The asset management plans (AMPs) are the Portland Water Bureau’s best efforts to create strategies, recommend actions, and quantify resources, using the available information and resources. The AMP asset information and recommendations will be used to inform future planning efforts at the bureau.

The recommendations and estimates in each AMP and this summary, however, are not intended as substitutes for the formal engineering studies conducted as a part of project planning and design.
Asset Management Planning at the Portland Water Bureau

June 2013

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1. Introduction

The American Water Works Association (AWWA) defines asset management planning as “an integrated set of processes to minimize life cycle costs of infrastructure assets, at an acceptable level of risk, while continuously delivering established levels of service.”\(^1\) Asset management planning incorporates processes from the financial, engineering, and management disciplines to analyze asset performance. Asset performance and benefits are evaluated for their economic, social, and environmental effects. The goal of analyzing assets through these lenses is to obtain a picture of the most cost-effective ways to maintain, repair, or replace assets at a specific level of service.

Asset management plans (AMPs) document information about the City’s almost $7 billion worth of water-system assets—such as pipes, tanks, and pumps—and provide recommendations for operating the asset and/or mitigating the risk of failure in the most cost-effective manner. At the Portland Water Bureau, this process includes recommending strategies for maintaining, renewing, or replacing assets and providing an initial estimate for the needed resources.

1.1. Purpose of this Overview

This overview of the Portland Water Bureau’s asset management program describes the progress of asset management planning to-date and summarizes broad themes that inform and unite the bureau’s 14 currently existing AMPs.\(^2\) These plans describe the bureau’s assets, recommend strategies for maintaining, renewing, and replacing water system infrastructure at the least cost with the best mix of benefits, and provide forecasts for future bureau expenditures to effect the recommendations.

Section 2 describes the development of the asset management program at the bureau. Section 3 is a description of the progress of the asset management program including strategic decisions that have already been implemented. Section 4 is an introduction to the AMP structure. Section 5 summarizes the broad themes that emerge from the AMPs. Section 6 is a list of 15 short-term strategic recommendations selected by the Asset Management Steering Committee. This short list was created specifically as an input into the bureau’s fiscal year 2013–2014 budget cycle and is not intended as a complete set of recommendations. A longer list of recommendations will be selected and shared in conjunction with other asset-management efforts such as reevaluating assigned risk levels and revising asset management plans.

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1.2. Introduction to PWB Assets

The Portland Water Bureau supplies water to approximately 900,000 people in the Portland metropolitan area. Water is supplied from the Bull Run watershed and the Columbia South Shore Well Field through more than 2,275 miles of pipes. The water system replacement value is currently estimated at close to $7 billion. The system includes four main subsystems:

- A **supply system**, which collects surface water from the Bull Run watershed and groundwater from the Columbia South Shore Well Field (CSSWF)
- A **transmission system** of conduits and transmission mains
- A **terminal storage system** of reservoirs, which stores water
- A **distribution system** of mains, service lines, pumps and tanks

The Water Bureau serves water to its retail service area and entities that purchase water on a wholesale basis (Figure 1). The assets used to provide wholesale water are owned and maintained by the City of Portland up to the point of the wholesale customers’ connections. Customers that receive water via the Washington County Supply Line also own a percentage of the capacity of the pipe.

The majority of the water system is out of sight—the Bull Run watershed is 26 miles east of downtown Portland; the well field system and the largest storage tanks are mostly underground; the pipes, valves, and service lines are buried beneath streets and sidewalks. This relative inaccessibility drives a lot of the bureau’s strategic approaches for maintaining, repairing, and replacing buried assets for the following reasons:

- Excavating underground pipes is expensive.
- The underground infrastructure shares space with other utilities’ pipes and conduits.
- Access points to water pipes such as vaults are sometimes made inaccessible by other agencies’ projects (for example, an access vault is inadvertently paved over).

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**Figure 1. Overview of Portland’s Water System**
2. **Asset Management Program**

2.1. **Brief History and Description**

In 2004, the Portland Water Bureau (PWB) established a formal Asset Management Planning group, charged with collecting information about water-system assets and providing recommendations to improve the bureau’s investment in maintenance resources and capital projects. Since 2005, this group has been providing business cases and initial cost estimates, creating and implementing a framework for assessing business risk, drafting a steadily increasing number of asset management plans (AMPs), and providing training and guidance to other bureau staff on the fundamentals of asset management planning.

As part of this effort, the bureau joined the International Water Association/Water Services Association of Australia (IWA-WSAA). IWA-WSAA is the global leader in asset management dedicated to continuous improvement in the water industry. IWA-WSAA has established that three factors are key to fostering asset management improvement within a utility:

- Establishing credible cost and service performance indicators and benchmarks.
- Critically identifying cost-saving opportunities.
- Understanding best practices and how they relate to improving performance.

IWA-WSAA conducts an international benchmarking project to help utilities better measure progress in implementing asset management. PWB participated in benchmarking in 2008 and 2012. Details of the benchmarking findings to-date are part of Section 2.2 of this summary.

Concurrent with early asset management efforts was the development of the bureau’s 2008–2011 strategic plan. The bureau’s first 24 key service levels were adopted as a primary element of the strategic plan. This approach elevated the visibility of the key service levels and helped to integrate them into performance-improvement work throughout the bureau. Since 2008, the list of key service levels has been expanded to 27 and the wording of some measures has been refined. In addition, relationships between the key service levels and related program and subprogram effectiveness measures have been documented in the quarterly program results reports. For a discussion of how service level indicators inform the asset management plans, see Section 3.1 of this document and Sections 2 and 9 of the individual AMPs.

Starting in 2005, PWB’s asset managers worked with bureau staff to create an instrument that measures the business risk exposure of asset failure in social, environmental, and financial terms. This Consequence and Likelihood Evaluation Matrix (CLEM) instrument (Figure 2) was applied to all major bureau assets as a means to evaluate, prioritize, and support decision making about projects. A CLEM committee created definitions and parameters for each consequence and likelihood level. For more information the bureau’s approach to calculating risk, see Section 6 of each AMP or Section 4.5 of this overview.

In 2005, the first draft of the Distribution System Mains AMP was completed. By 2008, three AMPs—on distribution system mains, valves, and hydrants—had been written. The production of these early AMPs helped refine the process for creating the larger body of AMPs. The effort
to gather data for these early AMPs revealed gaps between data sources and in some of the data sets—especially for older infrastructure or annexed service areas. The early AMP analysis efforts pointed to the need for a standardized approach.

Between 2008 and 2010, the asset management group developed a template with extensive guidelines, information on data sources, guidelines for structuring analyses, and examples drawn from other asset management plans. Co-leads with subject matter expertise gathered information, conducted analyses, and drafted sections of the AMPs. A key effort for some assets was gathering information on asset status and condition, which required mining data, extrapolating information from multiple sources, and interviewing expert stakeholders.

In 2009, PWB asset management staff created a guidebook and training for other bureau staff on developing business cases for project plans and incorporating a business case analysis into the bureau’s standard project-planning documents. In addition, staff have conducted nearly 60 business cases on proposals and projects. The results of the business case analyses have helped to direct the bureau’s scarce resources to efforts that provide the greatest benefits at the least cost.

In June 2012, the Office of the City Auditor reviewed PWB’s asset management program in a formal report. The report acknowledged the strides the bureau has made in implementing the program, particularly in considering capital project costs and benefits and in evaluating asset risks. The report also cited three areas considered to have room for improvement: data management, integrating service levels into the budgeting process, and providing an overall plan for managing its assets.

Since the publication of the auditor’s report, the bureau’s asset management effort has continued to mature. Fourteen asset management plans have been completed. A Data Management Asset Management Plan is in development; the bureau continues to refine its use of service levels to measure progress; and the bureau’s Asset Management Steering Committee oversees the implementation of asset management at the bureau.
As of the last quarter of 2012, AMPs for 14 asset groups are complete. Seven additional AMPs—for assets including Bull Run supply infrastructure, data systems, facility valves, large meters, regulators, terminal storage reservoirs, and vaults—are being developed in 2013.

2.2. Benefits of Using the Asset Management Approach

Since 2005, the Asset Management program at PWB has generated many work products and processes. The list of 325 recommended strategies will help provide direction and reference points for asset information for the foreseeable future. Business cases evaluations, risk assessments, and a life-cycle management approach provide frameworks for evaluating the benefits and costs of projects and plans. AMP recommendations for Key Service Levels will provide inputs to the bureau’s strategic planning processes.

2.2.1. Business Cases to Weigh Benefits and Costs

Business cases have been particularly valuable to assess the benefits and costs of replacement for the many assets that are at or approaching the end of their useful lives. As of 2010, all bureau planning studies require a business case analysis. Business cases have helped inform decision making on investments in major assets—information that is much-needed as multiple large projects compete for resources in a highly regulated and economically challenging environment.

As an example, one recent business case, conducted as part of a planning study, showed a low benefit-to-cost ratio for replacing a tank and a much better ratio for relying on pressure in adjacent pressure zones to provide service to the area (Figure 3). The bureau decided not to replace the tank, which has resulted in avoided costs for both the capital investment of the tank (almost $600,000) and the annual costs of maintenance and repair.

Figure 3. The Buddington Tank PCR Business Case Resulted in Nearly $600,000 in Avoided Capital Costs
2.2.2. Risk Analyses

Asset management has implemented a risk-management approach for evaluating assets. This has been an invaluable tool for refining priorities among the many assets that the bureau manages. The bureau’s risk-management matrix has helped the bureau identify assets that pose higher-than-acceptable risks, assets that represent acceptable risks, and projects to mitigate risks.

2.2.3. Life-Cycle Approach to Assets

The life-cycle approach to PWB’s assets has generated a number of benefits. The life-cycle approach considers not only initial capital expenses but also operating expenses for the lives of the assets. Using of a life-cycle approach, the bureau has been able to strategically manage energy use and introduce reliability-centered maintenance techniques for selected assets.

Life-cycle management has also helped bureau managers and operators make better-informed repair and replacement decisions. For example, in the past, meter replacement was based strictly on the age of the meter. Using an asset-management approach, stakeholders developed an algorithm to determine the longest useful life before replacement for meters based on both on meter age and on the consumption measured. This new method is now standard practice for meters.

Under reliability centered maintenance (RCM), an organization establishes a minimum safe level of maintenance, proposes changes to operating procedures and strategies, and establishes capital maintenance regimes and plans. Since 2010, RCM has been implemented at all pump stations. The changes in pump-station management include reducing pump redundancy, prioritizing repairs and maintenance according to the criticality of an asset, and setting up procedures for robust proactive maintenance actions (such as oil analysis) based on asset run time. The lessons learned from the pump-station RCM pilot program will be applied to other asset groups.

2.2.4. Data and Systems Coordination

Bureau Engineering and Operations staff have begun the process of more closely coordinating several key data sources and systems. The Geographical Information Systems (GIS) group has begun to clear the backlog of submitted field drawings of assets, taken from the final plans as the project was constructed (As-Builts). The As-Builts are being entered in order to consolidate sources of system information.

Operations staff have begun building a much greater degree of specificity into the computerized maintenance and management system (CMMS). For example, electronic data entry screens and field work orders in CMMS for pump stations now include selections for operators to enter specific information on condition and failure modes, including suggestions to mitigate the risk of future failure. The bureau’s CMMS system is being populated with drop-down lists of failure modes, lists of proactive and reactive maintenance actions, and asset condition information. Progress on this effort is tracked through quarterly CMMS Audit Reports. Once enough data are gathered, the CMMS will become a powerful tool for understanding causes of failure and the effects of maintenance strategies.
2.2.5. **Recommendations for Key Service Levels**

Some AMPs recommended changes to the key service levels that relate to the assets in the AMP. The recommended changes will be considered by the bureau’s Management Team and, if adopted, will be incorporated into the next version of the Strategic Plan. In addition, some AMPs provide recommended changes to programmatic service levels. Programmatic service levels are specific to one of the bureau’s 22 budget programs, and results are tracked in the quarterly program results reports.

2.3. **Costs Avoided as a Result of Asset Management Practices**

Since 2007, the Portland Water Bureau has been using business case analyses such as benefit-to-cost ratios to evaluate project alternatives and operations strategies and processes. These analyses have resulted in avoided costs for many projects and have provided justification for some projects that reduce the bureau’s business risk exposure. Several large capital replacement projects have been shelved in favor of no action or less-costly alternatives that provide greater financial, social, or environmental benefits. Since 2006, the bureau has used asset management principles to evaluate projects and reallocate an estimated $52 million in expenditures to better serve water customers.

2.3.1. **Tanks and Pump Stations**

Examples include the business case for five large tank projects (with initial capital costs of 2 to 6 million dollars each). In each case, alternatives to replacement were chosen after weighing the benefits and costs. Three tanks—Arlington, Buddington, and Texas—have been abandoned in lieu of replacement. In each case the bureau has been able to meet the pressure and flow service levels without the tanks. The estimated total of avoided costs for replacing those three tanks is more than $6 million. Two more tanks, Bertha and Mayfair, have been scheduled for repairs and refurbishment instead of demolition and replacement—which will extend the life of each tank. The estimated total of avoided costs for repairs and refurbishment instead of replacement of the Bertha and Mayfair tanks equals more than $6 million.

Pump stations assets are similar to tanks in that they require significant capital outlays to replace. Since 2010, PWB has elected to upgrade nearby pump stations (Verde Vista and Portland Heights) in lieu of demolishing and replacing the Burnside and Portland Heights pump stations. The improvements are expected to deliver the same level of service as the original configuration. The estimated total of avoided capital costs is more than $7 million.

For other projects, the business case analyses (which weigh benefits against the costs of implementation) provide estimates of the avoided costs of risks. For an important pump station, such as Fulton, the value of customer outages avoided (a risk) by keeping the current station open while constructing the new one is approximately $5 million.

2.3.2. **Operations and Maintenance**

The Operations and Construction and Maintenance groups have also used business cases to evaluate alternative strategies or processes. For example, Maintenance and Construction crews
had been performing hydrant overhauls on a 20-year cycle. Hydrant manufacturers recommend performing overhauls on a 10-year cycle. The Asset Management team conducted an analysis of the costs of overhauling hydrants and the benefits of avoiding repairs and replacements. The analysis results demonstrated little benefit associated with any periodic program of hydrant overhauls. The bureau eliminated the periodic overhaul program in favor of repair-based hydrant maintenance.

Through the use of business cases—which provide formal and logical economic evaluations of project alternatives costs and benefits—the bureau has avoided millions of dollars of capital costs and provided service-level-based decisions for projects that reduce the Water Bureau’s risk exposure.

3. **International Benchmarking**

A best practice for asset management is to measure and benchmark an organization’s progress in implementing asset management. The purpose of measuring and benchmarking is to improve the asset-management capabilities of the organization. The Australia-based IWA-WSAA—through Aquamark consultants—oversees an international water utility benchmarking effort. Each benchmarking year, approximately 40–50 utilities participate.

The Portland Water Bureau has participated twice in this benchmarking project (in 2008 and 2012). Project participants include water and wastewater utilities in the United States and Canada, the Middle East and Southeast Asia, and Australia and New Zealand. In most benchmarking years, utilities from Australia and New Zealand make up half or more of the participants. This is worth noting because utilities in those countries are the international authorities and best-practice leaders on asset management. The participation of those utilities means that PWB is ranked along with utilities that are noted for best practices in many areas of asset management.

The benchmarking project examines utilities in seven broad areas, made up of several subareas:

1. **Corporate policy and business planning**—which includes an evaluation of the organization’s strategic and financial planning and risk management efforts

2. **Asset capability forward planning**—which includes how well the business incorporates projections of its level of service and demand and its ability to optimize assets

3. **Asset acquisition**—which includes an evaluation of the organization’s planning, design, and procurement processes

4. **Asset operations**—which includes the organization’s development of its strategy as well as work practices, control, and execution

5. **Asset maintenance**—which includes technical knowledge of the asset and execution of the maintenance strategy
6. **Asset replacement and rehabilitation**—which includes how well the organization has assessed the risk of asset failure, identified the end of the economic life of the asset, and developed processes for replacing or rehabilitating assets.

7. **Business support systems**—which includes the data and information systems, the technical services (such as geographic information systems and hydraulic modeling), and organization-wide systems (such as Customer Service) that provide support for managing assets.

Staff and management in each participant organization score their own organization in how well it performs in each of the seven broad areas (Figure 4). Participants rank themselves on measures that contribute to process development and dissemination, including how frequently the process is used, and which documents support the process. A score of 100 percent, for example, would indicate that a process has been completely developed and documented and that the organization follows the process all of the time. Participants provide supporting documentation to independent evaluators that validate the self-assessments. The independent evaluating body is made up of experts in asset management. The published results show the median participant performance, the range of scores, and the participating utility’s performance. Utilities that participate in multiple studies over the years also receive comparisons of current to prior performance.

![Example Function: Corporate Policy and Business Planning](Image)

**Figure 4. Example of Benchmarking Performance Scores In Seven Broad Areas**
Comparison to AM Programs at Other Utilities

3.1. PWB Benchmarking in 2008

In 2008, the independent evaluators found that PWB assessed itself as being in the development phase of asset management development. PWB’s performance in the seven areas fell below the median scores for all utilities, but was strongest in Asset Capability Forward Planning, Asset Acquisition, and Business Support Systems (see Figure 5).³

![Figure 5. PWB 2008 Benchmarking Scores Compared With All Utilities](image)

The independent evaluation nevertheless noted several positive aspects of Portland’s program:

- The commitment of staff and management to the asset management program
- The skill sets of asset management staff and management
- PWB’s improvement plan (measurement and benchmarking)
- The development of advanced risk and prioritization tools
- Economic forecasting of asset life
- PWB’s active participation in water asset management projects at the national level

Areas with room for improvement included Corporate Policy and Business Planning, Asset Operation, and Asset Maintenance. These opportunities for improvement focused primarily on capturing and analyzing operations maintenance data, integrating disparate data streams and sets, integrating processes among asset stakeholders, finalizing the bureau’s strategic plan (later

completed in 2008), and developing asset management-based practices and culture across the organization. At the time of the benchmarking, some of these PWB processes were developed but had not yet been implemented.

As a final step, the Aquamark consultant team helped PWB create an improvement plan and road map for improvement. This road map included using business cases to support decisions related to compliance with regulations, optimizing asset performance with the best mix of resources (both staff and funds), continuing communications with customers about water rates, and continuing to develop its workforce as staff retire.

### 3.2. PWB Benchmarking in 2012

The 2012 benchmarking results show that PWB has been diligent in making improvements (Figure 6). The validated results showed that PWB improved its processes in every area and made marked improvements in four areas: Corporate Policy and Business Planning, Asset Capability and Forward Planning, Asset Operation, and Business Support Systems. PWB’s development of service levels; the creation of an organization-wide strategic plan; its integration of business cases into project planning; and changes to operations processes, CMMS, and customer-service functions have all been major drivers in the bureau’s improvements since 2008.
Comparison to AM Programs at Other Utilities

When compared with the group of all utilities, all of PWB’s 2012 scores are closer to the median than the 2008 scores (see Figure 7). In fact, PWB outperformed the median in some areas. PWB rose above the group median in its work on risk management; making asset decisions based on life-cycle costs and “best value”; implementing work practices for asset operation; optimizing productivity; capturing operational history with the supervisory control and data acquisition (SCADA); and managing consumables, energy, and inventory. The independent evaluators noted that PWB staff often underrated the bureau’s performance in the 2012 self-assessment and that the organization had improved in all areas.

![Figure 7. PWB 2012 Benchmarking Scores Compared with All Utilities](image)

As of 2012, PWB is regarded as having leading practices in three key strategic areas:

- Developing asset management plans that provide recommendations at the strategic and tactical levels
- Using business case tools to justify and validate all decisions to invest in infrastructure
- Advancing asset management practices through early adoption of AMPs, supporting and participating in research, and developing asset management methodologies

As leaders in asset management planning, Portland Water Bureau staff frequently share results, experiences, and best practices with other local, national, and international asset management organizations and continue to develop expertise in optimizing asset performance and life.

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4. **Asset Management Plan Structure**

This section is a brief general guide to the contents of the full asset management plans (AMPs). All of PWB’s AMPs follow the same structure: an introduction followed by sections on levels of service; asset inventory and replacement value; condition and utilization; failure modes; business risk exposure; maintenance, repair, and replacement; budget forecasting, performance tracking; and an improvement plan.

4.1. **Section 1—Introduction**

The introduction provides a clear description of the asset’s purpose and the scope of the asset class (for example, the asset class storage tanks does not include large terminal storage facilities such as the Powell Butte reservoirs and the open reservoirs).

4.2. **Section 2—Levels of Service**

The second section of the AMP links the Key Service Levels articulated in the bureau’s strategic plan to program service levels and subprogram workload targets for each asset. Information on asset performance is drawn from the bureau’s quarterly budget program results reports. Some of the AMPs include recommendations from asset managers and stakeholders for improvements to the specific measurable program service levels, arising from the analyses and information gathered during the development of the AMP.

4.3. **Section 3—Asset Inventory and Valuation**

The third section of the AMP provides a detailed description of the asset and its replacement value. Asset information for this section is drawn from multiple sources, which are listed with their locations. The replacement value of the asset is based on the estimated averages of all costs to plan, design, and construct the asset. Depending on the asset, the costs are based on past construction records adjusted for inflation, industry averages, or combinations of the two.\(^5\)

4.4. **Section 4—Asset Condition and Utilization**

The fourth section of the AMP details the asset condition and utilization. As the majority of the bureau’s assets are underground or in places that are difficult to access, asset condition (and in some cases utilization) must be estimated. Asset condition for some buried assets (such as pipes and valves) may be estimated from the asset age combined with other factors. For many assets, utilization data are provided through the bureau’s supervisory control and data acquisition (SCADA) system. Asset condition\(^6\) is used to establish the likelihood of failure. The likelihood of

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\(^5\) The replacement cost estimates are not based on detailed planning studies and should be used as rough estimates only.

\(^6\) An asset in Very Good condition is nearly new and requires only minimal maintenance; Good condition means the asset requires average levels of preventive maintenance and only minimal corrective maintenance to restore it to nearly new condition; in Fair condition an asset may require significant reactive maintenance or partial refurbishment to restore it to Good condition; in Poor condition the asset is operational but requires significant and timely refurbishment to avoid further deterioration or failure. If maintenance or refurbishment does not occur, the asset may be downgraded to a Very Poor condition, for which replacement is likely required to avoid failure.
failure within each asset class ranks all of the assets within one asset group (pump stations for example) on a five-point scale from (1) those least likely to (5) those most likely to fail. A bureau-wide analysis of likelihood of failure applies likelihood of failure ratings that use a slightly different scale developed independently through a bureau-wide process.

4.5. Section 5—Failure Modes and Asset Life

The fifth section of each AMP is a detailed discussion of the failure modes and expected life for each asset class. The AMPs describe failure modes for critical subcomponents and the asset overall. In many cases, factors that influence failure modes include the asset material, use, and location. The failure modes are discussed in terms of capacity, failure to meet service levels, obsolescence, and physical mortality. For some assets, the trend in physical mortality of PWB’s water system infrastructure is compared to trends for similar assets in the water industry. For other assets such as mains, Asset Management analysts used average known pipe failure rates to make estimates about the expected useful asset life for pipes of similar material and manufacture. These analyses are especially helpful for buried assets—for which little actual condition data are available. The analysis in Section 5 also lists actions that could be taken—such as protective measures, upgrading an asset to current seismic standards, or relocating or strengthening vulnerable assets—to extend the remaining useful asset life.

4.6. Section 6—Business Risk Exposure

The sixth section is an analysis of the level of business risk that the asset poses. The business risk exposure is calculated using the bureau-wide likelihood of failure rating multiplied by the consequences of failure.

\[ \text{Current Risk Cost} \quad \downarrow \quad \text{Triple Bottom Line Costs of the Consequence of Failure} \quad \downarrow \quad \text{Likelihood of Failure} \]

\[ \text{Business Risk Exposure (BRE)} \quad = \quad \text{Consequence of Failure (CoF)} \quad \times \quad \text{X} \quad \text{Related to Condition, Reliability and Redundancy} \]

\[ \text{BRE} = \text{CoF} \quad \times \quad \text{LoF} \]

An asset is considered to reach physical mortality when it no longer performs at a specified level. Assets that break, wear out, or perform inefficiently may all be considered to have reached physical mortality.
The consequences of failure are expressed as costs that take into account the environmental, social, and financial effects—referred to as the triple bottom line—of an asset’s failure to deliver the expected level of service. The consequences of failure may vary depending on the type of customer and the intended use for the water. Assets that deliver water to hospitals may be assigned a greater consequence of failure rating (also known as criticality) than assets that serve water to residential areas only. The business risk exposure of each asset is calculated with regard to other similar assets and then again in comparison to all of the bureau’s water system assets. This bureau-wide risk scale—the Consequence and Likelihood Evaluation Matrix, is discussed in Section 2.1 and illustrated in Figure 2.

In many cases, the asset-level risk rankings are higher than the asset risk rankings at the bureau level. In asset-level rankings the risk of one asset—a large valve for example—might be high compared to other valves. The same large valve may not be rated as highly when compared with assets across the bureau, however. A key pump station or large main may receive a higher rating on the bureau-wide scale because it represents a greater business risk exposure than the risks of large valve failure.

4.7. Section 7—Maintenance, Repair, and Replacement Strategies

The seventh section of the AMP provides a snapshot of the current maintenance, repair, and replacement strategies and proposes new strategies. The new strategies are intended to save resources, reduce risk, and optimize processes. The strategies focus on assets with a high consequence of failure. An introduction describes the current state of condition-assessment activities, the types of preventive and predictive maintenance performed, and the various reactive maintenance activities that have been recorded. The descriptions are organized to align with the newly reorganized computerized maintenance management system (CMMS).

Many of the recommendations focus on strategies to revise, replace, or add to current operations strategies. Other strategies provide information to help the bureau as it makes plans to replace aging infrastructure. These recommended strategies are the heart of the asset management plan. All recommendations enumerate the desired outcomes and benefits of the strategies, and preliminary estimates of the levels of effort required to implement the strategies.

The strategies are as varied as the assets. The Hydrants asset management plan recommends salvaging parts from hydrants that are permanently out of service to repair units that are in service. A Bull Run roads strategy recommends providing a tiered level of repairs to roads based on the criticality of the road. Among the many strategies for pump stations is one (already implemented) that designates the most efficient pump as a lead pump and leaves less-efficient pumps as backup equipment. The AMPs for buried assets such as pipes and valves include suggestions of criteria to rank assets by consequence and recommendations on how to assess condition and reduce the vulnerability of these high-consequence, critical assets.
4.8. Section 8—Budget Forecasting

The eighth section of the AMP is an estimate of the resources necessary to implement the current and proposed maintenance, repair, and replacement activities. The estimates are projections of cost based on the best available knowledge at the time. They are not estimates based on engineering analyses and studies, which would be implemented during a formal planning and design process.

The estimates are provided in labor hours multiplied by direct costs for PWB project staff plus any materials and known capital costs, derived from the bureau’s five-year budget. Some AMPs provide separate cost estimates for work on critical, or high-consequence, projects—especially if the AMP recommends that these projects be considered priorities. Other AMPs estimate future repair and replacement costs beyond the five-year capital improvement plan (CIP) horizon.

Many AMPs provide a long-term projection of bureau expenditures for repair or replacement using the current set of strategies—exclusive of any efficiencies gained through strategic management. This projection extends to the end of the useful asset life. Most plans also provide a budget forecast for the recommended maintenance, repair, and replacement activities. Although a study of the cost savings of implementing strategic recommendations was not part of the scope of the 14 initial AMPs, some AMPs (Distribution Mains, Pump Stations, and Roads) include examples of future avoided costs in the discussion of specific recommendations. Other AMPs identified areas in which business cases could be conducted to weigh the costs and benefits of strategic recommendations.

4.9. Section 9—Performance Tracking

The Water Bureau tracks and reports on service levels, budget program targets, accomplishments and expenditures. The Performance Tracking section of the AMPs describes the bureau’s approach to performance tracking, including the responsible staff, the measurements or targets, and the sources of the performance data. Most AMPs recommend concentrating data and data-tracking functions in CMMS. Final subsections recommend additional failure modes or risk evaluations that should be tracked for the asset.

4.10. Section 10—Improvement Plan and Data Requirements

The last section of each AMP provides a road map for improving the asset management effort overall. Recommendations for changes to services levels, approaches to condition assessment, analysis of failure modes, evaluations of risk, maintenance, repair, or replacement strategies are listed here. This section provides a gap analysis of data that should be collected or data that should be centralized or normalized to be useful for analysis.
5. **Summary of Major AMP Recommendations**

The 14 asset management plans generated a list of 325 recommended strategies that cover preventive and reactive maintenance, repair, and replacement practices. A few key themes emerge from the long list of recommended strategies. The strategies encompass all aspects of asset information, operations and maintenance, replacement, and decision-making to create opportunities for savings and efficiencies. The strategies fall into five general areas of practice:

- Improving the sources and accessibility of asset data to conduct analyses
- Improving condition assessment to strengthen the bureau’s ability to create appropriate maintenance schedules and make informed repair or replacement decisions.
- Continuing to identify critical assets and predating actions on asset criticality to help focus the use of constrained operating and capital funds
- Implementing strategic maintenance, repair, and renewal frameworks—such as the principles of reliability centered maintenance and examining existing projects for opportunities to avoid expenditures
- Providing support for decision-making through business case analyses such as benefit/cost ratios and risk-cost analyses

5.1. **Strategies for Data Sources and Accessibility**

Many of the bureau’s assets have data sources that are not centralized, contain incomplete information, or are not tied to other key systems such as the cartographic GIS system or the work-order system. For buried assets such as pipes and valves, condition data are difficult to obtain because inspection is difficult, impractical, or impossible.

The AMPs contain recommendations for improving data sources, such as creating electronic asset registers for information currently on paper and electronic records and inspection reports.

Several AMPs include recommendations for using proxy data to estimate condition and, therefore, likelihood of failure. The AMPs for the distribution and transmission mains recommend tracking installation dates, leak rates, soil types, customer complaints, and terrain features such as slope, stream, and major road crossings as proxy factors in the estimates of likelihood and consequences of failure estimates.

The Distribution Mains AMP also recommends reevaluating the scoring system in the Rank database that determines the timing and location of pipe replacement. The goal of the reevaluation would be to create a replacement schedule with more precise benefit/cost variables. Similarly, the Transmission Mains AMP recommends developing and using criteria to prioritize CIP projects. Both AMPs recommended that the condition and environmental data gained from maintaining or replacing leaking pipes be entered into the work-order system to build failure histories.
Major recommendations for improving data for other assets include completing data-gathering for air valves, facilities, fountains, groundwater system components, hydrants, roads, services, tanks, and large valves.

5.2. **Strategies for Condition Assessment**

Many of the AMPs acknowledge that condition assessment is a key element in understanding overall asset risk. Most of the assets in PWB’s system are buried, inaccessible, or accessible only through vaults that, themselves, may be difficult to access. These difficulties with accessibility are some of the barriers to obtaining a complete, accurate, and robust set of data on asset attributes and condition.

The AMPs for buried assets—the conduits and transmission and distribution mains as well as valves, services, and to some extent hydrants and vaults—include strategies for assessing condition and identifying critical assets. The Facilities AMP recommends creating protocols to assess facility condition, especially testing high-consequence facilities for the presence of lead paint, asbestos, radon, for plumbing issues, or for compliance with the regulations of the Americans with Disabilities Act.

The recommendations for improving bureau knowledge of buried asset condition include the following:

- Collecting condition data and data from soil samples near mains when they are excavated
- Improving data collection protocols for outages and customer complaints and using the data to estimate distribution system leak rates and likelihood of failure
- Analyzing service level failure patterns to estimate end of useful life
- Considering the costs and benefits of leasing or buying equipment for internal pipe inspection

All AMPs acknowledge the benefits of assessing and analyzing asset condition data, which include more effective scheduling of preventive maintenance and better predictions for the end of asset life. Critical assets are those that would benefit the most from specific actions to assess condition and to strengthen or harden the assets against failure.

5.3. **Strategies for Critical Assets**

All of the AMPs focus on the need to identify and strengthen or safeguard assets that show high consequences of failure—designated as critical assets. Critical assets with high consequences are those for which failure would cause larger or more far-reaching financial, environmental, or social problems than noncritical assets. Financial consequences might include requiring more bureau resources (labor and equipment) to resolve an issue, environmental consequences might include jeopardizing habitat with high water flows, and social problems might include interrupting the provision of health care.
Assets may be defined as critical for any of the following reasons:
- The equipment is essential to providing water
- The bureau has limited redundant (backup) equipment
- The equipment serves a large group of customers
- Failure of the equipment might have consequences in more than one of the triple bottom line areas

For example, the three large conduits from the watershed are essential infrastructure. Although the conduits have some built-in redundancies where water can flow between conduits, the failure of one conduit may reduce overall supply capacity. The Conduits AMP; therefore, suggests a program of systematic condition assessments to anticipate and prevent failures of these critical assets and their related appurtenances. The Services AMP ties criticality to certain customer functions and suggests strategies to both anticipate failures and mitigate time out of service should a failure occur. The Wholesale Meters AMP suggests a strategy to use the criticality ranking to prioritize CIP projects and install bypass piping to allow continuous water supply during meter maintenance.

The failure of critical assets may also trigger multiple consequences. For example a large main that crosses an interstate highway and a rail easement on a bridge under a busy street that causes vibration in the pipe is designated as critical (Figure 8). If the main were to fail, the repercussions would include not only the financial cost of repairing the main and landscape, but also potentially the social costs of disrupted traffic and trade. The bureau’s goal is to address these critical assets before failure can occur.

The Conduits and the Distribution Mains AMPs recommends a systematic effort to identify the pipes segments in known risk areas—such as those that cross streams, major and high-traffic roads, and slopes—and follow-up actions—such as casing uncased pipes, providing better joint support and cathodic protection—to reduce the likelihood of failure. The AMP suggests a strategy to give critical pipe segments consideration and ranking for maintenance and replacement and, in some cases, serious consideration for hardening or reducing the vulnerability.

Several of the strategies are proactive methods for gathering condition data for critical assets. The Valves AMP, for example, proposes a proactive condition assessment program for isolation valves on critical pipes.
Where possible, a critical-asset maintenance approach is also suggested to realize savings on time, labor, and energy. For example the pump station AMP focuses on critical pumps and related assets, such as generators. The plan includes a proposal to designate the most efficient pump as the lead pump and recommends a maintenance schedule based on this criticality. The lead pump and its related equipment would receive the most frequent preventive maintenance checks; the backup (non-lead) pumps and equipment would receive less frequent maintenance checks and operate only if needed or to maintain proper working conditions. The Pump Station AMP also suggests follow-up analyses, comparing breakdowns with maintenance actions taken in order to learn more about the effects of implementing this strategy.

5.4. Strategies for Maintenance, Repair, and Replacement

5.4.1. Applying RCM Principles

A few of the asset management plans suggest using reliability centered maintenance (RCM) principles to rethink some maintenance, repair, and replacement strategies. The emphasis of RCM is providing the most cost-effective mix of maintenance and replacement strategies given the resources and organizational goals (represented by the service levels). One component of RCM is tracking proactive maintenance activities to determine the best maintenance strategies given the levels of tolerable risk. Generally, RCM includes the following best practices:

- Employ multiple predictive maintenance technologies to gain a holistic understanding of the asset
- Use routine, high-level inspections to find problems that trigger detailed inspections
- Target the most common failure modes with condition assessments and preventive maintenance

Water Bureau staff have applied many of the RCM best practices at pump stations, including implementing the following:

- Designating the most efficient pump in a pump station as the lead pump to be operated the majority of the time
- Assessing the acceptable level of risk for each pump station by quantifying the number of customers affected, the potential duration, and likelihood of a failure
- Targeting critical subassets for detailed and regular testing and parts replacement
- Providing predictive and reactive maintenance based on criticality

Evaluating lifecycle costs is another recommendation for maximizing bureau investments. Asset components that are closer to the ends of their useful lives (such as motors that are at least 30 years old), are nearing obsolescence (such as certain types of hydrants, meters, groundwater pumping station and fountain components), or are failing for another reason might be better replaced with more efficient components. A number of the AMPs suggest conducting business cases to assess these lifecycle costs and benefits. The AMPs for both the distribution system and the Groundwater Pump Station include suggestions for managing life cycle costs for the life of
the asset. The Pump Station AMP proposes eliminating redundancy in some of the pump stations and designating the most efficient pumps as the lead pumps. Although running a lead pump will reduce its expected useful life by an estimated 10 years, analysis of the avoided electrical costs and charges weighed against the earlier replacement show a positive benefit/cost ratio for making the changes (Figure 9).

**Figure 9. Increases in Pump Station Efficiency Result in Avoided Costs**

In 2009 and 2010, operational changes at four pump stations contributed to reduction of electricity consumption by approximately 1,000,000 kilowatt hours (kWh). This resulted in an estimated $79,000 in avoided costs for 2011. In 2011 these pump stations operated 14 percent more efficiently than they had during the 2005-2008 baseline period.

In response to AMP recommendations to use RCM, the bureau has begun capturing failure modes for corrective maintenance work at the pump stations. In time, the failure mode data will help the bureau track and identify differences in the consequences of failure for each pump station, adjust the inspection frequency to an appropriate level, and identify the root causes of predictive and reactive maintenance.
Another strategic recommendation for pump stations is to evaluate the costs and benefits of maintaining motors older than 30 years. The options for these older motors would be to run them to failure or replace them with high-efficiency motors. This strategy acknowledges that, at some point, the cost of maintaining inefficient motors will outstrip the cost of investing in newer, more efficient units. Future analyses of maintenance and failure data could help the bureau better identify the point where the possibility of failure is outside the level of tolerable risk.

The RCM principles adopted at pump stations can also be applied to other assets. The Groundwater Pump Station and the Fountains AMPs include strategies to use RCM principles to guide maintenance and replacement actions for motors and pumps.

Other AMPs suggest strategies to address recurring failure modes. The Hydrants AMP, for example, recommends installing bollards in lieu of relocation to protect hydrants with high risks of vehicle collisions.

### 5.4.2. Leveraging Opportunities and Resources

Another strong theme that emerges from the AMPs is innovation that takes advantage of opportunities and resources. Some recommendations include strategically managing high-cost items by combining similar, redundant, or proximal projects. Other suggestions include reexamining interagency agreements— one of the biggest catalysts for pipe replacement—to consider changes in the policy for pipes in good to excellent condition that must be replaced for a street-renewal or transportation project.

Stockpiling and/or reusing spare parts is another strategy that would make the most of bureau investments and shorten the time from failure to repair or replacement. The Conduits AMP suggests evaluating establishing a stockpile of spare parts to facilitate repairs; the Hydrants AMP suggests reusing spare parts from nonworking hydrants and tracking the costs and benefits over time.

The Hydrants and Services AMPs suggest coordinating needed noncritical replacements with the list of upcoming bureau CIP projects in order to realize economies of scale on excavation costs. The Tanks AMP suggests taking advantage of opportunities to perform work during other projects, for example, recoating steel and repairing concrete tank interiors during the comprehensive inspection every five years instead of scheduling a separate shutdown for those activities.

The bureau’s roads in the Bull Run watershed provide critical access to important water-supply infrastructure (Figure 10). Each road also represents a significant initial investment. (The American Road & Transportation Builders Association estimates a new two-lane rural road costs at between $2 and $3 million per mile). The Roads
AMP includes an analysis of road segments by criticality and suggests a tiered schedule of maintenance, repair, and renewal actions that provides the most cost-effective use. The proposal leverages the bureau’s initial investment and suggests maintenance interventions (tied to the criticality of the road) to extend the design life of a road. The AMP demonstrates that investing $70–80 thousand in maintenance and repair of a 3.5-mile-long segment can avoid $700 thousand to resurface the same 3.5-mile segment after it has failed.

5.5. Strategies to Prepare for the End of Asset Life

As assets near the end of physical or useful life, they become less efficient and require more maintenance. Sometimes the cost of continuing to maintain an inefficient asset can be greater than or equal to the benefit that the asset delivers. Several AMP strategies were suggested to help the bureau prepare for decisions that must be made as the asset reaches the end of its useful life. The major strategies include determining the ideal rate of replacement for distribution-system mains—which may include rethinking criteria for replacement—and continuing to evaluate the options for renewal or replacement of many capital-intensive system assets, such as tanks, fountains, and facilities.

5.5.1. Sustainable Replacement for Noncritical Pipes

The majority of system pipes, approximately 90 percent, are noncritical mains. Ideally, noncritical mains should be replaced at a rate that is equal to or just ahead of the rate at which they fail. The cast iron and ductile iron pipes in the distribution system that are nearing the end of their useful lives have a fairly steady rate of failure. The AMP recommends maintaining a relatively stable rate of noncritical pipe replacement based on the useful life expectations (Figure 11). Implementing this

Figure 11. Forecasted Distribution Main Replacement in Miles of Pipe Per Year

*1 mile of pipe = approximately $1 million in 2012 dollars*
strategy would maintain knowledgeable staff and smooth the budget and work flow for future pipe replacement. The recommended strategy proposes using a target leak or break rate to desired service level. The target leak rate (of approximately 2-3 leaks/breaks per mile per year) would allow the bureau to replace pipes closer to the end of their useful life than is possible under the current replacement schedule.

The AMP also includes a forecast of replacement expenditures based on the actual pattern of installation over time. The miles of pipe that need to be replaced each year will increase significantly in later years as more and more pipe segments reach the end of their useful lives. The AMP suggests rehabilitating pipes as they approach the end of their lives but before they require total replacement. Similar to adopting a criterion for sustainable replacement, the pipe rehabilitation strategy would help level funding requirements—and therefore requirements for rate increases—over time.

### 5.5.2. Renewal and Replacement Decisions Based on Business Cases

Many of the AMPs recommend business cases to help determine how best—or whether—to replace an asset. Many of the business case-based requests suggest using parameters such as maintenance costs and efficiency ratings to determine when the costs of operating an asset outweigh the benefits that the asset delivers. The Facilities AMP, for example, recommends performing a business case analysis prior to approving any replacement or renewal work estimated at $25,000 or more.

### 5.6. Information to Support Decision Making

#### 5.6.1. Integrating Asset Information into Tactical Decisions

The bureau can use asset information and data to inform decisions about policies and planning for assets, making improvements, and developing priorities. The Hydrants AMP suggests a geospatial analysis of isolated hydrants as an input into replacement decisions. The Wholesale Meters AMP also recommends the development of criteria to inform decision-making about capital investments.

Several recommendations have bureau policy implications. The Transmission Mains AMP suggests an evaluation of a change to operate noncritical parts of the system on a “run-to-failure” basis. The Pump Station AMP proposes a similar change for noncritical motors within certain parameters. The Distribution Mains AMP proposes a change in main replacement criteria to more accurately reflect current conditions and the operating constraints that the bureau faces.

#### 5.6.2. Using Business Cases to Evaluate Strategies

The 14 existing asset management plans call for 30 different business case studies on various proposed strategies. The bureau is using business cases to evaluate some of the recommendations and strategies in the AMPs. Recommendations that provide sufficient
benefits will be implemented as funding and circumstances permit. The business case analyses provide cost-based evaluations and justifications for improvement alternatives and plans.

The Pump Stations AMP, for example, recommends evaluating the benefits and costs of adding variable frequency drives to some motors. The Services AMP calls for an evaluation of the costs and benefits of casing critical services in high-traffic streets. The Conduits and Distribution Mains AMPs recommend evaluating the benefits and costs of adding or filling in gaps in the cathodic protection systems. The Wholesale Meters AMP recommends evaluating installing automated meter-reading equipment to reduce expenses for accurately determining customers’ usage. As of early 2013, Asset Management staff are prioritizing and assigning lead authors for the recommended business cases.


The list of 325 recommended strategies generated by the AMP authors required further sorting and prioritization. To this end, the Asset Management Steering Committee designated a Recommended Strategies Subcommittee. The subcommittee’s first charge was to make an initial short list of strategies to consider from the following asset management plans: Conduits, Distribution Mains, Facilities, Fountains, Groundwater System, Hydrants, Pump Stations, Roads, Services, System Meters, Tanks, Transmission Mains, Valves, and Wholesale Meters.

Members of the subcommittee included Director of Operations Chris Wanner, Planning Principal Engineer Stan VandeBergh, Asset Management Senior Engineer Jeff Leighton, Project Planning Supervising Engineer Mike Saling, and Senior Water Maintenance Supervisor Kevin Suell, supported by Technical Writer Jessica Letteney.

All subcommittee members reviewed the AMP recommendations. Each member made a short list of recommendations and identified the arguments for and against implementing a particular strategy. The group weighed the relative merits of the short-listed strategies, identified areas of overlap, and considered any outlying strategies that fit the criteria, had merit, or could be made part of a coordinated plan. The group selected 15 strategies to consider for initiation or implementation beginning in fiscal year 2013-2014 (which begins July 1, 2013).

The 15 strategies have been presented to the Asset Management Steering Committee for consideration as part of the fiscal year 2013-2014 budget. In September 2012, the steering committee approved next steps for all of the 15 strategies. Project leaders and stakeholder groups have been designated. Many of the strategies (listed in Table 1) require scoping and a business case analysis to more fully determine costs and benefits. In some cases—such as the strategy to reconfigure criteria for road maintenance in the Bull Run—funding has been proposed in a draft budget that was submitted for consideration in late 2012. Project scopes and schedules are the anticipated outputs of this phase of study.
<table>
<thead>
<tr>
<th>Asset Name</th>
<th>Strategy Number from AMP</th>
<th>Strategy Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Conduits</td>
<td>2.13</td>
<td>Establish official process and procedures for collecting data on pipe condition whenever a conduit is exposed as part of other work. Gather and centralize conduit condition data. (This includes conduits strategy 2.2, Develop better system for tracking leaks and repairs. Get old data out of SRS basement into electronic form.)</td>
</tr>
<tr>
<td>1. Conduits</td>
<td>1.1</td>
<td>Conduct an internal inspection to verify condition of main and lining of high-risk conduits. Consider relining.</td>
</tr>
<tr>
<td>2. Distribution and Distribution-Transport Mains</td>
<td>4.10</td>
<td>Implement a sustainable replacement rate for pipes. Establish budget around useful life expectations for the piping system rather than replacement rate in the past. Include business cases. (This includes distribution and distribution-transport mains strategy 4.3, Business case framework for pipe replacement—alter the Rank database to be more effective in prioritizing pipe replacements.)</td>
</tr>
<tr>
<td>2. Distribution and Distribution-Transport Mains</td>
<td>3.1</td>
<td>Locate, exercise, and add/replace critical valves when needed. Begin with highest-risk pipes, especially those with prior leaks and breaks. Enter as corrective maintenance tasks in the computerized maintenance management system (CMMS).</td>
</tr>
<tr>
<td>4. Fountains</td>
<td>4.3</td>
<td>Calculate likelihood and consequences of failure if a member of the public were to slip and fall at Keller and Lovejoy fountains.</td>
</tr>
<tr>
<td>6. Hydrants</td>
<td>4.2</td>
<td>Renew obsolete hydrants (screw-type) models beginning by focusing on units that are also critical.</td>
</tr>
</tbody>
</table>
### Table 1. Strategies Selected by the Recommended Strategies Subcommittee of the Asset Management Steering Committee

<table>
<thead>
<tr>
<th>Asset Name</th>
<th>Strategy Number from AMP</th>
<th>Strategy Description</th>
</tr>
</thead>
</table>
| 7. Pump Stations    | 2.4                      | Reduce maintenance on redundant assets, according to the following criteria:  
- Base pump oil analysis on run time: Every 2 years for non-lead pumps and every year for lead pumps  
- Reduce motor starter preventive maintenance to once every two years for non-lead pumps  
   Note: consider checking oil condition based on pump run time.  
   (This works with pump station strategy 2.6, below.) |
| 7. Pump Stations    | 2.6                      | Perform preventive maintenance on critical subcomponents such as generator fuel and batteries including the following:  
- Replace batteries every 3 years (possibly more often)  
- Have technicians present for generator startup test  
- Test fuel every quarter for contaminants  
- Add pressure vacuum vent on outside fuel tanks  
   (This works with pump station strategy 2.4, above.) |
| 7. Pump Stations    | 5.5                      | Optimize reliability centered maintenance efforts by continuing to evaluate metrics and areas of focus                                                                                                              |
| 8. Roads/Culverts   | 1.3                      | Perform condition assessment by inspecting high-risk culverts on an annual cycle. Include culverts 36" or larger.                                                                                            |
| 8. Roads            | 2.1                      | Perform crack sealing, chip-sealing, and thin overlays based on pavement condition index (PCI) rating with frequencies that vary by road category. The break points for different actions vary by the consequence of failure for each road.  
   Actual maintenance will be determined by roads engineer and Sandy River Station manager. |
Table 1. Strategies Selected by the Recommended Strategies Subcommittee of the Asset Management Steering Committee

<table>
<thead>
<tr>
<th>Asset Name</th>
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</tr>
</thead>
<tbody>
<tr>
<td>11. Tanks</td>
<td>4.1</td>
<td>Conduct more in-depth analysis for seismic upgrades for tanks and standpipes.</td>
</tr>
<tr>
<td>12. Transmission Mains (and Distribution Mains)</td>
<td>1.6</td>
<td>Identify locations where valves are needed to isolate high-risk pipes and enter as a corrective maintenance task in CMMS.</td>
</tr>
<tr>
<td>12. Transmission Mains</td>
<td>1.3</td>
<td>Perform leak detection for high-risk mains (at uncased crossings).</td>
</tr>
<tr>
<td>12. Transmission Mains</td>
<td>1.8</td>
<td>Identify locations where air valves may need to be upsized to prevent pipe collapse if pipes rupture.</td>
</tr>
</tbody>
</table>
7. **Next Steps for PWB Asset Management**

The bureau’s AMPs provide robust data and information to shape strategies and approaches to water system assets. The AMPs are iterative documents, providing asset information that is relevant for a specific time period. Each AMP will need to be updated as the water system and circumstances evolve.

As of early 2013, seven additional AMPs are being drafted for the following assets: Bull Run Supply, Data Management, Facility Valves, Large Meters, Regulators, Terminal Reservoirs, and Vaults. These plans are anticipated to be completed by the end of the year.

A five-year Asset Management Work Plan is being developed for approval by the Asset Management Steering Committee. The work plan will incorporate committee recommendations, recommendations from benchmarking reports, selected strategic recommendations from AMPs, and lessons learned from information-sharing with leading utilities through professional contacts.

More broadly, the bureau’s Engineering Management Team is using some of the AMP key findings to help inform capital-investment and operations strategies. Projects identified through the AMPs are being considered for inclusion in the CIP budget. Explorations of efforts such as providing better connections between GIS and CMMS are underway. Cross-functional management groups are discussing how to obtain real-time condition assessment data when opportunities arise. In short, the AMPs will continue to provide guidance for managing water-system assets. Future progress with the bureau’s asset management program will be documented in updates to this overview.