Parsons, Susan

From: Scott Fernandez <scottfernandez.pdx@gmail.com>
Sent: Tuesday, March 07, 2017 3:57 PM
To: Moore-Love, Karla; Scott Fernandez
Subject: 11 Scott Fernandez memo- Documents and photos for Record, corrosion and flushing of system
Attachments: 3=6=17 AECOM UDF - corrosion - udf_handout.pdf; 3=2=17 2012 PWB 2 - 405 - Water Asset Mgmt standalone summary.pdf; 3=2=17 2012 PWB - 405 - Water Asset Mgmt - PUBLISHED.pdf; 3=2=17 2011 - Auditor PWB 398 Use of Utility Rates - PUBLISHED.pdf; 3=1=17 2004 Auditor Report - SUMMARY Portland s Water Distribution System (Report 299) - 8 23 04 (2).PDF; 3=1=17 - Audit 2004 - Portland s Water Distribution System Maintenance Program Needs Improvement (Report 299) - 8 23 04 (2).PDF; 3=6=17 Figure-2-1.jpg; 3=2=17 3 clean pipe - PipeWEB-150x150.jpg; 3=2=17 7 Organic and inorganic scale-contribute to chlorine demand and disinfection byproducts - pipes2.jpg; 3=6=17 Pipe_Section_clogged3-300x225.jpg

Karla

Attached documents and photos are for the record regarding corrosion and lead issues for tomorrow Council session. Document 1 shows benefits of unidirectional flushing. Additionally, are the Auditor reports of poor water system management and maintenance. The final photos show best flushing method and poor system maintenance.

Thank you,

Scott

Portland's Water Distribution System

Maintenance Program Needs Improvement

August 2004

Office of the City Auditor
Portland, Oregon

CITY OF

PORTLAND, OREGON

OFFICE OF THE CITY AUDITOR
Audit Services Division

Gary Blackmer, City Auditor
Richard Tracy, Director of Audits
1221 S.W. Fourth Ave., Room 310
Portland, OR 97204

(503) 823-4005, FAX (503) 823-4459
www.portlandonline.com/auditor

August 23, 2004

TO: Vera Katz, Mayor
Jim Francesconi, Commissioner
Randy Leonard, Commissioner
Dan Saltzman, Commissioner
Erik Sten, Commissioner
Mort Anoushiravani, Administrator, Bureau of Water Works

SUBJECT: Audit of the Water Distribution System Maintenance Program, Report #299

Attached is Report #299 containing the results of our audit of the maintenance of the City of Portland's water distribution system. The audit was included in our annual audit schedule and was conducted in accordance with generally accepted government auditing standards.

As a follow-up to our recommendations, we ask that the Administrator of the Bureau of Water Works prepare a status report in one year, detailing steps taken to address the report's recommendations. This status report should be submitted to the Audit Services Division and coordinated through the Commissioner's Office.

We appreciate the cooperation and assistance we received from personnel in the Bureau of Water Works as we conducted this audit.

GARY BLACKMER
City Auditor

Audit Team: Richard Tracy
Doug Norman
Katherine Still
Amoy Williamson

Portland's Water Distribution System

Maintenance Program Needs Improvement

August 2004

A report by the Audit Services Division
Report #299

Office of the City uditor
Portland, Oregon

Table of Contents

Summary

For years, the Bureau of Water Works has provided reliable, high quality, and reasonably priced water to residential and wholesale customers in the Portland region. The Bureau's financial and operational results have compared favorably to the water utilities in the region and around the country. Recently, however, a variety of events threaten the Bureau's ability to fund and operate a high quality water system. Specifically,

- increased federal and state regulatory demands may require significant capital funding in the years to come
- declines in retail and wholesale water sales due to conservation and use of alternative sources will place upward pressure on rates
- failure of the customer billing system tarnished the Bureau's reputation for good management and required shifting of resources from maintenance activities to customer services

These challenges are also occurring at a time when the Bureau must begin addressing an aging infrastructure that will require significant resources over a number of years to replace and rehabilitate. Our review of the water distribution system indicates that Bureau maintenance efforts

are not at levels viewed as adequate by Bureau managers and fall short of industry standards in several areas. Water mains are flushed and replaced infrequently, valves receive minimal exercising and maintenance, and meters are repaired and replaced slowly. In addition, the backlog of needed repairs has grown. Although water quality and reliability have not yet been adversely affected, we believe continued decline in the maintenance of the water distribution system assets could negatively affect water service performance in the future.

We have concluded that the decline in maintenance service levels is affected by a variety of factors, including reductions in resources devoted to maintenance and a surge in retirement of experienced personnel. While addressing staffing and funding issues is essential, long-term solutions to distribution system maintenance must also include making improvements in the Bureau's maintenance management systems. Specifically, the Bureau lacks a clear and comprehensive maintenance plan, complete and reliable information on the nature and condition of its assets, and adequate methods to organize and schedule maintenance work.

Our review indicates that the Bureau has taken a number of steps to address distribution system maintenance weaknesses including the creation of special maintenance teams and implementation of a new work order system. However, we believe the Bureau needs to take a more comprehensive approach in its efforts to improve its maintenance management program.

Specifically, we recommend that the Bureau:

- prepare a comprehensive maintenance master plan
- better plan and coordinate efforts to automate water system asset information
- improve systems for organizing, scheduling, and tracking maintenance work, and strengthen current efforts to implement a maintenance management system
- develop and report improved performance measures to track the efforts and accomplishments of water system maintenance activities

We do not make specific recommendations on the level or source of additional resources needed to improve the maintenance of the water distribution system. Additional analysis of the current organization is needed to determine the most appropriate combination of rate increases, productivity enhancements, and out-sourcing strategies.

Chapter 1 Introduction

This is the Audit Services Division's first performance audit of the Bureau of Water Works. The audit was included in the City Auditor's FY 2002-03 audit schedule. We initially reviewed the Bureau's overall operations to identify potential topics to study in detail. Due to the critical nature of the water distribution system and the weaknesses we found in some of the Bureau's maintenance operations, we decided to focus our work on maintenance of the water distribution system. We conducted the audit in accordance with generally accepted government auditing standards and limited our work to those areas specified in the objectives, scope, and methodology section of this report.

City water system

The Bureau of Water constructs, maintains, and operates the City water system to ensure customers receive sufficient quantities of high-quality water now and in the future. As shown in the map on page 3, the City water system begins in the Bull Run Watershed on National Forest land east of the City. Water is delivered to the City and to wholesale customers in the metropolitan area through three large conduits that terminate at storage reservoirs at Powell Butte, Mt. Tabor, and Washington Park. From these reservoirs, water is distributed to other smaller reservoirs and tanks,

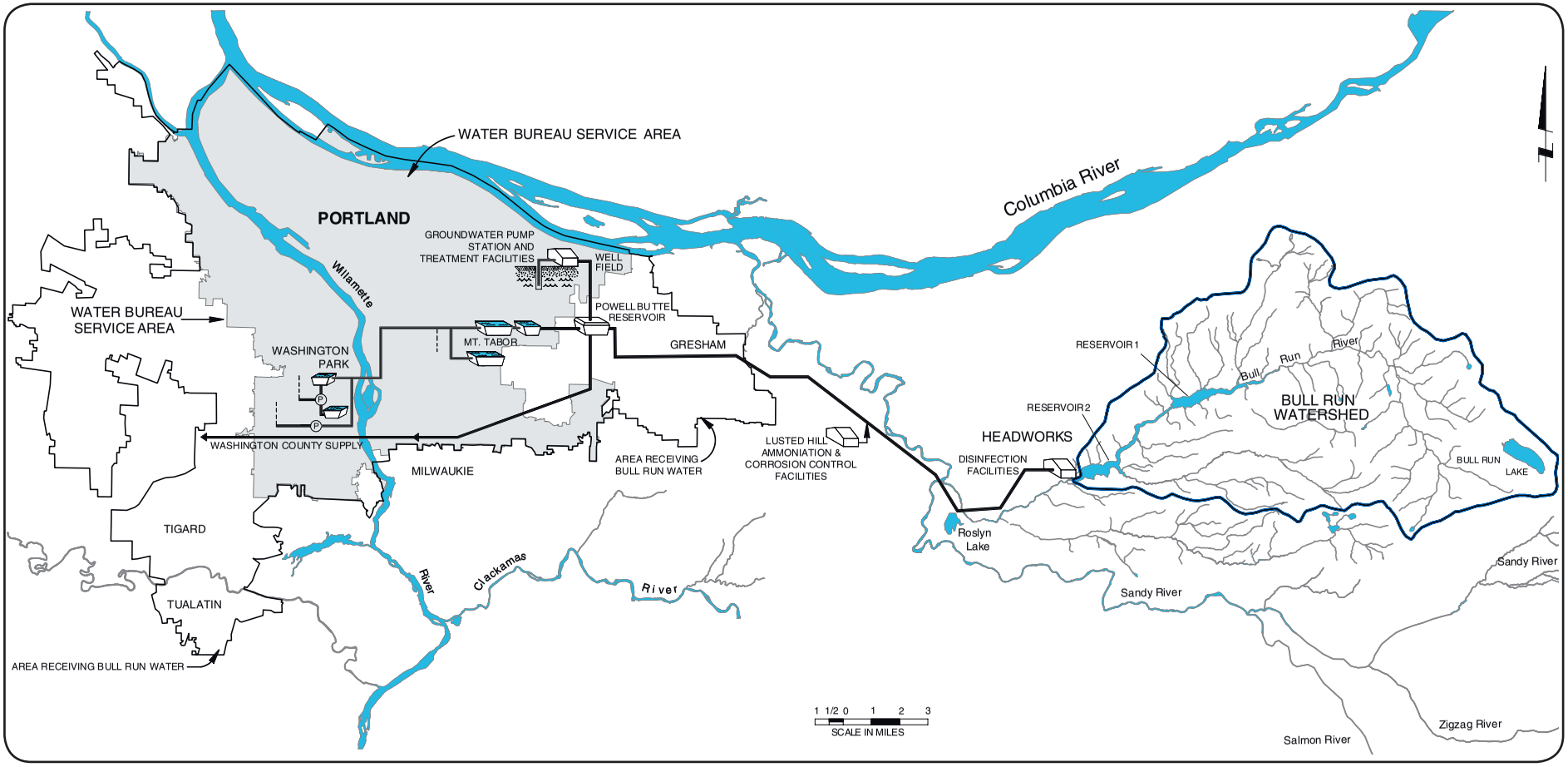
to other water districts in the region, and to customers through miles of underground pipeline. The Bureau also operates underground wells located in Columbia South Shore as a backup water supply. The shaded area on the map roughly corresponds to the distribution portion of the system, which includes water mains, fire hydrants, and service lines to customers. The supply portion of the water system begins with the Bull Run Lake and Reservoirs, and includes the conduits, in-town storage tanks and reservoirs, and the Columbia South Shore Well Field.

The City water system supplies over 35 billion gallons of water annually to nearly 800,000 people in the Portland metropolitan area. About 60 percent of the water is delivered to retail customers within Portland's city limits, while the remaining portion goes to neighboring cities and special districts on a wholesale contract basis. The Bureau works to ensure its primary water source – the Bull Run Watershed – and its backup water supply – the Columbia South Shore Well Field – are clean, safe and reliable. The Bureau tests and evaluates the quality of Portland's water at its water laboratory, and monitors and controls the supply and distribution of water using the automated Supervisory Control and Data Acquisition System (SCADA).

The Water Bureau has a FY 2003-04 Adopted Budget of $104 million, including 545 full-time positions and a $50 million capital budget. The largest portions of the budget go to Water Supply ($35.9 million), Water Distribution ($33.5 million), and Customer Services ($15.6 million), as illustrated in Figure 2. Almost half of the Bureau's total budgeted positions are assigned to the Water Distribution System.

Figure 1

Portland Water System



SOURCE: Water Bureau GIS.

Figure 2 **FY 2003-04 Adopted Budget, Bureau of Water Works**

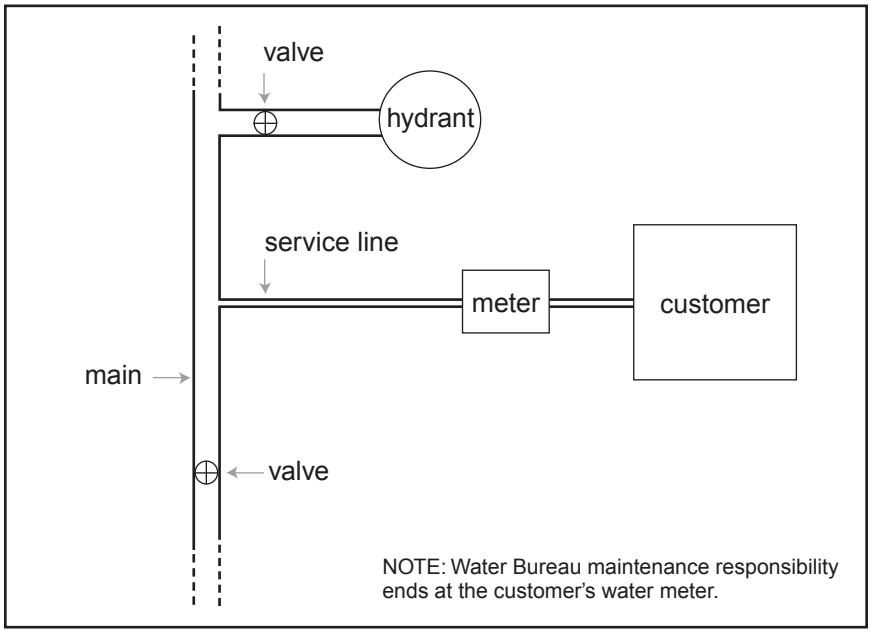
	Budget (millions)	Budgeted positions
Administration	$ 4.6	9
Finance	$ 5.0	29
Customer Services	$ 15.6	160
Water Distribution	$ 33.5	246
Water Supply	$ 35.9	57
Water Quality	$ 9.2	41
Hydroelectric	$ 0.5	3
TOTAL	$104.3	545

SOURCE: City of Portland FY 2003-04 Adopted Budget.

Maintenance of the distribution system

The Water Bureau is responsible for repairing and maintaining the City's entire water system from the Bull Run Watershed facilities to the meters that measure water flow to the customers. A majority of the assets requiring maintenance are part of the distribution system. The distribution system includes over 2,000 miles of distribution and transmission mains. Pipes range in size from 1- to 2-inch diameter services to 96-inch diameter transmission lines, and include cast iron, ductile iron, galvanized, and steel pipes with a variety of coatings and linings. The distribution system has in excess of 170,000 connections to residential, commercial, and wholesale customers, and includes 166,000 meters, 13,000 fire hydrants, and 39,000 valves. Figure 3 shows a schematic of the common elements of the distribution system requiring maintenance.

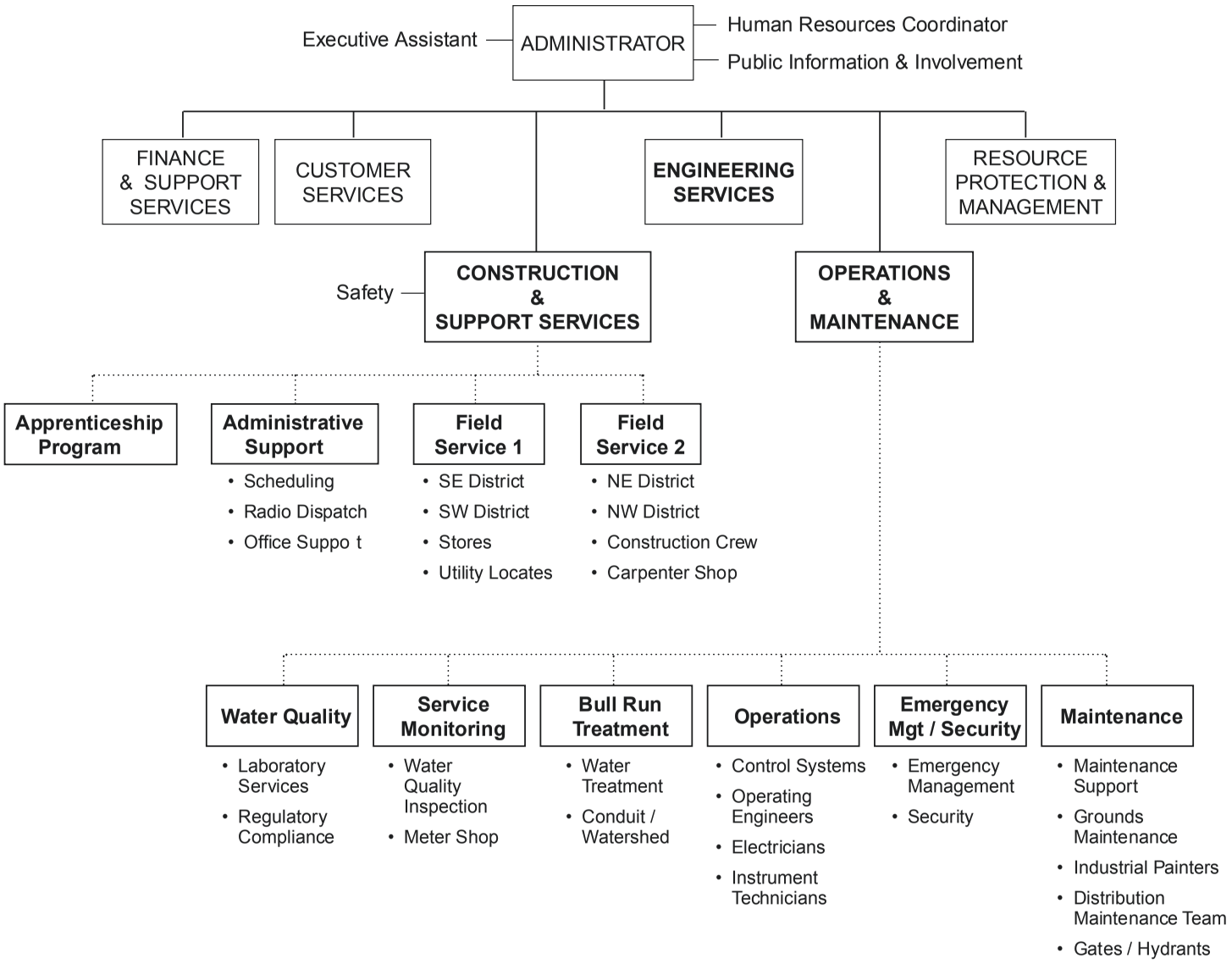
Figure 3 Schematic of common distribution system elements



SOURCE: Water Bureau records and interviews.

Maintenance and repair of distribution system assets is performed primarily by field personnel within the Bureau's Construction & Support and Maintenance & Operations Groups, which operate out of shops located on North Interstate Avenue near the Broadway Bridge. In addition, Engineering Services, with offices in the Portland Building, administers capital maintenance of the distribution system, provides design and engineering support to the Bureau's field operations, and maintains information on the water system assets. Figure 4 contains a Bureau organization chart illustrating where Construction & Support, Operations & Maintenance, and Engineering Services fit within the Bureau's overall organizational structure.

Figure 4 WATER BUREAU ORGANIZATION CHART



Construction & Support

Maintenance and repair of water distribution system assets below the ground (i.e., work requiring a backhoe) is performed by field crews within Construction & Support, as explained below:

Field Service Districts. Two to four work crews, equipped with backhoes, dump trucks, and a variety of equipment, are assigned to each of four Districts – Northwest, Southwest, Northeast, and Southeast – to carry out needed repair and construction work.

Construction Crew and Carpenter Shop. The Construction Crew installs water mains, valves, meters, and hydrants, and performs other construction related work. The Carpenter Shop performs carpentry services, although its role is diminishing because the shoring of trenches is no longer performed with lumber.

Utility Locates. Five personnel are assigned the responsibility of locating underground Water Bureau lines in response to requests from developers, builders, property owners, and other outside parties. These utility locates are required by State law.

Stores. The Stores function maintains a $1.4 million inventory of spare parts for use by Construction & Support and Operation & Maintenance crews. Stores also helps coordinate the acquisition of vehicles and equipment used by field crews.

Scheduling. Scheduling is responsible for receiving and logging work requests and preparing work orders that are given

to District Supervisors. The Scheduler processes completed work orders and sends them to Engineering Services staff who record the work in the Bureau's asset records.

Radio Dispatch. Radio Dispatch receives calls from the public, Water Bureau field crews, other City bureaus, and other utilities with emergency repair needs, and refers calls to Scheduling or gives them directly to the Field Service District Supervisors.

Operations & Maintenance

Operations & Maintenance is responsible for operating the water system, monitoring and ensuring water quality, as well as performing maintenance responsibilities. Distribution system maintenance functions within Operations & Maintenance include:

The Meter Shop. The Meter Shop is responsible for approximately 166,000 meters that register the volume of water usage for billing purposes. Meter Shop personnel test, clean, and calibrate meters to achieve customer equity, reading efficiency, and billing accuracy.

Gates / Hydrants. The Water Bureau is responsible for operating and maintaining approximately 39,000 valves, 13,000 hydrants, and 2,000 blow-offs (valves used for flushing water out of the system). Crews within the Gates/Hydrants Section perform routine maintenance, preventive maintenance, and some repair and replacement of these assets. They also provide flushing of distribution lines.

Distribution Maintenance Team. The Distribution Maintenance Team (DMT) was created in December 2002 to

perform a comprehensive review and repair of all components of the distribution system, including valves, hydrants, service lines, and meters. The DMT conducts its review one quarter section of the City at a time and limits its work to residential areas.

Water Leak Detection Crew. The Water Leak Detection Crew in Operations & Maintenance systematically tests pipes in the distribution system for leaks, and responds to requests for leak detection from Construction & Support.

Industrial Painters. Industrial Painters perform maintenance on the City's 27 decorative fountains, 130 drinking fountains, 73 water storage tanks, pump stations, reservoirs, and various buildings.

Engineering Services

The Engineering Services Group has several responsibilities that relate to the maintenance of the water distribution system. Engineering administers the Bureau's capital improvement program, which includes capital maintenance of distribution system assets. Two ongoing capital maintenance projects include the Main Replacement Program and the Large Meter Replacement Program. District crews within Construction & Support perform some work in support of these two programs; however, a significant amount of the actual construction work is performed by private contractors.

Engineering Services is also responsible for maps and other records containing the location and maintenance information on water system assets. Engineering staff responsible for GIS, maps, and other asset records are

physically located at the Water Bureau's shops on Interstate Avenue, to improve coordination with Construction & Support and Operations & Maintenance personnel.

Issues and challenges faced by the Water Bureau

The Bureau of Water currently faces several challenges that could impact its ability to address the maintenance needs of its water distribution system. We have highlighted on the following pages some of the most significant issues the Bureau is facing.

Billing system problems

The Bureau continues to address the functionality and performance of its billing system. The failure of the system implemented in February 2000 has cost millions of dollars due to increased staff requirements, foregone revenues, and other related expenses. In addition, a considerable number of maintenance positions were diverted to the Customer Services Group in order to handle the increased workload the faulty system created. The Office of Management and Finance is assisting the Water Bureau in purchasing a replacement billing system, which is expected to be implemented over the next two years.

Increasing regulatory demands

New federal regulations for surface water treatment will require modifications to the current Bull Run treatment process. It is anticipated that the Long Term 2 Enhanced Surface Water Treatment Rule may require unfiltered systems to provide treatment that inactivates or removes the microbial contaminant *Cryptosporidium*, with compliance

required by 2013. Several alternative treatment approaches are available, including ultra-violet light disinfection (UV), ozone disinfection, conventional filtration, and membrane filtration. The Bureau conducted an 18-month public decision process to evaluate and select a treatment process. The Citizens Panel on Bull Run Treatment recommended filtration with a preference for membrane filtration, but the Bureau is considering the less expensive UV over membrane filtration, which will require far less capital outlay.

Heightened water security concerns

The terrorist attack on September 11, 2001, resulted in stepped-up security measures taken by governments throughout the United States. Following the attack, the Water Bureau hired a local security company to provide 24 hour-a-day/seven days-a-week armed guard patrols of the City's reservoirs. The Bureau has since established 10 full-time security officer positions to work in conjunction with outside contractors to provide security to open reservoirs and other Bureau locations. The Bureau also completed a "Vulnerability Assessment" required by the U.S. Environmental Protection Agency (EPA) and is taking necessary water security precautions. The most significant improvements are planned for the City's five open reservoirs located at Mt. Tabor and Washington Park, which were identified as the greatest risk for intentional acts of vandalism, contamination, or terrorism. The assessment also extends to business and information systems, such as SCADA, and related hardware components. Overall, these water security improvements may have a significant financial impact on the Bureau.

Decline in water demand

Water demand for the Portland water system has fallen dramatically over the last five years, especially within the retail sector. Retail water sales peaked at 23.3 billion gallons in FY 1997-98 but fell to 21 billion gallons in FY 2002-03, a drop of over 10 percent. In addition, some wholesale customers, such as the Tualatin Valley Water District and the Powell Valley Water District, have increased their reliance on alternative water sources during the peak water season. Probably the greatest impact of the decline in water demand is the rise in water rates, especially for retail customers, which occurs because there are proportionally fewer units of water sold to cover the fixed costs of the Water Bureau.

Aging infrastructure and decline of capital financin

The Bureau estimates that the entire water system has a replacement value of over $3 billion dollars. Many of the Bureau's facilities, including dams, conduits, reservoirs, and portions of the distribution system are approaching 100 years in age and will require reinvestment due to age and condition. To facilitate decisions regarding whether to replace, rehabilitate or continue maintaining these facilities, the Bureau issued the Infrastructure Master Plan in July 2001, which focuses primarily on facilities in the supply system. The Bureau is currently seeking to hire a consultant to develop a Distribution System Master Plan to address needs of the distribution system. While water system facilities are aging, capital expenditures, along with operation and maintenance resources, have been reduced recently due to the billing system problems. The Bureau generally schedules construction bond sales every two years;

however, it postponed the bond sale that was scheduled for FY 2001-02, and finally issued two bond sales in April 2004, for $29.9 million and $61.9 million, respectively.

Water Bureau performance positive

Our review indicates the Water Bureau is continuing to provide quality services despite increasing challenges and recent setbacks. The Bureau continues to meet federal and state mandated water quality standards for regulated contaminants, including Giardia, Coliform Bacteria, Nitrate Nitrogen, E. Coli Bacteria, Trihalomethanes, and chlorine residual. The Oregon Department of Human Services (DHS) conducts a Sanitary Survey of the City's water system every five years to evaluate the system for its ability to provide safe drinking water to the public. In its last Sanitary Survey of the City's water system conducted in 1999, the DHS reported the water system was in excellent operating condition and that no "significant deficiencies" were found during the survey.

As reported in Portland's annual *Service Efforts and Accomplishments* report, the Water Bureau's operating cost per capita is less than the average of six other comparison cities. The Bureau's operating cost per capita was $62 in FY 2002-03 compared to the average cost per capita of $71 for Charlotte, North Carolina; Cincinnati, Ohio; Denver, Colorado: Kansas City; Missouri; Sacramento, California; and Seattle, Washington. In addition, the Bureau's debt coverage ratio was 3.0 in FY 2002-03, well above the Bureau's minimum goal of 1.9. The Bureau kept its debt coverage ratio above 1.9 in each of the past 10 years, with the exception of 1.8 in FY 2001-02.

Bureau water rates are relatively moderate compared to those of other jurisdictions in the Portland metropolitan area and comparably-sized cities around the country. Portland's average residential monthly water bill for 800 cubic feet of water consumed was $15.91 in 2003. This compares favorably to an average bill of $20.78 in seven other jurisdictions in the metropolitan area. In addition, Portland's bill of $14.60 for average monthly usage is lower than the average of $16.88 in six cities around the country (see Figure 5).

Figure 5 2003 residential monthly water bill: City of Portland vs. other cities and local jurisdictions

CITIES OUTSIDE OREGON (average monthly usage)	
Charlotte, NC	$13.54
Cincinnati, OH	$13.83
Denver, CO	$14.07
Sacramento, CA	$16.42
Kansas City, MO	$18.79
Seattle, WA	$24.60
Other city average	$16.88
City of Portland	**$14.60**

OTHER LOCAL JURISDICTIONS (for 800 cubic feet)	
City of Tigard	$16.81
Tualatin Valley Water Dist.	$18.40
Rockwood Water Dist.	$18.82
City of Tualatin	$19.70
City of Beaverton	$21.35
West Slope Water Dist.	$24.62
City of Gresham	$25.76
Local jurisdiction average	$20.78
City of Portland	**$15.91**

SOURCE: City Auditor's 2002-03 *Service Efforts and Accomplishments* report; Water Bureau's FY 2004-05 Preliminary Financial Plan.

As shown in Figure 6, over the last five years there has been a slight decline in the Bureau's service population (-1 percent) and operating expenditures (-4 percent). The Bureau's workload, as measured by gallons of water delivered (-9 percent), and feet of mains installed (-32 percent), declined while the number of retail accounts increased by 3 percent during the same 5-year period.

Figure 6 Change in Water Bureau workload and expenditures: FY 1998-99 through FY 2002-03

Fiscal Year	Population served	Operating expenditures	Capital expenditures	Authorized staffin	Water delivered (billions of gallons)	Number of retail accounts	Feet of new mains installed
'98-99	795,168	$51.1	$34.5	524	39.3	159,177	121,737
'99-00	773,171	$52.0	$37.6	535	39.2	160,100	107,590
'00-01	789,000	$48.8	$36.1	543	38.5	161,154	82,283
'01-02	830,834	$55.1	$21.9	531	38.2	162,631	32,781
'02-03	786,682	$49.0	$24.7	535	35.9	163,896	83,152
change	-1%	-4%	-28%	+2%	-9%	+3%	-32%

SOURCE: City Auditor's *Service Efforts and Accomplishments* report, 2002-03.

NOTE: Dollars adjusted for inflation (all ears adjusted to FY 2002-03 dollars).

Audit scope, objectives, and methodology

The objectives of this audit were to evaluate the adequacy of the methods used by the Water Bureau to manage its water distribution system maintenance operations. Specifically, we analyzed the quality, reliability, and accessibility of the Bureau's asset records; the organization and scheduling of personnel resources; the inventory of parts, supplies, and vehicles used to carry out maintenance work; and the Bureau's application of automated information systems to facilitate planning and tracking of maintenance activities.

We limited the scope of our work to maintenance of distribution system assets; we excluded maintenance of supply system assets and other facilities owned by the Water Bureau. Specifically, we did not review care of pump stations, tanks, reservoirs, regulators, control valves, buildings, grounds, and decorative and drinking fountains. Although closely tied to maintenance, we also excluded operations functions performed by Operations & Maintenance personnel, including the regulating of water flow and water pressure, the monitoring of water quality, and water system modeling and analysis. While we did not examine the Bureau's capital program in detail, we performed a limited review of Engineering's capital maintenance of distribution system assets, specifically the Main Replacement Program.

We focused our efforts on maintenance management systems. We reviewed the processing of work orders in both Construction & Support and Operations & Maintenance, documented the flow of work from work request through work completion, and examined methods for recording work completed on the distribution system. We reviewed

procedures used to manage the Stores' inventory of parts and supplies, and conducted a limited assessment of the adequacy of internal controls over this inventory. We performed a limited review of the utilization of fleet vehicles assigned to Water Bureau maintenance operations and of interagency services and charges by the City's Fleet Management.

We examined records containing information on distribution system assets, including the Bureau's map boards, GIS, and various databases. We examined the Bureau's efforts to develop two automated information systems, GIS and Synergen, and assessed the time, costs, and achievements associated with these development efforts. To help evaluate Water Bureau system development efforts, we studied the development of GIS and automated maintenance management systems by Portland's Bureau of Environmental Services and Office of Transportation.

Because of their impact on Bureau maintenance operations, we identified major issues and challenges the Water Bureau is currently facing and performed a limited review of overall Water Bureau performance. We interviewed personnel from each of the Bureau's major work groups, and conducted in-depth interviews with managers, supervisors, and support staff in Construction & Support and Operations & Maintenance. We also interviewed staff in the Engineering Services Group and the Finance & Support Services Group.

We interviewed personnel from the Bureau of Fire & Rescue regarding the inspection, testing, and maintenance of City fire hydrants. In addition, we interviewed represen-

tatives from the Oregon Department of Human Services, the federal Environmental Protection Agency (EPA), and the American Water Works Association (AWWA) to obtain information on water utility standards and performance criteria.

We toured major Water Bureau facilities, including the Bull Run Watershed (dams 1 and 2 and Bull Run Lake), the Sandy River Station maintenance shop, the Columbia South Shore Groundwater facilities, the Mt. Tabor reservoirs, the Interstate Avenue shops, the water laboratory, the Water Control Center, and the Customer Services Center in the Portland Building. In addition, we reviewed a variety of management studies, reports, and planning documents.

During this audit we became aware of several opportunities for potentially increasing the efficiency of Bureau maintenance operations by contracting-out work to the private sector. However, we did not study this issue in detail; we recommend that a detailed study of contracting-out opportunities be performed in the near future.

Chapter 2 Decline in Maintenance Service Levels

The Bureau's overall efforts to maintain the water distribution system are not at levels viewed as adequate by Bureau managers and fall short of industry standards in several areas. Replacement of aging water mains has slowed in recent years while, at the same time, the backlog of needed repairs has grown. Although water quality and reliability has not yet been adversely affected, we believe continued decline in the maintenance of the water distribution system assets could negatively affect water service performance in the future.

Several factors have contributed to the decline in maintenance service levels, including a decrease in resources devoted to maintenance, a surge in retirement of experienced maintenance personnel, and an unstable organizational structure. We also believe the Bureau needs to improve the systems it uses to manage its maintenance operations to ensure it uses its resources in an efficient and effective manner. This is discussed in detail in Chapter 3.

Best practices for distribution maintenance

The American Water Works Association (AWWA) provides a variety of guidelines and services to assist water utilities in the management of their water systems. We have

utilized AWWA guidelines – particularly the Guidance for Management of Distribution System Operation and Maintenance published by the AWWA Research Foundation in 2000 – in our analysis of the Water Bureau's distribution system maintenance operations. AWWA guidelines indicate that to enhance maintenance activities, water utilities should:

- be proactive
- establish management programs geared to specific distribution system components
- develop progressive information management tools

The AWWA identifies the primary elements of a water distribution system as mains, valves, fire hydrants, and meters. The reliability of these distribution system components can be maintained through regular exercise and maintenance of valves, testing and replacement of meters, maintenance and repair of hydrants, flushing of pipes, and water main rehabilitation and replacement. The AWWA also emphasizes the importance of ensuring that maintenance personnel are provided with appropriate training. Our review indicates the Water Bureau is taking steps to become more proactive and elevate its maintenance activities in many of these areas. In addition, the Bureau is endeavoring to develop automated information systems which the AWWA emphasizes as a key ingredient in the successful operation and maintenance of a water distribution system. However, as discussed in the remainder of this report, maintenance service and staffing levels have dropped, and the Bureau's maintenance management program can be improved.

Decline in maintenance efforts

Over the past several years, efforts to maintain the Bureau's distribution assets have declined. Specifically, water mains are flushed and replaced less frequently, valves receive minimal exercising and maintenance, and meters are repaired and replaced slowly. In addition, the backlog in the number of work requests for system repairs is growing.

Water Mains

Two primary means for maintaining the reliability of water mains are (1) flushing, and (2) main rehabilitation and replacement.

Flushing. The AWWA indicates that periodic flushing of main water lines is needed to remove bacteriological growth, sediment, and corrosion, to improve flow, and to introduce fresh water with higher chlorine residual. The most effective form of flushing is unidirectional flushing, which entails comprehensive flushing of large areas of pipe in order to systematically cleanse the pipes of debris. Bureau managers state they have been unable to implement a periodic unidirectional flushing program, however, because of a shortage of staff and because of restrictions placed on flushing by Federal regulations and the City's Bureau of Environmental Services (BES). These restrictions are related to the City's combined sewer overflow and problems associated with dumping large volumes of water into the sewer system. The Bureau's ability to perform unidirectional flushing is also hampered because the Bureau does not regularly exercise and maintain valves and does not have a complete and accurate inventory of valve status and location.

Flushing that is performed in the City's water system is driven primarily by water quality complaints. In addition, Operations & Maintenance crews flush various sites on a monthly, quarterly, or annual basis, where there are recurring problems with stagnation. This flushing essentially replaces dirty water with clean water, but does not address the debris that become lodged in the walls and various components of the pipes. The AWWA recommends that mains be flushed roughly every three to four years. While some stagnant areas of the City are being flushed within this time frame, the water system as a whole is not being flushed on a periodic basis.

Main rehabilitation and replacement. The AWWA indicates that consistent repair and replacement of aging water mains is needed to increase pipe carrying capacity, reduce leaks and emergency breaks, and improve fire flow requirements and customer service. While the timing of replacement varies depending on the type of pipe and ground conditions, the AWWA recommends that mains be replaced about every 50-100 years. The Bureau's Main Replacement Program is an ongoing capital program administered by the Engineering Services Group. As shown in Figure 7, expenditures on the program decreased by more than half over the past 5-year period, while the feet of mains replaced dropped from 46,500 to 9,800 feet, a 79 percent decline. If main replacement continues at the same rate as the past five years, it will take the Bureau over 400 years to replace all the City's 2,000 miles of water mains.

Our review also indicates the Bureau does not have good information on the condition of mains and, therefore, is unable to effectively prioritize and rank mains for re-

Figure 7 **Decline in water main replacement:** FY 1998-99 through FY 2002-03

Fiscal Year	Feet of mains replaced	Expenditures* (millions)
FY 1998-99	46,500	$8.6
FY 1999-00	46,000	$5.4
FY 2000-01	12,900	$4.1
FY 2001-02	15,600	$2.7
FY 2002-03	9,800	$4.0
5-year change	-79%	-53%

SOURCE: Water Bureau records.

* Adjusted to FY 2002-03 dollars.

placement. A good portion of the mains replaced are done in order to accommodate other agencies' construction projects (e.g. Oregon Department of Transportation, Portland Office of Transportation, and the Bureau of Environmental Services).

Slower replacement of aging water mains contributes to increased main breaks that in turn result in a greater repair workload and higher costs. Bureau managers state that slowing levels of water main replacement will result in reduced reliability and increased costs in the future.

Valves

The AWWA indicates that regular exercise and maintenance of water valves is needed to replace broken elements, repair stuck valves, and locate buried or hidden valves. Proper maintenance of valves can help reduce time needed to repair main breaks and leaks, prevent water quality problems, and reduce customer service complaints. Proper function-

ing valves are also needed for meter testing, flushing, and performing other maintenance activities.

The AWWA recommends that valves be maintained and exercised once a year. If not all valves can be maintained yearly, then the AWWA recommends that critical valves be identified and maintained. The Water Bureau currently does not perform periodic maintenance of valves, nor has the Bureau developed an inventory of critical valves and attempted to maintain them. Detection of valve problems occurs as the Distribution Maintenance Team makes its way through the City and as Field Service crews work on various portions of the water system on a piecemeal basis.

In addition, because the City's distribution system includes both valves that turn left to open as well as valves that turn right to open, it is important that the Bureau maintain up-to-date records on the location and status of valves. Unfortunately, the Bureau's asset records system does not provide complete and reliable information on valves.

We were also told there is a growing problem with valves being paved over by the Office of Transportation because the Water Bureau no longer has sufficient staff to coordinate with Transportation on its paving schedule.

Meters

The AWWA indicates that meter inspection, testing, repair, and replacement is needed to help ensure accurate measurement of service provided and improve revenue collection. We were told by Meter Shop managers that the City's water meters have not received adequate care for many years, and

that the Meter Shop has experienced severe cuts in staffing, training, and equipment over the past five years. We were also told that the large meters used to be privately owned and many were beyond their useful lives when the Water Bureau assumed ownership in 1996.

As a result, the Bureau has many old water meters that under-register customer water usage and impact the collection of water fees from customers. For example, the Bureau estimates that a large meter serving the Tualatin Valley Water District, which was recently replaced, had been under-registering the flow of water to the District by as much as 20% for many years. As a result, the City received between $400,000 and $1,000,000 less per year from the District than it should have because of the faulty meter. However, it should be noted that fees not paid by an individual customer due to a faulty meter are eventually shifted to other Water Bureau customers, in effect raising their water rates.

To help replace its old water meters, the Bureau established the Large Meter Replacement Program in FY 2002-03. While large meters represent only 8,000 of the total 166,000 meters in the system, they are responsible for 60 percent of City water sales. During the first year of the program, the Bureau replaced 152 of 3,500 meters targeted for replacement. While progress has been made, at the rate of 152 meters per year, it will take the Bureau over 50 years to replace all its large meters. Our research indicates meters generally need replacement in 20-25 years. Replacement of small meters is being performed by several work groups, including crews in Operations & Maintenance

(Gates/Hydrants Section, the DMT, and the Meter Shop) and Construction & Support (Field Service crews). Nevertheless, Bureau managers recognize that progress is much slower than it needs to be.

The Meter Shop has also established a 5-year cycle for testing, cleaning, and calibrating large meters. Managers in the Meter Shop indicate they have been unable to keep up with this cycle, even though five years is longer than industry standards. Moreover, they also state that their personnel have not followed uniform procedures for testing meters for many years; however, new operating procedures were being implemented as we completed our audit work.

Fire hydrants

The AWWA indicates that regular repair and replacement of fire hydrants is needed to ensure adequate water flow in fire emergencies and recommends that hydrants be tested once a year. The Water Bureau is responsible for the operation and maintenance of approximately 13,000 fire hydrants. Hydrants are inspected yearly, consistent with the AWWA standards. Inspections were performed by the Portland Fire Bureau until July 1, 2004, when the Water Bureau assumed responsibility for inspections. The Gates/Hydrants crew in Operations & Maintenance respond to deficiency reports based on the annual inspections. However, our interviews with Bureau managers and supervisors indicate that insufficient capital dollars are being devoted to replacement of hydrants, and the maintenance of hydrants has been neglected for several years.

Work order backlog

Because Bureau maintenance personnel have been unable to keep up with the maintenance and repair needs of the City distribution system, there has been a growing backlog of repair work orders. These work orders can include leaks, customer service complaints, and non-functioning meters and hydrants. While the Bureau does not have a completely accurate count of its backlogged work orders, records indicate the volume of the backlog has grown significantly over the last four years. A recently completed analysis of outstanding work orders by Construction and Support supervisors indicates the work order backlog may currently represent in excess of 26,000 hours of needed repairs and maintenance.

Distribution Maintenance Team

To help address the growing repair needs of the water distribution system, the Bureau created the Distribution Maintenance Team (DMT) a little over a year ago. The DMT performs a comprehensive review of distribution system needs on a quarter-section by quarter-section basis. The DMT works in conjunction with the Gates/Hydrants crew to operate, inspect, repair, and replace valves, and identify other repair needs in the distribution system. DMT personnel do small maintenance and repair work but refer major repair needs to Construction & Support's Field Service crews.

In its first year of operation, the DMT completed 47 of the City's 641 quarter sections containing water facilities. At this rate it could take nearly 14 years for the DMT to complete all 641 quarter sections. Currently, there are five

personnel assigned to the DMT, and some Bureau managers indicate that the size of the DMT crew needs to be doubled or tripled if it is to complete a sweep of the City water system in a timely manner. In addition, we were told that one of the purposes of the DMT is to allow unidirectional flushing of pipes to occur in sections cleaned-up by the DMT. As noted earlier, the Bureau has performed only limited unidirectional flushing because of regulatory restrictions and staffing shortages.

Factors contributing to the decline in maintenance service levels

We have concluded that the decline in maintenance service levels has been caused by a variety of factors, including a reduction in resources devoted to maintenance, a surge in retirement of experienced maintenance personnel, and an unstable organizational structure. While addressing staffing and funding issues will help stabilize maintenance efforts, we believe long-term solutions to water distribution system maintenance can only be achieved through improving the Bureau's systems for organizing and managing its maintenance activities. We discuss these needs in detail in Chapter 3 of this report.

Reduction in personnel resources

Bureau maintenance operations have experienced a reduction in the number of positions due to the shift of maintenance positions to the Customer Services Group to address billing system problems. Since FY 1999-00, the number of personnel who carry out maintenance, construction, and operations functions within the Bureau has been reduced by 63 positions. During the same period, the number of positions in the Customer Services Group increased

by 75. Bureau managers and supervisors indicate that because of the severe reduction in the number of maintenance personnel, the work of crews is mostly reactionary. That is, workers respond to customer complaints and run from repair to repair, but have little or no time for proactive maintenance work.

Loss of experienced personnel through retirement

In addition to the reduction in the number of maintenance personnel, there has been a significant increase in retirements in recent years, resulting in the Bureau's maintenance operations losing many experienced personnel. As shown in Figure 8, the number of retirements in Construction & Support, Operations & Maintenance, and Engineering

Figure 8 Number of retirements in Bureau maintenance operations: 1994 through 2003

Year	Construction & Support	Operations & Maintenance	Engineering	TOTAL
1994	2	5	0	7
1995	6	5	0	11
1996	2	4	0	6
1997	4	3	0	7
1998	3	2	1	6
Total '94-'98	**17**	**19**	**1**	**37**
1999	13	14	3	30
2000	5	3	2	10
2001	3	4	1	8
2002	11	16	7	34
2003	11	7	4	22
Total '99-'03	**43**	**44**	**17**	**104**

SOURCE: City of Portland Human Resources and Water Bureau records.

tripled during the past five years (1999-2003) compared to the preceding 5-year period, 1994-1998. In turn, the Bureau's maintenance workforce has become less experienced and knowledgeable. For example, we were told the Bureau no longer has someone capable of repairing large gate valves.

Organizational instability

Additional strain has been placed on employees in recent years because of frequent changes in organizational work groups. Over the last four years, the Engineering & Construction Services Group was split into the Engineering Services Group and the Construction & Support Group. The Maintenance Group and Water Operations Group were combined into the Operations & Maintenance Group. Also, the Bureau's Information Technologies Group was eliminated due to the transfer of information systems positions to the Bureau of Technology Services.

In addition, individual work units have been shuffled among the various Groups. For example, in FY 2002-03 the Bureau transferred the Meter Shop and Grounds Maintenance from the Construction & Support Group to the Customer Services Group. One year later, the Meter Shop and Grounds Maintenance were moved to the Operations & Maintenance Group. In FY 2003-04 the Gates and Hydrants Crews were combined, and Gates/Hydrants and the Emergency Crew were transferred from the Construction & Support Group to the Operations & Maintenance Group.

While Bureau managers believe that organizational changes have helped improve internal coordination and efficiency, our review indicates the magnitude of changes in

recent years may have had detrimental effects on maintenance operations. We were told by a number of employees we interviewed that the many changes in organizational work units have negatively impacted their understanding of work responsibilities and the coordination of work activities within the Bureau. We believe the frequent changes in organizational work units, combined with the surge in retirements and reduction in staffing levels, have had a negative effect on the productivity of Bureau maintenance personnel.

Chapter 3 Need to Develop Stronger Management Systems

Effective management of a large maintenance operation requires the development and application of good management systems and controls. These systems include comprehensive planning, written policies and procedures, methods for organizing and scheduling work, and accurate management information. Our review of the Water Bureau's distribution maintenance program indicates that while a number of management systems are in place, several critical elements of management control are outdated, missing, or ineffective. Specifically, in order to provide a firm foundation for the management of water distribution system maintenance, we believe improvements are needed in maintenance planning, asset information, maintenance work scheduling, and performance monitoring.

Maintenance management: Essential elements of management control

Good management systems and controls can help the Water Bureau provide safe, reliable drinking water and adequate water flow for fire suppression. Our review of industry publications from the American Water Works Association and our discussions with management officials from the Water Bureau indicate that critical components of good maintenance management should include a number of elements, as follows.

Comprehensive maintenance plan

The adoption of a comprehensive maintenance plan is essential to the effective operation of a water distribution system. The plan should establish overall maintenance goals, standards for the amount and frequency of work, and maintenance priorities. By defining the amount of maintenance effort that will be conducted, resource requirements can be more precisely estimated. The plan should identify long-term capital replacement needs, estimate the life of distribution assets, and focus efforts on the most important maintenance tasks. The comprehensive plan should also provide benchmarks against which to measure the performance of the maintenance program in addressing goals and standards.

Written maintenance policies and procedures

Written maintenance policies and procedures provide specific guidance on how to carry-out the maintenance plan and perform activities such as flushing, valve management, and water main replacement. Written policies and procedures should be used to train new staff, ensure maintenance work is correctly and consistently performed, and improve productivity of work crews. Written policies and procedures also provide standards for judging the quality of maintenance work and guidance to contract work crews.

Reliable information on assets

According to the AWWA, the "collection and management of information is a key element in the successful operation of a water system. Information is the necessary link between the maintenance, operation and design aspects of water distribution system management." Reliable information on

the nature, function, location, age, and condition of system assets is needed to ensure effective communication and coordination within the organization; to plan, carry out, and manage maintenance and repair work; and to plan capital improvements and replacements. Up-to-date information in the form of maps and data must be readily accessible to all employees and is most effective when fully integrated into an electronic maintenance management system.

Methods for organizing and scheduling work

Large water systems also require efficient methods for organizing staff resources in work units and scheduling work crews. A centralized scheduling system should be used to prioritize, assign and track the status of assigned work. Managers can control job costs by monitoring the time and costs of specific job requests and reduce duplicative efforts. This system is also most effective when integrated into an electronic maintenance management system.

Performance goals and monitoring

Effective management systems should also provide information so managers can actively monitor and measure the organization's performance in meeting goals for quality and timeliness. Performance measures track the productivity of work crews, efficiency of maintenance work, and accomplishment of maintenance plans. Performance reporting provides accountability to top management and City Council and aids budget and operational decision-making. Moreover, monitoring performance trends over time provides early warning of maintenance backlogs, declining asset conditions, and need for corrective actions.

Ongoing supervision and training

Another important tool to ensure maintenance is performed efficiently and effectively is ongoing supervision and training of maintenance staff. Supervisors ensure that policies and procedures are followed and work assignments are completed as planned. Supervisors also provide assistance to work crews to solve problems and advise management on work accomplishments. Work crews and supervisors also need ongoing training to ensure skills are adequate to perform duties assigned. Some water departments have formal training and apprenticeship programs to ensure staff have the competency to perform required tasks and activities.

Adequate equipment and supply support

Maintenance crews must have adequate equipment and materials. A sufficient number of vehicles and specialized equipment is required to perform construction work and move personnel and materials. An inventory of specialized supplies including replacement parts, valves, pipes, and other fittings should be on hand when crews are ready to perform maintenance work. Effective equipment and supply support helps reduce downtime, improve turnaround time, and reduce maintenance costs.

Weaknesses in Water Bureau maintenance management

The Water Bureau has done a good job with some of the above management elements. For example, the Bureau's system for managing its inventory of parts and supplies appears to be functioning adequately. Despite cutbacks in training in recent years, the Bureau has also developed training programs for maintenance personnel, including state

certified apprenticeship programs for new Utility Workers and Water Operations Mechanics. However, although the Bureau has taken steps to improve other critical management elements, some of its actions have proven ineffective, and important management systems remain incomplete or inadequate. Additional improvements are needed in these systems to ensure that the Bureau has the ability to efficiently and effectively maintain the water distribution system.

Lack of a comprehensive maintenance plan and procedures

The Water Bureau has not developed a comprehensive maintenance plan for its distribution system, and lacks a clear set of maintenance goals, standards, and work priorities. In addition, the Bureau has not prepared a complete policies and procedures manual for maintenance personnel to follow. Although some Bureau documents refer to maintenance standards, there is not a common understanding of, or commitment to, these standards by Bureau managers and supervisors. In addition, supervisors we interviewed stated that methods used to assign work to maintenance personnel do not always result in the most important needs being addressed first.

The Bureau conducted a comprehensive Maintenance Program Review in 1987 that recommended the development of a Master Maintenance Program for all elements of the water system including the distribution system. The Review indicated that to successfully implement a Master Maintenance Program, the Bureau would need to obtain additional funding and achieve increased operational efficiencies. Specific improvement opportunities identified in

the Review include better project scheduling, a maintenance monitoring program, a maintenance replacement program, optimizing personnel utilization, life-cycle cost analysis and improved cost controls. However, the Bureau failed to achieve most of the needed improvements and has made little progress toward developing a Master Maintenance Program.

Recently, the Bureau initiated an effort to hire a consultant to develop a Distribution System Master Plan. The Bureau's project engineer estimates that the Plan will require two to three years to complete. Although part of the Plan will involve developing a maintenance program, the focus will be to identify the long-term capital needs of the distribution system.

The Water Bureau has also not adopted a clear set of maintenance work priorities. Bureau managers told us that even though the highest priorities – such as ensuring safe water and fixing main breaks and out-of-service hydrants – are not written down, maintenance personnel are still aware of them. However, supervisors we interviewed indicated that workers are frustrated because they respond to "whomever yells the loudest" rather than prioritize service requests and customer complaints. Because of reduced staffing levels, a growing portion of the work performed by Bureau maintenance personnel is reactionary in nature. When a maintenance organization spends a significant amount of time reacting to complaints and service requests, its operations will inevitably be less efficient than when it systematically addresses a prioritized list of maintenance needs.

During the course of this audit, we were told that a *Mechanics Handbook* for Construction & Support staff was being updated, and that Standard Operating Procedures for Operations & Maintenance personnel would follow. Because these manuals have not been updated or actively used for many years, employees have had to rely on institutional knowledge and guidance provided by supervisors.

Lack of reliable information on distribution system assets

We found the Bureau's existing asset and maintenance information systems to be inefficient and unreliable. Asset and maintenance information has been stored in multiple databases, has not been kept up-to-date, and is incomplete and inaccurate as a result. Moreover, efforts to implement a much-needed Geographic Information System (GIS) have been hampered by delays and implementation problems that have contributed to weaknesses in the quality of asset information. While some recent progress has been made, more effort is needed to eliminate database and mapping backlogs, to resolve known data errors, to integrate numerous databases and information systems, and to develop a bureau-wide strategy for data and information management.

Prior to the advent of electronic databases and GIS, the Bureau maintained information on its distribution system assets on hand-drawn quarter section maps ("map boards") and 3x5 index cards. With improved technology, some maps were converted to computer assisted drawings and the index card data were migrated to a database called Infrastructure. Over time, however, separate databases were developed by various work groups to track information on specific assets, such as water mains, meters, and hydrants.

In some cases, multiple databases contain information on the same asset. In 1996 the Bureau initiated a project to develop a comprehensive GIS that would integrate asset data from Infrastructure and other information sources, link to several key water management systems, and serve as the Bureau's maintenance database.

Over the past eight years, GIS implementation has experienced significant problems that have delayed completion, increased costs and have substantially limited the system's usefulness (see GIS development time line in Figure 9). To date, the Bureau estimates that it has spent approximately $3.5 million on a system that is not yet fully functional.

Major problems include:

- Extensive delays and technical problems in the original digitization of the Bureau's quarter-section maps. The five-year consultant contract was terminated early with major deliverables incomplete and the entire budget expended.
- Substantial errors in the GIS database generated from subsequent software conversions, which GIS staff are still working to correct.
- Inadequate, sometimes unusable, maintenance tools which have contributed to the ongoing difficulty of keeping the Bureau's electronic maps up-to-date.
- A long delay in shifting Infrastructure users to GIS. This meant that GIS staff have spent several years maintaining the same information in both databases.

Figure 9 History of Water Bureau GIS development: 1996 to present

	aug	**Roy Weston, Inc** awarded contract to build comprehensive GIS for Water Bureau, estimated at **$1.35 million**
	dec	Water Bureau expresses concern about **Weston**'s reorganization and its impact on GIS project
1997	jan	Budget increase of **$34,000**, **Weston** contract, for test conversion (i.e. digitize 36 quarter-section maps)
	feb	Water Bureau expresses concern to **Weston** about ability to maintain maps during conversion process
	jun	Additional **$12,000** increase for **Weston** test conversion
	jul	Water Bureau expresses concern to **Weston** about delays for maintenance tools and impact on map updates
	nov	Additional **$43,000** increase for **Weston** test conversion and **$60,000** for final conversion of all maps
1998		
	jun	**Weston** completes test conversion of 36 quarter-section maps
	sep	Water Bureau issues stop work order on **Weston** contract; **Convergent Group** paid **$15,000** to review project
	oct	**Weston** receives approval to continue work on several key tasks
1999	jan	Water Bureau confirms commitment to new software platform, **ESRI** ArcInfo 7.2
	feb	Many quarter-section maps now 1 to 2 years out-of-date due to lack of maintenance tools
	mar	Purchase orders to **ESRI**: Implementation Plan - **$70,000** (March) software migration - **$100,000**; training - **$13,000** (April) query and display applications - **$76,000** (May) data model - **$99,000** (June) installation and training - **$25,000** (October)
	sep	Budget increase of **$138,000**, **Weston** contract, for final map conversion
	oct	**Weston** contract terminated with few deliverables other than approx 680 maps converted; final cost: **$1.5 million**
2000		
	mar	Purchase order to **ESRI**: technical support - **$8,000**
	apr	**ESRI** awarded **$487,000** contract to convert Water Bureau from ArcInfo 7.2 to ArcInfo 8.0
2001	feb	Water Bureau pays Bureau of Technology Service (Corporate GIS) **$5,000** to develop rudimentary data maintenance tools
	may	**ESRI** completes conversion to ArcInfo 8.0 but system is unstable
	oct	Water Bureau determines that **ESRI** maintenance tools are corrupting their data
	nov	Water Bureau upgrades to more stable software version, ArcInfo 8.1
2002		
	aug	Water Bureau pays Corporate GIS **$13,500** to develop improved maintenance tools; Water Bureau begins replicating data to the City's central GIS server (the Hub)
	oct	Water Bureau upgrades to ArcInfo 8.2
2003		
	nov	First electronic map is fully up-to-date; Bureau implements plan to keep maps current as they are completed
	dec	Three electronic maps are now kept current
2004	mar	Total of 19 electronic maps kept current; Water Bureau staff begins switching users from Infrastructure to GIS
	may	All Infrastructure users now use GIS

Ongoing problems with GIS development have contributed to the Bureau's diminished ability to maintain reliable asset and maintenance information. The existence of numerous backlogs has been a significant problem:

- *GIS electronic mapping backlog* – The Bureau estimates that it will be five to six years before all of its GIS maps are current. This is due in part to years without proper data maintenance tools and unstable software systems. Many maps reflect the water system at the time of the first conversion.
- *Data entry and mapping backlog for big projects* – Until early June of this year, the Bureau had not updated the paper map boards or the GIS database for many large projects dating back to 1998, including Interstate MAX and the Central City Streetcar. Originally expected to require one person about two years to eliminate this backlog, GIS staff recently eliminated all but one large project.
- *Project files and microfiche backlog* – Approximately 40 boxes of engineering project files and documents need to be reviewed, microfiched, and archived. Records have not been microfiched for four years due to insufficient staffing.

The Bureau recently terminated use of the Infrastructure database and was able to switch its users over to the GIS database which is now the central source of location and maintenance information for Water Bureau assets. While this is a significant improvement, a number of duplicative databases exist in the Bureau that could be eliminated through better integration with GIS. Figure 10 describes these databases, the assets tracked, and the type of information stored.

Figure 10 Asset inventory and maintenance information for the distribution system

Information Source	Distribution System Asset	Type of Information Stored
Map boards[1]	Services, mains, valves, air valves, blow-offs, hydrants, regulators, pumps, tanks	Location and size
GIS[1]	Services, mains, valves, air valves, blow-offs, hydrants, regulators, pumps, tanks, small & large meters	Maintenance history, location, size, material, model & installation (in some cases). Mains by street and quarter section, plus by pipe segment with year, size, and material. Meters with size, location, and make
Infrastructure[2]	Services, mains, valves, air valves, blow-offs, hydrants, regulators, pumps, tanks	Maintenance history, location, size, material, model & installation (in some cases). Mains by street and quarter section
Leaks	Mains	Leak detection requests, leak detections, and leak repairs
Rank	Mains	Leak history and condition of water mains
Blow-offs	Blow-offs	Tracks scheduled water quality flushing by location
Fireslips	Hydrants	Location, maintenance, make, status, address
Large Meter	Large meters	Size, make, type, location, testing frequency & results, maintenance history
Operating Engineers Preventive Management	Regulators, pumps, tanks	Maintenance and work orders for Operating Engineers
Scanned Documents	Services, mains, valves, blow-offs, hydrants	Scanned copies of work orders (for repairs and replacement), and “as-builts” drawings

[1] Does not contain comprehensive listing of every asset that is stored on the map boards/GIS. For example, they also contain reservoirs, water bureau easements, pressure zones, and facility sites.

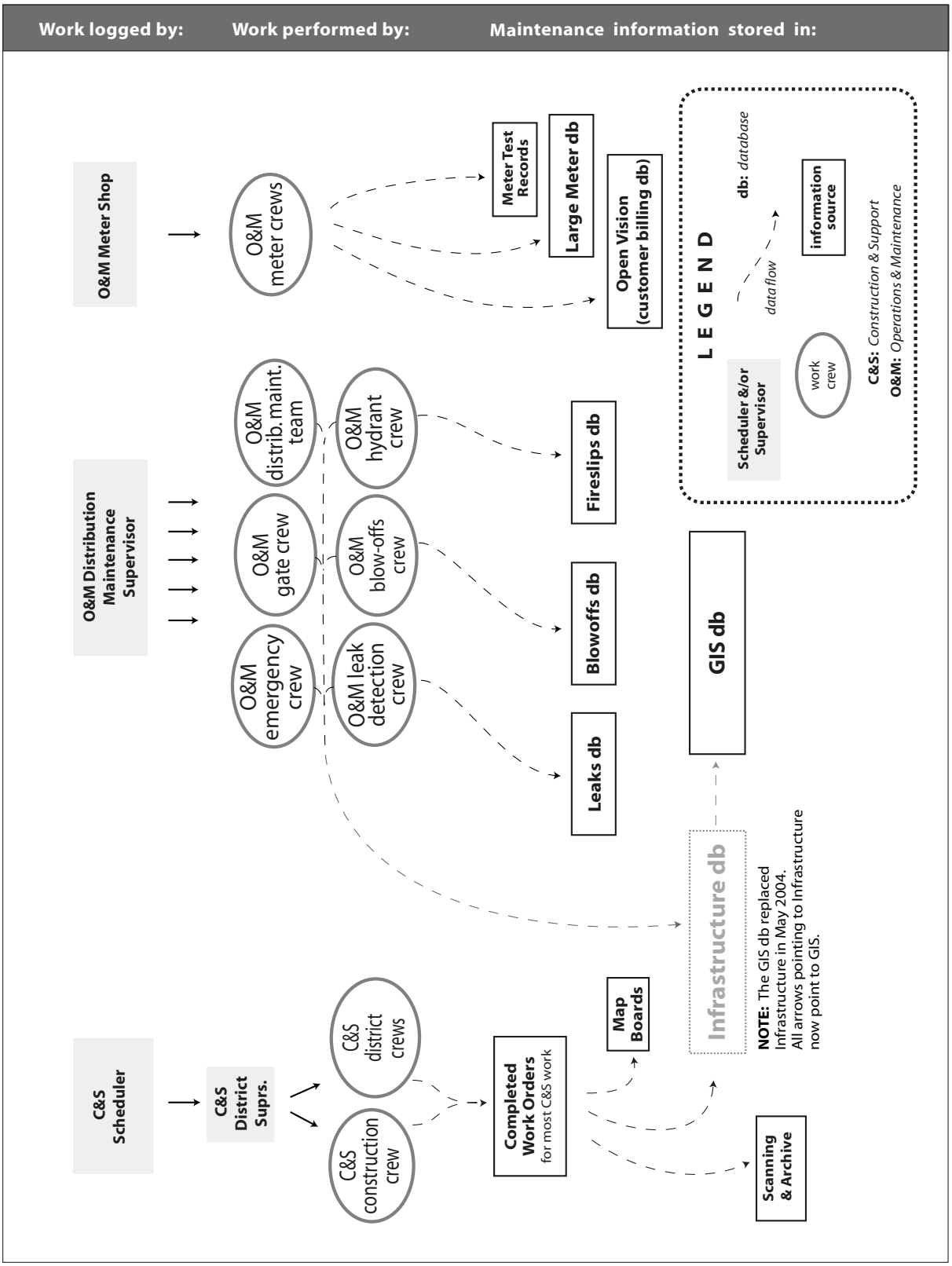
[2] As of early March 2004, this database is no longer in use. It was the primary source of information for the GIS database. Infrastructure users were switched to GIS in May 2004.

Inadequate methods for organizing, scheduling, and tracking maintenance work

The Bureau lacks an efficient and coordinated system for managing maintenance work. We found that there are multiple work order processes employed by the various work crews within the Construction & Support and Operations & Maintenance groups responsible for maintaining and repairing the distribution system. These processes have little relationship to one another, and do not comprehensively track distribution maintenance and repair. As a result, the Bureau lacks reliable and readily accessible information on what work is being performed, the amount of needed maintenance work, and the status of individual distribution assets. Because the Bureau lacks this critical information, it is difficult to schedule maintenance crews to ensure that staff resources are used efficiently to address the highest priority maintenance needs.

Figure 11 provides a simplified overview of the various work crews that perform maintenance and repair on the water distribution system, and the flow of information from work initiation to completion. As shown, work is assigned to several work crews within the Construction & Support and Operations & Maintenance groups. Some of the work is generated from requests from outside the Water Bureau (e.g. customers, builders) while most work is generated internally from Engineering Services and other departments. Figure 11 also shows that, when completed, information on work performed is entered into a variety of databases such as GIS, the Leaks database, and the Large Meter database.

Figure 11 Relationship Between Work Groups and Maintenance Information for Distribution System



Recognizing the weaknesses in current methods for generating and tracking work orders, the Water Bureau recently initiated an effort to introduce a maintenance management software tool called Synergen. Although the Synergen software has been used effectively by the Bureau for several years to support the parts and inventory function, its work scheduling and management features have never been implemented. Bureau managers believed that with a relatively small investment in updated software and consulting assistance, Synergen could replace the current work order and scheduling system and provide a more efficient and effective process for scheduling, tracking, monitoring, and recording maintenance work.

During the course of our audit, we had strong concerns regarding the level of planning and analysis that was being carried out prior to implementing the new Synergen module. Specifically we felt that there had been inadequate evaluation of existing maintenance work processes as well as Synergen's integration with other Bureau systems – especially GIS. Among individuals closest to the project, we found divergent views regarding the extent to which Synergen would be put into operation across the Bureau.

Near the completion of our audit, the Bureau was able to deploy Synergen's work order module within the Construction & Support Group. Our brief review of the system indicates that users are pleased with its functionality and it appears to be a substantial improvement over the previous scheduling system. Although synchronization with GIS is performed manually, we were told that there are plans to acquire software that will perform this process automatically. We were also told that the Bureau plans to bring the

Engineering Services Group into the system this Fall, and will coordinate closely Engineering's new Asset Management Group with both Synergen and GIS. It is not clear, however, when other maintenance activity performed by the Operations & Maintenance Group will be integrated into the system. If fully implemented across the Water Bureau, the Synergen program could vastly improve the efficiency and reliability of the Bureau's work order process, asset and maintenance management systems, as well as other financial and reporting systems.

Incomplete performance measurement and reporting

The Bureau lacks reliable information on the condition of key assets including mains, valves, and meters, as well as the level of effort needed to address maintenance requirements. This leads to an inability to create a comprehensive set of reliable performance indicators on the maintenance of its distribution system. Although the Bureau reports some valuable performance measures in the annual *Service Efforts and Accomplishments* report produced by this office, most of these measures relate to the final result of water services such as water quality, customer satisfaction, and rates. We believe some interim measures that track the effort and accomplishments of maintenance activities will provide the Bureau, Council, and the public with important information to assess the efficiency and effectiveness of maintenance work. For example, similar to Transportation infrastructure measures, the Water Bureau should develop indicators on the condition of certain major assets, progress made in addressing maintenance needs or backlogs, and the number of maintenance problems and the degree to which they are addressed.

Some water maintenance indicators could include:

- Trend in the number of major main breaks
- Trend in the maintenance work order backlog
- Number of customer service complaints and percent addressed within a certain time
- Number of out-of-service hydrants repaired or replaced within five working days
- Condition ratings/age for major groups of assets such as mains, meters, and hydrants

In addition, the Bureau should develop these new performance indicators as part of the "Managing for Results" efforts currently underway in the Bureau and in the City budget process for FY 2005-06. The Bureau should develop its program budget with sufficient performance indicators to assess progress toward Water Distribution goals, particularly as they relate to the efficiency and effectiveness of maintenance efforts.

Chapter 4 Recommendations

Effective long-term maintenance of the water distribution system requires the Bureau of Water Works to successfully address a number of challenges. Some of these challenges can be met with additional financial resources and by stabilizing the maintenance workforce. However, the source and level of funding needed to improve the maintenance of the distribution system will require a broader analysis of the current organization than was conducted in this audit. While water rate increases may be required, additional resource needs could be addressed through internal efficiencies, consolidation of functions, and out-sourcing tasks to the private sector.

We also believe that additional resources alone will not address the problems identified in this report. Fundamental changes in management practices are needed to ensure improvements in the maintenance of the water distribution system. In order to help begin these improvements, we recommend that the Bureau of Water Works:

1. **Prepare a comprehensive master plan to guide the maintenance of the distribution system.**

   The master plan should establish 1) overall maintenance goals, 2) standards for the amount and frequency of work, and 3) priorities for maintaining the water

distribution system. The plan should also estimate the useful life of distribution assets and identify a long-term capital replacement schedule. The plan should specifically define the roles and responsibilities of Construction & Support, Operations & Maintenance, and Engineering Services, and address opportunities for functional consolidation or reorganization. The Bureau may wish to build on previous efforts to develop a master maintenance plan initiated in 1987. The master plan should serve as the basis for a revised set of policies and procedures that provide specific guidance on how to carry out routine work activities and emergency repairs.

2. Better plan and coordinate efforts to improve the reliability and accessibility of water system asset information.

The Bureau needs reliable and accessible information on the function, location, age, and condition of its assets. While some progress has been made to develop and implement a Geographic Information System, a substantial effort is needed to eliminate multiple databases, reduce backlogs, and correct data errors. In addition, in order to improve the ongoing development of GIS and other information systems, we believe the Bureau should formulate a comprehensive Bureau-wide strategy for data and information management.

3. **Improve systems for organizing, scheduling and tracking maintenance work.**

   The Bureau should develop a centralized maintenance management system that schedules and tracks the completion of maintenance work. The Bureau should review and eliminate duplicative work order procedures, and standardize methods to track the time and costs of maintenance activities. Efforts should be taken to ensure reliable integration with GIS and other information systems so that asset condition information is updated when repair work is carried out.

4. **Develop and report improved performance measures to track the efforts and accomplishments of water system maintenance activities.**

   Performance measures should provide information on the condition of major assets and progress made in addressing maintenance needs and reducing work backlogs.

Responses to the Audit Report

CITY OF
PORTLAND, OREGON

Dan Saltzman, Commissioner
1221 S.W. 4th Avenue, Room 230
Portland, Oregon 97204
Telephone: (503) 823-4151
Fax: (503) 823-3036
dsaltzman@ci.portland.or.us

August 16, 2004

Gary Blackmer
Portland City Auditor
1221 SW 4th, Room 130
Portland, OR 97204

Dear Auditor Blackmer,

Thank you for the opportunity to comment on Audit Services most recent work with the Portland Water Bureau, Portland's Water Distribution System Maintenance Program Needs Improvement. It is a very straightforward and useful tool for determining the needed priorities for the Water Bureau' distribution system.

Your auditors did an excellent job of working with staff in the Water Bureau to determine what parts of our distribution system need the most work and how staff in the Water Bureau should prioritize their efforts. It is always easy for large agencies to become complacent in their processes and having a tool such as this audit will benefit the bureau immensely. I was especially appreciative that you identified a lack of resources and the recent staff disruptions caused by the billing system as probable causes for much of the inconsistency found in the maintenance of the distribution system. The recommendations contained in the report are excellent and I know the bureau is focused on their implementation.

Thank you again for you and your staff's diligent work on this important review. We all attempt to serve our customers as best we can and work such as this audit will be helpful to all.

Sincerely,

Dan Saltzman

Dan Saltzman
DS:mg
Cc: Mort Anoushiravani
Dick Tracy

CITY OF
PORTLAND, OREGON
BUREAU OF WATER WORKS

Dan Saltzman, Commissioner
Morteza Anoushiravani, P.E., Administrator
1120 S.W. 5th Avenue
Portland, Oregon 97204
Information (503) 823-7404
Fax (503) 823-6133
TDD (503) 823-6868

August 16, 2004

Memorandum

TO: Gary Blackmer, City Auditor

FROM: Mort Anoushiravani, Administrator, Portland Water Bureau

CC: Commissioner Dan Saltzman

RE: **Portland Water Bureau Response to Auditor's Report: "Portland's Water Distribution System"**

Thank you for the opportunity to respond on behalf of the Management Team of the Water Bureau to the audit report your office has just completed regarding maintenance of the City's drinking water distribution system. Ensuring adequate investment in the City's drinking water infrastructure has been an ongoing concern for the bureau and City Council, and more recently for some of our customers. I believe this report supports our concerns and provides effective guidance that will be helpful to all interested stakeholders and decision makers for the water system. It is particularly timely, as the bureau is just now beginning its preparations and planning for the FY 2005-06 budget year.

Briefly, I will address the bureau's planned actions in response to the four recommendations offered in your report. Lead staff and the corresponding implementation timelines are included.

***RECOMMENDATION #1**: Prepare a comprehensive master plan to guide the maintenance of the distribution system.*

The Water Bureau is currently performing a substantial reorganization of the Engineering Division. The new structure will include an Asset Management Group that will be responsible for an asset management plan that will develop maintenance, repair, rehabilitation and replacement programs and strategies for water system infrastructure to insure effective business management and customer service.

A key component of the asset management plan will be the development of a distinct distribution system master plan that will identify and describe deficiencies in the distribution system--both in terms of performance and condition--and establish priorities for addressing these deficiencies. The distribution master plan will also include a review of maintenance programs for key facilities and recommendations to improve asset management strategies.

Lead Staff: Dick Steinbrugge, Chief Engineer
Mark Knudson, Director of Operations and Maintenance
Michael Stuhr, Director of Construction and Support Services

Timeline: The Water Bureau anticipates completing the reorganization of the Engineering Division by January 2005. Work on the asset management plan will immediately follow with a priority focus on the distribution master plan. The bureau plans to request funding to support this work in next year's FY 2005-06 CIP budget and anticipates a completed distribution master plan and comprehensive asset management plan by December 2006.

***RECOMMENDATION #2**: Better plan and coordinate efforts to improve the reliability and accessibility of water system asset information.*

In addition to the development of an asset management plan described in the response to recommendation #1, the Water Bureau plans the following to address this recommendation.

Expedited GIS Implementation. As part of initial FY 2005-06 budget planning, the bureau is evaluating the feasibility of an expedited implementation of its Geographic Information System (GIS) by changing approach and adding staffing. Already in progress is installation of a link between the GIS and the Synergen Maintenance Management System (MMS) so that the MMS and GIS will share information directly. GIS is vital to the bureau's efforts and ability to establish a comprehensive asset information system.

Expanded Distribution Maintenance Staffing. As part of initial FY 2005-06 budget planning, the bureau is evaluating the feasibility of increasing staffing for the Distribution Maintenance Team (DMT). Expansion of DMT field staff will allow for more rapid condition assessment of assets in the distribution system, which is essential input to the maintenance work planning process, as well as verification and/or correction of asset records in GIS.

Asset Data Collection for Maintenance Management Systems. The bureau's Distribution Maintenance Team is currently collecting condition information on distribution system assets to develop complete asset descriptions. This effort includes consolidating all existing databases, updating current data and making it much more accessible throughout the bureau via the bureau's MMS described in more detail in the response to recommendation #3.

Lead Staff: Michael Stuhr, Director of Construction and Support Services

Timeline: Asset data collection is underway and anticipated to be completed by July 2005. A decision on the expedited GIS implementation will occur as part of the FY 2005-06 budget process. The expedited implementation would allow the GIS system to be implemented by October 2006, two years earlier than currently planned.

***RECOMMENDATION #3**: Improve systems for organizing, scheduling and tracking maintenance work.*

The Water Bureau plans to continue its efforts to improve systems for organizing, scheduling and tracking maintenance work. The bureau's principal tool for this effort is the Synergen Maintenance Management System (MMS).

The Water Bureau initially purchased Synergen in 1999 in response to an audit of its inventory system and in response to the City's Year 2000 efforts. Until 2003, only the inventory portion of the system was utilized. In the fall of 2003, the Water Bureau decided that full implementation of the maintenance module was essential to achieve additional efficiencies.

The bureau worked with the system manufacturer and the City's Bureau of Technology Services (BTS) to develop an incremental implementation approach that would provide system startup in the Operations and Construction Groups first, followed by Engineering, Resource Protection and Customer Service.

Synergen provides an opportunity to enhance the management of all water system assets from the road system in the Bull Run Watershed to the tens of thousands of valves, hydrants, pumps and pipes in the distribution system. Detailed data will be transferred into the system for each water system asset. The Synergen system will then function as the repository for asset history, maintenance and repair activity, replacement history, condition, and repair priority.

The Synergen system is compatible and links with the bureau's GIS system. Combined, the bureau believes the two systems will be extremely powerful tools for asset information management, comprehensive maintenance master planning, and performance management.

Lead Staff: Michael Stuhr, Director of Construction and Support Services, Water Bureau MMS Core Team

Timeline: On July 7th of this year 36 trained users in the Operations and Construction Groups began using the full maintenance module. "Go Live" in the Engineering and Resource Protection Groups is anticipated in late September and in Customer Service after the Cayenta customer information system implementation.

***RECOMMENDATION #4**: Develop and report improved performance measures to track the efforts and accomplishments of water system maintenance activities.*

The bureau is in the midst of an organization-wide development process to establish a set of relevant performance measures. The process began in December 2003 when the Water Bureau, in conjunction with Commissioner Saltzman's Office, initiated a revision of the bureau's mission, vision, and values to better serve ratepayers. Simultaneously, the bureau had examined a system called "The Balanced Scorecard"© (BSC) as a means of tying organizational strategies to performance measures. In March of 2004, the bureau adopted a revised mission, vision and values statement and committed to the development of a BSC for the organization.

BSC, which supports the City's Managing for Results Initiative, is a management tool for linking the Water Bureau's vision, mission, values to a set of strategies, targets, and performance measures organized into four balanced perspectives: Learning and Growth, Internal Business Processes, Customer, and Financial. As part of the development process, the bureau decided to add a fifth perspective, Stakeholder Perspective.

The bureau plans to use BSC to:

1. Align and prioritize work group strategies with the bureau's overall long-term initiatives,
2. Measure bureau and work group performance toward initiative and strategy achievement, and
3. Provide a framework for channeling the energies, abilities, and specific knowledge of Water Bureau employees into more effective and efficient methods for meeting customer and stakeholder expectations.

Full implementation of the BSC may take several years; however, the bureau's objective for FY 04-05 is development of an initial set of bureau and work group objectives and measures with corresponding implementation plans.

As part of this initial effort, the bureau will develop performance measures to track progress and accomplishments for water system maintenance activities. The Maintenance Management System described in the response to recommendation #3 above will provide a valuable tool in the development of appropriate performance measures.

Lead Staff: Water Bureau Management Team

Timeline: Work on developing the BSC is ongoing. Initial performance measures, objectives and implementations plans will be completed by July 2005

Thank you again for the opportunity to provide this response. The Water Bureau's lead management and I are committed to achieving the measures described here and anything else required to address the issues identified in your report completely and comprehensively. We plan to keep you updated on our progress as we move forward.

THIS REPORT IS INTENDED TO PROMOTE
BEST POSSIBLE MANAGEMENT OF PUBLIC RESOURCES

Requests for printed reports should be sent to the following address:

Audit Services Division
City of Portland
1221 S.W. 4th Avenue, Room 310
Portland, Oregon 97204

If you received a copy and no longer need it you may return it to the
Audit Services Division. We maintain an inventory of past audit reports
and your cooperation will help us save on printing costs.

Full copies of the report may also be accessed via the Audit Services Division's web page located at:
http://www.portlandonline.com/auditor/auditservices
The web page version of the report is the same as the printed version,
and can be downloaded and printed from most printers.

PORTLAND'S WATER DISTRIBUTION SYSTEM:
Maintenance Program Needs Improvement

AUDIT SUMMARY FROM THE CITY AUDITOR
August 2004

The objective of this audit was to evaluate the methods used by the Bureau of Water Works to maintain major components of the water distribution system, including mains, valves, hydrants, meters, and service lines to customers. We analyzed (1) the quality, reliability, and accessibility of the Bureau's asset records, (2) the organization and scheduling of personnel resources, (3) the inventory of parts, supplies, and vehicles used to carry out maintenance work, and (4) the Bureau's application of automated information systems to facilitate planning and tracking of maintenance activities. We also reviewed the impact of major issues and challenges the Bureau is currently facing. We conducted our work in accordance with generally accepted government auditing standards.

Photo by David Kling

BACKGROUND

The Bureau of Water Works constructs, maintains, and operates the City of Portland's water system to ensure sufficient quantities of water are available for fire suppression and for distribution to water customers. For years, the Bureau has provided reliable, high quality, and reasonably priced water to residential and wholesale customers in the Portland region. The Bureau's financial and operational results have compared favorably to water utilities in the region and around the country. Recently, however, several events have threatened the Bureau's ability to fund and operate a high quality water system. Specifically,

- New federal and state regulatory demands may require significant capital funding in the future
- Declines in retail and wholesale water sales due to conservation and the use of alternative water sources could place upward pressure on water rates
- Failure of the customer service billing system tarnished the Bureau's reputation for good anagement and required shifting of resources from maintenance activities to customer service

These challenges are occurring at a time when the Bureau must begin addressing an aging infrastructure that will require significant resources over a number of years to replace and rehabilitate.

more ---→

OFFICE OF THE PORTLAND CITY AUDITOR
Gary Blackmer, City Auditor • Richard Tracy, Director of Audits

AUDIT RESULTS

Our review of the water distribution system indicates that Bureau maintenance efforts are not at levels viewed as adequate by Bureau managers and fall short of industry standards in several areas. Water mains are flushed and replaced infrequently; valves receive minimal exercising and maintenance; and meters are repaired and replaced slowly. In addition, the backlog of needed repairs has grown. Although water quality and reliability have not yet been adversely affected, we believe that a continued decline in the maintenance of water distribution system assets could negatively affect water service performance in the future.

We have concluded that the decline in maintenance service levels has been affected by several factors, including reductions in resources devoted to maintenance and a surge in retirement of experienced personnel. While addressing staffing and funding issues is essential, long-term solutions to distribution maintenance also must include making improvements in the Bureau's maintenance management systems. First, the Bureau lacks a clear and comprehensive maintenance plan that establishes overall maintenance goals, standards for the amount and frequency of work, and work priorities. It also lacks an adequate policies and procedures manual for maintenance personnel to follow.

Second, the Bureau lacks complete and reliable information on the nature and condition of water system assets. The Bureau has worked for eight years to develop an automated Geographic Information System (GIS) to provide needed asset information. Progress has been slow and costly, and a substantial effort is needed to eliminate multiple databases, reduce backlogs, and correct data errors.

Finally, the Bureau lacks adequate methods for organizing and scheduling maintenance work. While the Bureau recently implemented a work order system for one of its maintenance work groups, we believe a centralized maintenance management system is needed to schedule and track the work of all Bureau maintenance personnel. The Bureau needs to eliminate duplicative work order procedures in various maintenance work groups and establish methods for tracking the time and costs of maintenance activities.

DECLINE IN WATER MAIN REPLACEMENT
FY 1998-99 through FY 2002-03

Fiscal Year	Feet of mains replaced	Expenditures* (millions)
FY 1998-99	46,500	$8.6
FY 1999-00	46,000	$5.4
FY 2000-01	12,900	$4.1
FY 2001-02	15,600	$2.7
FY 2002-03	9,800	$4.0
5-year change	-79%	-53%

SOURCE: Water Bureau records. *** Adjusted to FY 2002-03 dollars**

RECOMMENDATIONS

Our review indicates the Bureau has taken a number of steps to address distribution system maintenance weaknesses, including the creation of special maintenance teams and implementation of a new work order system. However, we believe the Bureau needs to take a more comprehensive approach to improving its maintenance management program. Specifically, we recommend that the Bureau:

- Prepare a comprehensive maintenance master plan to guide the maintenance of the distribution system.
- Better plan and coordinate efforts to improve the reliability and accessibility of water system asset information.
- Improve systems for organizing, scheduling, and tracking maintenance work.
- Develop and report improved performance measures to track the efforts and accomplishments of water system maintenance activities.

RESPONSES TO THE AUDIT

The Commissioner's Office supports the audit recommendations and states that the audit will be a useful tool in determining priorities for the water distribution system. The Commissioner agrees with the auditors' conclusion that a lack of resources and recent staff disruptions caused by the billing system problems have contributed to inconsistencies found in distribution system maintenance.

The Administrator of the Bureau of Water Works also agrees with the report's recommendations and proposes detailed actions for addressing them. The Bureau plans to establish a new Asset Management Group within the Engineering Division that will be responsible for developing a distribution system master plan. The plan will identify and describe deficiencies in the distribution system and establish priorities for addressing the deficiencies.

The Bureau hopes to expedite the implementation of its Geographic Information System (GIS) by changing its approach and adding staff. The Bureau is in the process of installing a link between the GIS and the Synergen Maintenance Management System (MMS) so the two systems can share information directly. The Bureau also hopes to increase the staffing of the Distribution Maintenance Team (DMT) to allow more rapid condition assessment of distribution system assets.

The Water Bureau Administrator also indicates that the Bureau is in the midst of an organization-wide development process to establish relevant performance measures. In March 2004, the Bureau adopted a revised mission, vision, and values statement and is committed to the development of "The Balanced Scorecard" as a means of tying organizational strategies to performance measures.

For the **complete** *Portland's Water Distribution System: Maintenance Program Needs Improvement* report (#299, issued August 2004):

View on the web at: **www.portlandonline.com/auditor/auditservices**

Call us for a copy: 503-823-4005

Write or visit: Office of the City Auditor
Audit Services Division
1221 SW 4th Avenue, Room 310
Portland, OR 97204

OTHER recent audit reports:

Corporate Geographic Information Systems: A Review of Status and Accomplishments (#307, August 2004)

Bureau of Licenses: Opportunities to Improve Revenue Collection and Strengthen Internal Controls (#305, April 2004)

Service Efforts and Accomplishments: 2002-03 13th Annual Report on City Government Performance (#300, November 2003)

Best Practices for Information Systems Software Acquisition and Implementation (#298, June 2003)

SPENDING UTILITY RATEPAYER MONEY:
Not always linked to services, decision process inconsistent

March 2011

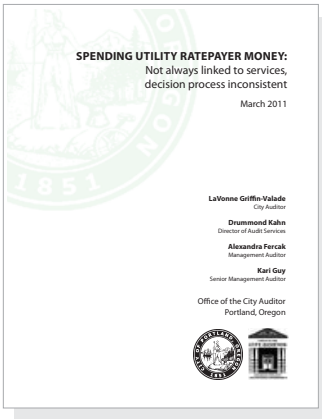
LaVonne Griffin-Valade
City Auditor

Drummond Kahn
Director of Audit Services

Alexandra Fercak
Management Auditor

Kari Guy
Senior Management Auditor

Office of the City Auditor
Portland, Oregon



Production / Design
Robert Cowan
Public Information Coordinator

OFFICE OF THE CITY AUDITOR
ENSURING OPEN AND ACCOUNTABLE GOVERNMENT

CITY OF PORTLAND

Off ce of City Auditor LaVonne Griff n-Valade

Audit Services Division
Drummond Kahn, Director
1221 S.W. 4th Avenue, Room 310, Portland, Oregon 97204
phone: (503) 823-4005
web: www.portlandoregon.gov/auditor/auditservices

March 30, 2011

TO: Mayor Sam Adams
Commissioner Nick Fish
Commissioner Amanda Fritz
Commissioner Randy Leonard
Commissioner Dan Saltzman
Dean Marriott, Director, Bureau of Environmental Services
David Shaff, Administrator, Portland Water Bureau

SUBJECT: Audit Report – *Spending Utility Ratepayer Money: Not always linked to services, decision process inconsistent* (#398)

The attached report contains the results of our audit of the City's spending of utility ratepayer money. Our work focused on whether spending by the Bureau of Environmental Services (BES) and the Water Bureau was related to providing utility services. We very much appreciate the cooperation and assistance we received from the involved bureaus and other City staff throughout this audit.

The budgets of the Water Bureau and BES are almost entirely supported by utility rates, fees, and bond proceeds. The combined capital and operating spending of the two bureaus will be approximately $478 million in FY 2010-11. The Water Bureau supplies domestic water to residents of the Portland area and serves approximately 900,000 people. BES provides sanitary sewer service to approximately 576,000 residents, numerous commercial and industrial facilities, and several wholesale contract customers.

While the vast majority of spending is directly related to water and sewer services, the audit found that some spending of ratepayer money is not consistent with the planning, budget, and rate setting process, and it is not always clear how these items are directly related to providing water and sewer services. Without following the rigorous and comprehensive public budget process required of all City bureaus, the use of ratepayer money may not be transparent to the public or support utility-related purposes. The City's budget process is designed to allow open discussion of spending priorities, and in doing so, it creates a public record of City decisions, helps to hold decision-makers accountable, and fosters the public's confidence in City government.

The audit also shows that the funding of some non-utility related programs has increased over the past five years. Although these projects may have civic importance and laudable goals, there are risks associated with such spending decisions. State law, City Code, and bond covenants require that utility ratepayer money be spent for utilities. For example, Council is granted authority to collect fees for utility services under state law, but spending the money on services not related to the utility could lead to this revenue being classified as an unauthorized tax.

Reasonable people may disagree about how to most efficiently operate a water or sewer system. Some may prioritize maintenance over new construction or rank conservation over new treatment facilities. While there may be disagreement, the budget decisions made by City Council should be made with clear rationale and consistent with constraints. The report recommends that the City demonstrate how future budget items would support the costs of providing water and sewer services and show the impact on utility rates. Further, we recommend not using ratepayer money for items that don't follow the budget and Council approval process.

Better Council oversight is needed to ensure that water and sewer ratepayers only pay for water and sewer service. We expect this audit report will be an important step in restoring control over how the City spends ratepayer money. We ask BES and the Water Bureau to provide us with a status report in one year, detailing steps taken to address our recommendations.

LaVonne Griffin-Valade
City Auditor

Audit Team: Drummond Kahn
Alexandra Fercak
Kari Guy

Attachment

SPENDING UTILITY RATEPAYER MONEY:

Not always linked to services, decision process inconsistent

Summary The City of Portland operates water and sewer utilities, and is required by City Charter to spend ratepayer money from water and sewer operations on these utilities. Recent concerns about the use of utility ratepayer money for non-utility purposes led us to conduct this audit. Our objectives were to determine whether utility ratepayer money is used for non-utility purposes, and whether the decision-making process and uses of ratepayer money are transparent to the public. The audit scope included utility ratepayer money spent by the Bureau of Environmental Services (which operates the sewer system) and the Water Bureau.

Most City spending of ratepayer money was both related to providing a utility service and approved through the complete public budget process. However, we identified other examples where this was not the case. We found that ratepayer money spent by the City falls into three categories:

1. Ratepayer money spent for purposes **directly linked** to providing water and sewer services that also **followed** the City's complete financial planning and budget process.
2. Ratepayer money spent for purposes **not directly linked** to providing water and sewer services, but **followed** the City's complete financial planning and budget process.
3. Ratepayer money spent for purposes **not directly linked** to providing water and sewer services, and **did not follow** the City's complete financial planning and budget process.

The first category includes water and sewer spending that was directly linked to the cost of providing sewer and water services and followed the complete financial planning and budget process. This includes major projects such as maintaining pipes for the water distribution system and operating the sewage treatment plant. Most water and sewer spending falls into this category.

The second category includes spending where the link to providing water and sewer services was not clearly explained and justified, but where the spending followed the complete financial planning and budget process. While the total dollar amounts in this category are relatively small, we found an increasing number of Council policy choices to spend ratepayer money where the benefits and costs to ratepayers were not well defined. This category includes several examples of spending for such items as sustainability programs, Parks Bureau arborists, and dog park enforcement. In these cases, Council's policy direction in approving the spending was clear, but the connection to utility services was not clearly explained.

The third category includes ratepayer money spent without a clear explanation of how the use of money benefits water and sewer ratepayers and where the City's complete financial planning and budget process was not followed. Spending items in this category included remodeling a building for the Rose Festival Foundation's use, building an environmental demonstration house, and funding community college scholarships. While these projects may have civic importance, they do not appear directly linked to providing utility service to ratepayers.

Without following the complete public budget process, City use of ratepayer money may not be transparent to the public and may not support utility-related purposes. Following the complete public budget process and providing rationale for budget decisions helps determine spending priorities and holds City government accountable.

The constraints to consider when the City makes decisions to spend ratepayer money include the question of whether the revenue is used on utility-related purposes, and whether the utility system is operated in an efficient and effective manner. We recommend that the City

always spend water and sewer ratepayer money following the complete financial planning and budget process. To do this, we further recommend that bureaus develop a utility rate impact statement for each new significant expenditure funded by ratepayer money. This will help to clarify how the expenditure is related to the cost of providing utility services to ratepayers, and how the new expenditure affects utility rates.

Finally, we found that Utility License Fees (to cover the benefit of using the City's rights-of-way) are authorized by City Charter, but those fees are not as clear to customers as they could be. We recommend the bureaus separate their Utility License Fees from the base rates charged on water and sewer bills. Doing so will help ratepayers clearly identify the fees used to support General Fund services.

Background

Utility rates support water and sewer services

The budgets of the Bureau of Environmental Services (BES) and the Water Bureau are almost entirely supported by utility rates, fees, and bond proceeds. The bureaus' combined capital and operating spending will be approximately $478 million for Fiscal Year (FY) 2010-11.

BES provides sanitary sewer service to approximately 576,000 residents, numerous commercial and industrial facilities, and several wholesale contract customers. The majority of the BES budget goes to the Engineering (71%) and Wastewater (14%) Programs. The Engineering Program manages the planning, design, and construction of all BES public improvements, including wastewater and stormwater facilities. The Wastewater Program operates and maintains the wastewater and stormwater facilities.

The Water Bureau supplies domestic water to residents of the Portland area and serves approximately 900,000 people. The Water Bureau manages the core functions of operating and maintaining the Bull Run watershed, water mains, storage facilities, meters, hydrants, decorative fountains, and drinking fountains. The Regulatory Compliance Program is responsible for water quality sampling and Endangered Species Act compliance. Together, these programs constitute almost 70% of the Water Bureau's FY 2010-11 budget.

Transparency of City budget process and utility rate setting
The City budget process starts with Council reviewing overall goals, establishing priorities, and providing direction to bureaus. This process includes a public information component to obtain direct public input on City service priorities, and bureaus include key stakeholders when developing their budget requests.

The Water Bureau and BES develop financial plans and capital improvement plans, and they submit those to Council before submitting their requested budgets. The financial and capital improvement plans and the adopted budgets are used to determine the total revenue required from utility rates to fund bureau operations. The total revenue amount needed from customers is used to calculate water and sewer utility rates. Using cost-of-service principles, the bureaus complete an annual utility rate calculation, which plays a central role in determining how the bureaus' budgeted services and programs will be funded. The City Charter authorizes the Council to establish fees and charges for the use of the water and sewer systems. Other than City Council, there is no government approval required to adopt fees and charges.

After reviewing the bureaus' requested budgets, City Council as the budget committee considers input from bureaus and testimony from the community. The Mayor can add or alter programs and projects when submitting the Mayor's Proposed Budget. After the Mayor's Proposed Budget is issued, the City Council can alter the bureaus' budgets as part of the City's Approved and Adopted Budgets. In 1994, the City established the Portland Utility Review Board (PURB), which consists of nine appointed volunteer residents. The PURB provides independent and representative customer review of the financial plans, budgets, and customer rates related to water, sewer, stormwater and solid waste. The PURB operates in an advisory capacity to provide input to City Council.

An open and inclusive city government promotes efficiency and effectiveness in City services. Access to information enables the public to participate in the City's decisions and to help determine the spending of ratepayer money. A complete public budget process allows the open discussion of spending priorities, creates a public record of City decisions, helps to hold decision-makers accountable, and fosters the public's confidence in City government.

Constraints on sewer and water uses of ratepayer money

Various restrictions and requirements, including State law, City Code and bond covenants, limit how the Water Bureau and BES may spend ratepayer money. In order to understand the guidance on how the City can spend ratepayer money, it is also necessary to review guidance on how utility rates are established. The items to consider when making decisions regarding the spending of ratepayer money are whether the utility charges are just and equitable and based on reasonable cost-of-service principles, whether the revenue is spent on utility service related purposes, and whether the utility system is operated in an efficient and effective manner.

State law authorizes the City to set sewer service charges that are "just and equitable," which determines the rate setting philosophy and methodology. Sewer charges should be based on reasonable cost-of-service utility ratemaking principles. This means the charges should not materially exceed the costs of providing the utility service, and the money collected must be spent to finance the service. The City Attorney interprets the State law as saying that sewer rates can only be collected to pay for activities or projects related to the City sewer system. In other words, customers are to pay rates tied to sewer services actually provided in return.

State law also gives Council the authority to collect fees for utility services. However, collecting money under this authority and then spending the money on services not related to the utility could lead to this revenue being classified as an unauthorized tax. According to the City Attorney, this classification could result in the requirement for repayment of ratepayer dollars.

City Charter authorizes the City to set sewer user fees only for the charges related to "design, construction, acquisition, operation, maintenance and contract requirements of sewage treatment or purification and related facilities." City Charter also limits the City in how it spends sewer ratepayers' money. The City is to spend the money for any matter connected with the sewer disposal or treatment system, and the bond debt service related to the sewer system. According to the City Attorney, these City Charter provisions authorize the collection and the expenditure of ratepayer money for purposes directly related to operation of the sewer utility.

City Charter also requires that funds and accounts of the Water Bureau related to the water system are separated from other accounts and funds of the City and treated as separate municipal operations. In addition, money in the Water Fund and the Water Construction Fund cannot be transferred to the City's General Fund or to special funds that are not related to the water system and related bond debt service. Although these provisions address transfers among city funds, the City Attorney's Office interprets the Charter to constrain indirect transfers of Water Bureau funds to support purposes not related to water services.

According to the City Attorney, the Charter's limitations are intended to "prevent the City Council from using the City's water revenues to carry out General Fund projects." The City Attorney indicated that Water Bureau money "cannot be spent on matters unrelated to the water system." In order to determine whether an expenditure is related to the system, the City Attorney considers whether the expenditure's primary purpose is to promote the objectives of the City's water services, and whether the expenditure is reasonably calculated to promote those objectives.

In addition to State statute and the City Charter, bond covenants also place restrictions on how utility rates are set and how ratepayer dollars are spent. Bonds require that the City establish rates in connection with the operation of the sewer and water system that are sufficient to pay all operating expenses and all lawful charges. In addition, it requires that spending of ratepayer money is prioritized from the highest priority (operating expenses of the utility systems) to the lowest priority (all other lawful purposes), and only after all higher priority expenditures have been covered. According to the City Attorney and City Treasurer's Office, this spending prioritization applies only when revenues are not sufficient to cover all bureau operating, debt and capital requirements.

Bond covenants further require that the City operate the water and sewer systems in a safe, sound, efficient, and economic manner in compliance with all regulations and laws. According to the City Treasurer's Office, this covenant was added in order to strengthen the focus on operations and to prevent the Water Bureau and BES from drifting away from their core missions of providing utility services.

According to the City Attorney, this bond requirement can lead to questions about whether water and sewer expenditures would be viewed by bondholders as sound, efficient, and economic costs for a municipal utility. The City Attorney stated that one way to meet this covenant requirement is to ensure that water and sewer funds are spent only for water and sewer related services.

State law, the City Charter, and bond covenants each contain requirements and restrictions over the use of ratepayer money, summarized in Figure 1. While each specific requirement is different, we found that overall, the legal, charter, and bond requirements share some important similarities. Specifically, each requires a connection or relationship between the use of ratepayer money and the utility that is being paid for.

Figure 1 Does the use of utility ratepayer money meet the following requirements?

State Law	- Based on reasonable cost-of-service principles - Related to sewer system
City Charter	- Connected with the sewer system - Related to water works or service
Bond Covenants	- Supports sound, efficient and economic operations of utility

Source: Audit Services Division developed this list of requirements based on input from the City Attorney's office.

Reasonable people may disagree about how to most efficiently operate a water or sewer system – for example, some may prioritize maintenance over new construction, or rank conservation over new treatment facilities. While there may be disagreement, the budget decisions made by the City Council should be made with clear rationale, so that utility ratepayers understand how spending decisions are consistent with the requirements in State law and the City Charter. It is the role of City Council to determine through the budget process that spending priorities are consistent with these constraints.

Audit Results

Decisions on spending ratepayer money are not always transparent or directly linked to water and sewer services

Although most bureau expenditures support the cost of providing water and sewer services and follow the budget process, utility ratepayers are assuming an increasing burden of costs for other City programs where the benefits to ratepayers and the connection to providing water or sewer services are not well defined. These City program costs added to various bureau budgets do not represent a significant share of those budgets. However, these increasing costs were not always directly linked to the cost of water and sewer services, and they did not always follow a transparent budget process.

For this audit, we collected and reviewed questionable expenditures by both the Water Bureau and BES. We focused on the financial planning and budget process that affects rate revenue and on the uses of ratepayer money questioned by a number of interested residents and stakeholders. Our review looked primarily at items that were new or had increased over the last five years.

Some spending items were adopted through the complete budget process, but ratepayer benefits and costs are not clear

Some of the spending items we reviewed were approved by Council and followed the financial planning, budget, and rate setting process, yet the link to utility services was not clear to the public and other stakeholders. Expenditures in this category represent policy choices made by Council. However, due to the lack of transparency in determining how and whether questionable spending is related to the utility service, the public and other stakeholders may disagree as to whether these expenditures are related to providing water and sewer services.

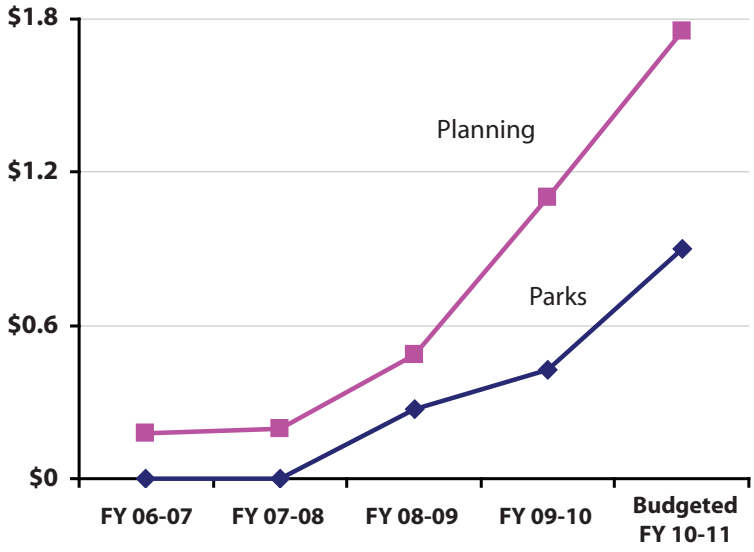
For example, we found an increase in the number of parks and planning programs funded with sewer ratepayer money. The most recent parks items added through the budget process include a tree inspector, fungicide to protect elm trees, invasive species control, and enforcement of dog rules in natural areas. BES management stated that it is more cost effective to manage stormwater before it reaches the stormwater system, and maintaining both tree canopy and natural areas helps prevent rainwater from reaching the storm-

water system. The City's response to the Federal Endangered Species Act was initially funded jointly with sewer funds, water funds, and the City General Fund. In FY 2009-10, the general funding was eliminated, and sewer ratepayer funds to the program were increased by almost $270,000. The program is now funded almost entirely by sewer and water rates.

Water ratepayers have also assumed increasing expenses for parks and planning programs. These include the cost of maintaining the City's decorative fountains for the Parks Bureau and contributing to a number of sustainability programs through the Bureau of Planning and Sustainability. Parks and Planning items funded with water ratepayer money totaled over $1.3 million in the current fiscal year.

These types of programs have purposes deemed valuable by Council and were added through the normal financial planning and budget process. However, the rationale for spending ratepayer money on these programs may not be evident to the public and other stakeholders. Following a process for describing how the items are related to the provision of utility services would help to explain the uses of money to ratepayers.

Figure 2 **Growth in BES-funded Planning and Parks-related programs not directly related to utility service** (millions)



Source: Audit Services Division analysis

Figure 2 shows the growth in parks and planning programs funded with sewer ratepayer money. Five years ago, sewer ratepayers funded less than $200,000 in parks and planning programs not directly linked to utility services. This year, the City expects to spend over $2.5 million of ratepayer money for these programs.

Some spending did not follow the complete financial planning and budget process, and it is not clear how these items are directly related to utilities

We found that some spending of ratepayer money is not consistent with the City's planning, budget, and rate setting process, and it is not clear how these items are directly related to providing water and sewer services. We identified a number of projects that were not included in the bureau financial planning process. We also identified two funded projects, the Yeon Building and the Water House, which Council discussed, but never explicitly approved or added to the Water Bureaus' adopted budgets. The following are examples of ratepayer spending not directly related to water and sewer services and where the spending appears not to have followed either the financial planning and budgeting process and/or the Council approval process.

River Programs: In the FY 2010-11 budget, the Bureau of Planning and Sustainability (BPS) requested City General Fund dollars to continue working on the River Plan. The project would include recommendations for zoning code amendments, prioritized investments, and programs to implement the City's river strategy. Early versions of the City budget included general tax dollars to fund the program. However, in the final budget adopted by Council, sewer ratepayer money was provided to fund the river planning activities in BPS. Because this shift to sewer ratepayer funds occurred so late in the budget process, the budget advisory and review committees did not have sufficient opportunity to provide input on the new use of ratepayer funds.

The Office of Healthy Working Rivers (OHWR) was created in 2009 to protect and restore the ecological, transportation, and recreational roles of the Willamette and Columbia Rivers. During that same year two positions from the Bureau of Planning's River Renaissance Office were moved to the OHWR, an additional four positions were

created, and the OWHR was included in the BES FY 2009-10 budget. Funding for the OHWR was not included in the BES budget request, and was not reviewed by the budget advisory and review committees. Ratepayer funding for OHWR was added to BES budget in the Mayor's proposed budget. According to Commissioner staff, the River Renaissance office advanced from the planning phase to the implementation phase and became the OHWR. The Commissioner staff also stated that OHWR is related to implementing water quality programs and consequently should be funded by sewer ratepayer funds.

Yeon Building in Waterfront Park: The Yeon Building, now owned by the Water Bureau, was remodeled for the use of the Rose Festival Foundation. In February 2009, Council approved the transfer of land between the Parks Bureau and Water Bureau to allow the Rose Festival Foundation to "make more strategic use of its limited revenues and reduce ongoing maintenance costs of the space to the City." During hearings on this proposal in April 2009, the Council had extensive discussion about whether water ratepayer money would be used to renovate the building. The legislative intent, as stated by the Mayor, was for the building's capital costs to "be reimbursed by the Rose Festival or donated or fundraised some other way." In a subsequent hearing, one Council member stated the understanding reached among Council members was that "at most, we might front the improvement costs somewhere in the $100,000 range." The same Council member also added the understanding that any additional building improvements will "be subject to the Water Bureau's budget process…and those improvements will have to fare with the other things that are competing with ratepayers' dollars."

Ratepayer-funded improvement costs on the building totaled over $1.5 million, including labor costs for existing staff and capitalized overhead. The project was never included in the Water Bureau capital improvement plan or budget. In May 2010, the Water Bureau signed a 25-year lease with the Rose Festival Foundation for the use of the Yeon Building, with the base rent for the property of $1 per month. There is also a remodel payment of $200,000 to be paid by the Rose Festival Foundation in increments of at least $666.67 each month for the term of the lease. However, ratepayer money will continue to be spent to maintain the building.

Water House: The Water Bureau's energy efficient demonstration project, also known as the Water House, located at 1616 NE 140th, was not included in the bureau's budget. In October 2009, Council passed an ordinance to allow donations of services and products for the construction of an energy efficient home. Bureau management explained that rather than sell an unused piece of property, they opted to develop the property, then sell it and fully recover the value of the land and the Water Bureau costs. At the Council hearing for this project, Water Bureau staff estimated the building cost at $200,000, and the land value at $150,000. The goal was to sell the house for $400,000. As of January 2011, the Water Bureau had spent over $700,000 of ratepayer funds, including capitalized overhead charges for bureau administration, on the Water House project.

Scholarships: In the FY 2010-11 budget process, the Mayor's Proposed Budget added a program to provide scholarship grants for the first two years of study at Portland or Mt. Hood Community Colleges. The $500,000 program cost is divided between the City's general fund, and water and sewer ratepayer funds. The scholarship program was not included in the financial planning for either water or sewer rates, but was added by Council after bureau budget requests were finalized.

Green Street Facilities: In March 2010, City Council directed the BES to include $20 million in its capital improvement plan over the next three years for Green Streets projects on bike boulevards. Green Streets is a stormwater program intended to cost-effectively decrease stormwater flow into the City's sewer pipes. This proposal linked the Green Streets developments to boulevards in the Portland Bicycle Plan for 2030. The Council action took place outside of the complete budget process, so the expenditure was not included in the bureau's financial planning and budgeting process.

Figure 3 shows representative examples of three types of expenditures funded by ratepayer money, including items that were added late in the budget process.

Figure 3 Examples of three types of expenses funded by ratepayer money

Examples of expenses funded by ratepayer money	Bureau funding the expenses	Directly related to provision of water or sewer service	In bureau budget request *(includes review by budget advisory committees and PURB)*	In Council adopted budget
	Expense directly related to utility services and complete budget process followed			
Wastewater treatment plant operations	BES	Yes	Yes	Yes
Maintenance of distribution mains	Water	Yes	Yes	Yes
	Expense **not** directly related to utility services and complete budget process followed			
Parks aborists and invasive species control	BES	*Council policy choice*	Yes	Yes
Drinking fountains and decorative fountains	Water	*Council policy choice*	Yes	Yes
Enforcement of dog park rules	BES	*Council policy choice*	Yes	Yes
	Expense **not** directly related to utility services and complete budget process **not** followed			
River planning	BES	*Council policy choice*	No	Yes
Green Street Facilities along Bike Boulevards	BES	*Council policy choice*	No	Yes
Community College Scholarships	Water/BES	*Council policy choice*	No	Yes
Yeon Building Renovation	Water		No	No
Water House	Water		No	No

Source: Audit Services Division

Each of the projects in the last category of Figure 3 may have a public benefit. However, there was no formal process clarifying how these projects are related to the operation of water or sewer services, nor whether those benefits should be funded with water or sewer ratepayer money. Adding spending items to bureau budgets late in the budget process, or not including the items in the financial planning and budget process, goes around the formal mechanism allowing review by bureau budget advisory and review committees, and the public. Not including these stakeholders undermines the public's input on spending prioritization of ratepayer money.

Since bureaus do not plan and budget for these items added late in the budget process, it may also impact how well the City operates the water and sewer systems. Moreover, spending ratepayer money on purposes not directly related to utility services, may lead bondholders to question whether the bureaus are drifting from their core mission of providing utility services, and whether they are operating the utilities in a sound, economic and efficient manner.

Utility license fee not identified on customer bill

Portland City Code includes a license fee (to cover the benefit of using the City's rights-of-way) on various utilities doing business within the City, including electric utilities, gas utilities, and the City's own water and sewer utilities. The City Council sets the level of the fee for each utility type. Revenues from the Utility License Fees are deposited in the City's General Fund, which pays for services such as fire protection, police, and parks. General Fund dollars are not used to fund water or sewer utility services.

Various stakeholders have questioned whether Utility License Fee revenues are collected with a customer's water and sewer bill to fund non-utility purposes. We found that while this separate fee may be imposed at the discretion of the City Council to fund general City operations, the Utility License Fee is not singled out and identified on the customer bill.

When the utility bureaus calculate the revenue required to run the bureaus for the subsequent year – the basis for setting utility rates – the bureaus include the Utility License Fee payment in the General Fund as part of this revenue requirement. Similarly, the customer

bill includes the Utility License Fee amount as part of the water and sewer charges, instead of listing the fee as a separate line item. Other utilities such as cable or gas list taxes and fees as separate line items on the customer bill.

Recommendations

To improve transparency of the Water Bureau and BES budget process and to ensure that ratepayer money is spent for utility-related purposes, we recommend that the Commissioners-in-charge direct those bureaus to implement the following recommendations. Some effort will be required by the full Council to ensure the highest levels of transparency in the budget and spending processes:

1. For new significant expenditures funded by ratepayer money, develop a utility rate impact statement demonstrating how the new budget item supports the costs to provide water and sewer services and how it will affect utility rates.
2. For new significant expenditures funded by ratepayer money, ensure that the budget process and Council approval process are followed. For any items that do not follow the complete budget and Council approval process, do not use ratepayer money.
3. Separate utility license fees from base payments on water and sewer bills, so that ratepayers can clearly identify the fees used to support General Fund services.

In addition, Council should solicit from bureaus and then use in its deliberations more detailed reviews of new significant expenditures of ratepayer money, examining whether budgets were met, and whether the results of the projects matched their intent. For example, Council could consider whether an approved ratepayer-funded project was completed within its budget and matched the intent of Council when it approved the project.

Objectives, scope and methodology

The objectives of this audit were to determine whether ratepayer money is used for non-utility purposes, and whether the uses of ratepayer money and the decision-making process are transparent to the public. We focused our audit on the spending of ratepayer

money by the Bureau of Environmental Services (BES) and the Water Bureau. We focused on the financial planning and budget process that affects rate revenue and on uses of ratepayer money questioned by a number of interested residents and stakeholders.

To determine constraints on the use of water and sewer revenue by the City, we studied the Oregon Revised Statute, the City of Portland Charter and Code, and the City's bond covenants. In order to interpret the legal and contractual constraints, we obtained input from the City Treasurer's Office and the City Attorney's Office.

We reviewed the Water Bureau and BES missions, goals, and strategic planning documents. To determine how bureaus develop their budget and how bureaus expend utility rate revenue, we reviewed the bureaus' budget processes and financial planning process, we reviewed bureaus' expenditures, and we interviewed bureau staff. We also reviewed utility rate studies, and we reviewed how the bureaus determine the total revenue needed from utility customers.

To gain an understanding of the public and stakeholders' concerns and questions regarding the bureaus' expenditures and use of ratepayer money, we interviewed members from the Portland Utility Review Board (PURB), staff from Office of Management and Finance, City Council staff, and we reviewed media coverage and residents' comments. Based on input from the bureaus and various stakeholders, we developed a list of bureau expenditures that were funded by ratepayer money but are questioned by various stakeholders. We focused our review on this limited number of bureau expenditures.

For this audit we did not review in detail the rate setting process. Based on PURB recommendations from 2010, the Water Bureau and BES hired an outside consultant to review the City's rate setting process and identify rate setting best practices based on a review of other cities.

We conducted this performance audit in accordance with Generally Accepted Government Auditing Standards. These standards require that we plan and perform the audit to obtain sufficient, appropriate evidence to provide a reasonable basis for our findings and conclusions based on our audit objectives. We believe that the evidence obtained provides reasonable basis for our findings and conclusions based on our audit objectives.

RESPONSES TO THE AUDIT

CITY OF

PORTLAND, OREGON

Dan Saltzman, Commissioner
1221 S.W. 4th Avenue, Room 230
Portland, Oregon 97204
Telephone: (503) 823-4151
Fax: (503) 823-3036
dan@portlandoregon.gov

To: Auditor Lavonne Griffin-Valade

From: Dan Saltzman Dan

Date: March 23, 2011

Subject: Audit Report #398: Spending Utility Ratepayer Money

Thank you for the opportunity to comment on Audit Report #398, "Spending Utility Ratepayer Money: Not always linked to services, decision process inconsistent." It is a clear, useful and thorough presentation of the issues around proper use of ratepayer funds. The distinction drawn between appropriateness of expenditure and relationship to the City's budget process is helpful.

I agree with the Report's recommendations for improving the transparency of the budget processes for Water and Environmental Services. Requiring impact statements for all budget decision packages is one way to do this, as well as including a rate impact on the Fiscal Impact Statement on City Council documents. The Bureau of Environmental Services will work with the Auditor's Office to determine a rate impact statement that is useful and clear to ratepayers. However, the bureaus can assess these impacts only with adequate lead time for analysis and agreement by City Council.

Finally, breaking out the Utility License Fee on customer bills would help customers understand the fees incurred for utility and General Fund services. Bureau of Environmental Services will work with the Water Bureau to break out that specific line item.

I am committed to working with our citizen committees and City Council to identify opportunities that will provide the transparency and linkages needed in spending ratepayer money for sewer and stormwater services.

PORTLAND WATER BUREAU
FROM FOREST TO FAUCET

Randy Leonard, Commissioner
David G. Shaff, Administrator

1120 SW 5th Avenue, Room 600
Portland, Oregon 97204-1926
Information: 503-823-7404
www.portlandonline.com/water

March 23, 2011

TO: Auditor LaVonne Griffin-Valade

FR: Commissioner Randy Leonard

Water Bureau Administrator David Shaff

RE: Audit #398, Spending Utility Ratepayer Money

Thank you for the opportunity to comment on Audit #398, "Spending Utility Ratepayer Money". We acknowledge receipt and generally concur with the analysis and recommendations of the audit.

As you note in the audit, reasonable people may disagree about how to most efficiently operate a municipal water system. However, we agree that projects undertaken by the Portland Water Bureau should be done for the benefit of the ratepayer and should be undertaken in a clear and transparent process allowing for public input and comment. We believe that we have done that, including the specific projects highlighted in the audit.

One project highlighted by the audit was the Water Bureau's renovation of the historic Visitor's Center in Tom McCall Waterfront Park. The Visitors Center was a severely neglected, unusable public facility on Portland's waterfront when the Council transferred ownership of the building to the Water Bureau in 2009. In the Council discussions about the renovation of the Visitors Center, we were very clear that the labor for the renovation would be undertaken by existing employees of the Water Bureau, while additional expenses associated with converting the building into the headquarters of the Rose Festival Association would be amortized in the Rose Festival's lease payments on the renovated building. The approach described to the Council in public hearing is what occurred, and any characterization to the contrary is inaccurate.

Further, outside of the costs that were incurred and passed along to the Rose Festival for the renovation of the Visitor's Center, the Water Bureau employee labor costs should be characterized as opportunity costs because the cost of those employees would have been borne by the ratepayers regardless of whether the Visitors Center renovation occurred or not. Those employees work on an ongoing basis to maintain and repair Water Bureau facilities all over the City and in the Bull Run watershed, and no new employees were hired for the purpose of renovating the Visitors Center. Therefore, the choice to direct those employees to work on the Visitors Center should be characterized as a choice between directing those resources to that project or a project at another Water Bureau facility.

Regarding the billing recommendation, the current bill statements include the following:

> "Customers of all utility services within the City of Portland pay a utility license fee that helps fund general City services including, but not limited to, fire fighting, parks and police. This fee is factored into each of the following charges"

Breaking out the ULF fee as a specific amount on each customer's bill presents some challenges, but we agree that customers would benefit from more information regarding what their money pays for. We will work with the Bureau of Environmental Services and the Office of Cable Communications and Franchise Management to explore better ways to inform our customers where their payments go and how they are used.

Audit Services Division
Office of the City Auditor
1221 SW 4th Avenue, Room 310
Portland, Oregon 97204
503-823-4005
www.portlandoregon.gov/auditor/auditservices

Spending Utility Ratepayer Money: Not always linked to services, decision process inconsistent

Report #398, March 2011

Audit Team Members: Alexandra Fercak, Kari Guy

LaVonne Griffin-Valade, City Auditor
Drummond Kahn, Director of Audit Services

Other recent audit reports:

Percent for Art: Progress made, but consistency can be improved (#401, February 2011)

Sewer Maintenance: BES and PBOT maintain the system together, but should consider operational changes (#365, December 2010)

City of Portland Service Efforts and Accomplishments: 2009-10, 20th Annual Report on City Government Services (#400, December 2010)

PORTLAND WATER BUREAU:

Further advances in asset management would benefit ratepayers

AUDIT SUMMARY
From City Auditor LaVonne Griffin-Valade
June 2012

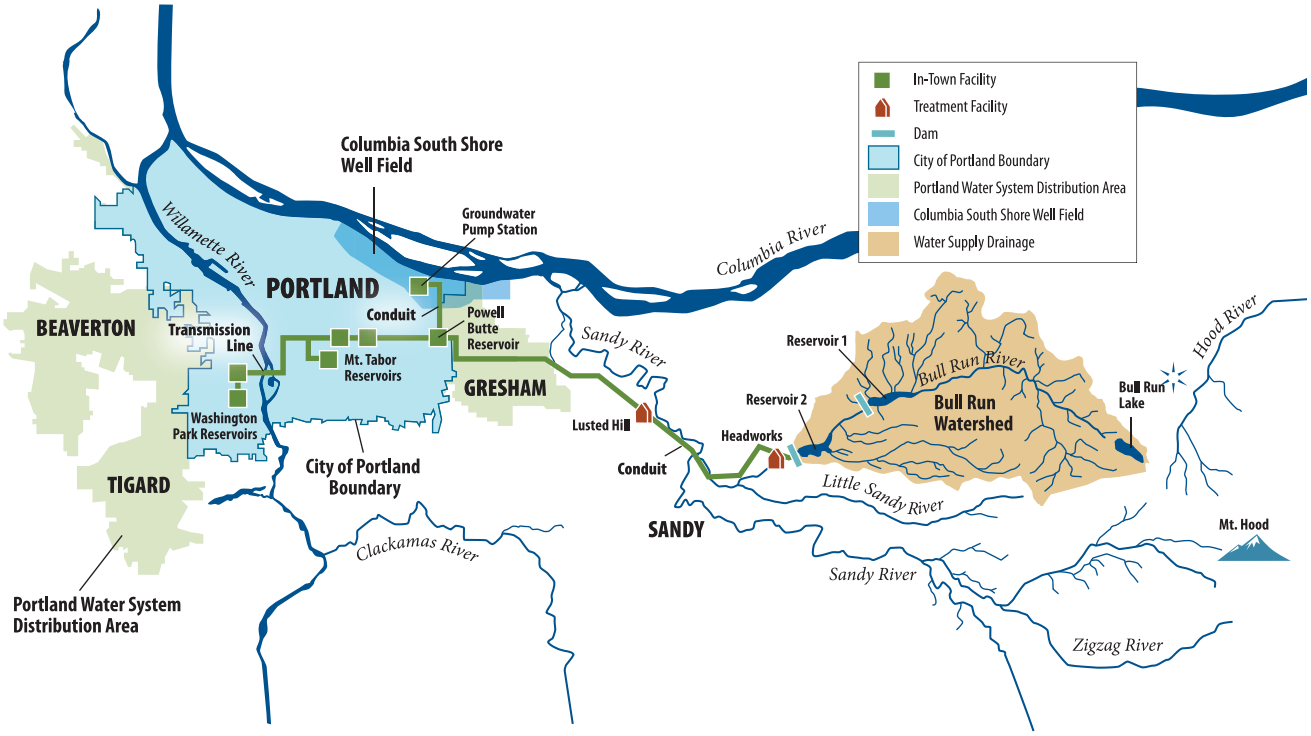
Water users depend on Portland Water Bureau assets - pipelines, pump stations, tanks, and other equipment that supply homes and businesses with clean water. These physical assets are valued at $7 billion. The Bureau supplies an average of 100 million gallons of water per day.

Asset failures, such as pipe breaks, could result in health emergencies and significant repair costs. But with good management, the Bureau can minimize its overall costs while providing the water service customers expect. We undertook this audit to review the way the Bureau manages the City's water assets.

Benefits to ratepayers that result from applying asset management principles include:

- Reducing overall costs through efficient operations and maintenance that prolongs asset life.
- Using service levels that regulators require and customers agree on, drives management decisions and helps prevent unnecessary spending.
- Using a sound basis for setting rates. Rates should be tied to and limited to providing agreed-upon services through cost-effective asset management that maintains required services at an acceptable risk.

Portland's Water System



Source: Portland Water Bureau, 2011

Best practices for asset management, while not yet widely adopted in the U.S., involve systematically basing choices on an understanding of asset performance, risks and costs in the long term. Best practices include:

- Having knowledge about assets and costs,
- Maintaining desired levels of service confirmed by customers,
- Taking a lifecycle approach to asset management planning, and
- Implementing the planned solutions to provide reliable cost-effective service.

The Bureau, City Council, and the utility industry agree that the internationally accepted process for asset management provides the best way to deliver the service levels customers want at the minimum overall cost.

City policy requires bureaus to maintain assets in good working order to minimize future costs of maintaining and replacing them, especially to avoid costly deferred maintenance.

Bureau milestones in asset management

2004	Formed Asset Management work unit Audit report on distribution system maintenance, conducted by Audit Services Division
2005	Formed Asset Management Steering Committee First "business case" analysis Self-assessment for benchmarking
2006	Improved asset information in the *Water System Status and Condition Report* International benchmarking First Asset Management Plan, for mains
2007	Signed *Asset Management Charter* Began reviews of work order data in the maintenance information system Developed and applied risk methodology
2008	Key service level indicators included in Strategic Plan
2009	Published the *Business Case Development Guidebook*
2010	*Guidelines for How to Develop an Asset Management Plan* Five-year work plan for Asset Management Plans

Source: Portland Water Bureau

Audit Results

Progress made in asset management

In its 2007 Asset Management Charter, the Bureau set a high standard for its asset management work. It has made progress and is considered a leader among U.S. water utilities. Bureau managers are involved in making improvements. The Bureau began using maintenance task management and cost forecasting software tools, defined its levels of service, and drafted asset management plans for some asset groups. As it works on many more plans, its asset management practice is improving cooperation among Bureau divisions.

Data management progress has not kept pace with asset management needs

At its core, asset management is about making decisions based on data and other evidence. We found that the Bureau has developed an overarching data management strategy, but has not yet implemented key tasks to meet general Bureau needs nor to meet specialized asset management needs.

For many years the Bureau has known about its data limitations. These limitations impact the data quality used for decision-making, and the efficiency of its business processes. Improving data management depends on leadership, dedicated technical resources and assigning responsibility for making data management improvements.

Use of service levels limited

One example of a service level is "limit outages to no more than three events per year per customer." We found that although the Bureau has defined its service levels, it is not using essential service levels systematically in budgeting.

The Bureau has not gotten agreement from representative customers that the identified service levels are appropriate for decision making. In addition, many of its 27 defined service levels do not clearly express which service is delivered, and some are not clear about what is actually measured.

Without useful plans, decisions may not be the most cost-effective

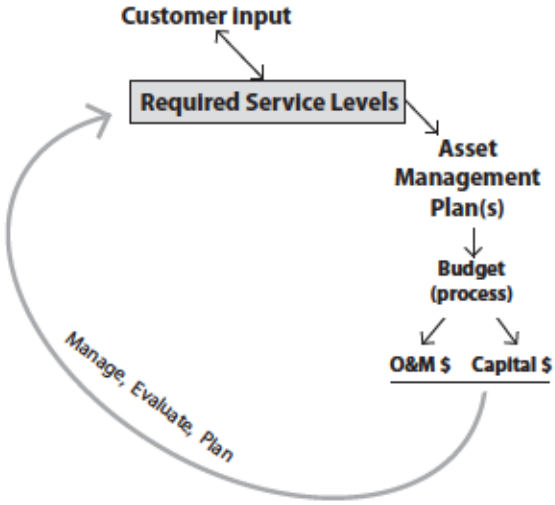
Instead of an overall written plan for managing assets, the Bureau is developing separate Asset Management Plans (AMPs) for about 20 of its major groups of similar assets, like valves and fire hydrants. It completed drafts for less than a third of those plans.

Meanwhile, the Bureau continues to rely on systems and practices that lead to reactive maintenance, although Bureau managers told us that more proactive maintenance is needed to reduce long term costs.

Without plans, decisions are typically made on a case-by-case basis by individual managers, and the Bureau may not perform asset maintenance, repair and replacement at the best times to save costs.

We also found that even when the Bureau had plans for asset groups, the extent of implementing the plans was unclear. Plans were partly implemented, but lacked elements needed for accountability.

Best practice use of service levels



Source: Audit Services Division

Status of Asset Management Plans (AMP) as of December 2011

Asset group	Started	Completed	In use
distribution mains	yes	yes *(2008, in revision)*	partly
large valves	yes	yes *(2008)*	partly
fire hydrants	yes	yes *(2010)*	partly
large meters (commercial)	yes	yes *(2007, in revision)*	partly
pump stations	yes	yes *(2008, in revision)*	partly
tanks	yes	yes *(2007, in revision)*	partly
Bull Run road system	yes	no *(revision sched for 2011)*	-
services (from main to meter)	yes	no *(revision sched for 2011)*	-
wholesale meters & vaults	yes	no *(revision sched for 2011)*	-
distribution - transport mains	yes	no *(revision sched for 2012)*	-
conduits (pipes from supply)	yes	no *(revision sched for 2012)*	-
fountains	yes	no *(revision sched for 2012)*	-
groundwater supply system	yes	no *(revision sched for 2012)*	-
line valves	yes	no *(revision sched for 2012)*	-
system meters	yes	no *(revision sched for 2012)*	-
transmission mains	yes	no *(revision sched for 2012)*	-
facilities, buildings	no	-	-
Bull Run supply	no	-	-
Sandy River Station	no	-	-
terminal storage (reservoirs)	no	-	-
regulator stations	no	-	-

Source: Portland Water Bureau planning documents

Recommendations

We recommend that Commissioner in Charge direct the Portland Water Bureau to:

- Deploy resources, formalize leadership and develop accountability structures to implement a data management approach that meets the Bureau's asset management needs.
- Identify and clarify the essential required service levels, obtain confirmation from representative customers so that required service levels can be more useful in decisions about resource allocation, and apply service levels as budget criteria.
- Document management decisions and directions for action in Asset Management Plans to increase accountability and the likelihood of implementing the plans to benefit customers. Consider an overall asset management plan or other means of clarifying management policy and providing guidance for decision making.
- Incorporate an accountability framework throughout the Bureau to increase the likelihood of successfully meeting its objectives.

How we conducted this audit

This report is a summary of a larger technical report that is available by contacting the City Auditor's Office or on our website: www.portlandoregon.gov/auditor/auditservices.

The Objectives, Scope and Methodology section of the technical report describes why and how we conducted the audit. We conducted this performance audit in accordance with generally accepted government auditing standards.

We appreciate the assistance and cooperation we received from the Water Bureau and the Commissioner in Charge throughout the audit.

Response to the audit

The Commissioner's Office and the Administrator of the Portland Water Bureau responded jointly to the audit. Their response, contained in the technical report, states that they "**…generally concur with the analysis and recommendations of the audit**." The response also notes the Bureau's recognition as a leader in public utility asset management.

The comments and observations presented in the response correspond to each of the nine audit recommendations and detail areas of disagreement, as well as agreement, with those recommendations. The response also contains an attached table of "Resources Currently Committed to Asset Management Plan Development."

Audit Summary
Portland Water Bureau:
Further advances in asset management would benefit ratepayers
(#405, issued June 2012)

for the complete report, go to:
www.portlandoregon.gov/auditor/index.cfm?c=53777&a=399785

PORTLAND WATER BUREAU:
Further advances in asset management would benefit ratepayers

June 2012

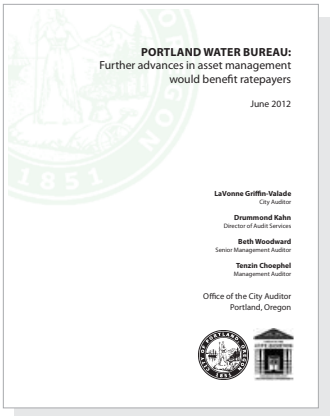
LaVonne Griffin-Valade
City Auditor

Drummond Kahn
Director of Audit Services

Beth Woodward
Senior Management Auditor

Tenzin Choephel
Management Auditor

Office of the City Auditor
Portland, Oregon



Production / Design
Robert Cowan
Public Information Coordinator

OFFICE OF THE CITY AUDITOR
ENSURING OPEN AND ACCOUNTABLE GOVERNMENT

CITY OF PORTLAND

Off ce of City Auditor LaVonne Griff n-Valade

Audit Services Division
Drummond Kahn, Director
1221 S.W. 4th Avenue, Room 310, Portland, Oregon 97204
phone: (503) 823-4005
web: www.portlandoregon.gov/auditor/auditservices

June 7, 2012

TO: Mayor Sam Adams
Commissioner Nick Fish
Commissioner Amanda Fritz
Commissioner Randy Leonard
Commissioner Dan Saltzman
David Shaff, Administrator, Portland Water Bureau

SUBJECT: Portland Water Bureau: Further advances in asset management would benefit ratepayers (Report #405)

The attached audit reviewed the Water Bureau's management of the extensive physical assets it uses to deliver water to customers. The Bureau set a high standard for managing its assets when it adopted asset management principles about five years ago. These principles focus on service delivery at the optimum long term cost. The Bureau has made progress in improving its asset management, particularly in evaluating capital project costs and benefits, and considering risk in plans for asset maintenance, repair and replacement.

We agree that asset management best practices benefit ratepayers, and we found the Bureau is viewed as a leader in asset management within the City and among U.S. water utilities as a result of its progress. However, we found several ways that the Bureau can improve its asset management practices to benefit ratepayers, including implemention of data management changes, confirmation and clarification of required service levels, and incorporation of clear management decisions and priorities in its Asset Management Plans.

We believe the improvements we recommend in this report will enable the Bureau to make further advances in providing cost-effective service to benefit Portland ratepayers.

As a follow-up to our report, we ask the Water Bureau to provide us with a status report in one year detailing steps taken to address the recommendations in this report.

We appreciate the cooperation and assistance we received from Portland Water Bureau staff as we conducted this audit.

L. Griffin-Valade

LaVonne Griffin-Valade
City Auditor

Audit Team: Drummond Kahn
Beth Woodward
Tenzin Choephel
Kari Guy
Daphne Lundi

Attachment

Table of Contents

Summary

Water users depend on Portland Water Bureau assets valued at $7 billion -- the pipelines, pump stations, tanks, and other equipment that get clean water to homes and businesses. The Bureau supplies an average of 100 million gallons of water per day.

Asset failures, such as pipe breaks, could result in problems – from customer inconvenience to health consequences and the costs to repair or replace assets. With good management, however, the Portland Water Bureau can minimize its overall costs while maintaining water service quality. We undertook this audit to review the Bureau's current practices to manage the City's water assets.

In 2007, The Bureau committed to adopting and carrying out internationally-accepted principles of asset management. The Bureau's commitment can be seen in its work drafting management plans for some assets, evaluating some capital projects to plan for maximum long term benefit, and prioritizing many maintenance and construction tasks based on risk. The Bureau published its goals for using asset management principles, in planning and revenue bond documents.

> "The 'Total Cost of Ownership' Principle – there exists a minimum optimal investment over the life cycle of an asset that best balances performance and cost given a target level of service and a designated level of risk."
>
> U.S. Environmental Protection Agency (EPA)

The Bureau also defined 27 service level indicators it uses to track and report progress, such as, "Respond to 95 percent of customer inquiries or requests within five business days," and "More than 90 percent of flow control valves will operate when needed."

These steps are positive and the Bureau has been recognized as a leader in asset management. In fact, many other U.S. utilities have yet to adopt a similarly comprehensive approach to asset management. However, we found the Bureau can do more to fulfill its goals for managing assets to benefit customers. The Bureau falls short in key areas, and these need attention to enable more cost-effective service delivery to ratepayers.

We found that the Bureau's data management efforts do not support its asset management objectives. Our 2004 audit reported the Bureau's difficulty in managing data to make evidence-based, cost-effective decisions about assets; the Bureau continues to experience that problem.

We found that the Bureau is not systematically using required service levels in budgeting. We further concluded that some service levels are internal workload targets that do not express the impact on customers, that the sheer number of identified service levels may dilute focus, and finally, that the Bureau has not sought input from representative customers about whether they agree with the required service levels the Bureau identified.

In addition, the Bureau has no overall plan for managing its assets, and planning efforts are splintered. It has drafted only a third of about 20 plans it identified as necessary for assets such as pipelines, fire hydrants, and meters. Meanwhile, the Bureau continues to rely on systems and practices that lead to reactive maintenance. Bureau managers indicated they agree that more proactive maintenance is needed to reduce long term costs.

To improve upon the foundation of asset management principles put in place, we recommend that the Bureau:

- Deploy resources, formalize leadership and develop accountability structures to implement a data management approach that meets its asset management needs.
- Identify and clarify the essential required service levels, obtain confirmation from representative customers so that required service levels can be more useful in decisions about resource allocation, and apply clarified service levels as budget criteria.

- Document management decisions and directions for prioritized actions in Asset Management Plans to increase accountability and likelihood of implementing the plans to benefit customers.
- Incorporate an accountability framework throughout the Bureau to increase the likelihood of successfully meeting its objectives.

Conduits at Bull Run

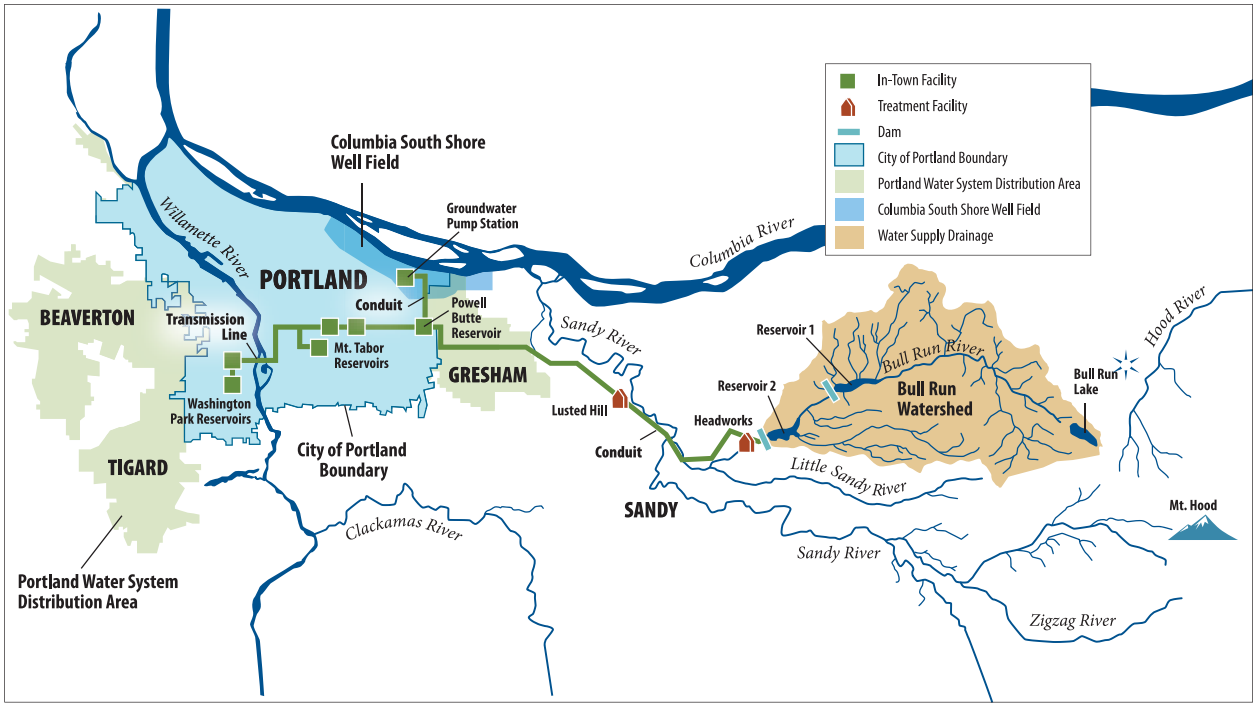
Source: Audit Services Division photo

Chapter 1 **Background**

Essential water delivery depends on high value assets

The Portland Water Bureau (Bureau) serves about one quarter of Oregon's population, both in Portland and other communities. It depends on its physical assets (assets) to continuously supply, store, pump, and deliver clean water to homes and businesses. The Bureau estimates that it would cost about $7 billion to replace its assets, such as treatment facilities, pipes, tanks, and meters. Figure 1 shows the extent of the water system and wholesale distribution areas, and some of the major assets needed to supply the average customer demand of 100 million gallons of water per day.

Figure 1 Portland water system



Source: Portland Water Bureau, 2011

Asset failures, such as pipe breaks or equipment breakdowns, could result in severe health consequences, transportation disruptions, and costs to repair or replace assets. Managing assets to provide water service at cost-effective rates while avoiding consequences to health and other unacceptable risks is a significant part of the Bureau's mission, "to be responsible stewards of the public's water infrastructure, fiscal and natural resources."

City policy requires bureaus to maintain assets in good working order to protect capital investments and to minimize future costs of maintaining and replacing them, especially to avoid costly deferred maintenance. In fiscal year 2011, the Bureau spent over $94 million in net operating expenditures (net of depreciation) and debt service (for purchasing new assets and major repairs on existing assets). Ultimately, Bureau and Council decisions about maintaining, repairing, and replacing assets directly affect current and future Bureau expenditures, water rates and water quality.

In 2004, we audited Bureau maintenance of the water distribution system (Report #299) and recommended that the Bureau prepare a maintenance plan, improve reliability of asset information, integrate information systems, and develop performance measures to track maintenance activities. At about the same time, the Bureau initiated elements of its asset management process. Our objectives in this audit were to review how the Bureau currently manages water system assets on behalf of its ratepayers, and whether it is following its commitment to asset management principles.

Broad agreement about the value of asset management

The Bureau, City Council, and the utility industry agree that the internationally accepted process for asset management provides the best way to deliver the service levels customers want at the minimum overall cost. Based on our review, we also agree that asset management would benefit customers and the City. Key principles and best practices of asset management are documented in the International Infrastructure Management Manual and by the U.S. Environmental Protection Agency (EPA). Our use of the term best practice, with respect to asset management, generally refers to those identified by these two organizations. The EPA's role in promoting asset manage-

ment in U.S. water utilities resulted from Congressional interest in the benefits of comprehensive asset management. At the City level, the Water Bureau and other City bureaus responsible for physical assets collaborate on an annual Citywide Assets Report, presented to City Council. The report includes their workplan for, and progress on applying seven specific asset management best practices.

Broad agreement about the value of asset management best practices does not mean they are widely implemented in the U.S. Although American Water Works Association (AWWA) policy also recommends comprehensive asset management planning for water uitilities, an AWWA representative told us that the organization is just starting to look at asset management and that the U.S. is lagging behind other parts of the world in utility use of asset management.

Advances in asset management benefit ratepayers

The cost of providing water is impacted by many factors including a consideration of what risks are acceptable. Asset management makes delivering required services over the long term the central focus of management's decisions. Benefits to ratepayers include:

- **Reducing overall costs through efficient operations and maintenance that prolongs asset life** - Asset management seeks to minimize total costs of acquiring, operating, maintaining, and renewing assets while keeping risk at an acceptable level. The American Water Works Association (AWWA) reported that utilities may save 20 to 30 percent of life cycle costs by adopting asset management practices.
- **Focusing on services delivered** - Delivering the service levels that customers confirm and regulators require, such as water quality, drives output-oriented management. Focusing on services helps prevent unnecessary spending.
- **Using a sound basis for setting rates** - Rates should be tied to, and limited to providing agreed-upon services through cost-effective asset management actions to maintain required services at acceptable risk levels. Asset management includes planning funding strategies for optimum capital, maintenance, and operations investments.

Overall, these benefits also improve accountability over the use of resources. Generally, service level measures and evidence-based asset decisions promote accountability and transparency.

Asset management best practices involve systematic, evidence-based, cost-effective decisions

Managing assets in a cost-effective way involves systematically making choices based on an understanding of asset performance, risks and costs in the long term. Asset management ties those asset maintenance and replacement choices to maintaining the services that assets are in place to provide. We summarize the following interrelated characteristics of a good asset management program, based on our review of these principles.

Having knowledge about assets and costs

Data and knowledge about assets form the basis of every decision and are the backbone of asset management practices. Needed data includes assets owned, asset condition, expected remaining life, cost to replace each type of asset, and how each asset would be likely to deteriorate. The key to good data and data systems is to tailor them to the utility's decision-making needs. Data quality, asset register, and data system architecture should support decision-making.

Maintaining desired levels of service, agreed by customers

The services a utility delivers are the reason for all the assets in its system. The utility must know the specific minimum levels of the services it delivers, in order to plan, budget, manage and evaluate the work and assets it needs to cost-effectively maintain those levels of service. An example of a service level is to deliver water reliably, limiting outages to no more than three events per year per customer. The steps for using service levels are: define the required levels of services that assets deliver; engage representative customers in confirming or modifying levels; and budget and manage as required to maintain the agreed-upon levels of service.

Lifecycle approach to asset management planning

An asset management plan (AMP) identifies the tactics and resources that are optimum (lowest cost) for meeting service requirements.

AMPs provide the basis for decisions about assets, including service levels and asset information such as condition, performance, and risks of failure. They include management strategies to maintain, repair and replace assets to achieve the lowest lifecycle (long term) cost, and the plan to fund those actions through rates and charges.

Implementing planned solutions to provide reliable cost-effective service

Planning optimal asset actions is not enough. Total cost over time is optimal only if the maintenance and other planned strategies are actually performed. It is through implementing evidence-based decisions, documented in Asset Management Plans, that service levels can be maintained at optimal long term cost.

Chapter 2 Progress made in asset management

Bureau committed to asset management best practices

The Bureau meets the City's voluntary timeline for implementation of asset management best practices described in the 2011 Citywide Assets Report, and is recognized as a leader in asset management among U.S. water utilities. The Bureau set a higher standard for its asset management approach in 2007, when it documented its commitment to becoming an "advanced asset management organization," in an Asset Management Charter, signed and prominently displayed by top management (Appendix). The Charter cites international best practices.

The Bureau's efforts to document asset information, evaluate asset failure risks and capital project alternatives, identify service levels, and begin drafting asset plans to guide cost-effective maintenance, repair and replacement are evidence of its commitment to asset management concepts. Figure 2 shows many of the actions the Bureau has taken since 2004. Moreover, the City has promoted the Bureau's commitment to asset management and the Bureau helps guide the Citywide efforts. The City publishes details about the Bureau's asset management program in its official statements to revenue bondholders.

Bureau leadership engaged in asset management

Bureau management formed an Asset Management Group within its Engineering Services Group to provide technical guidance, coordination and support to the Bureau as a whole. It also established the Asset Management Steering Committee ("Steering Committee") to make decisions and policy based on information presented to it by the Asset Management Group. With the exception of the Bureau Administrator, Steering Committee members include Bureau executive leadership and other selected managers with responsibilities tied to asset management.

Figure 2 Major milestones in Portland Water Bureau asset management program

2004	Formed Asset Management Group work unit in Engineering Services Received Audit Services Division's *Portland's Water Distribution System: Maintenance program needs improvement* audit report
2005	Formed Asset Management Steering Committee Conducted the first "business case" impacting management of an asset (hydrant overhaul) Utilized self-assessment tool to identify program gaps for benchmarking (first in a series of gap analyses)
2006	Improved asset information in the *Water System Status and Condition Report* Participated in the Water Services Association of Australia's international benchmarking study (first year of a three year program) Drafted the first Asset Management Plan for an asset group (distribution mains)
2007	Adopted Bureau *Asset Management Charter* Began reviews of work order data in the maintenance information system Developed a business risk methodology and applied to assets for the first time
2008	Adopted the *Bureau Strategic Plan (2008-2011)* with key service level indicators
2009	Published the *Business Case Development Guidebook*
2010	Published *Guidelines for How to Develop an Asset Management Plan* Developed a Bureau *Asset Management Work Plan* for 2010-2015 Prioritized completion of Asset Management Plans for about 15 asset categories

Source: Portland Water Bureau

Bureau information system improvements

The Bureau began using its Computerized Maintenance Management System (CMMS) in 2004, to manage in-house maintenance and construction task orders. It also uses a proprietary forecasting tool, Total Enterprise Asset Management Planner (TEAM Plan) to track the condition of water system assets and estimate time and cost of appropriate asset repair or replacement based on condition. The Bureau made progress developing its asset hierarchy and improving on the collection and organization of its asset information across CMMS, TEAM Plan and the Geographic Information System (GIS).

Bureau data management improvements

The Bureau reported that a significant accomplishment was to provide a better structure for finding information. A Bureau official stated that a multi-year project consolidated multiple file servers, removing a significant number of duplicates in the process. As part of this work, the Bureau stated it also reorganized the file server hierarchy, in part to better match the Bureau's asset hierarchy.

Bureau identified levels of service

The Bureau began identifying service levels in its first Asset Management Plan for water mains and continues to apply them to specific groups of assets. In its 2008 Strategic Plan, the Bureau identified 24 bureau-wide service levels. Since then it increased the number it considers key to 27. An important service level is to comply with all State and Federal water quality regulations.

Bureau case-by-case evaluation of risk and optimum cost

In 2007, the Bureau prioritized many assets according to estimated business risk. Since then, Bureau staff evaluated the risk for pipeline material types and many of the major assets it prioritized. The Bureau also performed business case analyses of projects and policy changes on a case-by-case basis, as directed by the Steering Committee or by capital project planners. Most of the Bureau's reported asset management cost savings have resulted from business case and risk evaluations.

Bureau guidance prepared

In order to assist other Bureau staff to participate in evaluations and planning, Bureau technical staff in the Asset Management Group prepared the Business Case Development Guidebook and Guidelines for How to Develop an Asset Management Plan. These documents provide Bureau methodologies for applying asset management practices to the water system. To support business case analysis, the Asset Management Group also prepared guidelines for estimating dollar values of changes in some service levels, including water outages and water pressure.

Draft Asset Management Plans in progress

The Bureau drafted AMPs for six groups of its similar assets and is working on many others to fulfill action items it described in its Asset Management Charter. It drafted plans for distribution pipes, tanks, commercial meters, pump stations, large valves, and fire hydrants. These efforts resulted in Bureau asset management experts presenting a peer-reviewed paper on the distribution pipes AMP to the American Society of Civil Engineers' Pipelines 2011 Conference.

Improvements in Bureau culture, coordination and communication

Throughout this audit, Bureau staff repeatedly described to us how asset management has become an important mechanism to make needed changes, although some also told us about resistance to it. The Bureau's asset management efforts brought teams together from distinct organizational divisions that may not have interacted before, to work on common goals. For example, engineers with asset design responsibilities and others with operations responsibilities are now more likely to discuss particular assets and projects from a broader perspective. Similarly, field crews responsible for collecting information about assets are improving their records to share the information with staff responsible for recording data in information systems.

Chapter 3 Data management progress has not kept pace with asset management needs

Managing information to make good decisions is one of the greatest challenges in today's operating environment. At its core, asset management is about making data-driven, evidence-based decisions. However, the Bureau is like other organizations that have pieced together a data management approach based on legacy systems and solutions to address emerging needs. Bureau staff, as well as expert sources outside of the Bureau, assessed the Bureau's current approach to data management as an impediment to its ability to meet its asset management objectives. We found that the Bureau has developed an overarching data management strategy but has yet to implement key tasks that meet the general needs of the Bureau as well as the specialized needs of asset management. Improving data management depends on leadership, dedicated technical resources and assigning responsibility for making data management improvements.

Long-standing data management challenges known

Over the years, the Bureau has relied on many data systems and processes to address its data needs. Our 2004 audit, at about the time the Bureau initiated an asset management program, dedicated a chapter to the Bureau's need for stronger data management. Since the 2004 audit focused on the maintenance of distribution assets, we reported that existing asset data systems were inefficient and unreliable, and that a number of duplicative databases existed at the Bureau due to the lack of good integration across existing systems. In addition, the Bureau was using unreliable information on the condition of key assets and the level of effort needed to address its requirements.

Figure 3 Select information systems significant to asset management

Name	System Type	Description
SAP	Enterprise Resource Planning System (ERP)	Financial system for the City, with personnel, timesheet, purchasing (e.g. capital project contracts) and aggregated cost data
Oracle WAM	Computerized Maintenance Management System (CMMS)	Work order and inventory management system with some asset attributes and cost-data for in-house projects
ArcGIS	Geographic Information System (GIS)	Visual presentation of mapped asset data with specific asset attributes, used primarily but not exclusively on distribution system and right-of-way assets
Cayenta	Customer Information System (CIS)	Customer billing system operated by the Revenue Bureau, which includes data from customer water meters
LabWorks	Laboratory Information Management System (LIMS)	Water quality information system with test data from water sampling stations, required for laboratory certification and data validation
OASys	Supervisory Control and Data Acquisition System (SCADA)	System remotely monitors and controls water treatment and distribution assets, and collects data for analytical purposes (e.g. water flow, pressure, etc.)
TEAM Plan	Forecasting model	Financial needs forecasting model, that includes asset-related data compiled from other Bureau sources
Various	Access databases	Individuals and units within the Bureau maintain various database files on specific asset groups, including data about infrastructure sites, roads, etc.
Microstation	Computer Aided Design & Drafting (CADD)	System includes three-dimensional models of key sites within the water system that augments existing asset information in GIS.
FileNet/P8 Job Tracks, General Plans	Content management	A software package and Access databases used collectively by the Bureau to store or provide location references for a variety of Bureau information
SQLserver	Database program	Primary and central repository for information about Bureau assets

Source: Portland Water Bureau

Now, about eight years later, the Bureau faces similar challenges, yet with even more data systems and its new objective of locating, collecting or analyzing data to use in asset management decisions. Figure 3 provides a list of the Bureau's current asset management-related data systems. Some of these systems are not directly within the Bureau's control (e.g. SAP, Cayenta), and the Bureau reports other systems (e.g. SCADA, LIMS) must stand alone due to security issues.

While the Bureau is aware of its data management issues, we found its recent asset management efforts have brought these concerns into the foreground. Because asset management activities have increased the coordination and communication between work units, the Bureau appears to have improved in its knowledge sharing and, likewise, its ability to identify areas for improvement.

During our review of Bureau documents, we studied detailed analyses that Bureau staff members prepared as part of their work developing business cases, status and condition reports, and especially Asset Management Plans. Staff members repeatedly reported a variety of limitations with data completeness, reliability and usefulness for asset management needs. They also cited inefficiencies due to numerous data sources and lack of system integration. The extent and type of problems vary depending on the asset category, information system, and work unit. These variations and inefficiencies led to inconsistencies when performing similar business processes. Our interviews with Bureau staff confirmed the limitations reported in these Bureau documents. Moreover, the Asset Management Group developed a document in 2008 to emphasize and prioritize the key data needs to support the Bureau's asset management efforts.

We found that numerous sources outside of the Bureau confirmed the importance of the data management issues identified in Bureau internal reviews. To help identify and prioritize needed improvements, the Bureau consulted with asset management experts and participated in various assessments with its international and domestic peers, beginning in 2005. In June 2011, it hired consultants to provide options for implementing improvements to its business processes and systems.

Figure 4 Past recommendations related to Bureau data management

	Select Recommendation(s)	Report	Author(s)
2004	Better plan and coordinate efforts to improve the reliability and accessibility of asset information.	*Portland's Water Distribution System: Maintenance Program Needs Improvement*	Audit Services Division
2005	Create data standard; improve data warehouse for storage, management and reporting of data; develop an information technology system strategy; and improve cost data.	*Asset Management Gap Analysis and Benchmarking*	GHD
2006	Define corporate data needs, data model, and implementation plan that reflects the needs of all stakeholders; integrate key systems.	*QualServe Peer Review Report*	AWWA, Water Environment Federation
2007	Initiate information management improvements to support asset management objectives, including data management, system integration and asset classification system.	*Distribution System Master Plan*	Camp Dresser & McKee Inc. (CDM)
2008	Establish common asset register, develop data mining capability, enhance cost accounting; establish procedures for data verification and import for data capture at asset handover	*2008 Asset Management Process Benchmarking Project*	Int'l Water Assoc., Water Services Assoc. of Australia, GHD, Marchment Hill, CH2M HILL
2009	Improve the asset hierarchy, asset register and asset attributes to enhance future modeling and improve the overall confidence level for decision-making activities.	*Report for Future Investment Needs Modeling for Asset Management*	GHD
2011	Improve business processes and integration of existing systems to support workflows; prioritize and implement gap closure action plans (19) based on available resources.	*Business Workflow Analysis Project*	Brown and Caldwell

Source: Audit Services Division, and documents provided by Portland Water Bureau

In all reports we reviewed, we found consistent recommendations for the Bureau to improve its data management, as listed in Figure 4. Since 2005, the Bureau has participated in self-assessment processes with other utilities, to identify any gaps in its asset management implementation. The Bureau acknowledged that in the "Data and Knowledge" category of the self assessments, it had a low overall score and also low scores relative to other top water and wastewater organizations.

Overarching data management strategy developed but needs to be implemented

We found the Bureau has developed an Information Technology Strategic Plan, but is still in the process of implementing our 2004 recommendation to better plan and coordinate efforts to improve the reliability and accessibility of water system asset information. The Bureau reported that it began developing an information technology strategy in 2006, culminating in the Information Technology Strategic Plan ("Strategic Plan") in 2009. The Strategic Plan includes a stated goal, objectives and strategies that encompass data and system enhancements. It also requires the development of annual Action Plans that list specific tasks to meet areas identified within the overall strategic framework. The Bureau reports that management and a separate Information Technology Strategic Plan Committee, comprised of representation from across the Bureau, annually reviewed the Strategic Plan and wrote the Action Plans.

Two tasks that are of particular importance to asset management are development of a common data model, and data standards for asset information. Both were included in each of the last three annual Action Plans. The fiscal year 2011-12 Action Plan states these tasks are planned for completion by the end of this fiscal year.

A Bureau official reported that these Action Plans serve as the backbone of its information technology efforts and, over the years, has successfully completed many of the tasks identified but not areas of focus in this audit. The official told us the Bureau's ability to implement the various tasks as planned was and is based on available resources. The Bureau reported that its Data Management Program resides within the Engineering Services Group but serves

Bureau-wide needs. Two staff members and their supervisor have data management as part of their portfolio of responsibilities. They coordinate and request time from other Bureau staff with information system-related responsibilities on a task- or project-basis. The Bureau reports, when funding is available, it has budgeted for the use of consultants to assist in projects if additional expertise or time is needed.

The Bureau tracks performance for the Data Management Program as part of its quarterly program budget reports. The reports include effectiveness measures as well as system-specific workload measures. However, despite agreed-upon goals and regular data quality reviews, performance in the areas tracked by these measures revealed mixed results. The most recent quarterly report we reviewed showed unmet or unclear targets for 11 of the 13 measures.

Given the 2011 consultant's report addressing data management challenges, this is a good time for the Bureau to implement its data management strategy. The consultant's report provided a foundation for the Bureau to build upon. For example, the report described whether or not the Bureau's data systems (listed in Figure 3) relate to each other. It also mapped 12 business process workflows, as well as the current and desired state of the Bureau's enterprise architectures (business, systems and technology) related to those workflows. The consultant's report states that Bureau teams agreed on the following objectives for the Bureau's future data management work:

- Integrate systems
- Provide for more effective reporting
- Provide end-to-end support for business processes
- Create a single version of the truth
- Reduce dependence on paper
- Define and enhance supporting business processes

The consultant's report identified 19 recommended action plans and the Bureau reported it began addressing key components from the report, which will require several years to implement.

Slow pace of data management improvements impede asset management progress

While the Bureau has begun to focus some attention on data management concerns, the slow pace of its improvements has delayed the Bureau's ability to meet its asset management objectives. We identify three interrelated areas where data management limitations have affected the Bureau's progress in fully implementing asset management.

Impact on asset register development

Data management challenges have affected the Bureau's ability to complete an asset register, the first step of any asset management program. The asset register is at the heart of asset management because it is the systematic recording of all assets an organization owns or for which it is responsible. The register should form the link between all asset-related applications. It must also support the structure and use of the information system to describe and appraise the assets as individual components, as composite assets – like a pump station - or as groups of similar assets. The register includes asset attributes and the asset hierarchy, on which additional data collection is based. Therefore, the Bureau has to determine what it knows about its assets, and also what unknown information it needs and how best to collect it.

The Bureau has invested staff resources and made progress in developing its register – for example, the Bureau reports that its Asset Hierarchy Subcommittee regularly meets to load and organize the asset register. However, challenges in accessing the Bureau's existing knowledge about its assets have made these efforts that much more difficult. Inefficiencies and limited data reliability, as described by the Bureau in its asset management-related documents, are examples of these challenges.

Impact on data quality used for decision-making

The 2011 consultant's report explained that current systems do not support the data collection and reporting needs of all processes and, as a result, data users have developed compensating processes and activities to fill any gaps. These compensating processes have created information islands that can result in multiple versions of the truth with users making decisions on inaccurate or expired information.

Elements of data quality include reliability, completeness, accuracy, consistency, timeliness and usefulness to decision-makers. Since asset data and data systems are central to asset management practices, the caliber of the organization's decision-making depends directly on the extent and quality of the organization's data.

There have been some improvements in data quality but not a systematic approach. For example, the Asset Management Group identified key data needs in 2008, focusing mostly on asset data attributes in GIS. The Bureau reported that it made progress in this area and, during our desk reviews, staff informed us of modifications made to data collection for GIS and CMMS. However, some data sets have yet to be addressed – for example, we reviewed multiple documents that stated the Bureau lacks some of the necessary cost data (e.g. tracking external costs against individual assets) it needs to make the cost-benefit decisions that are essential for effective asset management. While it may not be necessary to have the highest quality for all data, systematic standards and procedures are necessary to provide management with confidence in its data.

Impact on integrating asset management within existing business processes

The success of asset management in the Bureau depends on its ability to integrate asset management principles and practices within its overall business processes. For example, business processes at the Bureau involve information systems for accounting, maintenance, customer billing and spatial mapping. However, the Bureau has not yet defined its overall organization, or structure, for aligning systems and processes. An integration shortcoming reported by the Bureau is that some systems are outside of its control and that has caused significant inefficiencies and inabilities to share across its information systems. Without adequate system and process integration, those responsible for asset management tasks are put in the difficult position of developing asset management processes without the ability to relate them to, or integrate them in, the Bureau's business processes, systems and supporting technology.

Leadership, resources and accountability needed to effectively manage implementation

Even with the best strategies, data management changes at a large organization are risky because of the technical requirements and the changes employees need to adjust to. Organizations can easily become complacent, resistant to change or have difficulties implementing a good idea. In addition, the thought of trying to implement such changes can be daunting to management. Fortunately, the Bureau already has experience in this area, because much of its asset management success is due to its ability to facilitate changes within the organization.

Although the Bureau has made some recent efforts in the data management area, we found that these efforts could be more effective with stronger leadership, dedicated resources and a clearer accountability framework. The Bureau needs to apply to data management what it learned about organizational change from its asset management efforts. For example, asset management has the Asset Management Steering Committee to serve as executive leadership champions and the Bureau has dedicated resources for the Asset Management Group to manage implementation and coordinate across work units. If the Bureau can systematically identify leaders, dedicate technical resources, and establish clear accountability for implementing its data management strategy, it will increase its likelihood of success in asset management and its benefits to ratepayers.

The Bureau is in the process of addressing some of these areas. A Bureau official stated that one direct outcome from the consultant's work was the establishment of a Data Management Committee that will be in charge of implementing its data management strategy. As we were writing this report, the Bureau shared its charter for the newly formed Data Management Committee. Bureau staff informed us that the Asset Management Steering Committee adopted the charter and will be overseeing the work of the Data Management Committee moving forward.

In order for the Bureau to fully realize its asset management goals, it must incorporate its asset management needs in its Bureau-wide data management strategy. The Bureau reported it has included asset management experts who are familiar with data needs and

current data limitations to help lead the three subcommittees: Asset Management, Information Technology Infrastructure, and Business Workflows. The Bureau can gain from the investment it has made developing asset management experts, by involving them as leaders in planning its data management changes. Their input is crucial in prioritizing changes needed for general Bureau operations and reconciling differences between the Bureau's global, general needs and its specialized asset management needs.

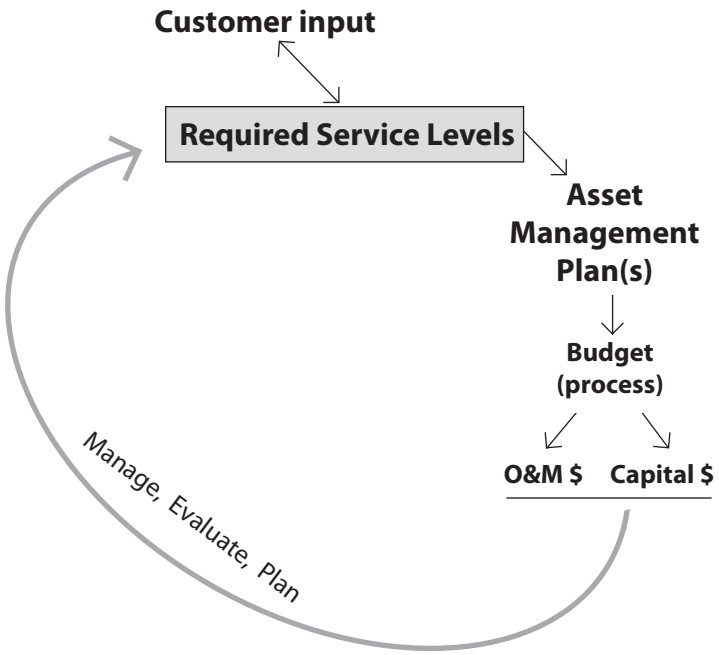
Chapter 4 **Use of service levels limited**

Although service levels are an essential part of the Bureau's asset planning – and the basis for decision-making according to its Asset Management Charter and best practices – we found that the Bureau has not begun using its identified service level indicators to budget its operating and maintenance expenditures, except in some project funding decisions. By not systematically using service levels as the basis for rates and spending, the Bureau has lost an opportunity to focus its operations on service delivery and effectively communicate the reason for any rate changes.

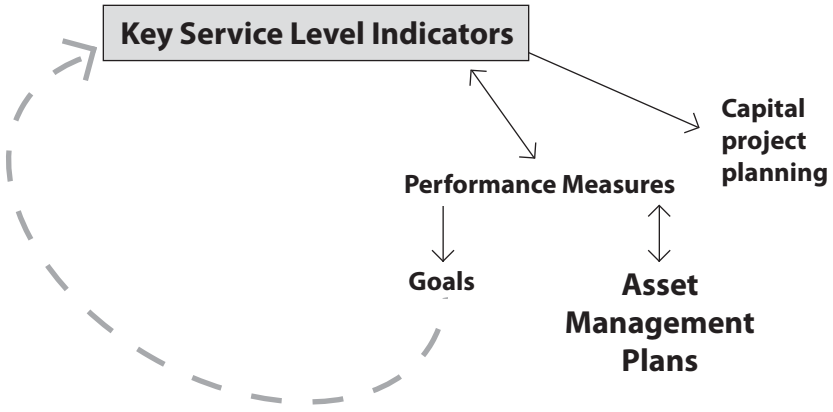
We found that managers' perceptions about the purpose of service levels are inconsistent, and some service levels are stated as internal workload targets instead of expressing required customer outcomes to guide resource decisions. In addition, the Bureau has not yet consulted with representative customers about whether services are delivered at the right level relative to cost. The difference between the Bureau's use of service levels as performance measures and goals, and their use according to best practice is shown in Figure 5.

Figure 5 Service levels in asset management

A. Best practice use of service levels



B. Portland Water Bureau current use of service levels



Source: Audit Services Division

Budget not based on defined service levels

Because assets exist to provide services, the service levels required by regulators and elected officials, and desired by customers, should be the criteria for making informed resource allocation decisions to manage assets. By City Code, ratepayers are responsible for payment of "water or water related service," and the City Charter constrains spending on other purposes. It follows that the Bureau should link rates and budgets to services, as asset management best practices indicate. However, based on Bureau managers' statements, we found that rates proposed to City Council during the budget process are not based on meeting the Bureau's defined service levels.

> "Knowing your required 'sustainable' level of service will help you implement an asset management program and communicate to stakeholders what you are doing. The required level of service is the basis for justifying your user rates."
>
> U.S. EPA

Capital project planners consider service levels. However, except when justifying the creation of new programs, the Bureau has not tied operating and maintenance costs to service levels. According to Bureau managers, rate increases are limited to the total amount that management thinks elected officials and customers would tolerate in the short term, rather than basing rates on the long term lowest overall cost of meeting specific service levels. Bureau managers told us the optimum cost would be higher to include more planned maintenance and other unmet needs, but practical considerations limit the Bureau's available resources. The amount budgeted for operations and maintenance (called the base budget) is effectively what remains of expected revenue after the Bureau subtracts debt service due on funds borrowed for capital projects, and all other obligations. The base budget is distributed to programs in proportion similar to prior years.

As annual debt service increases, less revenue is available for maintenance unless rates are allowed to increase to cover additional debt service. Debt service increased 52 percent from fiscal years 2007 through 2011, while in the same period, operating expenditures, net of depreciation, increased only 8 percent. As a fraction of available operating revenue, debt service increased from 18 to 25 percent in

those years. Bureau management told us that when revenue does not cover all needed operating, maintenance, and capital expenditures, the Bureau makes budget cuts to "minor maintenance," such as that in the backlog of task orders. These cuts result in deferring some maintenance to later years. Some deferred minor maintenance becomes more expensive 'major' capital maintenance.

The Bureau has not been able to limit its expenditures to those needed to meet service levels, although managers told us the base budget is insufficient to do the optimum amount of planned maintenance. Providing matching funds for transportation project grants is an example of Bureau expenditures not needed to achieve service levels. In our 2011 audit, *Spending Utility Ratepayer Money* (Report #398), we reported other examples of Bureau spending not directly related to utility services, such as spending over $1.5 million to remodel a building for Rose Festival Foundation use.

Bureau officials explained that service levels are a work in progress, evolving based on Bureau experience using them. The Bureau's insufficient cost data is one barrier to basing funding decisions on service levels, according to Bureau experts. We found that managers' perceptions about the purpose of service levels may be another reason the Bureau is not yet using service levels as criteria for budgeting. The need for more clarity in the way service levels are defined and the large number of Bureau service levels are two other possible reasons.

Bureau use of service level indicators unclear

Although the Bureau does not yet systematically use its service levels for budgeting operations and maintenance, it does use them as performance measures. It reports its key measures annually as a group, and quarterly in program budget reports with program-specific service levels. Once reported, however, it is not clear how the Bureau uses the information. Given this limited systematic use of service levels, management perceptions about them, lack of clarity in the way they are written, and the high number the Bureau identified as key, we found that generally the Bureau is not using them as the basis for cost-effective management, with customer input.

Management perceptions about required service levels inconsistent

Bureau managers expressed a variety of perceptions about the use of service levels. They said service levels are a mix of regulatory requirements, aspirations, and benchmarks – long term guides for what the Bureau would like to be doing as well as what it is providing. Bureau managers told auditors that they do not distinguish between commitments and aspirational goals, and that service levels are periodic performance reports, for which too much reporting of measures is required.

The Bureau's documented uses also differ. Only two Asset Management Plans that the Bureau drafted describe external service levels as "commitments and requirements that must be met under all circumstances," and internal service levels as establishing "what customers can expect from the Bureau with respect to response time, water quality, pressures, and system reliability." This is consistent with best practice, but one of the two AMPs was since revised, and other AMPs refer to service levels as goals, targets, or proposed levels. The Strategic Plan says they are pledged to customers, while the Bureau's asset management guidance documents refer to them as goals, or as service conditions that may need improvement.

Having the same understanding and use of the concept is more important than the specific terminology selected. According to best practice, it is essential to use required or actual service levels as a basis for customer consideration of higher service level targets.

Identified service levels unclear about specific service to customers

Many of the Bureau's 27 service level indicators do not clearly express which service is delivered to customers, and some are not clear about what is actually measured. The Bureau has not specified some services it uses the indicators to measure. Examples of Bureau service level indicators without clear outcomes for customers expressed include:

- "More than 90% of flow control valves will operate when needed" (Bureau category: Customer Service – Construction)

- "Meet at least 80% of standards established for inspection, testing, repair and replacement of assets that are identified as high or extreme risk. Risk scenarios rated extreme require immediate action" (Bureau category: Infrastructure Management)
- "50% of employees report they are fully engaged in and enthusiastic about their work" (Bureau category: Workforce and Workplace Excellence)

Three indicators in the Infrastructure Management category, including the one listed above, are technical measures of workload rather than measures of Bureau output or outcome. While these indicators may be useful as technical performance measures, neither the service delivered to customers nor its required level is clear. Since the purpose of identifying service levels is to focus on service rather than assets in decision-making, such indicators do not appear to be useful as service levels. Assets are the means of providing service. Service levels expressed and measured as outcomes would be more useful for relating service to cost and for decisions about changing service levels.

Bureau officials told us that service levels are too technical to be modified in a way that customers could understand – they are for Bureau use. However, utilities have many options for expressing service levels in a way that would be useful both to Bureau employees and for communicating with customers. The City of Seattle's water utility, another industry leader in asset management, reported clear "service level objectives" separate from its service level targets. The Bureau could use clearer service outcome descriptions for groups of service levels. For example, Seattle uses, "Provide adequate pressure for drinking water supplies," as the service level objective for maintaining minimum pressure. "Protect public health" could be a service objective for water quality. Seattle defines service levels as , "…desired performance outcome …high priority to customers…."

Large number of service levels

Although best practices recommend establishing a small, manageable set of service criteria that can be measured with available data

and are meaningful from a customer point of view, the Bureau identified 27 service level indicators that it considers key. The Bureau's use of its service level indicators as performance measures could be the reason it has included such a large number of service levels it considers key.

Even if each Bureau indicator was clear about the service, the large number of indicators the Bureau uses might be a barrier to clear communication within and beyond the Bureau. Fewer indicators would require less work to estimate costs for varying levels of service. In comparison, the City of Seattle's water utility uses less than half the number of water service levels at its highest level.

During completion of this report, a Bureau representative confirmed that it considers all of its 27 key service level indicators to be essential and pointed out that it has many more internal budget program service levels. The Bureau agrees that clarity of the service levels can be improved.

Bureau has not sought customer input on service levels

Although asset management best practices consistently refer to service levels as agreed-upon by customers, we found that the Bureau has not yet confirmed that representative customers would agree with the levels of services it has identified. Engaging representative customers in communication to confirm Bureau service levels and evaluate whether any are too high or too low would enable the Bureau to focus on the factors most important to customers and adjust spending to meet customer requirements. Bureau peer reviewers recommended in 2006 that the Bureau provide opportunities for customer input to understand "broadly-held community values." In 2010, the Bureau presented its service level indicators to the Bureau Employee/Community Budget Advisory Committee (BAC) as part of the introductory meeting. However, the Bureau told us that the nine community members were impressed but did not offer input, and that it has no plans to seek customer agreement.

Bureau officials explained that in addition to their difficulty expressing service levels in clear, non-technical terms, some service levels

are regulatory requirements that cannot be changed by customers, such as minimum water pressure. They also said that along with their significant responsibility to manage water supply and delivery, they have the authority to make decisions on behalf of ratepayers.

Seattle Public Utilities conducted a survey of randomly selected customers to help define its service levels. It reports that it plans to do more customer surveys as well as focus groups and studies of how much customers are willing to pay for services, to help set future service levels and ensure that customers understand the rate impacts of achieving specific levels. Surveying representative customers and hosting focus groups are methods of assessing customer perceptions consistent with best practice.

During completion of this report, Bureau management told us that it has sought input on service levels from its BAC every year since 2006. It also said its criteria for customer input is the 2010 Citywide Asset Management Workplan that called for bureaus to consult with BACs by 2014.

Need for effective service levels hampers accountable, efficient management

Without systematically using defined service levels as the basis for water rates and allocating resources, the Bureau can not assure ratepayers that resources are used cost-effectively, or that it is limiting spending on non-essential items. Not providing that assurance perpetuates the Bureau's difficulty defending rates it says are essential. Without clear service levels that can be understood by most customers, and customer confirmation of the levels to use as the basis for asset management decisions, the Bureau may not understand customer preferences.

Chapter 5 Without useful plans to implement, decisions may not be the most cost-effective

Despite its Asset Management Charter, and although asset management depends on substantial planning, the Bureau has no overall plan for managing assets. Instead, it is developing Asset Management Plans (AMPs) for each of about 20 of its major groups of similar assets like valves and fire hydrants. It completed drafts of less than a third of those plans, however, due in part to its data and resource limitations. Without plans, decisions are typically made on a case-by-case basis by individual managers, and the Bureau may not perform asset maintenance, repair and replacement at the best times to save costs. We found that even when the Bureau had plans for asset groups, the extent of plan implementation was unclear. We also found that the plans lacked elements needed for accountability.

No overall asset management plan and limited progress on specific plans

Portland residents have told government that maintaining existing utility assets is more important than spending on new projects, according to Davis, Hibbitts & Midghall, Inc., a Portland research firm, and others. Our 2004 audit of the distribution system recommended that the Bureau prepare a comprehensive maintenance plan. The Bureau affirmed its responsibility to maintain water system assets in its strategic plan and Asset Management Charter, and it addresses maintenance within AMPs. However, we found the Bureau has no overall plan for managing assets. Bureau management told us that one overall plan is not needed because it is developing comprehensive AMPs, a focus that was expanded in 2010.

Instead of an overall AMP, the Bureau is developing separate AMPs for its different groups of similar assets, including pipes, pump stations, and fire hydrants. Its primary objectives for the AMPs are to deter-

mine management strategies for each asset group and to identify which specific assets are most important to uninterrupted operation of the whole system. Asset groups differ in the ways they fail, and in maintenance, repair and replacement strategies and costs. This is the Bureau's rationale for creating many specific plans rather than one overall plan. Bureau assets may not all be included within the defined asset groups. In addition, creating so many different AMPs may not be the most efficient approach from the perspective of managers responsible for managing more than one asset group. Figure 6 lists the status of Bureau AMPs.

Figure 6 Status of Asset Management Plans (AMP) as of December 2011

Asset group	Started	Completed	In use
distribution mains	yes	yes *(2008, in revision)*	partly
large valves	yes	yes *(2008)*	partly
fire hydrants	yes	yes *(2010)*	partly
large meters (commercial)	yes	yes *(2007, in revision)*	partly
pump stations	yes	yes *(2008, in revision)*	partly
tanks	yes	yes *(2007, in revision)*	partly
Bull Run road system	yes	no *(revision sched for 2011)*	-
services (from main to meter)	yes	no *(revision sched for 2011)*	-
wholesale meters & vaults	yes	no *(revision sched for 2011)*	-
distribution - transport mains	yes	no *(revision sched for 2012)*	-
conduits (pipes from supply)	yes	no *(revision sched for 2012)*	-
fountains	yes	no *(revision sched for 2012)*	-
groundwater supply system	yes	no *(revision sched for 2012)*	-
line valves	yes	no *(revision sched for 2012)*	-
system meters	yes	no *(revision sched for 2012)*	-
transmission mains	yes	no *(revision sched for 2012)*	-
facilities, buildings	no	-	-
Bull Run supply	no	-	-
Sandy River Station	no	-	-
terminal storage (reservoirs)	no	-	-
regulator stations	no	-	-

Source: Portland Water Bureau planning documents

The Bureau's completed AMPs describe technical analyses and results, and they show that development included industry standards review, collection and analysis of available data, and knowledge of historical and current business processes. Typically, several sections of the AMPs identify and include proposals or recommendations for service levels, policies, management strategies, maintenance strategies, data collection, and other aspects of asset management. Most work on completed AMPs was done before the Bureau's guidance was ready.

Without completed and implemented plans, it is less likely the Bureau will discover and correct inefficiencies in a timely way. In addition, management can not determine whether its goals for managing Bureau assets are being met, and spending may be ineffective. According to Bureau management, implementing its Asset Management Charter depends on completing the AMPs and the Bureau is working to complete the majority on schedule. During completion of this report, the Bureau emphasized that prior to the current effort to update and complete most AMPs, it had devoted resources to other important asset management products, listed in Figure 2.

Challenges to plan completion

We found that the Bureau's data inadequacies were one reason it had not yet completed more AMPs. The reliable data needed for AMPs is often not available. Another reason was that team members may be accountable to different managers, and have other full-time responsibilities. Although the cooperative AMP development process has some benefits, it appears to depend primarily on individual motivation and perception of priorities. Other than the Steering Committee's generally reactive process, the Bureau lacks a framework for prioritizing asset management activities that involve more than one major Bureau division.

Data limitations

As discussed in Chapter 3 of this report, management has not yet implemented the comprehensive data management approach it needs for supporting asset management analyses. In our review of AMPs, we found confirmation of the Bureau's data limitations. For example,

a fire hydrant shown as active may not actually exist, and could cause potential delay to firefighters expecting to use it. Valve make and model was not routinely tracked and information about large valves was stored in 12 separate systems. Although identifying asset failure mode is essential for AMP analysis steps, maintenance staff only recently began to collect it and for only a few asset types. In addition, the Bureau does not measure all expenditures for planned and reactive maintenance sufficiently for its own use in determining optimum maintenance over time, and lacks reliable data on the extent of its deferred maintenance.

Early AMPs completed without guidance document

Staff in the Bureau's Asset Management group performed most work on the six AMPs completed, without the benefit of the Bureau's guidance document for preparing AMPs. In addition, the Steering Committee had prioritized the group's work on business cases, risk analysis, and defining service levels over its work on AMPS. The group prepared the 2010 guidance for AMPs based on experience gained during its work on AMPs and other asset management products.

Current team process for revising and completing plans

In 2010, the Steering Committee prioritized AMP completion and participated in developing current work plans for revising and completing priority AMPs, but it may not be directing the process as an essential Bureau activity. According to work plans, each team drafting an AMP includes expertise in different aspects of the specific asset group and in asset management, to incorporate collective organizational knowledge into the AMP and to spread understanding about asset management to the whole team Each team works cooperatively to complete its assigned AMP, and team leads meet monthly to share information as they progress. However, because assigned leads and members of AMP teams have other full-time responsibilities, work on AMPs is not their highest priority. Each member may be accountable to a different Bureau manager, and not necessarily to each other for completing tasks. For this reason it is unclear who is ultimately accountable for completing each AMP. Many different types of delays may occur when the higher priority work of any team

member takes precedence. During completion of this report, the Bureau reported that the leads are accountable for AMP completion, and it "has assigned a tremendous amount of resources to preparation of the AMPs."

Without plans, decisions are reactive and more costly

Without management plans for cost-effective maintenance, repair and replacement, individual asset managers typically make decisions on an informal basis, and more maintenance is performed in a reactive manner. The perception of managers and staff is that the Bureau needs to do more planned maintenance to reduce the amount of reactive work. Without enough planned maintenance performed at the best time, the risk of service interruption is higher and repair and replacement is likely more costly overall. During interviews, Bureau officials identified a concern that the Bureau has fewer resources than it needs for ongoing maintenance because of its funding structure. The Bureau knows that when assets are not maintained as they should be, more time is spent reacting to problems than it would take to prevent the problems through adequate maintenance. Although reactive unplanned maintenance can be the most expensive maintenance and should not take up more than a 20 to 25 percent of total maintenance effort, according to the EPA, the Bureau performs at least 40 percent reactive maintenance on the distribution system, according to a Bureau manager.

Bureau relies on individual subjective decisions

Bureau managers and staff typically make asset maintenance decisions, case-by-case, based on their professional judgment including historical practice and historical best practice, manufacturers' recommendations, and "rules of thumb." While they may use sound judgment given available information, an individual's judgment about maintenance cannot substitute for analysis of long term risk and cost combined with planning. Informal individual decisions also are unlikely to result in the improved distribution of resources under management authority that implementing a complete AMP could achieve. Accepted historical practices may not be the most cost-effective, and not all managers have extensive experience to draw from.

In addition, program managers may not have sufficient budget available to do preventive maintenance or timely planned repair. Managers told us they need higher operating and maintenance budgets to increase planned maintenance to an effective level. This reflects the lack of Bureau planning for adequate resources to accomplish needed maintenance. The Bureau does not create maintenance plans except those prepared for AMPs.

Comparison to peers showed high rate of breakdowns

By 2006 the Bureau had learned from benchmarking that it had a high ratio of breakdown to scheduled maintenance. Comparison with peers also showed that planning and scheduling maintenance could provide the highest potential cost savings for the Bureau. With exceptions in the Operations Group, the Bureau has changed little in maintenance practice for most asset groups, although officials express confidence that it will improve through asset management planning.

Neglected minor maintenance can turn into major maintenance

According to Bureau managers, because the base budget is inadequate to increase the proportion of planned maintenance, a major consideration for them is whether a needed maintenance expenditure meets accounting criteria for spending from the capital budget, and if not, whether their allotted base budget can cover the cost. Since bond proceeds can fund only capital projects, the Bureau must rely on ratepayer collections for the current year to fund its operating and maintenance (base) budget. For example, the expense of lubricating and exercising valves to keep them operating must be funded by the base budget, but replacing a valve in a water main would be an allowable capital expense. Planned maintenance needs compete with many other base budget needs including operational activities and reactive maintenance such as repairing leaks and breakdowns that may quickly use up available funds.

One Bureau official told us that preventive maintenance is expensive from a ratepayer perspective because it must be paid for in the year work is done. However, Bureau managers and staff know that when minor maintenance is not done it may become major – capitalized – maintenance.

Defined capital improvement work given priority

In revenue bonds, the City promises that it will maintain and preserve the water system, "in good repair, working order and condition," and City policy also requires bureaus to maintain assets to protect capital investments and minimize future costs of maintaining and replacing them. However, some Bureau managers told us that in practice, the Bureau gives higher priority to capital work than to planned maintenance. Unlike the Bureau's dedicated funding source and formalized process for capital projects, it has no comparable controlling and monitoring process for other maintenance work. When the Bureau's base budget is inadequate, although maintenance may not be targeted, ultimately it is cut. Without plans that specify maintenance requirements, there is a greater risk that maintenance could be cut to undesirable levels, increasing the need for more costly reactive maintenance and perhaps threatening compliance with bond covenants and City policy.

Drafted plans not systematically implemented

We found that the AMPs drafted were not systematically implemented. Because the role of the Steering Committee is unclear, it is also unclear what authority AMPs represent. Drafts of AMPs are presented to the Committee, but it has no formal approval process. Following Steering Committee consideration of an AMP, the budget program managers responsible for its specific asset group should facilitate implementation. However, according to the Bureau, even maintenance strategies and plans in drafted AMPs are not necessarily implemented, and the budget does not extend to implementing all of the recommendations made in AMPs. In addition, the Bureau does not track implementation of AMP recommendations. The effect is that the Bureau may not be achieving the extent of benefits in cost-effectiveness that it could be.

Bureau officials acknowledged that AMP implementation has been limited and said implementation should improve with the increased involvement of program staff on teams currently working on AMPs, and increased Bureau understanding of the benefits of implementing asset management.

Drafted plans missing accountability and implementation elements

We found that the Bureau's completed AMPs are missing elements that could make them more effective as management tools and easier to implement. It is not clear that the drafted AMPs are intended to be plans for action.

Bureau management considers the AMPs to be "compilation documents" that will be revised as Bureau understanding increases and more information is available. Despite all the information included, we found that AMPs do not clearly show which, if any, of the recommendations and strategies are intended actions to manage the assets more cost-effectively. Without more clarity about management's decisions and who is responsible for implementing its decisions, the AMPs could be viewed merely as reference documents. For example, the AMP for hydrants lists 21 recommendations, and additional recommendations can be found in other chapters. The AMP was presented to the Steering Committee in 2010, so it is not apparent to whom or by whom the recommendations are made, or which ones management adopted for action. Bureau officials explained that Steering Committee decisions about AMP implementation are discussed but not formally documented, consistent with the Bureau's collaborative approach to management.

Chapter 6 **Recommendations**

The Bureau has made progress in developing and using some asset management tools such as business case analyses and Asset Management Plans, and it has documented its commitment to achieving the benefits of using an asset management approach. However, five years after signing its Asset Management Charter, many of management's objectives have not yet been achieved. Improving the Bureau's overall structures for performance accountability and the decision process would address many of the conditions that are impeding asset management. For example, management could clarify to field crews that collecting data is an essential part of field work performance, and hold them accountable for collecting it, so that it can be used to determine lowest cost maintenance. Management's reliance on persuasion and voluntary cooperation to achieve essential work products and results is not effective by itself.

The Bureau can build on the work it has accomplished, overcome barriers described in this report and achieve its stated asset management objectives to manage assets cost-effectively in the long term. To do this, the Bureau needs to make decisions based on evidence to provide service levels agreed upon by representative customers. With its aging assets, potential costly legal mandates, and questions from members of the public about the justification for rate increases, the Bureau must strengthen its asset management capability and use those tools to inform decisions and its customers. Over the long term, this asset management approach will benefit ratepayers.

We recommend that the Commissioner in Charge direct the Portland Water Bureau to implement these recommendations:

To improve the availability and reliability of data necessary to carry out asset management objectives:

1. **Deploy resources, formalize leadership and develop accountability structures to implement a data management approach that meets the Bureau's asset management and other business process needs.**

   Develop and communicate to the whole organization the resulting data management implementation work, including data model, standards for asset-related data, and individual positions responsible for data sets and business workflows. Management should acknowledge the importance of this work by dedicating adequate resources for it, identifying milestones and timeframes for completion and by explicitly directing compliance with the implementation requirements developed.

To gain the benefits of using defined levels of service delivered to customers in determining rates and budgets and as criteria for asset management decisions:

2. **Agree on a consistent definition and use of "service level" in the Bureau, distinguishing between current service levels and higher goals.**

3. **Identify the essential service levels required to describe current results (outcomes) for customers, and make each one meaningful from the perspective of representative customers. Avoid using more service levels than necessary to define essential required and desired services to customers. Link the Bureau's more technical internal service levels and indicators to the service levels that are essential to customers.**

   Review the adequacy and clarity of each service level as a description of service outcome or output. The clarity of essential service levels and indicators used to measure them, together with any additional internal service levels, should be

adequate for use in decision making about water rates and budgets required to provide services.

4. **Obtain confirmation from representative customers that the Bureau's defined essential required service levels are appropriate for use in decision making, including financial decisions.**

5. **Apply service levels as budget criteria, allocating resources to meet service levels while excluding budget items that do not contribute to meeting service levels.**

To improve the planning process and Asset Management Plans:

6. **Document management decisions and direction in Asset Management Plans, using format and language to make the plans action plans supported by resources. Clarify the priority for implementing each planned action described.**

   Include assigned roles and responsibilities for taking action, by position title.

7. **Clarify accountability for preparing Asset Management Plans and provide resources for completing plans.**

   Include position titles.

8. **Consider preparing an overall asset management plan or other means of clarifying management policy and providing guidance for decision making that may not be explicit in the asset-specific AMPs.**

   An overall plan could be a resource for managers in the process of planning or making decisions, with links to asset-specific AMPs.

In support of achieving asset management objectives we also recommend that the Bureau:

9. Explicitly incorporate an accountability framework throughout the Bureau to increase the likelihood of successfully meeting its objectives as intended.

Document the authority and responsibilities of the Asset Management Steering Committee and other positions in the Bureau with responsibility for implementing AMPs.

Chapter 7 Objectives, scope and methodology

We conducted this performance audit to review the Bureau's approach to asset management. Our primary objective was to determine the status of the Bureau's implementation of its 2007 Asset Management Charter in which it listed goals for becoming an advanced asset management organization (Appendix). Secondary objectives were to determine whether the Bureau implemented recommendations made by contracted reviewers and others, to understand the Bureau's decision making process, and to determine the Bureau's results of applying its asset management criteria.

Our scope focused on the Bureau's actions and products related to asset management from 2005, when it began using asset management concepts in business cases, through about June 2011. Our 2004 audit, *Portland's Water Distribution System: Maintenance Program Needs Improvement* (Report # 299) recommended a comprehensive plan for maintenance and data management improvements. This audit expands upon the work of that prior audit in two ways. We included the whole water system in our review, and like the Bureau we enlarged our view of maintenance management to one of asset management.

As part of our analysis we reviewed various industry-specific reports and guidance documents about asset management. These included the *International Infrastructure Management Manual*, published by the Association of Local Government Engineering New Zealand and the Institute of Public Works Engineering of Australia, 2006; *Effective Utility Management* by American Water Works Association (AWWA) and other organizations, 2008; additional AWWA policy; U.S. Environmental Protection Agency (EPA) guidance documents; EPA slides for

Advanced Asset Management Training Workshops; and Government Finance Officers Association *Accounting for Capital Assets*, 2008. We reviewed *Seattle Public Utilities Asset Management Framework*, 2011, and other documents provided by SPU.

We also reviewed literature on performance management including *A Performance Management Framework for State and Local Government: From Measurement and Reporting to Management and Improving* published by the National Performance Management Advisory Commission, 2010; and "Better performance management," published by Public Performance & Management Review, 2011.

Given the context in which the Bureau operates, we reviewed various City and Bureau-specific documents. These included relevant portions of the City Charter and Code; City Financial Planning Policies (FIN-2.03, 2.11, and 2.12); *Citywide Assets Report 2010;* revenue bond documents; collective bargaining agreements, and financial plans and reports. We reviewed the Bureau's employee manual, results of its 2010 employee engagement survey results, verification of Bureau compliance with State and Federal regulations, and its capital project process guidance. We also reviewed the Bureau's work plans and guidance documents specific to its efforts to apply asset management principles, and gained familiarity with the Bureau's various information systems, conducting desk reviews of those systems that were significant to asset management.

Moreover, to better understand Bureau operations, concerns of Bureau managers and staff, and the implementation of asset management and decision-making at the Bureau, we conducted numerous interviews with management and staff across five of the Bureau's six operational groups, concentrating our interviews with Management Team members, those in the Asset Management Group, and others responsible for financial management and data management. Given the importance of field-based activities, we toured facilities and gained an understanding of assets significant to the Portland water system – from Bull Run Dams to treatment and storage facilities and residential customer meters. We spent time with maintenance crews to understand work order processing, completion and data capture into multiple Bureau information systems.

In order to achieve our audit objectives, we reviewed products describing or evaluating the Bureau's asset management efforts, and many Bureau products that resulted from those efforts. This work included analyzing specific consultant reviews, gap analyses and peer reviews referenced in this report. In addition, we reviewed numerous business cases, asset status and condition reports, Asset Management Plans (both in process and drafted), and records of Asset Management Steering Committee meetings. We conducted additional follow-up interviews based on results of our document reviews.

We relied upon management's representations about overall value of the water system and their conclusions from technical or cost-benefit analyses. We reviewed these documents for reasonableness, but our reviews are not intended to provide assurance about the reliability of Bureau documents nor that information provided by management is free from error, or fraud, waste and abuse.

The Office of the City Auditor developed this report independently for the public as well as for City officials. The report is the result of a performance audit, and was not part of the City's annual financial audit on the City's financial statements. Expressions of opinion in the report are not intended to guide prospective investors in securities offered by the City and no decision to invest in such securities should be made without referencing the City's audited CAFRs and official disclosure documents relating to a specific security.

We conducted this performance audit in accordance with generally accepted government auditing standards. Those standards require that we plan and perform the audit to obtain sufficient, appropriate evidence to provide a reasonable basis for our findings and conclusions based on our audit objectives. We believe that the evidence obtained provides a reasonable basis for our findings and conclusions based on our audit objectives.

APPENDIX

Our Asset Management Charter

Our organization is embarking on a journey to better manage our assets. Asset Management is a way to evaluate and discuss choices we make in taking care of the bureau's aging infrastructure. The term may be unfamiliar to us, but the principles of Asset Management really are not, having been practiced to some degree throughout our organization since the water delivery system was first created in the late 1800's. We have always done asset management; now we want to become better at it, as an advanced asset management organization.

The current focus on advanced asset management (AAM) is simply an effort to consistently apply accepted principles of science and economics to better determine when certain groups of assets will be maintained or monitored for condition changes; as well as whether to repair or replace those assets that have failed or will likely fail soon.

According to the International Standard, an advanced asset management organization should do the following:

- **Service Level**: Measure the level of service our assets currently deliver, the level of service our customers expect, and our customers' willingness to pay for that level of service.
- **Physical Condition & Criticality of Assets**: Understand and monitor the condition of assets so we can predict what future action will be necessary, and when. Understand the relative criticality of each asset so our focus is on maintaining or replacing those assets most critical to our business of delivering service.
- **Failure Modes of Assets**: Assess and understand the various ways in which an asset may fail and take steps to reduce the risk of failure by preventing or overcoming those failures.
- **Performance of Assets**: Measure and understand the performance of our assets in order to assess the effectiveness of operations, maintenance and capital improvement programs.
- **Prioritization of Projects Based on Value**: Schedule projects to suit available budgets so those with the greatest ratio of benefit to cost are undertaken first. The prioritization should consider lifecycle cost analysis, the triple bottom line (economic, social and environmental factors), and the impact of the project on risk of asset failure and on level of service.
- **Optimization of Operations and Maintenance Activities**: Minimize costs through an optimal blend of planned and unplanned maintenance activities, and by operating the system cost-effectively.

These are our goals. We need your participation and contributions to make this a success.

Portland Water Bureau Management Team

David Shaff, Administrator

Edward Campbell, Director, Resource Protection and Planning

David Hasson, Director, Finance and Support

Kelly Mulholland, Director, Maintenance and Construction

Mike Stuhr, Director, Engineering

Chris Wanner, Director, Operations

PORTLAND WATER BUREAU
FROM FOREST TO FAUCET

January, 2007

RESPONSE TO THE AUDIT

PORTLAND WATER BUREAU
FROM FOREST TO FAUCET

Randy Leonard, Commissioner
David G. Shaff, Administrator

1120 SW 5th Avenue, Room 600
Portland, Oregon 97204-1926
Information: 503-823-7404
www.portlandonline.com/water

May 30, 2012

TO: Auditor LaVonne Griffin-Valade

FR: Commissioner Randy Leonard

Water Bureau Administrator David Shaff

RE: Audit #405, Further Advances in Asset Management Would Benefit Ratepayers

Thank you for the opportunity to comment on Audit #405, Further Advances in Asset Management Would Benefit Ratepayers. We acknowledge receipt and generally concur with the analysis and recommendations of the audit.

As you note in the audit Summary, **"...the Bureau has been recognized as a leader in asset management."** We are very proud of our asset management program and embrace the principal idea of the report that encourages further advances. We believe that we are on the path of advancement and that we will continue to be recognized as a national leader in asset management practices.

Although we agree generally with the recommendations, we would like to provide the following comments and observations to each of the 9 recommendations:

1. **Deploy resources, formalize leadership and develop accountability structures to implement a data management approach that meets the Bureau's asset management and other business process needs.**

   The bureau has formed a Data Management Committee (DMC) and charged it with coordinating the implementation of Information Technology activities within the bureau. The DMC officially reports to the Asset Management Steering Committee, and the chair of the DMC (Mary Ellen Collentine) is now officially a member of the Asset Management Steering Committee. Mary Ellen Collentine is also the owner of the bureau's Data Management Budget Program. Staff representing the bureau's groups and all data system managers are members of the DMC.The committee has begun meeting.

   There are subcommittees to specifically address asset-related issues, IT system issues, and business workflow issues. The committee has a series of tasks identified, all of which come from our IT Action Plan. Some of the tasks specifically assigned to this committee include developing a data model, conducting a business intelligence needs assessment, and developing and implementing an asset management plan for data. Staff is being assigned to these tasks, and work plans will be developed shortly. The

work plans will include identified project milestones and anticipated time frames. The recommendations contained in the Data Asset Management Plan will be reviewed by the Asset Management Steering Committee and incorporated into the overall Asset Management Implementation Plan.

2. **Agree on a definition and use of "service level" in the Bureau, distinguishing between current service levels and higher goals.**

   The bureau originally used the term "Effectiveness Measure" in 2006 to define budget program goals and objectives. The bureau began its use of the term "Service Level" in its Strategic Plan in 2009, to be consistent with national and international terminology. It took some time for the bureau to transition from the use of "Effectiveness Measure" to "Service Level" in budget programs. As Bureau Administrator, I provided clear direction in October 2010 when I issued the following e-mail:

   > "I would like to get all of our various documents aligned and consistent in terms. Service Level would be used in the Budget Program description where we currently use the term Effectiveness Measure. Service Levels continue to be the goals and objectives we are trying to accomplish in our Strategic Plan and through our various budget programs."

3. **Identify the essential service levels required to describe current results (outcomes) for customers, and make each one meaningful from the perspective of representative customers. Avoid using more service levels than necessary to define essential required and desired services to customers. Link the Bureau's more technical internal service levels and indicators to the service levels that are essential to customers.**

   In regard to this recommendation, we respectfully agree in part and disagree in part.

   The Water Bureau believes it has a good number of "key" service levels (currently 27) that we report to the public. We have more service levels that we call programmatic service levels (there are 39 under consideration in the budget programs). Table 1 shows that leading utilities practicing asset management provide considerable information about performance relative to goals and objectives and related to customers, the community, the water system, and the water utility.

Table 1. Water Utility Reporting on Performance Against Goals and Objectives

Utility	Number of measures reported	Reference Document
Portland Water Bureau	27	FY 10-11 Progress Toward Meeting Key Service Level Indicators
Seattle Public Utilities	54	Tracking Sheet for Strategic Business Plan Service Levels and Performance Measures, May 2011
Tacoma Water	59	2012 Tacoma Water Master Level of Service Definitions
San Francisco Water	84	Strategic Sustainability Performance on Goals and Objectives, Fiscal Year 2010-2011
Watercare (New Zealand)	53	2010 Annual Report
Sydney Water (Australia)	40	2011 Annual Report

The development of programmatic service levels is part of the ongoing improvement efforts to tie workload measures to service levels. Those programmatic service levels are almost all "technical internal service levels."

The Audit report, however, has helped us identify a better way to organize our key service levels and, in response to the recommendation, the bureau has reworded the following 27 service levels in three areas to improve clarity.

- **Essential to customers (10)**: A.1, Achieve 100% compliance with state and federal water quality regulations; A.2, Maintain a minimum service pressure of 20 pounds per square inch; A.3, Maintain a low level of customer complaints on water quality and pressure; B.2, Respond to 95% of customer inquiries or request within 5 business days; B.3, Answer 80% of calls within 60 seconds; B.4, Provide a broad range of convenient payment options; C.1, Maintain no more than 5% of customers out of water for more than 8 hours a year; C.2, Meet a goal of no customer out of water more than 3 times per year; C.3, Complete 90% of service installs within 15 days; E.3, Manage the risk of assets failing

- **Important to our community (6)**: B.1, Achieve a high rating on the Auditor's city-wide survey; F.2, Maintain safety certification; F.4, Ensure that workforce diversity mirrors diversity in the community; G.1, Maintain per capita residential water use at a steady or declining rate; G.3, Reduce the bureau's carbon emissions; G.4, Increase the use of renewable energy sources

- **Key to water system operation (11)**: A.4, Maintain a chlorine residual between 0.5 and 4.0 mg/L total chlorine in 95% of samples; C.4, Ensure that there is a working hydrant within 500 feet of all service connections; C.5, Ensure that more than 90% of flow control valves will operate when needed; D.1, Maintain Aaa

bond rating; D.2, Meet or exceed planned debt service coverage; E.1, Complete projects on schedule; E.2, Achieve continuous improvement in maintenance; E.4, Develop an economic business case for all new Capital Improvement Program (CIP) projects; F.1, Ensure that 50% of employees report they are fully engaged in and enthusiastic about their work; F.3, Fill most promotional vacancies with internal candidates; G.2, Achieve water savings through technical assistance

Note: the codes (e.g., A.1), refer to the service level numbering used in our reports on service level performance, available for viewing in Portland Online.

4. **Obtain confirmation from representative customers that the Bureau's defined essential required service levels are appropriate for use in decision making, including financial decisions.**

The bureau is following the Asset Management Work Plan in the Citywide Asset Report that is issued to City Council annually. In the latest report, Task #7, Community Information & Consultation states "The four participating CAM group bureaus will have had informed community conversations regarding the costs of providing desired levels of service. Primarily, this will take place in bureau budget advisory committees." And "All four bureaus [Water, BES, Parks and Transportation] will continue to consult with public members on their budget advisory committees..." The Water Bureau intends to continue to use its public Budget Advisory Committee members for this purpose.

We will look into the costs and benefits of a variety of means for consulting with our customers about their desired level of service.

5. **Apply service levels as budget criteria, allocating resources to meet service levels while excluding budget items that do not contribute to meeting service levels.**

The bureau has been working on strengthening the relationship between workload measures (the activities we do) and service levels (the goals and objectives that the activities help us accomplish). This can be seen in budget program quarterly reports. We intend to continue to refine this process.

Table 2 taken from last calendar year, is a specific example. There are two parts to this Budget Program Report. In the upper section, service levels are listed that correspond to the budget program – in this case, Customer Service. There are three key service levels and one programmatic service level shown. Our results are given in the Measure of Effectiveness/Results column. In the Subprogram Detail, the workload measures are given and related to the corresponding service level. The Billing subprogram activities support Programmatic Service Level PSL 1 and Key

Service Level B.4 within Customer Service. The Budget Program Report shows how the Water Bureau is allocating resources to meet service levels.

Table 2. Budget Program Report

2nd Quarter, Program Results Report, July - December 2011/2012
Customer Service Program Summary

Service Level	Measure of Effectiveness/Results
Key Service Level (KSL) B.2 Respond to 95% of customer inquiries or requests within 5 days.	**Current Status: Service Level Met** We estimate that more than 99% of customer contacts are addressed within 5 business days based on the following: Customers reach the Bureau through phone calls, e mails and regular mail. If the customer needs can not be addressed in the first day of contact, a service order is issued. Fewer than 2% of the customer contacts require a service order.
KSL B.3 Answer 80% of calls within 60 seconds.	**Current Status: Service Level Not Met** 50% of calls were answered within 60 seconds from 7/11-12/11. 64% within 120 seconds and 84% within 240 seconds. The average hold time was 2 minutes, 45 seconds during the 2nd quarter.
KSL B.4 Transition customers to payment options that cost less.	**Current Status: Service Level Met** Preferred payment options include: AR upload, IVR (not yet installed), Web-Customer and Auto-Pay. The percent of payment transactions for the fiscal year by these methods is 43.6% of all payments.
Customer Service Programmatic Service Level (PSL) 1 Customer bills are processed accurately and on schedule (reading, billing) 99 percent of the time.	**Current Status: Service Level Met** "On schedule" means the bills are processed no later than 2 weeks following the bill date for the account's cycle. The weekly Unbilled report shows less than 70 accounts waiting to bill beyond the 2 week goal, which is approximately .47% of the 15,000 bills produced each week. Outstanding service orders beyond 2 weeks are less than 75 each week, accounting for .5% of accounts billed per week.

Subprogram Detail

Billing	**2nd Quarter FY 2011-12**		
	Revised Budget $ 5,517,284	**YTD Expenditures** $ 2,047,857	
Workload	**Year To Date Results**		**Associated Service Level**
Greater than 99% of bills processed accurately and on schedule.	**Current Status: Workload Target Met** # of accounts on 1/30/12 = 188,096		**PSL 1**
99% of bills and letters are printed on schedule. 99.5% of payments are processed when received.	**Current Status: Workload Target Met** # bills printed: 593,140 # letters printed: 58,746 # payments processed: 219,832;		**PSL 1**
Process Payments (Note: Total monies include amounts processed in Cayenta Utilities, our utility billing system)	**Current Status: Workload Target Met** Payments processed = 493,333 Manual payments: Amt = $121,898,943.20 Electronic payments: Amt = $61,422,274.01 Total value of payments processed = $183,321,217.21 Percent of payment transactions by preferred methods: 43.6% Est. percent of payment dollars by preferred methods: 33.5%		**B.4**

6. **Document management decisions and direction in Asset Management Plans, using format and language to make the plans action plans supported by resources. Clarify the priority for implementing each planned action described.**

The 2010 Asset Management Work Plan made the following recommendation to the Asset Management Steering Committee, which was adopted:

- Completion of all high- or medium-priority Asset Management Plans is to occur by the end of 2012, with completion of all AMPs by 2014.

The 15 AMPs that are nearing completion are those identified in 2010 as high and medium priority. They are on schedule. In each, there are maintenance, repair, and replacement strategies proposed (in Section 7). At the time of the audit, the bureau had not yet documented the next steps in using the results of the Asset Management Plans.

To address the relative priority of the strategy proposals in each AMP, the Asset Management Steering Committee, in mid-May, authorized the creation of a subcommittee to review and assess the strategy recommendations. The subcommittee has the assignment to develop an approach to define criteria, prioritize, and compare and recommend strategies to the full AM Steering Committee. The subcommittee is led by Mike Saling, from Engineering Planning, with representatives from Asset Management (Jeff Leighton), Operations (Crystal Yezman), Maintenance & Construction (Kevin Suell), and Engineering (Stan VandeBergh). In addition, the AMPs have identified high-risk assets and new consequence of failure categories (Section 6), to be evaluated by an existing Risk Committee, led by Jeff Leighton in Asset Management.

7. **Clarify accountability for preparing Asset Management Plans and provide resources for completing plans.**

Since 2010, all AMPs have had two co-leads with responsibility for preparing the AMPs. These co-leads have engaged stakeholder groups to review essential information and strategies. The composition of the resource teams is given in Attachment A.

8. **Consider preparing an overall asset management plan or other means of clarifying management policy and guidance for decision making that may not be explicit in the asset-specific AMPs.**

We will consider developing an overall plan. The key outputs of the AMPs are the strategies and the risk identification. The strategy subcommittee will create a prioritized list of strategies to be used in the bureau's budget process. Implementation outcomes will be reported in quarterly program reports and in the annual Key Service Level report.

There are 10 Sections in the Asset Management Plan. Key information from the sections will inform the bureau's budget process, operations strategies, information

management, and ongoing improvement efforts. Table 3 describes how results from each of the sections will be used by the bureau as part of next steps.

Table 3. Next steps for AMP section content

Section Topic	What will be used	Where it will be used
1. Introduction		
2. Levels of Service	Service Levels and workload measure proposals	In Budget Programs and in the Budget Program reports
3. Asset Inventory and Valuation	Estimates of what we have and the replacement value	In the Water System Status and Condition report
4. Asset Condition and Utilization	Estimates of asset condition	In CMMS or GIS (if not already there); in Water System Status and Condition report
5. Failure Modes and Asset Life	Identification of key failure modes and estimates of asset life	In CMMS (failure mode drop down menus – if not already there); in forecasting model – if not already there
6. Risk	Potential high risk assets; consequence of failure categories	Risk Committee will be meeting and updating risk database with new information
7. Strategies	Strategy recommendations	Strategy sub-committee of AMSC will be prioritizing strategies for budget process
8. Budget Forecasting	Budget estimates	Strategy sub-committee of AMSC will be using budget estimates for prioritized strategies
9. Performance Tracking	Implementation outcomes	Quarterly program reports and in the annual Key Service Level report
10. Improvement Plan and Data Requirements	Next steps to improve AMP and to improve data	Data improvements will be used in Data Management AMP; AMP co-leads will be following up on improvement tasks

9. Explicitly incorporate an accountability framework throughout the Bureau to increase the likelihood of successfully meeting its objectives as intended.

As recommended by the Auditor, the bureau will document the authority and responsibilities of the Asset Management Steering Committee and other AMP team members for implementing AMPs.

Attachment A. Resources Currently Committed to Asset Management Plan Development

Asset Type	Co-Leads and Primary Analysts	Stakeholder Group
Conduits	Jodie Inman (CL), Engineering Planning; Tim Collins (CL), Water Supply Program Manager in Engineering Design; Teri Liberator, Asset Management	Chris Wanner, Director of Operations; Tim Grandle, Watershed and Conduit Supervisor; Bill Vass, Conduits Operating Engineer; Rich Seright, Engineering Design; Steve Schenk, Water Supply Manager
Transmission	Jodie Inman (CL), Eng Planning; Marvin Weber (CL), Supervising Engineer over Tranmission/Mains Program in Eng Design; Vu Mai (CL), Eng Design; Teri Liberator, Asset Management; Martha Taylor, Asset Management	Chris Wanner, Director of Operations; Crystal Yezman, Water Operations and Support Manager; Tim Kading, Supervising Operating Engineer; Charles Smith, Senior Water Maintenance Supervisor; Stu Greenberger, Corrosion Engineer; Peter Nierengarten, Asset Management; Holly Walla, Transmission/Mains Program Manager in Engineering Design
Pump Stations	Peter Nierengarten (CL), Asset Management; Mia Sabanovic (CL), Engineer in Storage and Pump Station Program in Engineering Design; Keith Walker, Storage and Pump Station Program Manager in Engineering Design	Crystal Yezman, Water Operations and Support Manager; Eric Rathbun, Operating Engineer responsible for pump maintenance; Rod Allen, Operational Analysis Supervisor; Marc Crowder, Electrical/Instrumentation Tech Supervisor; Kirk Nibler, Instrumentation and Security System Supervisor; Tim Kading, Supervising Operating Engineer; Devin Sanders, CMMS Planner/Scheduler for Operations
Tanks	Keith Walker (CL), Storage and Pump Station Program Manager in Engineering Design; Eric Brainich (CL), Asset Management; Mike Ross, Engineer in Storage and Pump Station Program in Engineering Design	Chris Wanner, Director of Operations; Crystal Yezman, Water Operations and Support Manager; Tim Kading, Supervising Operating Engineer; Marvin Weber (CL), Supervising Engineer over Storage and Pump Station Program in Engineering Design; Mike Saling, Supervisor of Engineering Planning; Dave Evonuk, Engineering Planning; Jeff Leighton, Asset Management
Bull Run Road System	Scott Bryan (CL), Engineer in Water Supply Program in Eng Design; Eric Brainich (CL), Asset Management; Tim Grandle, Watershed and Conduit Supervisor; Dick Robbins, Watershed Protection Program Manager; Celia Cornett, Watershed Protection GIS Tech; Steve Kucas, Environmental Compliance Program Manager	Steve Schenk, Water Supply Manager; Tim Collins, Water Supply Program Manager in Engineering Design; Mike Saling, Supervisor of Engineering Planning; Jeff Leighton, Asset Management
Groundwater	Pat Easley, Lead, Groundwater Program Manager, and Randy Albright, Environmental Specialist, Engineering Design	Crystal Yezman, Water Operations and Support Manager; Tim Kading, Supervising Operating Engineer; James Garner, Groundwater Operating Engineer; Marc Crowder, Electrical/Instrumentation Tech Supervisor; Jeff Leighton, Asset Management
Wholesale Meter and	Bryan Robinson (CL), Engineer in Design; Vill Villanueva (CL),	Crystal Yezman, Water Operations and Support Manager; Tim Kading, Supervising Operating

Attachment A. Resources Currently Committed to Asset Management Plan Development

Asset Type	Co-Leads and Primary Analysts	Stakeholder Group
Vaults	Distribution System Maintenance Program Manager in Engineering Design	Engineer; Jan Warner, Finance and Support Services, Ron Drath, Small/Large Meters Supervisor; Andrew Heinsch, Water Meter Technician; Deborah Roach, Meter Shop Support Specialist
System Meters	Joe Howe (CL), Engineering Planning; Rod Allen (CL), Operational Analysis Supervisor; Eric Brainich, Asset Management	Crystal Yezman, Water Operations and Support Manager; Tim Kading, Supervising Operating Engineer; Russ Halverson, Senior Water Maintenance Supervisor; Vill Villanueva, Distribution System Maintenance Program Manager in Engineering Design; Kirk Nibler, Instrumentation and Security System Supervisor; Ron Drath, Small/Large Meters Supervisor; Dave Evonuk, Engineering Planning
Fountains	Marie Del Toro (CL), Engineering Planning; Luanne Zoller (CL), Maintenance and Security Program Manager in Engineering Design; John Robson and John Bee, Operating Engineers with current or past responsibility for Fountains	Crystal Yezman, Water Operations and Support Manager; Tim Kading, Supervising Operating Engineer; David Gray, Maintenance and Security Program in Engineering Design; Sarah Santner, Conservation Program Coordinator
Distribution and Distribution-Transport Mains	Dave Evonuk (CL), Engineering Planning; Teri Liberator (CL), Asset Management; Jeff Leighton, Asset Management	Crystal Yezman, Water Operations and Support Manager; Tim Kading, Supervising Operating Engineer; Charles Smith, Senior Water Maintenance Supervisor; Stu Greenberger, Corrosion Engineer; Peter Nierengarten, Asset Management; Holly Walla, Transmission/Mains Program Manager in Engineering Design; Vill Villanueva, Distribution System Maintenance Program Manager in Engineering Design; Jennifer Gardner, Mapping & GIS Supervisor; Rob Paterson, Public Works Supervisor, CMMS
Services	Teri Liberator (CL), Asset Management; Rob Paterson (CL), Public Works Supervisor	Kevin Suell, Senior Water Maintenance Supervisor; Remani Mathew, Financial Analyst, Accounting; Jan Warner, Financial Analyst, Finance; Chris Chambers, Engineer in Transmission/Mains Program in Engineering Design; Marci Rees, Customer Service Supervisor in Billing; Pamela Torres, Revenue Bureau; Mari Moore, Development Services Supervisor; Dave McDonnell and Jim Baker, Water Quality Inspectors; Jim Griner, Maintenance Planner/Scheduler; Jennie Gardner, Mapping & GIS Supervisor
Line Valves	Martha Taylor (CL), Asset Management; Russ Halverson (CL), Senior Water Maintenance Supervisor	Dean Nelson, Public Works Supervisor (Large Valves); Nate Burton, Public Works Supervisor (Small Valves); Holly Walla, Transmission/Mains Program Manager in Engineering Design; Vill Villanueva, Distribution System Maintenance Program Manager in Engineering Design; Jennifer Gardner, Mapping & GIS Supervisor; Rob Paterson, Public Works Supervisor, CMMS
Meters	Eric Brainich (CL), Asset	Kathy Koch, Customer Service Director; Jeff

Attachment A. Resources Currently Committed to Asset Management Plan Development

Asset Type	Co-Leads and Primary Analysts	Stakeholder Group
	Management; Ron Drath (CL), Small/Large Meters Supervisor; Andrew Heinsch and Mark DeVore, Water Meter Technicians; Deborah Roach, Meter Shop Support Specialist; Garrett Moffit, Applications Analyst (BTS)	Leighton, Asset Management; Cecilia Huynh, Finance
Facilities / Buildings	Anna Lyman (CL) Engineering Planning; Ross Turkus (CL), Engineering Design; Luanne Zoller, Maintenance and Security Program Manager in Engineering Design;	Crystal Yezman, Water Operations and Support Manager; Steve Schenk, Water Supply Manager; Tim Kading, Supervising Operating Engineer; Tim Grandle, Watershed and Conduit Supervisor; Tom Carter, Permitting, Engineering Planning; Tom Klutz, Property Acquisition and Service Manager; Rich Rice, Grounds Maintenance Supervisor; David Gray, Maintenance and Security Program in Engineering Design; Craig Sautter, Stores Supervisor; Dick Robbins, Watershed Protection Program Manager; Mike Saling, Supervisor of Engineering Planning; Bill Sinnott and Roger Hediger, Water Bureau Security; Paul Wallman (BIBS); Jeff Leighton, Martha Taylor, Teri Liberator and Eric Brainich, Asset Management
Bull Run Supply (starting in Fall 2012)	Chad Talbot (CL), Engineering Planning; Steve Schenk (CL), Water Supply Manager, Operations	To be determined in the fall
Terminal Storage (starting in Fall 2012)	Jodie Inman (CL), Engineering Planning; Crystal Yezman (CL), Water Operations and Support Manager	To be determined in the fall
Regulator Stations (starting in Fall 2012)	Dave Evonuk (CL), Engineering Planning; Co-lead from Asset Management (TBD)	To be determined in the fall
Data Management (starting in Fall 2012)	Teri Liberator (CL), Asset Management; Bob Goldie (CL), Program and CADD Manager and responsible for IT Strategic Plan	To be determined in the fall

CL = co-lead

Audit Services Division
Office of the City Auditor
1221 SW 4th Avenue, Room 310
Portland, Oregon 97204
503-823-4005
www.portlandoregon.gov/auditor/auditservices

Portland Water Bureau: Further advances in asset management would benefit ratepayers

Report #405, June 2012

Audit Team Members: Beth Woodward, Tenzin Choephel, Kari Guy, Daphne Lundi

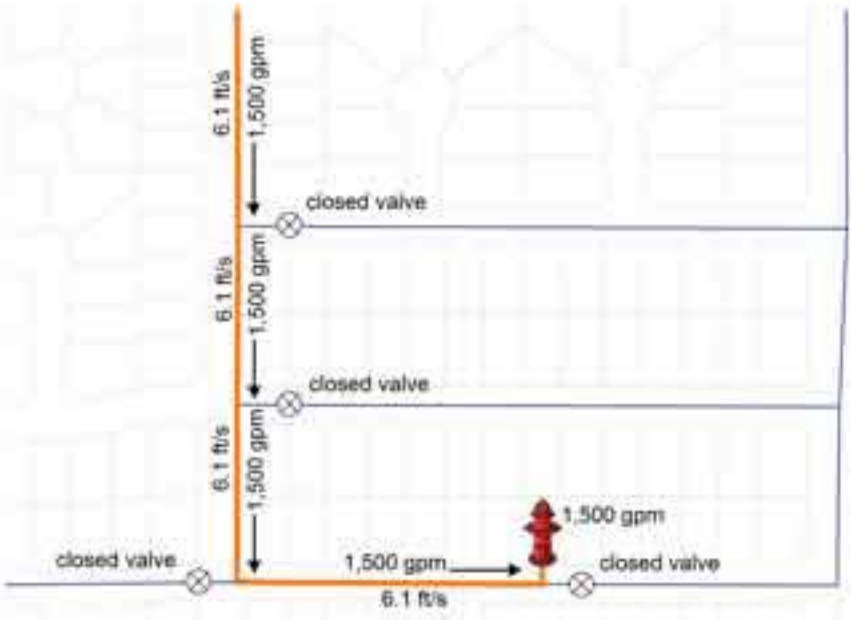
LaVonne Griffin-Valade, City Auditor
Drummond Kahn, Director of Audit Services

Other recent audit reports:

Portland Police Bureau Learning: Improvements needed to strengthen existing processes (#416, May 2012)

Downtown Office Space: City uses most of its owned space, but lease practices need attention (#417, April 2012)

PDC Economic Development Loans: Loan programs improved, but tracking major borrowers limited (#419, March 2012)


6.1 ft/s
1,500 gpm
closed valve
6.1 ft/s
1,500 gpm
closed valve
6.1 ft/s
1,500 gpm
1,500 gpm
closed valve
1,500 gpm
closed valve
6.1 ft/s

AECOM

MARCH 2014

Unidirectional Flushing (UDF)
Green Bay, Wisconsin

Introduction

A UDF plan, as opposed to routine water main flushing, is a process of closing valves and opening hydrants to direct clean water down a single water main, thus creating a velocity that can scour the pipe and remove sediments from the bottom of the pipe. A UDF process can:

- Improve water quality
- Improve carrying capacity of pipes
- Benefit the operation of the water system

A UDF plan identifies the general sequence of pipes to be flushed, the specific sequence of valve operations, and the estimated duration of each flushing sequence.

Why Flush?

- Improves water quality
  - Color
  - Turbidity
  - Taste & Odor
  - Biofilm Growth
  - Chlorine Residual
- Reduces PB & CU exposure
- Corrosion Control
- Improves C-values
- Fewer Customer Complains

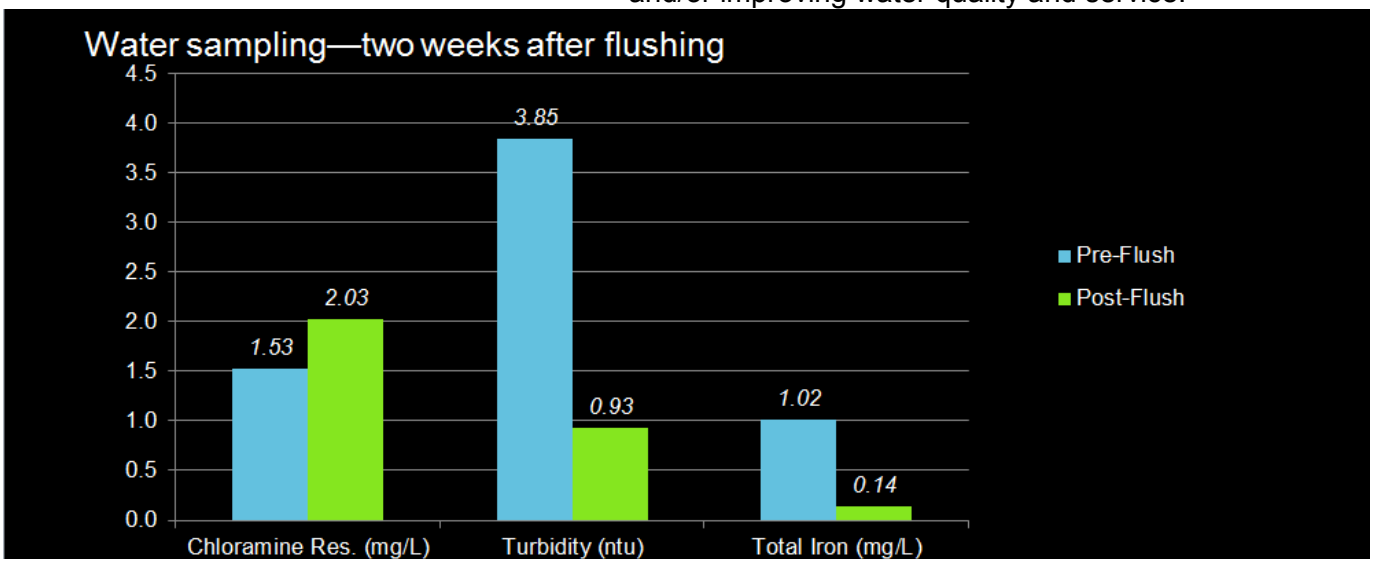
Flushing a Distribution System

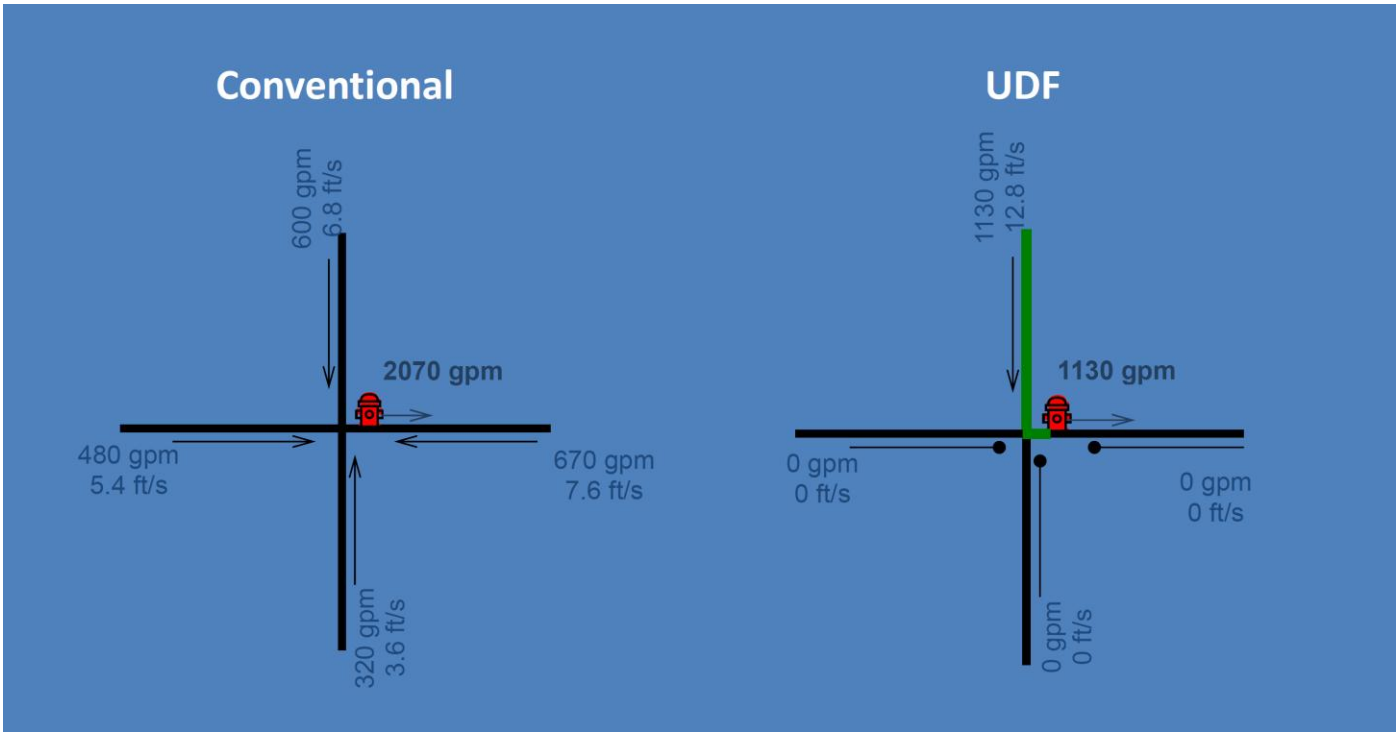
A variety of water quality problems that occur in a distribution system can be, at least partially, addressed by distribution system flushing. For example, the American Water Works Association Research Foundation (AwwaRF) maintained that once taste and odor problems are encountered, the only reasonable action is to bring better quality water into the area by extensive flushing. AwwaRF also noted the importance of records to assist in identifying problem areas, documenting effectiveness of operations, and promoting good customer relations (AwwaRF 1992).

Water main maintenance should include flushing distribution mains for many reasons, including:

- Corrosion control
- Sediment and debris removal
- Taste and odor control
- Colored water
- High turbidity
- Low disinfectant residuals
- Bacteriological growth
- Customer complaints

The general objective of flushing is to assist in preserving and/or improving water quality and service.





Conventional Flushing vs. Unidirectional Flushing

Traditionally, distribution system flushing included opening hydrants without closing valves to isolate specific water mains for flushing. Conventional flushing procedures involve flushing mains in areas where water quality complaints have occurred - a reactionary approach. Conventional flushing procedures can also be system-wide, but no effort is made to assure that clean water is entering the pipe being flushed or that adequate velocities are being reached to scour the pipes. Conventional flushing typically does not result in enough velocity to remove biofilm or to remove all sediment from the pipes. Improvements in distribution system water quality may be marginal and short-lived.

Advantages of a UDF Plan over Conventional Flushing:

- Improved flushing and scouring velocities
- Removes biofilm and sediment
- Flushes with clean water
- Overall cleaner distribution system

Unidirectional flushing consists of isolating particular pipe sections, typically through closing appropriate valves and opening hydrants in an organized, sequential manner. Unlike conventional flushing, unidirectional flushing targets individual pipe segments to maximize flushing effectiveness. By isolating individual pipe segments, it is possible to consistently achieve scouring velocities (generally recommended to be 5 feet per second (fps) or more) that can effectively remove sediments and biofilm which can accumulate in the water distribution system. In addition, a UDF plan is organized such that each target pipe segment is flushed from a “clean” source. Complete unidirectional flushing of a water system ensures that every pipe segment is effectively cleaned.

Steps for Flushing Program