (plastic) (0.2 percent), copper (0.1 percent), and kalamein (a type of steel) (0.1 percent). There is no asbestos pipe in the system. Figure 5-3 provides a breakdown of material types by pipe size. As indicated by the figure, the majority of pipe, or approximately 61 percent, is 8 to 10 inches in diameter.

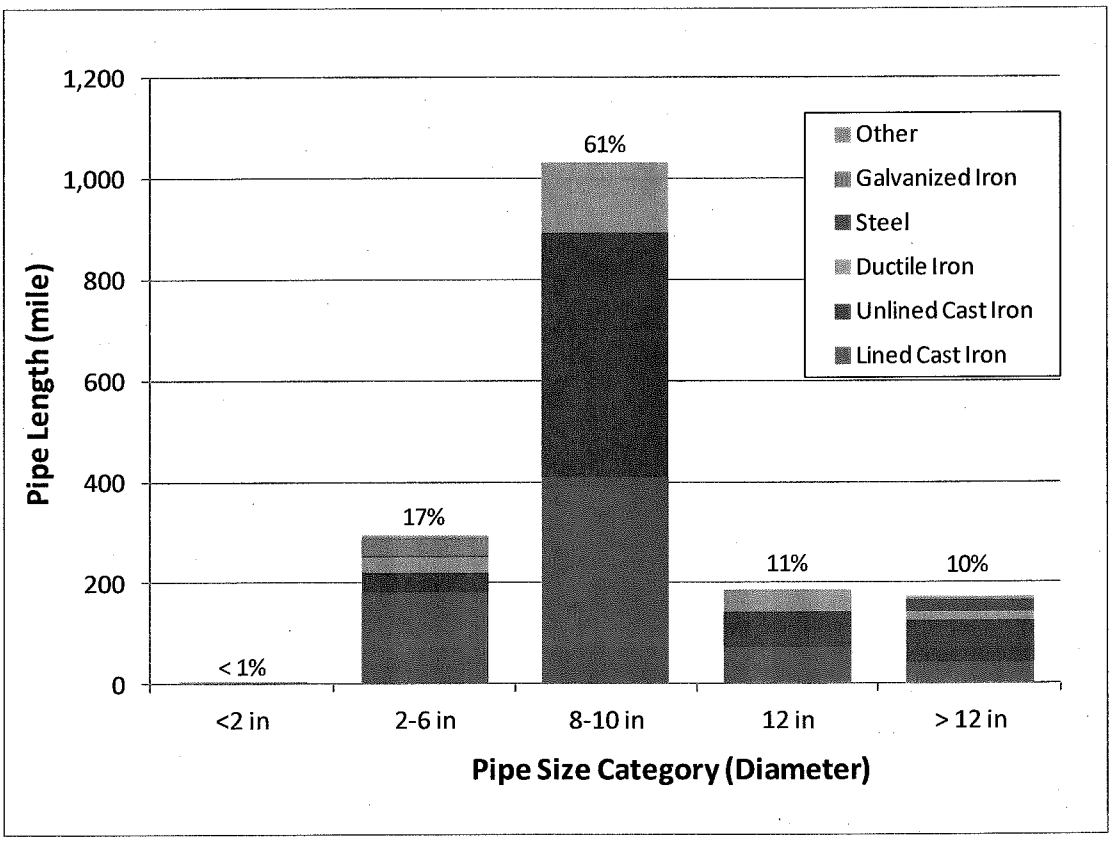


Figure 5-3. Pipe Diameter and Material Types for SPU's Distribution System Watermains

SPU does not have specific condition assessment information for most of the distribution system watermains. Although inspections are performed following watermain leaks and breaks, or when the watermain is exposed by potholing or adjacent construction, additional condition assessment activities are planned in the near term. Without specific condition assessment data, the most

appropriate measure of condition of the watermains is the pipe material, soil type, age and number and types of leaks and breaks. Based on data from 2004 through 2010, the rate of watermain leaks and breaks remains low, averaging less than 10 reported leaks or breaks per 100 miles per year in the distribution system. This is less than the rate experienced by other major water utilities in the United States[1]. SPU's approach to replacing and rehabilitating watermains is described in Section 5.4.

Not all leaks or breaks require water service delivery outages. However, if a repair does require an outage, it is considered unplanned. Distribution system improvement projects can lead to planned or scheduled outages. From 2006 through 2010, approximately one-half of all outage events were unplanned, and one-half were planned. During this period, fewer than 2 percent of all customers experienced water service delivery outages of more than 4 hours per year from all planned or unplanned events.

5.3.1.2 Distribution System Water Storage Facilities

SPU's distribution system includes eight in-city reservoirs and six elevated tanks and standpipes to provide operating and standby storage capacity to its retail customers. The amount of storage provided is explained more fully in the appendix on System Storage Level of Reliability.

Distribution System Reservoirs. The City of Seattle owns and SPU operates and maintains eight reservoirs in the distribution system. The Myrtle and Beacon reservoir replacement projects were completed and placed in service in mid-2008 and early 2009, respectively. SPU is investigating the possibility of retiring the last two open reservoirs, Volunteer and Roosevelt, as noted in Chapter 3.

Condition assessment of in-town reservoirs follows the same procedure as described for the water transmission system reservoirs. Based on inspections, the structures are in good condition. When last tested in 2009, the leakage rate at Magnolia Reservoir was negligible. The leakage rate from Volunteer Reservoir was 0.9 gallons per minute per million gallons (gpm/MG) in 2011. View Ridge Reservoir leakage was measured to be 2.9 gpm/MG in 2005. The leakage rates from Bitter Lake and Roosevelt Reservoirs were low and estimated to be 0.82 and 0.04 gpm/MG, respectively, when tested in 2009.

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[1] Neil S. Grigg, 2007, *Main Break Prediction, Prevention, and Control*. Report 91165. AwwaRF and AWWA.

Distribution System Elevated Tanks and Standpipes. In addition to its in-town reservoirs, the SPU water distribution system includes one elevated tank and five standpipes. The elevated tanks and standpipes were constructed between 1907 and 2008. They range in capacity from 0.9 mg to 1.9 mg. Maple Leaf Tank and Woodland Park Standpipe have been decommissioned but not demolished. In addition, Barton Standpipe is planned to be decommissioned in 2012 after its bypass is completed. Trenton Standpipes and Volunteer Park Standpipe are also being considered for decommissioning. The appendix on System Storage Level of Reliability provides more information on the approach used to analyze the system without these facilities.

Distribution system tanks and standpipes are inspected and maintained in the same manner as transmission system tanks, as described in Chapter 4.

5.3.1.3 Distribution System Pump Stations

SPU operates 16 distribution system pump stations with a total of 36 individual pump units. These pump stations are inspected regularly to ensure that they continue to function properly and equipment is repaired or replaced as needed. The most significant change to SPU's pump station assets is the addition of a new pump station on Queen Anne Hill to address low-pressure problems experienced by customers. An 8-inch pressure regulating valve (PRV) and bypass line were installed at the View Ridge Pump Station to allow water to recirculate through the reservoir and prevent over-pressurizing the 550 pressure zone, if the connection to the pressure relief at Roosevelt Way Pump Station is out of service.

One change planned for the pump stations is to retrofit the permanent stand-by diesel pump at Bitter Lake Pump Station with remote-manual start capability. This change will allow the pump to be started from the Operations Control Center to supply the 590 pressure zone in the event of a power outage. After this change is implemented, Richmond Highlands #1 Tank, which serves the northwest sub-regional system, will no longer be needed to supply the zone and could be decommissioned.

Distribution system pump stations are maintained in the same manner as transmission system pump stations, as described in Chapter 4.

5.3.1.4 Distribution System Appurtenances

Distribution appurtenances include various parts, features and elements that are incidental, integral, or subordinate to the system, such as valves and hydrants.

The SPU water distribution system includes a number of smaller appurtenances, such as valves, hydrants, service lines, and meters. The paragraphs below summarize SPU's inventory and replacement approach for each class of appurtenance.

Distribution System Valves. SPU's water distribution system includes more than 21,000 valves. More than 16,600 line valves exist to reconfigure the flow of water through the distribution system as needed, while other valves regulate pressure and flow, provide for bypassing of facilities, or allow air to escape the system. Most valves within the distribution system are gate valves.

SPU asset management approach focuses attention on assessing the condition of critical valves and conducting preventative maintenance or corrective repairs, based on condition. For non-critical valves (valves that isolate flow on non-critical watermains discussed in Section 5.4.1.1), repairs are initiated as needed when defects are noted during valve operation. Valve replacement is initiated when the repair or resolution of a defective condition is impossible, or would cost more than valve replacement. Valve replacement also occurs when distribution mains are replaced or relocated.

The valve chamber replacement program will continue through the next several years. This program replaces existing chamber lids and access maintenance holes with larger diameter lids and new access ladders. This program will provide SPU maintenance staff with safer valve chamber access and meet industry safety standards.

Distribution System Hydrants. SPU maintains more than 18,920 fire hydrants. Annual condition assessment of fire hydrants is performed by various fire service agencies operating in Seattle's retail service area[1]. Damage to fire hydrants is also commonly reported between routine condition assessment cycles.

SPU resolves problems observed and reported by the fire service agency and the public. Problems are categorized into two levels. First, problems that make a hydrant unusable or unsafe to use are given the highest priority to repair or replace. Second, problems

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[1] Fire departments with jurisdiction in Seattle's retail service area include the Seattle Fire Department, Shoreline Fire Department, Northshore Fire Department, North Highline Fire District, Burien / Normandy Park Fire Department, and King County Fire District 20.

such as minor leaks that do not affect a hydrant's availability for fire fighting and main flushing are given a low priority for repair or replacement. SPU's hydrant replacement strategy for obsolete hydrants is to replace these hydrants in areas when other water system projects are being constructed and where excavation costs are low and future costs are likely to be much higher. Other than these "opportunity projects," SPU replaces hydrants that are found to be inoperable and repairs are not possible or exceed the cost of replacement. New hydrants may also be installed as part of new development.

Since 2006, approximately 5% of all services have been shifted from plastic to copper.

Distribution System Service Connections. SPU has more than 188,000 retail service connections, an increase of more than 5,000 services since 2006, mainly for new residential customers. Most of the services (86 percent) are for residential customers, almost 12 percent are for commercial customers, and the remaining 2 percent are for fire service. Of all service connections, 80 percent are ¾-inch diameter pipes. Currently 74 percent of service lines are copper, 15 percent are plastic, and 6 percent are galvanized steel. The remaining 5 percent are made of other materials.

Service lines made of plastic or galvanized steel are more susceptible to failure and are now no longer used. Prior to 1947, all of the service lines were made of galvanized steel, and these have been primarily replaced with copper. Between 1968 and 1984, SPU installed or replaced approximately 40,000 small services (3/4-inch to 2-inch) with plastic tubing. The past 4 years of data shows that approximately 60 to 80 percent of small service failures were due to leaks on substandard pipes such as plastic and galvanized steel.

Prior to 2003, SPU's approach to renewal of small water service lines was "fix when fail." The cost of this primarily reactive strategy for some services has been high in both SPU's direct repair cost and social impact costs, such as damage to customer property, roads, and the environment. In 2003, a plastic service renewal pilot program began whereby blocks of plastic services were proactively renewed. In 2005, the programmatic approach was modified from block renewal to critical service renewal whereby plastic pipes with high risk costs were identified and renewed first. As part of the service renewal program, approximately 5 percent of all services have shifted from plastic to copper since 2006.

The current water service renewal program consists of both reactive and proactive components and is described more fully in Section 5.3.3.4.

Distribution System Meters. Each service line is fitted with a water meter used to determine customer consumption and charges. Nearly 92 percent of SPU meters are small (3/4-inch and 1-inch).

SPU has installed approximately 1,500 radio frequency modules on difficult-to-read meters. This form of automated meter reading (AMR) allows these meters to be read in walk-by mode more safely and at less cost than traditional meters. Examples of where AMR is cost-effective and used at SPU include:

- Meters that are a safety hazard and/or require costly setup to read visually, mostly due to being located in an area with traffic hazards.
- Clusters of meters located in larger vaults with heavier lids, which pose an injury risk to meter readers when repeated frequently.
- Meters located in parking areas that are unreadable when a vehicle is parked over them, leading to frequent estimated bills.
- Meters that tend to get buried and/or overgrown and require frequent clearing.
- "Deduct" meters owned by the customer and located on private property in hard to access locations, leading to lengthy time required to get a reading.

5.3.2 Distribution System Operation

SPU's water distribution system is primarily served by gravity, but pumps are used to serve some pressure zones. To control flow and storage levels, SPU water system operators at the Operations Control Center operate pump stations, valves and other water system components using the remote control capability of the SCADA system or by directing crews to locally operate field equipment. The current SCADA system, which was installed in 2006, provides real-time data regarding pressure, flow, storage facility water level, and pump/valve status to system operators. Archived SCADA data are also useful for hydraulic network modeling, system planning, and engineering design.

In addition to the control room at the Operations Control Center, SPU has a backup control room at the SPU North Operations Center. The backup control room has been improved to substantially reduce start up time to begin system monitoring and control from that location.

Additional information on system operations, particularly the Operations Planning and Scheduling function, is provided in the appendix for Water System Management and Operator Certification.

5.3.3 Distribution System Maintenance

SPU has prepared a number of SAMPs for each major class of distribution system infrastructure components and plans on updating as needed.

Proper maintenance of distribution system components ensures that SPU will be able to deliver reliable water service by reducing the risk of unexpected failures. SPU has prepared a number of strategic asset management plans (SAMPs) for major classes of distribution system infrastructure components. The SAMPs outline maintenance strategies for each asset. Summaries of those maintenance strategies are provided below.

5.3.3.1 Watermains

The most significant maintenance for watermains is leak assessment and control, watermain repairs and flushing. Watermain break/leak data from the past 22 years indicate that approximately 100 to 170 watermain failures (leaks and breaks) occur each year, with an average of 150. Approximately one-third of the failures, however, are joint leaks which do not always require a complete watermain shutdown. Also, repair of leaks from corrosion-related pinholes do not usually require complete shutdowns. Small watermain leaks can be repaired "live" by throttling adjacent valves and reducing the flow in the watermain. Only large breaks involve a complete watermain shutdown.

Watermain failures require immediate response. SPU distribution staff has been consistently meeting the service level target for problem response (90 percent problems responded to within one hour). To further optimize resource utilization, reduce lifecycle cost, enhance asset data and knowledge, the following improvements are being made:

- Implementing a Field Operations Mapping System with Automatic Vehicle Location capability: This improvement displays active maintenance crew/vehicles and work order locations on computerized maps, allowing the nearest equipped crew/vehicle to be dispatched quickly and address the problem.

- Implementing a MAXIMO Upgrade: This project improves the work order management process and asset data using SPU's computerized maintenance management software called MAXIMO.

- Proactive leak survey and condition assessment to reduce high risk watermain failures.

Other watermain maintenance practices include watermain flushing. Additional information on watermain flushing is provided in Chapter 3.

5.3.3.2 Reservoirs and Tanks

Storage facility cleaning is also performed to remove sediment, debris, and/or microbial growth as described in Chapter 3.

5.3.3.3 Water Pump Stations

Pump stations in the distribution system are maintained in the same manner as described for the transmission system pump stations in Chapter 4. The asset management approach used by SPU to optimize pump station inspection and repair is Reliability Centered Maintenance (see RCM in Transmission Section Maintenance – Water Pump Stations). RCM programmed maintenance procedures have been completed for Augusta, First Hill, Broadway, and View Ridge Pump Stations, and the preventative maintenance schedules have been optimized and updated in MAXIMO. Additional pump stations are planned for RCM review in the future. In cases where changing the type or frequency of maintenance will not bring the asset to acceptable functional performance, RCM identifies capital improvements needed to address the performance requirement. Other capital improvements may also be revealed during the RCM process. For example, the RCM process for View Ridge Pump Station identified a change in the operational requirements for View Ridge Pump Station which, in turn, resulted in installation of an 8-inch pressure regulating valve (PRV) and bypass line at View Ridge Pump Station.

5.3.3.4 Water Appurtenances

SPU also performs maintenance activities for its valves, hydrants, service lines, and meters to ensure their continuing operation. A brief description of each follows.

Valves. Between 2005 and 2011, SPU responded to an average of 110 valve-related problems per year, or approximately 0.5 percent of all valves. Most valve problems can be categorized as leaks, casting failures, mechanical inoperability, and valves being buried by new pavement. Deterioration of interior packing, broken and bent stems, and construction projects are usually the causes of valve problems.

Due to a shift in priorities, the routine operation work of exercising large valves, 16 inches or larger, is performed less frequently than in the past (prior to 2003). There have been no demonstrated negative impacts from this reduction in routine exercising.

As part of the Shutdown Block Analysis described in section 5.4.1.2, a GIS layer is being developed to identify the need for new isolation valves, or relocation of existing isolation valves. Cost effective system improvements can then be implemented as opportunities arise (e.g. third-party projects or asset failure).

SPU plans on reviewing and updating its maintenance strategy for distribution system gate valves in 2012.

Hydrants. Each fire service agency inspects hydrants located within its service area, generally on an annual basis. Defects are reported to SPU for repair. In 2010, SPU responded to approximately 2,200 work orders to address fire hydrant defects. During maintenance visits, SPU paints hydrants to prevent exterior corrosion and improve their appearance.

SPU will review and update the Hydrant SAMP and associated maintenance strategy in the near future.

Service Connections. Maintenance related to service connections includes leak investigations, minor repairs on service lines, and replacement of broken valves, rods, or fittings. In 2011, an analysis was performed to define the asset management strategy for services, which is summarized here. SPU's water service renewal program consists of both reactive and proactive components:

- Reactive renewals include asset failure renewals due to emergency or non-emergency breaks, leaks, or mechanical failures (shutoff valve or meter failures), typically reported by customers. Reactive renewals called "demand renewals" are also identified by SPU staff when other projects trigger the need for a service connection replacement, such as during watermain relocation/replacement, service upsizing/downsizing, or "companion" renewals (substandard service pipes located in the same trench as another excavated water asset, which would likely fail during backfill and compaction).

- Proactive renewals include opportunity renewals and critical renewals. Opportunity renewals are performed when other projects, typically transportation-related projects, are restoring

street pavement at no cost to SPU, which can be as much as 40 percent of the total cost to replace service connections. Critical renewals target small services where the remaining life is projected to be short and the consequences of a break would likely be significantly higher than typical. For example, a "critical" site may be in a steep slope or landslide area, or in high volume traffic roads offering few options for detouring traffic.

In addition, SPU has observed through practice that proactive service retirement is not cost effective, and, therefore, most service retirements are carried out reactively. Inactive service pipes are typically retired when leaks develop, new services replace the obsolete service, or the unused service is in conflict with or is abandoned with new right-of-way improvements or watermain work.

Meters. SPU's retail water meters ensure proper billing for water use as well as for wastewater services. Meter problems may be identified at the time of meter reading, such as when broken meter dials are found, or by the billing system, such as when consumption is much higher or lower than what is expected for a customer based on historical information. Metering issues may also be discovered when customers inquire about unusually high bills. Such issues may lead to testing, repair or replacement of a meter depending on its size and customer class.

A large meter outside the 97 to 103% accuracy range is either repaired to restore its performance or replaced. SPU does not typically repair small meters since it is generally less expensive to replace than repair them.

SPU has a meter testing and maintenance program for its large meters, which represent less than three percent of all retail meters. SPU's goal is to maintain accuracy of large meters to between 97 and 103 percent as per the guidelines of the American Water Works Association. A large meter with an accuracy falling outside that range is either repaired to restore its performance or replaced. In 2009 and 2010, SPU replaced approximately 125 large retail meters per year.

SPU does not typically perform maintenance activities for small meters since repairing small meters is not cost-effective and it is generally less expensive to replace a small meter than repair it. In 2009 and 2010, SPU replaced about 1,700 small meters each year, or less than one percent of all meters each year.

Existing meters may be retrofitted, or new meters may be equipped, with radio units for AMR to allow walk-by meter reading when more cost-effective than visual reading. Currently, this type of installation is determined on a case-by-case basis.

Update of the Meter SAMP is planned for 2012.

5.3.3.5 Record Keeping and Reporting

SPU uses its MAXIMO work management system to capture asset failure and maintenance history. A MAXIMO reimplementation project commenced in March 2010 and is planned to be completed in 2012. This project will accomplish the following objectives:

- Improve data collection reliability and consistency.
- Improve data accuracy to assess asset maintenance needs and asset life-cycle costs.
- Improve service delivery problem response and remedy through improved work planning and improved GIS interfaces for field crews to access information and enter data.

SPU uses a geographic information system (GIS) to record and display locations of physical assets and problems. This tool is also used to review shutdown blocks, gridding and hydrant spacing, identify critical assets and develop asset management strategies.

5.4 NEEDS, GAPS, AND ISSUES

The primary needs, gaps, and issues facing SPU's distribution system in the coming years are related to distribution system assessment, asset management planning, distribution system improvements, and opportunities presented by third-party projects. The following subsections summarize these issues and SPU's approach to addressing them.

5.4.1 Distribution System Assessment

The Distribution System business area is the most asset-intensive of the business areas for the drinking water system. In recent years, SPU has been reviewing needs and gaps related to maintenance, rehabilitation and replacement of these assets. SPU identified as near-term priorities the need for conducting watermain condition assessments and a shutdown block analysis, as described below.

5.4.1.1 Watermain Condition Assessment

Parts of SPU's water distribution system, in particular many of its pipelines, have been in place for more than a century. Although the existing system is in good condition, as evidenced by its low leakage and break rates, SPU has limited information of the

condition of watermains, especially those in critical locations. SPU uses an asset management framework to prioritize capital investments for watermains. Priority is given to replace or rehabilitate pipes that have reached the end of their economic life, and replace or rehabilitate critical pipes before they fail. Critical watermains are defined as pipes essential for service delivery or those with high consequences of failure. Critical watermains, which meet threshold criteria will undergo watermain condition assessment, if feasible. The threshold criteria used to determine criticality are under review.

As noted in Chapter 4, SPU conducted in 2007 a leakage test of Cedar River Pipeline 2 from Volunteer Reservoir to Maple Leaf Reservoir (also known as the 430 Pipeline) using "smart ball" technology to assess its condition. This initial phase of a proactive leak detection pilot was successful, and the program is being expanded. The expanded pilot will ascertain the condition of several of the most critical watermain segments by assessing for leaks and/or remaining pipe wall thickness. If critical watermains are found to be in need of repair, they will be repaired or given a high priority for capital investment to rehabilitate or replace prior to pipe failure. This evaluation will be based on asset management principles.

5.4.1.2 Shutdown Block Analysis

When one or more valves are closed to isolate a portion of the distribution system to make repairs or install new pipes or appurtenances, the area that no longer has water flowing is called a "shutdown block." Any water services or hydrants within the shutdown block area would experience a service interruption. A simple example is when a pipe segment is taken out of service by closing valves at each end and service delivery is interrupted along the pipe segment. Depending on the pipe network configuration, a shutdown block may cover more than one city block.

SPU has completed a shutdown block analysis in which each pipe segment in the retail service area was evaluated to determine the service delivery impact if that pipe segment is taken out of service. In this context, service delivery impacts are based on the number of customers, the number of hydrants, and the flow rate in the pipe. Pipe segments associated with High Impact Shutdown Blocks (HISB) will be identified on a GIS layer. The HISB GIS layer will be used during the planning phase of redevelopment and third-party projects to reduce the size of the shutdown block and mitigate service delivery impacts with the installation of additional isolation valves or watermains. The HISB GIS layer will also be

used during emergency shutdowns to improve operational response and customer service.

5.4.2 Asset Management Planning

What do you mean by "asset management"?

Asset Management is an approach to making decisions about operations and maintenance work and capital investments that is based on a long-term view of financial, social, and environmental costs and benefits, otherwise known as the "triple bottom line." Asset management provides the highest long-term value to ratepayers while minimizing life-cycle cost.

As noted in the *2007 Water System Plan*, important asset management planning documents that SPU uses include strategic asset management plans (SAMPs). SAMPs are 3- to 5-year planning documents that guide the management of assets to meet defined objectives. Each SAMP covers a class of assets (e.g., pipelines) and describes relevant assets and service levels, operations and maintenance strategies, replacement/renewal capital plans, and decision tools and models for that asset class. In some instances, maintenance strategies may be developed separate from a SAMP. Additionally, ongoing programs may be evaluated to determine near-term investment strategies, which are documented in what SPU calls a Programmatic Business Case. The complexity of the asset class and the complexity of the management strategy for the asset class determine which documents are most appropriate. Watermains, for example, require a Programmatic Business case, a SAMP and a maintenance strategy.

Since the Distribution System Business Area is the most asset-intensive business area for SPU – requiring major investments and significant resources to maintain – SPU has completed initial versions of SAMPs for all of the relevant asset classes in the distribution system. As noted previously in Section 5.3.3.4, in 2012 SPU plans to update the Meter SAMP and gate valve maintenance strategy. Additionally, the Water Distribution Pipes SAMP and Programmatic Business Case will be updated in 2012. SPU also plans on completing in the next few years updates to the Valve SAMP, and Hydrant SAMP and maintenance strategy.

5.4.3 Distribution System Improvements

SPU has a capital program for distribution system improvements. This program is used to identify, prioritize and fund seismic upgrades of the backbone pipeline system and fire flow and pressure improvements. The program may also consider cleaning and lining as an option for making system improvements in areas with unlined cast iron pipes. These aspects of the distribution system improvement program are described in the following subsections.

5.4.3.1 Backbone Pipeline System Seismic Upgrades

The benefits of seismic upgrades will be considered when pipe replacement projects with multiple benefits are prioritized and implemented.

As noted in the *2007 Water System Plan*, SPU investigated cost-effective approaches to mitigating the effects of earthquake pipeline damage on the water system functionality, including line valves to isolate the Duwamish River Valley area and reservoir valves to retain water in storage for drinking water and firefighting. Additionally, replacement of certain existing watermains with seismically resistant pipe can be cost-effective when the watermain needs to be replaced for other reasons, such as when third-party projects require relocation of the watermain. For example, the seismic upgrades in the Duwamish River Valley area occurred when SPU took advantage of opportunities created by Seattle Department of Transportation projects.

SPU has completed some seismic upgrades in conjunction with other projects, but some work remains, specifically completion of the seismic backbone for an 800-foot section of watermain located in the Duwamish River Valley area on the west side of Beacon Hill in the vicinity of Interstate 5 and the Burlington Railroad line at Spokane Street. Also, installation of additional valves along the general boundary of the liquefiable soils in the Duwamish River valley is planned. Exact locations, operating strategy, hardware, and SCADA requirements are yet to be defined. The benefits of other seismic upgrades will continue to be considered when pipe replacement projects with multiple benefits are identified and implemented.

5.4.3.2 Fire Flow Improvements

Although the majority of the SPU's hydrants are able to deliver more than adequate flows to combat fires, there are areas inside and outside of the City of Seattle where SPU's water system has hydrants that cannot deliver fire flows to existing buildings under current codes required for new buildings. This can be caused by a combination of factors including pipes with small diameters or areas with low water pressure due to older design standards, or pipes whose interiors have been reduced by deposits. There are also areas that were originally built to now obsolete fire codes, most notably the Arbor Heights area annexed to the City of Seattle in 1954.

Although SPU is not legally obligated to upgrade the existing system to meet current standards, SPU's distribution system is upgraded to current fire flow standards as needed for development/redevelopment and as other system improvements are made (see section 5.4.4).

In 2011 SPU and the Seattle Fire Department (SFD) formed a Joint Executive Team (JET) to enhance coordination between the departments in delivering fire protection services to the public. The JET will set policies to improve fire hydrant maintenance and testing practices, as well as communication between SFD and SPU's water system control center and emergency crews just prior to and during fire fighting. The JET also reviews and prioritizes fire flow improvement projects, the latest one being the Arbor Heights fire flow improvements expected to be completed by the end of 2012.

SPU also intends to engage in similar discussions with other fire departments having jurisdiction in SPU's retail service area.

5.4.3.3 Watermain Cleaning and Lining

SPU's distribution system contains more than 700 miles of unlined, cast iron pipes – approximately 42 percent of all watermains. As these pipes age, many of them exhibit varying degrees of tuberculation, small mounds and growths of corrosion (rust) inside of pipe. Tuberculation increases the pipe wall roughness inside of the pipe, thereby increasing resistance to water flow which reduces pipe flow capacity, lowers the pressure of water delivered to customers, increases pumping costs, and causes water quality problems such as discoloration, low chlorine residuals, and undesirable tastes and odors.

Replacing all of these pipes with new ductile iron pipes would be very costly. A less costly alternative to pipe replacement is to clean (scrape and remove the tuberculated areas) and then apply a lining to the interior of the pipe. This pipe rehabilitation method has been proven elsewhere to restore flow capacity, eliminate discolored water, reduce pipe leakage, and extend the life of pipes. Since cleaning and lining work generally does not require pipeline excavation, there is also less disruption to the community than with pipe replacement.

SPU completed a pilot cleaning and lining project in 2007 on approximately 19,130 feet of unlined, cast iron pipe in the Ballard area, and found this rehabilitation technique to be successful. The costs for completing the cleaning and relining, including associated costs such as laying temporary water service mains and installing flushing stations, was approximately $153 per foot, which is significantly less than the cost of pipe replacement. Issues with managing high pH levels shortly after construction, which are associated with the lime in the new cement mortar lining leaching out, can be managed through the use of unattended flushing

stations. Water quality, as indicated by chlorine residuals, significantly improved after lining. While customers in the area did complain about brown water from valve operations and tastes and odors associated with the new service lines used by the contractor, the overall impact to the community was minimal in comparison to pipe replacement projects.

In its options analysis to address fire flow, water quality, or pressure issues in the distribution system, SPU considers the use of cleaning and lining as an alternative to replacement of deteriorated unlined, cast iron pipe. To date, no additional clean and line projects have been implemented.

5.4.4 Third-Party Projects

Projects initiated by third parties may require SPU to make system changes or provide an opportunity for SPU to make improvements.

Other agencies, utilities and private developers construct projects in the retail service area that can impact the distribution system. These third-party projects often necessitate SPU to make system changes that it would not otherwise do, but they can also present opportunities for improving flow capacity, pressure, reliability, and water quality in the distribution system at a reduced cost to SPU ratepayers. The following sections describe the impact on the distribution system from transportation projects and new development.

5.4.4.1 Transportation Projects

Transportation projects are third-party projects that can have a significant impact on the water system because of the need to relocate or protect existing water infrastructure. Also, transportation projects often create opportunities to renew or upgrade water infrastructure assets at a lower cost by taking advantage of the street opening and reducing pavement restoration costs.

SPU considers whether to relocate or retire water infrastructure for transportation projects when the existing water infrastructure would not be able to remain in its existing location due to grade conflicts, would no longer be accessible for maintenance and repair, would have increased consequences of failure after the transportation improvements have been built, or would have a high probability of failure due to damage during construction that cannot be remedied by protection measures. Water infrastructure may be retired when it is not needed for water delivery to specific water services or fire hydrants, for the delivery of fire flow to the surrounding area, and for delivery of water to surrounding areas such as usually provided by feeder mains. Watermain gridding is

also considered in watermain decisions as a way to mitigate the impacts that dead-ends have on the system, such as to water quality and shutdown block size. Distribution mains that cannot be retired but are smaller or larger than the standard pipe sizes (8-inch for single–family residential areas and 12-inch for industrial and commercial areas) are evaluated for proper sizing prior to relocation. The evaluation usually involves hydraulic modeling of the present-day water system configuration and expected future uses and densities.

If water infrastructure does not need be relocated and is not slated for retirement, SPU may choose to protect it in place or take the opportunity to renew or upgrade it. SPU has developed a Watermain Replacement Opportunity Model, which was described in the *2007 Water System Plan*, and uses it to make data-driven decisions about whether to protect each existing watermain or to replace it. If the cost savings from the concurrent work with the transportation project are substantial enough, and/or the condition of the existing watermain is deteriorated, the model will indicate that the watermain is a candidate for replacement. The watermain may be replaced in kind, upsized or downsized depending on current and anticipated capacity requirements.

The extent of transportation improvements in Seattle's retail service area by Sound Transit, Washington State Department of Transportation (WSDOT), Seattle Department of Transportation (SDOT), and the City of Shoreline is expected to remain high at least through the first six years of the planning period, with the larger projects being as follows:

- SR99 Improvements through downtown Seattle by WSDOT, including new tunnel construction and demolition of the existing Alaskan Way Viaduct.
- Seattle Central Waterfront Redevelopment by SDOT.
- First Hill Streetcar implementation funded by Sound Transit and led by SDOT.
- Design and construction of the University, North, and East Links of the light rail system by Sound Transit.
- Aurora Ave/SR99 redevelopment between 192nd Street and the King-Snohomish county line by the City of Shoreline.
- The replacement of the SR520 highway, and improvements to the I-5/SR520 interchange by WSDOT.

- Arterial street resurfacing and reconstruction under the "Bridging the Gap" program by SDOT.

Because these transportation projects are led by third-parties, the schedule for completion is not within SPU's control and is subject to change.

5.4.4.2 Redevelopment

Redevelopment activities can have a substantial impact on the ability of the existing distribution system to provide sufficient water to customers and for fire flows. Redevelopment typically increases the population density of an area and can increase the quantity of water that must flow through SPU's distribution system pipes. Rezoning can also change distribution system requirements, particularly when single-family residential parcels are rezoned to mixed or commercial uses. Most often, extension of the distribution system or improvements to existing watermains in the redeveloped area becomes necessary to accommodate higher fire flows. Detailed hydraulic models or hydrant flow tests are used in conjunction with fire flow requirements provided by the fire department[1] to identify potential watermain improvements when properties are redeveloped, as well as when new development takes place.

New developments must meet the current fire code, and new service connections must be made to standard watermains. SPU reviews and provides a water availability certificate for each development as part of the local government's building permitting process. If there is a gap between what the existing system can provide and what the private development needs, the developer will be required to upgrade the existing system to meet requirements. Developers are required to pay for connection to the system. New tap installations are directly billed to the customers.

5.4.5 Service to Shoreline

SPU is in discussion with the City of Shoreline about how SPU's infrastructure within the City of Shoreline could be transferred to the City if they are successful in getting voter approval to form a utility. With conceptual agreement on a sale of assets in 2020, SPU and Shoreline will attempt to reach agreement on how the

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[1] See footnote on page 5-9 for fire departments with jurisdiction in SPU's retail service area. For the City of Seattle, fire flow requirements are defined by the Seattle Fire Code (SMC 22.600). Fire flow standards for unincorporated King County are defined by KCC 17.04 and 17.08.

systems would be separated and utility functions would be transferred, and at what cost.

5.5 IMPLEMENTATION/ACTION PLAN

As described in this chapter, the major needs for managing the distribution system to meet service level targets include distribution system assessment, asset management planning, distribution system improvements, and opportunities presented by third-party projects. SPU has identified the following actions to address these needs:

- Manage retail service delivery, problem response and leakage to meet service level targets.
- Complete analyses to determine whether to decommission Trenton Standpipes and Volunteer Park Standpipe.
- In a pilot effort, assess the condition of a portion of the most critical watermain segments and, if needed and supported by analysis, repair, rehabilitate or replace the pipe prior to anticipated failure. Expand the initial condition assessment pilot, if appropriate.
- Improve operational response and customer service by using information from the watermain shutdown block analysis in project and emergency shutdown plans.
- Complete additional asset management documents, including updates to the Meter SAMP, the Hydrant SAMP and maintenance strategy, and the Valve SAMP and maintenance strategy.
- Complete the remaining seismic backbone upgrades to the distribution system that serve the Duwamish River Valley.
- Consider the use of cleaning and lining as an alternative to replacement of deteriorated unlined, cast iron pipe to address pipeline life, fire flow, water quality, and pressure issues in the distribution system.
- Continue to work with the Seattle Fire Department to improve fire hydrant maintenance and testing practices, better coordinate communication between SFD and SPU's water system control center and emergency crews just prior to and during fire fighting, and prioritize fire flow improvement projects. Engage in similar discussions with other fire districts.

- Continue working with developers where watermain replacements or upgrades in redevelopment areas are required to meet current fire flow requirements and watermain standards.

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PART II: PLAN IMPLEMENTATION

Part I of the *2013 Water System Plan* presents SPU's water system business "roadmap" for the next six years and beyond. The first chapter of Part II details the anticipated costs of implementing that roadmap through 2040, with a particular focus on the next six years. The second chapter of Part II presents SPU's plan for financing identified operations and capital facilities improvements and priorities in addition to supporting the existing and ongoing costs of SPU's water utility operations.

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Chapter 1
Budget

Seattle City Council

Part I described SPU's drinking water CIP projects and O&M programs and identified a number of needs, gaps, and issues facing SPU in each of its business areas. This chapter focuses on the budget required to implement capital programs and operations and maintenance (O&M) activities to meet SPU's regulatory and customer service objectives, including addressing the needs and gaps identified in Part I of this plan. The first part of the chapter begins by describing SPU's process for developing a capital improvement budget for the water system. Later, the chapter identifies a draft budget for the six-year capital improvement plan (CIP) and capital facilities plan (CFP) and O&M budget outlook through 2040 for the water line of business.

1.1 Capital Improvement Budgeting

SPU has made a major commitment to using an asset management approach in selecting which capital improvement projects go forward.

Since the *2007 Water System Plan* was prepared, SPU has been implementing an asset management approach in selecting which capital improvement projects go forward. Asset management is a method of meeting established and well-defined service levels at a cost that represents the highest life cycle value to the utility's ratepayers. This may lead to new capital projects or shifts in O&M activities. By adopting an asset management approach, SPU is better able to ensure cost effectiveness in service delivery in the long-run.

Elements of SPU's asset management approach were described in the *2007 Water System Plan.* One key element is development of a business case for each project (formerly known as a Project Development Plan) that includes a clearly define problem, an analysis of alternative solutions, and a benefit-cost analysis to inform a preferred alternative decision. Business cases for projects or programs that are projected to cost $1,000,000 or more over their life, considering both capital and O&M costs, must be reviewed by SPU's Asset Management Committee (AMC), which is composed of SPU's Executive Team. Water CIP projects that are estimated to cost less than $1,000,000 must be reviewed by the AMC for the water line of business. Such approvals support asset

management by making deliberate decisions about projects and programs in a transparent manner, fully informed by financial, environmental, and social impact life-cycle costs and benefits of the business case.

Many of the projects that are included here have not yet gone through a final business case evaluation and review by the AMC. The project descriptions, scope, budget and timing are based on best current planning.

1.2 Business Area Actions and Costs

Part I of this *2013 Water System Plan* identifies key actions for each water utility business area over the next six years. Those key actions related to capital projects are recapped below for each business area. An overview of the 2013-2018 CIP budget, summarized according to business areas, is presented in Table 1-1. The detailed draft CIP is provided with the Capital Facilities Plan as an appendix. CIP cost estimates presented in this plan are preliminary and subject to change as the projects are further developed and analyzed. CIP projects are subject to AMC approval and budget adoption by the Seattle City Council.

Table 1-1. Capital Improvement Program Budget 2013-2018 (2012-2017 Adopted CIP, plus 2018 Estimate, in thousands of 2011 dollars)

Business Area	2013	2014	2015	2016	2017	2018	Total
Water Resources	5,359	8,239	8,076	11,070	9,147	3,245	**45,135**
Water Quality and Treatment	5,088	1,458	187	190	700	1,600	**9,223**
Transmission	2,910	2,898	2,898	2,894	3,013	3,013	**17,626**
Distribution	26,098	24,257	25,270	25,237	25,455	25,019	**151,335**
Other	22,016	23,945	21,238	19,807	22,636	16,890	**126,533**
Total	**61,471**	**60,797**	**57,668**	**59,199**	**60,951**	**49,767**	**349,853**

1.2.1 Water Resources

Major CIP projects for the Water Resources business area include the following:

- Implement the 2013-2018 Water Use Efficiency program for the Saving Water Partnership, which is budgeted at $1.7 million per year.
- Implement the Seattle-only low income conservation assistance program at a cost of $650K per year.
- Design and construct flood passage improvements at Landsburg Diversion Dam on the Cedar River. The

improvements include replacement of two existing spillway gates with one larger, radial gate and installation of a trash rake system for debris handling. The CIP includes a cost estimate of $1.7 million in 2013-2016 to complete this work.

- Complete the Overflow Dike Improvements. The CIP includes $3.6 million in 2013-2014 for this work.

- Implement any capital improvements resulting from regular inspections by Ecology and FERC of SPU's dams and related infrastructure, such as spillway gates and dam failure warning systems. The Dam Safety program CIP totals to almost $700K in 2013-2018, and also includes costs in future years for work anticipated after planned inspections.

- Design and construct the Morse Lake Pump Plant, which involves installation of axial flow floating pumps and improvements to the discharge channel. The CIP includes a cost estimate of $23.2 million in 2013-2017 to complete this work, but this estimate may increase as further engineering and design are completed.

1.2.2 Water Quality and Treatment

Completion of the open reservoir covering/burying program comprises the bulk of the CIP projects in the Water Quality and Treatment business area:

- The Maple Leaf Reservoir Replacement Project is estimated to cost $47 million and is scheduled to be on-line in 2012.

- The existing open Volunteer Reservoir may be decommissioned rather than constructing a new buried reservoir replacement at the site, but additional analysis is required to confirm this action. The CFP assumes that the reservoir will be buried by 2021 at a cost of $22.8 million.

- Roosevelt reservoir is planned to be taken out of service following the return to service and completion of Maple Leaf Reservoir and is targeted for decommissioning in 2015.

- The CIP includes $1.8 million in 2013-2015 to replace the gas chlorination facilities at Landsburg with liquid chlorination (hypochlorite) facilities to improve safety and security.

- The CIP includes approximately $100K per year for various smaller scale water quality and treatment facility rehabilitation

and improvement projects that relate to public health protection and drinking water regulatory compliance.

1.2.3 Transmission

- The major CIP projects identified for the transmission system include the following:Implement cathodic protection for transmission pipelines, where cost-effective. This is estimated to cost $1.6 million per year in 2013-2022.

- The CIP includes $1 million per year for Transmission Pipeline Rehabilitation, including any additional work to mitigate the risk of pipe failure in the Tolt Slide area.

- The CIP includes approximately $100K per year each for air valve chamber replacements and system dewatering.

- Purveyor Meter Replacements are estimated to cost approximately $90K per year through 2016 and $200K thereafter.

1.2.4 Distribution

Several ongoing improvement programs for the distribution system are contained in the CIP. These and other major CIP projects identified for the distribution system include the following:

- Where cost-effective, reline or replace aging watermains, provide seismic upgrades to the backbone system, and improve pressures and fire flows. The draft six-year CIP includes more than $4.5 to 10 million per year for these Distribution System Improvements and Watermain Rehabilitation projects.

- Extend watermains and install new taps to new developments. The draft six-year CIP includes approximately $650,000 to $750,000 per year for watermain extensions and $4 million per year for customer-reimbursed new taps.

- Relocate, rehabilitate or replace water mains and appurtances impacted by other projects, primarily transportation-related projects. This work includes water system improvements and enhancements required for major projects by other agencies, such as the Alaskan Way Viaduct and Seawall. The draft six-year CIP includes $25.3 million for these types of projects.

- Replace leaking or substandard service connections, primarily plastic. The draft six-year CIP includes approximately $5.5 to 5.9 million per year for this ongoing work.

- Replace meters. The draft six-year CIP includes approximately $600,000 per year for this ongoing work.

- Upgrade or replace hydrants, valves, chambers and pump stations. The draft six-year CIP includes approximately $1 to $1.3 million per year for this ongoing work.

1.2.5 Other Water Utility Capital Projects

In addition to the major projects discussed in this water system plan and summarized above, SPU has identified a number of other water system capital projects to be implemented over the next six years. These projects include those in the Major Watersheds business area, such as those related to the Cedar River Watershed Habitat Conservation Plan and watershed stewardship in both watersheds. Projects involving more than one business area yet important for achieving the overall goals of the drinking water utility are also included here. These other projects and their costs are listed in Table 1-2.

Table 1-2. Other Capital Projects and Six-Year CIP Costs (2012-2017 Adopted CIP, plus 2018 Estimate, in thousands of 2011 dollars)

Capital Improvement Program Projects	2013	2014	2015	2016	2017	2018	Total
Cedar River Watershed Habitat Conservation Plan	3,241	3,439	2,721	2,254	1,606	1,756	**15,016**
Watershed Stewardship	995	687	554	543	533	100	**3,412**
Technology	7,410	8,184	5,964	5,358	5,327	6,000	**38,242**
SCADA	466	457	443	408	355	400	**2,529**
Security	1,922	1,884	1,847	1,811	1,793	1,000	**10,258**
Heavy Equipment Purchases	2,951	1,934	2,979	2,156	1,931	2,500	**14,451**
In-Town Facilities	1,514	3,775	2,225	2,547	2,387	2,550	**14,998**
Regional Facilities	3,296	3,315	4,227	4,494	8,480	2,450	**26,262**
Emergency Storm Response	48	47	46	45	0	0	**187**
1% for Art	174	224	231	191	224	134	**1,177**
Total	**22,016**	**23,945**	**21,238**	**19,807**	**22,636**	**16,890**	**126,532**

1.3 Long-Range Capital Facilities Plan Budget

In addition to developing the six-year capital improvement program summarized above, SPU has developed its best estimate of a Capital Facilities Plan (CFP) budget through 2040, given what is known and anticipated at this time, including our understanding

of future regulations. Beyond 2018, the range of uncertainty in project costs and timing is greater. While projections are shown through 2040, experience has shown that new requirements emerge and projections change over time. In particular, many programs are shown with uniform expenditures in each future year even though it is likely that the costs will be concentrated into some years as specific projects are identified and scheduled. In particular, this CFP does not address any potential major emergency or disaster which could lead to the need for a new major project. SPU would most likely attempt to smooth out expenditures, but this is not always possible.

The CFP budget estimate is provided as an appendix and summarized in Table 1-3. SPU's CFP totals to $1.4 billion for 2013 through 2040, which is 64 percent of what was spent in the previous 28-year period, in 2011 dollars. Approximately one-half of the current CFP is for improvement to and rehabilitation of the distribution system.

Table 1-3. Capital Facilities Plan Budget through 2040
(2012-2017 Adopted CIP, plus 2018-2040 Estimate, in thousands of 2011 dollars)

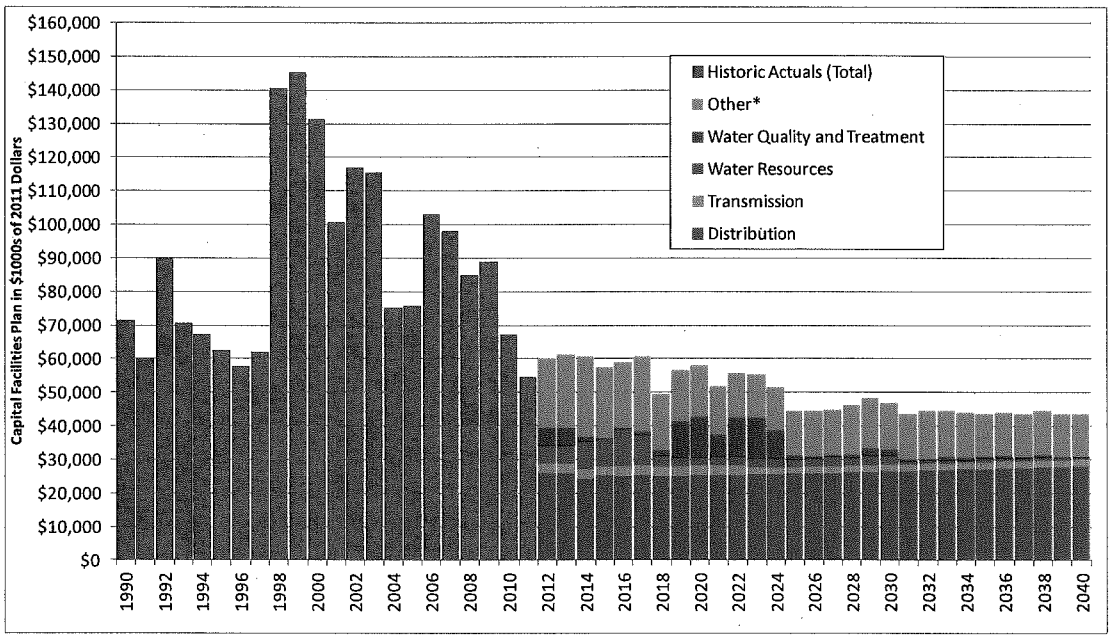
Business Area	2013-2020	2021-2025	2026-2030	2031-2035	2036-2040	Total
Water Resources	50,410	13,079	13,229	4,634	4,454	**85,806**
Water Quality and Treatment	31,723	39,400	5,800	3,450	2,250	**82,623**
Transmission	23,652	12,065	10,065	10,065	10,065	**65,912**
Distribution	201,712	128,029	131,247	134,778	138,630	**734,395**
Other*	157,318	67,018	71,071	67,699	64,407	**427,513**
Total	**464,815**	**259,591**	**231,412**	**220,626**	**219,805**	**1,396,249**

*See Appendix for additional detail.

Figure 1-1 graphically represents SPU's long-range CFP budget for the water utility. Capital spending is expected to be highest in the earlier years, but much lower than historical peak expenditures that occurred from 1998 to 2009. The first major new project is the Morse Lake Pump Plant Project (Water Resources). This is followed by increased expenditures in 2018-2025 to recover Lake Forest Park Reservoir and bury Volunteer and Bitter Lake Reservoirs (Water Quality and Treatment). Additional increases around 2030 are for improvements at the Tolt and Cedar water treatment facilities (Water Quality and Treatment). The long-range CFP also includes increasing costs in Distribution for an increasing need for watermain rehabilitation as the system ages.

SPU's *2007 Water System Plan* included a long-range capital facilities plan for the water utility. That plan covered the period 2007 through 2030. Table 1-4 compares the CFP budget for the

2007 plan with the CFP budget presented in Table 1-3 and Figure 1-1.



* Other includes Major Watersheds, Fleets, Facilities, Security, Information Technology, SCADA and other miscellaneous projects.

Figure 1-1. Historic and Proposed Capital Facilities Plan Spending through 2040

As Table 1-4 shows, SPU has increased its capital spending projections for the 2013-2020 period relative to that provided in its *2007 Water Systems Plan* primarily due to delays in large projects, such as the Morse Lake Pump Plant project, and increased expenditures for the distribution system.

Table 1-4. Comparison of Capital Facilities Plan Budget Estimates from *2007* and *2013 Water System Plans* (in total millions of dollars for the year range shown)

Water System Plan	2013-2020	2021-2025	2026-2030	2031-2035	2036-2040
2007 (in 2006 $s)	290	165	178	N/A	N/A
2013 (in 2011 $s)	465	260	231	221	220
Increase	175	95	53	N/A	N/A

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Chapter 2
Financial Program

This chapter describes the likely methods of financing the estimated cost of operating SPU's water system and investing in the capital projects described in Chapter 1 of Part II.

2.1 FINANCIAL POLICIES

Financial management of the water system is directed by formal financial policies adopted by the City Council and by informal guidelines that have evolved over time in response to specific issues. These policies and guidelines are used to decide how to finance water system operations and capital projects. They are intended to ensure that the water system finances its costs in such a manner that specific policy goals are achieved. These goals are:

- To ensure the financial integrity of the water utility.
- To moderate rate increases for water system customers over the near and medium term.
- To ensure an equitable allocation of capital costs between current and future ratepayers.

In 2005, the City Council adopted new water system financial policies that reflect changes and additions to the financial policies adopted in 1992. The new financial policies are more appropriate for the current financial environment and capital financing requirements, and also reflect changes made in 2005 to the conditions for activity in the Revenue Stabilization Subfund. The financial policies are as follows:

1. Maintenance of Capital Assets. For the benefit of both current and future ratepayers, the municipal water system intends to maintain its assets in sound working condition. Future revenue requirement analyses will include provision for maintenance and rehabilitation of facilities at a level intended to minimize total cost while continuing to provide reliable, high quality service.

2. Debt Service Coverage. Debt service coverage on first-lien debt should be at least 1.7 times debt service cost in each year on a planning basis.

3. Net Income. Net income should generally be positive.

4. Cash Funding of the Capital Improvement Program. Current revenues should be used to finance no less than 15 percent of the municipal water system's adopted CIP in any year, and not less than 20 percent of the CIP over the period of each rate proposal. Cash in excess of working capital requirements may be used to help fund the CIP.

5. Eligibility for Debt Financing. Unless otherwise authorized by the City Council, the following criteria must be met before project expenditures are eligible for debt financing:
   - Project is included in the CIP.
   - Total project cost exceeds $50,000.
   - Project has expected useful life of more than two years (more than five years for information technology projects).
   - Resulting asset will be owned or controlled by SPU, is part of the regional utility infrastructure, or represents a long-term investment for water conservation.
   - Consistent with generally accepted accounting practices, project costs include those indirect costs, such as administrative overhead and program management, that can be reasonably attributed to the individual CIP project.

Revenue Stabilization Subfund is available to offset shortfalls in metered water sales revenues or to meet financial policies.

6. Revenue Stabilization Subfund. A target balance of $9 million will be maintained in the Revenue Stabilization Subfund, except when withdrawals resulting in balances below this amount are needed to offset shortfalls in metered water sales revenues or to meet financial policy requirements. Funds in excess of the minimum balance may be used to meet operating expenses, pay CIP expenditures, or meet financial policy requirements.

   SPU may also make discretionary deposits to the Revenue Stabilization Subfund, provided that these discretionary deposits are in excess of the amounts required to meet the financial policy requirements. Should the balance in the Subfund fall below the target balance, SPU must submit within one year a water rate proposal that rebuilds the balance in the Subfund.

7. Cash Target. The target for the year-end operating fund cash balance is one-twelfth of the current year's operating expenditures.

8. Variable Rate Debt. Variable rate debt should not exceed 15 percent of total outstanding debt. Annual principal payments

shall be made on variable rate debt in a manner consistent with fixed rate debt.

The financial policies help determine how much revenue the utility must collect from its customers each year to meet the cost of operations, maintenance and repair, and capital improvements. Because of this, rate impacts stemming from specific courses of action recommended in this water system plan cannot be determined without also considering what financial policies are to be followed. If an action's rate impacts are unacceptable, the action can be scaled back to reduce costs or alternative financial approaches can be considered to spread costs over a longer period.

2.2 FINANCIAL HEALTH

Financially healthy organizations have the flexibility to respond to unexpected circumstances. Such circumstances may include new, unexpected-but-essential tasks or a shortfall in earnings. Flexibility can mean redirecting expenditures, borrowing money to meet an unexpected need, or other approaches.

The use of debt to finance a significant amount of new and replacement infrastructure has kept rates low but increased the amount of revenue used to repay loans.

In the past, the water system financed a significant amount of new and replacement infrastructure through the use of debt. While it helped keep rates low at that time, it has also greatly increased the portion of revenue that is used to pay off the debt. In 1990, 20 cents of every revenue dollar was used to repay loans. In 2010, 37 cents of every revenue dollar was used to repay loans. This means that SPU has less flexibility in how it spends its revenues. Current revenues that are used for new facilities are the most flexible resource for meeting unexpected needs.

The increasing commitment of each revenue dollar to pay off debt makes sources of financial instability more risky because SPU has less flexibility to adjust to revenue shortfalls and unanticipated needs. One cause of revenue fluctuation for SPU is seasonal rates, which are used to discourage water use in the summer when water is most scarce. Variations in summer weather can cause annual water use to vary from an average year by as much as 5 percent. Since this variation happens in the summer, when rates are higher than the winter, summer weather variation can result in annual water sale revenue shortfalls of up to 8 percent. The Revenue Stabilization Subfund can be used to offset revenue shortfalls beyond these levels.

Reducing this weather-related revenue risk could also be accomplished by reducing the difference between winter and summer rates. Higher winter rates or increasing the base service

charge would provide more annual revenue and therefore more of a "cushion" against revenue shortfalls. However, changing the seasonal rate structure would reduce incentives to conserve water in the summertime.

There are two key indicators used by the financial community that provide a measure of how well SPU is doing in the areas identified above. The first, debt-service coverage, is an annual measure of the revenue an organization has available to repay debt, divided by debt payments. Debt-service coverage is calculated after operational expenses and some taxes have been paid. While the legal requirement in bond covenants is 1.25, SPU's debt-service coverage policy target is 1.70. The higher target provides SPU flexibility when actual revenues are lower than projected. This flexibility enabled SPU to collect the necessary revenue to stay above the legal requirements, but below the policy target, when demand in the late 2000's and early 2010's was lower than originally projected and variable rate debt was refunded into fixed rate debt when market conditions changed. A commitment was made for the 2012-2014 rate study to meet the 1.70 target by 2014.

SPU's water utility is rated Aa1 by Moody's and AA+ by Standard and Poors.

The second key indicator is the debt-to-assets ratio. The debt-to-assets ratio is the outstanding debt of the utility divided by the sum total of its assets. The debt-to-assets ratio shows how reliant the utility is on debt to finance its infrastructure and how much flexibility is has to respond to unexpected circumstances. SPU's debt-to-assets ratio for the water system is currently higher than comparable utilities and is at a level that could be a concern to the financial community, which could result in higher debt financing costs if investors view SPU as overextended. To counteract this concern, SPU has generally decreased the levels of debt financing and has forecasted continuation of this trend in the future. As a result, in recent years, SPU has had excellent bond ratings.

While SPU has been generally decreasing the levels of debt financing of the capital improvement program, exceptions occurred in 2008 and 2009 when revenues fell to the point where cash available to fund the capital program was less than 20 percent of total spending, forcing more reliance on debt. Revenue financing of capital projects is expected to increase going forward because the binding financial policy has switched from cash-to-CIP to debt service. In order to meet debt service coverage targets, revenue requirements will generate more cash than needed to cover operating expenses and other financial policy targets. The excess cash will be put towards the capital program. By investing more current revenue in infrastructure, SPU will reduce its reliance on debt and thereby reduce its debt-to-assets ratio. The necessity of

meeting the debt service coverage targets will drive rate increases in the coming years.

A summary of SPU's financial results for its water utility over the past six years is shown in Table 2-1.

Table 2-1. Financial Revenues and Expenditures, 2005–2010 (in millions of dollars)

	2005	2006	2007	2008	2009	2010
Revenues						
Water Sales	136	142	144	149	179	184
Other (tap fees, interest income, operational grants, reimbursements, etc.)	11	17	26	16	24	16
Total	147	159	170	165	203	200
Expenditures						
Operations and Maintenance	60	62	77	81	84	79
Taxes	20	24	24	25	34	36
Debt Service	59	59	59	63	71	74
Revenue-Financed Construction	4	13	18	14	8	12
Total	144	158	178	183	197	201
Net of Revenues and Expenditures	3	1	(8)	(18)	6	(1)

2.3 FUNDING SOURCES

The primary source of funding for SPU's water utility is revenues derived from the wholesale and retail sales of treated drinking water.

The primary source of funding for SPU's water utility is revenue derived from wholesale and retail sales of treated drinking water. To finance capital facilities, SPU relies primarily on borrowing. SPU also receives contributions from developers, but that funding source plays a much smaller role in capital financing. The water system is in a period of declining capital expenditure as it emerges from a period of unprecedented investment in important capital projects, such as the water treatment facilities and buried reservoir program.

As stated earlier, debt service coverage is the binding financial policy moving forward. With debt service as the binding constraint, revenues will be in excess of operating expenses, leaving excess cash to fund the CIP. As a result, from 2012 through 2040, SPU plans to meet or exceed its financial policy of financing 20 percent of its capital facilities plan with revenues. However, because of the large size of the CIP in the next six years, SPU will still rely heavily on borrowing. This will result in larger rate increases in the near term but will increase future flexibility to respond to unexpected events and will help maintain or improve current bond ratings.

2.3.1 Water Rates

In 2010, water sales made up 95 percent of operating revenues. Rates must provide sufficient revenue to operate the water system. Rate-design objectives include:

- Provide financial soundness.
- Advance economic efficiency.
- Promote customer equity.
- Encourage customer conservation.
- Contribute to transparency and customer understanding.
- Reduce impacts on low-income customers.

The affordability of rates to retail customers is also an issue considered by City Council during rate setting.

In recent years, City Council has set rates for 3-year periods. Water rates were last set in 2011 and cover 2012 through 2014. These rate schedules are provided in the appendices.

Rates are set by customer class. The major customer groupings are wholesale and retail. Wholesale rates are set as described in their contracts with SPU. Retail customers are further categorized into residential and commercial classes. The rate structure for each of the customer classes includes a fixed monthly charge, which is graduated by the size of the service, and a seasonally-differentiated commodity charge. The combination of fixed and commodity charges can be fine tuned to meet the rate objectives identified above. For example, the fixed charge can be set to recover costs that are unrelated to the amount of water used, such as billing and meter reading. Similarly, seasonal commodity rates can be set to reflect the cost differentials that exist between winter, when streamflows are high and demand is low, and summer, when streamflows are low and demand is high. Setting rates so that the bills of individual customers reflect the cost of serving them is especially important in achieving customer equity because the most commonly used definition of equity is that bills reflect costs.

To encourage conservation in the summer period, the residential commodity rate is structured with three tiers. The first tier, up to five hundred cubic feet (CCF), is designed as a "lifeline" to meet basic needs. The second tier, from 5 to 18 CCF, is billed at a

If we use less water, shouldn't it cost less?

Most of the utility's costs are the same whether we sell a lot of water or a little. These fixed costs include debt service (principle and interest paid for past capital projects) and the labor needed to operate the system, treat the water, and respond to problems 24 / 7.

When we sell less water, we need to charge more per gallon to be sure that SPU makes enough revenue to operate and maintain the water system while meeting financial policies set by the City Council.

higher rate than the first. The third tier[1], above 18 CCF, is set at an even higher rate to discourage the use of very large volumes of water, often for irrigation.

System-wide average rates[2] are likely to increase faster than the rate of inflation, particularly in the near-term. A significant portion of current and near-term rates are due to debt service on prior capital investments, such as the Tolt and Cedar Water Treatment Facilities. Going forward, those effects are still felt as future CIP and O&M spending will put pressure on debt service coverage requirements, thereby requiring increasing rates. Additionally, future rate levels depend on revenue requirements as well as the amount of water sold. With demand for water forecasted to generally decline through 2040, there will be no growth in water sales to absorb any increases in revenue requirements.

While the above discussion applies to the system as a whole, there is a categorical difference between the rates paid by wholesale customers and the rates paid by retail service customers. Wholesale customers do not pay for SPU's distribution system, since they are not served by these facilities. They pay only for their share of water supply, treatment, and transmission. Going forward, the CIP contains fewer regional projects in the areas of supply, treatment, and transmission. The rates charged by SPU's wholesale customers to *their* customers include the cost of the wholesale customer distribution systems, and would be different than what SPU charges its retail customers.

2.3.2 Debt Financing

From 2012 through 2040, an average of 69 percent of the Capital Facilities Plan (CFP) is expected to be financed with debt, as shown in Figure 2-1, below. Debt is expected to be used to finance 64 percent of CIP through 2029 and 78 percent thereafter. Until 2030, debt service coverage is expected to alter the way capital projects are financed. Because of the large debt incurred since 1999, a larger portion of revenue must go to finance capital facilities in order to meet bond covenant requirements and financial policy targets. In order to maintain debt service coverage requirements, revenue is higher than otherwise would be required.

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[1] The third tier was instituted in 2001 in response to Ordinance 120532, the Initiative 63 Settlement Ordinance.

[2] System-wide average rates are defined as the average rate paid by all customers of the utility. It is computed by taking the total water sales revenue divided by total system water use by all customers.

The additional revenue will then be utilized to fund the current capital program, reducing debt issuance and future debt service requirements.

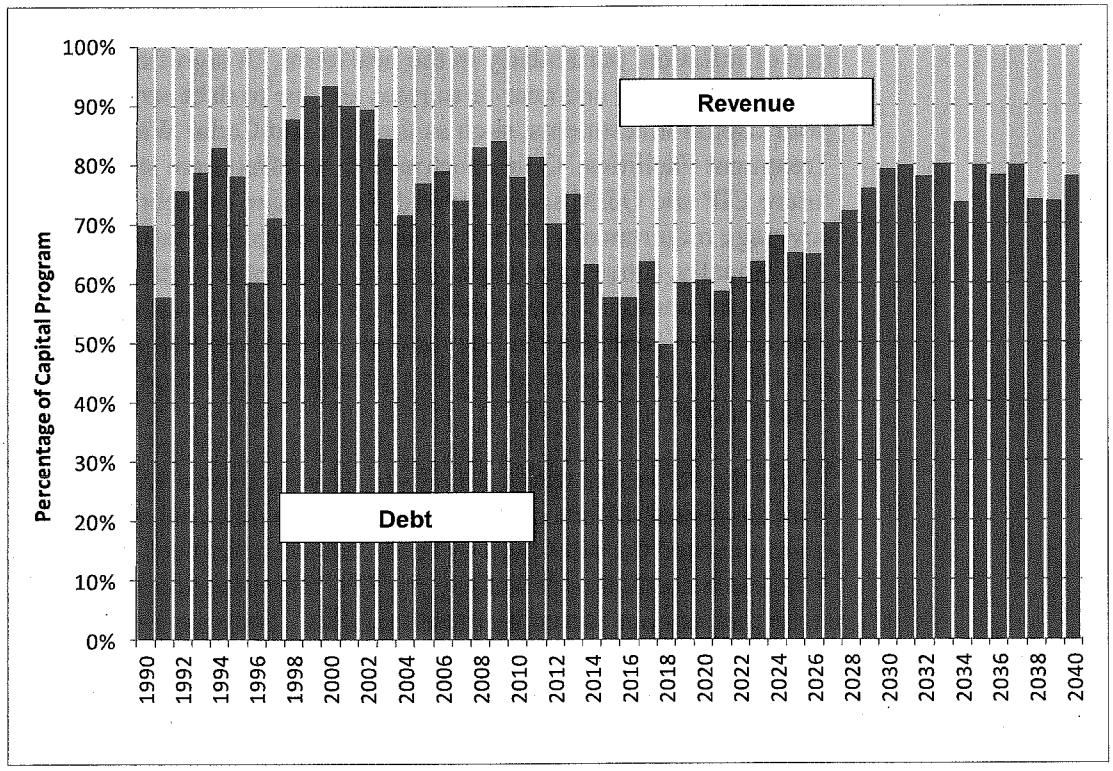


Figure 2-1. Past and Planned Debt Financing

2.3.3 Debt-to-Assets Ratio

Over the past 20 years, SPU has been borrowing extensively in order to finance the capital program and the building of new assets. This level of borrowing has increased the debt-to-asset ratio 40 percent over the past 15 years, peaking at 75 percent in 2012, as shown in Figure 2-2. However, as the utility enters a new phase of the asset life cycle, and generational asset construction slows, borrowing levels will decrease. Along with increased revenue financing of capital projects, this decreased borrowing will lower the debt-to-asset ratio in the future.

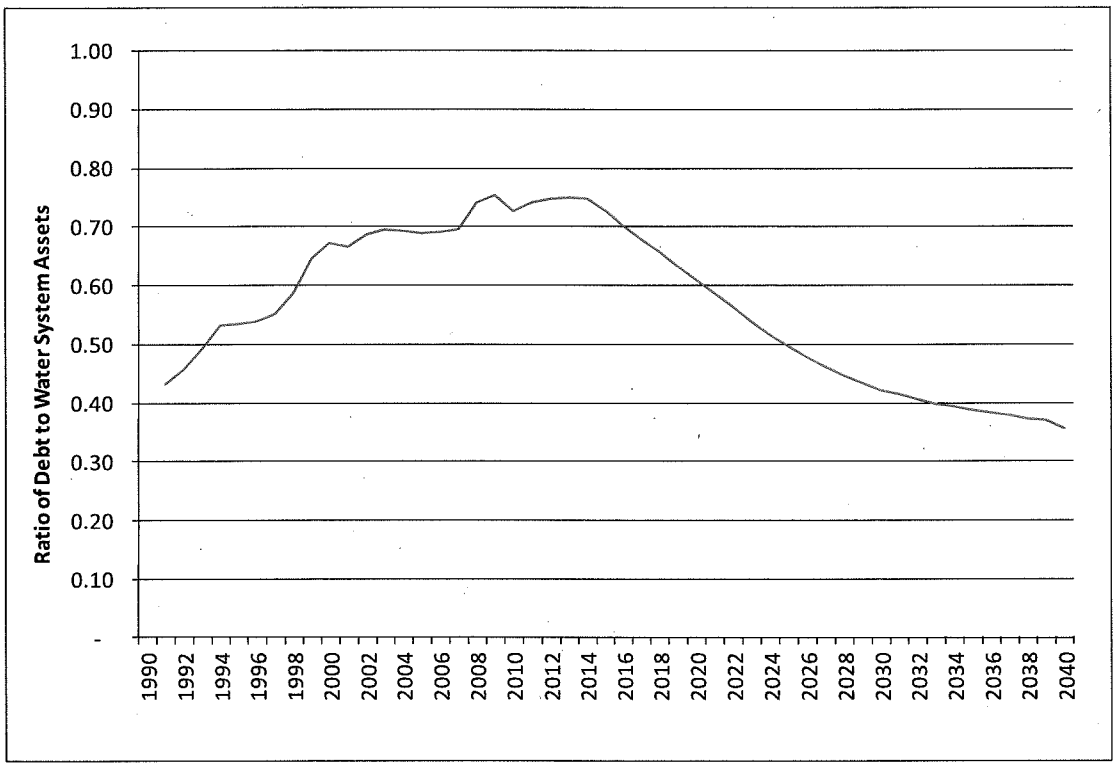


Figure 2-2. Past and Projected Debt-to-Assets Ratio

2.3.4 Alternative Financing Paths

A lower debt-to-assets ratio could be achieved more quickly by higher rate increases in the near-term, coupled with deferral of part of the capital program. This would allow a greater portion of the capital program to be financed out of revenues over time. However, it would also result in higher near-term rates, and deferring projects could prevent the water system from complying with regulatory agreements made with state and federal agencies. The current approach strikes a balance between short-term debt service needs and long-term financing that will provide the utility stability and address important capital needs and operating requirements.

2.4 Financial Model Cash Flow Analysis

The capital improvements summarized in the Part II, Chapter 1, together with projected operating expenses through 2040, were incorporated into the water system's financial model in order to develop a long-term picture of rate requirements and financial performance. The anticipated cash flows and financial performance generated by the financial model are summarized at five-year intervals in Table 2-2. The debt service coverage of 1.7

controls rates through 2030. After 2030, SPU's financial policy targets for net income and cash-to-CIP become binding for rates.

Table 2-2. Summary of Water System Cash (in millions of dollars)[1]

Revenue/Expenditures	2015	2020	2025	2030	2035	2040
Revenues						
Water Sales	241	283	318	342	398	458
Other (tap fees, interest income, operational grants, reimbursements, etc.)	21	24	26	28	32	35
Total Revenues	**261**	**307**	**345**	**370**	**430**	**493**
Expenditures						
Operations and Maintenance	102	127	158	197	243	289
Taxes	42	50	58	64	76	89
Debt Service	91	101	107	94	95	97
Revenue-Financed Construction	25	26	19	13	13	16
Total Expenditures	**260**	**304**	**343**	**367**	**428**	**491**
Net Revenue	1	2	2	3	2	1
Debt Service Coverage	1.7	1.7	1.7	1.7	1.9	2.0
Debt-to-Assets Ratio	0.71	0.61	0.48	0.43	0.38	0.36
Cash Balance	8	11	13	16	20	24
Capital Improvement Program	**2013-2015**	**2016-2020**	**2021-2025**	**2026-2030**	**2031-2035**	**2036-2040**
Revenue Financing	66	129	116	82	67	82
Contributions in Aid of Construction	6	11	12	14	15	17
Debt Financing	135	198	220	256	296	327
Total CFP Financing	**206**	**338**	**348**	**352**	**378**	**426**

[1]Notes and Assumptions:

- Actual dollars spent or received in any given year; revenues and expenditures are inflated to off-set the erosion of purchasing power over time due to inflation.
- Revenues and expenditures do not net zero in this summary because of rounding errors, contributions to cash balances, and lags between when revenues are billed and when they are received.
- Operations and Maintenance assumed to increase by 72 percent from 2011 through 2040 in real terms, or 1.8% compounded annual growth per year. For comparison, from 1990 to 2011, O&M costs have grown at an annual rate of 2.5% in real terms.
- The forecast assumes bond issues every other year at 5% interest and 30-year terms.
- The forecast assumes inflation of 2.5% per year.

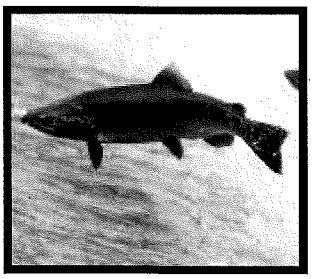
Cash expenditure growth fluctuates throughout the plan. From 2013-2025, cash expenditure grows quickly as capital expense is larger than revenue. A historically large portion of the CIP during this period is to be funded by revenue-generated cash. The largest of these include capital programs such as Distribution System Improvements, Service Renewals and Watermain Rehabilitation and large projects such as Morse Lake Pump Plant and Bitter Lake Reservoir Burying/Floating Cover Replacement. From 2025-2030, expenditures slow as a result of decreased debt service and revenue-financed construction. After 2030, expenditure growth returns to earlier levels as operations and maintenance are the primary drivers of spending.

2.5 CONCLUSION

SPU has been making, and continues to make, significant investments to protect public health, comply with federal and state regulations, and replace aging infrastructure. While SPU has invested in major regional facilities in the past decades, the need is now shifting to significant capital investments to rehabilitate and improve the distribution system. Implementation of this water system plan will help to ensure that SPU meets its mission to provide reliable, efficient and environmentally conscious water utility services to enhance the quality of life and livability in all communities we serve.

Attachment 2

Seattle Public Utilities



2013 Water System Plan

Our Water. Our Future.

Volume II Appendices
July 2012

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Seattle Public Utilities

Seattle Public Utilities

2013 Water System Plan

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SEATTLE PUBLIC UTILITIES
2013 WATER SYSTEM PLAN

APPENDIX A

WATER RESOURCES

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SEATTLE PUBLIC UTILITIES
2013 WATER SYSTEM PLAN

A. WATER RESOURCES

APPENDIX A-1

OFFICIAL YIELD ESTIMATE AND LONG-RANGE WATER DEMAND FORECAST

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2013 Water System Plan
Official Yield Estimate and
Long-Range Water Demand Forecast

Inputs and Assumptions for the Firm Yield Estimate

Firm yield of the water supply system is estimated using a simulation model developed by Seattle Public Utilities called the Conjunctive Use Evaluation (CUE) model. Additional details of the model and inputs are documented in the final report titled *Firm Yield of Seattle's Existing Water Supply Sources*, November 2011, prepared by Seattle Public Utilities.

Model Inputs and Assumptions

- ⇨ Firm yield is based on the **98% reliability standard**—one shortfall occurs in the 81 years of historic record.
- ⇨ **Historic weekly inflows** reconstructed for water year 1929 through 2009 are used.
- ⇨ **Total system demand** is shaped on a monthly demand pattern based on the average of actual deliveries from calendar year 2005 through 2009.
- ⇨ **Sources of supply are operated conjunctively as a single system.**
- ⇨ **Operational assumptions include:**
  - Cedar River System:
    Meet Cedar River Habitat Conservation Plan instream flow commitments below Landsburg, assuming flashboards in place on Overflow Dike.
    Fixed rule curve for Cedar Reservoir of 1550' for October-February and 1563' for May-August.
    Minimum levels for Chester Morse Lake: 1532'; Masonry Pool: 1510'
    Meet diversion limits specified by the 2006 Agreement with the Muckleshoot Indian Tribe.
  - South Fork Tolt System:
    Meet instream flows from 1988 Tolt Settlement Agreement (with treatment project).
    Fixed rule curve 1754' for October-January; 1765' for March-August.
    Minimum level for South Fork Tolt Reservoir: 1710'
    Treatment/Transmission capacity: 120 MGD
  - Seattle Well Fields:
    10 MGD withdrawn for 14 weeks as needed from July-December.
    5 MGD recharged for 14 weeks from January-March.

Results

Based on the above, **the system-wide firm yield is 172 million gallons per day**.

Inputs and Assumptions for the Water Demand Forecast Model

Seattle Public Utilities (SPU) is using the same basic water demand forecast model that was developed for the *2007 Water System Plan*. Following a literature review of demand forecast models used by other utilities, SPU settled on a "Variable Flow Factor" approach. As with simpler fixed flow factor models, current water demand flow factors are calculated by sector (single and multi- family residential, non-residential) for Seattle and each individual wholesale customer. However, like an econometric model, the Variable Flow Factor model reflects the impacts of variables such as price, income, and conservation on water flow factors for each sector over time. This approach takes advantage of past econometric analysis to provide estimates of how some of the variables (price and income) affect demand. SPU's Conservation Potential Assessment (CPA) Model and new Passive Savings model are then used to estimate the impacts of programmatic and passive conservation on the flow factors over time. The structure of the model is summarized in the flow chart on the next page while the model inputs and assumptions are outlined, below.

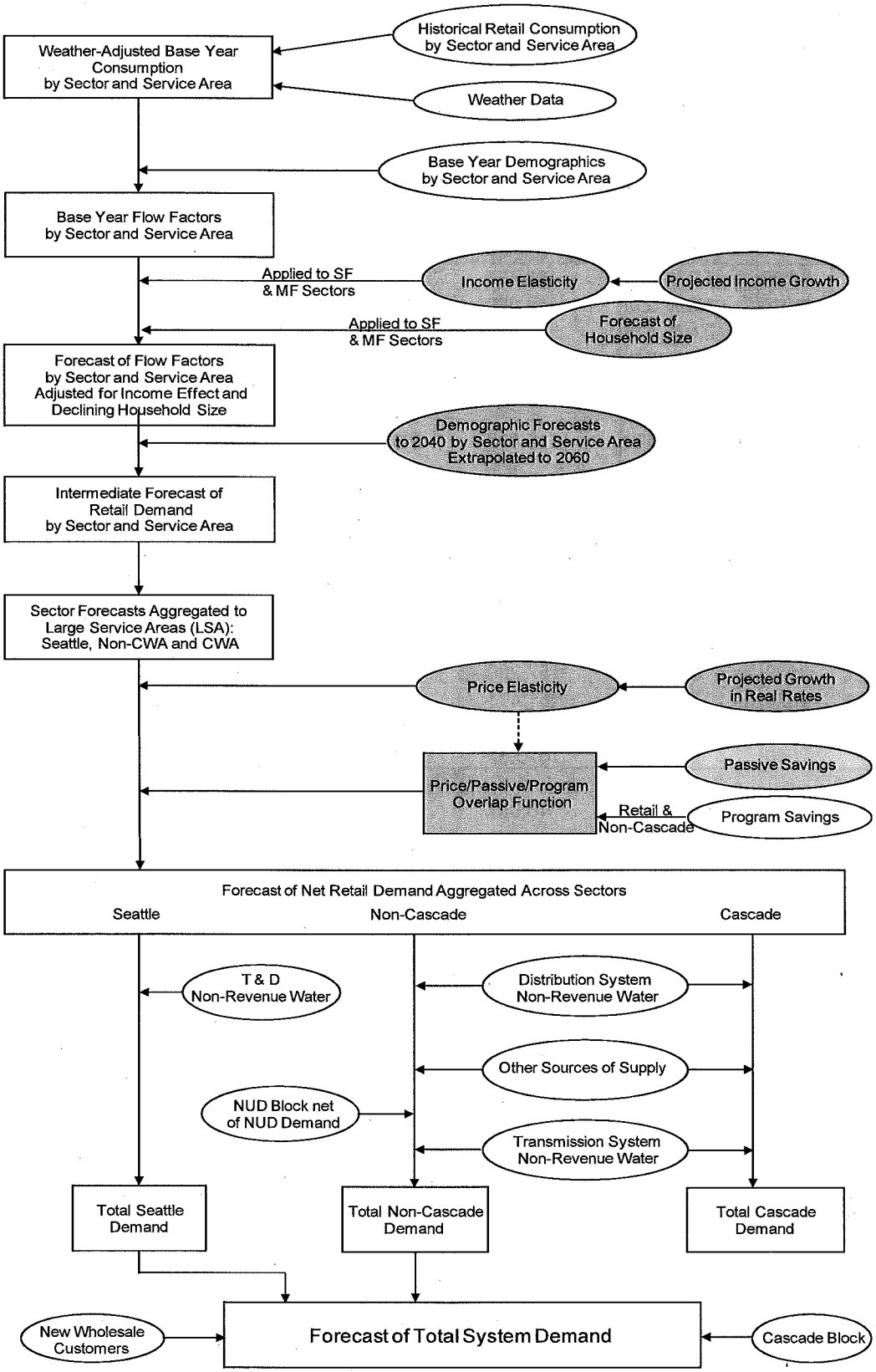
The structure of the water demand forecast model is represented in the flow chart on the following page. Intermediate steps and final results are shown as rectangles. Model inputs are shown as ovals with the gray shaded ovals indicating which inputs are subject to uncertainty and modeled using Monte Carlo simulations. The only real change in the flowchart since 2007 is the addition of household size as a factor affecting residential flow factors over time.

Model, Inputs and Assumptions

- **Weather adjusted base year consumption:**
  - By sector
    - single family residential
    - multifamily residential
    - manufacturing non-residential
    - non-manufacturing non-residential
  - By service area
    - Seattle-inside city limits
    - Seattle-outside city limits
    - Individual wholesale customers
  - Base Year
    - 2010
  - Weather
    - Sea-Tac Airport monthly average daily temperature and total precipitation
  - Sources: SPU billing data, Annual Purveyor Surveys, NOAA

- **Demographics: Current and projected single- and multi-family households and employment:** The model uses Puget Sound Regional Council (PSRC) 2006 TAZ-level forecasts of population, households and employment to 2040 apportioned to Seattle and individual wholesale service areas. (These are the most recent forecasts available.) A straight line extrapolation of average annual growth between 2010 and 2040 is used to forecast beyond 2040. Household and population data from the 2010 Census and PSRC 2010 employment estimates are used to calibrate the PSRC demographic forecasts to current conditions.

WATER DEMAND FORECAST MODEL STRUCTURE



In the first table below is displayed PSRC's forecast of population, households, and employment in King County. The tables that follow contain these forecasts as they have been apportioned into water service areas. Separate tables are provided for all of King County, SPU's retail service area, and the service area of Full and Partial Contracts (F&P) wholesale customers.

Actual[1] & PSRC Forecasts of Population, Households, & Employment

King County

		Households			
	Population	Single Family	Multifamily	Total	Employment
2000	1,737,034	453,437	257,479	710,916	1,196,043
2010	1,892,999	489,880	298,423	788,303	1,144,022
2020	2,075,426	532,658	362,451	895,109	1,498,043
2030	2,234,775	568,799	428,527	997,326	1,664,780
2040	2,401,521	605,712	501,095	1,106,807	1,830,535
2010-2040					
Growth	508,522	115,832	202,672	318,504	686,513
% Change	27%	24%	68%	40%	60%
Annual %	0.8%	0.7%	1.7%	1.1%	1.6%

As Apportioned to SPU's Retail Service Area[2]

		Household			
	Population	Single Family	Multifamily	Total	Employment
2000	618,323	151,741	128,450	280,191	555,410
2010	663,680	157,260	145,645	302,905	506,396
2020	710,784	161,471	175,775	337,246	608,178
2030	753,028	164,415	205,960	370,375	692,684
2040	801,169	167,267	240,078	407,345	781,846
2010-2040					
Growth	137,489	10,007	94,433	104,440	275,450
% Change	21%	6%	65%	34%	54%
Annual %	0.6%	0.2%	1.7%	1.0%	1.5%

As Apportioned to the Full and Partial Contracts Wholesale Service Area

		Household			
	Population	Single Family	Multifamily	Total	Employment
2000	381,658	103,318	40,032	143,351	156,737
2010	410,755	111,054	45,427	156,481	165,834
2020	447,193	121,192	54,608	175,800	187,930
2030	477,889	129,587	64,380	193,967	212,578
2040	511,852	138,012	76,427	214,439	241,712
2010-2040					
Growth	101,097	26,958	31,000	57,958	75,878
% Change	25%	24%	68%	37%	46%
Annual %	0.7%	0.7%	1.7%	1.1%	1.3%

[1] Census data used for 2000 and 2010 population and households. 2010 employment is based on latest (2011) PSRC estimate of 2010 employment.

[2] SPU's retail service area includes the City of Seattle and portions of the cities of Shoreline, Lake Forest Park and Burien, as well as portions of unincorporated King County south of the City of Seattle.

Household size is calculated for single and multifamily households in Seattle and for wholesale customers over the forecast period based on PSRC projections of single and multifamily households and population. Since the number of households is expected to grow faster than population through 2040, household size is projected to decrease over the next 30 years. The estimates of household size are as follows:

	Seattle		SWP Wholesale Customers	
	Single Family	Mutlifamily	Single Family	Mutlifamily
2010	2.41	1.93	2.76	2.25
2020	2.32	1.89	2.59	2.19
2030	2.24	1.85	2.50	2.13
2040	2.16	1.81	2.41	2.08
2050	2.16	1.82	2.40	2.09
2060	2.15	1.82	2.40	2.10

A straight-line extrapolation of average annual growth between 2010 and 2040 is used to forecast population beyond 2040. However, projections of the number of households beyond 2040 are based on the assumption that household size will stabilize and growth in the number of households will slow to about the rate of population growth. Per household flow factors are then reduced each year by the percent change in household size times the elasticity of demand with respect to household size. This elasticity is estimated to be 0.38 based on data from an end-use study conducted by the Seattle Water Department in the mid-1990s.

- **Base Year Flow Factors:** Base year flow factors are obtained by dividing the weather-adjusted base year consumption for each sector (e.g. single family residential) and service area (e.g. Bothell) by the corresponding number of households or employees in the base year.

- **Elasticity of residential demand to changes in real (inflation adjusted) household income:** Household income is generally expected to have a positive effect on water demand. A review of the literature revealed a range of estimated income elasticities. An elasticity value of **0.27**, representing the middle of this range, was chosen. (This means that a 10% increase in household income would be expected to cause a 2.7% rise in residential demand.)

  Source: Results of literature review

- **Forecast of annual growth in real median household income:** Mean household income was used in the 2007 WSP but on further reflection, median income appears to be the more appropriate concept. The past 40 years has seen a widening gap between growth in mean and median income. Both national and local time series on real per capita personal income show average annual rates of growth of about 2.0%. However after adjusting for inflation, median household income Washington State and King County is now slightly less than it was in 1989. The growth rate has been essentially zero. There is additional evidence that this is not just true for the median household but for most households except those at the very top of the income distribution. A recent analysis by economists Saez and Piketty based on 90 years of IRS data reveals that *average* household income for the bottom 90% of households has had zero real growth since 1970. Over the same 4 decades, the top 10%, 1%, 0.1%, and 0.01% of households has seen their real incomes increase twofold, threefold, fivefold and eightfold, respectively. If the present trend

continues with all income growth going to the top 10%, median income – in fact, the income of the bottom 90% – will remain flat in real terms. More optimistic scenarios would have the increasing skewness in the income distribution slow down, stop, or even reverse. Those conditions would correspond to rates of median income growth greater than zero but less than the average growth rate, equal to the average growth rate, or greater than the average growth rate. For the demand forecast, it is assumed that household income will grow at **0.9%** per year based on the median or about half the historical growth rate in per capita personal income based on averages.

Sources: U.S. Bureau of Economic Analysis, U.S. Census Bureau, Washington State Office of Financial Management, Dick Conway & Associates, Emmanuel Saez of UC-Berkeley.

⇨ **Elasticity of demand to changes in real water rates (prices):** A considerable body of literature has developed concerning the effect of price upon water demand and the inverse relationship predicted by economic theory is now well established. However, a number of complications summarized in the literature review (complex rate structures, conservation impacts, etc.) have made it difficult to estimate price elasticity with much confidence. As a result, there is a wide range of estimates in the literature but as with the income elasticity, values towards the middle of the range have been chosen for this model. These are shown below. (The value of -0.20 for single family households means that given a 10% increase in water prices, demand would be expected to decline by 2%.)

	Single Family	Multifamily	Non-Residential
Price Elasticity	-0.20	-0.10	-0.225

Sources: Results of literature review, Seattle's 1992 econometric model.

⇨ **Forecast of annual growth in real water rates (prices)**: Seattle and its wholesale customers have different water rates and different rate structures. Most customers face different marginal rates depending on whether they're residential or non-residential, what consumption block they fall in and what season it is. There is no single price of water. However, the model abstracts from all these complexities by using the average price of water, i.e., revenue requirements divided by billed consumption.

The model takes into account the significant increases in water and sewer[3] rates already adopted or anticipated through 2014. After that point, the SPU 20-year rate model forecasts that growth in inflation-adjusted retail water rates will slow to less than half a percent per year on average. The rates charged to SPU's wholesale customers are expected to increase even more slowly. However, wholesale customers have their own system costs to recover from their retail customers and these are likely to increase on a per ccf basis as well. The demand forecast model assumes the following growth rates:

[3] Because sewer bills in Seattle are based on metered water consumption, both water and sewer rates are assumed to impact water demand in the model. This is only the case for the retail service area, however. Many different cities and sewer districts provide sewer service in Seattle's wholesale water service area, each with different sewer rates and rate structures. Unlike Seattle's sewer rates that are entirely volume based, most other sewer providers have large fixed charges with much less of their revenue generated by volume rates. For that reason, as well as lack of information on past, current and anticipated sewer rates in the wholesale service area, the demand model for wholesale customers does not include sewer rates.

Annual Growth in Average Water Rates

	Seattle Retail*	Wholesale Customers
2010-2015	5.1%	2.0%
2016-2060	0.4%	0.4%
2030-2060	0.4%	0.4%

* Reflects anticipated increases in water and sewer rates

These are less than the average historical rate of growth of about 2.7% since 1974 but are consistent with the financial forecast used elsewhere in this Plan.

Sources: Historical rate and consumption data, SPU 20-year rate models for water and wastewater, King County Financial Plan dated June 27, 2011.

⇨ **Conservation - Reductions in Water Use due to Passive Savings:** Some conservation savings occur each year without SPU intervention due to federal and state plumbing codes setting efficiency standards for showerheads, toilets, aerators, and clothes washers. As old fixtures and appliances are replaced with new ones in existing buildings and new fixtures and appliances are installed in new construction, water use efficiency improves and conservation savings accrue. In addition, fixtures and appliances available from the market at competitive prices often become increasingly more efficient than is required by codes, especially as more years have passed since the codes were updated. "Passive savings" is made up of this phenomenon – referred to as "market transformation" – together with "code savings." A new model was developed to estimate these savings through 2060.

The model takes account of federal fixture and appliance codes adopted in 1992, 2002 and 2007. In addition, the impact of new clothes washer codes scheduled for adoption in 2011[4] to become effective in 2015 are also included. The model also reflects the current proportion of fixtures and appliances sold in the market that meet the more stringent Energy Star, Water Sense, and Consortium for Energy Efficiency (CEE) standards, as well as how those proportions are expected to continue shifting in the direction of higher efficiency over time. The model assumes that aerators, showerheads, clothes washers and toilets are, on average, replaced every 5, 10, 12 and 30 years, respectively.

Passive Savings in MGD

	Single Family	Multi-family	Non-Residential	Total
2020	2.5	1.7	0.6	4.9
2030	5.6	4.0	1.2	10.8
2040	7.5	5.8	1.7	15.0
2050	8.5	7.0	2.1	17.7
2060	9.0	7.8	2.4	19.2

Sources: Conservation Potential Assessment (CPA) model, U.S. EPA Office of Water, Alliance for Water Efficiency, Al Dietemann (personal communication)

[4] The US Department of Energy has proposed a two phase clothes washer efficiency standard with the first phase effective March 7, 2015, and the second, more stringent phase, effective for Janunary 1, 2018. This federal proposal has yet to be adopted as a final rule.

- **Conservation - Reductions in Water Use due to Programmatic Savings:** Based on the January 2006 decision by the Seattle Regional Water System Operating Board, the forecast includes **15** mgd of combined price-induced and programmatic conservation savings between 2011 and 2030, by assuming that demand is reduced evenly by 0.75 mgd each year over the 20-year period. Depending on what is assumed about the growth rate in water and sewer prices, more or less programmatic savings are required to meet this target. The price assumptions described above are estimated to produce a 7 mgd reduction in demand by 2030 leaving **8 mgd** to be achieved through programmatic conservation, assuming no price/conservation overlap (described below). This is equivalent to 0.4 mgd per year. These conservation savings only apply to Seattle and other members of the Saving Water Partnership. As is explained below, the Cascade Water Alliance has a block contract with SPU which limits its demand from the Seattle system. While Cascade is expected to pursue its own conservation programs, that doesn't affect the forecast of its demand from SPU which is assumed not to exceed the block. There is assumed to be no additional programmatic conservation after 2030.

- **Price/Passive/Programmatic Conservation Overlap:** Total conservation savings is adjusted downwards to account for the overlap between the different types of conservation. It is assumed that half of the price effect overlaps with passive and programmatic savings as long as the total amount of overlap represents less than half of total passive and programmatic conservation (as is the case over the forecast period). However, if the price effect exceeds combined passive and programmatic conservation, the amount of overlap is capped at 50%. The overall effect of the overlap function is to reduce total gross price/passive/programmatic savings by about 14%. For accounting purposes, the amount of overlap is deducted from the estimate of passive savings.

- **Non-Revenue Water:** Combined transmission and Seattle distribution system non-revenue water is assumed to start at **8** mgd in 2010 and increase uniformly to **10** mgd by 2060. This increase is expected to be caused by a growing number of leaks that will probably occur as the distribution system ages.

- **Wholesale Customer Demands:**

  - Wholesale customer distribution system non-revenue water is assumed to be a constant **6%** of retail water demand in the wholesale service area over the forecast period. This is added to the forecast of wholesale customers' retail demand.

    Source: Annual Surveys of Wholesale Customers, 1994-2010.

  - Water that full and partial contract wholesale customers expect to obtain from other sources of supply is subtracted from their demand from the SPU system. This amount is currently about **16** mgd and is projected to reach **18.5** mgd by 2020.

    Sources: 2010 Survey of Wholesale Customers, direct communication with individual wholesale customers.

  - Contract with the Cascade Water Alliance (Cascade). Under the Cascade contract, Seattle will provide a fixed block of **33.3** mgd to Cascade through 2017, and then the block will be increased by 2 mgd to **35.3** mgd in 2018, reflecting the supplemental block from the 2008 contract. The block will then be reduced by 10 mgd in 2024 and by another 5 mgd in 2030. Additional 5 mgd reductions will occur every 5 years thereafter through 2045, leaving a final block of **5.3** mgd. This has been incorporated into the

forecast by subtracting the projected demand of Cascade members that are currently Seattle wholesale customers, and adding the Cascade block. The following cities and districts are members of Cascade:

- Bellevue
- Covington
- Kirkland
- Issaquah
- Redmond
- Sammamish Plateau
- Skyway
- Tukwila

- Block contract with Northshore Utility District. Northshore Utility District also has a block contract under which Seattle will reserve a fixed block of **8.6** mgd for Northshore through the contract period which terminates in 2060. This has been incorporated into the forecast by subtracting Northshore's projected demand and adding the Northshore block. Note that current Northshore demand is about 3 mgd less than its block. By 2060, actual Northshore demand is expected to have grown to 7.3 mgd, still less than its block by more than 1 mgd.

- Forecasts of demand from potential new wholesale customers are based on data provided by them on their projected demand and existing supplies. Potential new wholesale customers included in the forecast are Ames Lake Water Association and City of Carnation. Demand from Ames Lake is expected to begin at zero ramping up to **0.5** mgd by 2033 and remaining constant thereafter. Carnation purchases from SPU are also expected to start at zero, ramp up to **0.5** mgd by 2028, and then remain constant. The City of Snoqualmie is also considered a potential new wholesale customer, but no specific demand is included in this forecast.

  Sources: Ames Lake Water Association, City of Carnation, City of Snoqualmie.

- Historically, Renton's water purchases from SPU have been negligible, but that is expected to change over time under the new contract as its demand begins to exceed its peak day capacity. Renton has provided a forecast of its estimated requirements from SPU ramping up to **0.9** mgd by 2060.

- Edmonds and Lake Forest Park are no longer included as wholesale customers. They do not purchase water from SPU nor do they have supply contracts after 2011 for regular supply.

Results

Given the assumptions described above, the water demand forecast is considerably lower than the last official forecast, particularly in the outer years, and remains considerably below SPU's current firm yield of 172 mgd through at least 2060. The demand forecast starts out at **133** mgd, higher than actual demand in 2010 because the forecast includes the Cascade and Northshore blocks that currently exceed the actual demand of those customers by 12 mgd. Total demand is forecast to remain relatively flat through 2023 at which point the Cascade block begins to step down. Over the following two decades, water demand is forecast to decline as the periodic reductions in Cascade's block more than offset what would otherwise be a modest amount of growth in demand. Once the Cascade block has been reduced to its minimum level in 2045, water demand is forecast to begin rising again, finally returning to **133** mgd by 2060.

The major changes in the forecast relative to the *2007 Water System Plan* forecast are summarized below:

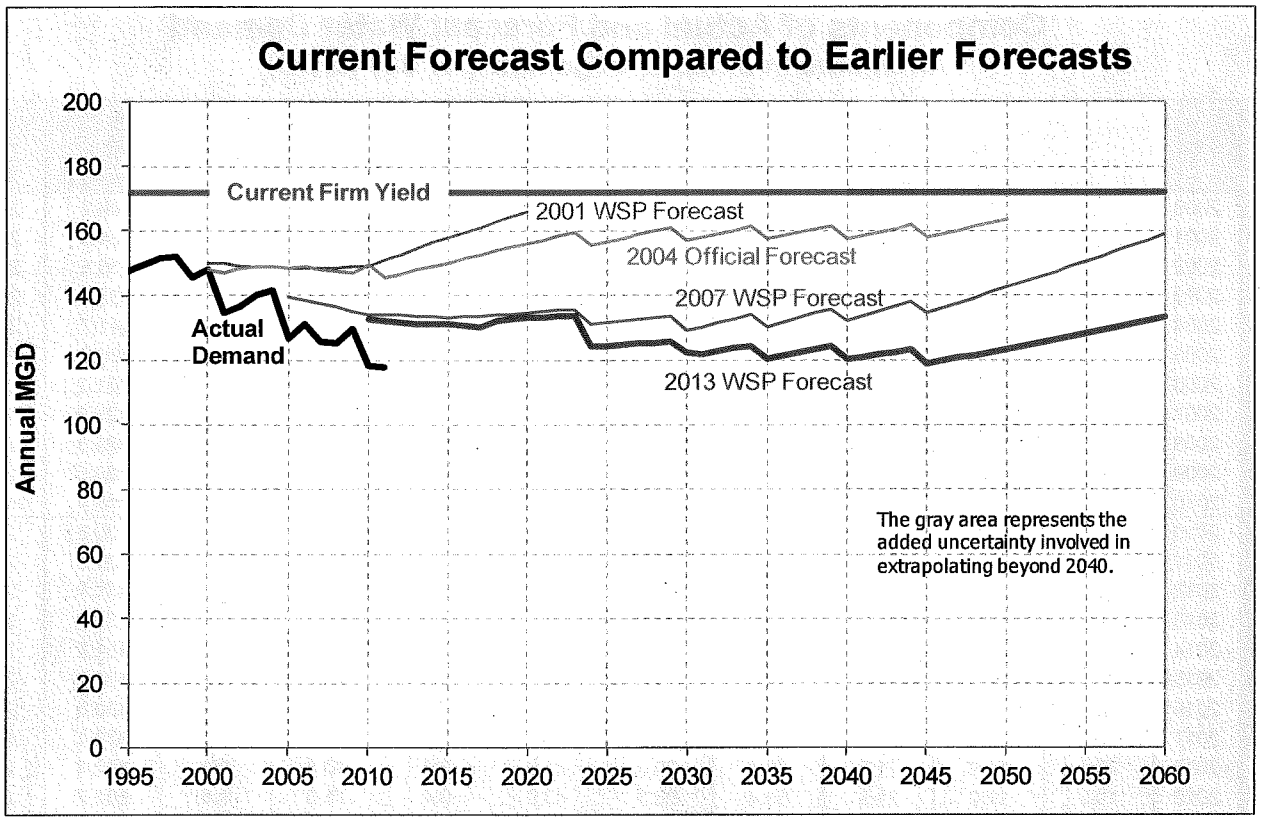
1. The new forecast is calibrated to 2010 actual consumption, adjusted for weather. Starting flow factors average just slightly lower than was projected for 2010 in the 2007 WSP forecast.
2. The Cascade block is higher, starting at 33.3 mgd rather than 30.3 mgd and then increasing to 35.3 mgd in 2018 before returning to original block path (25.3 mgd) in 2024, reflecting the supplemental blocks in the 2008 contract.
3. New PSRC forecasts (2006) of households, population and employment out to 2040 are used.
4. The model adjusts for what is now forecast to be a significant decline in household size.
5. The estimate of passive savings is 8 mgd more than the old forecast of code savings by 2060. Passive savings includes impact of codes implemented since 1993, new codes that are expected to be adopted in the near future, and the extent to which fixtures and appliances actually available in the market exceed current and anticipated codes.
6. Projected growth in median rather than mean household income is now used in the forecast. The assumption is that median income will grow at an average rate of 0.9%, about half as fast as mean income, as a disproportionate share of real income gains continue to accrue to the top 5% of households. Compared to the 2007 WSP forecast, this decreases 2060 demand by 11 mgd.
7. In the long-term, water rates are now projected to increase at about half the rate assumed in the 2007 WSP. This increases the 2060 forecast of demand by 3 mgd.
8. The forecast of non-revenue water has been reduced: 10 mgd in 2060 compared to 15.5 mgd in the 2007 forecast.
9. Renton has been added as a partial-requirements customer, which adds about 1 mgd to the forecast by 2060.
10. Highline purchases 2 mgd from Lakehaven beginning in 2016, reducing demand from SPU.
11. Potential new wholesale customers now include Ames Lake and Carnation, with total demand ramping up to 1 mgd by 2033.

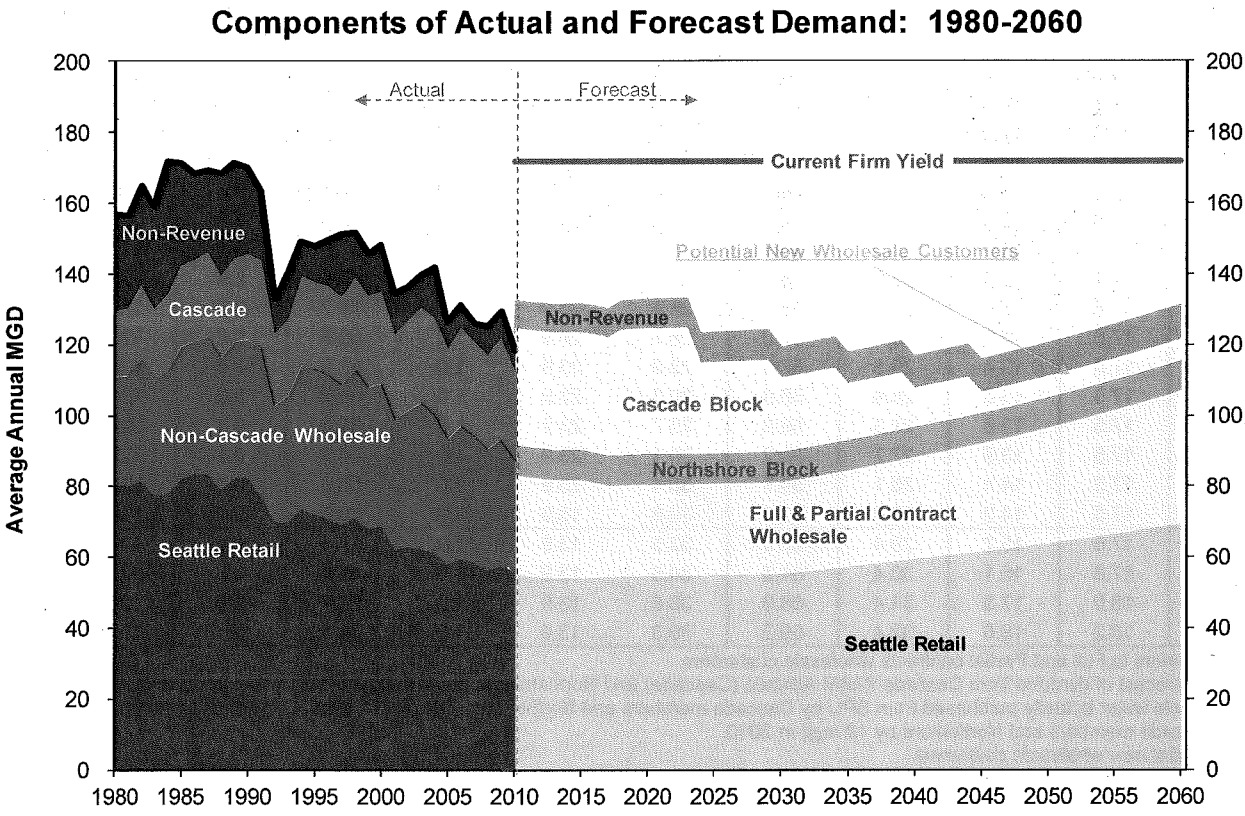
The *2013 Water System Plan* (WSP) demand forecast broken down by sector is shown in the table and graphs below. The first graph shows the forecast of demand and supply out to 2060 along with previous WSP forecasts. The gray area between 2040 and 2060 represents the additional uncertainty involved in forecasting out more than 30 years The second graph shows the various components that add up to the total demand forecast: Seattle retail, full and partial contract wholesale customers, the amounts specified in the Northshore and Cascade block contracts, potential new wholesale customers, and non-revenue water.

Components of Actual and Forecast Water Demand
All figures in millions of gallons per day (MGD)

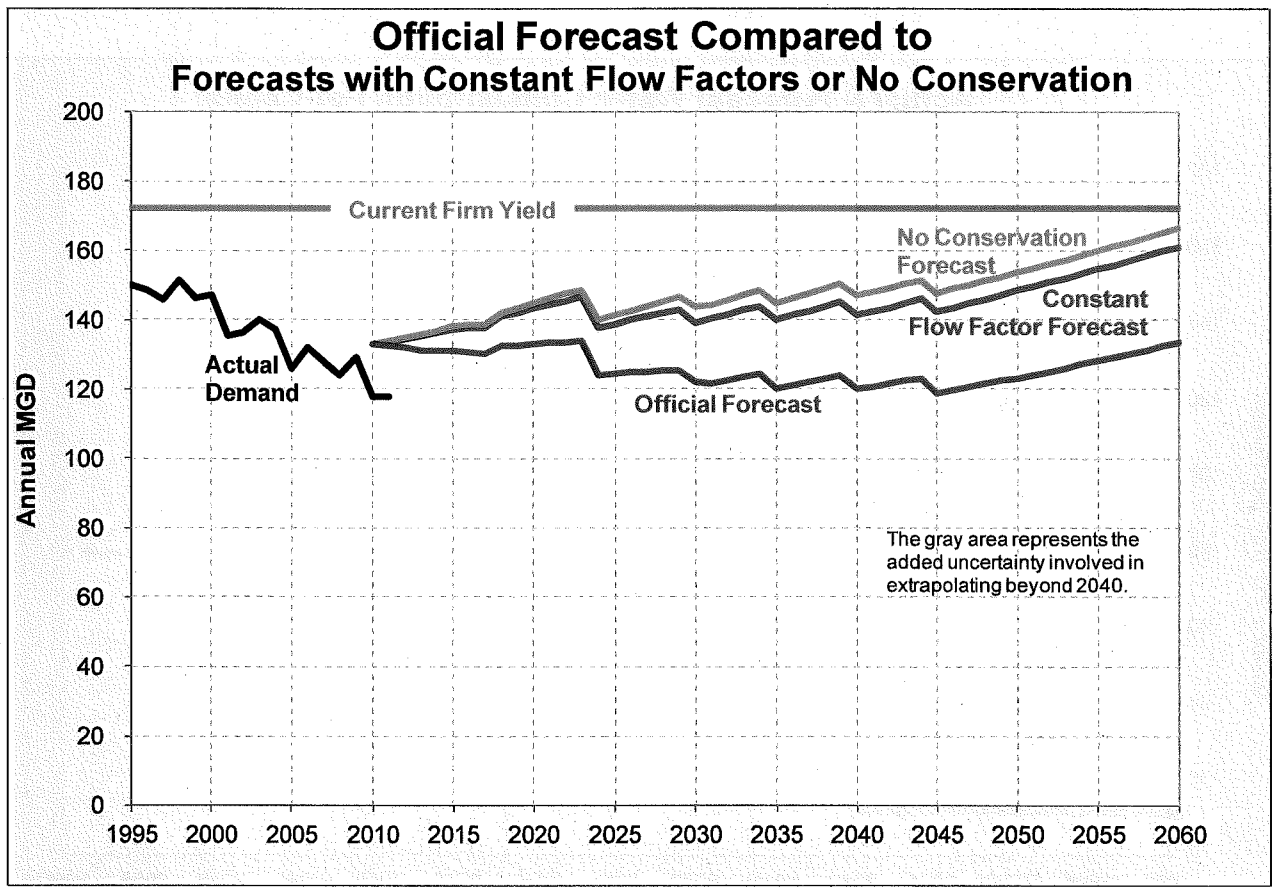
	Year	Billed Demand								Non-Revenue Water	Total System Demand	
		Seattle Retail				Wholesale					Annual Average[4]	Peak Day[5]
		SF Res	MF Res	Non-Res	Subtotal	F&P[1]	Block[2]	New[3]	Subtotal			
ACTUAL	2000	26.9	14.5	27.7	69.1	34.3	31.7	-	66.0	13.2	148.2	241.9
	2001	24.0	13.7	24.6	62.3	30.0	30.8	-	60.7	11.6	134.6	204.0
	2002	24.8	13.1	24.9	62.8	32.9	31.0	-	63.9	9.8	136.5	222.6
	2003	24.9	12.8	24.6	62.3	35.6	32.7	-	68.2	9.4	139.9	250.2
	2004	24.2	12.5	24.6	61.3	33.1	33.3	-	66.4	14.0	141.7	246.8
	2005	22.6	12.2	23.2	58.0	29.6	31.4	-	61.0	7.7	126.7	210.4
	2006	23.5	12.3	23.7	59.5	32.0	33.4	-	65.4	6.3	131.2	236.8
	2007	22.6	12.0	23.6	58.3	28.7	33.7	-	62.5	5.2	125.9	227.6
	2008	22.0	11.8	22.5	56.3	28.8	32.0	-	60.8	8.2	125.3	202.0
	2009	23.1	11.6	22.6	57.3	30.6	34.1	-	64.8	7.5	129.5	241.9
	2010	21.3	11.4	21.6	54.3	26.5	29.6	-	56.1	8.0	118.4	197.9
FORECAST	2010	21.9	11.4	21.6	55.0	28.0	41.9	0.0	69.9	8.0	132.8	265.7
	2011	21.5	11.5	21.2	54.2	28.2	41.9	0.0	70.1	8.0	132.3	264.7
	2012	21.2	11.6	21.0	53.8	28.1	41.9	0.1	70.0	8.1	131.9	263.8
	2013	20.9	11.6	20.8	53.3	27.9	41.9	0.1	69.9	8.1	131.3	262.6
	2014	20.7	11.7	20.7	53.0	28.1	41.9	0.2	70.1	8.2	131.2	262.5
	2015	20.4	11.7	20.6	52.8	28.1	41.9	0.2	70.2	8.2	131.2	262.3
	2016	20.3	11.8	20.9	53.0	27.3	41.9	0.3	69.4	8.2	130.6	261.3
	2017	20.2	11.8	21.1	53.2	26.5	41.9	0.3	68.6	8.3	130.1	260.1
	2018	20.1	11.9	21.3	53.3	26.6	43.9	0.4	70.8	8.3	132.4	264.8
	2019	19.9	12.0	21.5	53.4	26.8	43.9	0.4	71.0	8.4	132.7	265.5
	2020	19.7	12.0	21.7	53.5	26.9	43.9	0.5	71.2	8.4	133.1	266.2
	2021	19.5	12.1	22.0	53.6	26.9	43.9	0.5	71.3	8.4	133.3	266.7
	2022	19.3	12.1	22.3	53.7	27.0	43.9	0.6	71.4	8.5	133.6	267.2
	2023	19.1	12.1	22.6	53.9	27.0	43.9	0.6	71.5	8.5	133.9	267.7
	2024	18.9	12.2	22.9	54.0	27.1	33.9	0.7	61.6	8.6	124.1	248.3
	2025	18.7	12.2	23.2	54.2	27.1	33.9	0.7	61.7	8.6	124.5	248.9
	2026	18.5	12.3	23.5	54.3	27.2	33.9	0.8	61.8	8.6	124.8	249.5
	2027	18.3	12.3	23.8	54.5	27.2	33.9	0.8	61.9	8.7	125.1	250.1
	2028	18.1	12.4	24.1	54.6	27.3	33.9	0.9	62.0	8.7	125.4	250.7
	2029	18.0	12.5	24.3	54.8	27.4	33.9	0.9	62.1	8.8	125.7	251.3
	2030	17.8	12.5	24.6	54.9	27.5	28.9	0.9	57.3	8.8	121.0	241.9
	2031	17.7	12.7	25.0	55.4	27.8	28.9	1.0	57.6	8.8	121.8	243.6
	2032	17.7	12.9	25.4	55.9	28.1	28.9	1.0	57.9	8.9	122.7	245.4
	2033	17.6	13.0	25.8	56.4	28.4	28.9	1.0	58.2	8.9	123.6	247.1
	2034	17.6	13.2	26.1	57.0	28.7	28.9	1.0	58.5	9.0	124.4	248.9
	2035	17.6	13.4	26.5	57.5	29.0	23.9	1.0	53.9	9.0	120.3	240.7
	2036	17.5	13.6	26.9	58.0	29.3	23.9	1.0	54.2	9.0	121.3	242.5
	2037	17.5	13.8	27.3	58.6	29.7	23.9	1.0	54.5	9.1	122.2	244.4
	2038	17.5	13.9	27.7	59.2	30.1	23.9	1.0	54.9	9.1	123.2	246.4
	2039	17.5	14.1	28.1	59.7	30.4	23.9	1.0	55.3	9.2	124.2	248.3
	2040	17.5	14.3	28.5	60.3	30.8	18.9	1.0	50.6	9.2	120.2	240.3
5	2045	17.6	15.2	29.4	62.2	32.5	13.9	1.0	47.4	9.4	119.0	237.9
	2050	17.8	16.1	30.4	64.3	34.6	13.9	1.0	49.4	9.6	123.3	246.5
Y	2055	18.0	17.3	31.4	66.6	36.8	13.9	1.0	51.7	9.8	128.1	256.2
R	2060	18.2	18.6	32.4	69.2	39.3	13.9	1.0	54.1	10.0	133.4	266.8

1. F&P refers to Full and Partial contracts wholesale customers.
2. The forecast of demand from Cascade Water Alliance (Cascade) and Northshore is equal to their blocks while the historical consumption data reflects water actually purchased from SPU by Cascade members and Northshore. The blocks exceeded actual water purchases from SPU of Cascade members and Northshore by 12 mgd in 2010.
3. Potential new wholesale customers
4. The forecast of Total System Demand includes the Northshore and Cascade blocks while the historical consumption data reflects SPU water actually purchased by Northshore and Cascade.
5. The forecast of peak day demand is based on a peak day factor of 2.0, the ratio of peak day to average annual demand in 2009 with a 5% allowance for hot, dry weather. The forecast of average annual demand under average weather conditions is multiplied by the peak day factor to estimate peak day demand with hot, dry weather.

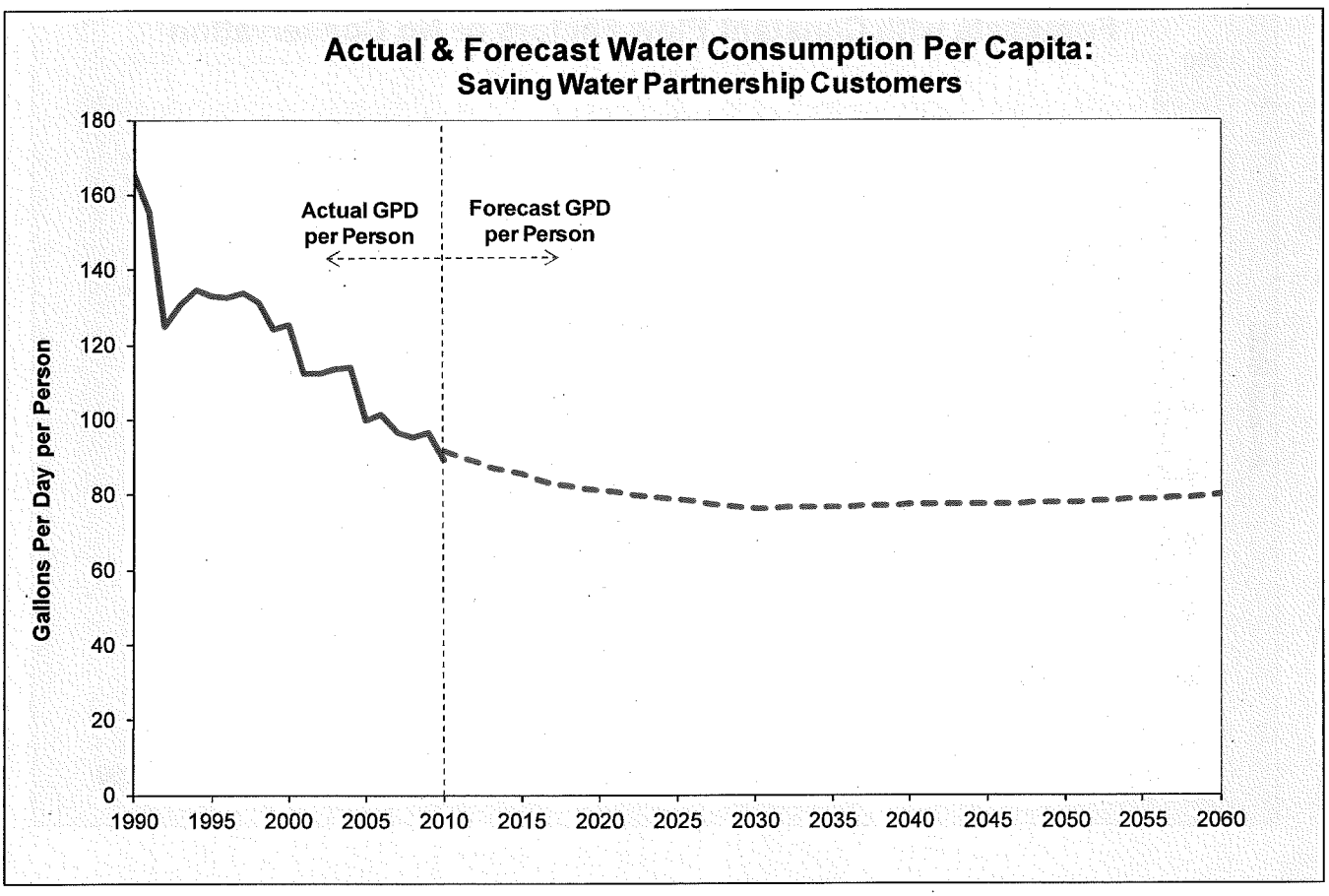

Current Forecast Compared to Earlier Forecasts
Annual MGD
200
180
160
140
120
100
80
60
40
20
0
1995
2000
2005
2010
2015
2020
2025
2030
2035
2040
2045
2050
2055
2060
Current Firm Yield
2001 WSP Forecast
2004 Official Forecast
2007 WSP Forecast
2013 WSP Forecast
Actual Demand
The gray area represents the added uncertainty involved in extrapolating beyond 2040.


Components of Actual and Forecast Demand: 1980-2060
Average Annual MGD
200
180
160
140
120
100
80
60
40
20
0
1980
1985
1990
1995
2000
2005
2010
2015
2020
2025
2030
2035
2040
2045
2050
2055
2060
Actual
Forecast
Current Firm Yield
Non-Revenue
Cascade
Non-Cascade Wholesale
Seattle Retail
Potential New Wholesale Customers
Non-Revenue
Cascade Block
Northshore Block
Full & Partial Contract Wholesale
Seattle Retail

The graph below contrasts the official demand forecast with what it would be with constant flow factors and with no future conservation of any kind (i.e., no price effect, no passive savings, and no programmatic savings). Note that the forecast with "no conservation" is higher than the forecast holding water flow factors constant over time because the "no conservation forecast" includes the impact of income growth and changes in household size, which net to an increase in flow factors. For the 2013 WSP forecast, all sources of conservation are estimated to produce a total reduction in water demand of more than 30 mgd by 2060.



Finally, the implications of the new demand forecast for total system per capita water consumption are shown in the graph below. Due to anticipated programmatic conservation, passive savings, and water and sewer rate increases, per capita consumption is forecast to continue declining over the next 20 years though at a slower rate than in the past. By 2030, per capita consumption is expected to level off at about 80 gpd (compared to 90 gpd currently). In contrast, between 1990 and 2010, total and per capita water consumption for Seattle and its non-Cascade wholesale customers declined 46% from 166 gallons per day (gpd) to 89 gpd. The demand model does not imply ever-decreasing per capita consumption.



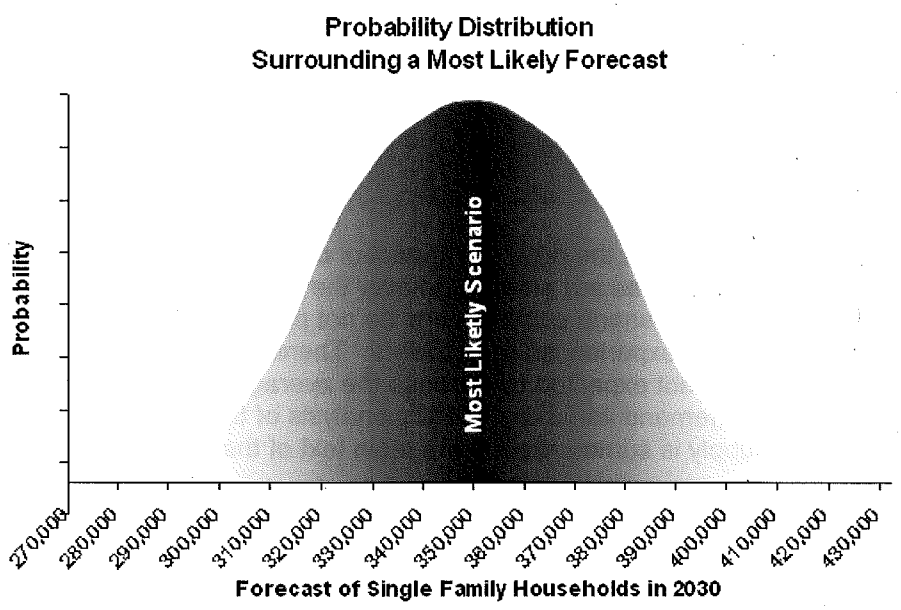
Forecast Uncertainty

What is most certain about a forecast out to 2060 is that it will be wrong. Actual demand in 2040 or 2060 is highly unlikely to be exactly what was forecast back in 2012. The official water demand forecast is itself based on forecasts of income, water prices, households and employment – all subject to uncertainty. Additional uncertainty surrounds the forecast model's assumptions about price and income elasticities, future conservation, wholesale customers' other sources of supply, and whether SPU will gain new customers and/or lose existing customers.

The Official Demand Forecast represents both SPU's policy intentions and its expectations of the future. However, it is prudent, especially in long-term planning, to consider the many uncertainties that could cause demand to be different from what's projected in the official forecast. These uncertainties fall into two categories – discrete and continuous – and are handled in two different ways.

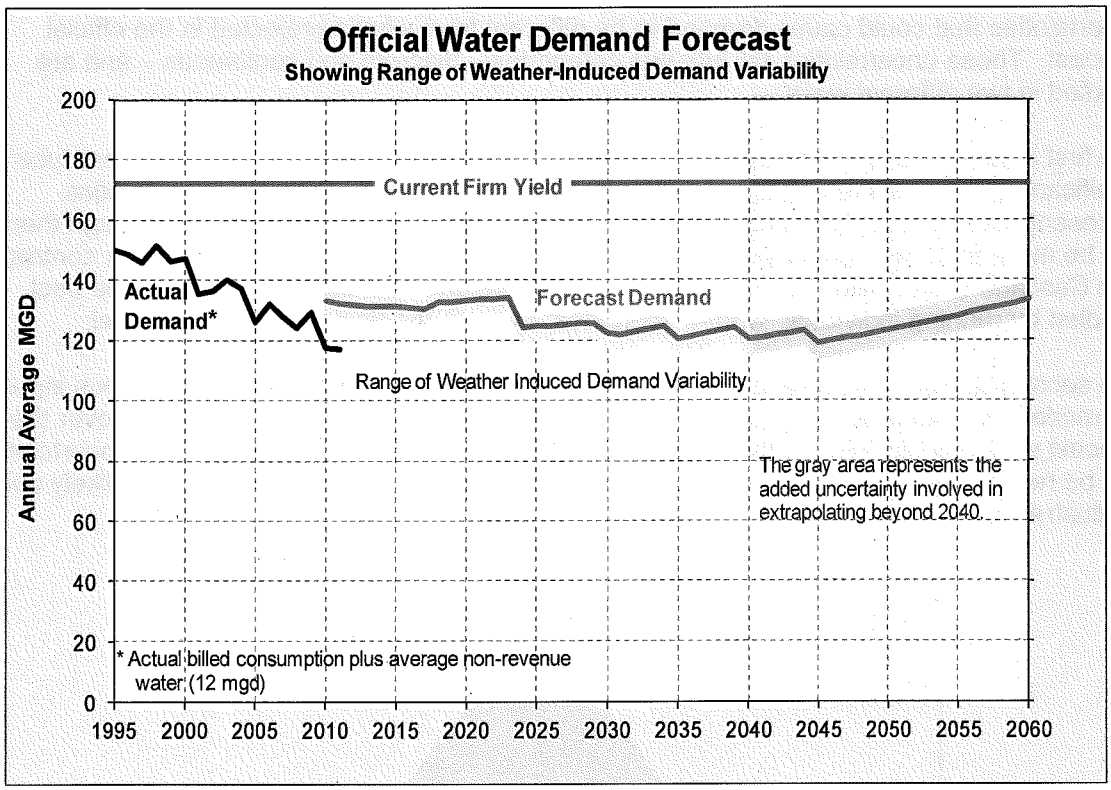
The first category refers to those uncertainties that result from discrete events that produce significant and sometimes abrupt changes in customer demand. Discrete uncertainties represent occurrences that either happen or don't. They're on or off, yes or no (though there can be more than two conditions). An example of a discrete uncertainty is the block contract with Cascade Water Alliance. This and other discrete uncertainties are thought to be best handled by running individual "what-if scenarios" through the demand forecast model.

The second category consists of the continuous uncertainty that surrounds the various inputs to the model. An example would be the forecast of household growth. Actual growth over the forecast period could turn out to be lower or higher than forecast. These types of uncertainties can be represented by a continuous probability distribution around a mean or most likely value as illustrated below.



Weather-Induced Demand Variability: Another source of "fuzziness" in the forecast is weather-induced demand variability. However, this is not really a matter of uncertainty because

there's no doubt that summer weather will continue to vary from year to year, and that this variation will cause water demand to fluctuate around the trend. Because base year flow factors are calculated from weather-adjusted consumption data, the forecast represents demand under average weather conditions. Analysis of daily consumption data back to 1982 shows a maximum variability of about plus or minus **5%**. In other words, an extremely hot dry summer would be expected to increase annual consumption *in that year* by up to 5% above the average trend. An extremely cold wet summer would be expected to do the opposite, reducing that year's annual consumption by about 5% below the average trend. The amount by which actual demand is expected to be higher or lower than forecast due to variation in summer weather is shown as the blue band around the forecast in the graph below.



This does not explicitly account for the potential impact of climate change on future demand. While higher summer temperatures are anticipated over the next century due to climate change, most climate model/emission scenario combinations do not project average temperatures to rise above what has already been experienced in hot years. Therefore, the impact of climate change on future demand is not expected to increase the average-weather forecast beyond the range of weather-induced demand variability. SPU's analysis of the impact of climate change on future demand and supply is summarized in the main text of the *2013 Water System Plan*.

Modeling Continuous Uncertainty

A number of model inputs were identified as being subject to continuous uncertainty. (These are shown in the model structure flowchart on page 2 shaded in gray.) They include forecasts of single and multi-family households and employment; average annual growth rates for water prices and household income; price and income elasticities; the impact of passive savings; and

the extent to which price-induced conservation overlaps with passive and programmatic conservation. Each uncertainty was modeled by specifying a probability distribution around the mean value of each variable. Many sources were consulted to define the range of uncertainty[5] and the shape of the distributions. The sources and assumptions used to characterize continuous uncertainties are outlined below.

Forecasts of Households and Employment: Two different sources were consulted to establish uncertainty ranges around the forecasts of long term demographic growth. In 2007, the Washington State Office of Financial Management (OFM) produced high and low forecasts of population by county based on historical variability in net migration rates. Dick Conway and Associates developed high and low alternatives around the 2002 PSRC long term regional forecasts of population and employment (but not households) based on optimistic and pessimistic scenarios for the local and national economies[6]. The greater geographical specificity of the OFM forecasts was combined with the more rigorous methodology and wider range between low and high provided by Dick Conway's analysis. The OFM uncertainty ranges are calibrated to 2005 and the Conway uncertainty ranges are calibrated to 2000. Both were brought forward and calibrated to 2010 so that low, medium and high forecasts all start of from the same point in 2010. The ranges of uncertainty around the projections of households, employment and population used in the demand forecast model are shown in the table, below. The forecast number of multifamily households in 2060, for example, is 28% less than the baseline forecast in the low growth scenario and 47% higher in the high growth scenario.

Uncertainty Ranges Around Mean Values
Associated with High and Low Demographic Growth Scenarios

	2030		2060	
	Low	High	Low	High
Single Family Households	-6%	9%	-10%	18%
Multifamily Households	-16%	26%	-28%	47%
Employment	-7%	12%	-14%	24%
Population*	-11%	17%	-21%	35%

* The number of single and multifamily households rather than population is used in the demand forecast model.

The ranges around single and multi-family households were derived from the reported high and low population values and the assumption that variability around the single family forecast is less than for the forecast of multifamily households. Note that the potential variation from forecast values is expected to be greater on the high side than on the low side.

Growth in the Price of Water: System water rates are obtained by dividing each year's projected revenue requirement by projected demand. Uncertainty about future water prices derives from variability in both of these terms. The baseline assumption is that after significant increases in water and sewer rates already adopted or anticipated through 2014, growth in inflation-adjusted retail water rates will ramp down to 0.4% per year by 2020 and remain there through the forecast period. This is slower than the average historical rate of growth but is consistent with the 20-year rate model forecast used elsewhere in this Plan. The range of uncertainty around this is skewed very much on the high side, **minus 50% to**

[5] Each range is characterized by a high and low value representing two standard deviations from the mean.
[6] Scenarios developed by DRI-WEFA (now known as Global Insights, Inc.)

plus 350%, resulting in projected annual growth rates in real prices of between **0.2%** and **1.8%**.

The model handles the impact on price of different levels of projected demand in a different way. Given the same set of revenue requirements, lower demand results in higher water prices and vice versa. That means that price effects would be expected to amplify swings in demand. For example, higher-than-projected demographic growth would cause demand to be higher than the official forecast, resulting in reduced prices and an additional boost in demand. The amount of the boost is determined by the price elasticity of demand and the amount by which prices fall. Incorporating this demand-price-demand-etc. feedback loop explicitly into the model isn't feasible because, as is explained in more detail below, the uncertainty analysis involves running 10,000 iterations of the demand model. However, the feedback loop has been approximated by widening the range of uncertainty around growth in households and employment. The amounts by which the ranges have been increased are **5.2%** on the high side and **5.3%** on the low side[7].

Price Elasticity: The uncertainty ranges around price elasticity represent a synthesis of the various estimates of price elasticity reported in the literature review. These are **plus or minus 50%** for single and multi-family elasticities and **plus or minus 33%** around the non-residential elasticity.

Uncertainty Ranges Around Mean Price Elasticities

	Single Family	Multi-Family	Non-Residential
Low	-0.10	-0.05	-0.15
Mean	-0.20	-0.10	-0.225
High	-0.30	-0.15	-0.30

Growth in Real Household Income: There is some uncertainty about future growth in average income but much more uncertainty around the distribution of that growth. As explained above, there has been a decoupling of average and median income growth over the past 4 decades. While overall per capita income has averaged 1.8% annual growth since 1970, median income and in fact, the income of the bottom 90% of households has grown very little if at all in real terms. Practically all the growth in national income has gone to households at the very top of the income scale in the last 40 years - the top 10%, 1%, 0.1%, and 0.01% of households seeing their real incomes rise twofold, threefold, fivefold and eightfold, respectively. The baseline assumption in the demand forecast is that median income will grow at **0.9%** annually, about half the rate expected for average income. This scenario represents a slowing of the rate at which the distribution of income gets worse. The continuation of present trends with all income growth going to the top 10% and **zero** income growth for median households is the most pessimistic scenario in the uncertainty analysis. At the high end is the assumption that income grows proportionally across all households and the increasing skewness in the income distribution comes to a halt. Here, annual growth in average income equals that for median income equals **1.8%.**

Income Elasticity: As with price elasticity, the uncertainty band around income elasticity was derived from the various estimates of income elasticity in the literature review. A range of income elasticities from **0.19** to **0.35** (i.e., **plus or minus 30%**) around the mean value of 0.27 was chosen.

[7] These percents were obtained by calculating the percent changes in 2060 water prices that would result from the high and low growth scenarios relative to the baseline scenario and multiplying them by the average price elasticity.

Passive Savings: Passive savings could be more or less than modeled. If the new clothes washer codes scheduled to go into effect in 2015 are reversed and market transformation towards fixtures and appliances that exceed code occurs slower than anticipated, passive savings could be less than estimated for the baseline forecast. Alternatively, if additional codes are passed in the future, market transformation takes place more quickly, and green buildings become the norm for new construction, passive savings could be more than estimated for the baseline forecast. A range of passive savings from **11.5** to **26.9 mgd** (i.e., **plus or minus 40%**) around the mean value of 19.2 mgd was chosen.

Conservation Savings: The price/code/programmatic conservation overlap function is used to introduce an element of uncertainty to overall conservation savings. The baseline assumption is that 50% of the price effect overlaps with code and programmatic conservation. Assuming a higher level of overlap produces a smaller amount of total conservation savings, and vice versa. A range of conservation savings are obtained in the model by varying the overlap parameters between **25%** and **75%**.

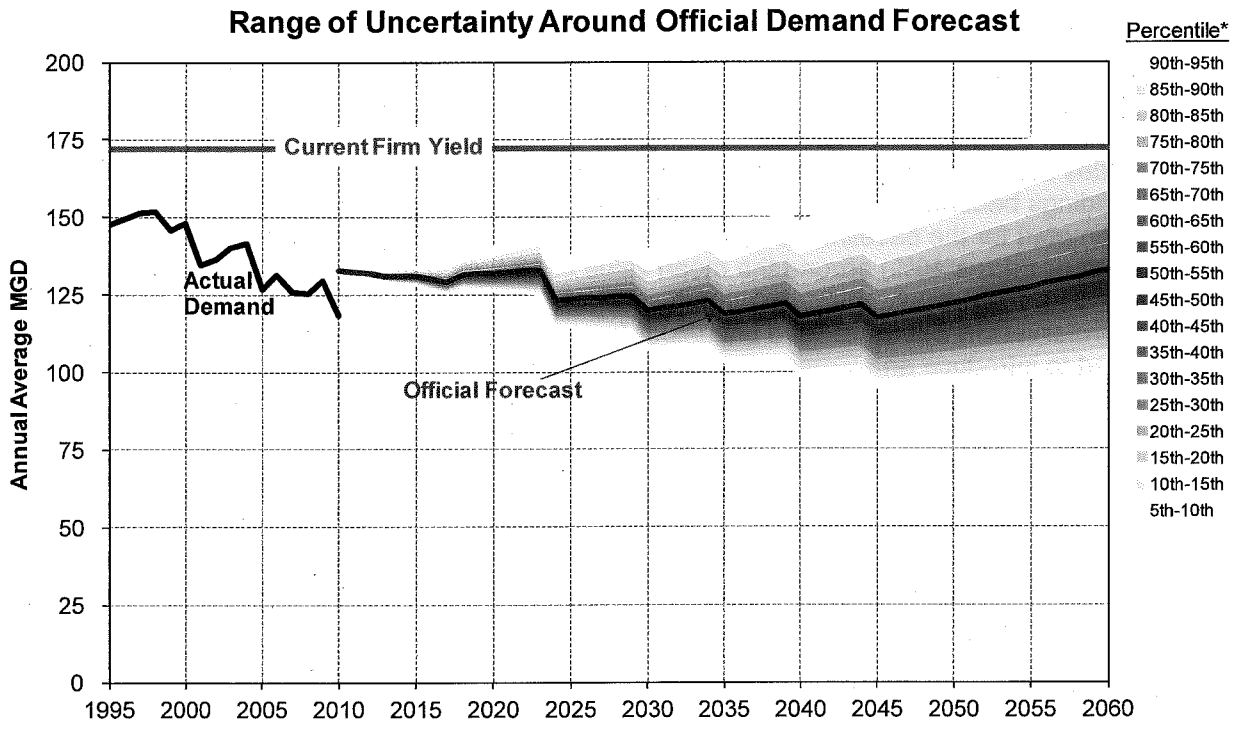
Modeling Uncertainty with @Risk: The uncertainty ranges described above are assumed to have normal or log-normal distributions,[8] with the endpoint values representing two standard deviations from the mean. These probability distributions become inputs to an aggregate uncertainty model using @Risk software (an add-in to Excel) which employs Monte Carlo simulation to characterize uncertainty around the official demand forecast. During each individual run of the Monte Carlo simulation, a value is randomly selected for each input variable based on the probability density function specified for that variable[9]. Then, the complete set of input values for that iteration is used to produce a water demand forecast. The simulation procedure performs a large number (10,000) of independent iterations, each generating a separate demand forecast. These forecasts are then pooled to obtain a probability distribution of forecast water demand through 2060.

The results of the Monte Carlo simulation are displayed in the graph on the next page. The green bands indicate the range of uncertainty around the official forecast with each band representing a 5% change in probability. For example, the bottom of the lowest band represents the 5th percentile. That means it's estimated there's a 5% chance actual demand will be below that point (and, thus, a 95% chance it will be above). The top band is the 95th percentile which corresponds to an estimated 95% probability that actual demand will be below that point. Taking a cross-section of the graph at 2060 produces the probability distribution around the official forecast shown below.

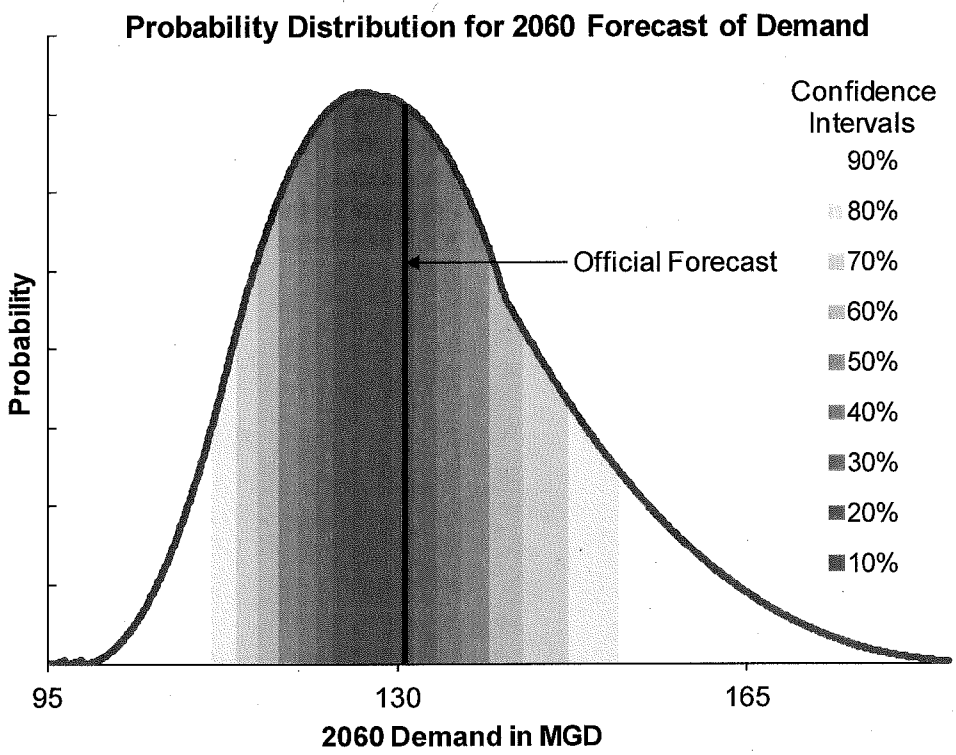
---

[8] Log normal distributions are used for the uncertainty around household and employment growth and average annual rate of growth in water prices because the high and low ranges exhibit positive skewness (i.e., the highs are higher than the lows are low).

[9] All variables with uncertainty are assumed to be independent except for growth in households and employment. These are linked in the model because they would be expected to move together.



* Percentiles represent the probability that demand is less than the value shown. Ranges reflect uncertainty in projected household, employment, price and income growth; price and income elasticities; and conservation. Note that the Official Forecast is at about the 58th percentile.



The uncertainty model represents a significant refinement over simply compounding all the high or all the low assumptions to create extreme high and extreme low scenarios. In the extreme high scenario, everything that could possibly cause demand to be higher than forecast is assumed to happen at the same time. The extreme low scenario is just the opposite with all low side assumptions applied simultaneously. These extreme scenarios overstate the actual uncertainty surrounding demand because they represent two highly unlikely combinations of events with essentially zero probability of occurring. The Monte Carlo simulation provides narrower bands of uncertainty and information about their estimated probabilities.

Implications: Given the current firm yield estimate for SPU's existing supply resources and the official demand forecast, a new source of supply will not be needed until well after 2060. Taking demand uncertainty into consideration, there's still more than a 90% probability that a new source will not be necessary before 2060. This analysis does not explicitly calculate the possible impact of the "discrete" category of uncertainties mentioned in the introduction. However, none of the discrete uncertainties that have been identified (e.g. changes in the Cascade contract) would shift the forecast of demand beyond the range calculated for continuous uncertainties and shown in the graph, above.

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SEATTLE PUBLIC UTILITIES
2013 WATER SYSTEM PLAN

A. WATER RESOURCES

APPENDIX A-2
WATER RIGHTS EVALUATION

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Water Rights Evaluation
Table 1 - Existing Water Rights Status

Permit Certificate or Claim #	Name of Rightholder or Claimant	Priority Date	Source Name/ Number	Primary or Supplemental	Existing Water Rights		Existing Consumption		Current Water Right Status Excess (positive)/Deficiency (negative)	
					Maximum Instantaneous Flow rate (Qi)	Maximum Annual Volume (Qa)	Maximum Instantaneous Flow Rate (Qi)	Maximum Annual Volume (Qa)	Maximum Instantaneous Flow Rate (Qi)	Maximum Annual Volume (Qa)
Certificates										
1. R-206	City of Seattle Water Department	7/14/1936	South Fork Tolt Reservoir	Primary	N/A	Storage 57,830 acre feet	N/A	Storage 57,830 acre feet	N/A	Storage 0 acre feet
Permits										
1. S1-25929	City of Seattle Water Department	8/17/1990	Cedar River: Temporary Pumping Plant	Supplemental (Term Permit)	390 cfs (252 mgd)	102,746 acre-feet Note 1				
2. S1-25330P	City of Seattle Water Department	8/22/1988	Cedar River: Aquifer Storage and Recovery (ASR)	Primary	10 cfs (6.5 MGD) (Oct thru May)	4,800 acre feet (1,564 mg)	3.5 cfs (2.3 MGD) Note 3	1,170 acre feet Note 2	6.5 cfs (4.2 MGD)	3,630 acre feet
3. 10602	City of Seattle Water Department	7/14/1936	South Fork Tolt Diversion	Primary	280 cfs (181 MGD)	168,000 acre feet (150 MGD)	263 cfs (170 MGD) Note 5	58,251 acre feet (52 MGD) Note 4	17 cfs (11 MGD)	109,749 acre feet
4. S1-28477	City of Seattle Seattle Public Utilities	1/30/2007	Rainwater	Primary	N/A	23,150 acre-feet (Not in totals)	Note 19	Note 19		
Temporary Permits										
1. G1-24619	City of Seattle Water Department	3/7/1985	Boulevard Park Well Field	Primary	4000 gpm (5.8 MGD)	To be determined Note 6	2,900 gpm (4.18 MGD) Note 7	764 acre feet Note 8	1,110 gpm (1.6 MGD)	To be determined
2. G1-24621	City of Seattle Water Department	3/7/1985	Riverton Well Field	Primary	4000 gpm (5.8 MGD)	To be determined Note 9	6,300 gpm (9.07 MGD) Note 10	2,422 acre feet Note 11	-2,292 gpm (-3.3 MGD) Note 12	To be determined
Claims										
1. 068624	City of Seattle Water Department	1888	Cedar River and Chester Morse Lake	Primary	Note 17	336,650 acre feet (300 MGD) Note 13	350 cfs (226 MGD) Note 14	161,312 acre feet (144 MGD) Note 15	115 cfs (74 MGD)	175,338 acre feet (156 MGD) Note 13
2. 068623	City of Seattle Water Department	1926	Lake Youngs	Primary	N/A	Storage 33,770 acre feet	N/A	Storage 33,770 acre feet	N/A	Storage 0 acre feet
Interties - Note 18										
TOTAL - Note 16	*********	*****	*******	**********	Note 17	504,650 acre feet (450 MGD)	638 cfs (412 MGD) Note 16	222,749 acre feet (199 MGD) Note 16	Note 17	281,901 acre feet (251 MGD)

Notes:

1. Not included in water rights calculations. Pumping plants operated under Cedar River claim when needed. Term permit has expired, and is considered "inactive" by Ecology (March 14, 2012).
2. Maximum volume recharged to date: January 1993 to May 1993 during demonstration project; recharge period is October through May.
3. Per Integrated Water Resource Management System (IWRMS) average rate over 24 hours recorded 1/3/95.
4. Tolt Pipeline 24-hour volumes from IWRMS (1985-1999); highest occurred in 1994.
5. Flow diverted from South Fork Tolt River and measured by Seattle City Light at powerhouse on 6/3/1996.
6. With June 2005 ASR application, City requested Qi of 2900 and Qa of 1200 acre-feet at Boulevard Well Field, based on this permit and application G1-24825
7. Per Seattle Well Field, O&M Manual; Maximum range of normal operations.
8. Maximum well field use occurred between June and December 1992.
9, With June 2005 ASR application, City requested Qi of 6300 and Qa of 3200 acre-feet at Riverton Well Field, based on this permit and application G1-24824
10. Per Seattle Well Field, O&M Manual; Maximum range of normal operations.
11. Maximum well field use occurred between June and December 1992.
12. The installed pumping capacity exceeds the Qi specified in the existing temporary permit.
13. Agreement with Muckleshoot Indian Tribe (MIT) (June 2006) limits average annual diversion from Cedar to 105 MGD until 2020, 110 MGD from 2021 to 2030, and 124 MGD beginning in 2031.
14. Per IWRMS data 226 mgd was recorded 6/23/96 (7:00 am reading).
15. Landsburg diversion calendar year 1990: 144 mgd, 52,560 mg, 161,312 ac-ft.
16. Peak instantaneous and peak annual demand occurred at different times on individual sources, so sums do not represent system wide peaks. Emergency source, ASR recharge water diversion, and storage not included.
17. Cedar Claim and MIT agreement do not specify a Qi.
18. SPU does not use interties as a normal supply source.
19. No rainwater harvesting systems have been installed under this permit.

Wate Rights Evaluation
Table 2 - Pending Water Rights Status

Water Right Application	Name on Permit	Date Submitted	Source Name	Primary or Supplemental	Pending Water Rights	
					Maximum Instantaneous Flow Rate (Qi) Requested	Maximum Annual Volume (Qa) Requested
1. S-4254	City of Seattle Water Department	Filing date 07/14/36 being held in abeyance	North Fork Tolt River	Primary	280 cfs (181 MGD)	203,000 acre-feet
2. Gl-24620	East King County Regional Water Association and City of Seattle Water Department	1/19/1994	Snoqualmie Aquifer	Primary	41,600 gpm (60 MGD)	To be determined
3. S1-27877	East King County Regional Water Association and City of Seattle Public Utilities	1/29/1998	Snoqualmie River	Primary	100 cfs (65 MGD)	To be determined
4. G1-24620	City of Seattle Water Department	3/7/1985	Glacier Well	Irrigation or other non-potable use only	To be determined	To be determined
5. G1-24824 (Note 1)	City of Seattle Water Department	4/14/1986	Riverton Well Field: (Note 3)	Primary	4000 gpm (5.8 MGD)	To be determined
6. G1-24825 (Note 2)	City of Seattle Water Department	4/14/1986	Boulevard Park Well Field (Note 3)	Primary	4000 gpm (5.8 MGD)	To be determined
7. R1-28168	City of Seattle	6/29/2005	Seattle Well Fields ASR (Note 3)	Primary	N/A	1500 acre-feet

Notes:
1. With June 2005 ASR application, City requested Qi of 6300 and Qa of 3200 acre-feet at Riverton Well Field, based on this application and temporary permit G1-24621
2. With June 2005 ASR application, City requested Qi of 2900 and Qa of 1200 acre-feet at Boulevard Well Field, based on this application and temporary permit G1-24619
3. Since the last WSP update, the Highline Well Field has been renamed Seattle Well Fields (Riverton Well Field and Boulevard Park Well Field)

February 2012

Water Rights Evaluation
Table 3 - Projected Water Rights Status

Permit Certificate or Claim #	Name of Rightholder or Claimant	Priority Date	Source Name/ Number	Primary or Supplemental	Existing Water Rights		Forecast Water Demand for 2040		Forecast 2040 Water Right Status Excess (+) / Deficiency (-)	
					Maximum Instantaneous Flow rate (Qi)	Maximum Annual Volume (Qa)	Maximum Instantaneous Flow Rate (Qi)	Maximum Annual Volume (Qa)	Maximum Instantaneous Flow Rate (Qi)	Maximum Annual Volume (Qa)
Certificates										
1. R-206	City of Seattle Water Department	7/14/1936	South Fork Tolt Reservoir	Primary	N/A	Storage 57,830 acre feet				
Permits										
1. S1-25929	City of Seattle Water Department	8/17/1990	Cedar River: Temporary Pumping Plant	Supplemental (Term Permit)	390 cfs (252 mgd)	102,746 acre-feet Note 1				
2. S1-25330P	City of Seattle Water Department	8/22/1988	Cedar River: Aquifer Storage and Recovery (ASR)	Primary	10 cfs (6.5 MGD) (Oct to May)	4,800 acre feet (1,564 mg)				
3. 10602	City of Seattle Water Department	7/14/1936	South Fork Tolt Diversion	Primary	280 cfs (181 MGD)	168,000 acre feet (150 MGD)				
4. S1-28477	City of Seattle Seattle Public Utilities	1/30/2007	Rainwater	Primary	N/A	23,150 acre-feet Note 1				
Temporary Permits										
1. G1-24619	City of Seattle Water Department	3/7/1985	Boulevard Park Well Field	Primary	To be Determined - Note 2					
2. G1-24621	City of Seattle Water Department	3/7/1985	Riverton Well Field	Primary	To be Determined - Note 3					
Claims										
1. 068624	City of Seattle Water Department	1888	Cedar River and Chester Morse Lake	Primary	Note 5	336,650 acre feet (300 MGD) Note 4				
2. 068623	City of Seattle Water Department	1926	Lake Youngs	Primary	N/A	Storage 33,770 acre feet				
Interties - Note 7										
TOTAL - Note 8	*********	*****	*******	**********	Note 5	504,650 acre feet (450 MGD)	668 cfs - Note 6 (431 MGD)	131,200 acre feet (117.1 MGD)	Note 5	373,450 acre feet (332.9 MGD)

Notes:
1. Not included in water rights calculations; pumping plants operated only for testing or under conditions of extreme drought.
2. With June 2005 ASR application, City requested Qi of 2900 and Qa of 1200 acre-feet at Boulevard Well Field, based on this permit and application G1-24825
3, With June 2005 ASR application, City requested Qi of 6300 and Qa of 3200 acre-feet at Riverton Well Field, based on this permit and application G1-24824
4. Agreement with Muckleshoot Indian Tribe (June 2006) limits average annual diversion from Cedar to 105 MGD until 2020, 110 MGD from 2021 to 2030, and 124 MGD beginning in 2031.
5. Cedar Claim and MIT agreement do not specify a Qi.
6. Flow rate listed is maximum capacity of raw water pipelines.
7. SPU does not use, and does not project to use, interties for normal supply.
8. Emergency source, ASR recharge water diversion, and storage not included. Forecast demand not divided by source.

February 2012

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SEATTLE PUBLIC UTILITIES
2013 WATER SYSTEM PLAN

A. WATER RESOURCES

APPENDIX A-3

GROUNDWATER ELEVATIONS AT SEATTLE WELL FIELDS

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Groundwater Elevations at Seattle Well Fields

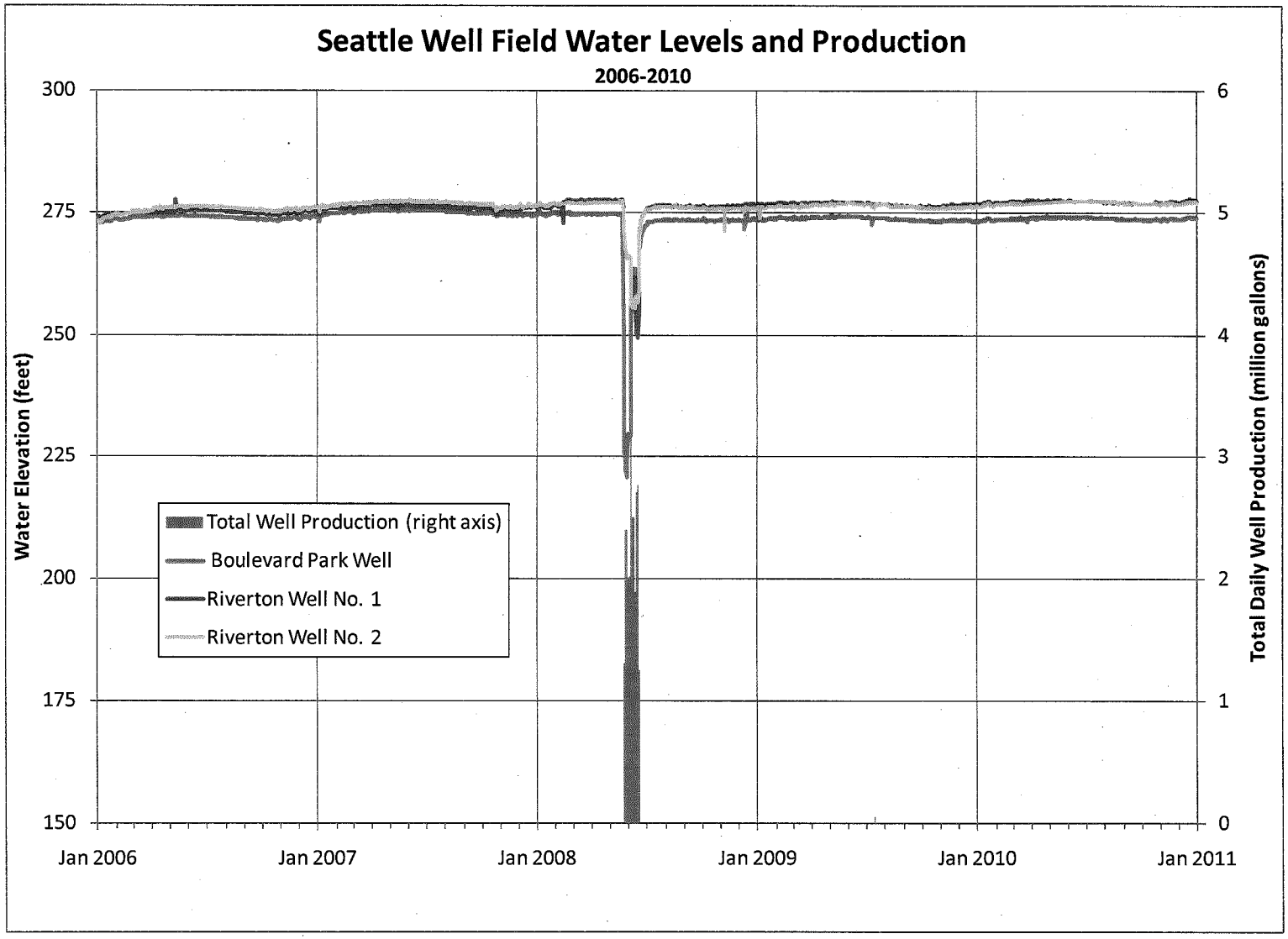
November 2011

SPU monitors groundwater levels in the vicinity of the Riverton and Boulevard Park Well Fields as part of its management of this supply source. Underlying the area are three water-bearing, sand and gravel formations now known as the Shallow, Intermediate and Deep Aquifers. The aquifers are arranged in layers and separated by much less pervious silt and clay layers which act as aquitards. At the land surface, over much of the area, is a highly compacted layer composed of glacial till. SPU has three production wells tapped into the Intermediate Aquifer.

In addition to the production wells, SPU has a network of six monitoring wells in the Well Fields. Three of these wells can monitor water levels in the intermediate aquifer, two in the shallow aquifer, and one in the deep aquifer. Data loggers collected continuous elevation data from the monitoring wells from late 1991 through late 1999, primarily during and immediately after the ASR demonstration project. Routine collection of water level data from the observation wells was suspended in early 2000. In the absence of recharge operations, it was felt that levels recorded continuously in the three production wells by the SCADA system would adequately track trends in the intermediate aquifer. Data are available from this system starting in January 2003 and from SPU's I-SCADA IMS Data Portal starting in April 2005.

The graph below shows the groundwater elevations from the SCADA system at the Riverton and Boulevard Park productions wells from January 2006 through December 2010. Also shown in the graph is total daily production from the three wells. No long-term trends appear in the data. Short-term declines occurred in May and June 2008 when the wells were used for 24 days, but levels quickly recovered when pumping ceased.

SPU will continue to monitor the elevations in the production wells for any trends, and will re-activate the monitoring well network if recharge operations are undertaken.


Seattle Well Field Water Levels and Production
2006-2010
Water Elevation (feet)
Total Daily Well Production (million gallons)
300
275
250
225
200
175
150
6
5
4
3
2
1
0
Jan 2006
Jan 2007
Jan 2008
Jan 2009
Jan 2010
Jan 2011
Total Well Production (right axis)
Boulevard Park Well
Riverton Well No. 1
Riverton Well No. 2

SEATTLE PUBLIC UTILITIES
2013 WATER SYSTEM PLAN

A. WATER RESOURCES

APPENDIX A-4
KING COUNTY RECLAIMED WATER CHECKLIST

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For questions, call Kristina Westbrook,
King County Reclaimed Water Program Manager at (206) 296-5279
www.kingcounty.gov/reclaimedwater

King County

Water Reclamation Evaluation Checklist
For Systems with 1,000 or more Connections

The County and State recognize that changing conditions could initiate a need to respond in new ways to future water quality standards, wastewater discharge requirements, take advantage of advances in treatment technologies and/or allow our region to be positioned to respond to changes associated with climate change and population growth.

In 2003, Chapter 90.46 of the Revised Code of Washington (RCW) was amended to require public water systems serving 1,000 or more connections to evaluate opportunities for reclaimed water when completing their water system plans. Please use this checklist to meet King County consistency requirements in responding to this legislation.

Please use this checklist, including the inventory template, to ensure that your water system plan includes sufficient information about opportunities for reclaimed water and your system's efforts to develop those opportunities. If a question is not applicable or the information is unavailable, then answer, "unknown" or "n/a." King County will consider the checklist completed if each answer is filled in with the best available information, even if the utility states that it is not aware of any reclaimed water opportunities within its service area.

Water System Name: Seattle Public Utilities
Date: December 2011
PWS ID# 77050 Y
Contact: Joan Kersnar

1. **Identifying Potential Future Demand for Reclaimed Water:** King County maintains a database and map of potential reclaimed water users for evaluating future projects. Please use the template below, or similar table, to provide information to assist King County in further researching these potential uses.
   - **Large Utility Water Users** (choose one):
     - ☐ Attached is an inventory of twenty large (above 20,000 gallons/month on average), non single-family residential, water users served by our utility that have a potential for reclaimed water use, or
     - ☑ Attached is an inventory of our utility's top twenty water users, or
     - ☐ The information requested is unknown or not available.
       Additional Comments: _____
   - **Large Self Suppliers** (choose one):
     - ☐ Attached is an inventory of large, self-supplied water users within our water utility's service boundaries - especially those near wastewater treatment plants, mainlines, outfalls, and pump stations or similar reclaimed water facilities), or
     - ☑ The information requested is unknown or not available.
       Additional Comments: See SPU, "An Economic Analysis of the North Seattle Reclaimed Water Project," September 2010.
   - **Other** (choose one):
     - ☐ Attached is an inventory of other water users (such as those that are clustered near one another and could be served by a single system) that may be likely candidates for reclaimed water use, or
     - ☑ The information requested is unknown or not available.
       Additional Comments: See SPU, "An Economic Analysis of the North Seattle Reclaimed Water Project," September 2010.

2. **Environmental Commitment**: Are you a city/town, or providing water service to a city/town, that has made commitments within resource management plans, salmon recovery plans, or other environmental initiatives for which there is a potential opportunity for using reclaimed water to assist in meeting commitments? (choose one)

   ☐ Yes, here are plans that have potential for reclaimed water use in our service area to meet the above commitments:

   _____

   _____

   ☑ The information requested is unknown, not available.
   Additional Comments: _____

3. **Identifying Areas of Potential Use of Reclaimed Water for Environmental Benefit:**
   Below are ***examples*** of uses of reclaimed water ***that comply with State, Federal and other reclaimed water environmental, health and safety standards***. All of these uses are currently in effect somewhere in Washington State. To the best of your knowledge, are any of these potential uses for reclaimed water applicable to your area?

   River Augmentation (choose one):

   ☐ Yes, our water rights are limited by instream flows. For more information, King County may contact:

   _____

   _____

   ☐ The information requested is unknown, or not available.
   Additional Comments: There is adequate water supply with existing instream flow conditions being met.

   Groundwater Recharge (choose one):

   ☐ Yes, we withdraw water from an aquifer that is in a groundwater management area, or from a declining aquifer, where water levels may need to be replenished or to maintain aquifer storage. For more information, King County may contact:

   _____

   ☐ The information requested is unknown, or not available.
   Additional Comments: Not applicable.

   Water Rights Mitigation (choose one):

   ☐ Yes, our area is pursuing, or planning to pursue, new or additional water rights, and there may be an opportunity to use reclaimed water for mitigation of those new water rights. For more information, King County may contact:

   _____

   ☑ The information requested is unknown, or not available.
   Additional Comments: _____

   Potential Areas of Environmental Need (choose one):

   ☐ Yes, parts of our service area include potential environmental enhancement locations, such as wetlands enhancement, aquifer recharge, stream flow augmentation, that might be candidates for reclaimed water use. For more information, King County may contact:

   _____

   ☑ The information requested is unknown, or not available.
   Additional Comments: _____

4. **Local Reclaimed Water Legislation**: If water reclamation is mandated for this water system through local government agreement, contract, local regulations, ordinances, or other mechanisms, please provide a copy of the governing mechanism (choose one).

   ☐ Yes, local legislation exists in our area in support of reclaimed water use. The following relevant legislation is attached (please list titles of documents):

   _____

   _____

   ☑ No water reclamation legislation exists, or is known to exist, at a local level in our service area.

5. **Coordination with Local Wastewater Utility:** Include a brief description of your interactions with any wastewater or reclaimed water utility (King County or other) adjacent to your service area to evaluate any potential opportunities to develop reclaimed water (choose one).

   ☑ Describe if applicable:
   Coordination with King County occurs through ongoing participation in the MWPAAC, development of the Reclaimed Water Comprehensive Plan, and evaluation of potential opportunities such as described in SPU.

   ☐ None. Additional Comments: "An Economic Analysis of the North Seattle Reclaimed Water Project," September 2010.

Template for
Inventory of Water Users and Identification of Potential Reclaimed Water Users

Site Owner or Site Name	Site Address (for general mapping purposes)	Estimated Annual Water Use	Water uses not requiring potable water[1]	Is this a Potential Reclaimed Water Customer?
SEE NEXT PAGE				

[1] See Washington State Reclamation and Reuse Standards, September 1997, Section 1, Articles 1-5 for allowable uses of reclaimed water. http://www.ecy.wa.gov/PROGRAMS/WQ/reclaim/standards.html

Seattle Public Utilities
Inventory of Water Users and Identification of Potential Water Users

Site Owner or Site Name	Site Address (for general mapping purposes)	Estimated Annual Water Use (Total 2010)	Water uses not requiring potable water[1]	Is this a Potential Reclaimed Water Customer?
PORT OF SEATTLE (SeaTac Airport)	2011 S 160TH ST	284,935 ccf	Possible landscape irrigation, fire fighting and protection, cooling water make-up, pavement washing, toilet and urinal flushing.	Unknown
UNIVERSITY OF WASHINGTON	2235-45 NE 45TH ST	114,859 ccf	Possible landscape irrigation, fire fighting and protection, cooling water make-up, pavement washing, toilet and urinal flushing.	Unknown
SEATTLE STEAM COMPANY	1319 WESTERN AVE	110,965 ccf	Possible industrial boiler feed, fire fighting and protection, pavement washing, and toilet and urinal flushing.	Unknown
NUCOR STEEL SEATTLE	4001 28TH AVE SW	105,020 ccf	Possible industrial process, cooling water make-up, dust control, fire fighting and protection, pavement washing, and toilet and urinal flushing.	Unknown
UNIVERSITY OF WASHINGTON	3780 15TH AVE NE	96,002 ccf	Possible cooling, landscape irrigation, fire fighting and protection, pavement washing, toilet and urinal flushing.	Unknown
CERTAINTEED GYPSUM	5931-37 E MARGINAL WAY S	87,082 ccf	Possible cooling water make-up fire fighting and protection, pavement washing, and toilet and urinal flushing.	Unknown
UNIVERSITY OF WASHINGTON	4000 15TH AVE NE	78,962 ccf	Possible cooling water make-up, landscape irrigation, fire fighting and protection, pavement washing, toilet and urinal flushing.	Unknown
DARIGOLD	4058 RAINIER AVE S	74,006 ccf	Possible landscape irrigation, fire fighting and protection, pavement washing, toilet and urinal flushing.	Unknown
PEPSI BOTTLING GROUP	2300 26TH AVE S	72,500 ccf	Possible landscape irrigation, fire fighting and protection, pavement washing, toilet and urinal flushing.	Unknown
PORT OF SEATTLE	2031 W HALLADAY ST	69,129 ccf	Possible cooling water make-up, ship ballast, fire fighting and protection, toilet and urinal flushing.	Unknown
SEATTLE STEAM COMPANY	1319 WESTERN AVE	66,346 ccf	Possible cooling water make-up, industrial boiler feed, fire fighting and protection, pavement washing, and toilet and urinal flushing.	Unknown
KING COUNTY FACILITIES MANAGEMENT	500 5TH AVE	64,418 ccf	Possible cooling water make-up, landscape irrigation, fire fighting and protection, pavement washing, toilet and urinal flushing.	Unknown
HOSPITAL CENTRAL SERVICES	1300 E COLUMBIA ST	59,015 ccf	Unknown	Unknown
SWEDISH MEDICAL CENTER	801 BROADWAY	51,129 ccf	Unknown	Unknown
SEAFREEZE LTD PARTNERSHIP	200 SW MICHIGAN ST	50,318 ccf	Possible cooling water make-up, fire fighting and protection, pavement washing, toilet and urinal flushing.	Unknown
WOODLAND PARK ZOOLOGICAL SOCIETY	5500 PHINNEY AVE N	49,334 ccf	Possible landscape irrigation, fire fighting and protection, pavement washing, toilet and urinal flushing.	Unknown
UNIVERSITY OF WASHINGTON	3900 MONTLAKE BLVD NE	37,887 ccf	Possible cooling water make-up, landscape irrigation, fire fighting and protection, pavement washing, toilet and urinal flushing.	Unknown
SHOREWOOD APTS	3209 SHOREWOOD DR, MERCER ISLAND	35,977 ccf	Possible landscape irrigation, fire fighting and protection, pavement washing, toilet and urinal flushing.	Unknown
R C HEDREEN LLC (ELLIOTT GRAND HYATT)	721 PINE ST	35,651 ccf	Possible cooling water make-up, fire fighting and protection, pavement washing, toilet and urinal flushing.	Unknown
UNIVERSITY OF WASHINGTON	4208 15TH AVE NE	35,042 ccf	Possible cooling water make-up landscape irrigation, fire fighting and protection, pavement washing, toilet and urinal flushing.	Unknown

SEATTLE PUBLIC UTILITIES
2013 WATER SYSTEM PLAN

APPENDIX B

WATER SYSTEM INVENTORIES

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SEATTLE PUBLIC UTILITIES
2013 WATER SYSTEM PLAN

B. WATER SYSTEM INVENTORIES

APPENDIX B-1
WATER FACILITIES INVENTORY FORM

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Washington State Department of Health
Division of Environmental Health
Office of Drinking Water

WATER FACILITIES INVENTORY (WFI) FORM

ONE FORM PER SYSTEM

Quarter: 1
Updated: 11/29/2011
Printed: 2/22/2012
WFI Printed For: On-Demand
Submission Reason: Annual Update

RETURN TO: Northwest Regional Office, 20435 72nd Ave S STE 200, Kent, WA, 98032

1. SYSTEM ID NO.	2. SYSTEM NAME	3. COUNTY	4. GROUP	5. TYPE
77050 Y	SEATTLE PUBLIC UTILITIES	KING	A	Comm

6. PRIMARY CONTACT NAME & MAILING ADDRESS	7. OWNER NAME & MAILING ADDRESS	8. Owner Number 005246
WILLIAM B. WELLS [WQ & T MANAGER] PO BOX 34018 SEATTLE, WA 98124-4018	SEATTLE, CITY OF DAVE HILMOE PO BOX 34018 SEATTLE, WA 98124-4018	TITLE: DIRECTOR
STREET ADDRESS IF DIFFERENT FROM ABOVE	**STREET ADDRESS IF DIFFERENT FROM**	
ATTN SEATTLE PUBLIC UTILITIES ADDRESS 700 5TH AVE # 4900 CITY SEATTLE STATE WA ZIP 98124	ATTN SEATTLE PUBLIC UTILITIES ADDRESS 700 5TH AVE # 4900 CITY SEATTLE STATE WA ZIP 98124	

9. 24 HOUR PRIMARY CONTACT INFORMATION	10. OWNER CONTACT INFORMATION
Primary Contact Daytime Phone: (206) 684-0221	Owner Daytime Phone: (206) 684-7414
Primary Contact Mobile/Cell Phone: (425) 241-5484	Owner Mobile/Cell Phone:
Primary Contact Evening Phone: (xxx) xxx-xxxx	Owner Evening Phone: (xxx) xxx-xxxx
Fax: | E-mail: XXXXXX	Owner Fax Phone: | E-mail: XXXXXX

WAC 246-290-420(9) requires that water systems provide 24-hour contact information for emergencies.

11. SATELLITE MANAGEMENT AGENCY - SMA (check only one)

- [x] Not applicable (Skip to #12)
- [ ] Owned and Managed SMA NAME: _____ SMA Number:
- [ ] Managed Only
- [ ] Owned Only

12. WATER SYSTEM CHARACTERISTICS (mark all that apply)

[ ] Agricultural	[x] Hospital/Clinic	[x] Residential
[x] Commercial / Business	[x] Industrial	[x] School
[x] Day Care	[x] Licensed Residential Facility	[ ] Temporary Farm Worker
[x] Food Service/Food Permit	[x] Lodging	[ ] Other (church, fire station, etc.):
[ ] 1,000 or more person event for 2 or more days per year	[x] Recreational / RV Park	

13. WATER SYSTEM OWNERSHIP (mark only one)				14. STORAGE CAPACITY (gallons)
[ ] Association	[ ] County	[ ] Investor	[ ] Special District	
[x] City / Town	[ ] Federal	[ ] Private	[ ] State	398,000,000

- SEE NEXT PAGE FOR A COMPLETE LIST OF SOURCES -

WATER FACILITIES INVENTORY (WFI) FORM - Continued

1. SYSTEM ID NO.	2. SYSTEM NAME	3. COUNTY	4. GROUP	5. TYPE
77050 Y	SEATTLE PUBLIC UTILITIES	KING	A	Comm

15	16 SOURCE NAME	17 INTERTIE	18 SOURCE CATEGORY									19 USE			20	21 TREATMENT					22 DEPTH	23	24 SOURCE LOCATION			
Source Number	LIST UTILITY'S NAME FOR SOURCE AND WELL TAG ID NUMBER. Example: WELL #1 XYZ456 IF SOURCE IS PURCHASED OR INTERTIED, LIST SELLER'S NAME Example: SEATTLE	INTERTIE SYSTEM ID NUMBER	WELL	WELL FIELD	WELL IN A WELL	SPRING	SPRING FIELD	SPRING IN SPRING FIELD	SEA WATER	SURFACE WATER	RANNEY / INF. GALLERY	OTHER	PERMANEANT	SEASONAL	EMERGENCY	SOURCE METERED	NONE	CHLORINATION	FILTRATION	FLUORIDATION	IRRADIATION (UV)	OTHER	DEPTH TO FIRST OPEN INTERVAL IN FEET	CAPACITY (GALLONS PER MINUTE)	1/4, 1/4 SECTION	SECTION NUMBER	TOWNSHIP	RANGE
S01	CEDAR RIVER									X			X			Y		X		X	X	X		12500	SW SE	19	22N	07E
S02	TOLT RIVER									X			X			Y		X	X	X		X		83280	NW SW	32	26N	09E
S03	RIVERTON HTS #1				X									X		Y		X		X		X	275	3200	NE NW	21	23N	04E
S04	BOULEVARD		X											X		Y		X		X		X	293	2000	NW NW	16	23N	04E
S05	RIVERTON HTS #2				X									X		Y		X		X		X	280	1800	NE NW	21	23N	04E
S06	RIVERTON HTS WF			X										X		Y		X		X		X	275	5000	NE NW	21	23N	04E

WATER FACILITIES INVENTORY (WFI) FORM - Continued

1. SYSTEM ID	2. SYSTEM NAME	3. COUNTY	4. GROUP	5. TYPE
77050 Y	SEATTLE PUBLIC UTILITIES	KING	A	Comm

	ACTIVE SERVICE CONNECTIONS	DOH USE ONLY! CALCULATED ACTIVE CONNECTIONS	DOH USE ONLY! APPROVED CONNECTIONS
25. SINGLE FAMILY RESIDENCES (How many of the following do you have?)	0	157463	Unspecified
A. Full Time Single Family Residences (Occupied 180 days or more per year)	157463		
B. Part Time Single Family Residences (Occupied less than 180 days per year)	0		
26. MULTI-FAMILY RESIDENTIAL BUILDINGS (How many of the following do you have?)			
A. Apartment Buildings, condos, duplexes, barracks, dorms	13330		
B. Full Time Residential Units in the Apartments, Condos, Duplexes, Dorms that are occupied more than 180 days/year	0		
C. Part Time Residential Units in the Apartments, Condos, Duplexes, Dorms that are occupied less than 180 days/year	0		
27. NON-RESIDENTIAL CONNECTIONS (How many of the following do you have?)			
A. Recreational Services and/or Transient Accommodations (Campsites, RV sites, hotel/motel/overnight units)	0	0	
B. Institutional, Commercial/Business, School, Day Care, Industrial Services, etc.	13399	13399	
28. TOTAL SERVICE CONNECTIONS		170862	

29. FULL-TIME RESIDENTIAL POPULATION

A. How many residents are served by this system 180 or more days per 668400

30. PART-TIME RESIDENTIAL POPULATION	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
A. How many part-time residents are present each month?												
B. How many days per month are they present?												

31. TEMPORARY & TRANSIENT USERS	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
A. How many total visitors, attendees, travelers, campers, patients or customers have access to the water system each month?												
B. How many days per month is water accessible to the public?												

32. REGULAR NON-RESIDENTIAL USERS	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
A. If you have schools, daycares, or businesses connected to your water system, how many students daycare children and/or employees are present each month?												
B. How many days per month are they present?												

33. ROUTINE COLIFORM SCHEDULE	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
* Requirement is exception from WAC 246-290	189*	189*	189*	189*	189*	189*	189*	189*	189*	189*	189*	189*

35. Reason for Submitting WFI:

☐ Update - Change ☐ Update - No Change ☐ Inactivate ☐ Re-Activate ☐ Name Change ☐ New System ☐ Other _____

36. I certify that the information stated on this WFI form is correct to the best of my knowledge.

SIGNATURE: _____

DATE: _____

PRINT NAME: _____

TITLE: _____

WS ID	WS Name
77050	SEATTLE PUBLIC UTILITIES

Total WFI Printed: 1

SEATTLE PUBLIC UTILITIES
2013 WATER SYSTEM PLAN

B. WATER SYSTEM INVENTORIES

APPENDIX B-2
WATER SYSTEM MANAGEMENT AND OPERATOR CERTIFICATION

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Water System Management and Operator Certification

December 2011

Seattle Public Utilities (SPU) reorganized its organizational structure since the *2007 Water System Plan*. An explanation of the management structure and personnel at SPU is provided here, followed by a description of SPU's current operator certifications and training programs.

Management and Organizational Structure

An organizational chart for SPU, which shows the current departmental structure, is provided as Exhibit 1. A brief explanation of the role of the Director's Office and each SPU branch is provided below.

Director's Office

The Director's Office includes the Director of Seattle Public Utilities and the Corporate Strategies and Communications (CS&C) Office. The Director is responsible for making sure the utility carries out the mission adopted for SPU. The Director has responsibilities typical of a water superintendent, such as developing budgetary requirements, assuring effective performance of the water system, and implementing City ordinances and utility policies regarding water service.

The CS&C Office assists the SPU Director to design and execute policy, strategy, analyses, internal and external communications, in order to maintain, improve, and explain service delivery, programs and projects, and to manage assets effectively and efficiently. The Office focuses on issues, initiatives, and agreements involving multiple disciplines, branches, departments, governments, and public constituencies. Groups comprising the Office consist of Community Relations Development, Corporate Policy and Performance, Asset Management and Economic Services and Communications Services.

Utility Systems Management Branch

Utility Systems Management (USM) provides overall management of each SPU utility system, including SPU's drinking water, sewer, drainage, solid waste programs and associated assets. USM also includes Watershed Services and Laboratory Services, which primarily support the drinking water system.

The Drinking Water Division Director serves as of the main contact for drinking water system-related issues. The Business Area Managers, who report to the Division Director, plan for projects and programs in their business area. For Drinking Water, these business areas are: Major Watersheds, Water Resources, Water Quality and Treatment, Transmission and Distribution.

Field Operations & Maintenance Branch
Field Operations and Maintenance strives daily to provide outstanding customer service by professionally operating, maintaining and improving SPU's drinking water, sewer, drainage, solid waste programs, and infrastructure investments which protect public safety, public health and the environment. The Branch includes the Water System Operational Planning and System Control section responsible for running day-to-day operations from the Control Center and includes certified water system operators.

Project Delivery Branch
The Project Delivery Branch (PDB) provides a variety of engineering and engineering support services to clients within and outside of SPU. PDB provides project management, engineering, design, survey, drafting, basemapping, construction specification and contract preparation, project cost estimating, geotechnical, materials testing, construction inspection, and contract payment services. Registered professional engineers and land surveyors reside in this Branch, as well as elsewhere in SPU. PDB executes SPU capital projects from start to completion, and provides specific services as appropriate on projects developed by other City departments, other agencies, and developers. PDB applies asset management principles and practices to achieve the triple bottom line goals of customer satisfaction, environmental protection/enhancement and cost efficiency.

Customer Service Branch
The Customer Service Branch is responsible for providing support and assistance to all residential, commercial and key SPU customers receiving water, sewer, drainage and solid waste services. The services this branch provides include: 1) Customer Billing Service, including meter reading; 2) Utility Service Teams, including water inspectors for new taps/lines, repairs, leaks, backflow assembly testing, cross connection control and water quality complaints; 3) Customer Response comprised of the Call Center; and 4) Customer Programs & Contracts Management, which includes water conservation program staff. This branch includes several water quality inspector positions which have Backflow Assembly Tester (BAT), and Cross Connection Control Specialist (CCS) certification requirements.

Finance and Administration Branch
The Finance and Administration Branch provides financial, accounting and information technology services to all sections and employees of SPU.

Human Resources & Service Equity Branch
The Human Resources Division provides the resources, consultation and assistance to enable SPU to recruit, develop and support a diverse workforce. Human Resource Operations & Data Management Division provides payroll support and employee records management for SPU. The Environmental Justice and Service Equity Division focuses on eliminating barriers to ensure all people of the City of Seattle receive equitable services and access to SPU's decision-making processes.

Operations Planning and Scheduling (OPS)
SPU's regional water supply system has multiple objectives that must be met and operational risks that must be actively managed:

- water resource management for people and for fish
- water quality source to tap
- pressure and flow in the transmission and distribution system
- system outages – called 'clearances' - for construction and major maintenance
- flood management and hydropower generation

In 2008, SPU established an Operations Planning and Scheduling (OPS) function that is supported by a core team. The OPS core team membership consists of:

- OPS Team Lead (as assigned)
- System Control Center Manager
- System Control Center Supervisor
- Clearance Work Order Process and Transmission and Distribution Operations representative
- Water Resources/River and Reservoir Operations representative
- Transmission and Distribution Business Areas representative(s)
- Water Quality and Treatment Business Area representative(s)

The OPS Team meets each week so establish a weekly web-based Water System Operating Plan (WSOP). OPS is responsible for developing, deconflicting and communicating (via the WSOP) the plan and schedule for operation of the water system to meet all of the objectives for the regional water system. OPS also reviews, approves, and schedules construction and major maintenance ('clearances') that affect system operations, as well as maintains a schedule of clearances (received, approved and scheduled, in-progress). The System Control Center, which operates 24/7, is responsible for operating the regional water system according to the WSOP, using best judgment where there are no specific instructions and responding to unusual and emergency situations. In addition, the System Control manages the configuration of the system, detects and directs response to water system emergencies, and coordinates and approves all construction and maintenance activities that require access to water system facilities (headworks, treatment, pump stations, gate houses, etc) or that may have an impact on water system.

Operator Certification
SPU is committed to meeting the requirements of the Water Works Operator Certification Program administered by the Washington State Department of Health (DOH) in conjunction with the Water and Wastewater Operator Certification Board of Examiners under the authority of Chapter 70.119 RCW and the comprehensive program regulations contained in Chapter 246-292 WAC. Under this program, water systems must employ certified operators to carry out various water system functions as part of treatment and distribution systems.

Certification Requirements

SPU is classified as a "Group A" public water system. The Group A classification requires that SPU have certified operators in charge of all active, daily, and technical operations of the water system. In meeting this requirement, SPU maintains certified personnel throughout the utility for a variety of water system operations. This certification includes water treatment plant operators at the Tolt and Cedar Water Treatment Facilities, which are operated and maintained by private entities under contract by SPU. Required Classifications include Water Distribution Manager (WDM) Levels 3 and 4, Water Treatment Plant Operator (WTPO) Levels 3 and 4, and Cross Connection Control Specialists (CCS) depending on the requirements of specific positions. Table 1 shows the current listing of mandatory water works operator positions and required certification levels for SPU as they relate to the organizational structure of the utility. This list is updated on an annual basis for utility staff and submitted to DOH for their review. Additionally, SPU also has internal SPU certification requirements for lower level positions (involving level 1, and 2 certifications), that are not detailed out here.

Certified operators are either on-site or on call for all critical water system operations. SPU also ensures that certified operators are in charge of all segments of the water system as appropriate. Certified operators staff the Control Center, and the two primary water treatment plants, 24 hours a day. Also, Water system operations and pipe district managers for the Water Transmission & Distribution Operations Division of SPU's Field Operations & Maintenance Branch maintain necessary Water Distribution Manager certifications.

Table 1
Mandatory Waterworks Personnel Certifications

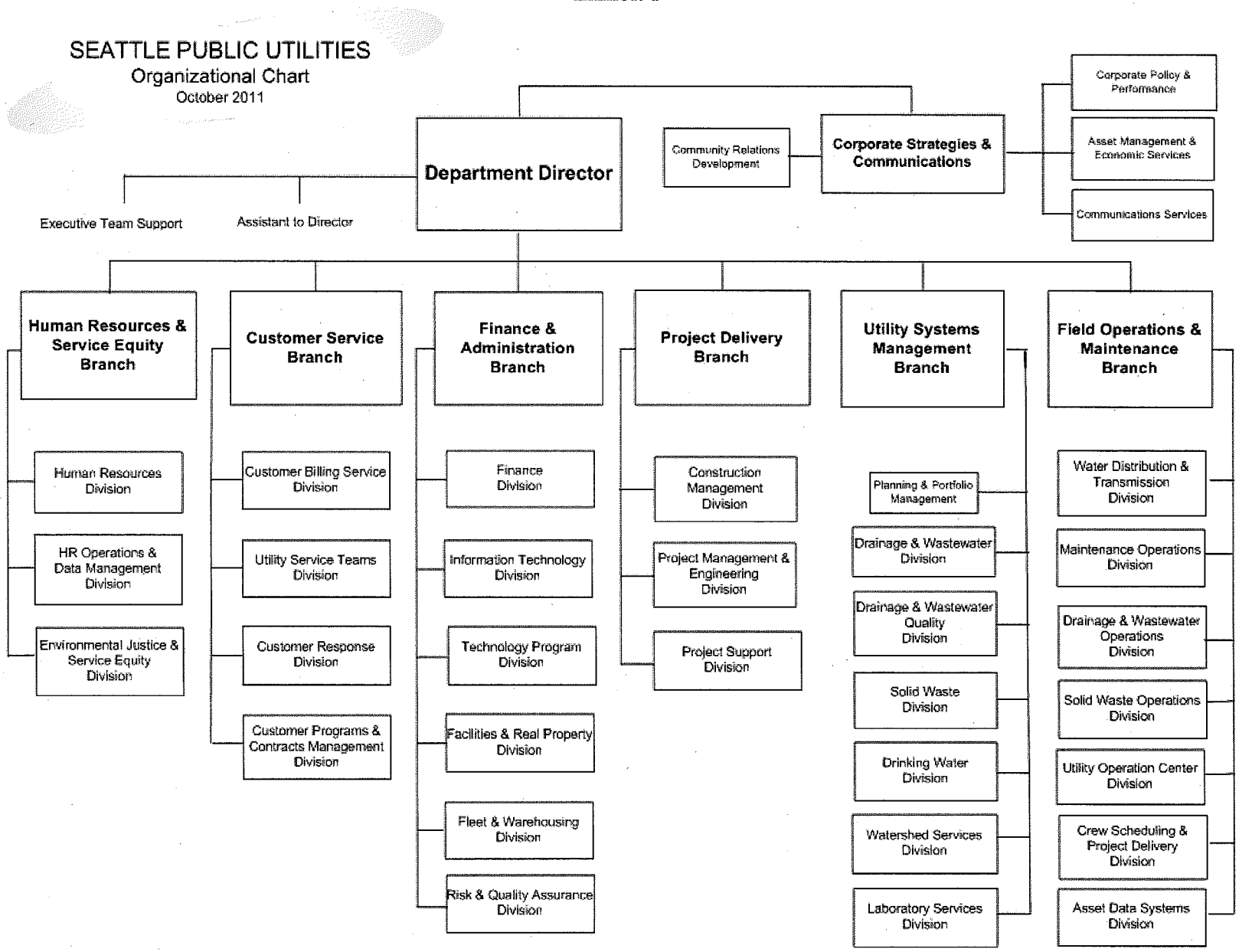
Branch	Division	Position	Required Certification
Utility Systems Management	Drinking Water	Drinking Water Director	WDM 4
	Contract Treatment Operations	Tolt Facility Manager	WTPO 4
		Tolt Chief Operator	WTPO 3
		Tolt Operator (multiple positions)	WTPO 3
		Cedar Project Manager	WTPO 4
		Cedar Operations Supervisor	WTPO 3
		Cedar Operator (multiple positions)	WTPO 3
Customer Service	Utility Service Teams	Utility Service Inspection Manager	WDM 3, CCS
Field Operations and Maintenance	Water Transmission & Distribution Operations	Water Transmission and Distribution Director	WDM 4
		Water Maintenance Manager	WDM 3
		Water Supply Operations Manager	WDM 3
		Water System Supervisor	WDM 3
		Water Transmission Manager	WDM 3
		Water Pipe Distribution Manager - North End	WDM 3
		Water Pipe Distribution Manager - South End	WDM 3
		Water Pipe Distribution Manager -All City	WDM 3

Training

All certified personnel for SPU renew their certificates on an annual basis and enhance their professional growth in the field by accumulating at least three college-related credits or continuing education units (CEUs) every three years. Personnel meet the CEU requirements through a combination of external and internal training opportunities. External opportunities include State-sponsored classes through the Washington Environmental Training Resource Center (WETRC). Examples of classes offered through this program include "Chlorination System Operation and Maintenance" and "Basic Electrical." Internally, SPU takes advantage of a wealth of expertise from a variety of professional staff to offer CEU approved classes. Examples of classes offered through this internal training include:

- National Incident Management System (NIMS)
- Cross Connection Control
- Operations Math
- Corrosion Protection
- Watermain Installation and Print Reading
- Successful Watermain Shutdowns

Exhibit 1


SEATTLE PUBLIC UTILITIES
Organizational Chart
October 2011
Department Director
Executive Team Support
Assistant to Director
Community Relations Development
Corporate Strategies & Communications
Corporate Policy & Performance
Asset Management & Economic Services
Communications Services
Human Resources & Service Equity Branch
Human Resources Division
HR Operations & Data Management Division
Environmental Justice & Service Equity Division
Customer Service Branch
Customer Billing Service Division
Utility Service Teams Division
Customer Response Division
Customer Programs & Contracts Management Division
Finance & Administration Branch
Finance Division
Information Technology Division
Technology Program Division
Facilities & Real Property Division
Fleet & Warehousing Division
Risk & Quality Assurance Division
Project Delivery Branch
Construction Management Division
Project Management & Engineering Division
Project Support Division
Utility Systems Management Branch
Planning & Portfolio Management
Drainage & Wastewater Division
Drainage & Wastewater Quality Division
Solid Waste Division
Drinking Water Division
Watershed Services Division
Laboratory Services Division
Field Operations & Maintenance Branch
Water Distribution & Transmission Division
Maintenance Operations Division
Drainage & Wastewater Operations Division
Solid Waste Operations Division
Utility Operation Center Division
Crew Scheduling & Project Delivery Division
Asset Data Systems Division

SEATTLE PUBLIC UTILITIES
2013 WATER SYSTEM PLAN

B. WATER SYSTEM INVENTORIES

APPENDIX B-3
WATER TREATMENT CHEMICALS

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Water Treatment Chemicals
February 2012

Facility	Chemical
Tolt Water Treatment Facility	Liquid Oxygen
	Carbon Dioxide
	Chlorine
	Ferric Chloride
	Hydrofluorosilicic Acid
	Lime
	Cationic Polymer
	Anionic Polymer
	Sodium Bisulfite (has not been used)
	Sodium Hydroxide
Cedar Water Treatment Facility	Liquid Oxygen
	Chlorine
	Lime
	Sodium Bisulfite
	Sodium Hydroxide
Landsburg Diversion & Pre-Treatment Facility	Chlorine
	Hydrofluorosilicic Acid
Seattle Wells*	Sodium Hypochlorite
	Sodium Hydroxide
	Hydrofluorosilicic Acid
In-Town Reservoir Treatment Facilities	Sodium Hypochlorite
	Salt (used for on-site hypochlorite generation)
	Chlorine

Notes:

* Indicates the facilities are only used seasonally during the high demand period. Chemicals may not be stored on site during the off season.

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SEATTLE PUBLIC UTILITIES
2013 WATER SYSTEM PLAN

B. WATER SYSTEM INVENTORIES

APPENDIX B-4
ASSET INVENTORIES

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Table 1 Tolt Water Treatment Facility Design Parameters	
Type:	Direct Filtration with Raw Water Ozonation
Capacity:	120 mgd
Ozone Generation	
Type:	LOX Feed
Number of units:	Two duty, one standby
Capacity:	2,388 lbs/day each
Applied dose:	2.9 mg/l (average)
	4.8 mg/l (maximum)
Production	1,651 lbs/day (average)
	4,775 lbs/day (maximum)
Ozone Contacting	
Type:	Fine bubble diffusion w/baffled contactor
Number of units:	Two parallel trains
Capacity:	60 mgd each
Contact time:	31.6 minutes (theoretical)
Flocculation	
Type:	Hydraulic flocculation w/baffled serpentine flow
	Pumped jet flash mix for chemical addition
Number of units:	Two parallel trains
Capacity:	60 mgd each
Detention time:	26.5 minutes (theoretical)
Filtration	
Type:	Anthracite mono-medium, with air/water backwash
Number of units:	Six (each with two bays)
Capacity:	24 mgd each
Rate:	12 gpm/sq ft
Bed depth:	72 inches
Clearwell	
Type:	Baffled concrete, cast-in-place
Number of units:	One (two equal halves)
Total volume:	7.4 MG
Washwater Recovery	
Type:	Settling/drying basins
Number of units:	Four
Capacity:	1.385 MG each
FTW/Equalization Basin	
Volume:	1.485 MG
Treatment Chemicals	
Ferric chloride:	Primary coagulant
Cationic polymer:	Primary coagulant/coagulant aid
Anionic/nonionic polymer:	Filter aid and washwater solids settling aid
Gaseous chlorine:	Disinfectant residual
Carbon dioxide:	pH and alkalinity adjustment
Lime:	pH and alkalinity adjustment
Hydrofluosilicic acid:	Fluoride addition
Sodium bisulfite:	Excess ozone quenching

Source: Process Design Criteria (February 2001), CDM PHILIP, SPU updated in 2006 and 2011

Notes:

FTW = Filter to Waste
gpm/sq ft = gallons per minute per square foot
lbs/day = pounds per day
LOX = Liquid Oxygen
mgd = million gallons per day
mg/L = milligrams per liter
MG = million gallons

Table 2 Cedar Water Treatment Facility Design Parameters	
Landsburg	
Chlorination	
System	Chorine Gas
Goal	Minimze entry of nuisance and invasive species at Lake Youngs
Fluoridation	
System	Hydrofluosilicic Acid
Target Residual	0.8 mg/L
Lake Youngs	
Plant	
Type:	Raw Water Ozonation and Ultra Violet Disinfection
Capacity:	180 mgd
Intake and Raw Water Pump Station	
Pump type	Submersible
Number of units:	7
Size	2 @ 20 mgd, 5 @ 40 mgd
Ozone Generation	
Type:	LOX Feed
Number of units:	2
Design concentration of ozone	6 - 12 %
Capacity:	825 lbs/day @ 12 % each (nomimal) 1250 lbs/day @ 6 % each (peak)
Applied ozone dose	0.3 - 0.6 mg/L (typical) 0.8 mg/L (peak)
Ozone Contacting	
Type:	Fine bubble diffusion
Flow direction	Counter-current
Contactor type	Pipeline
Number of units:	Two parallel trains
Volume	0.61 MG
Contact time:	9.8 min @ peak capacity
Ultra Violet Disinfection	
Design basis	3-log Cryptosporidium
Method	Medium pressure
Dosage	40 mJ/sq cm
Contactor type	Closed vessel
Number	13 total
Capacity:	18.4 MGD each
Clearwell	
Type:	Pre-stressed Concrete
Number of units:	2
Total volume:	20 MG
Treatment Chemicals	
Gaseous chlorine:	Disinfectant residual
Lime:	pH and alkalinity adjustment
Sodium Bisulfate	Excess ozone quenching

Source: Design Criteria (Updated July 12, 2004), CH2MHILL; SPU updated in 2006 and 2011

Notes:

lbs/day = pounds per day
mgd = million gallons per day
min = minutes
mg/L = milligrams per liter
LOX = Liquid Oxygen
MG = million gallons
mJ/sq cm = millijoules per square centimeter

Table 3 Seattle Well Fields Treatment Facilities		
Disinfection	System Target Dosage	Sodium Hypochlorite 1.0 to 1.4 mg/L
Fluoridation	System Target Dosage	Hydrofluosilicic Acid 0.8 mg/L fluoride*
Corrosion Control	System Target pH	NaOH Addition 8.2

* Historically, fluoride dose has been 1.0 mg/L. Reduction made in early 2011.

Source: Updated by SPU in October 2011

Table 4
Reservoir and Well Chlorination Facilities

	Year [1] Chlorination Facility Constructed	Type of Chlorination	Target Chlorine Residual (mg/l)	Redundancy	Condition
Outlet (Primary) Disinfection					
Roosevelt Reservoir	1996	Sodium Hypochlorite	1.1 - 1.3	One main storage tank, one day tank, and peristaltic pumps for sodium hypochlorite injection.	Treatment equipment is in good condition.
Volunteer Reservoir	1954	Chlorine gas 150-lb cylinders	1.2 - 1.3	Has one chlorinator and no sodium hypochlorite injection equipment or storage tanks.	Treatment equipment is in good condition.
Residual Maintenance (Secondary) Disinfection					
Beacon Reservoir	1987	Sodium Hypochlorite	1.0- 1.2	Two peristaltic pumps. Only one main storage tank.	Upgraded in 2000. Began operation as covered reservoir in 2009.
Bitter Lake Reservoir	2001	On-site Hypochlorite Generation	0.9	Backup pumps available. Can add sodium hypochlorite as a back up method.	Treatment equipment is in good condition.
Boulevard Park Well	1987	Sodium Hypochlorite	1.0 - 1.4	Backup pumps available. Well can be shut down if a disinfection equipment failure occurs.	Treatment equipment is in good condition.
Eastside Reservoir	1987	Sodium Hypochlorite	0.8	Backup pumps available. Can add sodium hypochlorite as a back up method of disinfection.	Treatment equipment is in good shape.
Lake Forest Park Reservoir	2002	On-site Hypochlorite Generation	0.9 - 1.1	Two peristaltic pumps. Can add sodium hypochlorite as a back up method of disinfection.	Treatment equipment is in good shape.
Lincoln Reservoir	2004	On-site Hypochlorite Generation	1.0 - 1.3	Two peristaltic pumps. Can add sodium hypochlorite as a back up method of disinfection.	Treatment equipment is in good condition.
Maple Leaf Reservoir	1996	Sodium Hypochlorite	1.0 - 1.3	One main storage tank, one day tank, and peristaltic pumps for sodium hypochlorite injection.	Reservoir is out of service for reconstruction (covering). Treatment equipment is in good condition.
Myrtle Reservoir	2007	On-site Hypochlorite Generation	0.9 - 1.0	Two peristaltic pumps. Can add sodium hypochlorite as a back up method of disinfection.	Treatment equipment is in good shape. Began operation as covered reservoir in 2008.
Magnolia Reservoir	1994	Sodium Hypochlorite	0.8 - 1.0	Two storage tanks and two metering pumps.	Condition of the equipment is good.
Riverton Well	1987	Sodium Hypochlorite	1.0 - 1.4	Backup pumps available. Well can be shut down if a disinfection equipment failure occurs.	Condition of the equipment is good.
West Seattle Reservoir: Inlet/Outlet and Trenton Outlet	1998	Sodium Hypochlorite	1.0 - 1.2	One main storage tank, one day tank, and peristaltic pumps for sodium hypochlorite injection.	Treatment equipment is in good condition.

Source: Reimer, 1999; Capron, 2011; Green, 2011; Nilson 2011

[1] In some cases, the year constructed is approximate. Some facilities have had equipment upgrades.

Table 5 Transmission Pipelines			
Pipeline Name	**Material Type**	**Largest Diameter (inches)**	**Length (feet)**
430 Pipeline	Cast Iron	30	178
	Concrete Cylinder	42	1,849
	Steel	42	22,643
550 Pipeline	Steel	72	41,006
8th Ave S Pipeline	Concrete Cylinder	24	4,462
Bel Red Road	Concrete Cylinder	24	2,718
	Steel	12	30
Cedar East Side Supply Line	Cast Iron	36	134
	Concrete Cylinder	36	53,499
	Steel	72	637
Cedar River Pipeline 1	Steel	72	85,796
Cedar River Pipeline 2	Concrete Cylinder	51	10,053
	Ductile Iron	52	11
	Steel	60	71,235
Cedar River Pipeline 3	Ductile Iron	48	38
	Steel	72	86,749
Cedar River Pipeline 4	Concrete Cylinder	60	3,428
	Reinforced Concrete	72	31,687
	Steel	72	18,530
Contactor Pipe Line 4	Steel	78	3,675
Contactor Pipe Line 5	Steel	78	3,730
Des Moines Pipeline	Cast Iron	20	14
	Concrete Cylinder	24	18,197
Finished Pipeline 4	Steel	78	13,720
Finished Pipeline 5	Cast Iron	24	17
	Concrete	84	333
	Steel	78	2,991
Lake Youngs Bypass 4	Steel	78	3,006
Lake Youngs Bypass 5	Steel	78	2,999
Lake Youngs Supply Line 4	Steel	92	35,712
Lake Youngs Supply Line 5	Steel	78	35,612
Lake Youngs Tunnel	Concrete	96	11,302
	Steel	96	6
Lake Youngs Tunnel Connection	Cast Iron	24	6
	Steel	72	233
Landsburg Tunnel	Concrete	96	10,129
Maple Leaf Pipeline	Steel	54	26,164
Mercer Island Pipeline	Cast Iron	20	1,384
	Concrete Cylinder	30	9,659
	Steel	30	5,094
	Unknown	20	21
NE 24th St	Cast Iron	16	2,273
NE 8th Pl	Concrete Cylinder	24	3,783
	Ductile Iron	24	174
	Steel	20	30
Olive St Pipeline	Cast Iron	30	2,055
	Concrete Cylinder	36	337
	Ductile Iron	30	374
Ozonation Overflow Line	Steel	54	875
Reg Basin Bypass	Concrete Cylinder	66	3,026
	Steel	66	6
S 146th St Pipeline	Concrete Cylinder	30	5,209
	Ductile Iron	30	32
	Steel	24	65
S 154th St Pipeline	Ductile Iron	36	6,203
	Steel	36	13
Soos Reservoirs 640 Zone	Cast Iron	14	5,470
	Ductile Iron	24	16,555
	Steel	48	1,785
South Fork Tolt Pipeline	Concrete	72	841
	Steel	72	25,820
Tolt East Side Supply Line	Concrete Cylinder	48	52,557
	Steel	54	1,221
	Unknown	16	8
Tolt East Side Supply Line Extension	Concrete Cylinder	48	7,657
	Ductile Iron	24	614
	Steel	48	5,441
Tolt Pipeline 1	Concrete Cylinder	66	56,300
	Ductile Iron	54	17,769
	Steel	81	54,379
Tolt Pipeline 2 Ph I	Steel	60	12,302
Tolt Pipeline 2 Ph II	Steel	60	21,498
Tolt Pipeline 2 Ph III	Steel	81	20,950
Tolt Pipeline 2 Ph IV	Steel	60	32,127
Tolt Pipeline 2 Ph VIa	Steel	87	8,598
Tolt Tieline	Steel	44	7,913
Tolt Treatment Facility Inlet	Steel	90	2,711
Transmission Connection	Steel	60	1
West Seattle Pipeline	Steel	54	25,591
Total		**96**	**1,021,247**

Source: Mantchev, 2012, based on SPU GIS

Pipeline lengths are from Arc_lngth field, and include both raw and treated water pipelines.
Excludes all pipelines in the Northwest Subregional System and some pipelines in the Southwest Subregional System which are also Seattle distribution mains.

Table 6
Treated Water Reservoirs

Reservoir	Year Constructed	Total Capacity (MG)	Number of Cells	Overflow Elev. (feet)[1]	Under- Drain	Construction Type
Regional and Sub-Regional Reservoirs - Covered						
Eastside	1989/90	31.9	1	560	Yes	Reinforced concrete tank. Below grade.
Lake Forest Park	1961/62	60	2	550	Yes	Hyplon-lined, reinforced concrete slab. Floating cover added in 2003.
Maple Leaf	see note 2	60	2	430	Yes	Reinforced concrete tank. Below grade.
Riverton Heights	1979/80	20.1	1	460	Yes	Reinforced concrete tank. Part below grade.
Soos North	1989/90	6.5	1	640	Yes	Reinforced concrete tank. Above grade.
Soos South	1989/90	6.5	1	640	Yes	Reinforced concrete tank. Above grade.
West Seattle	2010	30	1	440	Yes	Reinforced concrete tank. Below grade.
Distribution System Reservoirs - Covered						
Bitter Lake	1956/57	21.3	1	509	Yes	Reinforced concrete slab. Hypolon liner and floating cover added in 2001.
Beacon	2009	50	1	326	Yes	Reinforced concrete reservoir. Below grade.
Lincoln	2006	12.7	1	326	Yes	Reinforced concrete reservoir. Below grade.
Magnolia	1993/94	5.5	1	330	Yes	Reinforced concrete tank. Part below grade.
Myrtle	2008	5	1	498	Yes	Reinforced concrete reservoir. Below grade.
View Ridge	1977/78	2.5	1	276	Yes	Reinforced concrete tank. Below grade.
Distribution System Reservoirs - Open						
Roosevelt[3]	1910	50.3	1	326	Yes	Unreinforced concrete slab. HDPE liner.
Volunteer[3]	1901	20.5	1	430	No	Unreinforced concrete slab.

Updated 2011

1. Nominal elevation based on North American Vertical Datum (NAVD 88).
2. Under construction; planned for completion in 2012.
3. Roosevelt and Volunteer Reservoirs are planned to be removed from service following the completion of Maple Leaf Reservoir. Roosevelt Reservoir is planned to be test-decommissioned between 2012 and 2014, when a final decision will be made about decommissioning. Although modeling shows that the emergency scenarios can be met without storage at Volunteer, a decision to decommission the reservoir site has not been finalized. The decision requires further operational experience to determine the importance of the reservoir to normal system operations. If a new, covered reservoir is constructed, the likely size would be 10 million gallons.

Table 7
Standpipes and Elevated Tanks

	Year Const.	Capacity (MG)	Base Elev. (feet)[1]	Overflow Elev. (feet)[2]	Diameter (feet)	Tank Height on Riser (feet)	Tank Material	Date of Last Inspection	Interior Coating		Exterior Coating		Seismic Upgrade (or Date Scheduled)
									Type[a]	Date Applied	Type[b]	Date Applied	
Regional and Sub-Regional System													
Elevated Tanks													
Beverly Park	1959	2.0	460	585	105	35	Welded Steel	Oct 98	CTE/epoxy	1985	Zn/Alkyd	1985	To be determined
Myrtle #2	1946	1.0	506.5	585	84.25	NA	Riveted Steel	Jan 99	CTE/epoxy	2010	Lead base[3]	2010	2003
Richmond Highlands #2	1958	2.0	488.5	590	86	35	Welded Steel	Nov 98	CTE	1958	Lead base[4]	1981	N/A
Others													
Control Works NE Tank	1925	0.3	437	512	NA	-	Riveted Steel	Oct 97	polyurethane	1994	epoxy/urethane[5]	1994	1994
Control Works SW Tank	1925	0.3	437	512	NA	-	Riveted Steel	Nov 97	polyurethane	1994	epoxy/urethane[5]	1994	1994
Distribution System													
Standpipes													
Charlestown	1996	1.3	424	498	58	-	Welded Steel	Feb 99	epoxy	1996	epoxy/urethane	1996	Not needed
Queen Anne	2008	1.9	460	530	75	-	Welded Steel	N/A	epoxy	2007	urethane / epoxy / acryclic polyurethane[6]	2007	N/A
North Trenton	1932	1.2	296	330	92	-	Riveted Steel	Jan 98	Vinyl	1979	Lead base[7]	1990	Not needed
South Trenton	1932	1.2	296	330	92	-	Riveted Steel	Oct 98	Vinyl	1979	Lead base[7]	1990	Not needed
Volunteer Park	1907	0.9	460	530	50	-	Masonry/Riveted Steel	Apr 99	Vinyl	1981	Lead base	1981	To be determined
Elevated Tanks													
Magnolia Bluff	1947	1.0	369	480	86	25	Welded Steel	Mar 99	epoxy	1988	Zn/Alkyd[8,9]	1988	1993

Updated 2011

a CTE = Coal Tar Enamel; p-urethane = Monolithic polyurethane lining

b epoxy = NSF epoxy primer and intermediate coats; and a polyurethane top coat; Zn/Alkyd = Zinc yellow primer and silicone alkyd enamel top coat

1. Top of concrete base, based on North American Vertical Datum (NAVD 88).
2. Nominal elevation based on North American Vertical Datum (NAVD 88).
3. Myrtle #2 has an intermediate layer of aluminum or SS flake alkyd paint.
4. 1993 seismic upgrade added all new steel to legs and riser, and coated legs and riser with a non-lead alkyd enamel paint system. The bowls still have the lead based primer as noted.
5. Base of tank in building. Above the roof: epoxy prime coat and polyurethane top coat (in 1994); Inside the bldg: moisture cured polyurethane primer and top coats (in 1998).
6. Exterior coating consists of zinc-rich urethane primer then epoxy followed by acrylic polyurethane top coat.
7. Trenton tanks were power tool cleaned and overcoated with an urethane/epoxy/urethane paint system in 1990.
8. Magnolia Bluff was commercially blasted and coated with a non-lead alkyd system. Some lead remains on the tank.
9. 1993 seismic upgrade added all new steel to legs and riser, and coated legs and riser with a non-lead alkyd enamel paint system. The bowls still have the lead based primer as noted.

Table 8

Decommissioned Standpipes and Elevated Tanks[d]

	Year Taken Off-Line	Year Const.	Capacity (MG)	Base Elev. (feet)[e]	Overflow Elev. (feet)[f]	Diameter (feet)	Tank Height on Riser (feet)	Tank Material	Date of Last Inspection	Interior Coating		Exterior Coating		Improvements Needed If Returned to Service	Current Uses
										Type[a]	Date Applied	Type	Date Applied		
Regional and Sub-Regional System															
Standpipe															
Foy	2013[b]	1933	1.0	495	590	46	-	Riveted Steel	Feb 98	Vinyl	1980	Lead base	1980	Internal recoating, including coal tar removal, and installation of a mixing system.	Communications tower
Elevated Tanks															
Myrtle #1	2013[c]	1919	0.5	506.5	584.5	46	-	Riveted Steel	Feb 96	Vinyl	1982	Lead base Touch-up	1983 2009	Internal recoating.	
Richmond Highlands #1	2013[b]	1954	1.0	492.5	590	86	25	Welded Steel	Nov-99	CTE	1954	Lead base[g]	1981		
Distribution System															
Standpipes															
Barton	2012[b]	1927	1.4	277	326	80	-	Riveted Steel	Jan 98	CTE	1960	Lead base	1981	Internal recoating, roof repairs, drain improvements (air gap), and reconnection.	
Woodland Park	2003[h]	1925	1.0	356	430	50	-	Riveted Steel	Oct 98	Vinyl	1984	Lead base	1980	Reconnection	
Elevated Tanks															
Maple Leaf	2009	1949	1.0	431	530	84.25	25	Welded and Riveted	Jan 98	epoxy	1988/95	Lead base[i] Touch-up	2011	Internal recoating and reconnection.	Communications tower

Source: Capron 2011, Mantchev 2012

a CTE = Coal Tar Enamel
b Per current schedule.
c WDOH approval pending.
d Decommissioned facilities have been disconnected from the water system, but not demolished, and can be returned to service after the improvements shown are made.
e Top of concrete base, based on North American Vertical Datum (NAVD 88).
f Nominal elevation based on North American Vertical Datum (NAVD 88).
g Richmond Highlands: 1993 seismic upgrade added all new steel to legs and riser, and coated legs and riser with a non-lead alkyd enamel paint system. The bowls still have the lead based primer as noted.
h Disconnected and decommissioned in 2009.
i Maple Leaf has some remaining red lead primer then coated with moisture cured urethane primer and top coats.

Table 9
Regional and Sub-Regional System Pump Stations

	Pump #	Manufacturer	Model	Design Flow (gpm)	Head (feet)	Speed (rpm)	Horse-Power	Comments
Augusta	1	Aurora	411 BF	300	102	1,750	15	Pumps 1 and 2 are continuous
	2	Aurora	411 BF	300	102	1,750	15	duty; alternating daily
	3	Aurora	411 BF	1,200	102	1,750	40	
	4	Aurora	411 BF	2,400	113	1,750	100	Fire flow only
Bothell Way	1	De Laval	T36/30	38,200	80	450	900	
Burien	1	Allis Chalmers	209-648-501	2,000	180	1,760	125	Emergency pump connections
	2	Allis Chalmers	209-732-501	3,000	180	1,760	200	for diesel pump.
	3	Worthington	10-LNHS-18	6,000	180	1,775	350	
Control Works	1	De Laval		1,200		1,760	25	Standby use only
Eastgate	1	Byron Jackson	18-KXH-1-STG	4,250	145	1,770	200	
	2	Byron Jackson	18-KXH-1-STG	4,250	145	1,770	200	
	3	Byron Jackson	18-KXH-1-STG	4,250	145	1,770	200	
Fairwood	1	Aurora	411 BF	750	220	1,750	75	Emergency pump connections for
	2	De Laval	A0615L	2,000	215	1,750	150	diesel pump.
Foy	1	Ingersoll Rand	10 LR 18A	6,000	165	1,785	300	
	2	Ingersoll Rand	8 LR-18S	4,440	165/290	1,778	400	165 ft. head with 15.43";
	3	Ingersoll Rand	8 LR-18S	4,440	165/290	1,778	400	290 ft. head with 18" impeller
Highland Park	1	Worthington	10 LNH 18	5,500	175	1,775	300	
	2	Worthington	10 LNH 18	5,500	175	1,775	300	
	3	Ingersoll Rand	6 AFV	1,400	140	1,770	60	Small pump can be powered by diesel generator
Lake Hills	1	Peerless	8AE17A	5,000	160	1,780	250	New 1999 Emergency pump connections
	2	Peerless	8AE17A	5,000	160	1,780	250	New 1999 for diesel pump
Lake Youngs	1	Fairbanks Morse	7000 AW	7,700	182	1,185	500	
	2	Fairbanks Morse	7000 AW	7,700	182	1,185	500	
Maple Leaf	1	Patterson	18X14 MAC	10,300	156	1,180	500	Can be powered by diesel generator
	2	Patterson	18X14 MAC	7,200	156	1,180	350	
Maplewood	1	Worthington	20 LN 28	17,750	108	720	600	Standby use only, low hours
North City	1	Worthington	12 LN 14	6,500	113	1,775	250	
	2	Worthington	12 LN 14	6,500	113	1,775	250	
Trenton	1	De Laval		1,000	225	1,845		Water Turbine Powered
	2	De Laval		3,000	225	1,200		Water Turbine Powered
TESS	1	Worthington	8 LP 13	1,600		1,770	100	
	2	Aurora		3,500	272		100	Diesel pump

Source: Capron 2011, Goodman 2011

Notes:

gpm = gallons per minute

rpm = revolutions per minute

Vert. = vertical

Table 10
Distribution System Pump Stations

	Pump #	Manufacturer	Model	Design Flow (gpm)	Head (feet)	Speed (rpm)	Horse-Power	Comments
Bitter Lake	1	Gould	3405	4,000	162	1,775	200	
	2	Gould	3405	4,000	162	1,775	365	Diesel standby use only
	3	Gould	3405	4,000	162	1,775	200	
Broadway	1	Fairbanks Morse	2844C	4,700	245	1,781	400	
	2	Fairbanks Morse	2844A	2,800	237	1,784	250	
	3	Fairbanks Morse	K65226	4,000		1,150	300	
Dayton Ave.	1	De Laval	56064	1,400	110	1,750	50	
	2	MP		100	100	3,450	5	
First Hill(1)	3	Fairbanks Morse	2824C	2,800	180	1,775	200	
	4	Fairbanks Morse	2824C	4,900	190	1,775	350	
Green Lake	1	De Laval	98851	900	331	1,750	93	Water Turbine Powered
Interbay	1	Worthington	10 LN 18	3,500	110	1,185	125	Low service
	2	Worthington	8 LA 4	3,500	230	1,785	300	High service
Lincoln	1	Worthington		3,900	117	1,540	125	Water turbine powered
Northgate	1	Allis Chalmers	205-603-502	5,500	182	1,760	300	
	2	Allis Chalmers	205-603-501	5,500	182	1,760	300	
Queen Anne	1	Berkeley	B2TPMS	170			5	Variable frequency drive
	2	Berkeley	B2TPMS	170			5	Variable frequency drive
	3	Berkeley		450			15	Variable frequency drive
	4	Berkeley		2,400			40	
Roosevelt	1	Allis Chalmers	201-052-501	3,000	110	1,760	100	
	2	Allis Chalmers	201-052-501	3,000	110	1,760	100	
Scenic Heights	1	Aurora	411 BF	450	95	1,750	20	
	2	Aurora	411 BF	450	95	1,750	20	
	3	Aurora	411 BF	1,100	100	1,750	40	
	4	Aurora	411 BF	1,100	100	1,750	40	
SW Spokane	1	Allis Chalmers	207-52-510	4,000	290	1,760	400	New starters and transfer switch in
	2	Allis Chalmers	207-52-510	4,000	290	1,760	400	1997; can be powered by diesel gen.
Viewridge	1	Layne		2,500		1,750	100	To 326 zone
	2	Layne		3,500		1,750	350	To 530 zone
Volunteer	1	Allis Chalmers	201-194-502	4,000	108	1,760	125	
	2	Allis Chalmers	201-194-501	4,000	108	1,760	125	
Warren Ave.	1	Allis Chalmers	207-521-510	4,000	265	1,770	350	Can be powered by diesel generator.
	2	Allis Chalmers	207-521-509	4,000	265	1,770	350	
West Seattle	1	Ingersol Rand	10 AFV	4,500	62.3	1,750	100	One pump can be powered by diesel
	2	Ingersol Rand	11 AFV	4,500	62.3	1,750	100	generator

Source: Capron 2011, Goodman 2011

Notes:

(1) First Hill pump station has two pumps, they are labeled 3 and 4. The pumps work in conjunction with pumps 1 and 2 and the Broadway pump station.

Notes:

gpm = gallons per minute

rpm = revolutions per minute

Vert. = vertical

Table 11
Metered Connections by Classification and Size

CLASSIFICATION	CONNECTION SIZE (inches) 3/4	1	1-1/2	2	3	4	6	8	10	12	16	20	24	TOTAL
Residential [1]	143,514	16,751	1,263	439	1	1	1	1	-	-	-	-	-	161,971
Commercial [2]	6,902	5,244	3,634	4,578	497	725	334	115	36	6	-	2	-	22,073
Fire Service	83	1	2	610	29	1,526	1,262	728	28	9	-	-	-	4,278
RETAIL SERVICE TOTAL [3]	150,499	21,996	4,899	5,627	527	2,252	1,597	844	64	15	-	2	-	188,322

Source: City of Seattle, Consolidated Customer Service System, Meter Count By Connection Size Report, Run Date: 08-JAN-2011.

[1] Includes single-family residences, duplexes, and other residential services.

[2] Includes mulit-family residences, commercial properties and municipal services.

[3] Includes 10,871 services in Shoreline, 383 services in Lake Forest Park, and 4,780 other services outside the City of Seattle.

Table 12
Interties From Seattle Public Utilities to Other Purveyors
As of November 2011

Purveyor and SPU Meter No.	SPU Station	Meter Size (inches)	Service Location	Comments/Notes
CITY OF BELLEVUE				
2-533677-460238	47	8	128th Ave SE & SE 56th ST	
2-533677-460240	55	6	128th Ave SE & Newport Way	
2-533686-461091	56	8	128th Ave. SE & Newport Way	
2-533679-461120	58	12	145th Pl. SE & SE 28th Street	
2-533678-461098	59	8	132nd Ave. SE & SE 26th Street	
2-533900-460746	60	10	14509 SE Newport Way	
2-533880-461005	61	24	152nd Ave. NE & NE 8th Street	
2-533882-460302	62	12	132nd Ave. NE & Bel-Red Road	
2-533677-461245	63	10	132nd Ave. NE & NE 24th Street	
2-533675-461109	65	10	140th Ave. NE & 40th Street	
2-533680-460237	66	8	Mercer Is. Pipeline & 108th Ave. SE	
2-533677-461321	124	8	124th Ave SE & SE 38 PL	
2-533900-460746	182	10	14509 SE Newport Way	
CITY OF BOTHELL				
2-533588-461020	95	10	TRPL R/W - 104TH NE	
2-533591-460241	96	8	NE 180TH & 88TH NE	
2-533638-461029	99	6	TRPL & 96TH NE STA 1335	
CEDAR RIVER WATER AND SEWER DISTRICT				
2-533703-461103	30	8	141st Ave SE and SE 171st Way	
2-535998-460956	166	10	19201 SE Petrovitski Road	
2-533875-962982	187	10	FWPL4 at NE corner of Control Works property	
COAL CREEK UTILITY DISTRICT				
2-533690-461094	48	8	129th Ave SE & SE 73rd ST	
2-533689-461092	52	12	128th Ave SE & SE 70th ST	
2-533692-461099	54	4	132nd Ave SE & SE 96th ST	Meter not used, for backup only.
CITY OF DUVALL				
2-533661-461012	111	4	TOLT RIVER PIPELINE	
2-533885-461023	112	6	TRPL - STA 657 + 29	
CITY OF EDMONDS				
2-533584-460571	110	10	SE Corner N 205TH & Fremont AV	Emergency Intertie only

Table 12
Interties From Seattle Public Utilities to Other Purveyors
As of November 2011

Purveyor and SPU Meter No.	SPU Station	Meter Size (inches)	Service Location	Comments/Notes
HIGHLINE WATER DISTRICT				
2-534019-460587	41	12	Des Moines Way S & S 207th Street	
2-534079-460743	42	16	160th Ave S & Military Road S	
2-534018-460748	43	12	Des Moines Way S & S Normandy Road	
CITY OF KIRKLAND				
2-533676-460249	72	12	140th Ave. NE & NE 70th Street	
2-533668-460245	74	10	132nd Ave. NE & NE 113th Street	
2-533883-461006	75	16	132nd Ave. NE & NE 85th Street	
LAKE FOREST PARK WATER DISTRICT				
2-533597-971083	188	8	Tolt Pipeline ROW & NE 195th St	Emergency Intertie only
CITY OF MERCER ISLAND				
2-533669-461336	67	12	SE 43rd Street & 89th Ave SE	
2-533673-461333	68	6	SE 40th Street & 97th Ave SE	
2-539472-460740	171	10	E Mercer Way & Mercer Island Pipeline Right-Of-Way	Mercer Crest Water Association was taken over by City of Mercer Island.
CITY OF NORTH BEND				
2-1492723-971210	190	8	101 R @ SCL PP "RT 1-73"	
NORTHSHORE UTILITY DISTRICT				
2-533594-461018	81	6	Tolt Pipeline ROW & 119th Ave. NE	
2-533587-461026	83	10	Tolt Pipeline ROW & 112th Ave. NE	
2-533589-461024	85	6	Tolt Pipeline ROW & 104th Ave. NE	
2-533643-461014	86	20	88th Ave. NE & NE 180th Street	
2-533595-461205	89	6	64th Ave. NE & NE 185th Street	
2-533596-461206	90	6	64th Ave. NE & NE 185th Street	
2-533582-461004	92	6	40th Place NE & NE 195th Street	
2-533585-461013	93	12	Tolt Pipeline ROW & NE 195th Street	
2-533666-460246	94	10	132nd Ave. NE & NE 132nd Street	
OLYMPIC VIEW WATER AND SEWER DISTRICT				
2-533592-461242	107	8	8th Ave. NW & NW 205th St.	
2-533647-459418	108	8	Fremont N. & N. 205th St.	
2-533646-459419	109	8	Fremont N. & N. 205th St.	
2-533592-978166	192	6	24th Av NW & NW 205th St.	

Table 12
Interties From Seattle Public Utilities to Other Purveyors
As of November 2011

Purveyor and SPU Meter No.	SPU Station	Meter Size (inches)	Service Location	Comments/Notes
CITY OF REDMOND				
2-540865-460251	164	10	Trilogy Parkway NE & NE 125th Street	
2-533903-461057	165	10	160th Ave NE & NE 104th Street	
2-540865-951406	185	6	NE 172nd Street & Tolt Pipeline #2	
2-540865-460250	186	10	Trilogy Parkway NE & NE 125th Street	
CITY OF RENTON				
2-533998-460263	33	6	9602 S 160TH ST	
2-533707-460581	34	8	CRPL 4 - ST HWY 5 - C	
2-533708-460260	36	6	7TH - JONES ST - PL R/W	
2-533709-460281	37	3	PLAT RENTON	
2-533711-460578	38	6	CRPL & 84TH AV S	
2-533705-460573	39	10	CRPL RW & LK YOUNG WY	
2-533697-460257	179	10	Logan St & 2nd	Formerly SPU direct service to Boeing Renton plant
2-533698-460256	180	10	Logan St & 2nd	Formerly SPU direct service to Boeing Renton plant
2-533698-461130	196	8	7501-8001 S 153rd Pl	Serves Boeing/Longacres
SHORELINE WATER DISTRICT				
2-533579-480005	101	10	8th Ave NE & NE 160th Street	
2-533581-472896	102	10	16th Ave NE & NE 192nd Street	
2-533583-459353	103	6	32nd Ave NE & NE 195th Street	
2-533580-461207	104	8	8th Ave NE & NE 185th Street	
2-533580-975611	191	8	NE 195th St & 47th Pl NE	
2-533580-978151	193	8	NE 185th & 5th Ave NE	
2-533580-979000	194	8	NE 185th & 8th Ave NE	
SKYWAY WATER AND SEWER DISTRICT				
2-533712-471173	1	8	84th Ave. S & S 134th Street	
2-533720-457667	5	8	Beacon Ave S & S 124th Street	
2-533893-460571	172	6	Cornell Ave S & S 112th Street	
SOOS CREEK WATER AND SEWER DISTRICT				
2-533702-461124	27	10	148th Ave SE and SE 192nd Street	
2-533704-461155	28	10	SE 164TH Street and 132nd Ave SE	
2-533706-460576	29	8	SE 160TH Street and 114th Ave SE	
2-539118-461441	181	6	147th Ave SE and SE Petrovitski Road	

Table 12
Interties From Seattle Public Utilities to Other Purveyors
As of November 2011

Purveyor and SPU Meter No.	SPU Station	Meter Size (inches)	Service Location	Comments/Notes
2-539118-971209	189	10	SE 164th & 132nd SE (next to Sta.28)	
CITY OF TUKWILA				
2-534002-460582	13	10	South Center Parkway & Tukwila Parkway	
2-534001-461149	14	8	West Valley Hwy & S 162nd Street	
2-534004-457795	15	8	Christensen Rd. & Baker Rd	
2-534003-461363	16	6	53rd Ave S & S 160th Street	
2-536983-459031	183	12	E Marginal Way & S 112th Street	
2-536984-458373	168	12	7749 E Marginal Way S	
2-537357-460018	169	8	51st Ave S & S Leo Street	
2-539200-458356	170	12	W. Marginal Place & S 102nd St.	
2-537646-458802	173	6	47th Ave S & S Victor Street	
WOODINVILLE WATER DISTRICT				
2-533887-461022	53	8	TPL1 at pipeline station 1120	
2-533891-461021	57	6	TPL1 at pipeline station 1061	
2-533586-461027	76	4	TPL1 at 124th Ave NE	
2-533667-461096	77	6	132nd Ave NE & NE 140th Street	
2-533662-461019	78	8	TPL1 at Welcome Road Valve Station	
2-533904-461016	79	8	TPL1 at Avondale Road	
2-533665-461028	80	8	TPL1 at 168th Ave NE	
2-533663-461011	123	6	TPL1 at pipeline station 1197	
2-533870-460564	125	6	TPL1 at pipeline station 1049	
2-535993-461097	167	6	15002 132nd Ave NE	
TBD	195	6	132nd Ave NE & NE 144th Street	To be completed and operational in 2012.
KING COUNTY WATER DISTRICT #20				
2-534031-459065	19	16	12th Ave S & S 112th Street	
2-534044-461108	23	6	14th Ave SW & SW 149th Street	
2-534034-461419	126	8	8th Ave S & Aqua Way	
2-534030-461063	127	6	Des Moines Memorial Dr. & S 112th Street	
2-534029-460742	128	6	Military Road & S 125th Street	
2-534028-461093	129	6	Military Road & S 128th Street	
2-534032-461061	130	6	14th Ave S & S 112th Street	
2-534037-461329	132	8	4th Ave SW & SW 108th Street	

Table 12
Interties From Seattle Public Utilities to Other Purveyors
As of November 2011

Purveyor and SPU Meter No.	SPU Station	Meter Size (inches)	Service Location	Comments/Notes
2-534038-461330	133	10	4th Ave SW & SW 128th Street	
2-534039-460273	134	4	Ambaum Blvd SW & SW 132nd St.	
2-534011-460591	135	6	14th Ave S & S Director Steet	
2-534025-461422	136	10	8th Ave S & S 146th Street	
KING COUNTY WATER DISTRICT #45				
2-534036-461060	20	8	4th Ave SW & SW 108th Street	
2-534036-909301	176	6	12th Ave SW & SW 106th Street	
2-534036-479202	184	6	8th Ave SW & SW 99th Street	
KING COUNTY WATER DISTRICT #49				
2-541232-460590	25	8	16800 DesMoines Wy S	
2-534043-461052	139	10	10TH AV SW - SW 149TH	
2-536055-461420	140	12	DesMoines Way S. & 160th Ave S	
2-534042-461424	142	8	8TH AV SW - SW 146TH	
2-534017-460585	143	10	DESMOINES WY & AMBAUM	
KING COUNTY WATER DISTRICT #90				
2-533693-460274	45	10	132ND AV SE & SE 128TH	
KING COUNTY WATER DISTRICT #119				
2-533659-460940	116	4	ODELL STA 612 THRU 36 30	
2-533660-461010	117	6	34801 TOLT PL RW	
KING COUNTY WATER DISTRICT #125				
2-533717-460574	8	6	CRPLs 1,2 & 3 and S 131st Street	
2-534014-461335	9	6	42nd Ave S & S 160th Street	
2-534015-461148	10	8	Pacific Highway S & S 160th Street	
2-534024-461421	17	10	8th Ave S & S 146th Street	
2-533868-461089	119	6	CRPLs 1,2 & 3 and S 124th Street	
2-534006-466490	120	8	E Marginal Way & S 115th Street	
2-534027-461102	121	4	Military Road & S 135th Street	
2-535981-459141	174	10	2400 S 146th Street	Boeing Fire Service
2-535982-459140	175	10	2400 S 146th Street	Boeing Fire Service

SEATTLE PUBLIC UTILITIES
2013 WATER SYSTEM PLAN
APPENDIX C

POLICIES, PROCEDURES AND STANDARDS

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SEATTLE PUBLIC UTILITIES
2013 WATER SYSTEM PLAN

C. POLICIES, PROCEDURES AND STANDARDS

APPENDIX C-1

COMPREHENSIVE DRINKING WATER QUALITY MONITORING PLAN

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Seattle Public Utilities
Comprehensive Drinking Water Quality Monitoring Plan

February 2012

1.0 Overview

Providing public health protection is a primary concern in the operation and maintenance of a public drinking water system. Determining the adequacy of this protection is accomplished with a comprehensive monitoring program that covers the source of supply, treatment systems, the distribution system, and customers' taps. Sampling requirements are established by federal regulations, such as the Safe Drinking Water Act (SDWA), which are in most cases adopted by the state. Seattle Public Utilities (SPU) conducts monitoring in accordance with the Safe Drinking Water Act and Washington State Department of Health requirements, Chapter 246-290 WAC.

This monitoring plan addresses the following:

- Monitoring requirements under state and federal drinking water regulations;
- Future regulations, which are currently under development at the federal level;
- Non-regulatory monitoring, which SPU conducts for informational purposes and to assist in operating the water system;
- Sampling procedures;
- Laboratory Information Management System (LIMS); and,
- All parameters, locations, and frequency of monitoring conducted by SPU. Monitoring locations include source, treatment, transmission and distribution system, and customer taps.

A summary of SPU's monitoring requirements is shown in Table 1. This table includes source water and distribution system monitoring required by regulation. Monitoring of treatment operations required by the Surface Water Treatment Rule or Lead and Copper Rule is not included in Table 1, but is discussed below, and is reflected in Table 2.

Table 2 is a summary of the monitoring currently conducted by SPU and is organized by sampling locations, frequencies, and parameters. This table includes monitoring required by regulations, and monitoring conducted for operational or informational purposes (non-regulatory). All monitoring shown is directly related to the drinking water supply. Monitoring related to special studies, customer inquiries, disinfection of new mains, construction of facilities, environmental compliance when dewatering facilities, wellhead protection, aquifer recharge, source development, treatment chemicals, or other monitoring conducted for purposes other than drinking water quality compliance is not included in this document.

DOH has the authority to grant waivers for certain parameters, depending on vulnerability and previous sampling results. If a system is considered to have low vulnerability to contamination from a certain chemical or group of chemicals, the State may waive the requirements for

sampling, or reduce the amount of samples required. The State issued waivers for SPU for Volatile Organic Chemicals (VOCs) and Synthetic Organic Chemicals (SOCs) for the 2008 to 2010 monitoring period. SPU will apply for waivers for the 2011 to 2013 monitoring period. There are also several area-wide waivers in effect for several of the SOCs. These waivers apply to all systems within the designated area.

SPU operates its own State-certified laboratory for a majority of the parameters monitored. This includes total coliform, fecal coliform, HPC, most inorganic chemicals, trihalomethanes, haloacetic acids, lead, copper, VOCs, and all SWTR parameters. Samples for SOCs, asbestos, some inorganics, and *Cryptosporidium* and *Giardia* are sent to other laboratories certified by the state or EPA for the analysis.

Adjustments to monitoring are often required based on operational considerations, detection of organic chemicals, construction projects, or as required by the state based on a public health concern. SPU will work with the State to determine appropriate changes to the monitoring program to address any concerns that may arise.

2.0 Monitoring Requirements

The following summarizes the monitoring requirements for existing and future regulations. Existing regulations include those finalized by EPA and published in the Federal Register under 40 CFR Part 141. Any regulation the state has adopted into Chapter 246-290 WAC with changes or additions are also discussed under existing regulations. Future regulations include those currently proposed by EPA.

2.1 Existing Regulations

The existing regulations discussed below are organized by their common name with a reference to the appropriate federal and state section numbers.

Total Coliform Rule (40 CFR 141.21 and WAC 246-290-300 (3))

SPU collects and analyzes coliform samples from representative points throughout the direct service area as outlined in SPU's Coliform Monitoring Plan (attached without appendices). These samples are collected at designated sample stands according to established routes assigned by the Senior Water Quality Analyst or designee. Routes are designed to cover both the Cedar and Tolt service areas each day; with most sample stands being sampled weekly. To meet regulatory requirements, SPU must collect at least 189 coliform samples from its direct service area each month. The chlorine residual is also analyzed in the field at the time of coliform sample collection as required by state regulations. Temperature is also measured, although not required.

For any sample found to be positive for total coliform, or invalidated, follow-up action is taken according to state and federal regulations, as described in SPU's Coliform Monitoring Plan. This follow-up action may include additional sample collection, additional analyses such as fecal

coliform, *E. Coli*, or HPC, and notification to the state. SPU's Coliform Monitoring Plan lists all sample locations, schedules, test methods used, follow-up sampling requirements, and notification requirements.

Surface Water Treatment Rule (40 CFR 141.70-75 and WAC 246-290 Part 6)

The Surface Water Treatment Rule (SWTR) requires a significant amount of monitoring for SPU's filtered surface water supply, the South Fork Tolt River. This includes raw water, treated water, and distribution system water monitoring as follows.

Raw Water Monitoring – Continuous monitoring of turbidity at the inlet to the Tolt Water Treatment Facility occurs as required by the SWTR. Samples analyzed for fecal coliform density are collected at the inlet to the Tolt Water Treatment Facility daily, for at least 19 days a month.

Treated Water Monitoring – Treated water monitoring for the SWTR consists of monitoring required to determine the effectiveness of the disinfection process. This includes monitoring to determine log reduction of *Giardia* cysts and viruses. To determine the log reduction for virus, the pH, chlorine residual, temperature, clearwell volume, and peak hourly flow rate must be recorded. For the Tolt system, this monitoring is continuous, but is reported once a day at peak hourly flow. To determine the log reduction for *Giardia*, the pH, ozone residual at multiple locations along the contact chamber, temperature, and peak hourly flow are recorded. CT is calculated for each section of the ozone contact chamber. Ct is reported to the state for both the peak hourly flow and at minimum daily CT.

In addition, continuous chlorine residual monitoring for water entering the distribution system occurs at the outlet of the Tolt Water Treatment Facility. Turbidity is also monitored continuously at each individual filter unit and from the combined filter effluent.

Additional monitoring is conducted at the treatment plant to meet the requirements of the Service Agreement with the DBO contractor. This monitoring is summarized in Table 3.

Distribution System Monitoring – Residual disinfectant concentration is measured at the same time and location that a routine or repeat coliform sample is collected within the distribution system.

Limited Alternative to Filtration (WAC 246-290-691)

Beginning in November 2004, the Cedar water supply system was designated a Limited Alternative to Filtration status. As such, the source and treated water monitoring requirements are slightly different than an unfiltered surface water source subject to the SWTR. This includes raw water, treated water, and distribution system water monitoring as follows.

Raw Water Monitoring – Continuous turbidity monitoring occurs at the Cedar Water Treatment Facility for the raw water coming from Lake Youngs (or Landsburg during by-pass operations).

Fecal coliform samples are also collected at this location once per day for a minimum of 19 days a month.

Treated Water Monitoring – Treated water monitoring consists of monitoring to determine inactivation of Giardia, Cryptosporidium, and viruses. This monitoring is conducted continuously for the ozonation system, UV treatment, and chlorination. For ozone inactivation of Giardia and viruses, monitoring includes temperature, initial ozone concentration, ozone decay, and flow rate. For inactivation of Giardia and Cryptosporidium with UV, monitoring consists of flow rate through each reactor, UV transmittance, UV dose, lamp power, and lamp hours. For inactivation of viruses with chlorine, monitoring includes flow rate, clearwell volume, pH, chlorine residual, and temperature.

Finished water entering the system is continuously monitored for chlorine residual, temperature and pH. Daily samples are also analyzed for coliform, although this is not required by regulation. Additional monitoring is required to meet the Service Agreement with the DBO contractor. Service Agreement monitoring is summarized in Table 3.

Distribution System Monitoring – Residual disinfectant concentration is measured at the same time and location that a routine or repeat coliform sample is collected within the distribution system.

Disinfectants/Disinfection By-Products Rules (40 CFR 141.130-135, 141, 142) and WAC 246-290-300 (6)

Current regulations (Stage 1) require trihalomethane (THMs) and haloacetic acids (HAAs) monitoring in the distribution system. SPU is required to collect two samples each quarter at existing sample stands within the direct service area under an approved reduced monitoring schedule. One of these stands is generally served by Cedar water and one is generally served by Tolt water. These two samples are collected at sample stands that are considered to represent the maximum residence time in the system for each source. Currently, sample stands G2 and B4 are considered to represent the maximum residence time for the Cedar and Tolt, respectively. SPU elects to collect two additional THM and HAA samples each quarter for informational purposes. The other two sites used are J-3 and A-3. These are considered average residence time and generally represent higher HAA levels.

Monitoring for chlorine residual currently conducted at total coliform sample sites in the direct service area are reported under the Stage 1 rule. Bromate and bromide monitoring are conducted for the Tolt and Cedar supplies now that ozonation facilities for each supply are in operation. The monitoring for bromate is conducted monthly at the entry to the distribution system. The bromide monitoring was conducted monthly for the source water prior to any treatment during the first year of operation of the Tolt and Cedar Water Treatment Facilities.

Stage 2 DBP Rule was finalized in January 2006. This new rule will require increased monitoring for DBPs. Following the completion of the Initial Distribution System Evaluation in 2008, twelve sites were selected based on the criteria in the Stage 2 rule. Stage 2 DBP monitoring will begin at these 12 sites in the second quarter of 2012. Compliance under the

Stage 2 Rule will be based on locational running annual averages instead of system wide running annual averages.

Lead and Copper Rule (40 CFR 141.80-91)

SPU has conducted monitoring for lead and copper at customers' taps according to the regulations and a Bilateral Compliance Agreement with DOH. Two rounds of samples were collected at 375 homes in 2003 and 2004 after completion of a corrosion control optimization study for the Tolt. Two more rounds of samples were collected at 400 homes in 2005. These homes were selected based on criteria in the Lead and Copper Rule. For the last two rounds, the homes were divided into sub regions. One hundred samples were collected from the Seattle direct service area, 100 were collected from Bellevue, 100 were collected from the participating wholesale providers receiving water from the Cedar supply, and 100 were collected from the participating wholesale providers receiving water from the Tolt supply. Compliance was based on the 90th percentile for each sub-region. Based on previous rounds, each sub-region qualifies for reduced monitoring, which requires 50 samples per sub-region. Each sub-region is currently required to collect 50 samples once every three years. Monitoring requirements would change if the lead or copper action levels were exceeded. The Cedar wholesale provider group will collect samples in 2012, Seattle direct service area will collect samples in 2013, and the Tolt wholesale provider group will collect samples again in 2014.

Water quality parameter monitoring at the treatment plants and within the distribution system is also now required for the lead and copper rule. Monitoring of pH is required at the Cedar Water Treatment Facility and both pH and alkalinity is required at the Tolt Water Treatment Facility. The distribution system monitoring currently includes collecting 10 samples each month and analyzing the samples for pH and alkalinity. The 10 locations are distributed throughout the direct service area and Cedar and Tolt wholesale sub-regions that are part of the regional monitoring program.

Inorganic Contaminants, VOCs, SOCs (40 CFR 141.23-23, 40 and WAC 246-290-300 (4) and (7))

Primary and Secondary inorganic contaminants (IOCs), volatile organic chemicals (VOCs), and synthetic organic chemicals (SOCs) are monitored according to state and federal requirements. IOCs for the Cedar and Tolt supplies are monitored on an annual basis and VOCs are monitored once every three years, with the samples collected from the entry point to the distribution system, after treatment. This frequency assumes a state waiver has been granted for VOCs. The Riverton and Boulevard Park Wells are sampled once every three years (or when in operation) for IOCs and VOCs at the entry point to the distribution system prior to the first customer. SOCs are monitored as directed by the state, and the frequency is dependent on waiver status. SOCs were last collected in 2008. The year 2011 marks the beginning of a new three and nine year monitoring period. State waivers have not yet been issued for this monitoring period.

Radionuclides (40 CFR 141.26 and WAC 246-290-300 (8))

The new radionuclides rule (effective December 2003) requires monitoring for gross alpha, radium 226, radium 228, and uranium. This monitoring is conducted for each source at the entry point to the distribution system. Frequency is dependent on results. Two consecutive quarterly samples were collected before December 2007 for initial monitoring. After initial monitoring, samples will likely be required once every 9 years.

Fluoride (WAC 246-290-460)

As required by state regulations, fluoride is monitored daily at each point of fluoride addition and a report is submitted to the state monthly. For process control purposes, fluoride concentration is monitored continuously with an online instrument. In addition to fluoride monitoring at the treatment plants, a grab sample is collected daily and analyzed at SPU's Water Quality Laboratory as a check. Results for one monthly check sample are submitted to the state.

Unregulated Contaminants Monitoring Rule (40 CFR 141.35, 40)

The Unregulated Contaminants Monitoring Rule requires additional monitoring for SPU's source waters. For UCMR 2, four quarterly samples were collected at the entry point to the distribution system in 2009. The next projected UCMR monitoring (UCMR 3) is projected to occur between 2013 and 2015.

Groundwater Rule (40 CFR 141.400 - 405)

This regulation was finalized in late 2006, with an effective date of December 1, 2009. Only the Riverton and Boulevard Park Wells are subject to this regulation. SPU has decided to use triggered source water monitoring for the compliance strategy. This means a source water E. Coli sample will need to be collected from the wells any time the wells are in operation, and a TCR compliance sample from the area fed by the wells is positive. The sample must be collected within 24 hours notice.

Cryptosporidium Monitoring for LT2SWTR (40 CFR 141, Subpart W)

SPU currently conducts quarterly source water monitoring for *Giardia* and *Cryptosporidium* for the Cedar and Tolt supplies. This monitoring is currently voluntary. Monthly monitoring to determine compliance with LT2SWTR was completed in 2007. The results of *Cryptosporidium* monitoring are reported in the annual Drinking Water Quality Report sent to customers each year. Currently, samples are collected from two locations: Tolt Regulating Basin outlet (TPR-4), and Lake Youngs outlet (C1-Raw) prior to treatment. The next round of monthly monitoring for LT2SWTR compliance is required six years after completion of the previous round (possibly 2013 or 2014).

2.2. Future Regulations

The future regulations discussed below are organized by their currently accepted common name (may change in the future). *Federal Register* citations are provided for rules which have been published, either in draft or final form.

Revisions to Total Coliform Rule

Proposed RTCR regulations were published on July 14, 2010. Based on the proposed changes, there should not be any significant impact to the current coliform monitoring conducted in SPU's distribution system.

Fluoride Target

In January 2011, the U.S. Department of Health and Human Services (HHS) and the U.S. Environmental Protection Agency (EPA) announced a proposed recommended level of fluoride in drinking water of 0.7 part per million. A final recommendation on the fluoride level was expected in the late summer or early fall of 2011. The treatment target for Seattle supplies was lowered from 1.0 to 0.8 mg/L to match the minimum currently allowed by state regulation. SPU will continue to work with the Washington Department of Health and Public Health Seattle and King County in preparation for a final federal recommendation on fluoride levels.

2.3. Non-Regulatory Monitoring

Non-regulatory monitoring discussed below includes monitoring performed for informational purposes or to assist in making operational decisions. This monitoring is not required by regulation at this time, but may be required at some time in the future.

Limnology

Bi-weekly, monthly and quarterly monitoring of various limnological parameters is conducted at Lake Youngs, Chester Morse Lake, the Tolt Reservoir proper and reservoir tributary streams, and the Cedar River. In addition, samples are collected occasionally from the Tolt Regulating Basin. This data is collected for informational purposes, and is not required by state or federal regulations. Sample collection occurs at multiple locations and depths in Lake Youngs, Chester Morse Lake, and the Tolt Reservoir. The parameter list includes temperature, dissolved oxygen, transparency, turbidity, conductivity, alkalinity, calcium, pH, phosphorous, iron, manganese, ultra-violet light absorption, total organic carbon, phytoplankton, zooplankton, taste and odor, geosmin, MIB, and more.

Taste and Odor

Taste and Odor are analyzed on a weekly or bi-weekly basis for each of SPU's large in-town open reservoirs, the treated source waters, and other locations as needed. This monitoring is used to make operational decisions, but is not currently required by state or federal regulations. It

is anticipated that all of SPU's open reservoirs will be covered or removed from service in the near future. Once completed, taste and odor testing for those locations will discontinue.

Reservoir Protection

Each of SPU's in-town open reservoirs, and several closed reservoirs, currently have chlorination at the outlet or within a mixing system, prior to entry to the distribution system. The chlorine residual is monitored continuously to ensure adequate treatment occurs at all times. In addition, weekly check samples are collected and analyzed by laboratory staff for chlorine, total coliform, fecal coliform, *E. Coli*, pseudomonas, phytoplankton, pH, and HPC from the reservoir outlet and mid-reservoir. Treatment staff check each open reservoir treatment system daily. As required by WAC 246-290-470, SPU maintains and operates the open reservoirs according to a DOH approved Open Reservoir Protection Plan. In addition, DOH has approved SPU's Reservoir Covering Plan, which will replace, cover, or abandon all open reservoirs by 2018.

Treatment Processes

Existing source water treatment consists of ozonation, UV light, chlorination, fluoridation, and corrosion control on the Cedar supply. Treatment for the Tolt supply consists of ozonation, coagulation, flocculation, filtration, corrosion control, chlorination and fluoridation. Each of these processes is monitored continuously to ensure adequate treatment is maintained at all times. Portions of this monitoring are required by the regulations discussed above. Significantly more monitoring is required to meet the requirements of the Service Agreements for each DBO contractor operating the treatment plants. This monitoring is summarized in Table 3.

2.4 Sampling Procedures

Proper sample collection is important for accurate results. All laboratory assistants and other staff collecting samples in the field are trained in appropriate sample collection techniques based on parameter. Written sample collection procedures for bacteriological analyses such as total coliform are included in SPU's Coliform Monitoring Plan. Sample collection methods for all regulatory compliance samples follow standard procedures or methods listed in *Standard Methods*. In addition, training for laboratory staff conducting the analyses occurs on a regular basis.

2.5 Laboratory Information Management System (LIMS)

Beginning in 2006, SPU's Water Quality Laboratory implemented a new Laboratory Information Management System (LIMS). All water quality samples analyzed at the lab, or samples analyzed by outside laboratories for SPU's drinking water are entered into LIMS. This system provides the means to track sample status, record and validate results, and produce reports. Data from LIMS can then be extracted to other computer programs for long-term storage, analysis, or report formatting.

Table 1
Summary of Drinking Water Quality Monitoring Requirements (Regulatory) - Seattle Public Utilities

Dated: November 18, 2011

Parameter	Locations	Frequency	Monitoring Year	Lab Used	Waivers	Comments
Inorganic Chemicals						
Antimony	SO1 at CLT-5	Annually for Cedar and Tolt	Every Year for SW	SPU		EPA and State allow waivers.
Arsenic	SO2 at TPT-3			SPU		SPU not likely to apply for IOC waivers.
Barium	SO4 at BPW-T	Once every three years for wells	2011 for GW or when	SPU		
Beryllium	SO6 at RHW-T		operating	SPU		
Cadmium				SPU		
Chromium				SPU		
Copper				SPU		No MCL, AL = 1.3 mg/L
Cyanide				Outside		
Fluoride				SPU		
Lead				SPU		No MCL, Al = 0.015 mg/L
Mercury				Outside		
Nickel				SPU		
Selenium				SPU		
Sodium				SPU		Health Advisory Level = 20 mg/L
Thallium				SPU		
Nitrate Nitrite	CLT-5, TPT-3, RHW-T, BPW-T	Annually for SW and GW	Every Year, wells if operated	Outside		Sample during quarter with previous highest result (SW).
Asbestos	B-2 for Tolt, M-1A for Cedar	Once every nine years	Once before end of 2018	Outside		Seattle no longer has AC pipe.
Radionuclides						
Gross Alpha Emitters Radium 226 Radium 228 Uranium	CLT-5, TPT-3, RHW-T, BPW-T	Took 2 initial samples in 2007 for Cedar and Tolt. Once every 9 years thereafter.	Once before end of 2019 Next time Wells are used.	Outside		
Organic Chemicals						
VOCs	CLT-5, TPT-5, RHW-T, BPW-T	Wells once every three years. SW once a year without waiver.	Sampled S01 & S02 in 2011. Wells next time used.	Outside	Yes	State waivers for some
SOCs (includes herbicides, general pesticides, & insecticides)	CLT-5, TPT-3, RHW-T, BPW-T	2 samples every 3 year monitoring period.	2011 to 2013	Outside	Yes	Waiting for waiver status from state
Dioxin, endothall, Diquat, Glyphosate, EDB & other Soil Fumigants						State waivers
Bacteriological						
Total Coliform Rule	64 distribution system sample stands	189 samples per month	sampling conducted daily	SPU		Reduced monitoring for SPU
Chlorine Residual	Same locations as coliform	189 samples per month	sampling conducted daily	SPU		
Lead and Copper						
Lead Copper	At 50 customer taps in DSA	Once every three years	2013	SPU		Wholesale customers have 3 subregions: Cedar, Tolt, and Bellevue each take 50 samples once every 3 years
Water Quality Parameters	T-FINISH, C1-FIN, C2-FIN, 10 dist sites	Treatment: daily; Distribution: weekly		DBO, SPU		Cedar TF: pH only. Tolt TF & Distribution: pH & alkalinity
Disinfection By-Products						
Trihalomethanes	G2, J3 for Cedar, A3, B4 for Tolt	Quarterly	Every Year	SPU		One sample is from extreme end of each source.
HAAs (future)	G2, J3 for Cedar, A3, B4 for Tolt	Quarterly	Every Year	SPU		Stage 2 monitoring begins in 2nd quarter 2012 at 12 sites.
Secondary Contaminants						
Chloride	CLT-5, TPT-3, RHW-T, BPW-T	Annually for Cedar and Tolt	Every Year for SW	Outside		
Color		Once every three years for wells	Next time Wells are used.	SPU		
Fluoride				SPU		
Hardness				SPU		
Iron				SPU		
Manganese				SPU		
Silver				SPU		
Specific Conductivity				SPU		
Sulfate				Outside		
Total Dissolved Solids				SPU		Only required if conductivity > 700 µmhos/cm
Zinc				SPU		
Surface Water Treatment Rule (Tolt)						
Turbidity	TPR-5S 5N, T-CFE, individual filters	Continuous				All Part of DBO Contract
Fecal coliform	TPR-5S 5N	Daily, at least 24 days per month		SPU		
Chlorine Residual	T-FINISH	Continuous				
CT Complaince	Ozone contactors and clearwell	Continuous				For Giardia and Virus inactivation
Limited Alternative to Filtration (Cedar) - LAF						
Turbidity	C1-RAW	Continuous				All Part of DBO Contract
Fecal coliform	C1-RAW	Daily, at least 24 days per month		SPU		
Chlorine Residual	C1-FIN, C2-FIN	Continuous				
CT Complaince	Ozone contactors, UV units, and clearwell	Continuous				For Crypto, Giardia, and Virus inactivation

Table 2
Seattle Public Utilities
Drinking Water Quality Monitoring Conducted – by Parameter
Required and Optional

Parameter	Source	Monitoring Frequency and Location					
		Continuous	Daily or M-F	Weekly or Biweekly	Monthly	Quarterly	Annually
Turbidity	Cedar	CPR-1, C1-RAW, C1-FIN, C2-FIN, security sites	CPR-1, CT-2	GL-1, GLR, VO-1, VOR, C1-Raw, CPT-05, WS-1, 2 sites on LY, Masonry Dam	4 sites on CMR, 3 sites on Lake Youngs	CLT-5, M-1A	
	Tolt	TPR-5S 5N, T-FINISH, T-CFE, each Filter at plant, reclaimed water, Reg Basin Inlet	TPR-4, TT-1, 2		5 sites Tolt Reservoir	TPT-3, B-2, 9 Tolt Streams	
pH	Cedar	C1-RAW, C1-CWI, C2-CWI, C1-FIN, C2-FIN	CPR-1, CLT-4, 5, CT-1, 2, 3,	GL-1, GLR, VO-1, VOR, RVR-1, 30 TCR sites, Masonry Dam, 2 sites on LY, C1-Raw, CPT-05, WS-1	CT-4, 4 sites on CMR, 3 sites on LY, 12 TCR sites, Soos Res.	4 DBP sites	
	Tolt	TPR-5S 5N, T-FINISH, T-CWI, TPL1 at Welcome Rd.	TT-1, 2, 11	TT-3, TT-22,	TPR-4, 5 sites Tolt Reservoir	9 Tolt Streams	
Conductivity	Cedar	Security sites	CPR-1, CLT-4, 5, CT-1, 2, 3,	GL-1, GLR, VO-1, VOR, RVR-1, 32 TCR sites, Masonry Dam, 2 sites on LY, C1-Raw, CPT-05, WS-1	CT-4, 4 sites on CMR, 3 sites on LYS, 13 TCR sites, LNR	CLT-5, M-1A	
	Tolt		TT-1, 2, 11	TT-3, TT-22,	TPR-4, 5 sites Tolt Reservoir	TPT-3, B-2, 9 Tolt Streams	
Fluoride	Cedar	CPT-00	CPT-00, CT-2	6 sample stands, T-FINISH, RVR-1	TT-3, A-4, J-3	8 QTR sites	
	Tolt	T-FINISH, T-CWI	TT-1, 2				
Chlorine Residual	Cedar	CPT-00, 4 locations at CTF, 8 reservoirs	CLT-4, 5, CT-1, 2, 3, CPT-04	Closed tanks, standpipes, and reservoirs, open reservoirs and checkpoints, TT-3, WSP-1, CT-4, all TCR sites DSA	10 PBCU sites	4 DBP sites, QTR sites	
	Tolt	T-FINISH, T-CWI, LFP, BLR	TT-1, 2, 11				
Total Coliform - PA	Cedar		CLT-4,5, CT-1, 2, 3, C1 and C2-FIN	Closed tanks, standpipes, and reservoirs, open reservoirs and checkpoints, CT-4, TT-3, WSP-1, all TCR sites DSA			
	Tolt		T-FINISH, TT-1, 2, 11				

Table 2
Seattle Public Utilities
Drinking Water Quality Monitoring Conducted – by Parameter
Required and Optional

Parameter	Source	Monitoring Frequency and Location					
		Continuous	Daily or M-F	Weekly or Biweekly	Monthly	Quarterly	Annually
Total Coliform – QT	both		CPR-1, C1-RAW, TPR-5S	Open Reservoirs, Masonry Dam	3 sites LYR, 4 sites CMR, TPR-4, TW-10, 2 sites Tolt Reservoir		
Fecal Coliform	Cedar		CPR-1, C1-RAW, C1-FIN, C2-FIN	Open Reservoirs			
	Tolt		TPR-5S				
HPC	Cedar		CPR-1, C1-RAW, CLT-4, 5, C1-FIN, C2-FIN, CT-2	Closed tanks, standpipes, and reservoirs, open reservoirs and checkpoints, WSP-1	5 Sites CMR, 3 sites LY, 4 sites Tolt, average of 10 TCR sites per month		
	Tolt		TPR-5S, TT-1, 2, 11, T-FINISH				
Temperature	Cedar	C1-RAW, Control Works	CPR-1, CLT-4, 5, CT-1, 2, 3, C1-FIN, C2-FIN, C1-RAW	Closed tanks, standpipes, and reservoirs, open reservoirs and checkpoints, CT-4, TT-3, T-CFE, WSP-1, CPT-04 05, TPR-4, all TCR sites	10 Pb/Cu sites, TT-22	DBP sites, 8 quarterly sites, 9 Tolt streams	
	Tolt	TPR-5S, 5N	TT-1, 2, 11, TPR-5S 5N, T-FINISH				
UVA	Both	CPR-1	CPR-1	TPR-5S, T-CFE, CPT-05, C1-RAW, Masonry Dam, 2 LY sites	5 CMR sites, 5 Tolt Res sites, 3 LY sites, TPR-4	9 Tolt streams, 8 quarterly sites	
TOC	Both			CPR-1, TPR-5S, T-CFE, CPT-05, C1-RAW, 2 LY sites, Masonry Dam	5 sites CMR, 4 sites Tolt Res, 3 sites LY, TPR-4	9 Tolt streams	
Taste and Odor	Both			CPT-05, CT-2, C1-RAW, C1-FIN, C2-FIN, T-FINISH, open reservoirs			
Giardia/Crypto	Both					C1-RAW, TPR-4	
Alkalinity	Both		T-FINISH	CPT-05, CPR-1, C1-RAW, 2 LY sites, T-FINISH	10 Pb/Cu sites, TT-3, TPR-4, TW-10, LY7-B, 5 CMR sites	8 QTR sites, 9 Tolt streams	

Note: Sampling for Riverton and Boulevard Park Wells is not included in this table.

Table 3
Seattle Public Utilities
Drinking Water Quality Monitoring Conducted by DBO Contractors
Continuous Monitoring

Parameter	Tolt Water Treatment Facility					
	Reclaimed Water	Raw Water	Ozone Contactors	Filter Effluents	Combined Filter Effluent	Clearwell Effluent
Turbidity	X	X		X	X	X
Temperature		X				X
pH		X			X	X
Particle Count		X		X(1)	X	
Ozone Concentration			X			
Chlorine Residual					X	X
Fluoride					X	X

Parameter	Cedar Water Treatment Facility					
	Raw Water	Ozone Contactors	UV Reactors	Clearwell Influent	Clearwell Effluent	Finished Water
Turbidity	X					X
Temperature	X				X	
pH	X			X	X	X
Ozone Concentration		X				
UV Transmittance, UV Dose			X			
Chlorine Residual				X	X	X

Tolt grab sample parameters include coliform, alkalinity, bromate, iron, sodium, taste and odor, TTHMs and HAAs SDS, Color, TOC, and UVA.
Cedar grab sample parameters include coliform, bromate, iron, chlorophyll, sodium, and taste and odor.

SEATTLE PUBLIC UTILITIES
2013 WATER SYSTEM PLAN

C. POLICIES, PROCEDURES AND STANDARDS

APPENDIX C-2

DESIGN STANDARDS AND GUIDELINES – WATER INFRASTRUCTURE

SPU Design Standards and Guidelines, Chapter 5

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Chapter 5 WATER INFRASTRUCTURE

This chapter presents Design Standards and Guidelines (DSG) standards and guidelines for Seattle Public Utilities (SPU) water infrastructure. Standards appear as underlined text.

Facilities included here are transmission and distribution pipelines, storage tanks, standpipes, and reservoirs. The information in this chapter should be used in conjunction with other DSG standards. For water service connections, see *DSG Chapter 17.*

The primary audience for this chapter is Seattle Public Utilities (SPU) engineering staff.

Note: This DSG does not replace the experienced engineering judgment of a registered professional engineer. All design for upgrade, repairs, and new infrastructure should be done under the supervision of an experienced licensed engineer.

5.1 KEY TERMS

The abbreviations and definitions and given here follow either common American usage or regulatory guidance. Definitions for key elements of the SPU water system are given near the beginning of section for that element. For standard City of Seattle abbreviations for construction drawings, see section 1-01.2 of the City of Seattle Standard Plans.

5.1.1 Abbreviations

Abbreviation	Term
AC	asbestos concrete
ANSI	American National Standards Institute
AREMA	American Railway Engineering and Maintenance-of-Way Association
ASTM	American Society for Testing Materials
AWS	American Welding Society
AWWA	American Water Works Association
BNSF	Burlington Northern Santa Fe
CDF	controlled density fill
CI	cast iron
CIP	Capital Improvement Program
CSO	combined sewer overflow
DI	ductile iron
DIP	ductile iron pipe
DIPRA	Ductile-Iron Pipe Research Association
DOH	Department of Health
DPD	Department of Planning and Development
DV	district valve
ECA	environmentally critical area

Abbreviation	Term
fps	feet per second
ft	foot or feet
gpm	gallons per minute
HDD	horizontal directional drilling
HPA	Hydraulic Project Application
HPC	heterotrophic plate count
IBC	International Building Code
ID	inside diameter
LOB	line of business
mgd	million gallons per day
NACE	National Association of Corrosion Engineers
NPDES	National Pollution Discharge Elimination System
NSF	National Sanitation Foundation
O&M	operations and maintenance
OD	outside diameter
OSHA	Occupational Safety and Health Administration
PR	pressure regulating valve
PRV	pressure relief valve
psi	pounds per square inch
psig	pounds per square inch gauge
QA/QC	Quality assurance/quality control
RE	Resident Engineer
ROV	remotely operated vehicle
ROW	right-of-way
SCADA	Supervisory Control and Data Acquisition
SDOT	Seattle Department of Transportation
SDWA	Safe Drinking Water Act
SMT	Seattle Municipal Tower
Spec	specification
SPU	Seattle Public Utilities
Std	standard
TC	total coliform
USM	Utility Systems Management
WAC	Washington Administrative Code
WISHA	Washington Industrial Safety and Health Administration

5.1.2 Definitions

Term	Definition
anode	Location where metal is corroded.
cathodic protection	A means of providing a sacrificial material (usually a metal) to become the point where corrosion occurs. Cathodic protection is a technique used to provide corrosion control to buried or submerged metallic materials. Cathodic protection shifts the electrical potential off anodic sites in a pipeline or other structure. See also anode.
Capital Improvement Program (CIP)	Administered by SPU through its Capital Planning Committee (CPC) to plan, budget, schedule, and implement capital improvement projects, including flooding and conveyance improvements, protection and enhancement of water quality and habitat, protection of infrastructure, and drainage improvements within projects of other City agencies
Customer Service	The section within SPU through which customers purchase all new water services and receive notification of planned outages.
engineering	Generic term for SPU staff responsible for plan review and utility system design for CIP

Term	Definition
	projects.
guidelines	Advice for preparing an engineering design. Design guidelines document suggested minimum requirements and analysis of design elements in order to produce a coordinated set of design drawings, specifications, or life-cycle cost estimates. Guidelines answer what, why, when and how to apply design standards and the level of quality assurance required.
O&M	Generic term for SPU staff responsible for Field Operations and Maintenance.
resistivity	The resistance of an environment (either water or soil) to promote electrical current flow.
standards	Drawings, technical or material specifications, and minimum requirements needed to design a particular improvement. A design standard is adopted by the department and generally meets the functional and operational requirements at the lowest life-cycle cost. It serves as a reference for evaluating proposals from developers and contractors: For a standard, the word must refers to a mandatory requirement. The word should is used to denote a flexible requirement that is mandatory only under certain conditions.
Water Quality	A section within SPU that takes water samples and performs drinking water quality tests on new and existing water mains and inspects construction projects to assure pipe work is kept clean.

5.2 GENERAL INFORMATION

SPU water facilities supply water to more than 1.3 million people in the Seattle area, including wholesale customers (purveyors). The Tolt and Cedar watersheds supply most of the drinking water. The Seattle well fields serve as a supplemental water source during droughts and emergencies. Large transmission pipelines deliver water to treatment plants, and from the plants to in-town storage facilities such as tanks and reservoirs. Smaller water pipelines distribute water from in-town storage facilities to the public. Valves control water and isolate sections in the distribution mains, which are monitored by Supervisory Control and Data Acquisition (SCADA). Water services and fire hydrants are connected to distribution mains. Purveyors are connected to transmission mains.

In the SPU system, most water flows via gravity from the watersheds to storage facilities in Seattle. Storage facilities are set at high elevations to supply water via gravity to customers. Where necessary, pumps are used to lift water to higher elevation storage facilities or to increase water pressure. The system is managed by SPU Facility Operations and Maintenance and monitored through SCADA.

5.2.1 Policy

The guiding policy document for water infrastructure is the SPU 2007 Water System Plan. See Chapter 4 of the plan for SPU policy on water transmission. See Chapter 5 of the plan for SPU policy on water distribution.

5.2.2 System Maps

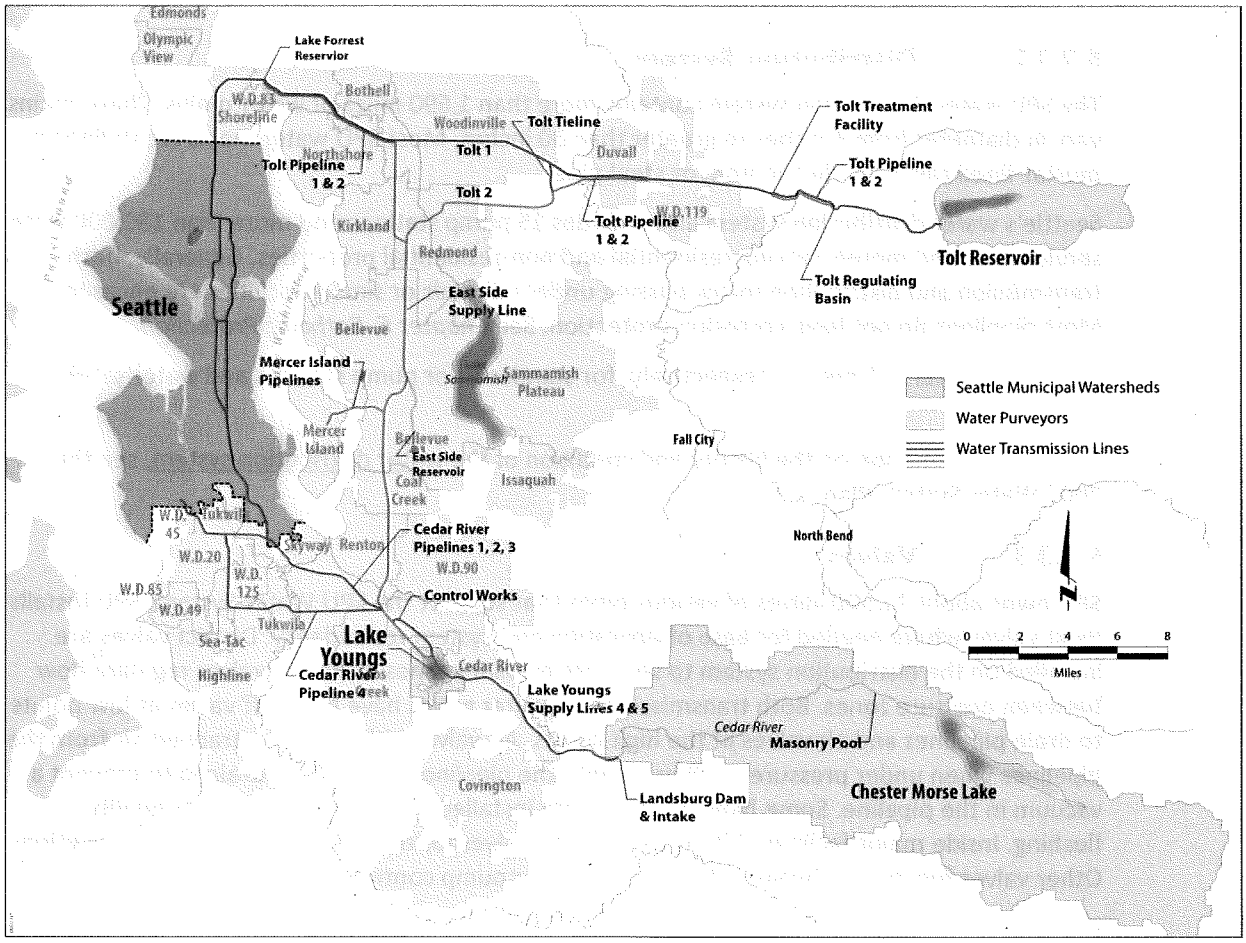
SPU's water maps are available at the following locations:

- Base Maps
- Customer Service Water GIS (software program). Contact SPU IT Service Desk
- Printed 400' Water System Map books
- SPU GIS Mapping Counter (SMT 47th floor)

5.2.3 Water System

The SPU Water System is comprised of transmission and distribution pipelines, and storage facilities and pressure zones. The system extends far beyond the Seattle city limits (Figure 5-1).

Figure 5-1
SPU Water Transmission System



5.2.3.1 Transmission System

The SPU regional and sub-regional water transmission system includes 189 miles of 16- to 96-inch steel, ductile iron or concrete pipeline. Some of the large transmission pipelines are the following:

- Lake Youngs supply lines 4 and 5
- Cedar River pipelines 1 through 4
- Tolt pipelines 1 and 2
- Eastside supply line
- Mercer Island pipeline
- West Seattle pipeline

The major supply transmission pipelines from the Cedar and Tolt sources deliver water to wholesale customer master meters and intertie locations, such as the City of Tukwila.

Transmission pipelines deliver water to various tanks, standpipes, and reservoirs throughout the system and on occasion directly to the distribution system. Twelve reservoirs and 14 tanks comprise the in-town storage facilities. Water from the in-town facilities is distributed to customers via the distribution system.

5.2.3.2 Distribution System

The SPU water distribution system contains more than 1,690 miles of water mains. These mains vary in diameter from 4 inches to greater than 30 inches. Most SPU water mains are unlined or mortar-lined cast iron, ductile iron, or steel pipe.

Seattle's water distribution system also includes 15 pump stations and more than 180,000 water service lines and meters serving residential and non-residential properties. Generally, both transmission and distribution mains passing under railroads or similar facilities are encased. Most pipelines do not have corrosion protection. See *Chapter 6, Cathodic Protection*.

See *DSG Chapters 11 and 17*, respectively, for standards for pump stations and water service connections.

For more information on the history and condition of the water distribution system, see the 2007 Water System Plan.

5.2.3.3 Valves

SPU owns about 21,500 valves of various types that support the SPU Water System. SPU installs most valves where needed for ease of operation and system redundancy. District valves are installed on the distribution system to separate pressure zones. Pressure valves regulate flow between pressure zones. Both transmission and water mains have blow-off valves at low points to drain pipelines and air valves at the high points. Air valves either release trapped air from the pipelines when under pressure or allow air into the pipelines while being drained to prevent a vacuum in the pipeline. Some blow-off valves are installed at dead ends for water quality flushing. Inside major facilities, SPU uses blow-off valves for dewatering and flushing operations. Other valves function as bypass, altitude control, or pump control.

5.2.3.4 Infrastructure Elements

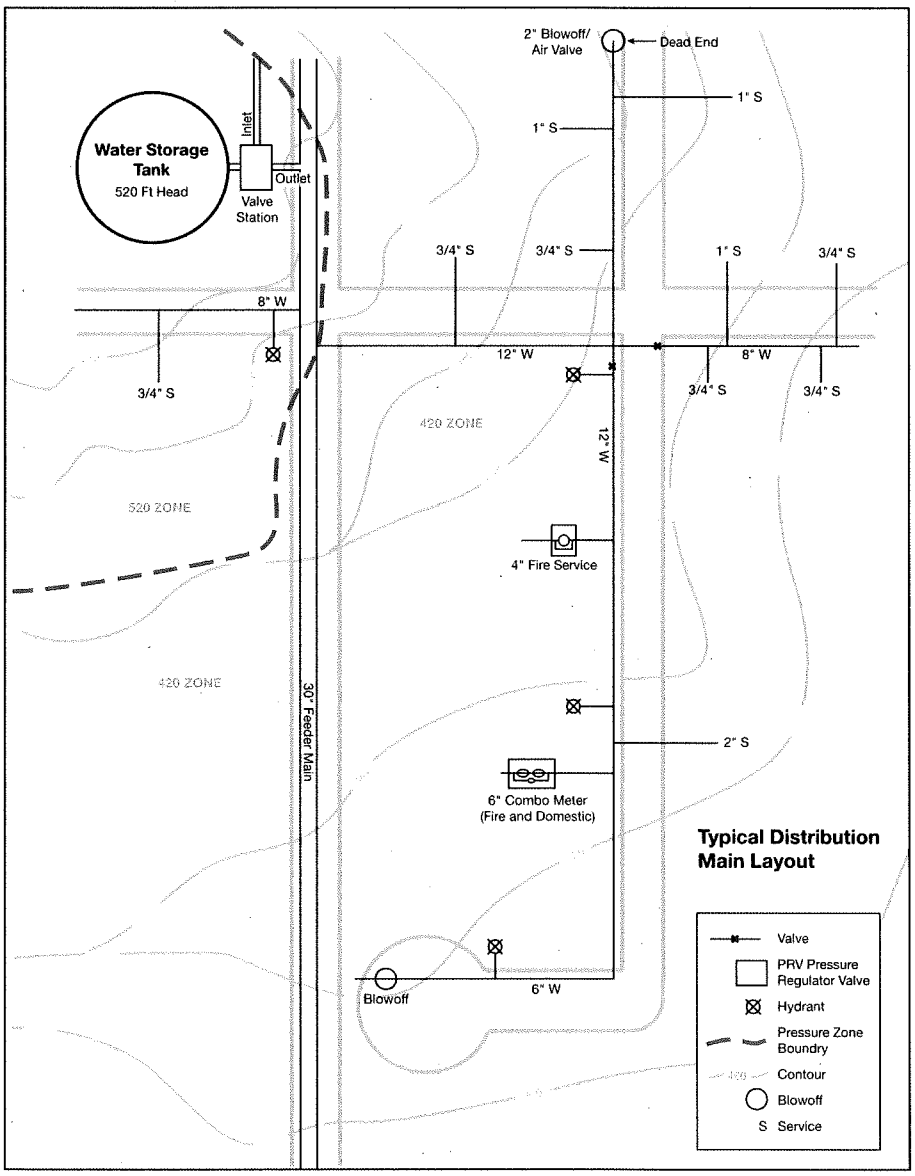
The following are key components in SPU water system infrastructure:

Infrastructure	Description
Water Main	
transmission main	Large diameter (generally >3 ft) pipeline that transfers water from source to feeder mains or storage tanks. There are no service connections on transmission lines, except for purveyors.
feeder main	Smaller diameter pipeline (generally <3 ft). The backbone of SPU distribution mains. Taps are allowed on feeder mains. Feeder mains may cross through multiple pressure zones. When crossing between zones, no services are allowed.
distribution main	Small to mid-sized pipeline (<2 ft) used to distribute water from a feeder main to a local service area. Distribution mains have service connections to adjacent properties.

Infrastructure	Description
Storage Facility	
standpipe	An aboveground, supported pipe with a height that is generally greater than the diameter. Used where additional height is needed to provide additional pressure without pumping.
reservoir	Tank that is at or below ground level with a diameter or footprint that is typically greater than the height. Reservoirs are usually large in size and storage capacity. SPU is currently covering all open reservoirs or will be removing them from service.
elevated tank	Elevated tanks have a supporting structure that elevates the lower operating elevation of water in the tank to a level above ground elevation.

Typical layout of SPU water system infrastructure is shown on Figure 5-2.

Figure 5-2
Typical Layout of SPU Water System Infrastructure



5.2.4 DSG Design Resources

DSG design resources include technical or material specifications developed specifically for and found only in the DSG. They include drawings, standard specifications, and other technical guidelines not available from other sources:

- **Drawings.** DSG standard drawings for an Access Port are in **Appendix A**:
  - DSG-5-01 24" Access port
  - DSG-5-02 24" Access port detail
- **Settlement Monitoring Requirements.** Settlement monitoring requirements for water mains are in Appendices B and C:
  - *Settlement Monitoring Requirements for Cast Iron Mains* (**Appendix B**)
  - *Settlement Monitoring Requirements for Ductile Iron Mains* (**Appendix C**)

5.3 GENERAL REQUIREMENTS

The design engineer must be familiar with water industry standards and code requirements.

If industry standards and City of Seattle requirements or regulations conflict, the design engineer must discuss the discrepancy with the line-of-business (LOB) owner, Facilities Maintenance and Operations manager, specifier and the owner of this DSG chapter through the formal resolution process.

5.3.1 Industry Standards

Water facilities must be designed to American Water Works Association (AWWA) standards. In addition, water facilities must meet Seattle-King County and Washington State Department of Health (DOH) standards.

Water storage facility design standards for SPU must also meet standards set forth in the Water Research Foundation's Maintaining Water Quality in Finished Water Reservoir.

5.3.1.1 American Water Works Association

AWWA standards and specifications must be followed, except when superseded by more strict requirements set forth in this DSG and City of Seattle Standard Plans and Specifications.

Table 5-1 lists relevant AWWA standards and specifications, organized by subject and intended as minimum requirements. Most of the specifications listed below may be found in the SMT 45th floor library. It is the design engineer's responsibility to use the latest version of these standards.

Table 5-1
AWWA Standards and Specifications for SPU Water Facilities

Designation	Title
Ductile-Iron Pipe:	
C104/A21.4	Cement Mortar Lining for Ductile Iron (DI) Pipe and Fittings for Water
C116/A21.16	Protective Fusion-Bonded Epoxy Coatings Interior or Exterior Surface DI
C105/A21.5	Polyethylene Encasement for DI Pipe Systems
C111/A21.11	Rubber-Gasket Joints for DI Pressure Pipe and Fittings
C115/A21.5	Flanged DI Pipe with Ductile Iron or Gray Iron Threaded Flanges
C150/A21.50	Thickness Design of Ductile Iron Pipe
C151/A21.51	DI Pipe; Centrifugally Cast, for Water or Other Liquids
C153/A21.53	DI Pipe; Compact Fittings for Water Service
Steel Pipe	
C200	Steel Water Pipe 6" and larger
C207	Steel Pipe Flanges for Waterworks Service Sizes 4"-144"
C216	Heat-Shrinkable Cross-Linked Polyolefin Coatings for the Exterior of Special Sections, Connections and Fittings for Steel Water Pipes
C206	Field Welding of Steel Water Pipe
C215	Extruded Polyolefin Coatings for the Exterior of Steel Water Pipelines
C217	Petrolatum and Petroleum Wax Tape Coatings for the Exterior of Connections and Fittings for Steel Water Pipelines
C210	Liquid-Epoxy Coating Systems for the Interior and Exterior of Steel Water Pipelines
C225	Fused Polyolefin Coating Systems for the Exterior of Steel Water Pipelines
C223	Fabricated Steel and Stainless Steel Tapping Sleeves

Designation	Title
C203	Coal-Tar Protective Coatings and Linings for Steel Water Pipelines, Enamel and Tape, Hot-Applied
C205	Cement-Mortar Protective Lining and Coating for Steel Water Pipe, 4" and Larger, Shop Applied
C208	Dimensions for Fabricated Steel Water Pipe Fittings
C213	Fusion-Bonded Epoxy Coating for the Interior and Exterior of Steel Water Pipelines
C218	Coating the Exterior of Aboveground Steel Water Pipelines and Fittings
C219	Bolted, Sleeve-Type Couplings for Plain-End Pipe
C220	Stainless-Steel Pipe, ½" and Larger
C221	Fabricated Steel Mechanical Slip-Type Expansion Joints
C222	Polyurethane Coatings for the Interior and Exterior of Steel Water Pipe and Fittings
C224	Nylon-11 Based Polyamide Coating System for the Interior and Exterior of Steel Water Pipe and Fittings
C226	Stainless Steel Fittings for Waterworks Service, Sizes ½"-72"
Valves/ Hydrants:	
C517	Resilient-Seated Cast-Iron Eccentric Plug Valves
C512	Air Release, Air/Vacuum, and Combination Air Valves for Waterworks Service
C561	Fabricated Stainless Steel Slide Gates
C563	Fabricated Composite Slide Gates
C560	Cast-Iron Slide Gates
C502	Dry-Barrel Fire Hydrants
C504	Rubber-Seated Butterfly Valves
C507	Ball Valves, 6"- 48"
C508	Swing-Check Valves for Waterworks Service, 2"- 24" National Pipe Size (NPS)
C509	Resilient-Seated Gate Valves for Water Supply ductile iron only
C510	Double Check Valve Backflow Prevention Assembly
C511	Reduced-Pressure Principle Backflow Prevention Assembly
C513	Open-Channel, Fabricated-Metal, Slide Gates and Open-Channel, Fabricated-Metal Weir Gates
C515	Reduced-Wall, Resilient-Seated Gate Valves for Water Supply Service (Does not meet City Spec, but can be used in special cases)
C540	Power-Actuating Devices for Valves and Slide Gates
C550	Protective Epoxy Interior Coatings for Valves and Hydrants
Pipe Installation:	
C600	Installation of Ductile-Iron Water Mains and Their Appurtenances
C602	Cement-Mortar Lining of Water Pipelines in Place—4" and Larger
C606	Grooved and Shouldered Joints
Disinfection	
C651	Disinfecting Water Mains
C652	Disinfection of Water-Storage Facilities
Storage	
D104	Automatically Controlled, Impressed-Current Cathodic Protection for the Interior of Steel Water Tanks
D110	Wire- and Strand-Wound, Circular, Pre-stressed Concrete Water Tanks
D100	Welded Carbon Steel Tanks for Water Storage
D102	Coating Steel Water-Storage Tanks
D103	Factory-Coated Bolted Steel Tanks for Water Storage
D115	Tendon-Pre-stressed Concrete Water Tanks
D120	Thermosetting Fiberglass-Reinforced Plastic Tanks
D130	Flexible-Membrane Materials for Potable Water Applications

Table 5-2 lists relevant AWWA design manuals for water supply practice. The list is not inclusive. Some of these manuals are available on SMT 45th floor. The manuals most frequently used by SPU are M11 (Steel Pipe Design), M41 (Ductile Iron Pipe Design) and M22 (Sizing Water Service Lines and Meters).

Table 5-2
AWWA Design Manuals for Water Supply Practice

Designation	Title
M1	Principles of Water Rates, Fees and Charges
M2	Instrumentation and Control
M3	Safety Practices for Water Utilities
M4	Water Fluoridation Principles and Practices
M5	Water Utility Management
M6	Water Meters: Selection, Installation, Testing, and Maintenance
M7	Problem Organisms in Water: Identification and Treatment
M9	Concrete Pressure Pipe
M11	Steel Water Pipe: A Guide for Design and Installation
M12	Simplified Procedures for Water Examination
M14	Recommended Practice for Backflow Prevention and Cross-Connection Control
M17	Installation, Field Testing, and Maintenance of Fire Hydrants
M19	Emergency Planning for Water Utilities
M20	Water Chlorination/Chloramination Practices and Principles
M22	Sizing Water Service Lines and Meters
M25	Flexible-Membrane Covers and Linings for Potable-Water Reservoirs
M27	External Corrosion: Introduction to Chemistry and Control
M28	Rehabilitation of Water Mains
M29	Water Utility Capital Financing
M31	Distribution System Requirements for Fire Protection
M32	Computer Modeling of Water Distribution Systems
M33	Flow meters in Water Supply
M36	Water Audits and Leak Detection
M41	Ductile Iron Pipe Fittings
M42	Steel Water-Storage Tanks
M44	Distribution Valves: Selection, Installation, Field Testing, and Maintenance
M48	Waterborne Pathogens
M49	Butterfly Valves: Torque, Head Loss, and Cavitation Analysis
M51	Air-Release, Air/Vacuum, and Combination Air Valves
M52	Water Conservation Programs-- Planning Manual
M55	PE Pipe--Design and Installation

5.3.2 Regulations

All water facilities must be built to the applicable City of Seattle, King County, Washington State and federal guidelines.

5.3.2.1 City Standards

The City of Seattle Standard Plans and Specifications are available online or from the Engineering Records Vault. The sections that apply to water systems are Standard Specifications

Sections 7 and 9, and Details Section 300. These standards are primarily based on AWWA industry standards.

5.3.2.2 King County

All water system works are subject to the provisions and requirements of Title 12 of the King County Board of Health Code.

5.3.2.3 Washington State Department of Health

The Washington State Department of Health (DOH) is the regulatory agency that ensures that water systems comply with system capacity requirements of the federal Safe Drinking Water Act (SDWA). Authority to regulate the public water supply system is granted under Washington Administrative Code (WAC), Chapter 246-290 "Public Water Supplies," also known as the Public Water System Rule. A key term under the rule is *system capacity*, which is defined as having the technical, managerial, and financial capacity to achieve and remain in compliance with all applicable local, state and federal regulations.

A. Water System Plan

The public water system rule (WAC 246-290) includes the Washington State Legislature-approved Municipal Water Law and the federal law, Long Term 2 Enhanced Surface Water Treatment Rule. DOH requires water purveyors to submit a Water System Plan to ensure water quality and protection of public health (WAC 246-290-100 and WAC 246-291-140, respectively). SPU's Water System Plan was last updated in 2007.

Water systems plans must be updated every 6 years. If a purveyor installs distribution lines or makes other improvements and the project requires State Environmental Protection Act (SEPA) analysis, a water system plan amendment is required (WAC 246-03-030[3][a]) before construction.

B. Water System Design Manual

The Washington State DOH Water System Design Manual (December 2009) provides guidelines and criteria for design engineers to use for preparing plans and specifications for Group A water systems, such as SPU, to comply with the Group A Public Water Supplies (chapter 246-290-WAC). This manual delineates mandatory requirements of the WAC that must be adhered to by SPU. Design engineers may use design approaches other than those in this manual as long as they do not conflict with chapter 246-290 WAC. DOH will expect the design engineer to justify the alternate approach used and the criteria that apply.

5.3.2.4 Other

Recommended Standards for Water Works (10-States Standards) – Part 7, Finished Water Storage is a source for water storage design.

5.3.2.5 Federal Safe Drinking Water Act

The Safe Drinking Water Act (SDWA) protects public health by regulating the nation's public drinking water supply. The law requires many actions to protect drinking water and its sources. SDWA does not regulate private wells that serve fewer than 25 individuals. SDWA authorizes the

U.S. Environmental Protection Agency (EPA) to set national health-based standards for drinking water to protect against both naturally-occurring and man-made contaminants.

5.4 BASIS OF DESIGN

For this DSG, basis-of-design documentation communicates design intent primarily to plan reviewers and future users of a constructed facility. For SPU, this documentation consists primarily of a basis-of-design plan sheet. By documenting the basis of design and archiving it with project record drawings (as-builts), future staff will have easy access to design decisions.

5.4.1 Basis-of-Design Plan Sheet

The basis-of-design sheet is a general sheet that shows a plan overview and lists significant design assumptions and requirements for major design elements (Figure 5-3). The following are SPU standards for this sheet:

- The design engineer must include a basis-of-design plan sheet in the plan set.
- The sheet must be archived with the record drawings (as-builts).

Figure 5-3
Basis-of-Design Plan Sheet Data for Water Infrastructure

Basis-Of-Design Plan Sheet

WATER----------
Type of Main (Transmission, Distribution, Feeder)
Design Flow Rate: _____
Flow Velocity: _____
Typical Pressure: _____ Pressure Zone(s):_____
Working Pressure: _____ Surge Pressure: _____
Pipe Materials:
_____
(type, lining, coating, joints, pressure class minimum slope, buoyancy safety factor, minimum cover [roads, non-roadway], deflection lag factor, construction tolerance, steel deflection limit)
Bedding Compaction:
_____
(roadway, non-roadway, bedding constant, modulus of soil reaction [E'])
Appurtenances:
_____
(isolation valves, blow-offs/drains, line valves, air-vacuum and air-release valves, valve limit settings for control valves, design criteria for all valves)
Access Ports:
_____Datum:_____
Basis of HVAC Design:_____
Basis of Process Control:_____
Project Specific/Special Information:

The basis-of-design plan sheet is not intended for construction and should not be included with the bid set. The sheet is inserted after the project has begun. See *DSG Chapter 1, Design Process*.

5.4.2 Design Criteria List

The design engineer may use a design criteria list to develop a basis-of-design plan sheet. The design criteria list is a shortened version of the most important design requirements (Table 5-2). For water system infrastructure, this information includes how key design criteria were selected, including working pressure, flow rate, and types of joints.

The list shows information that may be shown on the basis-of-design plan sheet. However, the list is not intended for construction and should not be included with the bid set. If included with the bid set, the design criteria list should be labeled "Informational Only."

Typically, the design criteria list is completed with the preliminary engineering report as a concise summary. However, that report can provide a much lengthier description of design requirements.

Table 5-3 is an example of what a design criteria list might contain for a water facility design.

Note: Table 5-3 is only an example. It is not intended to explain technical concepts.

Table 5-3
Design Criteria List for a Typical Water Facility Design (Example)

Description	Design Criterion/Design Data	Comments
General:		
Design Flow Rate	19,100 gpm (27.5 mgd)	Year 2040 peak flow rate in a 36-inch pipeline
Flow Velocity	6.02 fps	Year 2040 peak flow rate in a 36-inch pipeline
Typical Operating Pressure	120-180 psi	
Design Working Pressure, Pw	250 psi	
Design Transient (Surge) Pressure, Pt	332 psi	Based on 133% of working pressure and allowable stress of 66.7% of yield stress
Minimum D/t ratio	240	
Pipe Materials:		
Pipe Type	Mortar-Lined and Polyurethane Coated Welded Steel Pipe, AWWA C200	
Lining	Cement Mortar, AWWA C205	
Coating	Polyurethane Coated, AWWA C222	
Joints	Restrained Joint	Double lap-welded joint provides thrust restraint at bends, seal testing, and seismic restraint. Maximum joint length and resulting joint location is 60 ft. for steel pipe. Consider thermal expansion and fittings to allow movement, specifically with exposed pipe. Example: pip supported by hangers under bridges.
Pressure Class	250 psi	40,000 psi yield strength steel
Minimum Slope	0.001	
Pipe Buoyancy Safety Factor	1.1	
Minimum Cover – Roads	3 ft	
Minimum Cover – Non-Roadway	4 ft	
Pipe Loading – Traffic	HS-20 AASHTO	
Traffic – Trench Condition	HS-20 AASHTO "Prism Trench" design condition assumed	
Separation from Utilities	12 inch vertical, 10 ft horizontal	See Std Plan 286
Deflection Lag Factor, Dl	Minimum 1.25	
Construction Tolerance	½-inch from specified line and grade	Tolerances during tunneling higher as specified
Steel Deflection Limit	2.25% of Diameter	
Bedding Compaction – Non-Roadway	90% of Modified Proctor	
Bedding Compaction – Roadway	95% of Modified Proctor	
Bedding Constant	0.10	
Modulus of Soil Reaction (E')	700 psi	See Geotechnical Report
Appurtenances:		
Isolation Valves	Butterfly Valves, 250 psi rating	Located at tie-ins and interties to existing mains
Blow-offs/drains	6-inch size. Provide at all low points in pipeline	Used double valves, one for isolation and one for throttling.
Line Valves	2,000 ft	
Combination Air-Vacuum and Air Release Valves	4-inch size. Provide at all high points in pipeline	Also located at abrupt downward grade breaks

Description	Design Criterion/Design Data	Comments
Access Ports	24-inch	Located every 1,000 feet along pipeline and at both ends of tunneled crossings

5.5 DESIGN PROCESS

See *DSG Chapter 1, Design Process*. The design process for water infrastructure does not differ from that described in Chapter 1.

5.6 DISTRIBUTION AND FEEDER MAIN DESIGN

This section describes distribution and feeder main design. Distribution mains are smaller diameter (<3ft) pipes that carry water from a source (reservoir or tank) to a local service area (neighborhood or city block). Feeder mains are similar to transmission mains except that service connections are allowed.

5.6.1 Modeling and Main Sizing

When designing a water main that is 12 inches of larger in diameter, a hydraulic network modeling analysis must be completed (for sizing minimum sizing criteria see Section 5.6.3.1). SPU Utilities System Management (USM) maintains the models of the water distribution and transmission system and works with SPU engineering on modeling analyses. The modeling analysis will determine the capacity of the main to provide peak hourly demand and fire flow. In some cases, field hydrant flow tests will be required to verify modeling results.

5.6.1.1 Pressure Zones

The SPU water distribution system is divided into approximately 45 pressures zones that operate within a pressure range of about 30 to 130 psi. Individual zones are separated by closed line valves (district valves or DVs), pressure regulators, and control valves. Pressure zone boundaries are shown in the 400-foot map books and in GIS. USM specifies the pressure zone to which new water mains and service connections will be added.

5.6.1.2 Maximum and Minimum System Pressure

SPU Policy on Distribution System Water Service Pressure (SPU-RM-006) establishes SPU's pressure standards. Minimum pressure criteria for new water mains are 30 pounds per square inch (si) under peak hour demand (PHD) conditions, and 20 psi when flows are a combination of average maximum day demand (MDD) and required fire flow. In no cases shall pressure at the customer's meter be less than 20 psi. Pressures within distribution mains are not limited to a set maximum. All new services with static pressure above 80 pis require a pressure reducing valve (PRV) per plumbing code requirements.

5.6.1.3 Fire Flow Rate and Duration

The City of Seattle, City of Shoreline and King County have adopted the International Fire Code (IFC). Site specific fire flow requirements as determined by the appropriate Fire Marshall are used when issuing Water Availability Certificates and sizing of new water mains.

5.6.2 Location

Distribution mains are typically located within the right-of-way (ROW) in a standard location at a standard depth. See City of Seattle Standard Plan 030. Standard locations allow Field Operations and Maintenance to easily access the mains while keeping the ROW available to other utilities. SPU does not allow build-overs on water mains.

SPU may install or allow installation of water mains in private streets or easements. Location of the mains is determined case-by-case in easements less than 20 feet.

5.6.2.1 Separation from Other Utilities

Standard horizontal and vertical separations may not always be feasible in highly developed urban corridors. Special construction methods can be used to provide equivalent levels of protection to the standard separation criteria. Separation distances to provide structurally sound installations depend on the available working space for construction and soils and groundwater conditions at the site. See Standard Plans 286A and 286B.

For height, the design engineer must look for overhead power and maintain a safe distance to the power lines and structures. The distance depends on the power line voltage and the distance to a structure. Consult with the electrical utility to determine the project-specific safety distances and with the Department of Planning and Development (DPD) for any structural permit requirements.

Where standard pipeline separations cannot be achieved, an engineered design must be developed for adequate separation. The Washington State Departments of Health and Ecology jointly publish the Pipeline Separation Design and Installation Reference Guide. The design engineer must use this guide to design pipeline separations whenever standard SPU criteria are not feasible.

5.6.2.2 Geotechnical Investigations and Test Holes

Geotechnical (subsurface) investigations and test holes are typically not as critical for distribution lines as they are for transmission mains. The design engineer must review DSG section 5.8.2.2 (Geotechnical Report) and consider the necessity of subsurface information for the project.

5.6.2.3 Alternative Locations

For some projects, space may not be available to locate the water main in the standard location shown on Standard Plan 030. Other controlling factors such as water supply require that an existing water main be kept in service while a new main is installed in a non-standard location.

5.6.3 Materials

This section describes standard materials used in SPU water distribution system projects.

5.6.3.1 Minimum Pipe Size

The standard water distribution main size is:

- 8-inch-diameter pipe for residential areas
- 12-inch diameter pipe for industrial and commercial areas

Dead-end distribution mains typically include fire hydrants and must be at least 8-inches in diameter. Typically, feeder mains are 16- to 30-inch diameter pipes. Some SPU feeder mains are more than 30 inches in diameter. Pipes more than 30 inches in diameter must not have service connections.

5.6.3.2 Material Types

All new or replaced water pipe in the City of Seattle must meet the standard material types shown in Table 5-4.

Table 5-4
Standard Materials for SPU Distribution and Feeder Mains

Structure	Material
Pipe	• 2-inch diameter pipe must be Type K copper (when allowed by SPU). • 4-inch diameter and larger pipe must be ductile iron pipe, class 52 or thicker, cement lined-double thickness. • Feeder mains larger than 20-inch diameter must be ductile iron or steel.
Bends and Fittings	• Typically, bends and fittings must be the same material as the pipeline. • Fittings for 2-inch copper soft coil must be brass, either flared or compression.
Joints	• Joints for ductile iron water mains must be restrained joint, slip joint, or mechanical joint. • Joints on steel casing pipe must be welded and conform to AWS D1.1 Structural Welding Code, Section 3, Workmanship.
Casing	• Whether installed above- or below-grade, casing pipe must be smooth steel, with the diameter and wall thickness specified in the drawings. • All joints must be welded by qualified operators. Steel casing pipe is discussed in Std Spec 9-30.2. • Casing seals and spacers must be per Std Spec 9-30(15). • If specified in the contract, the space between the carrier pipe and casing pipe must be filled with sand, grout, or some other material.

Non-standard mains less than 8 inches in diameter and approved by SPU, must be ductile iron, except for 2-inch pipe, which must be Type K copper.

5.6.3.3 Pipe Cover

Depths of cover for water mains are shown on Standard Plan No. 030. The depths vary depending on size of pipe. Mains larger than 12 inches in diameter typically use butterfly valves. Butterfly valves require less cover due to their shape and allow large mains to be buried at shallower depths. Generally, SPU attempts to bury the pipes as shallow as feasible for ease of installation and maintenance, but no less than 35 inches deep except in special cases as directed by SPU. The depth to the pipe invert should be kept to less than 6 feet to reduce the need and cost for excavation and shoring.

5.6.3.4 Bedding and Backfill

The design engineer must require sand bedding for water mains unless another agency dictates otherwise. Sand bedding creates a less corrosive environment around a pipe than does native soil. Sand bedding also eliminates point loads on the pipe caused by stray rocks. Sand bedding is typically Class B, Sand Mineral Aggregate Type 6 or 7 unless otherwise specified. *Note: Type 9 is for transmission mains.*

Backfill is either suitable native material, Mineral Aggregate Type 17, or other material as approved by the design engineer. For suitable native backfill material, see Standard Specification 7-10.3(10) for requirements. For requirements for Mineral Aggregate Type 17, see Standard Specification 9-03.16.

For more information on bedding and backfill, see Standard Specifications 7-10.3(9), 9 03.12(3) and 9-03.16.

A. Standard Trench Section

For requirements for a standard trench section, see Standard Plan 350.

B. Controlled Density Fill

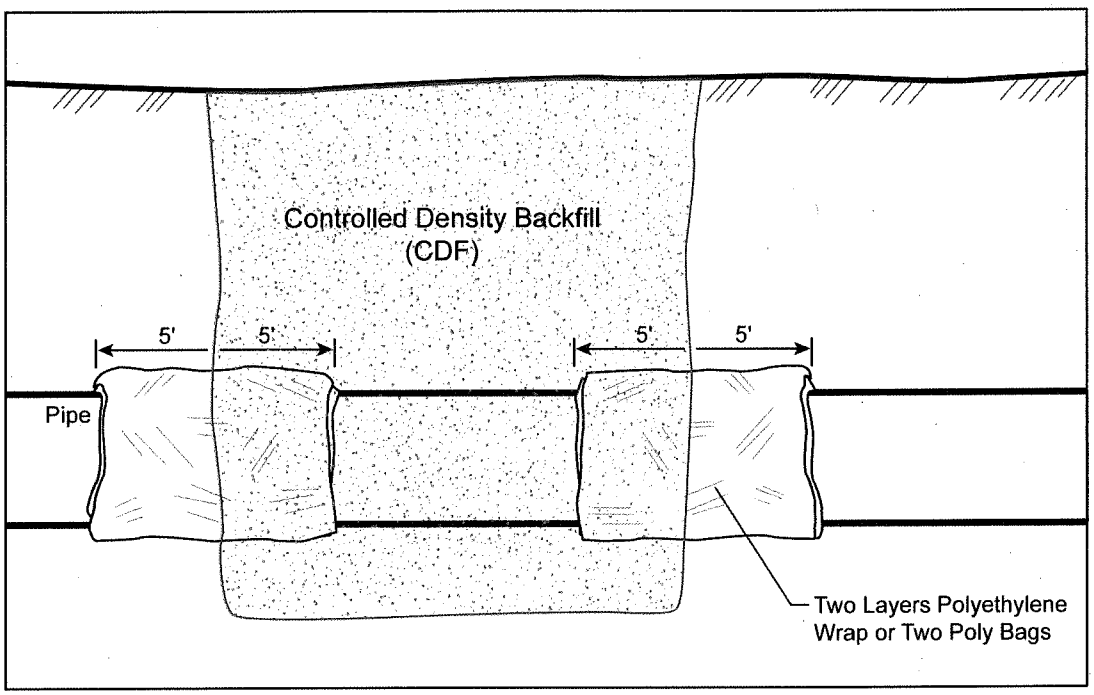
Sometimes an outside agency, time constraints, or compaction will require that a water main be bedded and backfilled in controlled density fill (CDF). When this requirement outweighs the benefit of using sand bedding, a metallic water main must be coated both where embedded in CDF and for some distance beyond the CDF encasement. Typically, SPU uses either two layers of 5-foot-wide visqueen or two polyethylene bags over the main to keep it separated from the CDF (Figure 5-4).

When CDF is used near the metallic pipe, a corrosion specialist should be consulted because CDF can create a corrosion cell.

The CDF used to encase the water main must be the weaker (diggable) CDF mix. All CDF must be ⅓ sack mix, less than 200 psi, and preferably less than100 psi. SPU has approved various types and uses of CDF. CDF can be used as a trench plug, trench backfill, or for grouting an annular space. Each use has a different mix ratio. The design engineer must reference the City Standard Plans and Specifications for each CDF use. See Standard Specification 9-01.5.

When CDF is used to fill pipe and the annular space between two pipes, it must have 100 psi strength at 28 days. See Standard Specification 9-05.15.

Figure 5-4
Controlled Density Fill



5.6.3.5 Line Pressure

Distribution water mains must be designed to withstand both external loads and test pressure according to Standard Specification 7-11.3(11)A1.

Most distribution lines serve a portion of the city, and are within a designated pressure zone. In cases where there is an extreme pressure differential (e.g. downhill pipeline), it may be advisable to change material thicknesses along the pipeline route and/or install a pressure reducing valve. Test pressure is measured at the downhill end of the pipe run. Before considering installation of a pressure reducing valve, the design engineer must coordinate with USM to ensure the valve will not negatively affect the system.

If a pressure regulating valve (PR) is used, an emergency pressure relief (PRV) must be installed and set to relieve pressure at 80 psi or maximum zone pressure.

Note: Some current City zones have pressures up to about 120 psi. These zones lie at the bottom of steep hillside areas. If the site is steep, do not put a PRV where it might cause unstable soil conditions (i.e. landslides).

Tip: *It is best to install both PRVs and PRs at the lowest point possible. However, sites in environmentally critical areas (ECAs) may not allow for that.*

5.6.3.6 Pipe Supports

A licensed civil or structural engineer must design the pipe supports and review pipe loads and potential deflections caused by lateral and vertical movement. AWWA M11 (Steel Pipe Design) and AWWA M41 (Ductile Iron Pipe Design) manuals provide some explanation on how to

properly design pipes on supports. The Ductile Iron Pipe Research Association (DIPRA) also publishes a computer program for selecting supports and spacing of ductile iron pipes.

A. Pile Supports

Pile supported pipelines are rare in the SPU water system. However, in some locations, such as crossing a wetland or in loose soils, pile-supported pipelines may be necessary. A licensed civil or structural engineer must design the pile support and calculate pipeline thickness. Because pipelines installed on piles are typically not continuously supported, they present unique design challenges. Among the issues are additional stresses placed on the pipeline due to the lack of support. Such design issues must be investigated and modeled by a licensed structural engineer.

i Above Grade Pile Support

For an above-grade exposed pile support, the design engineer should consider the pipeline and pile coating system. In most cases, both the pile and pipe will require a coating, and cathodic protection must be considered. Additionally, pipeline insulation may be needed to protect the line from freezing temperatures and in no-flow situations.

ii Buried Support

If the pipeline is on piles and buried, a qualified licensed civil or structural engineer must carefully review the connection to the piles to ensure the pipe and piles operate as one entity during seismic and uplift conditions.

B. Aerial/Bridge Supports

SPU owns and operates a few aerial (aboveground) pipelines in its water system. A structural engineer licensed in Washington State should be involved in aerial pipeline design. Like pipelines on piles, aerial pipelines are not continuously supported, and therefore present unique design challenges.

Aerial pipelines can either be supported from above, by hanging the pipe, or cradled in a utility corridor under the bridge. In either case, the pipe supports place additional loadings on the pipe wall.

The following are special considerations for aerial design:

- Where possible, aerial pipelines should be avoided for security and vibration concerns.
- When pipes are hung under existing bridges, roadway clearance design must consider the potential for damage from trucks traveling above the legal height limit. Additional protection should be considered such as line valves or structural modifications to the bridge.
- With an exposed pipe design, the design engineer must consider the pipeline coating system. Additionally, pipeline insulation may be needed to help control thermal expansion of the pipeline, and keep the line from freezing temperatures and no flow situations. AWWA Manual M11 provides an analysis method to determine if freezing is a concern.

- The design engineer must carefully review the buried-to-aerial transition to ensure the pipeline will be able to handle ground movement from earthquakes. In most cases, a restrained joint with both rotational and expansion capabilities (e.g. a double ball expansion joint fitting) is recommended. See also DSG section 5.8.4, Seismic Design.
- Freeze protection design must be considered. Potential options include one or more of the following:
  1. Insulation of the pipe;
  2. Heat tape.
  3. In case of a temporary change in the way the pipe is used resulting in low flows consider installation of a system to allow a release of a small volume of water to a location that does not cause an environmental impact or safety hazards

C. Temporary Supports during Construction

Supporting existing utilities during construction can be difficult, but is necessary to ensure no damage occurs to the existing pipelines. Typically, the construction contractor is responsible for supporting all existing utilities throughout construction. The contractor must provide a support plan that is stamped by a Professional Engineer licensed in Washington State. SPU engineering and Field Operations and Maintenance will review temporary supports in the field and notify the contractor of deficiencies. SPU Water Operations staff does not direct repairs.

The following is a list of cautions contractors must take to avoid damage to pipelines:

- Contractors must not use chains to move or support any pipe materials because it will damage the pipeline.
- Contractors must not rest the pipe on any sharp or pointed objects, including the bucket of any equipment, single point supports, or rods.
- Pipelines must not be unsupported for a length longer than one stick of pipe or one joint.
- If the joints are not restrained, the contractor must ensure crew safety by restraining the pipe from movement, which could separate the joints.
- Pipelines must be supported in cradles or on wide support beams sufficiently spaced so the pipeline does not sag and cause undue stress on the joints or pipeline wall. This is especially important for cast iron with lead joints.
- Do not expose more than one unrestrained joint.
- Lead joint cast iron water mains must not be allowed to deflect while they are exposed.

5.6.3.7 Casing

Water mains are installed in casings to protect the mains from excessive loads and to provide a means of replacing the pipe beneath structures such as rail road tracks. Casings also reduce the damage to facilities over the water main in the event of a leak or main break. Sometimes casings

are required by other entities (e.g. railroads) where SPU utilities cross over or under them. Casings can be installed via open cut if there are no obstacles.

Casing materials must follow Standard Specifications 9-30.2 (14) and 9-30.2(15).

A. Jacked Casings

Casings installed under the railroad are often jacked into place. When designing jacked casings, adequate space is required for the casing and pipe jacking pit. Jacking pit size can vary depending on the lengths of casing or pipe. Restrained joint pipe must be used through the casing and beyond to a logical location to terminate the restrained joint pipe. Keep in mind that the cased length of pipe offers no thrust resistance via skin friction as does a buried pipe. Access must be provided for the pipe to be cut and connected to a new pipe. SPU preference is to have the jacking pit located on each side of the casing.

Note: Jacking casing is dependent on pipe size. The larger the pipe size, the larger the jacking pit is. Keep the casing as far as practical from the other utilities to allow future access for pipe removal.

B. Other Utility Crossings

The design engineer must determine where casings are needed at locations where an SPU transmission main is crossing either over or under other utilities. For separation requirements between water mains and other utilities, see Standard Plans 286A and 286B. All pipes in casings must be restrained joint. See Standard Specifications 7-11 3(6)D and 7-11.3(7)C-D2.

C. Railroad Crossings

Where water mains cross under a rail system (e.g. street car, light or heavy rail, or other as determined by SPU), the main must be placed inside a casing. The casing must extend such a distance from the tracks that maintenance can be performed from the side without affecting the rail. For cathodic protection for pipes crossing a rail line, see *DSG Chapter 6, Cathodic Protection,* Test Procedure (TP) 31 – Light Rail and Street Car Cooperative Interference Testing.

i Heavy Rail

- When crossing beneath heavy rail, a casing must extend from ROW line to ROW line unless the main is more than 25 feet from the track centerline. If the railroad agrees, the casing must extend a minimum of 25 feet from the track centerline. See the American Railway Engineering and Maintenance-of-Way Association (AREMA) Design Guideline before designing a heavy rail crossing.
- Pipelines parallel to heavy rail must be encased if they are 40 feet or less from the track centerline.

ii Light Rail

Light rail does not impose the extreme loading on pipelines that heavy rail does. However, light rail imparts some loading and causes significant pipeline access issues and stray current corrosion concerns.

Water mains crossing beneath Sound Transit Central Link light rail tracks are encased a minimum distance of 12 feet perpendicular to the centerline of the track. The tracks have a 5.5 foot minimum separation between the top of the rail and the top of the casing. See the Sound Transit Design Criteria Manual.

Casings crossing a light rail line must be electrically isolated from the carrier pipe. A permanent test station should be installed to perform future isolation checks. See *DSG Chapter 6, Cathodic Protection*, Test Procedure (TP) 31 – Light Rail and Street Car Cooperative Interference Testing.

iii Street Car

The presently used street car designs have the least impact on buried pipelines of the three types of rail. Street cars are smaller and lighter, but still limit pipeline access and generate stray current.

The design engineer must consider depth of cover, pipeline size, age, thickness, material, importance, and access.

The design engineer should consider various pipeline protection methods ranging from do nothing to casings and protective concrete slabs.

D. Parallel Rail Installations

For worker safety, parallel mains should not be closer than 15 feet from the rail center line. However, rail installation will likely have to be considered case by case.

5.6.3.8 Permanent Restraint Systems

Restraining of forces due to internal pressure at fittings, valves, or dead ends is a major consideration in pipe installation. Thrust restraint is by welded or mechanically restrained joints or poured in place concrete thrust blocks depending on pipe size and type.

All bends, fittings, and line valves must be restrained by a joint restraint system compatible with the pipe type.

A. Thrust Restraint Calculations

For all projects requiring thrust restraints beyond that required by Standard Plans 330a, 330b, 331a, and 331b, the design engineer must calculate the thrust restraint.

Restrained joint pipe is self-restrained. The restrained length for pipe and fittings depends on the test pressure, backfill, depth, soil characteristics and pipe coating. The design engineer must calculate the restrained length for both pipe and fittings.

B. Connecting to the Existing System

In the SPU water system, most connections to existing (non-steel pipe) are unrestrained. A difference in outside diameters of various materials can create a force imbalance at the connection similar to that of a reducer.

For example, a 100-year-old cast iron, 20-inch-diameter water main could be ½-inch greater in outside diameter than a new 20-inch-diameter ductile iron main. This force imbalance must be accounted for at the connection, especially if corrosion preventative isolation couplings are used to make the connection. At 100 psi, this difference in

outside diameter creates a force imbalance of more than 3,000 lbs in a 20-inch-diameter pipe connection. The connection coupling can be restrained by using tie-backs, wedge restraint glands, or welded tabs on the smaller pipe, or some combination. The idea is to keep the connection coupling from sliding off the larger pipe and onto the smaller pipe due to the force imbalance.

Be very careful with restraint for new valves near connections to existing pipe, especially when new restrained joint pipe is connected with unrestrained pipe. When closed and under pressure only from the existing side, the valve will tend to collapse the new flexible restrained joints and pull away from the unrestrained connection. This effect is usually overcome with a concrete thrust collar on the new pipe that is fixed rigidly to the new valve.

5.6.3.9 Types of Pipe Restraints

This section describes the types of pipe restraints used in the SPU water distribution system. Typically, ductile iron pipe is joined by a non-restrained bell and spigot joint. Some steel pipe is also joined in this manner. Thrust blocks are the SPU standard for restraining pipe when non-restrained bell and spigot joints are used. The design engineer should use Standard Plans 330A, 330B, 331A, and 331A and the AWWA Manual M41 to design thrust blocks. Some situations will not allow space for concrete thrust blocks. In those situations, use a pipe with a built-in restrained joint, or pile supported thrust restraint systems.

A. Concrete Blocking

Concrete thrust blocks are the most common joint restraint in the SPU system. Thrust blocking relies on the surface area of the block being in contact with undisturbed soil to counteract the pressure acting on the pipeline fitting. Conditions may require a pile-supported thrust restraint system. The soil conditions are a very important factor in concrete thrust block design.

In concrete thrust block design, excavations or disturbance of soils behind thrust blocks should be avoided. An assessment should be performed by a qualified engineer to determine if there is a safe distance away from the thrust block that an excavation could be performed.

NOTE: During design consider future disturbance of thrust blocks

i Horizontal Thrust Block

Horizontal thrust block sizing calculation must follow either Standard Plan 331 or AWWA Manual M-41.

ii Vertical Thrust Block

In some cases, vertical thrust blocks may be needed. Vertical thrust block must follow Standard Plan 330.

B. Concrete Thrust Collars

Concrete thrust collars are occasionally used as a method of thrust restraint. Typically, thrust collars are used to restrain large valves in chambers and valves near casings or connections to existing pipe. Collar refers to the section of concrete formed around the pipe to counteract thrust forces. Collars withstand thrust force by both passive soil

pressure and friction on the bottom surface of the block. To keep the pipe from sliding within the collar, the concrete needs to interface with the pipe. The wedge restraints on ductile iron pipe should be wrapped in polyethylene so the concrete does not seep into the wedges of the wedge restraint gland and stop it from working.

i Steel Pipe

If using concrete collars on a steel pipe, a factory integrated thrust ring must be welded around a pipe section, then embed in concrete.

ii Ductile Iron Pipe

If using concrete collars on ductile iron pipe, a factory ring must be installed on a pipe section. An alternative is to install two wedge style restraints face-to-face to act as a thrust ring.

iii Poor Soil Conditions

Design should consider the potential settlement impact the concrete thrust collar could have on the pipe.

iv Pipe Anchors/Tie Backs

Pipe anchors consist of a large mass of concrete usually on one side of a pipeline. The concrete is attached to the pipeline by steel rods. Anchors act like vertical thrust blocks (except in a horizontal plane) to restrain the pipe at a bend. Typically, pipe anchors are only installed for temporary service because the rods can corrode.

C. Rigid Restrained Joints

Flanges, welded joints, and threaded couplings are types of rigid restrained joints. Flanges can be used on both ductile iron and steel pipes. SPU does not use threaded couplings in water mains.

i Flanges

SPU does not recommend burying flanges in soil. Flanged fittings are used where joint flexibility is not needed and are typically found in vaults associated with valves or other appurtenances. Flanged pipe must be installed perfectly to fit up and offers no flexibility. A dismantling joint must be used to allow disassembly and repairs. Flanged valves are usually used in the installation of a large run of flexible restrained joint pipe. Each flanged valve will have a short flange by flexible restrained joint adapter on each side of it.

Manufacturers can weld a flange to the steel pipe. See AWWA Manual M-11 for the class of flange rating. Consult with the manufacturer to ensure the flanged connection can be provided. An electrical isolation kit may be necessary if joining the steel pipeline to a ductile iron appurtenance. Steel and ductile iron are dissimilar materials that can corrode.

ii Welded Joints

Steel pipe can be assembled with welded joints, making the pipeline fully restrained. Field-welded joints provide restraint against the unbalanced hydrostatic and hydrodynamic forces acting on the pipe. There are several styles of welded joints. The

most common are the lap-weld, butt-weld, and butt strap joints. Refer to AWWA Manual M-11 for a photo of each type of joint:

- **Lap-Weld Joint.** In general, SPU prefers a lap-weld joint because they are easy to install. Lap-welded pipe is a bell and spigot pipe with the bell welded to the spigot where they overlap. The design engineer can select an interior only weld, exterior only weld, or double lap weld (interior and exterior). SPU recommends the double lap weld. It provides an added safety factor at each joint, but can only be done in larger diameters because it requires a welder to make an interior weld. Also, each joint can be checked for leakage with an air test. With a lap-weld joint, small deflections can be made at each joint before welding. Given the geometry of the double welded lap joint, it experiences twice as much strain as the pipe wall when post-construction forces (settlement) cause pipe movement.
- **Butt-Weld Joint.** Butt-weld joints are made by aligning the ends of two pipe sections and welding at the point of "near-contact" of the two ends. To complete a butt-weld joint, both ends of the pipe must be the same size. A butt-weld joint is more difficult in the field because the pipes must be near perfectly aligned. This style weld eliminates the geometric strain that can be induced at a lap-weld joint. SPU has used butt-welded joints for pipelines designed for higher levels of seismic loading. The butt-weld joint is also used in horizontal directional drilling (HDD) applications, where having a bell shape on the pipe is not recommended. A full penetration butt-welded steel pipe is one of the best choices for seismic protection.
- **Butt-Strap Joint.** A butt-strap joint consists of a strip of steel that overlaps two plain end pieces of pipe by several inches. The butt strap is joined to each pipe by an exterior weld (and an interior weld if the pipes have sufficient diameter). The two pipe ends do not have to have identical outside diameters, but they must be relatively similar. Typically, a butt-strap joint is used to join a new steel pipe to an existing steel pipeline.

SPU follows the recommendations of the American Welding Society (AWS) Structural Welding Code.

D. Flexible Restrained Joints

Flexible restrained joints allow some deflection and movement of the joint, but restrain the joint while under pressure. These joints are the standard restrained joints used by SPU. All ductile iron pipe manufacturers make a boltless restrained joint ductile iron pipe that uses a restraining ring and locking lugs to restrain joints yet provide flexibility. Check the manufacturer's literature because products vary.

The use of flexible restrained joint pipe systems should be used when special site or system conditions are present and the use of concrete thrust blocks is not appropriate. Flexible restrained joint pipe systems are required when site/project needs have the following characteristics:

- The water main is to be located in an area of liquefiable soils.
- The area is defined to have soils with a poor bearing capacity.

- The area is on a steep slope and particularly if the water main is to be in an area determined to be a slide area.
- If the site is congested with underground utilities or other facilities such that concrete thrust blocks are unfeasible.
- To provide flexibility in shutdown areas and avoid using temporary thrust restraints.
- In areas where excavations, soil settlement or subsidence is anticipated, restrained joint pipe should be considered.
- In pipelines critical to the functioning of the water supply system after a major seismic event.

i Wedged Restraints

Other examples of flexible restrained joints are a wedge restraint gland type device or a restrained gasket type of pipe. Wedge restraint glands must follow Standard Specification 9-30.5(5)B. Wedge restraint glands are typically used on mechanical joint pipe and fittings and grip the pipe, which forces a lug with teeth to imbed into the pipe. Most wedge restraint systems remain flexible after installation.

ii Gasket Restraint

The restraint gaskets are readily available and can be installed on field-cut push-on joint pipe. The restraining gaskets have stainless steel teeth imbedded in them that grip the pipe for restraint. The restraint gaskets are only pseudo-flexible restrained joints. Once assembled, they offer little or no deflection capability. They also require special tools to disassemble.

Note: SPU has used the restraint gaskets on occasion, but found they do not save costs. The AWWA M41 Manual or DIPRA computer program can be used to calculate ductile iron pipe restraint requirements.

Restrained joint pressure ratings for each type and pipe size must be verified with the manufacturer. The length of pipe in casings on any run of ductile iron pipe does not count towards its overall restraint length, unless the casings are filled with grout after the pipe is installed. When using restrained joint pipe, all pipe in each individual system must be restrained joint. In addition to pipe joint restraint, concrete thrust blocks must be provided unless site-specific conditions do not allow.

Note: Field cutting and modifying a factory restrained joint pipe is difficult and time consuming. The pipe must be ordered specific to the project site. Contractors must submit and receive approval of a 3-D lay plan before ordering pipe.

iii Grooved Restraint

Grooved restraint couplings can be used to restrain ductile iron and steel pipe. These couplings are uncommon in the SPU system but can be found on some blow-off facilities. Grooved restraint couplings are generally not used in buried service.

The standard grooved restraint coupling engages a groove that is cut on the exterior of the full circumference of the pipe. Thicker pipe must be used for these couplings.

Grooved restraint couplings can also be used with a rolled groove in thin wall steel pipe and with a welded end ring on both ductile iron and steel pipe. Flexible steel restrained joints come in the form of a coupling that connects two pipe sections. The restraint is obtained by grooves on the coupling engaging a steel rod that is welded to the outside of the pipe. These couplings are custom designed to each project and can be ordered with some minor expansion capability. While quick and easy to install, grooved restraint couplings are expensive. One manufacturer is Victaulic brand.

For how to design restrained joint pipe systems without concrete blocking, see the Ductile Iron Pipe Research Association (DIPRA) program.

E. Flexible Single-Ball and Double-Ball Expansion Joints

For projects where extreme flexibility is needed, several manufacturers offer river crossing pipe that has restrained, ball joints that provide a high flexibility in alignment. Another flexible product is a single or double-ball expansion joint, which is very expensive. The double-ball expansion joint can rotate, extend, contract, and adjust in any direction, yet will not separate. However, improperly installed expansion joints can expand unintentionally under pressure. The design engineer should use care in designing expansion joints in the pipe system.

At a location on each side, the pipe must be fixed by a thrust collar or other means to keep the expansion joint from moving.

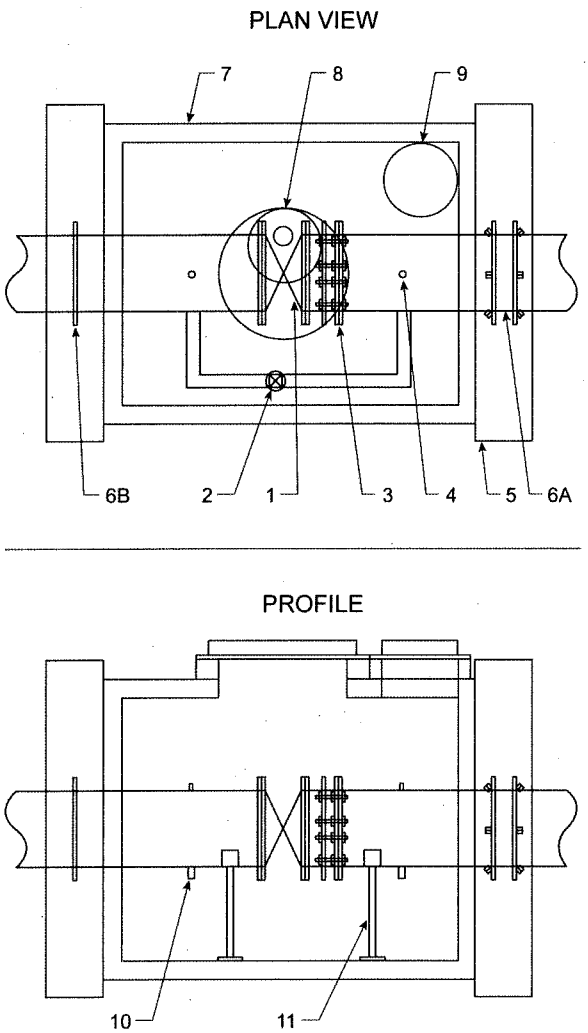
5.6.3.10 Temporary Restraint

Temporary restraint is sometimes required during construction to restrain pipe thrust forces usually where the pipe has been cut and capped and a dead end is created. Temporary restraint can come in many forms, and usually is installed before other work so that the pipe can be cut, capped, and turned back on in a single outage. In smaller diameters, a precast concrete block (Ecology block) is usually placed in front of the cap to act as a thrust block. In larger diameters, a tie-back system is usually used where steel rods connect the cap to an anchor (usually two precast concrete blocks) and sometimes piles. Often, the contractor must provide temporary restraint and submit a design stamped by a licensed engineer to SPU for approval.

5.6.3.11 Vaults

Vaults are used to provide access to appurtenances (Figure 5-5). Vaults are required for line valves 16 inches or larger in diameter and air, complex blow-off, pressure reducing, pressure relief, check, and district valves. These vaults require sumps and sump pumps with drains when there is electrical equipment inside. Vaults should not be located in the roadway and should provide hatch doors for ease of access. Provide enough space inside the vault to accommodate required electrical clearances and work space. For detail on aboveground pipe supports and standard vaults, see *DSG Chapter 4, General Design Considerations*.

Figure 5-5 Typical Layout of a 16-inch or Larger Line Valve



NOTES:

1. 16"-30" LINE VALVE (SHOWN AS FLXFL)
2. BYPASS VALVE (GENERALLY 4") W/ VALVE BOX. CAN GO OUTSIDE VAULT
3. FLXFL DISMANTLING JOINT
4. AWWA X IPT CORP ONE EACH SIDE OF VALVE, TOP OF PIPE
5. REINFORCED CONCRETE THRUST COLLAR (GENERALLY NOT NECESSARY ON WELDED STEEL PIPE)

6A. BACK TO BACK OPPOSING WEDGE RESTRAINT GLANDS POLY BAGGED (OPTION A) (NOT APPLICABLE TO WELDED STEEL PIPE)

6B. WELDED STEEL COLLAR (OPTION B) (GENERALLY NOT NECESSARY ON WELDED STEEL PIPE)

7. PRECAST OR CAST IN PLACE VAULT. IF CAST IN PLACE, THRUST COLLARS CAN BE INTEGRAL TO VAULT.
8. 42" RING AND COVER WITH 24" INNER COVER. CENTER 42" COVER OVER VALVE AND 24" COVER OVER VALVE OPERATOR.
9. 24" RING AND COVER FOR ACCESS
10. AWWA X IPT CORP ONE EACH SIDE OF VALVE, BOTTOM OF PIPE
11. PIPE SUPPORT STAND TYPICAL OF 2.

GENERAL NOTES:

A. DESIGNS WILL VARY DEPENDING ON PIPE TYPE (DUCTILE VS STEEL) AND JOINT TYPE.

B. SIZES OF ALL VALVES SHOWN CAN VARY DEPENDING ON LINE VALVE SIZE AND USE.

C. VAULT SIZE AND PIPE ALIGNMENT WITHIN THE VAULT WILL VARY DEPENDING ON SITE CONDITIONS.

D. FOR CLARITY, NOT ALL PIPE JOINTS ARE SHOWN. A PIPE JOINT SHOULD BE INSTALLED OUTSIDE THE VAULT WITHIN A FEW FEET OF THE THURST COLLARS WHEN USING FLEXIBLE JOINT PIPE.

5.6.4 Appurtenances

Pipeline appurtenances (line valves, access ports, blow-off/drains, and air release/air vacuum valves) must be provided along the pipeline as needed to support the pipeline function and operation. Appurtenance locations should be determined during design and consider conflicts with other structures, vehicular traffic, and existing utilities. Appurtenance locations should avoid areas most vulnerable to damage or vandalism.

5.6.4.1 Valves

When selecting a valve for a distribution main, pay close attention to the type of valve, whether a bypass is required, clearance for future maintenance, and purpose of valve (sacrificial, throttling, isolation). The types of valves used in the SPU water system are shown in Table 5-5. For more information on valves, see Standard Specification 9-30.3.

Table 5-5
Valve Uses within SPU Water System

Use	Type	Function	Size (in inches)	Comments
Line Valve	Gate, C509 resilient	On/Off	4" – 12"	Typically used for smaller line valves
	Gate, C500 double disc	On/Off	4" – 12"	• No longer commonly used • Much larger sizes in system
	Butterfly	On/Off	4"-12"	• No longer commonly used • More head loss than others
		On/Off	16"-84"	• Typically used for line valves • More head loss than others
	Ball	On/Off, throttle	4"-48"	• Costly • Low head loss
District Valve	Gate	On/Off	4"-12"	In chamber, generally closed, locked out
Backflow Prevention	Check Valve	Prevents backflow	4'-12'	Only allows flow in one direction
Air Relief, Air Vacuum, Air Release	Stand Pipe, Air Valve, Combo Air Valve	Allows air in and/or our of pipe	2"-16"	• Air release allows trapped air to escape pipeline and improve flow characteristics • Air vacuum allows air into pipe to prevent collapse during draining. • Largest likely future need is 8"
Pressure Regulating/ Pressure Relief Valve	Control Valve	Maintain system pressure	2"-16"	Maintains a constant downstream pressure
Sacrificial/ Throttling	C500 Gate	Limit discharge	4"-8"	Typically the "Throw away valve" in double valve setup
	C515 Gate	Limit discharge	4"-8"	Typically the "Throw away valve" in double valve setup
	C509 Gate	Limit discharge	4"-8"	Typically the "On/Off valve" in double valve setup
	Ball	Limit discharge	4"-8"	Long-term high head throttling valve
	Plug	Limit discharge	4"-8"	Long-term high head throttling valve

A. Types of Valves

The following are types of valves used in the SPU Water System

Valve	Use in SPU Water System
Line	Line valves are typically either gate or butterfly valves, depending on pipeline size. Ball and plug valves may be used in the following situations: high pressure (±250 psi), significant throttling under high flow rates, control of pressure surges, or where throttling of high pressure differentials may be required.
Gate	Gate valves are preferred where possible. They completely exit the flow path when fully open and allow drained water mains to fill without bypasses. Gate valves require space for a valve bonnet above or to the side (laydown valves) of the pipeline. Cover over water main may be critical. In cases where substandard cover is allowed, the gate valve operating nut must be below the bottom of the paving. This is particularly sensitive for concrete pavement, which tends to be thick. Gate valves are typically more expensive than butterfly valves. Laydown valves must be operable from the street surface and require a sealed right angle gearbox. (See Std Plan 030 for standard cover requirements.)
Butterfly	Butterfly valves are frequently used on larger pipelines. All valves 16-inches and larger should be full-size inline butterfly valves and be installed in vaults. Valves under 16-inches can be either gate or butterfly valves. Standard practice is to use gate valves. Butterfly valves 16" or larger must be installed with a bypass to allow a drained pipe to fill without throttling the butterfly valve seats. Throttling of large-diameter butterfly valves with pressure differentials of over 50 psi is a primary reason seats have been destroyed after only one or two usages. Make provision for replacement of butterfly valves in the vault design. Include a dismantling joint, or similar, to enable disassembly of the pipe.
Distribution	Distribution line valves should be placed at interties and roadway intersections located at street margins. The valves should be spaced to provide operational flexibility and redundancy to the water system and reduce impacts of shut down blocks.
District	District valves are typically gate valves and separate different pressure zones. They require the valve to be installed in a chamber with a special lock-out tag or cover on the operator to prevent accidental operation.
Check	Check valve is a special valve that only allows flow in one direction through the valve. Check valves are usually installed in vaults. Several styles are available. Check the valve's coefficient value (C) and slam characteristics before finalizing check valve design.
Pressure Relief and Pressure Regulating	Control valves (pressure reducing, pressure sustaining, etc) typically are installed at the interface between pressure zones. They are sized based on anticipated fire flow at projected peak hour demand conditions. Control valve stations should be below-grade in a concrete vault, and include a mainline meter and a bypass to the main waterline.
Air Relief, Air Vacuum, Air Release	Air valves are most commonly found on transmission pipelines and large feeder mains. They are not common on small-diameter distribution mains. There are two general types of air valves: air and vacuum valves and air release valves.
Air and Vacuum	Air and vacuum valves are large-orifice valves used to allow large volumes of air to flow into or out of the pipe during filling and draining and to prevent a vacuum from valve operations, rapid draining, column separation, or other causes. Without air vacuum valves, a vacuum can cause the pipe to collapse from atmospheric pressure. Fire hydrants can be used to release air at the high points of the distribution system and between isolation valves while filling water mains.
Air Release	Air release valves are small orifice valves that may be required at pipe high points or at significant changes in pipe grade to release small amounts of slowly accumulating air buildup in the pipeline. Air is dissolved or entrained in water from many sources including naturally occurring surface waters, at open reservoirs and while filling the pipeline at locations of cascading flow in a partially filled pipe to name a few. Entrained air may be dissolved into the water as pipeline pressure increases (decreasing pipe slope). Entrained air may collect at the top of the pipe at abrupt downward changes of pipe grade. Dissolved air may come out of solution many miles from the air source as the pressure decreases, especially at high points. Air may bubble out of solution where there is significant increase of flow velocity caused by changing pipe diameters (Bernoulli principle) and increasing pipe slope, and changes in pipeline elevations and reduced pressure. Reducing the accumulation of air within a pipe decreases head loss in the pipeline.

Valve	Use in SPU Water System
Combo Air Release/ Air Vacuum	Combination air release/air vacuum valves are air valves that have both large orifices and small orifices and provide the combined functions of both types of valves. These valves must comply with the requirements of ANSI / AWWA C512. They are sized per AWWA M51 based on 2-psi pressure differential for filling and draining. Air release valve orifice sizes are chosen based on water main operating pressure and air release rate, which must be selected to avoid abrupt pressure surges. Air vacuum and air release valves must be equipped with isolation valves and be installed in vaults. Discharge from all air valves must be plumbed to the surface. Washington State DOH regulations for cross connections do not allow discharge into the vault. On large pipelines, open air stand pipes are sometimes used in lieu of a combination valve.

B. Bypass Requirements

Bypass assemblies are used on larger valves to ease valve opening. When a line has been closed, and one side of the pipeline drained, pressure on the valve becomes unbalanced making it very difficult to open the valve. A bypass line allows water to backfill the unpressurized side of the valve, which equalizes pressure on the valve allowing it to open more easily. Bypass assemblies also allow the operator to fill an empty pipe more precisely. Bypass assemblies must be installed on all valves 16-inches and larger in diameter. A typical bypass assembly is included in the standard line valve vault detail. Typically, SPU will use a hydrant or an adjacent active line with a PRV and temporary piping to do this. See Figure 5-5 Typical Layout of a 16-inch or Larger Line Valve.

C. Valve Turns

The number of turns to close a valve is very important. Rapidly closing a valve can create a surge pressure wave in the pipeline and damage the line and appurtenances. See Standard Specification 9-30.3(4).

D. Valve Spacing and Location

Line valves are to be located at grid junctions in the distribution system, such that each of the converging main segments can be independently isolated. Additional intermediate valves may be required between grid connections, such that any single shutdown segment will be no more than one block (approximately 300 to 500 feet) in length within commercial/multi-family residence zones.

On primary distribution mains and feeder mains larger than 12 inches in diameter, valves are to be located where these mains intersect with other mains larger than 12 inches, such that each of the converging large diameter main segments can be independently isolated. Additional intermediate valves may be required between large diameter pipe junctions, such that any shutdown segment of a main larger than 12 inches in diameter will be no more than 1,300 feet in length. The actual number and positioning of intermediate line valves on a main larger than 12 inches in diameter is to be guided by an analysis of secondary outage impacts associated with the isolation of individual segments of mains larger than 12 inches in diameter. As a general guideline, the total outage area resulting from the isolation of any one main segment including all of its subordinate dead-end systems (if any), should include no more than 130 accounts or 20 fire hydrants or 200 gpm of average daily consumption. Placement of line valves

will typically be at the margins of the street intersection that contains a grid junction and also intermediate line valves at street margin of the desired location.

E. Clearances

Clearances around a valve are very important to operations and maintenance of the valve. When placing a valve in a vault, the design engineer should ensure that maintenance staff will have access to all valve parts for maintenance and enough space for wrenches and other tools. Typically, a minimum of 1-foot space is needed around all valves. SPU prefers a 3-foot space.

F. Valve Restraint Systems

All valves in chambers and those installed on a restrained joint pipe should be fully restrained. There are several options for restraining valves, including flanges and a mechanical joint with a wedge restraint gland. The system chosen should be consistent with other SPU designs and consistent across the project.

G. Valve Replacement

The design engineer should pay close attention to removal of the valve. Valves 16-inch and larger should have an access hatch directly over the valve, adequately sized to remove the valve.

Another consideration for valve removal is a dismantling joint. When flanged valves are installed, the pipeline is extremely tight. If the valve needs to be replaced, unbolting it may not provide sufficient space to slide the valve out. A dismantling joint has a special sleeve that can be retracted a few inches. This allows enough extra space to remove the valve. The dismantling joint also provides some adjustment if a different brand or style of valve is installed in the future. SPU standard practice is to install a dismantling joint on valves 16-inch and larger in diameter.

5.6.4.2 Access Ports

SPU installs access ports only on large-diameter (24" or greater) pipelines.

Access ports provide access during construction and to Field Operations and Maintenance staff. Typical access port sizes are 24-inches in diameter. Typical spacing for a large transmission main is 1,200 feet except in low areas subject to high groundwater tables. Because access ports typically only extend 1 to 2 feet above the pipeline surface, they can be buried or encased in a maintenance hole that extends to the surface. If the access port is fully buried, it should be well documented on the record drawing (as-built) so future O&M staff can find it. If possible, a waterline marker should be installed over the access port.

SPU typically installs all access ports vertically. In certain cases, a side-mounted access port may be necessary given space restrictions. See the DSG standard access port details (**Appendix A**).

5.6.4.3 Air Gap Structures

Air gaps, also known as goosenecks, are required to prevent cross connections between the domestic water supply and any other liquid. The ultimate function of this air gap is similar to that of a check valve. Typically, air gap structures are located on facilities (e.g. tanks) or equipment (e.g. pumps) connected to the system. The gooseneck discharge must be a minimum of two discharge pipe diameters aboveground or receiving water surface. Floodwater surface

levels may need to be considered when designing air gap height. Air gaps are usually found at the end of the discharge line on pipeline and tank blow-offs.

5.6.4.4 Blow-offs

Blow-offs are outlets located at low points in a pipeline profile. They consist of a tangential outlet off the bottom of the pipeline with an isolation valve and riser located in an access vault opening to grade. Blow-off valves are used when pipelines need to be drained or flushed for repairs. Drain rates are limited by the receiving utility or water body. A tap to add sodium thiosulfate or ascorbic acid for dechlorinating water can be provided at the blow-off, but is not common.

All blow-off outlets must have an air gap between the pipeline discharge point and the ground (or surface water elevation of the receiving body) equal in length to a minimum of two discharge pipe diameters. See example plans in the Virtual Vault 776-227 and 776-203. Both show examples with sacrificial throttling valves. Example plan 776-203 also shows a pipeline-to-pipeline pumping connection.

For detail on design of small blow-off valves, see Standard Specification 7-10.2(11) and Standard Details 340a and 340b.

Fire hydrants can also be used as blow-offs on dead-end mains.

5.6.4.5 Flow Meters

Flow meter selection is covered in more detail in *DSG Chapter 10, Instrumentation & Control.* When selecting a flow meter, make sure to follow the upstream and downstream clearances requested by the manufacturer. In general, there should be smooth straight pipe (no appurtenances, bends, fittings, etc) for the equivalent length of 10 pipe diameters upstream of the meter and the equivalent length of 5 pipe diameters downstream.

5.6.4.6 Fire Hydrants

Fire hydrant installations must be in accordance with the Standard Specification 7-14 and Standard Plans 310a, 310b, 311a, 311b, 312, 313, and 314.

Hydrants must be located in areas that are accessible and approved by the Seattle Fire Department or other fire departments with jurisdiction.

5.6.5 Rehabilitation of Existing Mains

SPU rehabilitates existing water distribution main either through slip-lining the pipe or re-lining the large diameter pipe. Additionally, cathodic protection can be used to prevent further corrosion of the buried exterior. For detailed information on cathodic protection, see *DSG Chapter 6.*

5.6.5.1 Slip-lining

In slip-lining, a pipe of smaller diameter is installed within the original larger pipe. Usually slip-lining is performed on distribution or feeder main pipes 30-inches or larger in diameter. The existing pipe becomes the casing for the new pipe. It is often a cost-effective no-dig alternative to traditional open-cut installation of pipe. Typically, slip-lining is used as a structural repair. However, it cannot be used if there is substantial damage (crushed or misaligned joints) to the

pipe. The annular space between the two pipes is sometimes filled with grout. The design engineer should carefully consider the hydraulic implications of reducing the pipeline diameter.

5.6.5.2 Relining

If video inspection of the pipeline interior shows significant deterioration of the lining, relining of the pipe may be possible. Pipes are relined by thoroughly cleaning the existing pipe interior then using a machine to spray-coat new cement mortar lining inside the pipe. The method used depends on pipe size. The relining can be designed to strengthen the pipe through use of a structural mesh embedded in the spray-coated cement mortar lining.

5.6.5.3 Cathodic Protection

Cathodic protection is one method SPU uses to rehabilitate existing water pipelines. For more detail on cathodic protection for distribution and feeder mains, see DSG section 5.6.8 and *DSG Chapter 6, Cathodic Protection.*

5.6.6 Emergency Pump Connections

In some emergencies, a connection between two nearby pipelines may be needed. If the pipelines operate in different pressure zones, then a pump may be needed between the two lines. If possible, use an existing interconnection. If no inter-connecting pipe structure is available, SPU recommends using a nearby blow-off location and installing a pump between the two pipelines.

5.6.7 SCADA

See *DSG Chapter 10, Instrumentation & Control*, for SCADA system design. The design engineer should consider whether any monitoring or controls are needed and if the controls should be linked to the system wide SCADA system.

5.6.8 Corrosion Control

Corrosion control of SPU pipelines comes from both active and passive protection systems. Bare metal steel or ductile iron pipe will rust when exposed to corrosive soils or water if no protection system is installed. The rate of corrosion depends on the corrosivity of the environment (typically soil or water). The rate of corrosion is mostly a function of how well the environment conducts electrical current.

Resistivity plays a key role in corrosion control of pipelines. Resistivity refers to the resistance of the environment to promote electrical current flow. When the resistivity of water or soil is high, less current can flow through that environment and the rate of corrosion is lower. For internal corrosion (inside of pipes), water resistivity is constant. For external corrosion (exterior surfaces of pipes), soil resistivity is highly variable. SPU GIS maps show the results of tests taken to date for soil resistivity. SPU staff can test for specific areas for soil resistivity.

The internal corrosion of pipes is managed through a combination of water chemistry adjustments and the use of internal linings..

SPU controls external (on the soil-pipe interface) corrosion through one of three methods:

1. Testing the soil environment for resistivity

2. Applying external bonded coatings or polyethylene film encasements (unbonded film)
3. Using a cathodic protection system

See *DSG Chapter 6, Cathodic Protection*, for detailed discussion of that protection method.

5.6.8.1 Soil Resistivity

Resistivity refers to the resistance of the environment to promote electrical current flow. It is the inverse unit measurement used to determine conductivity/corrosiveness of the internal or external environment in contact with the pipe surfaces. By selecting appropriate backfill (soil) or modifying chemical properties of the water being carried within the pipe, resistivity can be adjusted. When resistivity is adjusted, the corrosion rate on pipe surfaces is reduced. See *DSG Chapter 6, Cathodic Protection*, Tables 6-9, 6-10, and 6-11.

For the soil pipe interface, adjusting soil resistivity is usually neither possible nor practical. Providing select backfill has a short-term effect. Over time, constituents in the soil surrounding the pipe will degrade the backfill and resistivity will approach that of the surrounding material.

Soil corrosivity is based on resistivity measurements of the soil in the pipeline location. Typically, several measurements are taken and an average value is determined. Where soils are very near a classification break point, engineering judgment is required to classify the soil (Table 5-6). Where resistivity tests in one area vary, greater weight is given to the lower values found.

Table 5-6 Corrosion Protection Requirements for Water Piping Systems*

Soil Resistivity (ohm/cm)	Soil Corrosivity Classification
0 – 900	Severely-corrosive
901 – 3,000	Very-corrosive
3,001 – 10,000	Moderately-corrosive
10,001 – 50,000	Mildly-corrosive
> than 50,000	Non-corrosive

*Large projects may have several soil classifications and will need to accommodate each type appropriately.

Table 5-7 shows SPU requirements for water pipelines where coating is dictated by resistivity.

Table 5-7 SPU Corrosion Protection Requirements for Corrosive Soil

Soil Classification	Corrosion Protection Requirements
Severely-corrosive	approved bonded coating joint bonding - #2 AWG insulating coupling or flange kit @ connections full dielectric covering on service lines to meter setter electrolysis test station class b bedding (sand) magnesium anodes @ 18' intervals (17 lbs high potential magnesium anodes)
Very-corrosive	[same as above – except anodes are spaced @ 36' intervals]
Moderately-corrosive	[same as above – except anodes are spaced @ 100' intervals]
Mildly-corrosive	- polyethylene encasement – 8 mil - class b bedding (sand)
Non-corrosive	- no protection required unless organic or clay materials are encountered - additional soil tests may be required for proper recommendation
Notes:	

- All steel pipe must have bonded coating for all soil conditions
- Additional corrosion protection may be required where stray current is present (i.e. rail transit)
- If bonded coating cannot be provided where required, pipe can be installed bare and additional anodes supplied at SPU engineer's direction; impressed current cathodic protection may be required.

5.6.8.2 Coatings

Coating refers to products applied to the outside of pipes. Steel and ductile iron pipelines have different coating requirements. Before selecting a coating system, soil sampling (resistivity testing) should be completed to determine the corrosive nature of the soil.

A. Steel Pipe Coatings

All steel pipes must be coated. Several different coating options are available. The design engineer should use best judgment in deciding among coatings. Table 5-8 lists coating types found in the SPU water system in order of use and preference.

Table 5-8 Steel Pipe Coating Types for SPU Water System

Coating	Description
Polyurethane Coating	SPU standard for steel pipe coating. This is a thin film bonded dielectric coating with both water and chemical resistance. It is typically factory-applied and thickness is customized to a specific application. Surface preparation and curing process is very critical.
Fusion Bonded Epoxy (FBE)	FBE is typically applied at the factory on the pipe, and field applied on the joints. Applied by heating the steel pipe, then blowing epoxy in powder form on the heated pipe. Generally considered one of the most durable coatings. Typically most costly.
Paint Coatings	Paint systems work well with cathodic protection systems. Resilient and extremely abrasion resistant. Paint coatings are applied according to AWWA C210 and C218. Commonly used where there is minor damage to the existing coating or the extent of damage is small.
Heat Shrink Wrap Sleeve	Tubular sleeves that can provide effective coating protection around field-welded joints. It is field-applied. Known to be reliable and effective against thermal, chemical, and environmental attack. Economical due to ease of application and no need for primer.
Tape Coating	Most commonly specified dielectric coating systems. Has a good performance record at reasonable cost. Typical application includes 80-mil cold-applied plastic tape in three layers over a properly prepared steel surface.
Cement-mortar Coating	No longer used, but may be encountered on existing pipes. Chemically protects pipe from corrosion by providing an alkaline environment where oxidation of steel is inhibited. Can be applied in various thicknesses. Provides mechanical protection against handling and installation damage. Typical application thickness is 1 inch.
Coal-tar Enamel Coating	One of oldest methods to provide corrosion protection for steel pipelines. Coal-tar enamel is applied over a coal tar or synthetic primer. Application includes cleaning, priming, application of hot enamel, and covering of a fiberglass matte and/or felt outer wrap. Recommended application includes 7/32-inch coal tar with fiberglass reinforced mineral felt with heat-shrinkable cross-linked polyolefin sleeves at joints.

B. Ductile Iron Pipe

Due to its thickness, ductile iron pipe does not always need a coating. It generally only needs coating when soil conditions warrant. Soils should be tested to identify that need.

For ductile iron pipe, the standard factory coating is an asphaltic coating approximately 1-mm thick. This coating minimizes atmospheric oxidation, but provides no in-ground protection.

Ductile iron pipe must conform to Standard Specification 9-30.2(1).

Table 5-9 lists ductile iron pipe coating options. SPU requires a double cement mortar lining thickness for ductile iron pipe. See AWWA C104 for more detail on cement mortar linings for ductile iron pipe.

Table 5-9 Ductile Iron Pipe Coating Types for SPU Water System

Coating	SPU Preference
Thermoplastic Powder Coating	SPU standard coating for ductile iron (DI) pipe in a corrosive environment. See Standard Spec 9-30.1(6)C. Can also be used on steel pipe.
Wax Tape system	When used with appropriate primer and a fiber reinforced outer wrap, this coating can protect any buried metal surface, bolts, nuts, rods, copper, ductile, steel, etc.
Polyethylene film encasement (un-bonded film)	Common application for corrosion control. Acts as an environmental barrier to prevent direct contact between pipe and corrosive soils. Not watertight; groundwater can seep beneath the wrap. Integrity depends on proper installation, careful handling by contractor, and inspection by owner. Polyethylene encasement must be per Standard Spec 9-30.1(6) D. SPU has limited success using this product.
Fusion-Bonded Epoxy, Polyurethane, and Tape Coatings	Can be considered as an alternative coating system. Manufacturer has been unwilling to apply bonded coating at factory. Design engineer should recognize potential invalidation of pipe warranty if this is field applied.

C. Linings

Lining refers to a product used to protect the inside of a pipe from corrosion and improve performance and service life. SPU requires a lining for all pipelines. All linings must be National Sanitation Foundation (NSF) 61-approved.

Ductile iron pipe is typically supplied with a double thickness Portland cement-mortar lining unless otherwise specified. See Standard Specification 9-30.1(1).

Welded steel pipe is furnished with two primary lining options: cement-mortar or polyurethane. Cement mortar is a nominal thickness of ¼- to ½-inch. For interior linings, polyurethane thickness is typically around 20-mils. See Standard Specification 9-30.1(1).

D. Cathodic Protection

Cathodic protection is a means of providing a sacrificial material to become the point where corrosion occurs.

For a pipeline, cathodic protection provides a separate metal known as a sacrificial anode to be the point where corrosion occurs. This anode protects the pipeline from corrosion. By use of either an impressed current rectifier or materials that are galvanically active (zinc or magnesium), the pipeline becomes the cathode and corrosion is transferred to the anode.

See DSG Chapter 6, Cathodic Protection, for standards for cathodic protection systems.

E. Environmental Modifications

SPU employs corrosion control techniques such as modifying the pH at its water treatment plants to reduce internal corrosion of water pipelines. This practice is controlled by federal regulation under the Safe Drinking Water Act and EPA's Lead and Copper Rule and is a water quality operational methodology beyond the scope of this DSG.

Other engineering practices such as selecting less corrosive soils for pipelines are design considerations for corrosion control.

5.7 WATER SERVICE CONNECTIONS

For standards and guidelines for water service connections, see *DSG Chapter 17, Water Service Connections.*

5.8 TRANSMISSION MAIN DESIGN

This section describes transmission main design. Transmission mains are major (16- to 64-inch diameter) pipelines within the SPU water system. They convey or transport water from a source to a reservoir and typically do not have any service connections. This section covers the types of materials used, appurtenances, and restraint systems used in transmission main design. For detailed information on water storage tanks, standpipes and reservoir design, see DSG section 5.9.

This section of the DSG frequently directs the user to DSG section 5.6, Distribution Main Design. Many of the elements of transmission main design are identical to those for distribution mains.

5.8.1 Modeling and Main Sizing

See DSG section 5.6.1 for distribution mains. SPU's contracts with its wholesale customers specify the minimum hydraulic gradient or head at each wholesale service connection. The newer wholesale service contracts also specify the maximum flow rate at a given hydraulic gradient that would be provided for each service connection. Any modification to the transmission system should consider these hydraulic criteria. While these hydraulic criteria may be modified if beneficial to the regional system, SPU may make these modifications only once during any 15 year period provided that 4 years advance written notice is given. At a minimum, transmission mains must be sized to maintain a pressure of 5 psi or more, unless the mains are directly adjacent to the storage tanks.

5.8.2 Location

SPU transmission mains are primarily located in the right-of-way (ROW). However, their design is based on least conflict with other utilities and cost of easements. SPU transmission mains within Seattle are not moved for other utilities. Outside of Seattle, SPU generally owns the transmission pipeline ROWs and mains are typically not moved. An exception is some holdings that belong to WSDOT.

5.8.2.1 Separation from Other Utilities

See DSG section 5.6.2.1.

5.8.2.2 Geotechnical Report

With a new or major refurbishment to transmission main, a geotechnical engineering study must be done for the proposed route (alignment) and documented in a geotechnical report. Consult the SPU Materials Lab for recommendations on what the report should cover. The Materials Lab geotechnical staff must review findings on all projects, even when an outside consultant completes the geotechnical evaluation.

5.8.3 Materials

Transmission mains must be designed to withstand internal working pressure, external loads, and transient pressures. Design should minimize the use of pump stations.

5.8.3.1 Minimum Pipe Size

Transmission mains must be sized to carry the designed peak flow required including fire flow without exceeding the design velocities or head losses.

5.8.3.2 Material Types

A. Pipe

Water transmission mains are typically constructed of steel or class 52 ductile iron. Both ductile iron pipes and steel pipes are to be cement mortar lined in most instances. For more detail on materials for water transmission mains, see Standard Specification 9-30.

Note: ductile iron pipe is only manufactured up to 48-inch diameter. SPU does not use pre-stressed concrete cylinder. Large diameter steel pipe (>48-inches), fittings, and structures housing valves and appurtenances should be designed or overseen by a licensed engineer.

See DSG section 5.6.7.

B. Casing

See DSG section 5.6.3.7.

5.8.3.3 Pipe Cover

Transmission mains are subject to special pipe strength design considerations and analysis by the design engineer. The minimum depth of cover for water transmission mains is given in the contract for each project. Use AWWA M11 or other applicable design manual to meet the requirements of the project. SPU typically buries transmission mains with 4 feet of cover to allow smaller utilities to cross over the pipeline and to reduce live-load on the pipe.

5.8.3.4 Bedding and Backfill

See DSG section 5.6.3.4.

A. Standard Trench Section

For detail on a standard trench section, see Standard Plan 350.

B. Controlled Density Fill

See DSG section 5.6.3.4B.

5.8.3.5 Line Pressure

Pipelines must be designed to withstand the required internal working pressure, external loads, and transient pressures.

A. Standard Conditions

Transmission lines do not have a typical operating pressure, but rather operate at the pressures required by the system. The design engineer should review the modeling results to determine the maximum operating pressure in the pipeline and design the pipeline system for that pressure. Transmission mains must not be designed for less than 100 psig. In cases where there is an extreme pressure differential (e.g. downhill pipeline) it may be necessary to change pressure capacity of the pipeline along the pipeline route.

B. Transient Conditions

Transient pressures result from sudden velocity changes in the water flowing through a pipeline. These transient (or surge) pressures can propagate from closing a valve rapidly, an electrical power failure at a pumping facility that causes a sudden pump shut down, large or abrupt fluctuations in water demand from major users along the pipeline, or a sudden release of entrapped air from the pipeline. Methods to control transient pressures are standpipes, surge tanks, pressurized tanks, surge anticipator valves, vacuum relief valves, regulated air release valves, and optimizing main size and alignment. Valve operator speed controls can also mitigate valve-related surge events.

Each pipeline material has a standard allowance for surge conditions (typically at 1.5 times the pipeline design pressure for steel or 100 psig for ductile iron). The design engineer should consult AWWA Manuals to determine pipeline surge allowance. Those allowances should then be compared with the maximum surge pressure from the modeling results to ensure the pipeline can withstand the surge pressure. In the SPU water system, surges of 100 to 150 psig have occurred, particularly in commercial and industrial areas.

5.8.3.6 Pipe Supports

Transmission lines should rarely be allowed to run aboveground. If that occurs, the design mechanical engineer should evaluate temperature differences between the pipe and atmosphere that will affect expansion and contraction at the joints. The issue should be addressed either through HVAC temperature controls, pipe insulation, or design pipe supports to allow movement.

5.8.3.7 Casing

See DSG section 5.6.3.7.

5.8.3.8 Trenchless Technology

Trenchless technologies such as bore and jacking, micro-tunneling, horizontal directional drilling, and pipe ramming are alternative methods of construction to the more typical cut-and-cover. Typically, trenchless technology is considered to avoid environmental or construction impacts. Before considering trenchless technologies, the design engineer should rule out alternatives.

Every trenchless project is unique and requires custom evaluation and analysis. Items to consider include topography, soil conditions, regulatory issues, and site constraints.

A. Bore and Jacking

Bore and jack installation (also called horizontal auger boring) consists of installing a casing by jacking and concurrently auguring the soils out through the casing. Alignment is fairly accurate with bore and jacking. However, there can be potential problems with high ground water and excessive lengths. Once the casing pipe is installed, the carrier pipe is installed with spacers to support the pipe. The gap can be filled, typically with blown sand or a non-shrink grout.

B. Micro-tunneling

Micro-tunneling is typically a closed-face pipe jacking process. Micro-tunneling requires both launching and receiving shafts, which are typically constructed out of slurry walls. Micro-tunneling machines are laser controlled remotely from the surface. Micro-tunneling installs a casing pipe, and then a carrier pipe is installed. Because this process allows precise grade control, it is frequently used in water and sewer applications.

C. Horizontal Directional Drilling

Horizontal directional drilling (HDD) consists of drilling progressively larger diameters from ground surface to ground surface in an arch under the obstruction. No shafts are constructed with HDD construction. Typically, the first pass of a drilling operation creates the route. The pipeline route is then increased in diameter by forward and back reaming the drill path. The hole is kept open with drilling fluids, typically a bentonite slurry. During drilling, various methods are used to track the drill bit and determine the route. Recent history has shown HDD pipeline installation to be relatively accurate. Once the desired diameter is achieved, the carrier pipe is pulled through the drilled path. No casing pipe is used in HDD applications.

D. Pipe Ramming

Pipe ramming consists of using a hydraulic hammer to push the pipe through the soil. Once the casing pipe is installed, the center channel is removed, typically by an auger method or compressed air. With small diameters, the carrier pipe may be rammed with a closed end. Frictional forces can limit the overall length of the pipe ramming, and there is no line or grade control.

5.8.3.9 Restraint Systems

See DSG section 5.6.3.9.

5.8.3.10 Vaults

See DSG section 5.6.3.11.

5.8.3.11 Appurtenances

Pipeline appurtenances, such as line valves, access ports, blow-off/drains, or air release/air vacuum valves should be provided along the pipeline as needed to support the transmission main function and operation. Appurtenance locations should be determined to avoid conflicts

with other structures, vehicular traffic, existing utilities, and locations vulnerable to damage or vandalism. See DSG section 5.6.3.12.

5.8.3.12 Line Valves

Each transmission main project should examine the proposed route for the best location of isolation line valves. Consideration should be given to future operational issues such as draining the pipeline and isolating a mainline break. SPU recommends placing isolation valves at least every 2,000 ft and at every intertie location. All line valves should be installed within a vault per the standard line valve vault detail in the DSG (see Figure 5-5 in section 5.6.3.11).

5.8.4 Seismic Design

This section describes seismic requirements for water system design.

5.8.4.1 Critical Needs Assessment

The purpose of a critical needs assessment is to establish design requirements to provide for the highest level achievable for continuity of service, i.e. for the transmission pipeline to function within its design limits with as little service interruption as possible. A critical needs assessment of the proposed new or refurbished transmission main and associated facilities should be completed as part of the basis of design. From the critical needs assessment, design criteria should be clearly established for the following:

- Design operational life of the transmission main.
- Maximum length of time that the transmission main can be out of service for repairs or maintenance without negatively affecting the water demand requirements. Identify seasonal considerations that affect the length of time the main can be out of service.
- Redundancy of critical components or functions, such as line isolation valves.
- Accessibility for the transport of repair and maintenance equipment.
- Access to the interior of pipes, vaults, and other structures for inspections and repairs.
- Impacts from geologic events (landslides, erosion) and seismic events (ground movement), including:
  - Foundation and backfill requirements
  - Drainage and control of or protection against groundwater
  - Allowable pipe movement
  - Allowable joint leakage (if any)
  - Need for and location of seismic valves

5.8.4.2 Seismic Joints and Connections for Pipe Movement

This section describes potential design issues when SPU water pipes must cross settlement prone areas, faults, liquefaction zones, slides, or where two types of pipe with different restraint characteristics must be connected. In both cases, design must allow pipe movement.

A. Cast Iron Pipe

Much of the SPU Water System piping is non-restrained, inflexible cast iron pipe with lead joints. No matter how robust a system design may be for crossing a given fault or landslide zone, if a connection to the existing pipe is faulty it will fail when the ground moves. Either of two methods will stabilize the structure within the zone:

1. Extend flexible restrained joint pipe a significant distance beyond the fault/slide zone.
2. Install some immovable structure on the new flexible restrained pipe near its connection with the existing pipe.

B. Ductile Iron Pipe

Where smaller (≤24") diameter pipes cross movement prone areas, they are usually ductile iron. The options are:

- **Standard Flexible Restrained joint pipe with expansion fitting(s) such as a restrained telescoping sleeve**. A telescoping sleeve allows axial elongation of the piping system.
- **Restrained Ball Joint pipe with expansion fitting(s) such as a restrained telescoping sleeve**. Ball joint pipe is the most flexible and the most expensive pipe available. The balls must be encased in polyethylene bags to keep dirt out of the ball.
- **Standard Flexible Restrained joint pipe with double ball expansion joints placed where the most differential movement is expected**. Flexible Single/Double Ball Expansions Joints are discussed in DSG section 5.6.3.9.E. Currently these fittings are only available up to 48-inch diameter and one size beyond at 72 inches. The large-diameter sizes are extremely expensive.

See **Appendix C** for the allowable ductile iron deflections. In all of the options above, shorter sections of pipe with extra joints can be used to provide more pipeline flexibility.

C. Steel Pipe

Where larger (≥24") diameter pipes cross movement prone areas, they are generally steel. Steel pipe is somewhat flexible and the nature of the material allows it to yield and elongate significantly before failure. Some studies indicate that good welds can elongate 20% before failure. However, bending and buckling of the steel pipe can be a problem when the settlement trough is not smooth. Best options for steel pipes are:

- **Full penetration butt welded steel for heavier wall thickness than normal**. See DSG section 5.6.3.9B1. Steel pipe with no special fittings works well for long smooth settlement troughs. See Virtual Vault plan set 774-569 for an example of a 24-inch butt welded steel pipe with several design features included to increase seismic survivability of the system in a liquefiable zone.
- **Full penetration butt welded steel with expansion fittings**. Large-diameter steel expansion sleeves are available, but offer little expansion or deflection capability. If possible, double ball joint expansion fitting(s) should be installed if large differential ground movements are expected. Due to their current limited

range of available sizes, steel pipe size may need to be reduced in the immediate vicinity of the ball joints. See Virtual Vault plan set 785-38 for an example of an 89-inch OD steel pipe crossing a slide plane with a 48-inch double ball expansion joint.

Where fault crossings/slide planes are encountered, a double ball expansion joint should be installed right at the fault crossing as shown in Virtual Vault plan set 785-38. If this is not possible, the thickest pipe wall and strongest steel should be used, with some flexibility built in elsewhere if possible.

Design considerations such as predicted ground movement, installation cost, cost of failure, and reliability must be analyzed. It may be cheaper to install an inexpensive pipe system and replace it every 10 years than to install a system that will last 100 years. Some SPU pipelines are extremely critical and must be designed to withstand the largest expected ground movement.

5.8.4.3 Seismically Actuated Valves

Seismically actuated valves automatically close during an earthquake to prevent the uncontrolled drainage from water storage tanks due to broken downstream pipelines. Many factors must be determined for each valve installation: sensitivity, speed to close, battery life requirements, power availability, and SCADA.

The seismic actuator must be properly matched to the valve it protects.

All valves must have a manual operator for emergency operation.

5.8.5 Inter-Connection of Parallel Mains

In some cases, pipelines may be installed parallel, or a new line may be installed near an existing main. The design engineer should consider whether a connection between the two pipelines is possible and beneficial. A primary reason to consider the interconnection is draining of the pipelines. Typically, when a pipeline is drained, millions of gallons of water are wasted. Pumping from pipeline to pipeline allows for much faster draining than can normally be achieved by draining to the water system. If parallel or nearby pipelines are interconnected, water from the pipeline to be drained can be pumped into the other pipeline, thus not wasting water.

The interconnection between mains will likely require room for a pump. If possible, route an interconnection line from each pipeline into a single vault, leaving a gap for a pump and the final connecting piping. The size of the interconnection should be based on flow calculations and an acceptable amount of time to drain the line. A good location for an intertie is at the blow-off.

5.8.6 Rehabilitation of Existing Mains

See DSG section 5.6.5.

5.8.7 Emergency Pump Connections

See DSG section 5.6.6.

5.8.8 SCADA

See DSG section 5.6.7.

5.8.9 Corrosion Control

See DSG section 5.6.8.

5.9 WATER STORAGE TANKS, STANDPIPES AND RESERVOIR DESIGN

This section describes water storage facility design. Water storage facilities primarily function to provide adequate flow and pressure for all design conditions where the transmission and distribution system cannot otherwise maintain the flow or pressure required. Water storage tanks, stand pipes, and reservoirs are critical infrastructure that directly influences public health and safety. These SPU facilities must be designed and operated to prevent cross-contamination of water and degradation of water quality. For more detail on SPU reservoirs, see *DSG Chapter 13, Dam Safety*.

5.9.1 Planning

USM determines the need for a new or refurbished water storage facility. This planning includes determining the facility's general characteristics, size, location, and a timeline for service based on hydraulic modeling and demand projections. If approved by SPU management, a storage facility project is incorporated into the Capital Improvements Program (CIP) plan.

5.9.1.1 Service Life

A. Concrete Reservoirs

For new concrete water storage reservoirs, service life must meet the specific project requirements. Most water utilities use a typical service life of not less than 50 years for concrete structures. For refurbished existing concrete water storage reservoirs, the design service life will be established case-by-case based on the specific conditions and requirements for the reservoir.

B. Steel Storage Tanks

For new steel water storage tanks, most water utilities use a design life of 75 or more years, assuming that the coatings are well maintained. An economic analysis of coating and cathodic protection systems should be done to determine the most cost-effective method for preventing corrosion. For refurbished existing steel water storage tanks, design service life is established case-by-case based on specific conditions and requirements for the tank.

5.9.1.2 Hydraulic and Capacity Requirements

Generally, the size of a finished water storage facility must provide sufficient capacity to meet both domestic demands and any requirements for fire flow.

Specific capacity requirements must meet the applicable elements of the Washington State Department of Health Water System Design Manual or SPU's system reliability criteria under defined emergency scenarios, whichever is less. Storage facilities are expensive to construct,

operate and maintain, plus they increase the water age and as such should not be unnecessarily oversized.

Capacity must be established and documented by an engineering study using the following basic criteria:

- The planning horizon for demand projections must be not less than 20 years. For new facilities, the planning horizon should be 50 years or more.
- Volume should be sufficient to deliver design peak hourly demand at 30 psi to the pressure zone(s) served. This volume requirement may be reduced when the source water facilities have sufficient capacity with standby power for pumping to the reservoir and/or when another storage reservoir can be used to supplement peak demands of the zone(s). During fire flow conditions, the combination of storage and delivery system capacity must be adequate to provide water at the required flow rate and a minimum 20 psi in the main.
- To determine the emergency /standby storage component, identify the reasonable emergencies, define the duration and level of service during the emergency, then apply SPU's reliability criteria as described in the current WSP.
- Water quality impact of storage and design considerations to enable regulatory compliance throughout the life of the facility.

5.9.1.3 New or Modifications/Expansions of Existing Storage Facilities

A. General Considerations for New Facilities

The following are general considerations for planning and preliminary design of new storage facilities or for modifications, expansions of existing facilities, retirements of facilities or downsizing facilities:

- Hydraulic grade line of the water supply system
- Pressure zones served by the storage facility
- Sizes and capacities of transmission or feeder mains and, where applicable, booster pumping stations, that supply the storage facility (existing and future)
- Sizes and capacities of distribution mains in the pressure zones served by the storage facility (existing and future)
- Availability and type of discharge points for overflow and drain-down water from the storage facility
- Geotechnical and seismic characteristics
- Vehicle access for all anticipated vehicle and equipment types
- Security
- Fire services (fire flow, emergency engine fill points post-earthquake)
- Land ownership and future use by City of Seattle departments
- Environmental impacts to adjacent properties

- Multi-use site considerations (e.g. public access, recreation, memorandum of agreement addressing maintenance and use on reservoir sites and sites adjacent to reservoirs)
- Anticipated future development of adjacent properties

B. Communications Equipment

Antennas and other communications equipment can be mounted on a separate towers on the site or on a storage facility. If antennas or communications equipment are mounted on the storage facility, proposals must include structural and wind-load engineering calculations demonstrating the tank can safely accommodate the additional weight of equipment and cables. SPU Real Property is the lead for communicating with tenants and issues the permits for use of SPU property.

Calculations must factor in other equipment already installed on the tank. Equipment should be clamped to the facility rather than welded when possible, to avoid damage to interior and exterior coatings.

Note: It is extremely important to ensure that the interior coating of the tank is undamaged either by welding or by an activity that may jeopardize the interior lining or the exterior coating. The cost of such damage is significant.

C. Location of New Facilities

Location of new storage facilities should consider site features and constraints that affect the sanitary and structural integrity of the facility:

- Drainage of site and structure
- Locate storage facilities at least 50 feet from the nearest potential source of contamination
- For above-grade facilities: foundations should be at least 3 feet higher than the 100-year flood elevation
- For below-grade facilities:

At least 50% of reservoir or tank should be above highest point of groundwater table
Accessible vents and hatches should be at least 2 feet above normal ground surface. Grade should slope away from the reservoir. Access points and vents are located above the 100-year storm elevation

- Proximity to closest sanitary sewer and storm drainage mains
- Overflow route

D. Green Stormwater Infrastructure and Flow Control for New Facilities

The City of Seattle requires green stormwater infrastructure (GSI) on all new facilities. Flow control may be required. For detailed information on GSI and flow control requirements, see *DSG Chapter 8 section 8.7.8*.

5.9.1.4 Operations and Maintenance (O&M) Requirements

A. Routine Operations

At a minimum, each water storage facility must follow water supply and quality goals for operational procedures common to all facilities as shown on Table 5-10.

Table 5-10 Sample Requirements for Routine Operation of Water Storage Facilities

Parameter	Requirement	Comments
Pressure Maintenance to Zone(s) Served:	30 psi	Maintain 30 psi under peak hourly demand conditions Maintain 20 psi under fire flow conditions
Minimum	20 psi	
Drawdown and Filling	Typical draw between 8AM and 5PM Typical fill between 8PM and 5AM	Draw and fill cycles for some storage facilities may vary from this objective to meet other requirements. Note: These times are a starting point. Drawdown occurs during day and fill overnight as a general rule
Water Age (turnover rate)	3 – 5 days	Longer water ages may be acceptable for some storage facilities based on chlorine residual data, water mixing systems and ease of chemical injection
Operational Volume	As required to meet seasonal demands, pressure requirements, and water age targets	Operational volumes will vary seasonally for many of the storage facilities
Sample Collection	Easily accessible sample port enclosed in cabinet	Sampling may be required at different elevations within the tank
Supervisory Control and Monitoring	Water elevation Overflow indication Inlet and outlet metering	

B. Emergency Operations

The following are minimum design requirements for operation of water storage facilities under emergency conditions that can result in loss of power or a water quality condition that could be harmful to health:

- Maintain at least one storage cell on-line if facility has two or more storage cells. If the facility is a single cell, maintain at least 50% of the volume online
- Fill all storage cells
- Draw from at least one storage cell to meet emergency demands for at least (as required) hours
- Hydraulically isolate all storage cells from the supply and distribution system
- Complete drain-down of a storage cell as specified in the basis of design
- Inject a solution of treatment chemical
- Collect a water quality sample from an easily accessible collection point

5.9.2 Water Storage Facility Structures

The following are the primary structural functions of a water storage facility:

- Remain as water tight as achievable for the design seismic, geotechnical, and thermal conditions over its design life
- Survive the design seismic event so that its operational purpose (fill, storage, and draw of potable water) is maintained
- Maintain the sanitary integrity of the tank so that its water quality is not compromised.

The following are general design requirements for structural and material design elements of storage facilities to meet the above requirements. All elements must be evaluated and addressed to establish the basis of design for every new or refurbished storage facility.

5.9.2.1 Geotechnical and Seismic Requirements

The following are SPU standards:

1. A geotechnical study must be performed before design of any new or structurally refurbished storage facility. Soils and groundwater characteristics for each site are unique, so the geotechnical study must be tailored accordingly.
2. The methods, findings, and recommendations of the geotechnical study must be documented in a geotechnical report.
3. The structural design requirements of storage facilities must address specific seismic criteria for Essential Structures per the Seattle Building Code (SBC) and AWWA D-100.

The following are guidelines for the geotechnical report:

- Identification of previous geotechnical work for the storage facility site and the key observations and conclusions from the previous work.
- A detailed description of subsurface soils and groundwater conditions.
- Identification and descriptions of known geologic hazards, including seismic, steep slopes and landslides, erosion, and contaminated soils hazards
- Identification of locations for additional field explorations/borings, if needed.
- Conclusions and recommendations for design, including geologic hazards, seismic criteria (e.g. probabilities of peak ground acceleration), excavation and shoring, dewatering, foundation and backfill requirements, erosion and sedimentation control measures, and hazardous materials.

5.9.2.2 Structural Materials

A. Concrete Reservoirs

Two primary issues for concrete storage reservoirs must be addressed in design:

1. Corrosion of exposed reinforcing steel and corrosion caused by use of dissimilar metals, such as stainless steel ladders adjacent to mild steel, either coated or embedded.
2. Foundation failure due to settlement or leaks causing undermining of the foundation.

The low alkalinity and pH of cement materials can cause deep cracking on the interior of the facility and may expose the reinforcing steel to air and moisture, resulting in corrosion. As reinforcing steel corrodes, the integrity of the structure will weaken and eventually fail if not repaired.

Cracking in walls roofs and floors, failed expansion joints, failed water stops, are also common concerns with concrete reservoirs that should be addressed in design.

For concrete reservoirs, the following AWWA standards must be applied:

- D110 – Wire- and Strand-Wound, Circular, Pre-stressed Concrete Water Tanks
- D115 – Circular Pre-stressed Concrete Water Tanks With Circumferential Tendons.

B. Steel Tanks

The structural integrity of steel storage tanks is primarily affected by corrosion. Corrosion can attack specific portions of the tank and cause significant structural problems.

For steel tanks, the following AWWA standards must be applied:

- D100 – Welded Steel Tanks for Water Storage
- D103 – Factory-Coated Bolted Steel Tanks for Water Storage.

5.9.2.3 Coatings

For steel tanks, the following AWWA standards must be applied:

- D102– Coating Steel Water Storage Tanks

5.9.2.4 Liners

For liners and floating covers in contact with potable water, the following AWWA standards must be applied:

- D130 – Flexible-Membrane Materials for Potable Water Applications.

5.9.2.5 Corrosion Control Systems

If used for steel tanks, the following AWWA standards must be applied:

- D104– Automatically Controlled, Impressed-Current Cathodic Protection for the Interior of Steel Water Tanks.

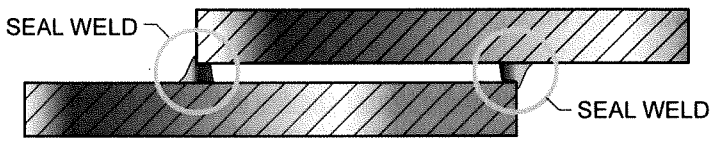
The design engineer should consult with a corrosion control specialist and evaluate the following:

- Conditions above and below the water level

- Fasteners and appurtenances located within the tank.

Surfaces exposed to fluctuating water levels and the undersides of roofs are particularly at risk, yet they receive little benefit from cathodic protection. Proper coating systems are critical for these surfaces. Do not use dissimilar materials inside the tank (e.g. steel structure and stainless steel ladders).

Seal weld all adjacent metal to avoid corrosion between the plates (see illustration).



For more detail on corrosion control systems, see *DSG Chapter 6, Cathodic Protection*.

5.9.2.6 Demolition

Demolition of other structures or buried utilities adjacent to or below a water storage facility's foundation or footings requires careful consideration to avoid damaging the foundation, footings, or yard piping associated with the facility. Before design of demolition, geotechnical and structural analyses should be done to determine potential impacts of the proposed demolition to establish a basis of design for their protection. For information on demolition permit requirements, see *DSG Chapter 2, Design for Permitting and Environmental Review*.

5.9.2.7 Configuration and Control for Service Reliability

The configuration and control for service reliability should consider the number of cells and flow control.

A. Number of Cells

To the extent practicable, new or refurbished facilities should have two or more cells to provide for greater reliability/redundancy.

If it is determined that a single cell meets the project requirements, it should be a dual outlet system. The lower outlet typically uses an earthquake/seismic valve.

B. Flow Control

The following are the minimum flow control requirements for storage facilities:

- Isolation valves on inlet and outlet lines that can be controlled locally and via SCADA
- Piping and valves to provide for the bypass and drainage of the storage cell

5.9.3 Hydraulic Mixing for Water Age and Water Quality Control

To prevent hydraulic dead zones and excessive water ages within a storage tank or reservoir, there must be a means for complete hydraulic mixing throughout the entire volume of the storage cell. The configuration and sizes of inlet and outlet pipes to the cell have a direct impact on the degree of hydraulic mixing achievable.

Each storage cell should have a volume in which water age (hydraulic detention time) is not more than 5 days at projected average water demands when the reservoir operates at full capacity. The goal is to keep total water age through the reservoir to no more than a 5-to-7-day range.

The Water Research Foundation publication, *Maintaining Water Quality in Finished Water Storage Facilities*, describes design considerations and features for controlling water quality in storage facilities.

5.9.3.1 Inlet and Outlet Pipes

Generally, a separation of the inlet and outlet points within a storage cell will enhance mixing and help avoid water quality problems associated with dead zones and short circuiting. For ground tanks, this is done by locating the inlet discharge near the perimeter of the cell with an upward bend. The tank outlets are then placed into the center of the tank floor. In elevated tanks, inlet an outlet points are separated one of two ways:

- Bring separate inlet and outlet lines up through the tank
- Split the line in the riser and use check valves to introduce water into the center of the tank near the top of the water column. In this option, the outlet pipes are placed at the tank perimeter with a vertical separation to the inlet elevation of not less than about ½ the total cell height.

Proprietary pipe and valve systems for storage facilities can be specifically designed based on the momentum mixing principle. The Red Valve Company system has gained widespread use.

For smaller tanks (less than 0.5 million gallons), the inlet and outlet may not need to be separated. Smaller tanks have smaller volumes, which allow adequate momentum for mixing.

A. Inlet Pipe

The inlet pipe should be as small as practicable to maximize inlet velocity to provide for adequate momentum mixing throughout the storage cell to preclude hydraulic short-circuiting. Reductions of inlet diameter have also been retrofitted on existing SPU tanks during tank renovation by using a reducer on the discharge end of the inlet pipe.

B. Outlet Pipe

In ground level reservoirs, each storage cell should have two outlet pipes, one near the mid-level and the other near the bottom of the cell. Both outlets should have isolation valves. The mid-level and lower outlets remain open for normal operation. The lower outlet should have a seismic valve that closes automatically during an earthquake to prevent the cell from draining past the mid-level.

5.9.3.2 Sizing Inlet Nozzles for Momentum Mixing

The inlet pipe and nozzle to each reservoir cell should be sized to provide a velocity of the entering water to enable complete hydraulic mixing throughout the entire cell. Typical time to mix the cell should be 4 to 6 hours at the designed inlet flow rate for lower-demand periods.

5.9.3.3 Mechanical Mixing Systems

If adequate momentum mixing cannot be achieved using inlet jet velocity (due to flow rates in relation to reservoir cell size), consider enhancing using a mechanical method. The following are three mechanical mixing methods:

1. **Pumped recirculation.** The only form of reservoir mixing SPU currently uses is pumped recirculation. This system features a pumped recirculation loop with the suction line from the reservoir and the discharge line entering the reservoir through a single or multiple ports.
2. **Mechanical mixers within the reservoir**
3. If higher-pressure water is available, consider a **gravity hydraulic mixing system** that pipes the higher pressure water to the tank and mixes through a series of nozzles attached to a riser pipe in the tank.

A. Recirculation

- Recirculation systems should be designed for continuous pumping. A general estimate for recirculation pump sizing is 1 hp per million gallons of storage volume.
- Provide at least two pumps for full redundancy.
- To the extent practicable, select pump sizes and types that are compatible with recirculation pumps at other reservoirs so that pumps are interchangeable and can be used as replacements or spares.
- The recirculation grid size depends on the size of the storage cell, but should extend to cover all areas of the cell. Pipe sizes for these grids are typically 4 to 6 inches in diameter.
- Orifice sizes and spacing are designed to achieve the velocities necessary for adequate localized momentum mixing. Typically, the range of velocity needed is 8 to 10 fps at the orifice discharge.
- Provide an easily accessible sample collection point on the recirculation piping.
- Provide an easily accessible chemical injection point on the recirculation piping.

5.9.4 Water Level and Flow Measurement

- Each storage cell must have provisions for online measurement and recording of water levels between lowest anticipated operating and overflow levels.
- Provide a totalizing meter on the outlet side to accurately measure demand from the reservoir.

- Provide positive online indication of overflow.

5.9.5 Mechanical Appurtenances and Equipment

This section describes mechanical appurtenances and equipment for water storage facilities.

5.9.5.1 Location

To the extent practicable, mechanical appurtenances such as valves, pumps, and controls should be located in clusters. If applicable, they should be located in mechanical rooms or vaults for ease of maintenance and security.

5.9.5.2 Penetrations to Storage Cells

Penetrations for pipes, hatches, vents, and sensors into storage cells require special design considerations to preclude the intrusion of contaminants. The following are general considerations for mechanical appurtenances and equipment that penetrate storage cells:

- Materials and coatings of appurtenances should provide for high resistance to corrosion.
- Open ends of vents and overflow lines should be oriented downward and provided with 24-mesh, corrosion resistant screens.
- Wall and roof penetrations are welded on steel tanks and equipped with seep rings on concrete reservoirs.
- Valve stem penetrations must be sealed to prevent entry of contaminants.
- Materials used at penetrations must be selected to avoid creating galvanic currents between dissimilar metals.

5.9.5.3 Vents

- Vents should be located at least 2 feet above finished grade or the 100-year flood elevation, whichever is greater.
- Vents must be sized to allow for adequate air intake during rapid drawdown of the water level such that the maximum pressure drop within the storage cell does not impose structural stresses. The acceptable maximum pressure drop is a function of structural materials and configuration of the storage cell. Acceptable maximum pressure drop must be established by a design engineer or manufacturer.

5.9.5.4 Overflows

The following are SPU standards for overflow pipes:

1. Overflow pipes must be sized to accept flow rates equal or greater to the maximum inflow rate to the storage cell.
2. Overflow pipes must terminate 1 to 2 feet but a minimum of two pipe diameters above grade to provide an air gap, and should be easily visible to O&M staff. Provide a minimum of two pipe diameters gap.

3. The surface below the air gap must slope away from the storage cell and direct the flow to a sump or catch basin from which the flow is conveyed to the designated discharge point.

The following are guidelines for overflow pipes:

- If the overflow water enters a sewer, check sewer pipe hydraulics for any constraints to accepting the design overflow rate.
- If the overflow water can enter a natural stream or pond directly from the discharge point, a passive dechlorination system should be installed. For example, a passive dechlorination system is a catch basin within which bags of a dechlorination chemical (ascorbic acid or sodium thiosulfate) are placed. The overflow water is passed through the dechlorination structure before discharge to the receiving water body.
- In addition to a screen, consider installing a flap gate or duckbill valve at the end of the overflow pipe to prevent animal access.

Note: Overflows usually go to a reservoir's dedicated storm drain line. This line must also be capable of the flow rate. The receiving water body must likewise be able to receive this flow rate.

5.9.5.5 Connections

Connections between the storage cell structure and pipes external to the structure (either exposed or buried pipes) should allow for longitudinal expansion and lateral movement that occurs during earthquakes and through long-term differential settlement. Pipes located under ground-level reservoirs should be encased in reinforced concrete to minimize future maintenance.

5.9.5.6 Hatches

The following are SPU standards for water storage hatches:

1. All access hatches not bolted to the main structure must be lockable and provide intrusion switches linked to the SCADA system.
2. Hatch lids must be designed to prevent drainage runoff from entering interior of the hatch and/or accumulating next to the hatch area. This also provides protection from ice damage. For hatches with raised curbs or frames, the lid should overlap the curb/frame.

The following are guidelines for hatches:

- For accessible ground-level hatches to concrete reservoirs, the hatch should be designed either to lock or to accommodate a 600-lb block or lid on top.
- Hatches manufactured by LW Products or Bilco have typically met SPU requirements.
- Hatches installed in graveled areas should be raised above grade to prevent gravel from becoming lodged and jammed between the frame and the lid, or becoming lodged in the locks.

5.9.5.7 Access Ladders and Catwalks

- Fall protection equipment must be provided and used before accessing structure

- Select material and coatings to provide for high resistance to corrosion and graffiti
- For above grade facilities, entries to ladders or catwalks should be elevated at least 10 feet above grade and have a lockable gate or door. The gate or door must be designed to allow for safe access from a "cherry-picker" man-lift.
- For elevated stairwells inside of storage cells, the steps should be solid plates with raised edges to help prevent dirt from entering the water.

5.9.5.8 Mechanical Rooms and Vaults

- Provide for proper interior drainage within the valve vault or chamber, including floors sloped to drains and/or sumps.
- Provide for perimeter drainage.
- Top of chamber should be at least 1 foot above finished grade.
- For access hatches and vents to valve chambers, see DSG section 5.9.5.6.

5.9.5.9 Storage Cell Drainage Equipment and Features

- Cell drain pipes must not be cross-connected to a storm or sanitary sewer line. They also need an air gap or backflow prevention device.
- The floor of a storage cell should be sloped to enable drainage to a single sump.
- If feasible, the sump should have a pipe that drains via gravity to the designated cell drain point with an air gap. The sump should be sized to accommodate a portable sump pump, even if there is no drain pipe.
- Size drain pipes to accept flow rates such that the cell can be drained in the minimum amount of time without exceeding the capacity of the vents. The maximum drain line capacity should approach the maximum operational inflow rate to the storage cell.
- Control valves for drain pipes should be easily accessible. Wherever possible, the location of drain valves should be within the valve chamber for the storage facility.
- Provide a removable mud/silt stop at the entry to the drain pipe.

A. Roof Drains

- Roofs must be water tight and sloped for drainage.
- Roof drains must be connected to a permitted drainage system.
- Roof downspouts must be external and not mounted within the storage cell. None of the drain system should be within the storage cell.
- Domestic water and stormwater must not co-mingle.
- SPU requires certain Green Stormwater Infrastructure (GSI) elements be incorporated into structural design of new projects. For more information on GSI, see *DSG Chapter 8, section 8.7.8*.

5.9.6 Standby Power

Consideration should be given to the need for dedicated standby power and in some cases standby power may be required for some types of projects/facilities for continuous operation. Alternatives to dedicated standby power may be considered by the reviewing authority with proper justification. At a minimum, a power receptacle to the switchgear is required for the connection of a portable generator. Powered equipment and controls critical for water storage facility operation should be capable of using standby power. For more detail on standby power, see *DSG Chapter 9, Electrical Design*.

5.9.7 Multi-Use Facilities

Where a storage facility is to be integrated with other recreational uses (e.g. tennis or basketball courts), grass-covered recreational areas, or parking lots special consideration should be given to physical and sanitary security issues. Storage facility design should address the following:

- Locate hatches to storage cells and valve chambers that are physically separate and secure from public areas, but visible from adjacent streets to enable observation by law enforcement or security personnel.
- Provide physical security to intrusion for hatches, tank ladders and doors to valve chambers or other enclosures.
- Provide appropriate signs that clearly indicate areas that are for authorized personnel only.
- Provide lighting fixtures and features that give the necessary level of lighting for security without negative impacts to adjacent public areas. Lighting fixtures should be designed so that the wiring and/or bulbs are not exposed or easily accessed to preclude inadvertent damage or vandalism.

Refer to the current agreement between Seattle Parks and Recreation and SPU for specific items associated with multi-use reservoir sites. Contact Kim Serwold at kim.serwold@seattle.gov.

5.9.8 Landscaping and Weed/Pest Control

For detailed information on landscaping and weed and pest control, see *DSG Chapter 4, General Design Considerations*.

5.9.9 Access and Security

For detail on site access and security, see *DSG Chapter 15, Physical Security*.

5.9.9.1 General

The following are general considerations:

- Include SPU Security Plan requirements for general security and security design requirements for water facilities.
- If the storage facility site is not open for public use, provide a means of controlled access around the entire perimeter. If the site will be open for public use, provide a means of controlled perimeter access around the hatches, vents and vaults.

- Provide security alarms at access doors or hatches tied into the SCADA system.
- To the extent practicable, do not allow site features where unauthorized persons or materials can be easily concealed, such as structures, trees, or vegetation.

5.9.9.2 Personnel Access and Safety

A. Access

The design of access features for storage facilities should address the following:

- Vehicular access to hatches and ladders is required and must be sized to accommodate the size of the vehicles normally used in maintenance or inspection of the facility.
- Ladders, stairways, and catwalks designed to conform to OSHA requirements.
- Hatches placed to facilitate ease of maintenance and cleaning.
- Hatches sized to accommodate access for personnel with tools, inspection divers, and remotely operated vehicle (ROV) inspection/cleaning equipment. For larger facilities, this requirement typically results in one or more large equipment hatches, through which field equipment can be lowered, and one or more personnel access hatches.
- Provide ladders or stairways inside of storage cells.
- Ladders should be caged and have climbing or fall protection.

B. Egress and Emergency Escape

The following are egress and emergency escape features:

- Provide internal and external restraint support/safety equipment.
- Ensure unobstructed clearances to access/egress points.
- Provide any other features necessary to meet requirements associated with confined-space entries.

5.9.9.3 O&M

A. Lighting

- Permanent lighting fixtures should be provided to light hatch doors into storage cells and vaults and to provide visibility to the local work area perimeter.
- Permanent lighting fixtures should be provided to provide a minimum acceptable level of lighting within storage cells and vaults for routine inspections and maintenance.
- Power outlets should be easily accessible to all hatches for the operation of temporary lights within storage cells and vaults.
- Convenience outlets should within 6 feet of all mechanical equipment.

B. Ventilation

- Hatches to storage cells and vaults should be located to accommodate temporary ventilation equipment, including points for the introduction and exhaust of ventilation air.
- To the extent practicable, power outlets should be easily accessible to all hatches to better enable the operation of temporary ventilation equipment.
- Permanent ventilation system should be capable of eight exchanges per hour at all times.

C. Communication System

- Determine the methods of communication to be used by personnel during facility maintenance (e.g. radio, wire intercom) and provide appropriate equipment or appurtenances for their use.
- At a minimum, provisions for antenna mounts are one mount for every two communications lines. If there is only one communications line, then one mount is needed. Locations of the mounts are site specific. Roundup spare conduits for future installation should be considered.

5.9.10 Water Quality Monitoring/Sampling

At a minimum, water quality should be monitored weekly in open storage reservoirs. For closed reservoirs, water quality should be monitored every 2 weeks. At chlorine injection locations, remote monitoring should continuous. The following should be continually monitored:

- Chlorine residual
- pH
- Temperature
- Total coliform (TC)
- Heterotrophic Plate Count (HPC)

Other parameters may be measured case-by-case, depending on operational circumstances.

5.9.10.1 Sampling Points

At a minimum, design must provide sample points for withdrawal of water for continuous online measurement of chlorine residual, pH, and temperature at the following locations:

- Inlet to each storage cell
- Outlet from each storage cell

Provide sample ports from which to obtain manual grab samples for any type of analyses at the following locations:

- Inlet to the storage cell
- Outlet from the storage cell
- From varying depths of the storage cell, at a minimum from the top (75% level), middle (50% level), and bottom (20% level) of the cell

- If possible, in the center of the storage cell. (Center point sample line installation may require adding a small support structure to keep the lines from breaking.) The in-tank sample lines can be used to collect coliform samples after tank disinfection.
- If the extent of the horizontal footprint of the storage cell is large relative to the vertical height, add one or two additional locations across the cell in addition to the center point.

Sample ports should be easily accessible without the need to open hatches to the storage cell. Where practicable, the pipes from all sample ports should terminate at a single sampling station within a lockable cabinet at or near ground level outside the storage cell or within the valve chamber.

5.9.11 Disinfection and Dechlorination

SPU uses portable ascorbic acid dechlorination units for all dechlorination operations. The drain-down pipe from each storage cell must have a liquid chemical injection station for direct injection of ascorbic acid.

5.9.11.1 Booster Disinfection

Historically, SPU water storage facilities have received booster disinfection (chlorination). Booster chlorination may need to be considered for some existing storage facility sites should chlorine residual maintenance become a problem or a potential problem. Booster chlorination should be incorporated for new storage facilities located near the periphery of the distribution system where water demands may be initially low.

The following are major design considerations for booster chlorination at storage facilities:

- Footprint space for the chlorination storage and feed system facility
- Access and security for the chlorination facility
- Injection point(s) for the chlorine
- Post-treatment chlorine residual monitoring equipment and sampling points
- Point of diversion of potable water for the chlorine feed system
- Type of chlorination system: liquid commercial strength (12.5%) hypochlorite or on-site generation of hypochlorite. Gaseous chlorination systems must not be used.

5.9.11.2 Emergency Disinfection

Regardless of whether provisions are installed for booster chlorination, provide for facilities to apply emergency chlorination to each storage cell, to include the following:

- Hatches on top of each storage cell that can be used to introduce chlorine
- Sample withdrawal points from within the storage cell and on the outlet of the cell to measure chlorine residua.
- Minimum of two valves between the storage cell and the distribution system that can be closed during disinfection

5.9.12 Removal from Service

The following are key design features for the isolation and removal from service:

- Isolation valves on inlet and outlet lines
- Piping and valves to provide for bypass of the storage cell

5.9.12.1 Drain-Down Features

Note: This section was not completed for the 2010 edition of the DSG.

5.9.12.2 Drain-Down Discharge Points

A. Sewers

To the extent practicable, the discharge point for drain-down water should be the same point used for overflow water discharge. Whenever possible, the point of discharge should be a sanitary or combined sewer because dechlorination of the drain-down water is not required. If neither a sanitary or combined sewer is available, a storm sewer may be used, but dechlorination is required.

The maximum allowable drain-down water discharge rate to sewers should be based on the following:

- The hydraulics and sizes of the receiving sewer mains must be checked for any constraints and the maximum allowable dry-weather sewer capacity established.
- The acceptable minimum rate of discharge that meets operational requirements. If the operational minimum exceeds the maximum allowable dry-weather sewer capacity, the local sewer system may need to be modified, such as increase main sizes, re-lay mains to steeper grades, and/or add mains.
- The discharge flow rate design criteria must clearly establish the operational limits for the design flows, e.g. drain-down operations are limited to dry-weather conditions to preclude sewer surcharging, etc.

B. Open Water Bodies

The discharge of drain-down water to an open water body such as a lake, pond, stream, or salt water, should be avoided to the extent practicable and only if there are no sewers available or suitable for receiving the discharge. Provisions for dechlorination must be made with guidance from the SPU Water Quality Lab on a project-by-project basis. Some standard methods such as for hydrant testing are available but they are subject to change. To get the most current methods contact the SPU Water Quality Lab.

The rate of discharge to an open water body is highly case-specific. Discharge flow rates to streams will typically be the most limited to preclude scouring and sediment mobilization. It should be assumed that a permit will be necessary for stream discharges, such as a Hydraulic Project Approval (HPA) and/or an NPDES Water Treatment Plant General Permit. Therefore, the permits required must be determined before design. The specific requirements of the permit(s) are the basis for the maximum allowable design discharge rate.

For more detail on permits, see *DSG Chapter 2, Design Considerations for Permitting.*

5.9.12.3 Washdown Equipment

The following are SPU standards for washdown equipment:

1. The source of water to hose bibs must be potable water from the distribution system.
2. The washdown water piping system must be separated from the distribution system with an approved backflow prevention device.

The following are guidelines for washdown equipment:

- Provide hose bibs or washdown system connections at or near access hatches used for maintenance to each storage cell. Hoses may be permanently stored at or near a hose bib, depending on maintenance and security requirements. However, washdown hoses should never remain permanently attached to the bib to avoid the potential for cross connections. Bibs and hoses should have quick-disconnect fittings for ease of maintenance.
- For larger facilities, provide washdown hose connections in a pattern such that any part of the facility can be washed using a 100-foot-long hose.

5.10 CONSTRUCTION

The section describes design considerations for construction of water system infrastructure.

5.10.1 Requirements for Protecting Water Mains and Appurtenances

Any work on, connecting to, or near existing water mains must monitor and take steps to reduce construction impacts.

5.10.1.1 Conditions Requiring Protection and Protective Measures

Projects that involve roadway construction or repaving, utilities construction, or deep excavations for structures often create conditions that can affect existing water mains (Table 5-11). Pipe with lead joints, particularly bell and spigot joints in older mains, is susceptible to leaking and at high risk of failure if exposed to these activities.

Table 5-11 Common Construction Conditions and Protection Measures for Water Mains

Condition	Occurs When and Where	Pipe Protection Measure
Excessive loads	Haul routes for heavy construction equipment crossing over pipes Construction site entrances/exits Paving construction where excavations have reduced the cover over pipes	Steel plates in roadway Concrete pad Temporary cribbing Bridging Pipe relocation
Settlement	Dewatering of soils with higher water content around or adjacent to pipes Trench excavations adjacent to water pipes, e.g. excavations for sewer mains or duct banks that result in soil loss Tunneling and other large open excavations	Temporary pipe supports Shoring of adjacent deeper trenches, as applicable Use drilling methods for the installation of shafts / columns instead of vibratory methods to the extent practicable

	Excavations for other utilities below water pipes Vibration from construction equipment, e.g. driven piles, sheet piles, or stone columns Excessive loads Landslides	Establish clear tolerances for acceptable pipe settlement and provide field monitoring for settlement
Thrust restraint	Excavations behind thrust blocks (loss of bearing surface behind the thrust block) Excavation and exposure of water pipes that are under pressure (loss of pipe surface friction component of thrust restraint)	Locate thrust blocks prior to construction Avoid disturbing thrust blocks to extent practicable Use temporary thrust blocks or collars Avoid exposing pipes that are under pressure Avoid placement where future excavation may occur behind the thrust block. The clear area behind the thrust block should be determined with the consultation of a geotechnical engineer.
Contamination	Exposed water pipe joints w/in trench excavations that can fill w/ runoff or ground seepage water, particularly if main is depressurized Exposed water pipe joints within common trench excavations that have an active sewer main, particularly if water main is depressurized	Control runoff water to trench Sump pumps

5.10.1.2 Settlement

The water system must be protected from vibration and settlement to achieve its full, expected life. Vibration and settlement can cause joints to pull apart and leak or pipes to crack and catastrophically fail. Vibrations and settlement also reduce the flexibility of pipe joints, which can allow ground movement during an earthquake.

A. Monitoring and Protection

When a large project such as building construction, deep excavation, or tunneling takes place near the water system, SPU's main concerns are vibration and settlement of water mains. Any time a large project of this type is planned near an SPU facility, the design engineer should consider requiring settlement monitoring devices be installed on the facility before construction.

Various types of pipe have differing thresholds for both vibration and settlement. Cast iron lead joint pipes have the most stringent protection requirements. Some larger cast iron mains have virtually no allowable settlement.

See **Appendices B and C**, respectively, for standard requirements for settlement monitoring of cast iron and ductile iron pipe.

During construction, anytime a design engineer suspects settlement impacts near existing water mains, it should be brought to the attention of the Resident Engineer.

B. Liquefaction Zones

Allowable settlements should also consider liquefaction and landslide zones. Settlement from construction is more critical in liquefaction or environmentally critical areas (ECAs), where settlement has a higher potential. Within these zones, SPU has set strict limits. Only 50% of the settlement/deflection is allowed in liquefaction or ECA zones as compared with other locations.

C. Mitigation of Damaged Water Mains

When vibration monitoring is required, SPU will perform a pre- and post-construction acoustic leak survey of the existing water lines near the construction activities. If damage or leaking increases and is determined to be caused by the construction activities, the RE will send a written request to the contractor to restore damaged or destroyed property to its original condition. The contractor, not the owner or City of Seattle, must pay for and the repair or replacement of the pipe according to City Standard Specifications.

5.10.2 Removal and Abandonment of Existing Water Mains and Appurtenances

The following are SPU standards:

1. Where required for water main projects, removal of existing water mains and appurtenances must meet the requirements of Standard Specification 2-02.3(7)B.
2. All ends of abandoned water mains must be plugged. Pipes 12 inches or larger in diameter must be abandoned and filled in accordance with Standard Specification 2-02.3(5).
3. Water pipes designated on project drawings to be abandoned and filled must be filled with pumpable, flowable cement slurry that completely fills the pipe (Standard Specification 9-05.15).
4. After the record drawings (as-builts) have been incorporated into GIS, the design engineer must check that the abandoned pipe is properly shown.

5.10.2.1 Considerations for Disposal of Hazardous Materials

The design and specifications of projects that remove or abandon water facilities must identify pipes that are known to have or may have hazardous materials. The contractor needs this information to calculate the costs for special handling and disposal. The most commonly found hazardous materials in SPU's water system and considerations for their mitigation or removal are described in Table 5-12.

Table 5-12 Hazardous Materials associated with SPU Water System

Material	Prevalence in System	Mitigation/Removal
Asbestos Cement Pipe	Commonly used in water mains installed in 1940s and 50s. Uncommon now	Avoid removal and abandon in-place where possible. If removal is necessary, containment and filtration requirements must follow OSHA and WISHA
Lead Joints	Almost all joints in older cast iron pipe have lead seals. Most of SPU's distribution system is cast iron w/ lead joints and can be expected to have decades useful service if not physically disturbed	Recycled by crews for other crew work
Coal Tar-Lined and Coated Steel Pipe	SPU has coal tar coatings and or linings in the Cedar River Pipeline System as well as a few other steel pipes	If removed, disposal to a licensed hazardous waste landfill. Working and handling of coal tar materials must follow OSHA and WISHA standards.

5.10.3 Construction, Startup and Acceptance Procedures

The design and specifications of transmission and distribution water mains must address the potential impacts of construction and repair activities on the hydraulic and sanitary conditions of the water system. Such activities pose the greatest risk of microbiological contamination of new and existing water mains. Appropriate design and specification requirements are major elements to achieving hydraulic requirements and sanitary conditions after construction or repair of water mains.

See the following Standard Specifications for construction (installation), startup, and acceptance of new and repaired water mains and appurtenances:

- Section 7-11 Pipe Installation for Water Mains
- Section 7-12 Valves for Water Mains
- Section 7-14 Hydrants

For further information on design and operational practices to prevent contamination of water mains, see the Water Foundation publication, *Practices to Prevent Microbiological Contamination of Water Mains*.

5.10.3.1 Connections to City Water Mains

All connections of new or repaired water mains to the SPU water system are made by SPU Water Operations. See Standard Specification 7-11.3(9)A and Standard Plans 300a, 300b, and 300c.

5.10.3.2 Shutdown of Water Mains

Shutdown and isolation of new and existing water mains must be addressed as part of design. There are three major considerations for the shutdown and isolation of mains:

1. Provide adequate numbers of valves for the isolation of the new or repaired mains to minimize impacts to water service in the distribution grid
2. Work with SPU Water Operations to provide a means to depressurize and dewater the main for a shutdown
3. Consideration of which customers will be out of water and for how long. For customer impacts and service disruptions, see DSG section 5.10.4.

5.10.3.3 Construction and Repair Practices for Sanitary Control

The following section describes construction and repair practice for sanitary control.

A. Pre-installation Materials Storage and Handling

Proper handling and storage practices (Standard Specification 7-11.3[2]) are key elements for achieving sanitary conditions in water mains.

SPU requires a pre-installation taste and odor testing of water pipe (Standard Specification 7-11.2[2]) of non-approved pipe sources. Request a current list from the SPU Water Quality group.

B. Pipe Installation and Repairs

Controlling water and soil from entering pipes is a critical factor for achieving sanitary conditions in water mains. See Standard Specifications for sanitary control practices for water main construction and repairs:

- Section 7-11.3(2)A Handling of Pipe – General
- Section 7-11.3(5) Cleaning and Assembling Joints

5.10.3.4 Post-Construction or Repair Startup and Acceptance

A. Acceptance

After water main construction or repair, the following requirements must be met before SPU will accept the connection to the water system and place it into service:

- Hydraulic and structural integrity, as demonstrated by hydrostatic pressure testing
- Sanitary conditions, as provided by flushing, disinfection, and verified by water quality testing

B. Hydrostatic Pressure Testing

Water mains and appurtenances, including extensions from existing water mains greater than 18 feet, hydrants, and hydrant runs must meet the requirements of Standard Specification 7-11.3(11).

C. Cleaning and Flushing

After a water main installation has passed the hydrostatic pressure tests, cleaning and flushing must be completed per the requirements of Standard Specification 7-11.3(12)B.

D. Disinfection

The following Standard Specifications address water main disinfection procedures:

- Section 7-11.3(12)C Required Contact Time
- Section 7-11.3(12)D Form of Applied Chlorine
- Section 7-11.3(12)E Chlorine Dosage
- Section 7-11.3(12)F Point of Application for Liquid/Gas Disinfection
- Section 7-11.3(12)G Backflow Prevention Requirement
- Section 7-11.3(12)H Rate of Application
- Section 7-11.3(12)K Disinfection of Connections to Existing Water Systems

E. Water Quality Testing and Criteria

Following chlorine disinfection contacting, samples for bacteriological analysis must be taken per the requirements of Standard Specification 7-11.3(12) A.

All samples must meet the bacteriological criteria. If any sample does not meet the criteria, the installation must be flushed, and re-tested until acceptable bacteriological results are achieved as required by Standard Specification 7-11.3(12)M.

Post-installation taste and odor testing may also be required as described in and Standard Specification 7-11.2(3).

F. Dechlorination

Chlorinated water from the disinfection of water mains must be dechlorinated before discharge.

Depending on discharge location, water drained from pipelines before shutdown must also be dechlorinated.

Typically, SPU uses an ascorbic acid (vitamin C) injection system for dechlorination. The chlorine concentration acceptable for discharge may vary depending upon the type and point of discharge. Discharges to a combined sewer may have some chlorine residual. Discharged water that may enter the environment, either through direct discharge to the ground for infiltration or via a storm drain, should have zero chlorine residual. The design engineer should clearly establish the acceptable points of discharge and chlorine residual criteria in the contract specifications. On most projects, dechlorination of disinfection water is the contractor's responsibility.

5.10.4 Customer Impacts and Service Disruptions

The design engineer or project manager should coordinate with SPU's Communications and Customer Service Branch to determine timelines associated with water main shutdowns.

5.10.4.1 Customer Impacts

All known or potential impacts to customers associated with construction or repair of water system facilities must be identified. Community notification requirements vary depending on the following:

- Length or size of the project area
- Number of customer services impacted, including anticipated service disruptions
- Number and type of streets and street intersections in the project area
- Extent of work outside of public ROW, such as work within temporary or permanent easements
- Access to project area, including points of access, types of construction vehicles/equipment, and frequency of construction vehicle trips
- Length of time and schedule constraints of the project
- Work hours (day, night, weekends) needed to meet the project schedule and/or minimize community impacts

- Type of environmental impacts to the local community, including noise, dust, mud, and light

5.10.4.2 Service Disruptions

Service disruptions (water outages) are the impact of most concern to customers. Specific requirements for service disruptions must be established for each project. These requirements can vary depending on type of work, construction constraints, and schedule.

5.11 O&M

This section describes O&M elements common to all SPU water infrastructure. See the appropriate sections of this chapter for O&M design issues specific to the infrastructure under design consideration.

5.11.1 Water Easements

An easement gives SPU specific property rights on land that it does not own. These property rights may be temporary or permanent. Permanent rights typically include, the right to restrict activities or improvements by the land owner and gives SPU the right to install, operate, maintain, replace and have access to SPU utility infrastructure, such as pipes, fire hydrants, or valves. Easements must be project specific. Construction easements may differ from standard utility O&M easements because they are temporary and typically need a larger area. Table 5-13 lists SPU minimum width requirements for water main easements. This table is a guideline. Engineering judgment and future expansion may require larger easement areas. The size of the easement area for water infrastructure is also subject to the specifics of the site.

Note: SPU prefers to purchase property and own the land where facilities are installed. However, SPU realizes this is not always possible.

Table 5-13 SPU Minimum Water Easements

Inside Pipe Diameter or Nominal Pipe Diameter (inches)	Minimum Easement Width (feet)
<8 to 24	20
30 to 92	30

5.12 RESOURCES

Documents

1. Burlington Northern Santa Fe (BNSF) Utility Accommodation Policy, August 21, 1998
2. Burlington Northern Santa Fe (BNSF) Design Guidelines for Industrial Track Projects, October 21, 2001

3. Sound Transit Design Criteria Manual. Contact Joe Herold, joe.herold@seattle.gov or 206.386.9857
4. American Water Works Association (AWWA) Design Manuals for Water Supply Practices
5. American Water Works Association (AWWA) Pipe Materials Selection Manual
6. American Water Works Association (AWWA) Potential Techniques for the Assessment of Joints in Water Distribution Systems
7. American Water Works Association (AWWA) Maintaining Water Quality in Finished Water Storage Facilities
8. American Welding Society (AWS): D1.1 Structural Welding Code, Section 3; Workmanship
9. Washington Administrative Code (WAC); Chapter 246-290, Cross-Connection Control Public Water Supplies
10. Washington State Department of Health; Division of Drinking Water; Water System Design Manual.
11. Washington State Department of Health; Pipeline Separation Design and Installation Reference Design Guide
12. Seattle Parks Department; agreement on multi-use reservoir sites. Contact Kim Serwold, kim.serwold@seattle.gov or 206.733.9340
13. Seattle Public Utilities; Water System Plan – 2007. Contact Joan Kersnar
14. Trenchless Technology: Pipeline and Utility Design, Construction, and Renewal. Najafi, Mohammad, PhD, PE. WEF Press, 2004

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SEATTLE PUBLIC UTILITIES
2013 WATER SYSTEM PLAN

C. POLICIES, PROCEDURES AND STANDARDS

APPENDIX C-3
DESIGN STANDARDS AND GUIDELINES – PLAN REVIEW

SPU Design Standards and Guidelines, Chapter 18

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Chapter 18 PLAN REVIEW

This chapter of the Design Standards and Guidelines (DSG) describes the engineering plan review function at Seattle Public Utilities (SPU). Plan review at SPU covers a wide range of activities related to the review of plans for private development and public Capital Improvement Program (CIP) projects.

Standards are shown as underlined text.

The primary audience for this chapter is plan reviewers for SPU's Project Delivery Branch in the Project Management and Engineering Division.

18.1 KEY TERMS

The abbreviations and definitions given here follow either common American usage or regulatory guidance.

18.1.1 Abbreviations

Term	Abbreviation
CIP	Capital Improvement Program
DPD	Department of Planning and Development
DR	Director's Rule
Field Ops	Field Operations
FOM	Field Operations and Maintenance Branch
GSI	Green Stormwater Infrastructure
MOA	Memorandum of Agreement
MUP	Master Use Permit
PAR	Preliminary Assessment Report
PAT	Preliminary Assessment Tool
PDB	Project Delivery Branch
PMED	Project Management and Engineering Division
PRD	Plan Review Database
SDOT	Seattle Department of Transportation
SIP	Street Improvement Plan
SMC	Seattle Municipal Code
SPU	Seattle Public Utilities
USM	Utility Systems Management Branch
WAA	Water Availability Approval
WAC	Water Availability Certificate
WAI	Water Availability Inquiry

18.2 GENERAL INFORMATION

This section describes the authority for and general organization of the plan review function within SPU.

18.2.1 Authority

For plan review of projects, SPU exercises authority granted by the Seattle Municipal Code (SMC). Director's Rules (DR) further clarify this authority. SPU has a Memorandum of Agreement (MOA) with the Department of Planning and Development (DPD) and an MOA is pending with the Seattle Department of Transportation (SDOT) to exercise this authority and review projects on behalf of SPU through various development permits and a Public Works Contract.

SPU documents roles, responsibilities and financial agreements with SDOT and DPD through Memoranda of Agreement (MOA), which are typically updated every other year. The sections of the SMC, which authorize SPU's role in plan review, are described in SPU Client Assistance Memos(CAM's). These CAM's are delineated in Table 18-8 of DSG Section 18.6.4.

The SPU Plan Reviewer staff review plans to ensure that the SMC requirements for drainage, wastewater, water, and solid waste are met in project design. SPU provides plan review to ensure:

- Protection of SPU's infrastructure and the ability to serve current and future customers.
- Assurance that development by private developers and other agencies meet the requirements of the SMC that SPU enforces and design standards to protect existing SPU infrastructure and the construction of new SPU infrastructure.
- Assurance that plans for City construction meets design standards.

18.2.2 Organization

SPU works collaboratively with other departments and government agencies to protect City of Seattle (public) infrastructure. The SPU PMED Division will often need to rely on DPD, SDOT, or other municipalities or agencies to identify and refer to SPU those projects that may impact SPU facilities. SPU interests include protecting and managing the capacity and operability of its infrastructure. DPD and SDOT (via MOA's) work on SPU's behalf to protect SPU interests on private property and in the ROW.

Other work groups within SPU also become involved with plan review to protect SPU property, infrastructure, and related interests (Table 18-1). The SPU Plan coordinator will route plans to these other groups if specific triggers are attained or specific questions arise. Additionally, these SPU groups receive plans to review from other City of Seattle departments.

Table 18-1 SPU Sections Involved with Plan Review

Organization	Involvement
SPU PMED	Conducts more complex water, drainage and wastewater plan reviews
SPU Materials Lab	May review detailed plans to assure appropriate products or materials will be used
SPU Real Property	Reviews detailed plans for projects near SPU property or easements to assure SPU interests are protected. Obtains easements if SPU facilities are proposed on private property. Coordinates with jurisdictions in which SPU facilities are located. Main SPU point of contact in the street vacation process.
SPU Customer Service	Manages relationships with SPU customers, including establishing new water services and

Organization	Involvement
Branch	billing.
SPU Solid Waste Division	Reviews detailed plans to assure new construction allows for safe access to solid waste containers by property owners, citizens, and waste disposal employees and vehicles.
SPU Survey	Reviews plans for work in the ROW to protect City property. SPU Survey may also conduct or review surveys for SPU or other City projects.
SPU Field Operations and Maintenance Branch	Reviews plans to ensure that installed improvements can be operated and maintained using standard procedures. Reviews to ensure that planned improvements will not negatively affect the ability to operate and maintain existing SPU facilities. Coordinates plans and construction by SPU crews.
SPU Utility Systems Management Branch (USM)	Advises on complex policy issues that are escalated by SPU PMED.

18.3 TYPES OF PLAN REVIEW

The SPU PMED Division is involved in four general types of plan review: private development, CIP projects, other agency projects, and property-related reviews. The degree of SPU involvement may vary greatly depending on type of permit and project specifics.

18.3.1 Private Development Projects

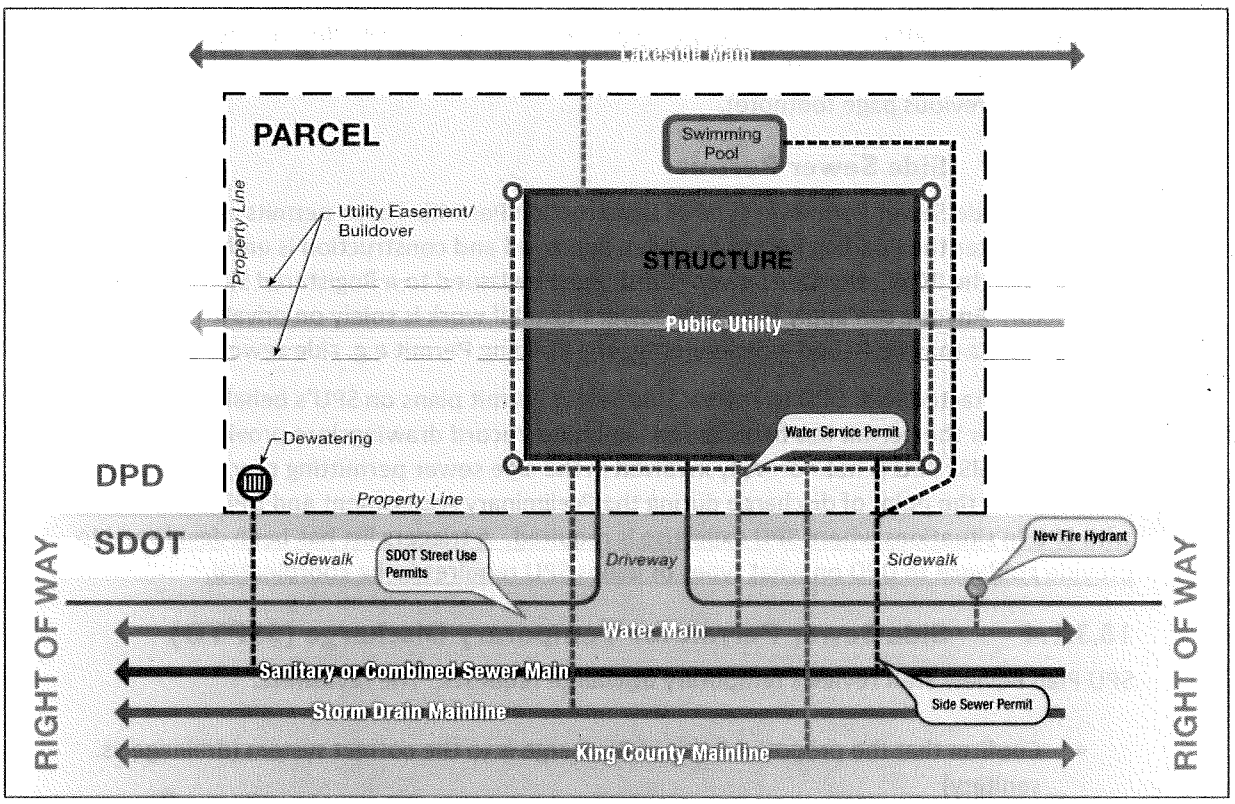
Private development refers to projects that are constructed by private parties and modify, build, or impact public water, stormwater, wastewater, or solid waste systems. The SMC regulates private development and requires development permits for most private development. Examples of private development include a new commercial building, subdivision of property, or redevelopment of a block.

City of Seattle development permitting is organized into two primary categories (Figure 18-1):

- **Parcel.** This development or redevelopment is on private property either owned by a private party or a public agency. DPD manages parcel based permitting through the Master Use, Building, and Side Sewer Permits and the plans are reviewed, approved, and inspected through the DPD permit process.
- **Right-of-Way (ROW).** This development or redevelopment is within the public ROW. SDOT manages ROW permitting through its Street Use Permit Process. Infrastructure review is managed by SDOT, however SPU Plan Review staff has an active role in the 30%, 60% and 90% design phases, as well as preliminary design guidance. ROW work can be conducted by a variety of entities including SDOT, SPU, SCL, Franchise Utilities, and private developers.

As shown on Figure 18-1, some permits may cross boundaries. For example, a Side Sewer Permit (a type of construction permit) is issued by DPD, although part of the permitted work occurs in the ROW. Similarly, permitting issues may cross boundaries because drainage or wastewater discharges from developed parcels can impact adjacent wetlands or SPU infrastructure.

Figure 18-1
Development Permit Boundaries for Plan Review



18.3.1.1 Preliminary Assessment

DPD administers a process called Preliminary Assessment, which provides private developers with a general set of requirements for their project. This is called the Preliminary Assessment Report (PAR). The PAR is completed prior to the Master Use Permit application intake (or Building Permit application, if no MUP is required) to notify developers of costly requirements that could affect their project. Each department is required to input information into an electronic tool called the Preliminary Assessment Tool (PAT).

18.3.1.2 Master Use Permit Review

DPD issues a general private development project approval called a Master Use Permit (MUP). SPU provides Preliminary Assessment comments during the MUP pre-submittal phase, but is not routed plans for review. This permit is issued before the detailed architectural and engineering plans are developed and submitted with the Building Permit application. DPD staff review development proposals for compliance with land-use regulations and SMC[1]. SPU plan reviewers do have the ability to attend DPD pre-submittal conferences for MUPs. SPU can request invitation to the meeting through the Preliminary Assessment Tool (PAT), or the applicant can

[1] The Seattle Land Use Code, Seattle Shoreline Master Program, SEPA, and the Environmental Critical Areas (ECA) Ordinance.

request that SPU attend.

DPD issues Building Permits (a type of Construction Permit), which are required for most construction in Seattle. DPD staff, i.e. planners, plans examiners, site development staff review private development proposals for compliance with Seattle's Land Use, Building and Drainage Codes (see previous page footnote).

18.3.1.3 Side Sewer Permit

DPD issues Side Sewer Permits (a type of Construction Permit). These permits are generally processed after the Building Permit has been approved and construction is underway. If work is proposed in the ROW, the Side Sewer Permit must be issued to a Registered Side Sewer Contractor, Anyone can apply for a Side Sewer Permit if work is solely on private property. Side Sewer Permits may be issued independently of a Building Permit e.g. side sewer repair.

SPU has contracted with DPD to review Side Sewer Permit plans on SPU's behalf, and to inspect the work after the permit has been issued. As-builts (record drawings)are provided to SPU for inclusion in GIS. SPU is not normally involved in the side sewer permitting process. SPU reviews and confirms the point of discharge during the Preliminary Assessment and DPD must consult with SPU in situations where SPU expertise is required. A triggers list has been developed to provide guidance to DPD on what types of issues SPU requires to be coordinated.

18.3.1.4 Side Sewer Permit for Temporary Discharge (SSPTD)

SPU Plan Review staff reviews temporary discharge requests. The reviewers:

- Confirm that the proposed Point of Discharge is to the correct system (drainage vs. sanitary)
- Ensure that the Point of Discharge is acceptable (i.e. the connection is not allowed directly to a manhole)
- Review proposed discharge rate for infrastructure capacity impacts

The Plan Reviewer must balance SPU's infrastructure needs with the project needs. If the proposed discharge rates are higher than the standard maximum rate allowed, the Plan Reviewer must determine that risks to the infrastructure are within acceptable range.

For proposed permanent and/or temporary discharges to the sanitary or combined sewer system, SPU may coordinate with King County Industrial Waste Section (KCIW) to confirm the allowed discharge flow rate. The Plan Reviewer communicates the allowed discharge flow rate to the project contact, and coordinates with the KCIW staff to have SPU conditions written into the King County Industrial Waste Permit.

Once SPU and KC are satisfied, the SPU Plan Reviewer informs the project contact and the DPD Plan Reviewer that the Side Sewer Permit for Temporary Discharge may be applied for and issued.

Note: At the time of publication, a new Dewatering Director's Rule is being finalized and the corresponding processes may change.

18.3.1.5 Street Use Permit

SDOT issues Street Use Permits, which are required for many activities in the public ROW, including construction projects. Types of Street Use Permits that may impact SPU infrastructure include Street Improvement Permit, Utility Permit, Shoring and Excavation Permit, and Street Tree Permits.

A. Street Improvement Permit (SIP)

The SIP plan is the most common plan SPU reviews because SPU infrastructure is generally located within the ROW. SDOT issues Street Improvement Permits (SIPs) for work as required by the Seattle Land Use Code, which is enforced by DPD and/or Street Improvements as required by the Right of Way Improvement Manual, which is enforced by SDOT. If DPD or SDOT requires street improvements, then a SIP is required and reviewed by SPU Plan Reviewers if facilities that SPU will own are constructed or existing infrastructure is impacted. SPU has the opportunity to review preliminary plans and attend design guidance meetings for SIP's at the 0-60% design phase and to provide formal review and comment at the 90% design phase.

B. Utility Permits

SDOT issues Utility Permits for the installation of underground utility mains, overhead wires and services in the public ROW. They include public utilities such as water, sewer, drainage mains and Green Stormwater Infrastructure; franchise utilities such as power, communication, gas, steam; and privately-owned facilities such as oil pipelines. This permit is one that SPU both reviews as an approver, and also requests from SDOT as an applicant. Many SPU projects need to obtain this permit. See DSG Chapter 2, Design for Permitting and Environmental Review

C. Shoring and Excavation Permits

Shoring and Excavation Permits are issued for excavations in or near a public ROW that could potentially affect the integrity of the ROW or utilities in the ROW. SDOT leads the review and may engage SPU to ensure SPU infrastructure is protected.

18.3.2 Other Projects

The SPU PMED reviews plans for SPU and other City departments Capital Improvement Program (CIP) projects.

18.3.2.1 SPU CIP Projects

Plan reviews of SPU CIP projects have many similarities to private development plan reviews, but are not part of the formal plan review process. The Plan Review section gets involved in SPU CIP projects based on their expertise, knowledge of a specific basin, or complexity of the project. Examples of SPU CIP projects include construction of a new water main, reservoir undergrounding, or installation of a new pump station.

18.3.2.2 Other City Department CIP Projects

The SPU Plan Review staff reviews plans for other City department CIP projects. For these projects, other City departments are the developer. As with the SPU CIP projects, these reviews have many similarities to private development plan reviews, but are part of different processes. If development or redevelopment is parcel based, then the DPD MUP and Building Permit process is followed. If in the ROW, the plans are routed to SPU PMED Plan Coordinator to be

assigned to a Primary Reviewer. Examples of other City plan review are construction of: a new Fire Station and related infrastructure; a new street with water, sewer and storm mains plus Green Stormwater Infrastructure (GSI); or a new facility that the Parks Department is building on Parks property that needs full frontage improvements including new water, sewer and storm mains extended. In particular, SDOT street reconstruction projects can have impacts on SPU infrastructure, especially drainage facilities.

18.3.3 Other Agency Projects

The SPU PMED reviews plans for work done in other municipalities or by other government agencies, where SPU interests are involved. Examples of this would be Sound Transit's Light Rail project or a project in Bellevue potentially impacting a SPU water transmission pipeline. These types of projects are categorized as either Major or Non-Major. For Major Interagency Projects (MIP) of high complexity, SPU typically assigns a project manager who assembles an in-house team for plan review.

18.3.4 SPU Property Related Projects

Property related plan review usually involves SPU property, easements or other property rights, street vacations, and proposed sales of City property. SPU must approve any actions that may threaten SPU property or property rights. The SPU PMED must determine the potential impact of property related action on any existing or planned SPU infrastructure. Usually, SPU Real Property coordinates these reviews, which involve SPU PMED only in more complex or higher risk situations. For many ROW actions, such as street vacations, SDOT leads review and SPU Real Property is the main point of contact for SPU.

18.4 SPU PLAN REVIEW PROCESS

SPU reviews plans either through informal coordination with other staff or through the formal plans routing process. *Coordination* refers to a simple conversation, email, or a meeting between an SPU plan reviewer and another City branch or department (or private development applicant) in which plans are reviewed or discussed. *Plans routing* is a more formal process by which SPU receives hardcopy or electronic plans for review.

18.4.1 Review Process with Routed Plans

The following is the SPU Plan Review Process:

1. The Plan Review Coordinator receives and logs plans into the Plan Review Database (PRD). A Primary Reviewer is assigned.
    a. Upon assignment, the Primary Reviewer screens to see if the project triggers the need for Conditional Reviewer(s) to review plan.
    b. If workload balancing or special skills are required, the Plan Review Coordinator consults with Primary Reviewer to assign Conditional Reviewer(s).
2. Primary Reviewer or Plan Review Coordinator will coordinate for plan to be reviewed by the Conditional Reviewer.

3. The Conditional Reviewer enters comments and corrections into the PRD and returns the marked up drawings to Primary Reviewer.
4. If workload balancing or special skills are required, Plan Review Coordinator consults Plan Review Supervisor.
5. If not, the Primary Reviewer screens to see if the project triggers the need for a Conditional Reviewer to review plan.
6. The Primary Reviewer arranges for plan to be reviewed by the Conditional Reviewer.
7. The Conditional Reviewer enters comments and corrections into PRD and returns marked up drawings to Primary Reviewer.
8. The Primary Reviewer reviews plans, resolves conflicts and issues, and enters final comments into the PRD.
9. The Plan Review Coordinator compiles final comments and sends them to the Point of Contact per plan review request.
10. The Plan Review Coordinator tracks and reports performance measures relating to the Plan Review process.

    Note: For more information, the SPU Plan Review Folder includes detailed process information, checklists, process diagrams, and other useful information. (J:\PDB\WS480\Public\Plan Review).

18.4.2 Coordination

SPU has regularly scheduled meetings to foster communication and coordination with other groups within SPU and other City departments:

- Representatives from SPU PMED, Operations and USM meet weekly to discuss drainage and wastewater utility issues that have come up during plan review. These issues have implications for policy, operations, or maintenance. During the meeting, the SPU reviewer consolidates branch comments onto a single set of plans.
- USM, Real Property Services, and SPU PMED hold monthly Build-over Meetings where they evaluate private proposals to build over SPU infrastructure.
- DPD, SDOT, and SPU PMED hold weekly meetings for both pre-submittal coordination and side sewer permitting. These meetings are used to discuss drainage and wastewater issues for projects seeking DPD or SDOT permits.
- SDOT holds semi-weekly meetings, which includes all reviewing departments. Pre-design guidance and 0%-90% design issues are discussed. SPU participates in these meetings by communicating requirements and coordinating water, drainage and wastewater concerns for projects seeking SPU approval on DPD or SDOT permits.
- SPU PMED attends monthly coordination meetings with SDOT to collaborate on SDOT's CIP program.

18.4.3 Master Use Permit Plan Review

SPU reviews preliminary MUP applications and communicates requirements using the Preliminary Assessment Tool (PAT). DPD takes input from SPU and other City departments and uses it to condition MUP decisions so that the applicant has information and approval to develop project plans for the building permit phase. Currently, SPU PMED receives MUP plans for water infrastructure reviews more often than for drainage or wastewater infrastructure. SPU PMED engineers return any comments directly to DPD. The SPU Solid Waste Division does not generally have any input to a MUP plan.

If the DPD reviewer observes issues or has questions on the following, they should coordinate with the SPU Plan Reviewer:

- System capacity
- Impacts to sensitive areas and public infrastructure
- Compliance with comprehensive plans and land use or drainage/sewer codes
- Resolution of unusual conditions, nonstandard designs, or exception requests

Generally, DPD staff split their project review workload into North of Denny review staff and South of Denny review staff. These DPD reviewers consult on triggered issues with the two SPU PMED review staff contacts, who are the north or south regions.

18.4.4 Preliminary Assessment Review

For this review, SPU plan reviewers focus on water, drainage and wastewater infrastructure. Applying for a Preliminary Assessment automatically triggers a Water Availability Certificate (WAC) review. SPU plan reviewers are assigned reviews on a weekly rotational basis. The SPU plan reviewer is responsible for projects forwarded from SDOT from 10 AM the previous day to 10 AM the designated day. A maximum of four projects is assigned per day.

18.4.4.1 Preliminary Assessment Review Process

SPU plan reviewers follow these steps to review Preliminary Assessments:

1. Access preliminary application information through Hansen Web Tools.
2. Select "Complete" button to route the project to DPD Administration who sends the Report to the applicant.
3. Use Route Back options as necessary. Occasionally, it may be best to contact the reviewer outside of the PAT via email or telephone. If a DPD build-over or main extension requirement is waived, then a comment is written in the internal comment field and the project must be routed back to the DPD Site Team.
4. DPD, SDOT and SPU meet biweekly to evaluate appeals of requirements that have been identified during the Preliminary Assessment.

Review City resources for each pertinent item on the Preliminary Assessment Resource List.

Table 18-2 Information Included in the Preliminary Assessment Tool (PAT)

Utility	Information to be provided in the Preliminary Assessment Tool
Water Drainage and Wastewater (D/WW)	The WAC is automatically triggered in PAT. Verify the following information input by DPD Site Team - Locations of existing public infrastructure (sanitary sewer, storm sewer or combined) and pipe sizes - Preliminary drainage control requirements including flow control, WQ treatment and/or green stormwater infrastructure (GSI) if required - Preliminary drainage water quality treatment requirements if required Waive or Concur with the following DPD-identified requirements: - If drainage or sewer main extension is required - If a build-over process is required Other additional areas of investigation: - If more than one possible connection point, the reviewer may suggest preferred pipe and location of connection - Potential capacity issues

18.4.4.2 Preliminary Assessment Performance Measures

The SPU service level agreement is to complete the Preliminary Assessment review within 48 hours of receipt from SDOT. If route backs are required, then an additional 48 hour window is allowed once the project enters SPU's queue a second time.

18.4.5 Water Plan Review

SPU reviews Water Utility plans as part of four related processes:

- Water Availability Certificate (WAC)--The Water Availability Certificate (WAC) is the most common process by which SPU confirms there is adequate domestic water flow and pressure for a new development. The developer may be required to pay SPU to perform hydrant flow tests and/or system model calibration in order to assure the water system can serve the project and surrounding area.
- Water Availability Inquiry (WAI)—Similar to a WAC, but is not related to a specific project.
- Water Availability Approval (WAA)--The Water Availability Approval (WAA) allows a developer to obtain a Building Permit for new development without obtaining a WAC from SPU. SPU has a MOA with DPD that allows DPD to issue the WAA in lieu of a WAC for certain smaller projects that will not require increased water services.
- Detailed Water Infrastructure and Water Service Plan Review.

18.4.5.1 Water Availability Certificate (WAC)

The Water Availability Certificate (WAC) is the most common process by which SPU confirms there is adequate domestic water flow and pressure for a new development. The WAC reviewer performs analysis and applies SPU water policy in determining the need for any water system improvements. The WAC reviewer estimates fire flow in determining requirements, but this is

subject to confirmation by the Seattle Fire Department. Under most circumstances, the SPU WAC Administrator completes these Certificates within five business days. DPD requires an approved WAC before it will issue a building permit for new development.

Not all projects require a WAC. DPD or SPU will determine whether a WAC is required based on a seven-item WAA checklist. If a developer meets all criteria listed on the checklist, DPD issues a Water Availability Approval without requiring a WAC from SPU. If project conditions change, DPD's Water Availability Approval can be invalidated. If so, SPU requires a WAC.

A. WAC Process

Normally the WAC is obtained during Preliminary Assessment, which automatically requests it. However, a developer can request assurance at any time that there is sufficient water available for a proposed new development. Or, at any time, a developer can complete a WAC request form and submit it to DPD. The SPU plan reviewer should follow the WAC process .

Tip: *DPD routes WAC requests with a site or utility plan to SPU for plan review. While the WAC typically indicates if a project needs to upgrade or build a new water main, SPU water policy can be unclear as to the best application of this requirement. If so, consult with the SPU Plan Review Supervisor.*

B. WAC Appeal

The developer can appeal WAC conditions by submitting a WAC Customer Appeal to the plan review supervisor. The appeals go through the following process:

1. Plan review supervisor conducts a bi-weekly meeting that includes the following:
    a. Engineering plan reviewer who developed the WAC
    b. Water lead
    c. Engineering Plan Review Manager
    d. USM Water Business Area Manager
    e. Customer Service (not at all meetings)
2. Meeting attendees decide whether to approve or deny the appeal, or possibly negotiate alternatives with the developer. On occasion, site visits or follow-up research may be required.
3. Engineering plan reviewer prepares and sends the developer a letter stating the decision.

The entire process should be completed within two weeks. Applicants who receive a denial letter may re-appeal if new information is presented that was not previously considered. When all appeals have been heard, if the applicant still believes the decision was in error, they can elevate the issue to the Project Management and Engineering Director in the Project Delivery Branch at SPU.

C. Water Availability Inquiry (WAI)

The Water Availability Inquiry (WAI) follows the same steps as the WAC process, but is based on a preliminary understanding of proposed land use. Under most circumstances, it is completed in

5 working days. If an SPU plan reviewer is unable to meet this goal, the reviewer should contact the plan review supervisor. The SPU plan reviewer follows these steps to prepare a WAI:

1. Checks project type and WAC policy to determine overall requirements.
2. Reviews the City's GIS to identify the size of the main. If the water system is substandard, City staff will indicate the process for required mitigation.
3. The WAI informs developer that fire flows are determined by the Fire Department and may require additional upgrades to water system.

D. Water Availability Approval (WAA)

The Water Availability Approval (WAA) allows a developer to obtain a Building Permit for new development without obtaining a WAC from SPU. SPU has a MOA with DPD that allows DPD to issue the WAA in lieu of a WAC for certain smaller projects that will not require increased water services.

18.4.5.2 Water Plan Review Procedure

SPU PMED may need to perform detailed plan reviews for new development projects that may impact SPU water infrastructure, examples are water main extensions and large water meter installations. See DSG Chapter #17 for Water Services.

The Water Plan Review procedure can be required for both private developments within City limits and within jurisdictions that SPU-owned systems are located.

The following resources may be useful in performing a detailed water plan review:

- For new and existing water mains, water project review is covered in the 2007 Water System Plan.
- For non-standard or complex issues or if the code is unclear, get additional assistance in the bi-weekly water appeal meeting.

Meetings with outside jurisdictions in SPU's water service area such as Shoreline, Tukwila, Bellevue, Kirkland, Mercer Island, Burien, Normandy Park, King County, and WSDOT may be scheduled as needed.

The SPU Primary Reviewer should follow the Drainage, Wastewater and Water Plan Review procedure in Appendix A.

18.4.6 Drainage and Wastewater Plan Review

This section describes general guidance for reviewing private development wastewater and drainage plans.

18.4.6.1 Stormwater Code Compliance

The SPU plan reviewer uses a number of established thresholds to determine Stormwater Code requirements for public and private development or redevelopment projects. There are 13 minimum requirements for all projects.(V.III, Chapter 2, page 2-30) Of these the requirements to maintain natural drainage patterns, amend soils, implement GSI, protect wetlands, ensure capacity, and comply with the Side Sewer Code are most often encountered by the reviewer.

Two additional minimum requirements (flow control and water quality) vary depending on project type and where the site ultimately drains. A tool was developed to assist the reviewer in identifying flow control requirements.

Additional system requirements may be identified. Drainage and wastewater thresholds for improvements and extensions within the City of Seattle are triggered by code (often a lack of available main in abutting ROW). If there is no sewer or combined main or if the sewer or combined main may be under capacity for the improvements, the SPU PMED Plan Reviewer may need to coordinate with USM and to determine the following:

- Delineation of service area
- Possible downstream hydraulic constraints
- Point of discharge (POD)
- Evaluation of service alternatives
- Determination of benefit of new or upgraded main to SPU

18.4.6.2 Review Procedure

The SPU Primary Reviewer should follow the Drainage, Wastewater, and Water Plan Review procedure in Appendix A.

18.4.6.3 Green Stormwater Infrastructure (GSI) Plan Review

Green Stormwater Infrastructure (GSI) is required under current Stormwater Code for projects with >2,000SF new and replaced impervious surface or >7,000SF total land disturbing activity. GSI limits the negative impacts of stormwater runoff by redesigning streets to take advantage of plants, trees, and soils to clean runoff and manage stormwater flows. Vegetated swales (biofiltration swales), permeable pavement, amended soils, and specific trees and vegetation allow soils to absorb water, slowing flows and filtering out many contaminants. SPU has coordinated with SDOT to develop general guidelines, plans, and specifications for GSI Design in the ROW. GSI options for ROW applications are included in the ROWIM. Additional resources and updated information are included on SPU's GSI website.

18.4.6.4 DRAINAGE AND WASTEWATER APPEALS

Applicants can appeal requirements or decisions relating to drainage or wastewater reviews. Appeals are sent to the Plan Review Coordinator who then schedules the appeal meeting and ensures that the package is complete and ready for the meeting. Appeals often involve ROW issues. The meeting generally includes representatives from SDOT, DPD, USM and PMED. Decisions are sent to the applicant within two weeks of the initial submittal. On occasion, follow-up investigation can be required either by the applicant or internally, which can delay the decision.

18.4.7 Survey Requirements and Monuments

City of Seattle survey and monument requirements are described in CAMs 1401 and 1402, respectively. CAM 1401 explains when a survey is required and general information regarding survey. CAM 1402 explains how to locate and identify a survey monument, the developer's

responsibility in verifying and protecting monuments, and how a developer gets approval to disturb a monument.

The SPU PMED Survey Plan Reviewer performs survey reviews as a service to SDOT. Through this review, street alignments, rights of way, and horizontal and vertical survey control data are verified.

The Survey Plan Reviewer uses City Survey records, City quarter section (engineering) maps, City ordinance records, County records, superior court cause documents, State and County survey control data bases, and occasionally field verification to confirm that the submitted plan or base map is a reasonable representation and interpretation of survey control.
The Survey reviewer may also be asked to review new plats, short plats and lot boundary adjustments submitted to SDOT. In the case of new plats, geometry, ROW, and control of re-aligned streets are checked, and ties to control outside of the plat are reviewed.

If the survey is incorrect, inadequate, or unverified, the reviewer may return the plan to the developer to correct before design review.

Survey review is also performed for SPU and SDOT CIP alignments.

18.4.8 Solid Waste Plan Review

The SPU Solid Waste Division in USM reviews Building Permit plans for larger multi-family, commercial and industrial projects to assure the following:

- Garbage trucks have sufficient access to dumpsters
- There is sufficient storage available for solid waste dumpsters
- Dumpsters can be safely moved from their storage location to the pickup location

Note: At the time of DSG publication, DPD identifies when Solid Waste should be involved and routes plans directly to the Solid Waste Division.

18.4.9 Build-overs

SPU may allow a developer to construct a permanent structure over an existing sewer or storm main located in an easement on private property subject to site specific engineering and maintenance requirements. If any or all of the requirements can't be met SPU reserves the right to reject the proposed build-over. SPU prefers re-routing the existing main around the proposed build-over if the longitudinal grade allows it to maintain the minimum velocity or less.

Real Property Services (RPS) is the primary point of contact and they work with the Plan Reviewer to determine that the City's rights and facilities are adequately protected. The developer must agree to pay the administrative costs plus excess future costs due to the project's construction. For detailed information on build-overs, see CAM 507.

Note: Build-overs are generally only approved for drainage or wastewater mains. Build-overs are almost never approved for water mains.

18.4.9.1 Build-over Review

The SPU plan reviewer must confirm:

1. That the casing pipe inside diameter is larger than the outside diameter of the bell of the sewer/storm main. The proposed pipe must be sized to convey the design flows for the entire basin under full "build-out" for the corresponding zoning.
2. The minimum steel casing thickness shall be ¼-inch. External loading may require thicker and stronger casing. Casing shall extend at least 5 feet beyond the edge of building foundation 1:1 influence line. Steel casing pipe is preferred, although ductile iron pipe may be used in certain circumstances. Use of any HDPE, PVC or any other plastic pipe is not allowed.
3. The sewer/storm main must be restrained joint within the casing pipe.
4. No private side sewer or storm connections are allowed within the casing pipe.
5. Casing spacers must be stainless steel to maintain line and grade of pipe and to prevent floatation. Place at bell ends with 9 feet maximum spacing.
6. An unobstructed 10 x 20 foot minimum access area (unobstructed) located on both sides of the building is preferred. If that is not feasible, SPU may allow one access area for future trenchless maintenance or repair. Larger diameter pipes may require larger access areas and easement widths.
7. A removable end cap or a 1 foot deep concrete plug must be included in order to seal the space between the casing the main.
8. Additional MHs may be required, as necessary.
9. The Seattle City Council must approve any easement legislation required prior to issuing the permit for construction.
10. Final as built plans must be filed in the SPU Records Vault.

18.4.9.2 Build-over Process

The following are the steps for a developer to request a build-over:

1. Real Property Services (RPS) circulates the owner's proposal to the SPU Plan Reviewer and to Field Operations for preliminary evaluation.

Participants discuss proposal in a scheduled build-over meeting

a. If necessary, RPS coordinates a meeting with the property owner or their agent.

b. RPS, after consulting with Plan Review and FOM, will advise if SPU can grant consent.

The Plan Reviewer conducts preliminary review and sends recommendations to RPS.

RPS sends letter to property owner with site specific requirements for modifying the wastewater/storm drainage main or denying the build-over request.

RPS includes an estimate of fee for processing of the request.

Developer signs and returns letter to RPS including the following:

a. Payment of fee for administrative costs in excess of the deposit.

b. Revised design document incorporating SPU preliminary comments prepared by a licensed engineer.

c. Three sets of finalized plans and profiles showing impact details on wastewater/stormwater mainline.

2. RPS routes revised plans to the Plan Reviewer.
3. SPU Plan Reviewer coordinates comments to the property owner.
4. RPS drafts a Consent Agreement for developer review, approval and acceptance.
5. Developer submits a copy of signed Consent Agreement and approved plans to RPS.
6. Once all changes are made and staff accepts the proposal, RPS schedules the build-over for City Council review and action.
7. Upon City Council approval, the Developer submits a copy of signed Consent Agreement, approved plans and payment of current fees to DPD to obtain a sewer permit
8. DPD and/or SDOT inspects construction of relocated or replaced drainage/wastewater main and obtains red-lined drawings. Before building occupancy, DPD must obtain SPU PMED final approval.

18.5 PLAN REVIEW ROLES AND RESPONSIBILITIES

Plan review at SPU is performed by a team as shown in Table 18-3. .

Table 18-3 SPU Project Management and Engineering Plan Review Team

SPU Position	Responsibilities
Engineering Plan Review Manager	Manages SPU PMED Plan Review Section
Plan Review Supervisor	Workload management and project assignment Preliminary Assessment Management Deals with exceptions
Plan Review Coordinator	Organizes and distributes plans for review Compiles comments and transmittals Provides general support Tracks and reports performance measure data
Primary Reviewer	Engineering plan review and project management Reviews projects for adherence to SPU DSG, City Standards, SMC and relevant DR's.
Conditional Reviewer	Supports Primary Reviewer by performing specialized reviews, as necessary for adherence to SPU DSG, City Standards, SMC and relevant DR's..

Other City of Seattle departments and groups within SPU share responsibilities for plan review. Table 18-4 shows an overview of the role of other City departments and SPU groups in plan review.

Table 18-4 Plan Review Roles and Responsibilities

Organization	Group	Role	Responsibilities
DPD	Multiple	Issue permits	Issues MUP, Building, Grading. and Side Sewer Permits Review to protect SPU interests when issuing permits Involve SPU as needed or agreed in the permitting process
SCL	Plan Review Team	Review	Assure customer service levels are met Protect citizens health and safety Review plans as needed to assure SCL interests are protected
SDOT	Street Use Operations	Issue permits; Review	Administers the Street Use Process Protect SPU interests when issuing permits Protect SDOT interests when reviewing plans Involve SPU as needed or agreed in permitting process
SPU	Customer Service	Authorize new water service	Assure WAC is issued before accepting new water service applications Accept plans from developers for water service review
SPU	USM	Conditional Review	Review plans as agreed with SPU PMED for projects with complex policy issues
SPU	Solid Waste	Conditional Review	Review building permit plans to assure safe access to dumpsters for residents and garbage trucks.
SPU	Survey	Conditional Review	Assure plans reviewed meet City survey standards Assure planned projects meet City ROW monumentation and future grade requirements.
SPU	Materials Lab	Conditional Review	Assure appropriate products and materials are used in construction projects involving SPU infrastructure.
SPU	Real Property Services	Conditional Review	Assure SPU and City property are protected Assure easements and other legal documents protect City property and interests
SPU	Field Operations & Maintenance	Conditional Review	Assure proposed projects do not negatively impact Operations' ability to operate or maintain SPU infrastructure
King County	Dept of Natural Resources (Wastewater Treatment Division)	Review	Protect King County wastewater interests Review plans for wastewater concerns as requested by SPU, Industrial Waster, Construction and Real Property are Sections where coordination takes place.

18.5.1 Coordination

Coordination with other Branches, Divisions, and Departments is critical to successful projects. Table 18-5 lists examples of when coordination is needed with other SPU groups and DPD. The list is not exhaustive.

Table 18-5 Plan Review Coordination and Conditional Reviewers

Department/Branch	Issues for Coordination
Field Operations and Maintenance	Access points to casing pipes Safety platforms for deep maintenance holes Inside drop vs. outside drop for MH's Access to public facilities in difficult to reach locations Confirming access locations in drive aisles, roads, & private property with SPU facilities Bends required in lines Backwater valves

	Pipe slopes less than or greater than allowable standards Project with limited overhead or horizontal clearance due to trees, overhead utilities, underground utilities, walls etc. Utility infrastructure to be decommissioned Other unique issue creating non-standard installation Non-standard location or complex/non-standard work by crews Connections & maintenance of water quality facilities such as storm filters or wet vaults Utility conflicts Proposed trees over/near mainline Opportunistic replacement of plastic or galvanized water services
Real Property Services	RPS initiates review for projects requiring an easement or Build-over Agreement. SPU coordinates with RPS easement issues with a build-over. RPS coordinates with outside jurisdictions and SPU facilities needs.
Materials Lab	Point load on pipes due to proposed adjacent improvements Angle of repose for trench adjacent to ex structures or utilities Use of epoxy for water proofing utilidor Casing pipe inspections Pipe bedding/support Trenchless installations Mix designs for porous pavements and structural inspections Review of non-standard products or materials Soil compaction tests
USM	SPU PMED and USM have a MOA that outlines areas the two branches must coordinate. This MOA includes a "Triggers" list that shows SPU PMED plan reviewers what types of project issues require coordination with USM
Construction Management	Casting surveys Constructability review Inspection services
DPD	SPU PMED and DPD have a MOA that outlines areas of coordination. This MOA includes a "Triggers" list that shows DPD Site Reviewers what types of project issues require coordination with PMED Plan Reviews. Coordination includes: Interpretation of the drainage code for on-site drainage review Side Sewer Permitting Main extension Temporary Construction Discharge Build-over or relocation inspections permitted by DPD Projects that may have significant impacts on SPU system capacity.
Customer Service	Review of large water services Review for Customer Service issues
Solid Waste	Review for access issues regarding large containers
Survey	Professional survey issues that are elevated by the Developer

18.6 RESOURCES

This section contains information available to SPU plan reviewers.

18.6.1 Codes and Authority

Table 18-6 describes relevant Authority for Plan Review Staff.

Table 18-6 Relevant Codes and Authority for Plan Review Staff

Code	Authority
Side Sewer Code (2010) SMC Chapter 21.16	Regulates construction/ use of service drains and side sewers in Seattle

Stormwater Code(2009) SMC Chapter 22.800	Regulates stormwater, flow control, water quality, temporarily during construction and permanently after construction.
Water Code (2007) SCM Chapter 21.04	Regulates current and future water demands, ensures high quality drinking water, and establishes rates for purveyors and customers.
King County Code KCC Title 28	Regulations for the disposal of industrial waste into the sewerage system and establish the fees and rules.

18.6.2 Director's Rules

Table 18-7 describes relevant Director's Rules (DR's) for Plan Review Staff. Director's Rules are administratively approved and signed by City Department Directors. They are legally binding rules that clarify how SMC will be implemented and enforced. Most DR's related to plan review are joint DPD and SPU Director's Rules, and can be located in Table 18-7 or on DPD's web site.

Table 18-7 Relevant Director's Rules for Plan Review Staff

DR Number	Description
2010-002*	Requirements for Design and Construction of Side Sewers(Drainage and Wastewater Discharges
2010-003*	Side Sewer Code Enforcement
2010-005**	Groundwater/Dewatering
2009-003	Vol. I Source Control Technical Requirements Manual
2009-004	Vol. II Construction Stormwater Control Technical Requirements Manual
2009-005	Vol. III Stormwater Flow Control and Water Quality
2009-006	Vol. IV Stormwater Code Enforcement Manual
2009-007***	Green Stormwater Infrastructure to the Maximum Extent Feasible (GSI to the MEF)

*Note: As of DSG publication date, this DR is slated for approval and implementation in early 2011.

**Note: As of DSG publication date, this DR is slated for approval and implementation in 2011.

***Note: As of DSG publication date, this DR is in active discussion with DOE. Best info available is the Draft dated Dec. 2009

18.6.3 Memoranda of Agreement and Understanding

Memoranda of Agreement and Memoranda of Understanding are binding documents between a minimum of two parties. Often two or more Departments or Branches/Divisions within a Department will have a MOA or MOU. There is an Agreements Library located on PMED's SharePoint site.

18.6.4 Client Assistance Memos

Table 18-8 describes relevant Client Assistance Memos (CAM's) for Plan Review Staff. Client Assistance Memo's are general in nature and aid the public in applying regulations.

Table 18-8 Relevant Client Assistance Memos for Plan Review Staff

Client Assistance Memo	Description
CAM 502	Grading Regulations in Seattle
CAM 503	Side Sewer Permits in Seattle
CAM 504	Side Sewer As-Built Plan Requirements
CAM 505	High Point Impervious Surface Calculation
CAM 506*	Side Sewer Permits for Temporary Dewatering on Construction Sites
CAM 507	Side Sewer Permits for Build-Over Agreements
CAM 509	Green Parking Lots
CAM 520	Rainwater Harvesting for Beneficial Use - Green Building CAM
CAM 1101	Drainage and Wastewater: Regulation of Development
CAM 1102	Sewer Submeter Program
CAM 1180	Design Guidelines for Public Storm Drain Facilities
CAM 1201	Water Availability Certificate
CAM 1202	Water Service Application
CAM 1301	Solid Waste: Information for Developers
CAM 1302	Building Material Salvage and Recycling
CAM 1401	SPU Survey Requirements
CAM 1402	What are Survey Monuments?

*To be updated with DR 2010-005 in 2011.

18.6.5 Administrative Procedures

18.6.5.1 Plan Review Billing Codes

Plan reviewer staff use Activity Codes to track their time:

Table 18-9 Plan Review Timesheet Codes

N480305	DPD Engineering Support
N480306	Other Plan Review
N480307	General Engineering
N480308	Water Availability Certificate
N480340	Design Standards and Guidelines
N480341	Code Development, Director's Rules and CAM's

18.6.5.2 SDOT Projects

Projects billed to SDOT are charged to one of three Activity Codes:

NS09029	Design Guidance
NS09030	Plan Review
NS09031	Inspection

When completing the timesheets, the Plan Reviewer enters the permit number in the Doc # field and a brief description of work performed in the Comment box on the HRIS timesheet. After

each pay period, SPU Finance sends a report that includes this information, and the Primary Reviewer reviews to ensure that all charges are appropriate before approving. SPU Finance then sends the approved billing to SDOT for processing.

Refer to the Plan Review billing process map SPU internal CIP projects with an assigned SPU project Manager have Activity Codes that Start with a C. (e.g. C305501)

18.6.5.3 DPD Projects

Currently, projects originated from DPD are billed to N480305 DPD Engineering Support.

18.6.6 Technology

The City uses a variety of software to manage and track plan review. To access these systems, the SPU plan reviewer should contact the appropriate IT department (Table 18-10).

Table 18-10 Technology Tools for Plan Review Staff

Software Name	Description	IT Dept.
Hansen Web Tools (HWT)	HWT provides a web based view of DPD's Hansen permitting application data, and other permitting application data (e.g.: GIS, EDMS.). HWT also provides additional functionality supporting interdepartmental permitting. This tool allows the reviewer to view project information and details from other City reviewers. Access to this system must be requested from DPD	DPD
Preliminary Assessment Tool (PAT)	PAT is an application within HWT that supports determination of Code requirements. It is used by DPD Land Use, DPD Site Team, SCL, SDOT and SPU. Access must be requested from DPD. PAT is used in the preliminary application process by Review Staff to provide early guidance and Code Requirements for all new private parcel development projects.	DPD
Plan Review Database (PRD)	PRD is an MS Access database used to track plans, archive comments & decisions for projects reviewed by SPU PMED. It is used for SDOT Street Use Permit plan review, for other Dept CIP plan review, and for other reviews that occurs in the Plan Review Section. Write access is requested from the Plan Review Supervisor, who then contacts the SPU IT service desk. Read access is available to all SPU staff and can be accessed through	SPU
Field Operations Mapping System (FOMS)	FOMS is a tool to graphically see Maximo work orders, O&M truck locations, and work order status and expeditiously gain O&M information. O&M truck locations are real time locations using GPS to locate them.	
Virtual Vault	Virtual Vault is a desktop tool to access to SPU infrastructure as-built information	
Maximo	Maximo is a desktop tool that enables access to O&M crew scheduling, work activities, and costs	

18.6.7 SPU Library and Storage Area

The SPU Library is located on SMT 45th floor. The library contains copies of industry standards to which SPU subscribes. It also contains engineering textbooks, City standards, and other technical engineering publications.

Physical copies of plans received by SDOT are stored in the PRD portion of Central Files on SMT 45th floor while plan review is in progress. At regular intervals, completed projects are packaged and sent for off-site archiving.

18.6.8 Mapping

Table 18-11 lists resources SPU plan reviewers and developers use to obtain property information. Physical maps are housed on the west side of SMT 45th Floor.

Table 18-11 Property Resources for Plan Review Staff

Resource Name	Description (if applicable)	Link/Location (if applicable)
General		
DPD CAM 233	(Sources for Property Information)	CAM 233
City GIS (Public)	Public Information	City GIS
City GIS (Internal Use)	Internal Access Information	ArcView & Utiliview
Microfilm Library	Public Information	Seattle Map Counter Public Resource Center SMT 20th Floor
City of Seattle Vault	400 Scale Water Maps and limited record water system drawings (as-builts). Limited wastewater and stormwater record drawings (as-builts). Sewer Cards (also available on-line) Reviewers have access to more accurate detailed information from the internal SPU on-line system.	Virtual Vault 700 Fifth Avenue SMT 47th Floor Seattle, WA 98104 (206) 684-5132 Hours: 8:00 AM to 4:30 PM, M-F
CAM 107 (DPD Public Records)	The CAM includes brief descriptions of records maintained by DPD along with locations and hours of operations, copy fees, and documents exempt from public disclosure.	CAM 107
Plat Maps	Official document that portrays subdivision boundaries, easements, restrictions, and legal descriptions.	KC Dept of Records & Elections and DPD Drainage/WW Desk in the ASC SMT 20th Floor
Water		
Water System Map Book	Public Information	Seattle Map Counter Public Resource Center SMT 20th Floor
SPU Customer Service Branch	Public Information General Index Cards (GI cards for historical info)	Water Service Account Executive (206-684-3000), M-F 8:00 AM to 5:00 PM 810 Third Avenue, Suite 600 Seattle, WA 98104
Drainage and Wastewater		
Sewer Cards	Historic mapping information (updated until 2001)	Map Information City of Seattle Vault Sewer and Drainage counter at DPD
SPU Engineer's Maps		See base maps
Sewer & Drainage Infrastructure Map Sheets		Seattle Map Counter Public Resource Center SMT 20th floor

If plan reviewer notes a discrepancy on GIS maps or sewer cards, verify using the mapping resources listed above, and then once confirmed that a correction is needed, complete a GIS change request to correct discrepancies. The depository is in the Plan Review Section currently on the west end of SMT 45th floor.

SEATTLE PUBLIC UTILITIES
2013 WATER SYSTEM PLAN

C. POLICIES, PROCEDURES AND STANDARDS

APPENDIX C-4

STANDARD, CONNECTION, AND ADMINISTRATIVE CHARGES RULE AND WATER RATES

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Seattle Public Utilities

Director's Rule

Title	Number	Rev. no.
Standard, Connection and Administrative Charges—Water Services	FIN-210.2	0
Responsibility	**Supersedes**	**Pages**
Finance Division	DR-2010-001	19
SPU Director's Approval	**Effective Date**	
Ray Hoffman	April 1, 2012	

1. PURPOSE

To set fees for special recurring and nonrecurring water services provided by Seattle Public Utilities.

2. DEFINITIONS

Site-specific costs: For certain services, SPU will determine the cost related to that service based on the site. This site-specific cost will include labor, material, equipment, and any other cost related to that site and that service. Cost will vary between sites.

Time and materials: The cost of a service as calculated by SPU, including labor, equipment, materials, applicable permit fees and taxes, pavement restoration, overhead costs and any similar costs incurred by SPU while performing the service.

Normal hours: Times from Monday through Friday from 7:30 a.m. to 4:00 p.m., excluding those holidays observed by the City of Seattle.

Extended hours: Times from Monday through Friday from 4:00 p.m. to 9:00 p.m., from April through October, excluding those holidays observed by the City of Seattle.

After hours: Times other than normal or extended hours.

3. NEW WATER INSTALLATIONS AND MISCELLANEOUS SERVICE CHARGES

3.1 STANDARD CHARGES FOR INSTALLATION OF NEW SERVICE (EXCLUDING STREET-RESTORATION CHARGES) AND CONNECTION CHARGES

Domestic Services

Size (inches)	Installation Fee		Connection Charge
	Residential	*Arterial*	
¾	**$2,167**	**$2,558**	**$920**
1	**$2,283**	**$2,682**	**$1,564**

1 ½	**$5,152**	**$5,821**	**$3,036**
2	**$5,491**	**$6,361**	**$4,876**
3	**Cost ***	**Cost ***	**$10,120**
4	**Cost ***	**Cost ***	**$15,640**
6	**Cost ***	**Cost ***	**$30,360**

Fire Services

Size (inches)	Installation Fee		Connection Charge
	Residential	*Arterial*	
2	**$7,576**	**$10,508**	**$1,950**
4	**Cost ***	**Cost ***	**$6,256**
6	**Cost ***	**Cost ***	**$12,144**
8	**Cost ***	**Cost ***	**$19,504**

* All services 3 inches and larger will be based on a site-specific cost.

Plus, as required, Street Restoration charges as stated below.

Arterial streets include every street, or portion thereof, designated as such in Exhibit 11.18.010 of the Seattle Municipal Code.

The new service connection charge is based on the Connection Charge Unit Rate of **$920**. For application of connection charges, see policy/procedure SPU-DR-02-03, Connection Charge. Fire-only services are based on 40 percent of the corresponding new service connection charge. If a domestic service and a fire service are purchased together, contact an SPU Account Executive at 206-684-5800 to determine the applicable connection charge. The connection rate for meters 8 inches and larger is based on the unit rate of **$920**, multiplied by the appropriate meter equivalency factor:

- 8 inches **$48,760**
- 10 inches..... **$70,840**
- 12 inches..... **$95,680**
- 16 inches..... **$154,560**
- 20 inches..... **$224,480**
- 24 inches..... **$303,600**

If new service is being installed with developer water main, see section 4.6.

Any service request deemed by SPU to be nonstandard will be based on a site-specific cost.

Combination Fire/Domestic Services

Combination fire/domestic services are available in 4-, 6- and 8- inch sizes. These services require approval from the SPU Director or designee.

- All combination fire/domestic services will be based on a site-specific cost.
- Subject to the Connection Charge in section 3.1.
- Plus, as required, Street Restoration charges under section 3.1.

Other New Service Installation Standard Charges

- Pre and post-inspection..... **$327** per job site
- Street saw cutting..... **$497** per job site
- Arterial installations for 2-inch and smaller meters will be charged **$569** for traffic control if required. For 3-inch and larger meters, costs for traffic control will be considered in the site-specific cost.

All required City, County, and/or State, and other permits and fees are in addition to the standard charges listed above.

Within Seattle City Limits

- Permit Fee **$146**
- Traffic Control Plan Review..... **$172 per hour**
- Street Use Inspection Fee (initial and final) **$172**
- Premium Street Use Inspection (minimum 4 hours) ..... **$344 per hour**

Unincorporated King County

- Permit Fee **$140**
- Inspection Fee ..... **$150 per site**

City of Shoreline

- Permit Fee (one-day project)..... **$299**
- Inspection Fee (additional days)..... **$ 74.75 per day**

City of Lake Forest Park

- Permit and Inspection Fee (flat fee)..... **$200**

City of Burien

- Permit Usage Fee **$200**
- Inspection Fee (minimum 2 hours per site)..... **$ 75 per hour**

For ¾-inch and 1-inch services installed in conjunction with new water main construction, if ordered 30 days prior to estimated start of construction: **$533** reduction from standard charges.

For multiple ¾-inch and 1-inch services installed with a manifold: **$533** reduction from standard charges for each additional service.

For 2-inch and smaller domestic services installed concurrently with fire services in a common trench: **$533** reduction from standard charges.

Time and materials, but not less than the applicable standard charge, for all purveyor services, for all services tapped on transmission mains or for special circumstances as determined by the SPU Director or designee.

Contractor Standby Charge when site/contractor not ready as previously scheduled: **$562** per event

Isolation valve, if required:

- 8-inch **$7,749**
- 10-inch **$11,552**
- 12-inch **$15,713**
- 16-inch ..... site-specific cost

- Isolation valve installation is subject to the Street Restoration charges under section 3.1.

Ring and cover casting, if required:

- For new or existing ¾-inch, 1-inch and all fire service: **$314** additional
- For new or existing 1½-inch or 2-inch domestic services: **$683** additional

Automated meter reading equipment, if required by meter installation standards:

- 2 inches or smaller meter ..... **$239** additional
- 4 inches or larger, single-register, with fire service ..... **$239** additional
- 4 inches or larger, two-register, domestic or combo ..... **$422** additional
- 4 inches or larger, three-register, with fire service ..... **$602** additional in the same chamber

Service Conversions

All service size conversions will be based on a site-specific cost.

Note: Service conversions are subject to the Connection Charge in section 3.1.

Street Restoration

Street restoration costs are in addition to the above charges and will be assessed based on street paving type and condition. Charges will be based on a jobsite pre-installation inspection and in accordance with the requirements of the Seattle Department of Transportation's (SDOT) Street and Sidewalk Opening and Restoration Director's Rule 5-2009.

If the customer chooses to have street restoration work arranged by SPU, the fee for street restoration will be collected from the customer at the same time the fee for the new water service is collected. If the customer chooses a private contractor to perform the street restoration work, the customer must: (1) obtain SDOT approval of the contractor and the applicable SDOT permit; and (2) submit the SDOT permit number to SPU at the same time the customer submits payment to SPU for the new water service.

Street restoration costs for SPU water service work in Washington State Department of Transportation right-of-way, City of Burien, Skyway, City of Shoreline, City of Lake Forest Park and unincorporated King County are based on agreements with these cities or state agencies. Charge will be determined by jobsite pre-installation inspection by SPU and street restoration agreement with these jurisdictions.

3.2 SERVICE SIZE INCREASE

To increase service size of existing 2 inches and smaller service in the same location (within 30 inches of existing service) at customer request, applicable new service installation charge will be made (see section 3.1). No charge for meter removal or retirement will be made. Subject to limitations established by SPU Director or designee.

Exception: To renew and increase ½-inch or ¾-inch steel or plastic service to 1-inch copper service in same location (within 30 inches of existing service) at customer request: **$278**.

Size-increase request at a location exceeding 30 inches from existing service will also be subject to a new service installation charge (section 3.1) and service retirement charges (section 3.6) for the existing service.

Service size increases are subject to the Connection Charge and Street Restoration charges under section 3.1.

3.3 SERVICE SIZE REDUCTION (WITHIN 30 INCHES OF EXISTING SERVICE)

2 inches and under, when reduced to smaller size: **$308**

All other sizes: Site-specific cost

Service size decreases are subject to the Street Restoration charges under section 3.1.

3.4 METER TEST (AT REQUEST OF CUSTOMER)

Charge will be waived if tested meter is found to be over-registering.

Tests conducted at the meter shop:

- Meter shop test of 1 ½ inches and under **$378**
- Meter shop test of 2-inch meter..... **$399**
- 3-inch and larger meter **$544**

Field testing of 1-inch or smaller meters **$99**

Field testing retail-service meters
outside Seattle direct-service area..... **$608**

3.5 METER REMOVAL

- ¾- inch or 1-inch meter **$122**
- 1 ½ -inch and larger meter **$158**
- 3-inch and larger meter,
  time and materials, deposit **$800**
- Removal of illegal jumper **$88**

3.6 SERVICE RETIREMENT

Abandonment with or without meter removal. This charge also applies to a customer-requested service transfer from one abutting water main to another, not related to new water main construction:

- 1 inch and smaller: **$1,153**
- 1 ½ inch and 2 inches: **$1,229**
- 3 inches and larger..... **$5,007**

Additional service retirement charge for second trip due to contractor delay. When contractor needs continuous water service or some other condition requires SPU to return to job site to perform the retirement:

- 1 inch and smaller **$692**
- 1 ½ and 2 inches **$737**
- 3 inches and larger **$3,004**

Service retirements are subject to the Street Restoration charges under section 3.1.

Repaving happens after SPU visits the site. If a contractor repaves before this time additional costs incurred by SPU will be billed at Time and Materials.

3.7 METER RESET

For meter resets following customer-requested removals:

- ¾-inch meter **$220**
- 1-inch meter **$222**
- 1 ½ -inch meter **$462**
- 2-inch meter **$565**

For meter resets following credit-related removals:

- ¾-inch meter **$220**
- 1-inch meter **$222**
- 1 ½ -inch meter **$462**
- 2-inch meter **$565**

Install temporary service jumper:

- 2 inches and smaller: **$91**

Note: If reduction in size occurs at time of reset, then charge reduction fee only.

3.8 SPECIAL FIELD TRIPS

Investigating on-property loss of water:

- When loss of water is caused by actions taken on-property, the same charges apply as for meter turn-ons and shut-offs above.
- When investigating leaks on-property and it is found that the City water-service line is intact, the same charges apply as for meter turn-ons and shut-offs above.

Inspection services for re-inspection required because the requesting customer is not ready for inspection by deadline or stated date: **$262**.

Special meter read:

- For actual readings meters of all sizes ordered in connection with property ownership or occupancy changes **$98**
- For obstructed meter readings **$117**

- Adjust buried, obstructed or low meter boxes or valve boxes caused by customer installed landscaping or resurfacing (¾-inch to 2-inch meters)..... **$462**

Trim customer-installed vegetation obstructing meter boxes or fire hydrants: **$149**

Replace customer damaged lock: **$50**

3.9 STATEMENT OF COMBINED UTILITY ACCOUNT

Customer request for billing system screen-print statement of account activity for each 12-month period: **$7**

Customer request for formal statement of account activity, for each account number per 12-month period: **$54**

External utility request for water consumption information to be used for billing the retail services of that utility: **$2** per account for information covering any period of 12 months or less.

3.10 PROCESS RETURNED CHECK OR DRAFT

Includes checks returned for nonsufficient funds or other reasons which prevent processing: **$25**

3.11 CREDIT AND COLLECTION CHARGES

Meter shut-off or turn-on charge, including Fire Services. Charges are for each trip.

Meter size (inches)	Charges		
	Normal Hours	*Extended Hours*	*After Hours*
¾ to 2	**$144**	**$252**	**$530**
3 or larger	**$565**	**$670**	**$775**

- This charge may be suspended in special circumstances as determined by the Director of SPU or designee.
- No charge for the first trip for a credit-related turn-on during SPU normal business hours. Second and subsequent trips are subject to applicable standard charge above.

Late Payment Charge. Past due balances may be subject to a late payment charge that will include one or both of the following charges:

- Collection Notice Charge: **$10** for active account Urgent or Shutoff Notice, or closed account Final Notice.
- Delinquent Interest Charge: Monthly interest at the legal rate on past due balances.

Credit field visit: **$44**

3.12 DUPLICATE BILL PREPARATION

For all duplicate bills produced at customer request after original bill was produced: **$7**

3.13 DELAYED FINAL CUSTOMER BILLING

Customer request for final bill when notification is received more than 45 days after final bill date: **$39**.

3.14 ACQUISITION OF HYDRAULIC FLOW DATA

Where records are available for fire protection grading purposes: No charge.
SPU measures hydrant flow, flushes main, and prepares flow test report: **$1,599**

Contractor measures hydrant flow with SPU assistance, SPU flushes main and reviews flow test results prepared by contractor: **$841**

Performance of hydraulic analysis and report to determine best alternative to meet or exceed fire flow requirements: Time and materials with **$2,000** deposit.

Preparation of Hydraulic Modeling Simulation Report, when a flow test is not feasible, during a declared water emergency, or when a calibrated hydraulic model is available: **$326**

3.15 NONFIREFIGHTING HYDRANT USE PERMIT

Permit fee: **$176**

Charge for water use, if SPU determines water use will be less than 8,000 gallons per day:

- September 16 - May 15..... **$43** per day
- May 16 - September 15..... **$55** per day

Otherwise, a hydrant meter is required and commercial rates are charged.

During a declared water emergency, any hydrant permit users allowed to continue their permits will be charged at established surcharge commercial rate, if any.

Billing fee: **$51** for billing made by SPU for payment subsequent to hydrant permit use.

Hydrant valve and meter assembly: **$400** deposit for use of any SPU supplied hydrant equipment and material. Deposit refunded upon return of all equipment and material in same-as-issued condition. In the event of damaged equipment, SPU will keep a portion of the deposit equal to the cost of the damaged equipment, including overhead cost.

Installation and removal: **$103** each

Water use charged at the commercial rate or surcharge commercial rate if during a declared water emergency.

3.16 HYDRANT RESET

Set hydrant back or move closer to water main, where no re-tapping of main is required: **$7,367**, plus City or County permitting, plan review or inspection fees.

Plus, as required:

- Street Restoration charges under section 3.1.
- Pre and post-inspection: **$327** per job site
- Quick connect adapter: **$254**

3.17 HYDRANT RELOCATION

Remove existing hydrant and move to new location, new tap on main required: **$14,186**, plus City or County permitting, plan review or inspection fees.

Plus, as required:

- Street Restoration charges under section 3.1.
- Pre and post-inspection: $**327** per job site
- Quick connect adapter: **$254**

3.18 INSTALL NEW HYDRANT ON EXISTING WATER MAIN

Install new hydrant on existing water main: **$5,982**, plus City or County permitting, plan review or inspection fees.

Plus, as required:

- Street Restoration charges under section 3.1.
- Quick connect adapter: **$254**

3.19 INSTALL VERTICAL EXTENSION ON EXISTING HYDRANT

Install vertical extension on existing hydrant: **$2,098**, plus City or County permitting, plan review or inspection fees.

Plus, as required: Street Restoration charges under section 3.1.

3.20 CROSS-CONNECTION CONTROL PROGRAM

Charge for mailing reminder letters to customers who do not provide acceptable proof of satisfactory performance test of their backflow preventers within 30 days of receiving original notification, or to customers who have not installed backflow preventers as required: **$98** for each backflow preventer.

Hanging shut-off notices: **$141**

Shut-off and turn-on: Applicable standard charge for Special Field Trip as specified in section 3.8.

3.21 ACCESS ALONG OR CROSSING TRANSMISSION RIGHT-OF-WAY

Gate opening:

- Minimum: **$167**
- Charge may be in excess of the minimum depending upon the circumstances of opening.

Third-party work on SPU property: Time and materials costs for City employees and equipment stationed to protect City property the pipeline during third-party work on SPU Property shall be charged as per section 5.10.

3.22 ADDITIONAL SERVICES

Relocation of meter and box
Limited to a lateral move of 30 inches, deposit amount to be determined upon order: Billed at site-specific cost.

Service damage
For repair of damaged curb stop or meter setter, tailrun, etc.: Billed at site-specific cost.

Water main cut and cap
For cut, cap and block of existing water main: Billed at site-specific cost.

Design and/or Install Pressure Reducer

- SPU design, time-and-materials, deposit: **$8,200**
- Installation by SPU, time-and-materials - deposit:
  - 4 inches PR (2 inches Bypass) **$31,000**
  - 6 inches PR (2 inches Bypass) **$33,000**
  - 8 inches PR (4 inches Bypass) **$41,000**
- The deposit amounts listed above are the expected project costs, and do not include the cost of street repair. Street repair costs will be borne by the developer.

Work Outside Normal Business Hours
All work performed outside of SPU normal business hours due to customer request, or due to customer water supply concerns, will be charged at an overtime rate.

SDOT Right-Of-Way
When any work is to be performed in a SDOT right-of-way which necessitates a Letter of Justification: **$600** deposit required for application to SDOT by SPU.

Installation Plans
Water meter and fire hydrant installation plans may be prepared by SPU at the developer's expense. The cost to prepare the plans depends primarily on the availability of as-built information and the number and complexity of the existing utilities. An advance deposit of **$360** is required from the customer before design work begins.

4. DEVELOPER PROJECTS

Note: Charges paid more than 12 months in advance of work performed will be recharged at current year's rate.

4.1 WATER MAIN CONNECTION

For cut-in tee connection to charged water mains, SPU furnishes sleeve(s) to connect new tee into existing main. For wet tap connection, SPU furnishes tapping sleeve and tapping valve. Contractor furnishes all other materials, tees, valves, valve boxes and lids, fittings, sleeves, excavation, backfill, compaction and restoration. SPU performs shutdown and draining of existing mains, connection of new main, and restoration of service: **$3,829** per connection.

4.2 WATER QUALITY INSPECTION, SAMPLE COLLECTION AND BACTERIOLOGICAL TESTING

- **$838** for first 500 feet of water main
- **$591** for each additional 500 feet thereafter

4.3 DESIGN REVIEW, PLAN APPROVAL, ADMINISTRATION AND ACCEPTANCE OF MAIN

- **$1,577** per water main project

4.4 CONSTRUCTION INSPECTION

Rate includes travel to and from job site:

- 0 to 350 lineal feet..... **$6,308**
- 351 to 700 lineal feet..... **$7,780**
- 701 to 1,050 lineal feet..... **$11,354**
- Over 1,050 lineal feet requires Special Estimate: time and materials

Time and materials will be charged for re-inspection caused by contractor.

4.5 COMPACTION TESTS

Required when contractor uses native or imported backfill instead of control density fill

- Field in-place density test per ASTM D 2922.....**$139**
- Maximum dry density per ASTM D 698.....**$182**

4.6 NEW SERVICE INSTALLATION (DEVELOPER)

Standard charges will be reduced for new service installation in conjunction with developer installed water mains. None of the discounts for nondeveloper service installations listed in section 3 apply to the developer fees listed below.

The following conditions must be met:

- Property is within the direct service area of Seattle's water utility
  AND EITHER:
- Developer is installing a water main to serve the property
  OR

- During peak work load conditions, the Department authorizes the developer to open trench, shore, backfill, and complete all street/sidewalk paving restoration.

Note: If above conditions are not satisfactorily met, developer will pay SPU on a time and materials basis for completion of work.

Charges for new service installations meeting the conditions above are:

Domestic Services

Size (in.)	Installation Fee	
	Residential	*Arterial*
¾	**$1,932**	**$2,276**
1	**$2,018**	**$2,362**
1 ½	**$4,389**	**$4,926**
2	**$4,745**	**$5,498**
3	Cost*	Cost*
4	Cost*	Cost*
6	Cost*	Cost*

* All services 3 inches and larger will be based on a site-specific cost.

Fire Services

Size (in.)	Installation Fee	
	Residential	*Arterial*
2	**$6,667**	**$9,549**
4	Cost*	Cost*
6	Cost*	Cost*
8	Cost*	Cost*

* All services 3 inches and larger will be based on a site-specific cost.

Arterial streets include every street, or portion thereof, designated as such in Exhibit 11.18.010 of the Seattle Municipal Code.

If new service is being installed with developer water main, see section 5.

Any service request deemed by SPU to be nonstandard will be based on a site-specific cost.

Combination Fire/Domestic Services

- Combination fire/domestic services are available in 4-inch, 6-inch and 8-inch sizes. These services require approval from the SPU Director or designee.
- All combination fire/domestic services will be based on a site-specific cost.

Legislation for an easement granted to the City of Seattle for infrastructure to be owned by SPU but installed by a developer, see section 5.6.

5. PROPERTY SERVICES

SPU must charge for any administrative costs it incurs as a result of processing applications or requests for the use of SPU's property, or the purchase of SPU's property or property rights (such as an easement). These costs can be charged in the form of a "Standard Charge" or "Time and Material" as established by section 5 herein.

In addition to administrative costs SPU must receive "Fair Market Value" for any property sold, easements granted, other permanent or temporary property rights granted, or the use of SPU Property. Fair Market Value can include the value of any real and substantive benefit to SPU (Mutual and Offsetting Benefits).

Unless otherwise provided by Ordinance, no permit shall be issued that would extend for more than a year. Otherwise, all permits must be revocable.

Due to the variables inherent to real property transactions, administrative costs, legislative costs, and Use Fees established by section 5 may not always accurately apply. In such cases, charges may be adjusted to reflect the actual situation.

Leasehold Excise Tax is required on all permits and leases as required by RCW 82.29A, and RCW 82.29A.130.

All charges established by City of Seattle ordinance or regulations take precedence over all charges established by section 5 herein.

5.1 TIME AND MATERIAL CHARGES

If SPU determines that a Standard Charge established by section 5 is expected to be inadequate to cover SPU's administration costs arising from any application or request, an estimate of the expected Time and Material cost will be determined by SPU. The applicant or requester shall pay the estimated amount, which shall be deposited in a SPU Guaranteed Deposit Account, and billed periodically. If actual Time and Material costs are less than the deposit, the balance shall be refunded; if the actual costs exceed the deposit, the balance owing will be charged to the applicant.

If mutually agreed between SPU and the applicant or requester, the estimated amount may be paid up-front as payment in full, and no accounting of Time and Materials will be kept.

At SPU's discretion, a deposit will not be required for governmental or public entities such as state, county or municipal governments, or public utilities, provided that such entity has entered into an agreement with SPU to pay accrued charges on a periodic basis.

5.2 STANDARD CHARGES FOR USE PERMIT APPLICATION

The following fees are nonrefundable:

- **$1,745** is the Standard Charge for a permit application, when administration costs are expected to require up to 16 hours of SPU time. Generally, this charge applies for simple Utility Crossings, Linear Use, and Surface Use of SPU

Property. If more than 16 hours are expected to be required, Time and Material costs may be charged.

- **$340** is the Standard Charge for the first-time preparation of a Special Short-Term Surface Use Permit. **$110** will be the Standard Charge for each renewal of the permit. In addition, the Permittee is required to pay the appropriate gate opening fees, the Special Short-term Surface Use Fee of **$50** a day for the use of SPU's property, and provide proof of insurance as required by SPU. A single permit may be issued for recurring use up to 30 days per year.
- **$570** is the Standard Charge for Permittee name change with no change in use. Permit Terms and Conditions, and Use Fee, may be updated.

5.3 USE FEES

In addition to the Standard Charge for Use Permit Application Fee under section 5.4, herein, Use Fees for the use of SPU property for permits and leases to be granted shall be established at "Fair Market Value" unless a specific rate is provided below:

Utility Crossings
There is no use fee for utility crossings of SPU fee-owned right of way.

General Surface Use

- There are Use Fees for Surface Use of SPU fee-owned property. Typically this use is for parking in SPU right of way used by adjacent property owners, but, can include other uses such as construction staging, job shacks, etc.
- The Annual Use Fee for all for-profit Permittees shall be no less than **$1,000**, even if the estimated "Fair Market Value" for the use of the SPU fee-owned property is less.

Special Short-term Surface Use
$50 per day. Typically this use is for short term parking for community sponsored and non-profit events that are compatible with utility use, but is not limited to parking.

Linear Use of Property
There are Use Fee's for Linear Use of SPU fee-owned property, typically utility use of the surface, underground, or overhead. Linear Use Fees are currently under review. Until such time as the fees are officially changed, unless established otherwise by an existing permit, the following fees apply:

- **$500** Annual Use Fee for each communication related conduit, cable, or wire, plus 25 cents for each conduit, cable, or wire for each linear foot over 1,000 feet. This fee applies to cable, conduit, or wire of no more than 4 inches in diameter. This fee will be increased proportionately for larger sizes or more impactful installations.
- **$500** Annual Use Fee for each distribution or service related utility facilities, such as water, sewer, drainage, and gas, plus 25 cents for each conduit or cable, for each linear foot over 1,000 feet. This fee applies to facilities of no more than 4 inches in diameter. The fee for transmission facilities and facilities of more than 4 inches in diameter shall be determined on a case by case basis.
- When issuing new permits, there is a **$250** Annual Use Fee for each hand hole, vault or other above or below ground structure measuring less than 2 feet in width, height and depth. The Annual Use Fee for each hand hole, vault or other

below- or above-ground structure measuring over 2 feet in height, width or depth shall be determined on a case-by-case basis. An Annual Use Fee may be instituted for each hand hole, vault or other below- or above-ground structure that is discovered to exist within SPU property and was not included in approved plans submitted at the time of application of the permit.

Utility Use in SPU Tunnels

Use fees are currently under review, and could be changed at any time. Until such time as the fees are officially changed, unless established otherwise by an existing permit, the following annual fees apply.

- **$767** for each communications related conduit or inner duct under 2 inches diameter.
- **$1,534** for each communications related conduit between 2 to 3 inches diameter.
- **$2,300** for each communications related conduit (which can contain inner duct) 3-plus inches diameter up to 48 square inches in cross sectional area of the cable or conduit.
- The Annual Use Fee for non-communications related facilities, such shall usually be at the same rates as the communication facilities. However, the fee may be determined on a case by case basis.
- Any facilities of more than 48-square inches in cross sectional area may be determined on a case by case basis.

5.4 PREPARATION OF LEGISLATION

The following fee is nonrefundable.

$3,807 is the Standard Charge for the administrative cost for any legislation required due to the requests or actions of any person or entity, other than SPU. This charge is based on the requirement that the applicant and or requester provide all necessary information, such as acceptable proof of ownership, signatory authority, and an adequate survey and legal description. If, due to the applicant or requester's actions, SPU staff time significantly exceeds the cost of the Standard Charge, the applicant and or requester may be charged for additional SPU Time and Material costs.

Legislation is required when SPU buys or sells property, grants or acquires easements or any other property rights, grants permits, rental agreements or leases for more than one (1) year in duration.

Legislation is required for Partial or Full Transfers of Jurisdiction between City Departments.

5.5 REAL PROPERTY REVIEW OF STREET VACATION APPLICATIONS

No charge if SPU infrastructure is not located within the proposed vacation area.

Time and Materials shall be charged to the applicant or requester for SPU costs when either there is SPU infrastructure in the street vacation area, or the street vacation will impact other SPU infrastructure.

All reservations of rights for SPU infrastructure shall be subject to all other applicable costs and fees including, but not limited to legislation costs.

5.6 SURPLUS, SALE OR EXCHANGE OF SPU FEE-OWNED PROPERTY

Time and Materials and legislative costs shall be charged, as per section 5.1, for SPU costs in conjunction with the sale or exchange of SPU property, when initiated by an outside entity. These costs may include, but are not limited to: SPU staff time, title, appraisal, survey, document preparation, closing and recording. If actual costs are less than the deposit, the balance shall be refunded; if the actual costs exceed the deposit, the balance will be charged to the applicant.

Time and Materials and legislative costs generally are not charged when SPU initiates a sale of surplus property.

In addition to these charges, SPU must receive Fair Market Value for its property.

5.7 ENCROACHMENTS

Encroachments are unauthorized use of SPU fee-owned property or easement rights. Types of encroachments and the impact to SPU property rights vary greatly. Therefore, the Time and Material and Use Fees to resolve encroachments shall be determined on a case-by-case basis.

5.8 MINOR PROJECTS AND ACCESS TO SPU PROPERTIES

Gate opening fees according to section 3.21.

$125 per hour with a one hour minimum charge for entry to SPU facilities when a security specialist is required for access and/or to stay with non-SPU personnel while on SPU property.

$80 to **$125** per hour will be charged (hourly rates will vary) for entry to SPU facilities when SPU personnel are required for access and/or to stay with non SPU personnel while on SPU property. The rate will include overtime when applicable. When overtime is applicable, a minimum of 4 hours overtime will be charged. Travel time will also be charged.

$125 may be charged if a Site Security Plan provided by SPU Security is required.

6. LABORATORY ANALYSIS

All laboratory analyses will be conducted at the discretion of the Water Quality Laboratory Manager and on the basis of time availability. Prices reflect the cost for routine analyses with standard reporting and turnaround times. The price for analyses not included in this list will be based on the cost for labor, equipment, material and overhead, as determined by the Water Quality Laboratory Manager. If available and mutually agreeable, analyses may be available on a call-out basis at double the charges listed.

6.1 BACTERIOLOGICAL ANALYSIS — PER ANALYSIS

Total Coliform (MF)	**$25**
Total Coliform (MPN)	**$21**
Total Coliform/E. Coli (MMO/MUG; P/A)	**$17**
Coliform verification; including Fecal Coliform/E. Coli (EC/MUG)*	**$26**
Fecal Coliform (MF)	**$25**
Fecal Strep (MF)	**$21**
Enteric culture identification (API)	**$99**
Heterotropic plate count	**$26**
Pseudomnonas (MF)	**$25**
Biolog	**$145**
Sample prep for non-drinking water (filter/dilutions)	**$13**

* This test is performed on drinking water samples that test positive for Total Coliform by the membrane filtration method. It is used to verify the presence of Total Coliform and simultaneously test for Fecal Coliform and E. Coli.

6.2 CHEMICAL ANALYSIS — PER ANALYSIS

Metals/Inorganics

Metals by Flame AA and Flame Emission Screen	**$19** per element
Batch of 8 to 19	**$39** per element
Batch of 20 or more	**$22** per element
Metals by Graphite Furnace AA	
Batch of 1 to 19~	**$43** per element
Batch of 20 or more	**$29** per element
Digestion for non-drinking water samples	**$25** per sample
ICPMS 21 element screen†	**$237** per sample
ICPMS (less than 20 samples, 3 to 7 elements/sample	**$23** per element
ICPMS (20 or more samples for 3 to 7 elements or 10 or more samples for 8 or more elements)	**$16** per element
Metals Filtration	**$23** per sample

~ If two or more metals can be analyzed simultaneously, then 10 samples of two metals qualify for volume discount.

† ICPMS screen includes: Al, Ag, As, Ba, Be, Cd, Co, Cr, Cu, Fe, Hg, K, Mn, Na, Ni, Pb, Sb, Se, Sn, Tl, Zn

Titrations

Total Alkalinity ..... **$21** per sample
Batch of 10 or more ..... **$16** per sample
Calcium or Hardness, edta ..... **$24** per sample
Batch of 10 or more ..... **$18** per sample

Organics

Total Trihalomethanes (TTHMs) **$96**
Total Organic Carbon (TOC) **$29**
Haloacetic Acids (HAAs) **$140**
Dissolved Organic Carbon (DOC) **$39**
DBP Formation/Simulate, Distribution System (prep only) **$83**

Nutrients

Total Nitrogen **$25**
Total Phosphorus **$25**
Nitrate-Nitrite **$25**
Soluble Reactive Phosphorus **$24**

Other Procedures

Color **$9**
Copper (comparitor, colorimetric) **$11**
Fluoride (potentiemetric) **$15**
Iron (colorimetric comparitor) **$11**
pH, potentimetric **$15**
Specific conductance **$11**
Turbidity **$9**
Chlorine Residual, colorimetric **$11**
Chlorine Demand
Single contact time at the requested temperature, pH, and Cl2 dosage **$103**
For each additional contact time, temperature, pH or Cl2 dosage on the same water source. **$35**
Seepage (minimum or sum of parameters tested) **$58**
UVA (254-545) **$14**
SOC-VOC Screen **$166**
VOC Screen **$134**
Nitrate-Nitrite Screen and UVA **$28**
Solids, Total Suspended **$30**
Solids, Total Dissolved **$30**

SEATTLE PUBLIC UTILITIES
2012-2014 WATER RATES

Effective January 1, 2012

(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)	(m)	(n)
	Direct Service												Wholesale
RATE SCHEDULES	Inside City				Outside City				City of Shoreline / City of Lake Forest Park				Full and Partial
	Residential	MMRD*	Gen Svc	Fire Service	Residential	MMRD*	Gen Svc	Fire Service	Residential	MMRD*	Gen Svc	Fire Service	
Commodity Charge ($/100 Cubic Feet)													
Offpeak Usage (Sept 16-May 15)	$4.04	$4.04	$4.04		$4.61	$4.61	$4.61		$4.90	$4.90	$4.90		$1.52
Peak Usage (May 16-Sept 15)													
Up to 5 ccf**	$4.34	$4.34	$5.15		$4.95	$4.95	$5.87		$5.26	$5.26	$6.25		$2.26
Next 13 ccf**	$5.15	$5.15	$5.15		$5.87	$5.87	$5.87		$6.25	$6.25	$6.25		$2.26
Over 18 ccf**	$11.80	$11.80	$5.15		$13.45	$13.45	$5.87		$14.31	$14.31	$6.25		$2.26
Usage over base allowance				$20.00				$22.80				$24.30	
Utility Credit ($/month)	$16.97		$10.14		$16.97		$10.14		$16.97		$10.14		
Demand Charge ($/1000 gallons of deficient storage)													$22.00
Base Service Charge ($/month/meter)													New Srvc Fee (One Time)
3/4 inch and less	$13.25		$13.25		$15.10		$15.10		$16.05		$16.05		$783
1 inch	$13.65		$13.65		$15.55		$15.55		$16.55		$16.55		$1,566
1-1/2 inch	$21.05	$21.05	$21.05		$24.00	$24.00	$24.00		$25.55	$25.55	$25.55		$3,915
2 inch	$23.35	$23.35	$23.35	$15.40	$26.60	$26.60	$26.60	$18.00	$28.30	$28.30	$28.30	$19.00	$6,264
3 inch	$86.35	$86.35	$86.35	$20.00	$98.45	$98.45	$98.45	$23.00	$104.70	$104.70	$104.70	$24.00	$17,226
4 inch	$123.75	$123.75	$123.75	$37.00	$141.10	$141.10	$141.10	$42.00	$150.10	$150.10	$150.10	$45.00	$24,273
6 inch		$152.30	$152.30	$63.00		$173.60	$173.60	$72.00		$184.70	$184.70	$76.00	$51,678
8 inch		$199.00	$199.00	$100.00		$227.00	$227.00	$114.00		$241.00	$241.00	$121.00	$87,696
10 inch		$297.00	$297.00	$144.00		$339.00	$339.00	$164.00		$360.00	$360.00	$175.00	$132,327
12 inch		$402.00	$402.00	$210.00		$458.00	$458.00	$239.00		$488.00	$488.00	$255.00	$186,354
16 inch		$477.00	$477.00			$544.00	$544.00			$579.00	$579.00		$186,354
20 inch		$614.00	$614.00			$700.00	$700.00			$745.00	$745.00		$186,354
24 inch		$771.00	$771.00			$879.00	$879.00			$935.00	$935.00		$186,354

Effective January 1, 2013

(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)	(m)	(n)
	Direct Service												Wholesale
RATE SCHEDULES	Inside City				Outside City				City of Shoreline / City of Lake Forest Park				Full and Partial
	Residential	MMRD*	Gen Svc	Fire Service	Residential	MMRD*	Gen Svc	Fire Service	Residential	MMRD*	Gen Svc	Fire Service	
Commodity Charge ($/100 Cubic Feet)													
Offpeak Usage (Sept 16-May 15)	$4.50	$4.50	$4.50		$5.13	$5.13	$5.13		$5.46	$5.46	$5.46		$1.53
Peak Usage (May 16-Sept 15)													
Up to 5 ccf**	$4.73	$4.73	$5.72		$5.39	$5.39	$6.52		$5.74	$5.74	$6.94		$2.26
Next 13 ccf**	$5.72	$5.72	$5.72		$6.52	$6.52	$6.52		$6.94	$6.94	$6.94		$2.26
Over 18 ccf**	$11.80	$11.80	$5.72		$13.45	$13.45	$6.52		$14.31	$14.31	$6.94		$2.26
Usage over base allowance				$20.00				$22.80				$24.30	
Utility Credit ($/month)	$18.19		$11.22		$18.19		$11.22		$18.19		$11.22		
Demand Charge ($/1000 gallons of deficient storage)													$22.00
Base Service Charge ($/month/meter)													New Srvc Fee (One Time)
3/4 inch and less	$13.50		$13.50		$15.40		$15.40		$16.35		$16.35		$783
1 inch	$13.90		$13.90		$15.85		$15.85		$16.85		$16.85		$1,566
1-1/2 inch	$21.45	$21.45	$21.45		$24.45	$24.45	$24.45		$26.00	$26.00	$26.00		$3,915
2 inch	$23.75	$23.75	$23.75	$15.40	$27.10	$27.10	$27.10	$18.00	$28.80	$28.80	$28.80	$19.00	$6,264
3 inch	$88.00	$88.00	$88.00	$20.00	$100.30	$100.30	$100.30	$23.00	$106.70	$106.70	$106.70	$24.00	$17,226
4 inch	$126.10	$126.10	$126.10	$37.00	$143.75	$143.75	$143.75	$42.00	$152.95	$152.95	$152.95	$45.00	$24,273
6 inch		$155.15	$155.15	$63.00		$176.85	$176.85	$72.00		$188.15	$188.15	$76.00	$51,678
8 inch		$199.00	$199.00	$100.00		$227.00	$227.00	$114.00		$241.00	$241.00	$121.00	$87,696
10 inch		$297.00	$297.00	$144.00		$339.00	$339.00	$164.00		$360.00	$360.00	$175.00	$132,327
12 inch		$402.00	$402.00	$210.00		$458.00	$458.00	$239.00		$488.00	$488.00	$255.00	$186,354
16 inch		$477.00	$477.00			$544.00	$544.00			$579.00	$579.00		$186,354
20 inch		$614.00	$614.00			$700.00	$700.00			$745.00	$745.00		$186,354
24 inch		$771.00	$771.00			$879.00	$879.00			$935.00	$935.00		$186,354

Effective January 1, 2014

(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)	(m)	(n)
	Direct Service												Wholesale
RATE SCHEDULES	Inside City				Outside City				City of Shoreline / City of Lake Forest Park				Full and Partial
	Residential	MMRD*	Gen Svc	Fire Service	Residential	MMRD*	Gen Svc	Fire Service	Residential	MMRD*	Gen Svc	Fire Service	
Commodity Charge ($/100 Cubic Feet)													
Offpeak Usage (Sept 16-May 15)	$4.99	$4.99	$4.99		$5.69	$5.69	$5.69		$6.05	$6.05	$6.05		$1.53
Peak Usage (May 16-Sept 15)													
Up to 5 ccf**	$5.13	$5.13	$6.34		$5.85	$5.85	$7.23		$6.22	$6.22	$7.69		$2.27
Next 13 ccf**	$6.34	$6.34	$6.34		$7.23	$7.23	$7.23		$7.69	$7.69	$7.69		$2.27
Over 18 ccf**	$11.80	$11.80	$6.34		$13.45	$13.45	$7.23		$14.31	$14.31	$7.69		$2.27
Usage over base allowance				$20.00				$22.80				$24.30	
Utility Credit ($/month)	$19.46		$12.38		$19.46		$12.38		$19.46		$12.38		
Demand Charge ($/1000 gallons of deficient storage)													$22.00
Base Service Charge ($/month/meter)													New Srvc Fee (One Time)
3/4 inch and less	$13.75		$13.75		$15.70		$15.70		$16.70		$16.70		$783
1 inch	$14.20		$14.20		$16.20		$16.20		$17.20		$17.20		$1,566
1-1/2 inch	$21.85	$21.85	$21.85		$24.90	$24.90	$24.90		$26.50	$26.50	$26.50		$3,915
2 inch	$24.20	$24.20	$24.20	$15.40	$27.60	$27.60	$27.60	$18.00	$29.35	$29.35	$29.35	$19.00	$6,264
3 inch	$89.65	$89.65	$89.65	$20.00	$102.20	$102.20	$102.20	$23.00	$108.70	$108.70	$108.70	$24.00	$17,226
4 inch	$128.45	$128.45	$128.45	$37.00	$146.45	$146.45	$146.45	$42.00	$155.80	$155.80	$155.80	$45.00	$24,273
6 inch		$158.05	$158.05	$63.00		$180.20	$180.20	$72.00		$191.70	$191.70	$76.00	$51,678
8 inch		$199.00	$199.00	$100.00		$227.00	$227.00	$114.00		$241.00	$241.00	$121.00	$87,696
10 inch		$297.00	$297.00	$144.00		$339.00	$339.00	$164.00		$360.00	$360.00	$175.00	$132,327
12 inch		$402.00	$402.00	$210.00		$458.00	$458.00	$239.00		$488.00	$488.00	$255.00	$186,354
16 inch		$477.00	$477.00			$544.00	$544.00			$579.00	$579.00		$186,354
20 inch		$614.00	$614.00			$700.00	$700.00			$745.00	$745.00		$186,354
24 inch		$771.00	$771.00			$879.00	$879.00			$935.00	$935.00		$186,354

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SEATTLE PUBLIC UTILITIES
2013 WATER SYSTEM PLAN

C. POLICIES, PROCEDURES AND STANDARDS

APPENDIX C-5

WATER AVAILABILITY CERTIFICATES

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Seattle Public Utilities

Policy and Procedure

Title	Number
Water Availability Certificates (WACs)	CS-101
Responsibility	**Supersedes**
Drinking Water Division	2003 version
SPU Director's Approval	**Effective Date**
Ray Hoffman	May 9, 2011

1. PURPOSE

To establish policies for Seattle Public Utilities for issuance of Water Availability Certificates (WACs) in response to either certain applications within SPU Water's direct service area for the issuance of building permits, land use permits, or to customer requests for information about SPU's infrastructure and capacity requirements.

2. ORGANIZATIONS AFFECTED

- City of Seattle, Seattle Public Utilities
- City of Seattle, Department of Planning and Development
- City of Seattle, Fire Department
- King County Department of Building and Land Use
- King County Fire Districts
- City of Shoreline, Planning and Development Services
- Shoreline Fire District
- City of Burien
- City of Renton
- City of Lake Forest Park
- Developers/potential developers within SPU Drinking Water's direct service area

3. DEFINITIONS

Condominium is a type of housing consisting of one or more multiple-unit buildings. Each unit is owned separately but the surrounding land is owned in common. For purposes of this policy, the entire condominium is considered a single legal parcel.

Cottage-style development is a type of multi-family housing consisting of detached, separately-owned units with the surrounding land owned in common. For purposes of this policy, the entire cottage-style development is considered a single legal parcel.

Developer is a property owner, or a property owner's designee, who is building a structure to be supplied with water service on at least one legal parcel.

Engineering standards are Seattle Standard Specifications and Standard Plans, professional and technical society standards (such as AWWA, APWA), and City memoranda specifying design standards.

Frontage, for the purposes of this policy, is a boundary of any legal parcel or unit lot abutting a street right of way which is at least ten feet wide.

If the parent lot of a subdivision has frontage on more than one street right of way, the resulting lots are considered to have frontage on the street right of way nearest to the boundary.

If the parent lot of a subdivision has frontage on only one street right of way, all of the resulting lots are considered to have frontage on the same street right of way as the parent lot.

Landlocked Lot is a parcel or unit lot which has no street right of way within ten feet of any part of the boundary.

Master meter is a metered water service from a SPU-owned water main, serving more than one legal parcel or unit lot.

No-tap main is a water main for which SPU has determined that no new services shall be installed. Examples of no-tap mains are transmission or large diameter feeder mains, substandard mains with capacity inadequate for service, and mains from a different pressure zone. In some circumstances a main may be a no-tap main for services on only one side of the street.

Private water line is the customer-owned water pipe that extends from the end of the SPU water service at the city union point.

Standard water main is an SPU main which meets current size and material engineering standards and which can deliver required flows to service the project and surrounding area.

Townhouse, or *unit lot subdivision*, is a type of high-density residential development consisting of single or multiple-unit buildings. Each unit and its surrounding land are separately owned. For purposes of this policy, each unit lot is considered a separate legal parcel.

Union is a coupling at the end of SPU's water service connecting the public water service to the privately owned water service.

Water service is the portion of the SPU water distribution system dedicated to providing metered water service to a specific account. The water service begins at the water main, continues through the meter, and ends at the city union point.

4. GENERAL POLICIES

A. SPU will offer all customers in like circumstances the same requirements, services, agreements, or privileges.

B. WACs provide information on the SPU water system only. Information about on-site or privately owned water mains and/or hydrants is not included. The WAC document includes the following information:

1) Location of the property, including street address or Assessor's Parcel Number, and SPU map number.
2) Type of certificate (Inquiry, Meter Only, Building Permit or Land Use).
3) Certificate number, date of issue, and certifier's name.
4) Description of existing service(s) if any, including size, type and material.
5) Pressure zone and elevation.
6) Description of existing water main (if any), including size, material, installation date and distance from margin.
7) Description of hydrant, including distance from site and flow test or flow model, if available

C. Requirements for water service will be determined prior to issuing the WAC. An approved WAC is required for approval of building and land use permits.
   1) If an existing water service will be retained with no change, OR if the proposed project does not require water service, OR if water service is available at the project site with no changes to the existing distribution system, the WAC will be approved.
   2) If changes to the distribution system are required to provide water to the project, the WAC will not be approved, and the required changes to the distribution system will be described on the WAC.
   3) An Approved with Contract WAC will be issued when the property-owner/developer signs SPU's Property Owner Contract to Change SPU's Distribution System and pays the required fees.
   4) If the proposed project changes, the WAC will be re-evaluated. Changes to the project may result in increased requirements for water service.

D. SPU may reduce or waive the water main requirements under this policy, or may require an alternate improvement of equal or lesser cost, if such changes best serve the distribution system.

E. In some conditions (e.g., 20 percent or greater slopes, riparian corridors or other geological barriers, poor soil) the public right of way may be inappropriate for water main operation. The requirement to install a water main may be waived in such circumstances. SPU will determine on a case-by-case basis whether engineering remedies exist which would suffice for the construction of a main extension.

F. In special circumstances, the system may be best served by installation of a water main larger than required by this policy. In such cases, SPU will pay the difference in materials cost between the required standard main and the desired size.

G. In some circumstances, including but not limited to state highways, divided roads, presence of active railroad tracks, or other obstructions in the right of way, installation of a standard water main to serve each side of the road may be required.

H. Conditions not specifically described in this policy, including but not limited to multiple households on a single service, relocation of an existing service, increasing the size of an existing service, multiple services to the same legal parcel, and "no-man's land" areas not included in any existing water district, shall be evaluated on a case-by-case basis.

I. The property owner or developer may appeal the requirements made on the WAC by calling or writing to SPU. The WAC Review Committee will review the project and respond within two (2) weeks after receipt of the appeal to all interested parties, including the person appealing and other affected agencies. A revised WAC will be issued if required.

5. REQUIREMENTS FOR NEW WATER SERVICE

A. If no frontage of a parcel or unit lot abuts an existing standard water main, a standard water main will be extended to cross the full frontage of the property, and a portion of the adjoining street and/or alley, if any.

B. Unless landlocked, a parcel or unit lot must have at least ten feet of frontage abutting an existing standard water main to obtain water service from that main. The ten-foot width must be maintained from the frontage to the parcel or unit lot.

C. For parcels or unit lots with frontage on only one street or right of way:
   1) If there is an existing standard water main in that right of way, service shall be provided from that main.
   2) If there is not an existing standard water main in that right of way, a standard main will be extended across the full frontage of the legal parcel, and a portion of the adjoining alley, if any.
   3) SPU shall waive the requirement to install a standard water main if
      a. The parcel is located in a single family zone, AND
      b. The parcel is the last developable, single-family lot on the block, as determined by the permit-issuing agency with jurisdiction over it, AND
      c. There is no existing water main on the block.

D. For parcels or unit lots with frontage on more than one street right of way:
   1) If there are existing standard water mains on more than one frontage, SPU shall determine which main shall provide water service to the parcel.
   2) If a parcel or unit lot has frontage abutting only one existing standard water main, service shall be provided from that main.
   3) If there are no existing standard water mains on any frontage, SPU may require installation of a standard water main across the full frontage of the legal parcel, and a portion of the adjoining alley, if any.

E. If a parcel or unit lot is landlocked (has no frontage within ten feet of any right of way), SPU may require the Developer to install a water main on private property, to be owned by SPU. Landlocked parcel(s) or unit lot(s) for which SPU determines not to require a water main shall be served via private water lines through private easements, or through a master meter.

F. If the parent lot of a subdivision, including unit lot subdivisions, is more than 200 feet deep as measured from the property line at the public right of way to the point farthest away from it, SPU may require the Developer to install a water main on private property, to be owned by SPU.

G. New water mains installed under this policy shall follow current City of Seattle Plans and Specifications and SPU water main design standards.

H. Private water lines shall be on private property unless specifically approved by SPU and SDOT.

I. At SPU's discretion, new services may be installed each in a separate standard meter box (individual), or consolidated together into larger vaults and connected to the main with manifold piping, whereby each group of services is supplied from a single tap on the existing or newly installed water main in the public right of way.

J. The easement for an SPU-owned main on private property must be at least twenty feet wide.

K. Private water lines in easements may be bundled if desired.
   1) Bundled private water lines shall be installed in a casing pipe.
   2) Each private water line in the bundle shall be separately identified.

L. The easement for one private water line or for a casing pipe containing bundled private water lines must be at least 5 feet wide. If more private water lines will be installed in any portion of an easement, a minimum of one additional foot of easement width must be allowed for each additional private water line. The easement must be continuous from the water meter to the parcel or unit lot served by that meter.
   1) The easement must be obtained by the developer, recorded, and a copy provided to SPU at the time of ordering water service.
   2) Individual and bundled private water lines in easements shall be impermeable to petroleum products.

M. Cottage developments shall be served by an SPU master meter. Private submeters may be used if desired.

N. A common fire and/or irrigation service may be installed to serve properties which have individual domestic services (e.g., live/work townhouses with a common garage).

O. A covenant and a homeowners' association are required for legal parcels which are served by a master meter (with or without private submeters) OR by a privately owned water distribution system, OR which share a common fire and/or irrigation service. To order water service for the project, the Developer must provide:
   1) A signed, recorded covenant for each legal parcel/living unit within the boundary of the project stating that SPU will not separate shared water service(s).
   2) Documentation of the creation of a homeowners' association or other entity which will be responsible for the operation, maintenance, repair, replacement of the privately owned piping and/or shared water service as well as the payment of all SPU utility charges.
   3) SPU will not read or bill any privately owned water meters from privately owned water systems.

P. Lot boundary adjustments which have the effect of avoiding water main installation requirements under this policy shall not be considered by SPU when such determination is made.

6. AUTHORITY/REFERENCES

- RCW 80.28.080, Gas, electrical, and water companies
- SMC 21.040.060, Water rates and regulations

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SEATTLE PUBLIC UTILITIES
2013 WATER SYSTEM PLAN

C. POLICIES, PROCEDURES AND STANDARDS

APPENDIX C-6

WATER SERVICE WITHIN THE DIRECT SERVICE AREA

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Seattle Public Utilities - Policy & Procedure

Subject:		Number: SPU-CS-102
Water Service within the Direct Service Area		Effective: October 17, 2003
		Supersedes: SPU-CS-010 (12/30/83) 400P-23-05 (9/01/82)
Approved:	Department: Seattle Public Utilities	Page(s):

1.0 PURPOSE

To establish policies and procedures for Seattle Public Utilities for granting water service connections to its water distribution system within its direct service area.

2.0 ORGANIZATIONS AFFECTED

2.1 City of Seattle, Seattle Public Utilities (SPU)
2.2 City of Shoreline
2.3 King County
2.4 Customers residing near and within SPU's direct water service area

3.0 AUTHORITY FOR RULE

3.1 Revised Code of Washington 35.91; 35.92; 80.28.080
3.2 Seattle Municipal Code 21.04
3.3 Most current SPU Water System Plan

4.0 GENERAL POLICIES

4.1 Standards and Requirements for New Services

4.1.1. All new SPU water service connections will be connected to a standard water main designed to serve that property. (see also Policy SPU-CS-101, Water Availability Certificates)

4.1.2 All water service connections to SPU's water distribution system will be metered and either monthly or bi-monthly bills will be sent to the property owner or owner's designee,

4.1.2.1 The only exception to the above metering and billing policy will be for the fire services on Interstate Highways 5 and 90.

4.1.3 Application for water service by the property owner will be approved when SPU has issued a current, approved Water Availability Certificate, and when SPU has been provided with the following:

4.1.3.1 SPU's application for water service form completed and signed by the property owner, and

4.1.3.2 the common street address and legal description of the parcel to be served, and

4.1.3.3 utility plans showing all existing and proposed utilities

4.1.3.4 all recorded easements needed for private service lines, when applicable.

4.1.3.5 payment of the current standard or estimated deposit fees for installation, and

4.1.3.6 payment of the street use permit if applicable, and

4.1.3.7 payment of the Connection Charge in full (see Policy _____, Connection Charge), or entering into SPU's finance contract for its payment over a 10-year period

4.1.4 Each legal parcel will be served by one domestic water service, except

4.1.4.1 When SPU has allowed or required parcels not abutting a water main to be served by either a privately owned water main or long service lines, a covenant or homeowner bylaws will be filed with those parcels to run with the land and prohibit the property owners of those parcels from requesting individual service directly from SPU's distribution system.

4.1.4.2 Certain parcels may be served by more than one domestic service due to the use of the property, i.e., hospitals, nursing homes and similar facilities, to assure continuous uninterrupted water service. Each service will be from separate water mains abutting the parcel when possible.

4.1.4.3 A community containing more than one legal parcel and either more than 350 feet of private road, or a gated private road of any length, will be served with one domestic meter at the perimeter of that community of legal parcels.

It may be possible that a second SPU domestic service be available to this community's private system from a second SPU-owned water main if needed to provide reliability via a "looped" private water system, i.e., a system having two separate sources of water from the SPU distribution system. Both domestic services would be located at the perimeter of the community of legal parcels. (see also Sec. 4.4.5 of Policy SPU-CS-101, WACs)

4.1.4.4 One very large parcel of land which contains a privately owned water distribution system may be served by more than one domestic service to provide reliability via a "looped" private water system (e.g., the University of Washington campus).

4.1.4.5 One property may not serve another with water service, unless explicitly approved by both SPU and the affected property owners for a temporary, specified time period.

4.1.4.6 Each legal parcel will be eligible for separate water service for irrigation in addition to other domestic service.

4.1.4.7 Each legal parcel will be eligible for separate fire-only service.

4.1.5 Fire-only water services will consist of a detector check valve and a bypass meter assembly.

4.1.5.1. Water may be used at no charge for testing of the on-property fire suppression system monthly as follows:

- 100 cubic feet for fire services 1-to-2inches
- 500 cubic feet for fire services 3-to-5 inches
- 1,000 cubic feet for fire services larger than 5 inches

4.1.5.2. The detector check valve will be changed by SPU, at the property owner's expense, to a fully metered fire service if water used at the property regularly exceeds the above limits set for system testing

4.1.6. If a property's water service will be used solely or in part for an internal fire suppression system (e.g. sprinkler heads), the property shall not be served by a water service less than one inch (1") in size.

4.1.7 Water service to direct service area customers will be from SPU's distribution water main system and not from its supply or transmission pipelines.

4.1.8 Water services up to two inches (2") in size will be charged a reduced installation rate when

4.1.8.1 a new water main to serve the property and to be owned by SPU is installed by a property owner, and

4.1.8.2 the property owner's contractor will trench for SPU's service line and backfill the trench.

4.1.9 Water service to customers within SPU's direct service area may be obtained from a water purveyor whose distribution system abuts the property within SPU's direct service area and SPU requests this purveyor in writing to provide temporary service to a particular property until SPU is ready to serve from its own distribution system.

4.1.10 SPU will consider an application for water service to a property not located within its direct service area only when

4.1.10.1 SPU's water service pipe and meter will be within SPU's direct service area, and

4.1.10.2 the water utility whose direct service area includes this property has requested SPU in writing to serve this property until such time as that utility is prepared to serve it directly, and all other applicable requirements in SPU's policies have been fulfilled.

4.1.11 Temporary water service from the distribution system for less than six months may be authorized via a hydrant use permit or hydrant use meter issued by SPU Customer Services if no other source of water is available. No administrative or water usage charges for hydrant permit holders will be made for water main installation projects sponsored by SPU and for which SPU will pay all project costs.

4.1.11.1 Hydrant use without a hydrant permit or hydrant meter, or use of a restricted hydrant, will result in monetary penalties in addition to all other hydrant use charges:
$ 300 penalty for the first occurrence
$ 500 penalty for the second occurrence
$1,000 penalty for the third and subsequent occurrence

4.1.11.2 Permits may be issued if water use will be for less than 8,000 gallons per day

4.1.11.3 Permit holder will pay a permit fee as well as a daily charge for the water used. Payment may be made either in advance of service, or subsequent to service following a billing by SPU. A billing fee will be charged for payments made subsequent to service.

4.1.11.4 Permit holder will use an SPU supplied (or approved) hydrant valve.

4.1.11.5 Permit holder will pay SPU for any hydrant repairs necessitated by the improper operation of the hydrant at a time and material basis.

4.1.11.6 Hydrant meters will be required either

4.1.11.6.1 at the discretion of SPU Customer Services, or

4.1.11.6.2 under the following circumstances:

- water use will exceed 8,000 gallons per day, and
- use will be longer than 30 days, and
- no other acceptable or practical method of measuring or estimating actual water used is practical, and
- one hydrant only will be used, and
- projected weather conditions will permit the meter to be used without danger of freezing its parts.

4.1.12 Metered service will be required when temporary water is needed from one location for longer than six months.

4.2 Standards and Requirements for Changes to Existing Services

4.2.1. Existing substandard water service will be brought to standard water service whenever possible.

4.2.1.1 When a distribution main is installed which extends the distribution system to abut properties not formerly served by an abutting main, or to serve properties not formerly served by a main designed to serve that property, each property will abandon the service line to the nonabutting main and receive service from the main designed to serve or abutting the property.

4.2.1.1.1 Property owner will not be responsible for the cost either for SPU to retire the existing water service if it is two inches (2") in size or smaller, or for SPU to relocate an existing two-inch (2") or smaller water service. (see also Policy_____ Connection Charge)

4.2.1.1.2 Property owner will be responsible for the SPU costs for retirement and relocation of the existing water service if it is larger than two inches (2"). (see alsoPolicy _____ Connection Charge)

4.2.2. When a water main is replaced, existing water services from that segment of water main will be transferred to the new main, the property owner will not be responsible for either retirement or new installation charges.

4.2.3. When the City or SPU changes the street or other infrastructure abutting a property with substandard water service, that water service will be changed to conform to standard practices in preparation for other changes to or in the street.

4.2.4. Property owners may request changes in the size of their water service, the location of their meter along the frontage of their property, and the type of use of their existing water service.

4.2.4.1. When increasing a service size, SPU will both retire an existing service and tap for a new service and property owner will pay SPU standard or time-and-material charges.
(see also Policy _____ for Connection Charge.)

4.2.4.2. When decreasing a two-inch (2") or smaller service, SPU will reduce the size of the existing meter and property owner will pay on a time-and-material basis. Any subsequent changes to water service size at this property will require a service retirement and new tap.

4.2.4.3. When decreasing a service larger than two inches (2"), SPU will both retire the existing service and tap for a new service and property owner will pay SPU standard or time-and-material charges.

4.2.4.4. Property owner may request a relocation of an existing service to a site along the property's frontage, the new location may not be in a driveway or within five feet (5') of a tree. SPU will both retire the existing service and tap for a new service if the lateral distance between the old and new locations is 31 inches or greater. Property owner will pay SPU standard or time-and-material charges in keeping with the current SPU Standard, Connection and Administrative Charges.

4.2.5. An existing domestic, irrigation or fire service may be changed to another use at the request of the property owner if no change in size or location is needed. (see Connection Charge Policy _____)

4.2.5.1. The property owner will pay for any SPU services required to change a fire-only service to a combination fire and domestic service

4.2.5.2. Any other changes to meter type will be at SPU's discretion at no additional cost to the property owner when no change in water service location or size is requested by the property owner.

4.2.6. Property owner will be charged for SPU repair of damage to the curb stop, meter, meter setter, meter box or lid, or tailrun.

4.2.7. Termination of existing water service

4.2.7.1. Domestic (including irrigation) water service may be shut off by SPU due to either nonpayment of utility charges (see Policy 400P-23-02 Credit and Collection), at the request of the property owner, or to effect maintenance, repair or changes to the water system.

4.2.7.1.1. SPU may remove the meter at owner's expense following shut off of service

4.2.7.1.2. Property owner may request SPU, at owner's expense

- to remove the water meter to stop water and sewer services and charges during an extended vacancy at the property. The eventual reset of the water meter also will be charged to the property owner. Removal of the meter does not stop solid waste services or charges.

- to shut off the water meter to prevent damage to the property from leakage or unauthorized water use

- to retire the domestic or irrigation service to the property.

4.2.7.2. Fire service (either fire-only or combination domestic and fire) will not be terminated by SPU without written request by the property owner and written acknowledgement and concurrence by the local fire department or district.

4.2.8. SPU may retire a domestic water service after 15 years of nonuse and charge the property owner for the cost of the retirement.

4.2.9. If a jumper, not authorized by SPU, is installed to pilfer water, SPU may retire the service and charge the property for the retirement, as well as charge for estimated water and other utility services provided during the time period the jumper was in use, as determined by SPU.

5.0 PROGRAM REVIEW

Periodic review of this policy shall be performed by the SPU Customer Services Branch as changes or conditions warrant in order to ensure that it remains current and effective in guiding SPU employees. Any recommended changes will be submitted to the SPU Director for consideration.

6.0 RESPONSIBILITIES

6.1 Property owner is responsible for

- the installation, replacement or repair of the privately owned service line from the City's union to the building(s) served, including changing a private service line when the service location to the property changes in accord with this Policy
- calling SPU Customer Services for inspection of all private underground water service line installations, repairs or replacements prior to covering
- marking the desired location of a new water service before SPU installs the service
- identifying and correcting water leakage or unauthorized water usage and notifying SPU of corrections allowing SPU to inspect any repairs or corrected water use problems
- notifying SPU of changes in property ownership or owner's designee for receiving the utility billings

6.2 SPU is responsible for

- the installation, replacement or repair of the publicly owned service from the City's water main, including the tap into the main, to the City's union
- timely inspection and other customer services
- responsiveness to customer needs
- offering all customers in like circumstances the same requirements, services, contracts or agreements, or privileges
- notifying property owner of any water usage excesses through fire services to allow owner to correct any problems prior to SPU's changing the fire service from a detector check to a meter.

7.0 DEFINITIONS

7.1 Abutting water main is a main which crosses some amount of the property; it may not be a standard main designed to serve if either the abutting main does not cross the full frontage of the property and there is a developable parcel beyond the property, or if the abutting main is not standard in size or material.

7.2 Direct water service area is the retail service area served by SPU's water distribution system as defined by the most current SPU Water System Plan.

7.3 Domestic service is a type of water service serving all potable water used at a property except fire-only water service.

7.4 Fire-only water service is available to provide stand-by water service for the sole purpose of supporting fire suppression devices on property (sprinklers, private hydrants, etc.) via a detector check meter assembly. A combination fire and domestic service is a domestic water service and is not a fire-only water service.

7.5 Irrigation service is a type of domestic water service designed to provide irrigation-only water at a property; sewer charges are not made on the water used through irrigation-only water services.

7.6 Jumper is a pipe installed to allow domestic or irrigation water to freely flow from the publicly owned service line to the user without being measured or billed by a meter, usually located in the meter box when a meter has been removed or not yet installed.

7.7 Master meter is a metered water service from a SPU-owned water main serving more than one legal parcel due to and in accordance with established SPU policy and procedure.

7.8 Private water service consists of the underground pipe leading from SPU's union to the building(s) being served, including any valves, stopcock, private submeters, backflow devices, etc.

7.9 Retirement of water service occurs when SPU has removed the connection to its distribution system by removing the tap to the water main and all other related water service equipment

7.10 Standard water service exists when a property receives metered water service from a standard water main designed to serve that property

7.11 Substandard water service exists either when a property's water service comes from a water main not designed to serve that property (i.e., it could be an abutting or non-abutting substandard water main or a non-abutting standard main), or when a property's water service comes from a neighboring property's water service.

7.12 Tail run is a short length of pipe installed by SPU from the meter box to SPU's union.

7.13 Termination of water service may include shut off of water at the meter, removal of the water meter, or retirement of SPU's tap and service line to the property

7.14 Transmission or supply pipelines are used to move water from the source to the treatment plant and from the plant to the distribution system.

7.15 Union is a coupling at the end of SPU's water service connecting the public water service to the privately owned water service.

7.16 Water main designed to serve a property is a main either abutting the property or located as close to the property as possible considering barriers such as slope, soil or other conditions which make it unsafe or impractical to bring the water distribution system closer to the property. (see also Standard and Substandard Water Service)

7.17 Water service provides water from the distribution system to residential, industrial and commercial users within the direct service area. It includes a tap into a SPU water main and a SPU service line. (An active water service also includes a meter, tail run and union which connects to the property's private service line; an inactive water service has had the meter removed or not yet installed.)

7.17.1 Domestic water service is available to provide any potable water to a property, excluding fire-only water service.

7.17.2 Fire-only water service is available to provide stand-by water service for the sole purpose of supporting fire suppression devices on property (sprinklers, private hydrants, etc.) via a detector check meter assembly. A combination fire and domestic service is a domestic water service and is not a fire-only water service.

SEATTLE PUBLIC UTILITIES
2013 WATER SYSTEM PLAN

C. POLICIES, PROCEDURES AND STANDARDS

APPENDIX C-7
SYSTEM STORAGE LEVEL OF RELIABILITY

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Seattle Public Utilities
System Storage Level of Reliability
June 2012

A. INTRODUCTION AND BACKGROUND

As the water system evolved over the past century, reservoirs, tanks and standpipes were constructed to meet then anticipated needs for the system as configured at that time. Since the original formation of the City of Seattle, there have been 41 annexations to the City, which have created differences in the water infrastructure, primarily in pipe sizing, and resulted in variations in how that infrastructure met changing design standards. Over time, there has been a benefit of an increasing number of interconnections and amount of redundancy in the overall system. The system is now large and complex, with multiple ways of delivering water within the system. Major improvements include the addition of the Tolt supply, which resulted in a second, multi-pipeline supply source coming into the north end of the system, and substantial improvements to the transmission pipelines.

Another significant change that has occurred over the years is the anticipated water consumption used in planning for the water system. For most of Seattle's history, water consumption increased along with its population. However, that connection was broken around 1990 when consumption reached its highest level. Since then, total annual water consumption has declined by about 30 percent (50 MGD) despite population growth of 15 percent. Peak water demand has fallen even more than annual average demand. In the 1980's hot summer weather could produce peak day consumption of over 330 MGD, but in the last ten years peak day consumption has stayed below 250 MGD, even on the hottest days. As an example of how planning criteria have changed, the System Storage and Reliability Analyses (SSRA) conducted in the mid-1990s used a demand forecast for 2020 of 103.5 MGD average annual and 207.3 MGD peak day demand for the retail system, and 199.0 MGD average annual and 416.2 MGD peak day demand for the total system. The demand forecast in the *2013 Water System Plan* for 2020 indicates 53.5 MGD average annual and 107 MGD peak day demand for the retail system (without non-revenue water), and 133.1 MGD average annual and 266.2 MGD peak day demand for the total system (with non-revenue water), with the demand levels used in the SSRA not forecasted to be reached within the planning horizon (before 2060).

These changing conditions and anticipated needs have allowed SPU to downsize or decommission certain treated water storage facilities. Reservoirs that have been downsized consist of Lincoln, Myrtle, Beacon, and West Seattle Reservoirs. Roosevelt and Volunteer Reservoirs are being considered for decommissioning after testing. Maple Leaf Tank and Woodland Park Standpipe have been decommissioned and Barton Standpipe, Foy Standpipe, and Richmond Highlands #1 Tank will soon be decommissioned. Myrtle #1 Tank is proposed to be decommissioned. Decommissioning these facilities saves capital, operating and maintenance costs over the long-term. Also, the reduction in treated water storage allows for increased system turnover than would otherwise occur, thereby improving water quality. The approach, analysis and results used to determine reservoir sizing and identify facilities for decommissioning are described below.

B. SYSTEM RELIABILITY ANALYSIS

Hydraulic modeling of various scenarios is an effective way to evaluate current and future storage requirements for a complex system such as SPU's. Scenarios representing peak and off-peak demand seasons, as well as a range of emergency conditions, provide the basis for the analysis. SPU has analyzed its entire system to ensure that there is adequate storage to maintain continuity of retail and wholesale service in the future for certain emergencies with current and planned facilities in service or decommissioned. Under certain emergency scenarios and during periods of higher than average demands, SPU would aggressively message to retail and wholesale customers to reduce water use to indoor-use levels within 12 to 24 hours.

While the storage facilities are periodically removed from service for maintenance such as cleaning, the analyses assume all available storage facilities for that scenario are in service. Such maintenance outages slightly increase the water supply risk, but SPU mitigates this risk by scheduling the larger reservoirs for cleaning during the off-peak and shoulder seasons, and by taking only one large reservoir out of service at a time, if possible. Additionally, the frequency of reservoir cleaning is now lower than in the past because of filtration on the Tolt supply and covering of the reservoirs. Planned outages of other major facilities are also scheduled to reduce risks to the water supply whenever possible.

SPU has identified specific emergency scenarios that are appropriate for its system. These scenarios represent abnormal operating conditions associated with unscheduled power outages and facility failures, but without specific identification of the root cause of the outage or failure, although examples are provided for some scenarios. The scenarios analyzed could be caused by natural events such as severe weather storms or earthquakes, intentional or unintentional actions by humans (e.g., vandalism), or failure of a facility component due to age or other cause. Extreme events that may cause more than one scenario to occur concurrently are not considered because these have a very low probability of occurrence and system performance is very difficult to predict. There are three types of emergency scenarios that are used:

1. Transmission pipeline outages
2. Source water treatment facility outages
3. Regional power failure affecting all six individual pumped zones

1. Transmission Pipeline Outages

Transmission pipeline outages were analyzed in detail in the mid-1990s System Storage and Reliability Analyses (SSRA) where specific emergency scenarios were defined, each involving at least two system components serving a certain part of the system being unavailable. (For more details on the SSRA please refer to SPU's 2007 WSP.) Through detailed modeling it was demonstrated that retail and wholesale service can be maintained at average day demand levels which were much higher in the mid-1990s than they are now for at least seven days, which is a little more than twice the expected 3-day maximum repair time for any large pipeline break. (The 3-day maximum repair time is part of SPU's wholesale continuity of service level of service and is based in part on

actual experience with the 1987 Tolt Pipeline break repair.) This analysis also demonstrated that Roosevelt and Volunteer Reservoirs could be decommissioned, and affirmed that Lincoln, Myrtle, Beacon, and West Seattle Reservoirs could be downsized to what is now in place.

2. Treatment Facility Outages

The first set of scenarios examines the reliability of the system in the event of loss of treated water delivery from one of the two primary treatment facilities. These scenarios could be due to the loss of treatment capability at the treatment plant itself, or loss of transmission to or from the treatment plant. It should be noted that both the Tolt and Cedar Water Treatment Facilities have backup electrical power supplies, as well as dual treatment trains, which reduce the likelihood of full loss of treated water supply. The Tolt Water Treatment Facility has a maximum treatment capacity of 120 MGD, and the Cedar Water Treatment Facility has a maximum treatment capacity of 180 MGD.

These scenarios were analyzed as part of the Tolt/Cedar Transfer Improvements Study conducted in 2006 and 2007. The study analyzed five emergency scenarios that represent complete outage of the Tolt or Cedar supply, both during peak week and the off-peak season, and complete Tolt outage during a shoulder (spring or fall) season. The different system-wide demand levels were as follows:

- Off-peak demand (November through March) of 110 MGD
- "Shoulder season" demand level (June and September) of 170 MGD
- Peak day demand of 250 MGD, with reduction to indoor water use only demand of 120 MGD under emergency mandatory water use restrictions within 12-24 hours.

Tolt Outage. This scenario examines complete failure of the Tolt Water Treatment Facility during the summer or shoulder season, requiring s days to repair. The scenario assumes that the clearwell and Tolt transmission pipelines are in service. The results indicate that off-peak water demands can be met indefinitely without any supply from Tolt, and without storage drawdown. If the emergency were to occur during higher demands, public messaging would be implemented to bring demand down to indoor levels within 12-24 hours, during which time service would be maintained by drawing down transmission and distribution reservoirs while maintaining at least 20 psi in the distribution system.

Cedar Outage. This scenario examines complete failure of Cedar Water Treatment Facility during summer, requiring 7 days to repair. It is assumed that the Clearwells would be available and Control Works would be functional. The operating strategy would be to reconfigure several transmission pipeline junctions (some remotely, while others manually in the field) so that available supply from the Tolt could be delivered far south into the area typically served by the Cedar. Additionally, the Seattle Wells would be activated without on-site treatment, if necessary, within 8 hours of the onset of the emergency. The analysis demonstrated that normal service can be maintained for up to 7 days at indoor water use levels through a combination of supply from the Tolt and the Seattle Wells and from drawing down reservoirs while maintaining at least 20 psi in the

distribution system. If the emergency were to occur during higher demands, public messaging would be implemented to bring demand down to indoor levels within 12-24 hours. It was also noted in the course of the analysis that the Cedar Water Treatment Facility is much more distributed in nature than the Tolt, such that a problem with one component it less likely to affect the entire facility.

The results from the Tolt/Cedar Transfer Improvements Study affirmed that the reduced reservoir volumes identified in the SSRA provided the necessary level of reliability for these scenarios. In addition, this study indicated the need to install the modulating valve at Maple Leaf Gatehouse and improvements to the TESS Junction Pump Station.

3. Extended Regional Power Outage

This emergency scenario would involve disruption to the regional power grid that lasts for several days, similar to those experienced recently in the Northeast United States and the San Diego Metropolitan Area. Approximately 80 percent of SPU's system is supplied (directly or via reservoirs) by gravity from the clearwells of the two treatment facilities, which in turn are equipped with full capacity backup power generators. An extended power outage would therefore not be expected to affect the operation of the treatment facilities, nor the gravity flow to a large part of the system.

Six pressure zones (Richmond Highlands 590, Magnolia 480, Queen Anne 530, Volunteer 530, West Seattle 585 and West Seattle 498) that are normally supplied by pumping have been analyzed in greater detail to determine storage needs to maintain service through a combination of storage drawdown and pumping with non-electric pumps. This analysis resulted in the decision to provide a remote manual start for the permanent diesel pump at Bitter Lake pump station.

The operating strategy would be to meet demands at the onset of the outage through gravity flow out of elevated storage until pumped supply from larger ground-level storage or from transmission pipelines was actuated using power sources that are not dependent on the commercial power grid. SPU requires and plans for enough gravity storage to the pumped zones to allow for at least 15 minutes for activation of remote controlled facilities or at least three hours for activation of locally controlled facilities that pump water to the zone. SPU assumes average day demands in the zone at the onset of the power outage when determining the necessary gravity storage volume (deliverable at no less than 20 psi) to keep up with demand until the alternative pumping facilities can be activated. These alternative pumping facilities include hydraulic turbines and diesel powered pumps that receive regular maintenance and are periodically operated to ensure readiness.

The above approach is not applied to pressure sub-zones with booster pump stations, such as the Augusta 550, the Scenic Heights 550, the Queen Anne 580, and the Dayton Avenue 650 zones. For these zones, if the booster station fails or loses power, check valves at the pump station and the pressure zone boundary automatically open and the zone reverts to the surrounding zone's pressure, maintaining at least 20 psi pressure.

SPU has three hydraulic turbine-driven pumps that do not rely on electric power to run, but instead use the force of water flowing by gravity from higher pressure zones or

pipelines to lower pressure zones to drive turbines that turn pumps to lift water from the same source to other higher pressure zones. These turbines can provide water to five of the six pressure zones that rely on pumps. The turbines are used regularly and controlled remotely from SPU's system control center. These non-electric pumping facilities provide water from gravity-fed ground level storage or from transmission pipelines operating at pressures lower than the zone's.

Table 1 below summarizes how supply to each of the six pumped-only zones would be maintained in the event of an extended regional power outage through a combination of gravity supply at first, and alternative pumping later. The amount of gravity standby storage provides adequate time to remotely or locally activate the non-electric pumping facilities, even under peak day demands. However, delivery to Magnolia 480, Queen Anne 530 and Volunteer 530 would be limited to the capacity of Lincoln Turbine, and emergency curtailments to reduce demands to indoor use only would be needed in these areas if a widespread power outage were to occur during peak season.

C. CONCLUSION

In conclusion, SPU has analyzed the performance of the water system under the above emergencies. Results show that at least five days of indoor water use can be met through year 2040 and possibly beyond. If the emergency were to occur during peak consumption periods, such as the summer irrigation season, SPU will request its customers to curtail discretionary water use until the emergency has been resolved.

SPU will make storage sizing and decommissioning decisions consistent with this emergency scenario based model for system storage reliability. Storage that is deemed necessary will be maintained (e.g., regular recoating, cleaning, sanitary surveys, structural inspections, etc) and storage that is deemed unnecessary will be physically disconnected from the system. Some decommissioned steel storage may be kept in a 'mothballed' state (e.g., aesthetic painting on the outside and left standing).

Table 1. Pumped Zones Summary

Pressure Zone	Average Day Demand, MGD[1]	Source of Gravity Standby Storage	Total Volume, MG (Depth, feet)	Operating Storage, MG (Operating Band, feet)	Dead Storage, MG[2]	Available Gravity Standby Storage, MG[3]	Amount of Time Provided, hours[4]	Actions Taken	Source of Non-Electric Powered Pumped Standby Storage
Richmond Highlands 590	3.95	Richmond Highlands Tank No. 2	2.0 (35')	0.5 (10')	1.4	0.1	0.6	Diesel engine driven pump at Bitter Lake Pump Station activated within 15 minutes.	Bitter Lake Reservoir via Bitter Lake Pump Station diesel engine pump (4000 gpm), remote manual startup (15-minute minimum start-up). Bitter Lake Reservoir is supplied by gravity from Lake Forest Park Reservoir, which is gravity-fed from the Tolt Water Treatment Facility and Clearwell.
Magnolia 480	0.82	Magnolia Tank	1.0 (25')	0.4 (10')	0.0	0.6	17.5	Lincoln Turbine activated within 15 minutes. Manually operated butterfly valve at 12 Av W & W Howe opened within 3 hours to re-activate 530 Armory Way feeder.	Cedar Water Treatment Facility and Clearwells via Lincoln Turbine (4000 gpm), remote manually controlled (15-minute minimum start-up).
Queen Anne 530	1.21	Queen Anne Standpipe	1.9 (58.5')	0.3 (10')	1.4	0.2	4.0	Lincoln Turbine is activated within 15 minutes.	Cedar Water Treatment Facility and Clearwells via Lincoln Turbine (4000 gpm), remote manually controlled (15-minute minimum start-up).
Volunteer 530	1.50	Volunteer Standpipe	0.9 (60')	0.1 (10')	0.4	0.3	4.8	Lincoln Turbine activated within 15 minutes.	Cedar Water Treatment Facility and Clearwells via Lincoln Turbine (4000 gpm), remote manually controlled (15-minute minimum start-up).

Table 1. Pumped Zones Summary (continued)

Pressure Zone	Average Day Demand, MGD[1]	Source of Gravity Standby Storage	Total Volume, MG (Depth, feet)	Operating Storage, MG (Operating Band, feet)	Dead Storage, MG[2]	Available Gravity Standby Storage, MG[3]	Amount of Time Provided, hours[4]	Actions Taken	Source of Non-Electric Powered Pumped Standby Storage
West Seattle 498	2.70	Charlestown Standpipe	1.3 (64')	0.2 (10')	0.9	0.2	21.3	35th & Morgan PRV activated within 15 minutes. Trenton Turbines activated within 15 minutes. Burien Pump Station diesel driven pump activated no earlier than 3 hours from the outage.[5]	Combination of West Seattle Reservoir via Trenton Turbines (4000 gpm), which is remote manually controlled (15-minute minimum start-up), and Riverton Heights Reservoir via Burien PS diesel-powered pump (6000 gpm), which has local manual start-up (3-hour minimum start-up). Both reservoirs are gravity-fed from the Cedar Water Treatment Facility and Clearwells.
		Myrtle Reservoir	5.0 (27')	1.2 (7')	1.5	2.2			
West Seattle 585	1.99	Myrtle Tank No. 2	1.0 (26')	0.4 (10')	0.2	0.5	14.4	Trenton Turbines activated within 15 min. Burien Pump Station diesel driven pump is activated no earlier than 3 hours from the outage.[5]	Combination of West Seattle Reservoir via Trenton Turbines (4000 gpm), which is remote manually controlled (15-minute minimum start-up), and Riverton Heights Reservoir via Burien PS diesel-powered pump (6000 gpm), which has local manual start-up (3-hour minimum start-up). Both reservoirs are gravity-fed from the Cedar Water Treatment Facility and Clearwells.
		Beverly Park Tank	2.0 (35')	0.4 (10')	0.9	0.7			

1. Average Day Demand based on metered water consumption in 2009 for each pressure zone.
2. Dead storage is storage below 20 psi, as measured as static pressure to nearest service connection.
3. Available gravity standby storage is available exclusively to pressure zone shown, and excludes operating storage and dead storage volumes.
4. Amount of time provided is the available gravity standby storage divided by average day demand, and converted to hours.
5. If electrical generation at West Seattle Reservoir is available from the portable generator permanently kept at the site, then West Seattle Low Service and Highland Park Pump Stations would be started instead.

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SEATTLE PUBLIC UTILITIES
2013 WATER SYSTEM PLAN
APPENDIX D

MISCELLANEOUS

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SEATTLE PUBLIC UTILITIES
2013 WATER SYSTEM PLAN

D. MISCELLANEOUS

APPENDIX D-1
CAPITAL FACILITIES PLAN

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Seattle Public Utilities - 2013 Water System Plan

Capital Facilities Plan

2011 Dollars (in $1000s)

Business Area	Project / Program	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027
Water Resources	Morse Lake Pump Plant	$1,922	$1,790	$4,998	$8,357	$6,145	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Overflow Dike Improvements	$619	$2,981	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Landsburg Flood Passage Improvements	$192	$942	$554	$91	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Dam Safety	$100	$25	$23	$23	$22	$500	$275	$250	$300	$0	$0	$0	$0	$0	$500
	Regional Conservation Program	$1,850	$1,850	$1,850	$1,850	$1,850	$1,700	$1,700	$1,700	$1,700	$1,700	$1,700	$1,700	$1,700	$1,700	$1,700
	Low Income Conservation Assistance	$650	$650	$650	$650	$650	$650	$650	$650	$650	$650	$650	$650	$650	$650	$650
	Water System Plan	$25	$0	$0	$100	$480	$395	$50	$0	$44	$90	$450	$395	$50	$0	$44
Water Resources Total		**$5,359**	**$8,239**	**$8,076**	**$11,070**	**$9,147**	**$3,245**	**$2,675**	**$2,600**	**$2,694**	**$2,440**	**$2,800**	**$2,745**	**$2,400**	**$2,350**	**$2,894**
Water Quality and Treatment	Landsburg Chlorination	$700	$1,135	$1	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Reservoir Covering-Volunteer	$0	$0	$92	$100	$100	$1,500	$10,000	$10,000	$1,000	$0	$0	$0	$0	$0	$0
	Reservoir Covering-West Seattle	$24	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Reservoir Covering-Maple Leaf	$4,133	$94	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Roosevelt Reservoir Retirement	$0	$0	$0	$0	$500	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Lake Forest Park Burying/Floating Cover Replacement	$0	$0	$0	$0	$0	$0	$0	$0	$0	$500	$1,000	$8,000	$500	$0	$0
	Bitter Lake Reservoir Burying/Floating Cover Replacement	$0	$0	$0	$0	$0	$0	$500	$1,500	$5,000	$11,000	$11,000	$0	$0	$0	$0
	Water Quality Equipment	$135	$135	$1	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Treatment Facility/WQ Improvements	$96	$94	$92	$91	$100	$100	$100	$400	$500	$100	$100	$100	$600	$600	$250
Water Quality and Treatment Total		**$5,088**	**$1,458**	**$187**	**$190**	**$700**	**$1,600**	**$10,600**	**$11,900**	**$6,500**	**$11,600**	**$12,100**	**$8,100**	**$1,100**	**$600**	**$250**
Transmission	Cathodic Protection Program	$1,600	$1,600	$1,600	$1,600	$1,600	$1,600	$1,600	$1,600	$1,600	$1,600	$600	$600	$600	$600	$600
	Transmission Pipeline Rehabilitation	$1,010	$1,000	$1,000	$1,000	$1,000	$1,000	$1,000	$1,000	$1,000	$1,000	$1,000	$1,000	$1,000	$1,000	$1,000
	Purveyor Meter Replacements	$96	$94	$92	$91	$200	$200	$200	$200	$200	$200	$200	$200	$200	$200	$200
	Air Valve Chamber Replacements	$108	$110	$113	$113	$113	$113	$113	$113	$113	$113	$113	$113	$113	$113	$113
	Water System Dewatering Program	$96	$94	$92	$91	$100	$100	$100	$100	$100	$100	$100	$100	$100	$100	$100
Transmission Total		**$2,910**	**$2,898**	**$2,898**	**$2,894**	**$3,013**	**$3,013**	**$3,013**	**$3,013**	**$3,013**	**$3,013**	**$2,013**	**$2,013**	**$2,013**	**$2,013**	**$2,013**
Distribution	Distribution System Improvements	$3,967	$4,619	$5,545	$6,342	$7,104	$7,104	$7,104	$7,104	$7,104	$7,104	$7,104	$7,104	$7,104	$7,104	$7,104
	Transportation & Multiple Utility Relocations	$8,097	$4,539	$4,402	$3,574	$3,155	$1,500	$1,500	$1,500	$1,500	$1,500	$1,500	$1,500	$1,500	$1,500	$1,500
	Watermain Rehabilitation	$1,538	$1,508	$3,000	$3,000	$3,000	$3,970	$4,082	$4,197	$4,313	$4,433	$4,555	$4,679	$4,804	$4,933	$5,064
	Watermain Extensions	$650	$750	$750	$750	$750	$750	$750	$750	$750	$750	$750	$750	$750	$750	$750
	New Taps	$4,000	$4,000	$4,000	$4,000	$3,922	$3,922	$3,922	$3,922	$3,922	$3,922	$3,922	$3,922	$3,922	$3,922	$3,922
	Service Renewals	$5,500	$5,500	$5,900	$5,900	$5,900	$5,900	$5,900	$5,900	$5,900	$5,900	$5,900	$5,900	$5,900	$5,900	$5,900
	Meter Replacement	$683	$600	$599	$598	$603	$603	$603	$603	$603	$603	$603	$603	$603	$603	$603
	Hydrants	$502	$502	$447	$446	$395	$395	$395	$395	$395	$395	$395	$395	$395	$395	$395
	Valves	$300	$300	$100	$100	$100	$100	$100	$100	$100	$100	$100	$100	$100	$100	$100
	Chamber Upgrades	$25	$25	$25	$25	$25	$25	$25	$25	$25	$25	$25	$25	$25	$25	$25
	Pump Station Improvements	$500	$500	$500	$500	$500	$500	$500	$500	$500	$500	$500	$500	$500	$500	$500
	Tank Improvements	$336	$1,413	$1	$1	$1	$250	$250	$250	$250	$250	$250	$250	$250	$250	$250
Distribution Total		**$26,098**	**$24,257**	**$25,270**	**$25,237**	**$25,455**	**$25,019**	**$25,131**	**$25,246**	**$25,362**	**$25,482**	**$25,604**	**$25,728**	**$25,853**	**$25,982**	**$26,113**
Major Watersheds	Cedar River Watershed Habitat Conservation Plan	$3,241	$3,439	$2,721	$2,254	$1,606	$1,756	$1,756	$1,756	$1,354	$1,354	$1,354	$1,354	$1,354	$1,354	$1,354
	Watershed Stewardship	$995	$687	$554	$543	$533	$100	$100	$100	$100	$100	$100	$100	$100	$100	$100
Major Watersheds Total		**$4,236**	**$4,125**	**$3,275**	**$2,797**	**$2,139**	**$1,856**	**$1,856**	**$1,856**	**$1,454**	**$1,454**	**$1,454**	**$1,454**	**$1,454**	**$1,454**	**$1,454**
Other	Technology	$7,410	$8,184	$5,964	$5,358	$5,327	$6,000	$6,000	$6,000	$6,000	$6,000	$6,000	$6,000	$6,000	$6,000	$6,000
	SCADA	$466	$457	$443	$408	$355	$400	$400	$400	$400	$400	$400	$400	$400	$400	$400
	Security	$1,922	$1,884	$1,847	$1,811	$1,793	$1,000	$1,000	$1,000	$1,000	$1,000	$1,000	$1,000	$1,000	$1,000	$1,000
	Heavy Equipment Purchases	$2,951	$1,934	$2,979	$2,156	$1,931	$2,500	$2,500	$2,500	$2,500	$2,500	$2,500	$2,500	$2,500	$2,500	$2,500
	In-Town Facilities	$1,514	$3,775	$2,225	$2,547	$2,387	$2,550	$1,100	$1,350	$1,200	$1,200	$900	$1,150	$1,150	$1,400	$1,400
	Regional Facilities	$3,296	$3,315	$4,227	$4,494	$8,480	$2,450	$2,250	$2,250	$1,700	$700	$500	$500	$500	$850	$850
	Emergency Storm Response	$48	$47	$46	$45	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	1% for Art	$174	$224	$231	$191	$224	$134	$160	$164	$147	$162	$162	$150	$128	$127	$128
Other Total		**$17,781**	**$19,820**	**$17,963**	**$17,010**	**$20,497**	**$15,034**	**$13,410**	**$13,664**	**$12,947**	**$11,962**	**$11,462**	**$11,700**	**$11,678**	**$12,277**	**$12,278**
Grand Total		**$61,471**	**$60,797**	**$57,668**	**$59,199**	**$60,951**	**$49,767**	**$56,684**	**$58,278**	**$51,970**	**$55,951**	**$55,433**	**$51,740**	**$44,498**	**$44,676**	**$45,002**

Seattle Public Utilities - 2013 Water System Plan

Capital Facilities Plan

2011 Dollars (in $1000s)

Business Area	Project / Program	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2013-2040 Total
Water Resources	Morse Lake Pump Plant	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$23,213
	Overflow Dike Improvements	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$3,600
	Landsburg Flood Passage Improvements	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$1,779
	Dam Safety	$0	$0	$0	$250	$250	$250	$0	$0	$100	$100	$400	$25	$0	$3,393
	Regional Conservation Program	$1,700	$1,700	$1,700	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$31,350
	Low Income Conservation Assistance	$650	$650	$650	$650	$650	$650	$650	$650	$650	$650	$650	$650	$650	$18,199
	Water System Plan	$90	$450	$395	$50	$0	$44	$90	$450	$395	$50	$0	$44	$90	$4,271
Water Resources Total		**$2,440**	**$2,800**	**$2,745**	**$950**	**$900**	**$944**	**$740**	**$1,100**	**$1,145**	**$800**	**$1,050**	**$719**	**$740**	**$85,806**
Water Quality and Treatment	Landsburg Chlorination	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$1,836
	Reservoir Covering-Volunteer	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$22,792
	Reservoir Covering-West Seattle	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$24
	Reservoir Covering-Maple Leaf	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$4,227
	Roosevelt Reservoir Retirement	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$500
	Lake Forest Park Burying/Floating Cover Replacement	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$10,000
	Bitter Lake Reservoir Burying/Floating Cover Replacement	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$29,000
	Water Quality Equipment	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$270
	Treatment Facility/WQ Improvements	$850	$2,200	$1,900	$500	$500	$1,000	$850	$600	$600	$600	$850	$100	$100	$13,973
Water Quality and Treatment Total		**$850**	**$2,200**	**$1,900**	**$500**	**$500**	**$1,000**	**$850**	**$600**	**$600**	**$600**	**$850**	**$100**	**$100**	**$82,623**
Transmission	Cathodic Protection Program	$600	$600	$600	$600	$600	$600	$600	$600	$600	$600	$600	$600	$600	$26,800
	Transmission Pipeline Rehabilitation	$1,000	$1,000	$1,000	$1,000	$1,000	$1,000	$1,000	$1,000	$1,000	$1,000	$1,000	$1,000	$1,000	$28,010
	Purveyor Meter Replacements	$200	$200	$200	$200	$200	$200	$200	$200	$200	$200	$200	$200	$200	$5,173
	Air Valve Chamber Replacements	$113	$113	$113	$113	$113	$113	$113	$113	$113	$113	$113	$113	$113	$3,156
	Water System Dewatering Program	$100	$100	$100	$100	$100	$100	$100	$100	$100	$100	$100	$100	$100	$2,773
Transmission Total		**$2,013**	**$2,013**	**$2,013**	**$2,013**	**$2,013**	**$2,013**	**$2,013**	**$2,013**	**$2,013**	**$2,013**	**$2,013**	**$2,013**	**$2,013**	**$65,912**
Distribution	Distribution System Improvements	$7,104	$7,104	$7,104	$7,104	$7,104	$7,104	$7,104	$7,104	$7,104	$7,104	$7,104	$7,104	$7,104	$190,963
	Transportation & Multiple Utility Relocations	$1,500	$1,500	$1,500	$1,500	$1,500	$1,500	$1,500	$1,500	$1,500	$1,500	$1,500	$1,500	$1,500	$58,267
	Watermain Rehabilitation	$5,198	$5,334	$5,473	$5,614	$5,758	$5,904	$6,053	$6,204	$6,358	$6,515	$6,675	$6,836	$7,001	$135,999
	Watermain Extensions	$750	$750	$750	$750	$750	$750	$750	$750	$750	$750	$750	$750	$750	$20,908
	New Taps	$3,922	$3,922	$3,922	$3,922	$3,922	$3,922	$3,922	$3,922	$3,922	$3,922	$3,922	$3,922	$3,922	$110,118
	Service Renewals	$5,900	$5,900	$5,900	$5,900	$5,900	$5,900	$5,900	$5,900	$5,900	$5,900	$5,900	$5,900	$5,900	$164,400
	Meter Replacement	$603	$603	$603	$603	$603	$603	$603	$603	$603	$603	$603	$603	$603	$16,958
	Hydrants	$395	$395	$395	$395	$395	$395	$395	$395	$395	$395	$395	$395	$395	$11,379
	Valves	$100	$100	$100	$100	$100	$100	$100	$100	$100	$100	$100	$100	$100	$3,200
	Chamber Upgrades	$25	$25	$25	$25	$25	$25	$25	$25	$25	$25	$25	$25	$25	$700
	Pump Station Improvements	$500	$500	$500	$500	$500	$500	$500	$500	$500	$500	$500	$500	$500	$14,000
	Tank Improvements	$250	$250	$250	$250	$250	$250	$250	$250	$250	$250	$250	$250	$250	$7,503
Distribution Total		**$26,247**	**$26,383**	**$26,522**	**$26,663**	**$26,807**	**$26,953**	**$27,102**	**$27,253**	**$27,407**	**$27,564**	**$27,724**	**$27,885**	**$28,050**	**$734,395**
Major Watersheds	Cedar River Watershed Habitat Conservation Plan	$1,354	$1,354	$1,354	$1,354	$1,354	$1,354	$1,354	$1,354	$1,354	$1,354	$1,354	$1,354	$1,354	$45,608
	Watershed Stewardship	$100	$100	$100	$100	$100	$100	$100	$100	$100	$100	$100	$100	$100	$5,612
Major Watersheds Total		**$1,454**	**$1,454**	**$1,454**	**$1,454**	**$1,454**	**$1,454**	**$1,454**	**$1,454**	**$1,454**	**$1,454**	**$1,454**	**$1,454**	**$1,454**	**$51,221**
Other	Technology	$6,000	$6,000	$6,000	$6,000	$6,000	$6,000	$6,000	$6,000	$6,000	$6,000	$6,000	$6,000	$6,000	$170,242
	SCADA	$400	$400	$400	$400	$400	$400	$400	$400	$400	$400	$400	$400	$400	$11,329
	Security	$1,000	$1,000	$1,000	$1,000	$1,000	$1,000	$1,000	$1,000	$1,000	$1,000	$1,000	$1,000	$1,000	$32,258
	Heavy Equipment Purchases	$2,500	$2,500	$2,500	$2,500	$2,500	$2,500	$2,500	$2,500	$2,500	$2,500	$2,500	$2,500	$2,500	$69,451
	In-Town Facilities	$2,400	$2,900	$1,900	$900	$1,200	$1,200	$1,200	$900	$900	$900	$900	$900	$900	$42,948
	Regional Facilities	$850	$600	$500	$1,100	$1,600	$1,100	$600	$500	$500	$500	$500	$500	$500	$45,712
	Emergency Storm Response	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$187
	1% for Art	$129	$134	$134	$124	$125	$127	$126	$127	$128	$127	$129	$126	$127	$4,166
Other Total		**$13,279**	**$13,534**	**$12,434**	**$12,024**	**$12,825**	**$12,327**	**$11,826**	**$11,427**	**$11,428**	**$11,427**	**$11,429**	**$11,426**	**$11,427**	**$376,292**
Grand Total		**$46,283**	**$48,384**	**$47,068**	**$43,604**	**$44,499**	**$44,691**	**$43,985**	**$43,847**	**$44,046**	**$43,858**	**$44,520**	**$43,597**	**$43,784**	**$1,396,249**

SEATTLE PUBLIC UTILITIES
2013 WATER SYSTEM PLAN

D. MISCELLANEOUS

APPENDIX D-2
LAND USE AND ZONING MAPS

LAND USE AND ZONING MAPS

Land Use Zoning Maps provided here were downloaded on February 22, 2012, from the following websites, except as noted. For maps not provided, please refer to the website listed below.

City of Seattle

Generalized Zoning (attached):
HTTP://WWW.SEATTLE.GOV/DCLU/RESEARCH/GIS/WEBPLOTS/SMALLZONEMAP.PDF

Zoning Maps Online: http://www.seattle.gov/dpd/Research/Zoning_Maps/default.asp

City of Shoreline

http://www.cityofshoreline.com/index.aspx?page=125

http://cosweb.ci.shoreline.wa.us/uploads/attachments/gis/maps/complu.pdf
(downloaded and added 6/1/2012)

http://cosweb.ci.shoreline.wa.us/uploads/attachments/gis/maps/Zoning.pdf

City of Lake Forest Park

http://www.lakeforestca.gov/civica/filebank/blobdload.asp?BlobID=3663

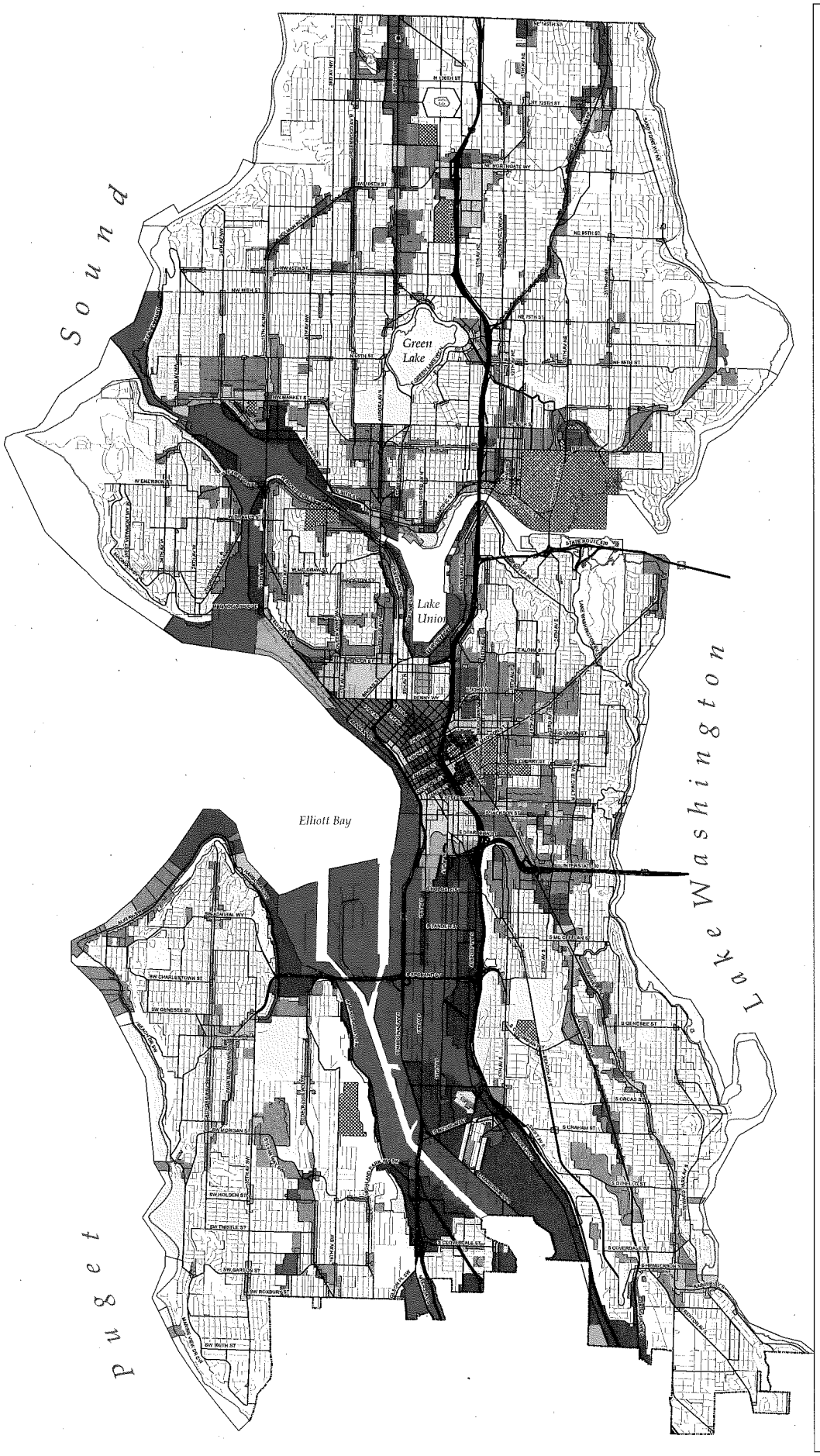
City of Burien

http://www.burienwa.gov/index.aspx?nid=717 http://www.burienwa.gov/DocumentView.aspx?DID=665

King County

http://www.kingcounty.gov/operations/GIS/Maps/VMC/Planning.aspx#DCC1A71A09194E73A35D915B4A3FE271

http://www.kingcounty.gov/operations/GIS/Maps/VMC/~/media/operations/GIS/maps/vmc/images/zoning_2004.ashx



City of Seattle

Generalized Zoning

as of January 27, 2012

Legend

- Single Family 5000
- Single Family 7200
- Single Family 9600
- Residential Small Lot
- Lowrise
- Midrise
- Highrise
- Seattle Mixed
- Neighborhood Commercial
- Neigh/Comm Incentive
- Commercial
- Downtown Office Core
- Downtown Harborfront
- Downtown Mixed
- International District
- Pike Market Mixed
- Pioneer Square Mixed
- Industrial Buffer
- Industrial Commercial
- Industrial General 1
- Industrial General 2
- Major Institution
- Pedestrian Areas

Note: This map is a view of generalized zoning only. For precise zoning information, please call or visit the Seattle Municipal Tower, Department of Planning and Development at 700 5th Ave Suite 2000, 206-684-8850.

0 1 2 Miles

Prepared by:

Department of Planning and Development

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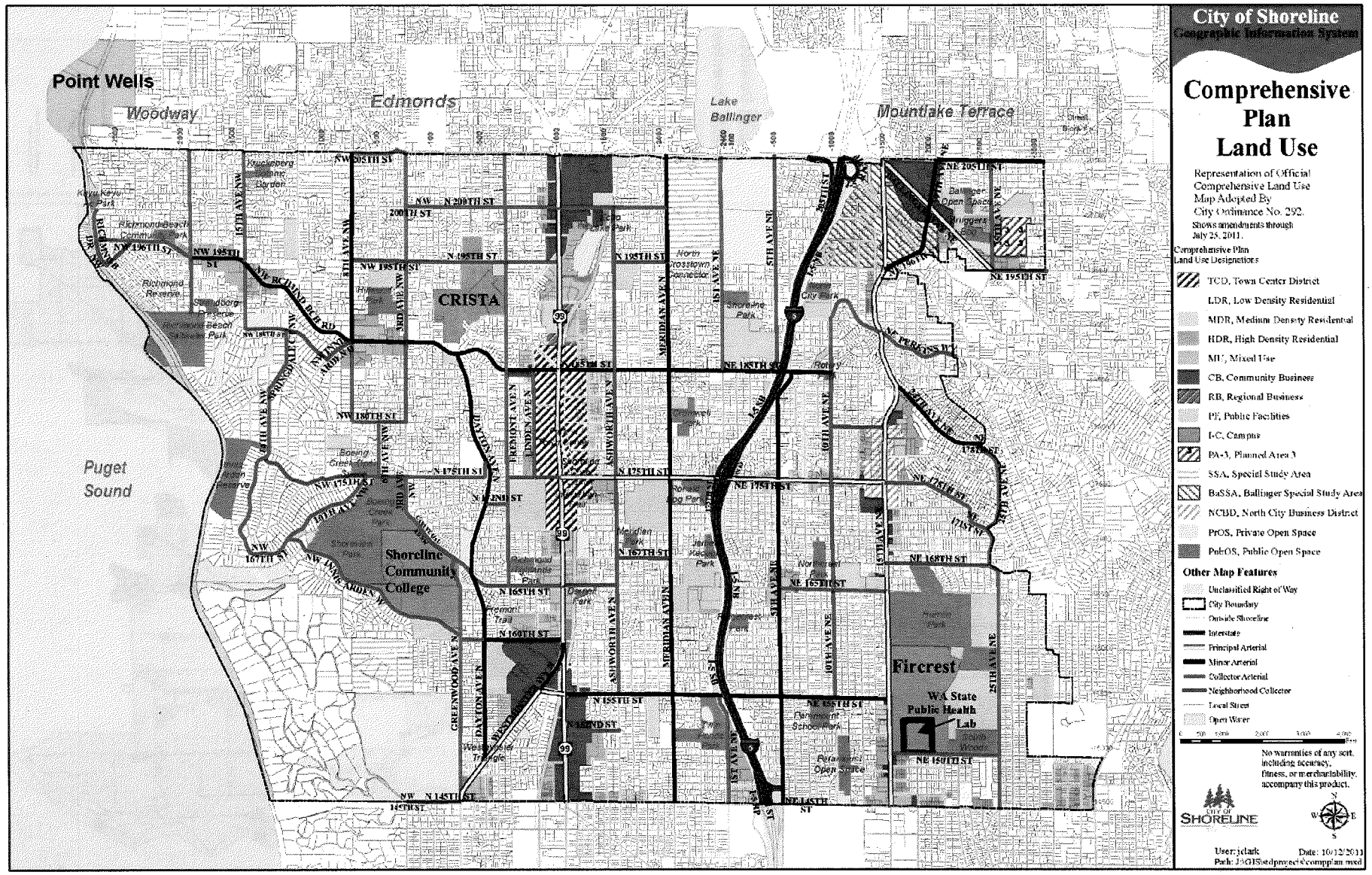
City of Shoreline
Geographic Information System
Comprehensive Plan Land Use
Representation of Official Comprehensive Land Use Map Adopted By City Ordinance No. 292.
Shows amendments through July 25, 2011.
Comprehensive Plan Land Use Designations
TCD, Town Center District
LDR, Low Density Residential
MDR, Medium Density Residential
HDR, High Density Residential
MU, Mixed Use
CB, Community Business
RB, Regional Business
PF, Public Facilities
I-C, Campus
PA-3, Planned Area 3
SSA, Special Study Area
BaSSA, Ballinger Special Study Area
NCBD, North City Business District
PrOS, Private Open Space
PubOS, Public Open Space
Other Map Features
Unclassified Right of Way
City Boundary
Outside Shoreline
Interstate
Principal Arterial
Minor Arterial
Collector Arterial
Neighborhood Collector
Local Street
Open Water
No warranties of any sort, including accuracy, fitness, or merchantability, accompany this product.
CITY OF SHORELINE
User: jclark
Date: 10/12/2011
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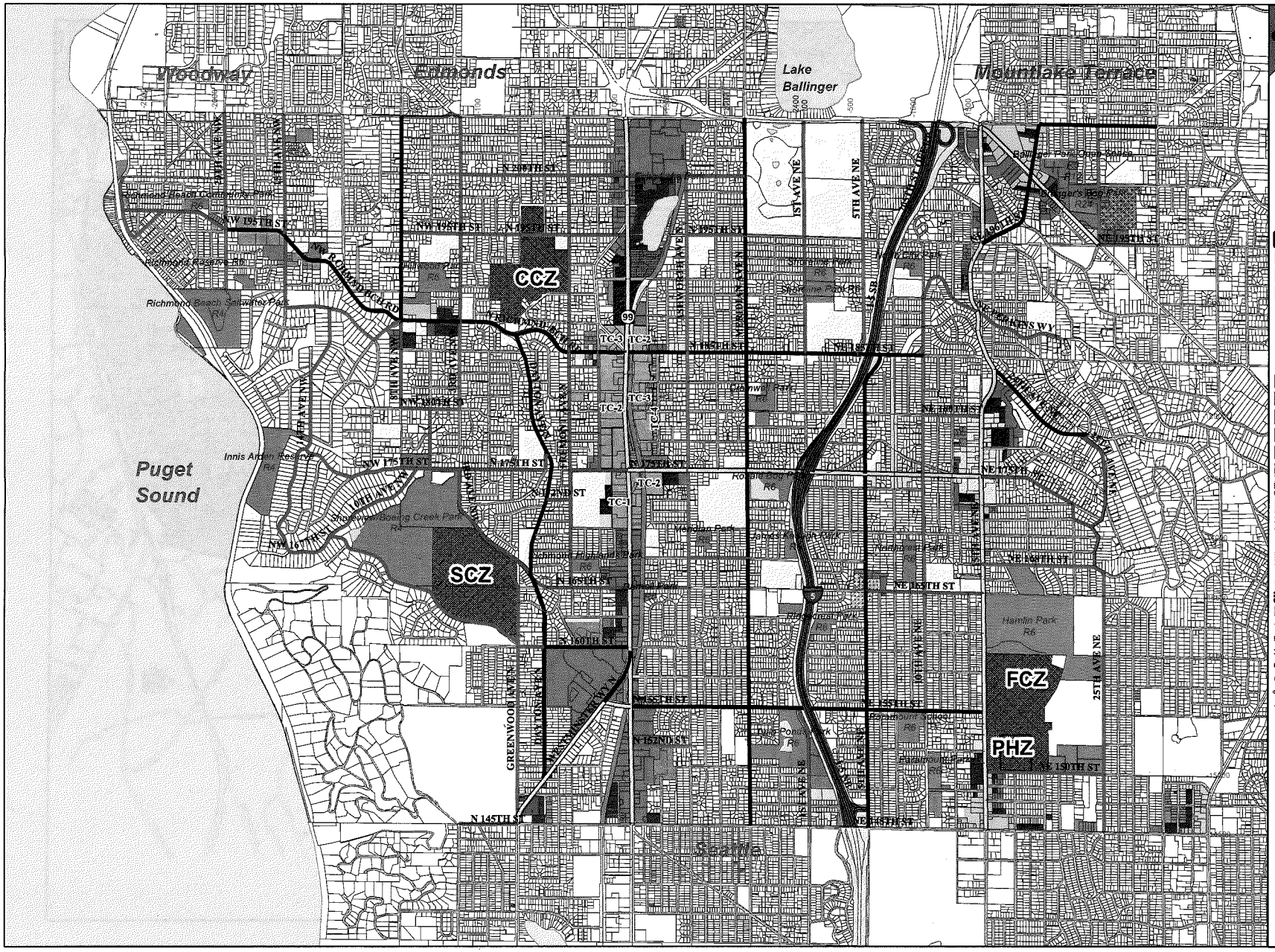
Point Wells
Woodway
Edmonds
Lake Ballinger
Mountlake Terrace
CRISTA
Puget Sound
Shoreline Community College
Fircrest
WA State Public Health Lab



City of Shoreline
Geographic Information System

Zoning

Representation of Official Zoning Map Adopted By City Ordinance No. 292.
Shows amendments through November 28, 2011.

Zoning Designations

- TC 1-4; Town Center 1 to 4
- R-48; Residential, 48 units/acre
- R-24; Residential, 24 units/acre
- R-18; Residential, 18 units/acre
- R-12; Residential, 12 units/acre
- R-8; Residential, 8 units/acre
- R-6; Residential, 6 units/acre
- R-4; Residential, 4 units/acre
- I; Industrial
- MUZ; Mixed Use Zone
- MUCZ; Mixed Use Contract Zone
- PA 2; Planned Area 2
- PA 3; Planned Area 3
- C; Campus
- NCBD: North City Business District
- O; Office
- CB; Community Business
- NB; Neighborhood Business
- CZ; Contract Zone

Other Map Features

- City Boundary
- Open Water
- Outside Shoreline
- Interstate
- Principal Arterial
- Minor Arterial
- Collector Arterial
- Neighborhood Collector
- Local Street
- Tax Parcel Boundary
- Park
- Unclassified Right of Way

Note:
See SMC Figure 20.92.020 for Town Center Overlays

1 inch = 2,000 feet

0 500 1,000 2,000 3,000 4,000 Feet

No warranties of any sort, including accuracy, fitness, or merchantability, accompany this product.

CITY OF SHORELINE

User: jclark
Date: 12/7/2011
Path: J:\GIS\standardprojects\Zoning2.mxd

CITY OF LAKE FOREST
DECEMBER 20, 1991

CITY OF LAKE FOREST

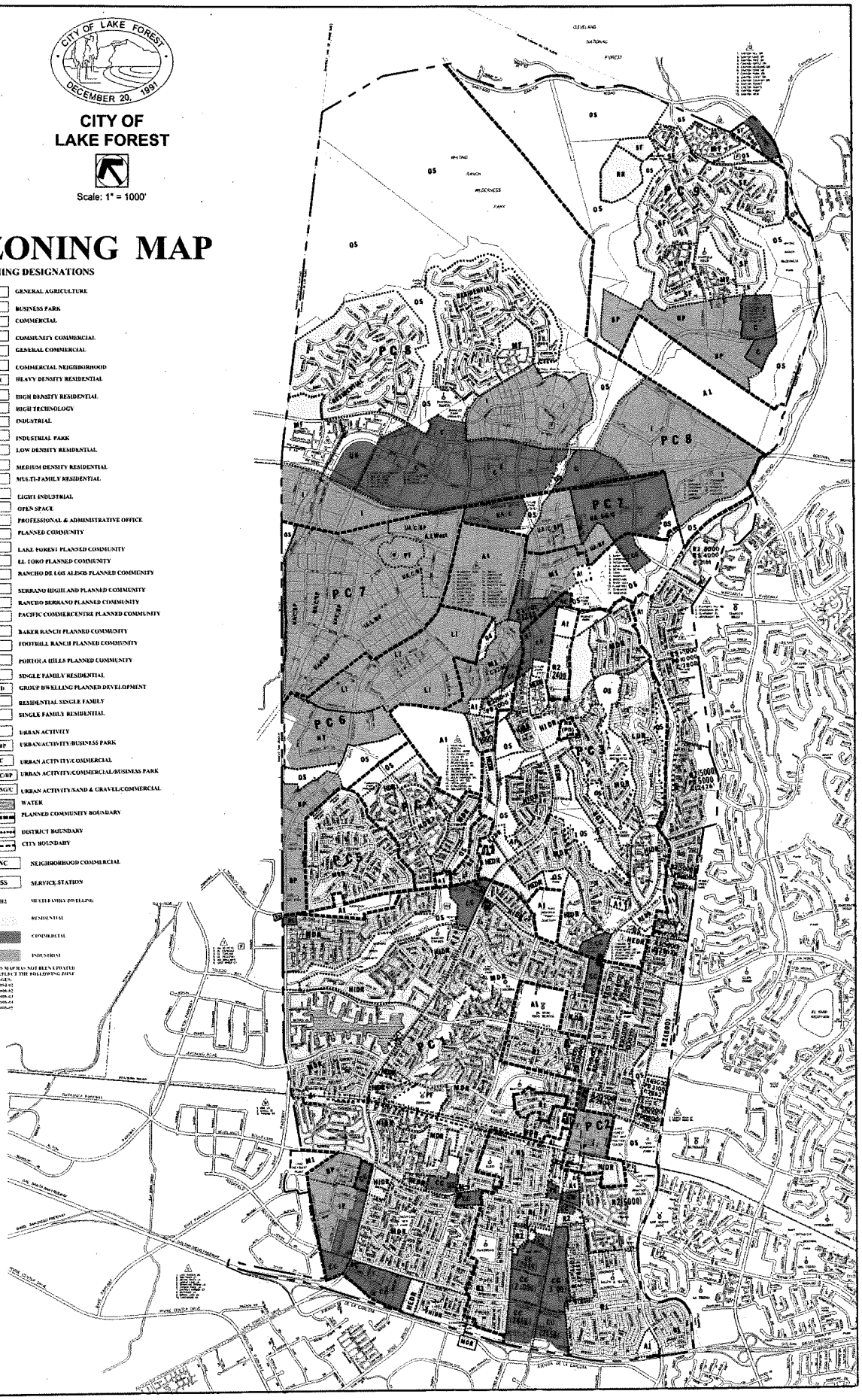
Scale: 1" = 1000'

ZONING MAP

ZONING DESIGNATIONS

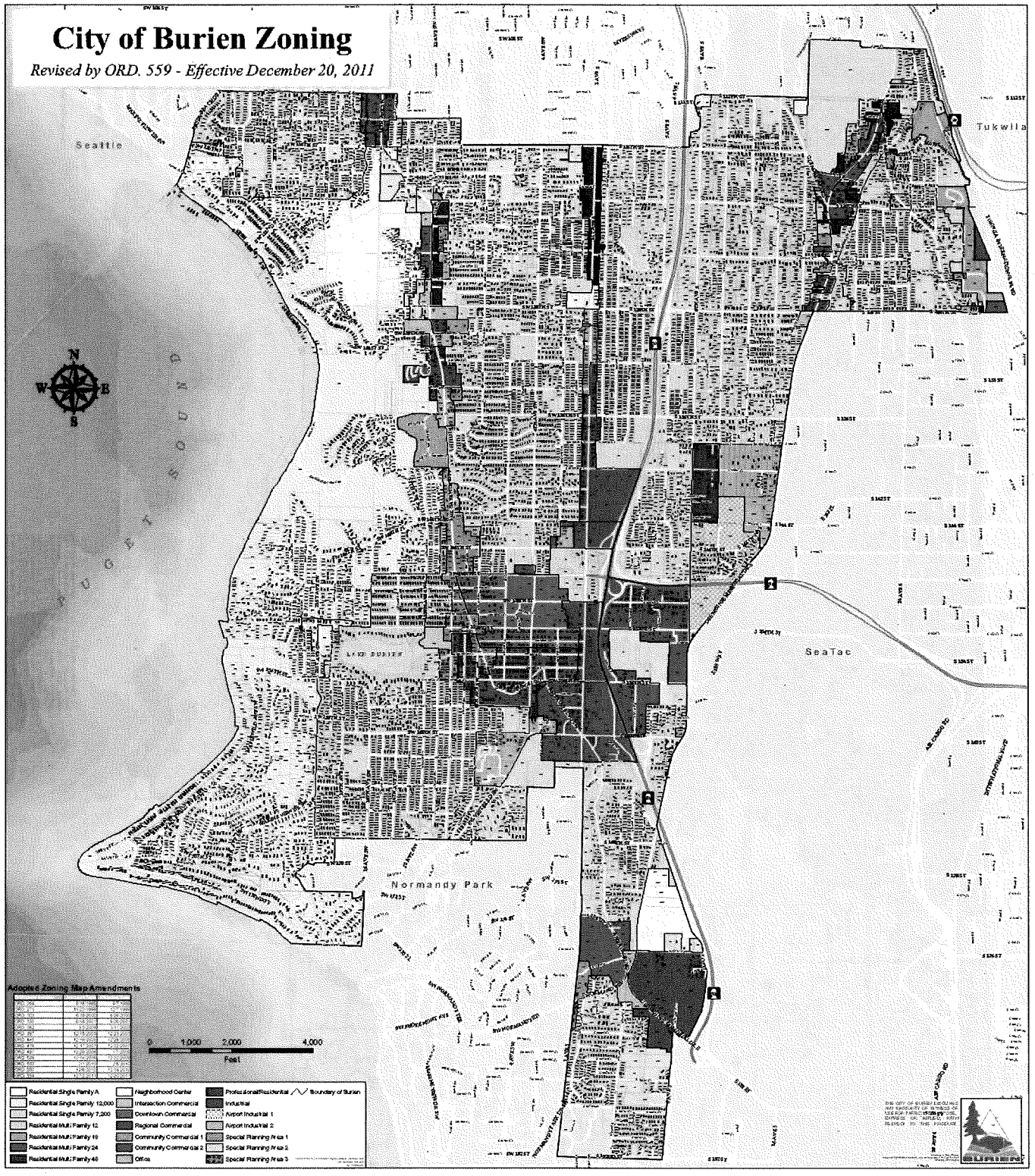
A1	GENERAL AGRICULTURE
BP	BUSINESS PARK
C	COMMERCIAL
CC	COMMUNITY COMMERCIAL
C2	GENERAL COMMERCIAL
CN	COMMERCIAL NEIGHBORHOOD
HEDR	HEAVY DENSITY RESIDENTIAL
HDR	HIGH DENSITY RESIDENTIAL
HT	HIGH TECHNOLOGY
I	INDUSTRIAL
IP	INDUSTRIAL PARK
LDR	LOW DENSITY RESIDENTIAL
MDR	MEDIUM DENSITY RESIDENTIAL
MF	MULTI-FAMILY RESIDENTIAL
M1	LIGHT INDUSTRIAL
OS	OPEN SPACE
PA	PROFESSIONAL & ADMINISTRATIVE OFFICE
PC	PLANNED COMMUNITY
PC 1	LAKE FOREST PLANNED COMMUNITY
PC 2	EL TORO PLANNED COMMUNITY
PC 3	RANCHO DE LOS ALISOS PLANNED COMMUNITY
PC 4	SERRANO HIGHLAND PLANNED COMMUNITY
PC 5	RANCHO SERRANO PLANNED COMMUNITY
PC 6	PACIFIC COMMERCENTRE PLANNED COMMUNITY
PC 7	BAKER RANCH PLANNED COMMUNITY
PC 8	FOOTHILL RANCH PLANNED COMMUNITY
PC 9	PORTOLA HILLS PLANNED COMMUNITY
R1	SINGLE FAMILY RESIDENTIAL
R2 PD	GROUP DWELLING PLANNED DEVELOPMENT
RS	RESIDENTIAL SINGLE FAMILY
SF	SINGLE FAMILY RESIDENTIAL
UA	URBAN ACTIVITY
UA/BP	URBAN/ACTIVITY/BUSINESS PARK
UA/C	URBAN ACTIVITY/COMMERCIAL
UA/C/BP	URBAN ACTIVITY/COMMERCIAL/BUSINESS PARK
UA/SG/C	URBAN ACTIVITY/SAND & GRAVEL/COMMERCIAL
	WATER
	PLANNED COMMUNITY BOUNDARY
	DISTRICT BOUNDARY
	CITY BOUNDARY
NC	NEIGHBORHOOD COMMERCIAL
SS	SERVICE STATION
R2	MULTI-FAMILY DWELLING
	RESIDENTIAL
	COMMERCIAL
	INDUSTRIAL

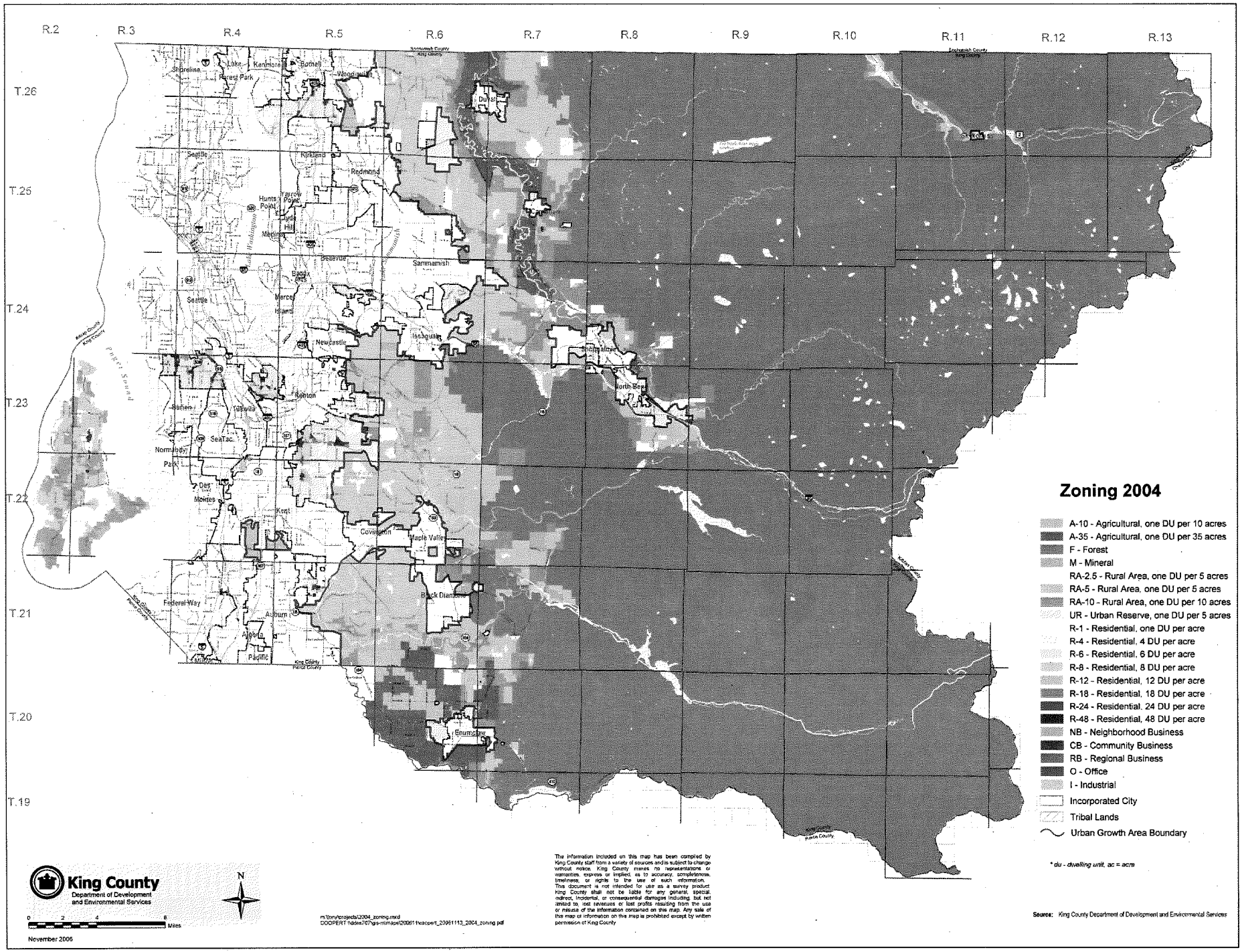
**THIS MAP HAS NOT BEEN UPDATED TO REFLECT THE FOLLOWING ZONE CHANGES:
ZC 2004-02
ZC 2008-02
ZC 2008-03
ZC 2009-03
ZC 2008-05



City of Burien Zoning

Revised by ORD. 559 - Effective December 20, 2011




R.2
R.3
R.4
R.5
R.6
R.7
R.8
R.9
R.10
R.11
R.12
R.13
T.26
T.25
T.24
T.23
T.22
T.21
T.20
T.19
Shoreline
Lake Forest Park
Kenmore
Bothell
Woodinville
Duvall
Seattle
Kirkland
Redmond
Hunts Point
Yarrow Point
Clyde Hill
Medina
Bellevue
Sammamish
Beaux Arts
Mercer Island
Issaquah
Snoqualmie
North Bend
Newcastle
Renton
Burien
Tukwila
SeaTac
Normandy Park
Des Moines
Kent
Covington
Maple Valley
Black Diamond
Federal Way
Auburn
Algona
Pacific
Enumclaw
Puget Sound
King County
Pierce County
Snohomish County
Chelan County
Kittitas County
Zoning 2004
A-10 - Agricultural, one DU per 10 acres
A-35 - Agricultural, one DU per 35 acres
F - Forest
M - Mineral
RA-2.5 - Rural Area, one DU per 5 acres
RA-5 - Rural Area, one DU per 5 acres
RA-10 - Rural Area, one DU per 10 acres
UR - Urban Reserve, one DU per 5 acres
R-1 - Residential, one DU per acre
R-4 - Residential, 4 DU per acre
R-6 - Residential, 6 DU per acre
R-8 - Residential, 8 DU per acre
R-12 - Residential, 12 DU per acre
R-18 - Residential, 18 DU per acre
R-24 - Residential, 24 DU per acre
R-48 - Residential, 48 DU per acre
NB - Neighborhood Business
CB - Community Business
RB - Regional Business
O - Office
I - Industrial
Incorporated City
Tribal Lands
Urban Growth Area Boundary
* du - dwelling unit, ac = acre
King County
Department of Development and Environmental Services
N
0 2 4 8 Miles
November 2006
m:\tony\projects\2004_zoning.mxd
COOPERT \\dev707\gis-mimage\20061 \hcaspert_20061113_2004_zoning.pdf
The information included on this map has been compiled by King County staff from a variety of sources and is subject to change without notice. King County makes no representations or warranties, express or implied, as to accuracy, completeness, timeliness, or rights to the use of such information. This document is not intended for use as a survey product. King County shall not be liable for any general, special, indirect, incidental, or consequential damages including, but not limited to, lost revenues or lost profits resulting from the use or misuse of the information contained on this map. Any sale of this map or information on this map is prohibited except by written permission of King County
Source: King County Department of Development and Environmental Services

SEATTLE PUBLIC UTILITIES
2013 WATER SYSTEM PLAN

D. MISCELLANEOUS

APPENDIX D-3

PLAN CONTENT AND CONSISTENCY REVIEW CHECKLISTS

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Seattle Public Utilities
2013 Water System Plan
Plan Content Checklist

Water System Planning Handbook Chapter	Water System Plan		
	Part	Section	Comments
Chapter 1 - Description of Water System			
Ownership and Management			
System Name	I	1.1	
Type of Ownership	I	1.1	
Management Structure	Appendix	B-2	
Water Facilities Inventory Report Form	Appendix	B-1	
System Background			
History of Water System Development and Growth	I	1.1	
Geography	I	1.1	
Neighboring/Adjacent Purveyors	I	1.4.2.5	
Ordinances/By Laws	I II	1.3.1 2.1 3.1 4.1 5.1 2.1	
Inventory of Existing Facilities			
Description of Facilities and Major Components	I Appendix	2.3 3.3 4.3 5.3 B-4	
Number of Service Connections (Existing and Approved)	I	2.3	Approved number of connections is not applicable.
Existing Interties	I Appendix	2.3 B-4	SPU does not use interties as a normal source of supply.
Related Plans			
List of Related Plans	I	1.4.2	
Comments From Agencies and Adjacent Purveyors			Comments from agencies and public sent under separate cover
Responses to Comments			Sent separately
Existing Service Area and Characteristics			
Existing Service Area Map	I	1.1 2.3	See Figures 1-1 and 2-1.
Zoning and Land Use	Appendix	D-2	
Future Service Area			
Future Service Area Map	I	2.3	
Zoning and Land Use	Appendix	D-2	

Water System Planning Handbook Chapter	Water System Plan		
	Part	Section	Comments
Service Area Agreements	I	2.3.1.3	Wholesale water contracts provided to WDOH under separate cover, as they become available.
Service Area Policies	I	1.2	Service Area Policy from 2007 WSP carried forward.
Satellite Management	I	1.1.2	Not applicable.
Condition of Service Policies	I Appendix	1.2 C-4 C-5 C-6	Service Area Policy from 2007 WSP carried forward.
Complaints			
Policy	I	3.3.7.3	
Recordkeeping	I	5.3.3.5	
Chapter 2 - Basic Planning, Data and Water Demand Forecasting			
Current Population, Service Connections, Water Use, and Equivalent Residential Units			
Current Population	I	2.3	
Total Service Connections	I	2.3	
Water Use Data Collection	I Appendix	2.3.2 A-1	
Equivalent Residential Units			Not applicable
Projected Land Use, Future Population, and Water Demand			
Projected Land Use	I Appendix	2.4.1.2 A-1	
Projected Population	Appendix	A-1	
Projected Non-Residential Water Needs	I Appendix	2.4.1.2 A-1	
Projected Non-Revenue Water	Appendix	A-1	
Water Rates and Rate Impacts on Water Demand	II Appendix	2.3.1 A-1	
Water Demand Forecasting	I Appendix	2.4.1 A-1	
Chapter 3 – System Analysis			
System Design Standards	Appendix	C-2 C-7	
Water Quality Analysis			
Historical Review of Trends	I	3.3	
Future Requirements	I	3.4	
System Description and Analysis			
Source	I Appendix	2.3 – 2. 4 A-3	
Water Treatment	I Appendix	3.3 – 3.4 B-4	
Storage	I Appendix	3.3.6 B-4 C-7	

Water System Planning Handbook Chapter	Water System Plan		
	Part	Section	Comments
Distribution System/Hydraulic Analysis	I Appendix	5.3 – 5.4 B-4	
Identification of System Improvements Assessment of Alternatives Prioritizing Improvements Selection of Alternatives	I II	2.4 – 2.5 3.3 – 3.5 4.4 – 4.5 5.4 – 5.5 1.2 – 1.3	
Chapter 4 - Conservation Program, Water Right Analysis, System Reliability and Interties			
Conservation Program Development and Implementation			
Required Measures For All Systems Other Measures and Level of Implementation Conservation Program Outline Regional Conservation Programs	I	2.4.1.1	
Source of Supply Analysis			No new water rights to be pursued in next 20 years
Enhanced Conservation Measures	I	2.4.1.1	
Water Right Changes	I Appendix	2.3.4.2 A-2	
Interties			SPU has no plans to use interties for normal supply purposes.
Artificial Recharge	I	2.3.4.1	
Use of Reclaimed Water, Reuse, and other Non-potable Sources	I Appendix	2.4.1.4 A-4	
Treatment	I Appendix	3.3.5 3.4 B-3 B-4	
Water Right Evaluation			
Permits, Certificates, Claims and Applications – Narrative Existing Water Right(s) Status Forecasted Water Right(s) Status Water Rights, Current Water Usage and Projected Needs Assessment of Need for Additional Water Rights	I Appendix	2.3.4.2 2.4.1 A-2	
Water Reservations			Not applicable
Water Supply Reliability Analysis			
Summary of System Reliability Efforts	I Appendix	2.3.4.3 2.4.1.2 2.4.1.3 C-7	
Water Shortage Response Planning			No change from 2007 WSP.
Monitoring Well Levels	Appendix	A-3	
Interties			
Existing Interties	I Appendix	2.3.1.3 B-4	
New Intertie Proposals	.	.	See 2007 WSP; no change in policy.

Water System Planning Handbook Chapter	Water System Plan		
	Part	Section	Comments
Intertie Agreements	I	2.3.1.3	Wholesale water contracts provided to WDOH under separate cover, as they become available.
Identification of System Improvements Assessment of Alternatives Prioritizing Improvements Selection of Alternatives	I Appendix	2.4 A-2	
Chapter 5 - Source Water Protection			
Wellhead Protection Program	I	3.3.3.2	See also Seattle Public Utilities, *Highline Wellfield Wellhead Protection Program*, 2000. Unchanged since approval with 2001 WSP, except for potential contaminant inventory updated every other year.
Watershed Control Program	I	3.3.3.1	See also Seattle Public Utilities, *Watershed Protection Plan*, October 2011, covering Cedar River Municipal Watershed, South Fork Tolt Municipal Watershed, Lake Youngs Reservation.
Identification of System Improvements Assessment of Alternatives Prioritizing Improvements Selection of Alternatives	I	3.4	Refer also to Wellhead Protection and Watershed Protection Plans, above.
Chapter 6 - Operation and Maintenance Program			
Water System Management and Personnel	Appendix	B-2	
Operator Certification	Appendix	B-2	
System Operations and Control			See Seattle Public Utilities, *System Operations and Control*, February 2012.
Identification of Major System Components	I Appendix	2.3 3.3 4.3 5.3 B-4	
Routine System Operation	I	2.3.5 3.3.7 4.3.2 5.3.2	See Seattle Public Utilities, *System Operations and Control*, February 2012.

Water System Planning Handbook Chapter	Water System Plan		
	Part	Section	Comments
Preventative Maintenance Program	I	2.3 3.3.8 4.3.3 5.3.3	
Equipment, Supplies and Chemical Listing	Appendix	B-3 B-4	
Comprehensive Monitoring (Regulatory Compliance) Plan	I Appendix	3.3.7.1 C-1	
Emergency Response Program Water System Personnel Emergency Call-Up List Notification Procedures Vulnerability Analysis Contingency Operational Plan	Appendix	C-7	See also Seattle Public Utilities, *System Operations and Control*, February 2012, and 2007 WSP.
Safety Procedures			See 2007 WSP; no significant changes.
Cross-Connection Control Program	I	3.3.7.2	
Customer Complaint Response Program	I	3.3.7.3	
Recordkeeping and Reporting	I	5.3.3.5	
O & M Improvements Identification of System Improvements Assessment of Alternatives Prioritizing Improvements Selection of Alternatives	I	2.3 - 2.5 3.3 – 3.5 4.4 – 4.5 5.3 – 5.5	
Chapter 7 - Distribution Facilities Design and Construction Standards			
Project Review Procedures	Appendix	C-3	
Policies and Requirements for Outside Parties	I Appendix	5.4.2 - 5.4.3 C-2	
Design Standards (Performance Standards and Sizing Criteria)	Appendix	C-2	
Construction Standards (Materials and Methods)	Appendix	C-2	See also the *2011 City of Seattle Standard Specifications* and *2011 Seattle Standard Plans.*
Construction Certification and Follow-up Procedures	Appendix	C-3	
Identification of System Improvements Assessment of Alternatives Prioritizing Improvements Selection of Alternatives	I	5.4 – 5.5	
Chapter 8 - Improvement Program			
Improvement Schedule	II Appendix	1.2 1.3 D-1	
Chapter 9 - Financial Program			
Water Systems with 1,000 or More Connections (Not Regulated by UTC)			
Past and Present Financial Status	II	2.2	
Available Revenue Sources	II	2.2 2.3	
Allocation of Revenue Sources	II	2.4	

Water System Planning Handbook Chapter	Water System Plan		
	Part	Section	Comments
Program Justification	II	2.4 2.5	
Assessment of Rates	II	2.3	
Chapter 10 - Miscellaneous Documents			
Supportive Documents			
State Environmental Policy Act			Separately bound
Other Documents	Appendix	D-3	Local government consistency certifications
Agreements			Sent separately
Comments on WSP from County			To be sent separately as appropriate
Comments on WSP from Adjacent Utilities			To be sent separately as appropriate

Washington State Department of Health
Division of Environmental Health
Office of Drinking Water

Local Government Consistency Review Checklist

Water System Name: Seattle Public Utilities PWS ID: 77050 Y

Planning/Engineering Document Title: 2013 Water System Plan Plan Date: April 2012

Local Government with Jurisdiction: City of Seattle

WAC 246-290-108 Consistency with local plans and regulations:
Consistency with local plans and regulations applies to planning and engineering documents under WAC 246-290-106, 246-290-107, and 246-290-110(4)(b (ii).

1) Municipal water suppliers must include a consistency review and supporting documentation in its planning or engineering document describing how it has addressed consistency with **local plans and regulations**. This review must include specific elements of local plans and regulations, as they reasonably relate to water service as determined by Department of Health (DOH). Complete the table below and see instructions on back.

Local Government Consistency Statement	Page(s) in Planning Document	Yes – No – Not Applicable
a) The water system service area is consistent with the adopted land use and zoning within the applicable service area.	Part I, Section 1.4.2 Appendix D-2	yes
b) The six-year growth projection used to forecast water demand is consistent with the adopted city/county's population growth projections. If a different growth projection is used, provide an explanation of the alternative growth projection and methodology.	Part I, Sect. 2.4.1.2 Appendix A-1	yes
c) Applies to cities and towns that provide water service: All water service area policies of the city or town are consistent with the utility service extension ordinances of the city or town.	Appendix C-5 and C-6	yes
d) Service area policies for new service connections are consistent with the adopted local plans and adopted development regulations of all jurisdictions with authority over the service area [City(ies), County(ies)].	Appendix C-5 and C-6	yes
e) Other relevant elements related to water supply are addressed in the water system plan, if applicable; Coordinated Water System plans, Regional Wastewater plans, Reclaimed Water plans, Groundwater Area Management plans, and Capital Facilities Element of Comprehensive plans.	Part I, Section 1.4.2 Part II, Chapter 1 Appendix A-4 Appendix D-1	yes

I certify that the above statements are true to the best of my knowledge and that these specific elements are consistent with adopted local plans and development regulations.

Signature Date 4/6/12

TOM HAUGER, Comprehensive Plan Manager, City of Seattle
Printed Name, Title, & Jurisdiction

Consistency Review Guidance

For Use by Local Governments and Municipal Water Suppliers

This checklist may be used to meet the requirements of WAC 246-290-108. When using an alternative format, it must describe all of the elements; 1a), b), c), d), and e), when they apply.

For **water system plans (WSP)**, a consistency review is required for the retail service area and any additional areas where a municipal water supplier wants to expand its water right's place of use.

For **small water system management programs**, a consistency review is only required for areas where a municipal water supplier wants to expand its water right's place of use. If no water right place of use expansion is requested, a consistency review is not required.

For **engineering documents**, a consistency review is required for areas where a municipal water supplier wants to expand its water right's place of use (water system plan amendment is required). For non-community water systems, a consistency review is required when requesting a place of use expansion. All engineering documents must be submitted with a service area map per WAC 246-290-110(4)(b)(ii).

A) Documenting Consistency: Municipal water suppliers must document all of the elements in a consistency review per WAC 246-290-108.

1 a) Provide a copy of the adopted **land use/zoning** map corresponding to the service area. The uses provided in the WSP should be consistent with the adopted land use/zoning map. Include any other portions of comprehensive plans or development regulations that are related to water supply planning.

1 b) Include a copy of the **six-year growth projections** that corresponds to the service area. If the local population growth rate projections are not used, provide a detailed explanation on why the chosen projections more accurately describe the expected growth rate. Explain how it is consistent with the adopted land use.

1c) Include water service area policies and show that they are consistent with the **utility service extension ordinances** within the city or town boundaries. This applies to cities and towns only.

1 d) Include all **service area policies** for how new water service will be provided to new customers.

1 e) **Other relevant elements** related to water supply planning as determined by the department (DOH). See Local Government Consistency – Other Relevant Elements, Policy B.07, September 2009.

B) Documenting an Inconsistency: Please document the inconsistency, include the citation from the comprehensive plan or development regulation, and provide direction on how this inconsistency can be resolved.

C) Documenting Lack of Consistency Review by Local Government: Where the local government with jurisdiction did not provide a consistency review, document efforts made and the amount of time provided to the local government for their review. Please include: name of contact, date, and efforts made (letters, phone calls, and e-mails). In order to self-certify, please contact the DOH Planner.

The Department of Health is an equal opportunity agency. For persons with disabilities, this document is available on request in other formats. To submit a request, please call 1-800-525-0127 (TTY 1-800-833-6388).

CITY OF
SHORELINE

Planning and Community Development
17500 Midvale Avenue North
Shoreline, WA 98133-4905
(206) 801-2500 ♦ Fax (206) 801-2788

June 1, 2012

Joan M. Kersnar
Drinking Water Planning
Seattle Public Utility
P.O. Box 34018
Seattle, WA 98124-4018

RE: Consistency Review of Seattle Public Utility's 2013 Water System Plan

Dear Ms. Kersnar:

This letter is in response to your requested review of SPU's water system plan (Plan). As you are aware WAC 246-290-108 directs municipal water suppliers to submit their plans to local government for a determination of the plan's consistency with all adopted local plans and development regulations applicable to the supplier's service area. For cities like Shoreline with special districts, municipal water system plans are incorporated by reference into the Comprehensive Plan and accordingly must demonstrate internal consistency.

For the purpose of our review we evaluated the water system against the City's 2005 Comprehensive Plan, Title 20 of the Shoreline Municipal Code, and Vision 2029. Vision 2929 is a set of framework goals developed by our shared citizens in collaboration with the Shoreline City Council. The framework goals provide the overall policy foundation for the Comprehensive Plan and support the City Council's vision. When implemented the goals are intended to protect the City's future. It is a vision where newer development has accommodated for changing times and both blends well with established neighborhood character and sets new standards for sustainable building, energy efficiency and environmental sensitivity. The vision of the citizens of Shoreline sees growth and development as necessary to fulfill the vision and implement the principles of the Growth Management Act (GMA).

The format of our review follows the criteria outlined in the checklist published by the Washington State Department of Health (DOH) to aid local government and suppliers in determining consistency. Our observations are listed below and a completed DOH checklist is enclosed for reference.

a. *The water system service area is consistent with the adopted <u>land use and zoning</u> within the applicable service area.*
   The general land use designations from the Comprehensive Plan are not included or referenced in the Plan. The planning model appears to use the current zoning designations. By not using general land use designations from the City's Comprehensive Plan planning for future densities

may be limited and inaccurate relative to development potential but, this would not cause the Plan to be inconsistent.

b. *The six-year growth projection used to forecast water demand is consistent with the adopted city/county's population growth projections. If a different growth projection is used, provide an explanation of the alternative growth projection and methodology.*
The Plan appropriately describes the methodology used for calculating the growth projections. In gross measures the forecast appears to be reasonable.

c. *Applies to cities and towns that provide water service: All water service area policies of the city or town are consistent with the utility service extension ordinances of the city or town.*
Not applicable.

d. *Service area policies for new service connections are consistent with the adopted local plans and adopted development regulations of all jurisdictions with authority over the service area [City(ies), County(ies)].*
City of Shoreline's development regulations require that an adequate supply of potable water and water for fire protection exist at the time development is ready to be occupied. The Plan is consistent with the City's plans and development regulations.

e. *Other relevant elements related to water supply are addressed in the water system plan, if applicable; Coordinated Water System plans, Regional Wastewater plans, Reclaimed Water plans, Groundwater Area Management plans, and Capital Facilities Element of Comprehensive plans.*
Not applicable.

Based on our review and we have found that the update is generally consistent with the Capital Facilities and Land Use Elements of the Comprehensive Plan.

Sincerely,

Rachael Markle, AICP
Director of Planning and Community Development

Cc: Julie T. Underwood, City Manager
Jeff Forry, Permit Services Manager
Mark Relph, Public Works Director

Enclosure: Department of Health Checklist

Washington State Department of Health
Division of Environmental Health
Office of Drinking Water

Local Government Consistency Review Checklist

Water System Name: Seattle Public Utilities PWS ID: 77050 Y

Planning/Engineering Document Title: 2013 Water System Plan Plan Date: April 2012

Local Government with Jurisdiction: City of Shoreline

WAC 246-290-108 Consistency with local plans and regulations:
Consistency with local plans and regulations applies to planning and engineering documents under WAC 246-290-106, 246-290-107, and 246-290-110(4)(b (ii).

1) Municipal water suppliers must include a consistency review and supporting documentation in its planning or engineering document describing how it has addressed consistency with **local plans and regulations**. This review must include specific elements of local plans and regulations, as they reasonably relate to water service as determined by Department of Health (DOH). Complete the table below and see instructions on back.

Local Government Consistency Statement	Page(s) in Planning Document	Yes – No – Not Applicable
a) The water system service area is consistent with the adopted land use and zoning within the applicable service area.	Part I, Section 1.4.2 Appendix D-2	YES
b) The six-year growth projection used to forecast water demand is consistent with the adopted city/county's population growth projections. If a different growth projection is used, provide an explanation of the alternative growth projection and methodology.	Part I, Sect. 2.4.1.2 Appendix A-1	YES
c) Applies to cities and towns that provide water service: All water service area policies of the city or town are consistent with the utility service extension ordinances of the city or town.	Appendix C-5 and C-6	NA
d) Service area policies for new service connections are consistent with the adopted local plans and adopted development regulations of all jurisdictions with authority over the service area [City(ies), County(ies)].	Appendix C-5 and C-6	YES
e) Other relevant elements related to water supply are addressed in the water system plan, if applicable; Coordinated Water System plans, Regional Wastewater plans, Reclaimed Water plans, Groundwater Area Management plans, and Capital Facilities Element of Comprehensive plans.	Part I, Section 1.4.2 Part II, Chapter 1 Appendix A-4 Appendix D-1	NA

I certify that the above statements are true to the best of my knowledge and that these specific elements are consistent with adopted local plans and development regulations.

Signature 5/30/12 Date

JEFFREY E FORRY PERMIT SERVICES MANAGER CITY OF SHORELINE
Printed Name, Title, & Jurisdiction

Consistency Review Guidance

For Use by Local Governments and Municipal Water Suppliers

This checklist may be used to meet the requirements of WAC 246-290-108. When using an alternative format, it must describe all of the elements; 1a), b), c), d), and e), when they apply.

For **water system plans (WSP)**, a consistency review is required for the retail service area and any additional areas where a municipal water supplier wants to expand its water right's place of use.

For **small water system management programs**, a consistency review is only required for areas where a municipal water supplier wants to expand its water right's place of use. If no water right place of use expansion is requested, a consistency review is not required.

For **engineering documents**, a consistency review is required for areas where a municipal water supplier wants to expand its water right's place of use (water system plan amendment is required). For non-community water systems, a consistency review is required when requesting a place of use expansion. All engineering documents must be submitted with a service area map per WAC 246-290-110(4)(b)(ii).

A) Documenting Consistency: Municipal water suppliers must document all of the elements in a consistency review per WAC 246-290-108.

1 a) Provide a copy of the adopted **land use/zoning** map corresponding to the service area. The uses provided in the WSP should be consistent with the adopted land use/zoning map. Include any other portions of comprehensive plans or development regulations that are related to water supply planning.

1 b) Include a copy of the **six-year growth projections** that corresponds to the service area. If the local population growth rate projections are not used, provide a detailed explanation on why the chosen projections more accurately describe the expected growth rate. Explain how it is consistent with the adopted land use.

1c) Include water service area policies and show that they are consistent with the **utility service extension ordinances** within the city or town boundaries. This applies to cities and towns only.

1 d) Include all **service area policies** for how new water service will be provided to new customers.

1 e) **Other relevant elements** related to water supply planning as determined by the department (DOH). See Local Government Consistency – Other Relevant Elements, Policy B.07, September 2009.

B) Documenting an Inconsistency: Please document the inconsistency, include the citation from the comprehensive plan or development regulation, and provide direction on how this inconsistency can be resolved.

C) Documenting Lack of Consistency Review by Local Government: Where the local government with jurisdiction did not provide a consistency review, document efforts made and the amount of time provided to the local government for their review. Please include: name of contact, date, and efforts made (letters, phone calls, and e-mails). In order to self-certify, please contact the DOH Planner.

The Department of Health is an equal opportunity agency. For persons with disabilities, this document is available on request in other formats. To submit a request, please call 1-800-525-0127 (TTY 1-800-833-6388).

Washington State Department of Health
Division of Environmental Health
Office of Drinking Water

Local Government Consistency Review Checklist

Water System Name: Seattle Public Utilities PWS ID: 77050 Y

Planning/Engineering Document Title: 2013 Water System Plan Plan Date: April 2012

Local Government with Jurisdiction: City of Lake Forest Park

WAC 246-290-108 Consistency with local plans and regulations:
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b) The six-year growth projection used to forecast water demand is consistent with the adopted city/county's population growth projections. If a different growth projection is used, provide an explanation of the alternative growth projection and methodology.	Part I, Sect. 2.4.1.2 Appendix A-1	YES
c) Applies to cities and towns that provide water service: All water service area policies of the city or town are consistent with the utility service extension ordinances of the city or town.	Appendix C-5 and C-6	N.A.
d) Service area policies for new service connections are consistent with the adopted local plans and adopted development regulations of all jurisdictions with authority over the service area [City(ies), County(ies)].	Appendix C-5 and C-6	YES
e) Other relevant elements related to water supply are addressed in the water system plan, if applicable; Coordinated Water System plans, Regional Wastewater plans, Reclaimed Water plans, Groundwater Area Management plans, and Capital Facilities Element of Comprehensive plans.	Part I, Section 1.4.2 Part II, Chapter 1 Appendix A-4 Appendix D-1	YES

I certify that the above statements are true to the best of my knowledge and that these specific elements are consistent with adopted local plans and development regulations.

Signature Date 6/11/12

STEPHEN BENNETT, PLANNING DIRECTOR, LFP
Printed Name, Title, & Jurisdiction

Consistency Review Guidance

For Use by Local Governments and Municipal Water Suppliers

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Washington State Department of Health

Local Government Consistency Review Checklist

Water System Name: Seattle Public Utilities PWS ID: 77050 Y

Planning/Engineering Document Title: 2013 Water System Plan Plan Date: April 2012

Local Government with Jurisdiction: City of Burien

WAC 246-290-108 Consistency with local plans and regulations:
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d) Service area policies for new service connections are consistent with the adopted local plans and adopted development regulations of all jurisdictions with authority over the service area [City(ies), County(ies)].	Appendix C-5 and C-6	YES
e) Other relevant elements related to water supply are addressed in the water system plan, if applicable; Coordinated Water System plans, Regional Wastewater plans, Reclaimed Water plans, Groundwater Area Management plans, and Capital Facilities Element of Comprehensive plans.	Part I, Section 1.4.2 Part II, Chapter 1 Appendix A-4 Appendix D-1	YES

I certify that the above statements are true to the best of my knowledge and that these specific elements are consistent with adopted local plans and development regulations.

Signature Date 5/22/12

SCOTT GREENBERG, COMMUNITY DEVELOPMENT DIRECTOR, CITY OF BURIEN
Printed Name, Title, & Jurisdiction

Consistency Review Guidance

For Use by Local Governments and Municipal Water Suppliers

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Form revised: December 6, 2011

FISCAL NOTE FOR NON-CAPITAL PROJECTS

Department:	Contact Person/Phone:	CBO Analyst/Phone:
Seattle Public Utilities	Joan Kersnar/ 4-0839	Karl Stickel/ 4-8085

Legislation Title: AN ORDINANCE relating to Seattle Public Utilities; adopting the 2013 Water System Plan.

Summary of the Legislation:
This legislation adopts the *2013 Water System Plan* (WSP).

Background:
The WSP provides guidance for planning and managing the City's drinking water system and associated capital facilities for the next 20 years, in coordination with growth management planning by the City and that of other planning agencies in the Puget Sound Basin. The WSP was drafted to meet state requirements for water system plans and land-use planning consistency, as well as King County requirements for franchises and permits.

As a condition of its utility operating permit from the Washington State Department of Health (WDOH), every six years SPU is required to submit for approval a Water System Plan for planning, managing and operating the drinking water system that serves Seattle and its wholesale customers. Additionally, King County reviews the WSP for compliance with requirements for franchises and permits and land-use consistency. The plan was developed to address items identified in a June 2010 pre-plan scoping meeting with WDOH and King County. Part of the process to develop the plan included retail customer input through the Water System Advisory Committee and wholesale customer input through the Seattle Water System Operating Board. The public was also invited to comment on a draft of the plan that was released on April 2, 2012. Changes have been made to the draft plan to address those comments received through May 31, 2012.

The WSP provides guidance to SPU on future direction for all elements of its water system. The plan includes new water use efficiency goals for the regional water conservation program; a request to change SPU's Service Area and the place of use of SPU's water rights to include areas in south Snohomish County; a new system storage level of reliability standard; and strategies and plans for operating, maintaining, and improving the system for the next six years and beyond. The policies of the *2007 Water System Plan* are being carried forward in this WSP. Adoption of this WSP will replace the action plans of the previous water system plan adopted by the City (Ordinance 122309).

The WSP contains a Capital Facilities Plan covering the period from 2013 through 2040, which includes the budget endorsed through 2017 in the 2012-2017 Adopted Capital Improvement Program (CIP). While the WSP contains references to proposed projects and programs, it does

not commit SPU to specific expenditures, as these funding levels are adopted through the regular City budget and CIP approval processes. This includes funding commitments for the 2013-2018 Water Use Efficiency Goal contained in the 2013 WSP.

Please check one of the following:

_X_ **This legislation does not have any financial implications.**

____ **This legislation has financial implications.**

Other Implications:

a) **Does the legislation have indirect financial implications, or long-term implications?**
Yes, adoption of the 2013 WSP has indirect financial implications. To meet the 2013-2018 Water Use Efficiency Goals of the 2013 WSP, both capital and O&M expenditures will need to be made for the regional water conservation program. As mentioned above, however, the WSP does not commit SPU to specific expenditures, as these funding levels are adopted through the regular City budget and CIP approval processes.

b) **What is the financial cost of not implementing the legislation?**
A cost estimate for not implementing the legislation is difficult. By not adopting the legislation, SPU would not be able to submit an updated plan to WDOH and King County for their approval. Implications of not having an approved water system plan include:
- SPU would no longer have a "green" operating permit for its water system.
- SPU would not meet the requirements for obtaining a low-interest loan under the Drinking Water State Revolving Fund, such as that received for the Maple Leaf Reservoir Burying Program.
- SPU would need to obtain written WDOH approval for each individual distribution project now covered by the pre-approval process.
- SPU would not be able to get new or renewed franchises or right-of-way permits in unincorporated King County.
- SPU and its wholesale customers would not meet State regulations requiring establishment and reporting of Water Use Efficiency Goals (WAC 246-290, Part 8).
- SPU's Water Fund bond ratings may be downgraded.

c) **Does this legislation affect any departments besides the originating department?**
No other City departments are directly affected by this legislation.

d) **What are the possible alternatives to the legislation that could achieve the same or similar objectives?**
No alternatives to legislation exist.

e) **Is a public hearing required for this legislation?**
A public meeting was held on April 17, 2012, regarding the plan. The City's wholesale water customers have also provided input in the development of the plan. However, a public hearing to adopt the WSP will meet Washington State requirements for public meetings to set the 2013-2018 Water Use Efficiency Goal and new system storage level

of reliability standard.

f) Is publication of notice with *The Daily Journal of Commerce* and/or *The Seattle Times* required for this legislation?
Not required.

g) Does this legislation affect a piece of property?
No properties are directly affected.

h) Other Issues:
None.

City of Seattle
Office of the Mayor

July 24, 2012

Honorable Sally J. Clark
President
Seattle City Council
City Hall, 2nd Floor

Dear Council President Clark:

I am pleased to transmit the attached proposed Council Bill adopting Seattle Public Utilities' (SPU) 2013 Water System Plan. As a condition of its utility operating permit, SPU must submit an updated plan every six years to the Washington State Department of Health.

The 2013 Water System Plan is an update of the 2007 Water System Plan. Policies established under the previous plan are being carried forward into this update. The 2013 Water System Plan includes new water use efficiency goals for the regional water conservation program; a request to change SPU's Service Area and the place of use of SPU's water rights to include areas in south Snohomish County; a new system storage level of reliability standard; and strategies and plans for operating, maintaining, and improving the system for the next six years and beyond. Importantly, the Plan indicates that no new water source will be needed before 2060, even with the uncertainties presented by future growth and climate change.

SPU has been making, and continues to make, significant investments to protect public health, comply with federal and state regulations, and replace aging infrastructure. While SPU has invested in major regional facilities in the past decades, the need is now shifting to significant capital investments to rehabilitate and improve the distribution system. Implementation of this water system plan will help to ensure that SPU meets its mission to provide reliable, efficient and environmentally conscious water utility services to enhance the quality of life and livability in all communities we serve.

Thank you for your consideration of this legislation. Should you have questions, please contact Joan Kersnar at 4-0839.

Sincerely,

Michael McGinn
Mayor of Seattle

cc: Honorable Members of the Seattle City Council

Michael McGinn, Mayor
Office of the Mayor
600 Fourth Avenue, 7th Floor
PO Box 94749
Seattle, WA 98124-4749

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mike.mcginn@seattle.gov