

FINAL

INNOVATION AND EFFICIENCY STUDY

of the Phoenix Water Services Department

B&V PROJECT NO.173843

PREPARED FOR

City of Phoenix, AZ

27 FEBRUARY 2012

Table of Contents

LIST OF ACRONYMS..... v

Executive Summary 1

 Areas of Excellence 1

 Areas of Potential Improvement, Efficiency Gains, and Potential Cost Savings 2

 Recommendations..... 6

 Department Actions to Date..... 11

1. Introduction 15

 1.1. SCOPE and Purpose..... 15

 1.2. Methodology 16

 1.3. Tools and Techniques 16

 1.3.1. Effective Utility Management (EUM)..... 16

 1.3.2. Interviews with Managers and Employees..... 17

 1.3.3. Benchmarking as a Tool to Support the Analysis..... 17

 1.4. Disclaimer 18

2. Current Operating Conditions..... 19

 2.1 Facility Visits..... 19

 2.2 Review of Water and Wastewater Operations 19

 2.2.2 Overview of the Current Process – Wastewater Treatment and Collections 21

 2.3. Staffing Levels and Performance Measures..... 22

 2.3.1. Field Interviews 22

 2.3.2. Performance Measures 23

 2.3.3. Findings 24

 2.3.4. Recommendations..... 26

3. Water Resources..... 32

 3.1. Purpose 32

 3.2. Findings 32

 3.3. Recommendations..... 34

 3.3.1. Efficiency Recommendations 34

4. Water System Opportunities..... 35

 4.1. Purpose 35

 4.2. Water System General 35

 4.3. Findings 35

 4.3.1 Energy Management Task Force 35

4.3.2	Distribution System Energy Efficiency, Use Reduction and Costs	36
4.3.3	Stage 2 Disinfectants and Disinfection Byproducts Rule Requirements.....	37
4.3.4.	Water Treatment Plant	38
4.4.	Recommendations.....	41
4.4.1	Efficiency Recommendations	41
4.4.2	Innovation Recommendations.....	44
4.4.2.4.	Evaluate Implementing System-Wide Distribution System Operations Optimization Software.....	47
4.4.3	Cost Savings Recommendations.....	49
5.	Wastewater System	52
5.1	Purpose.....	52
5.2	Findings	52
5.2.1	Wastewater Collection System	52
5.2.2	Wastewater Treatment Facilities.....	53
5.3	Recommendations.....	55
5.3.1	Efficiency Recommendations	55
5.3.2	Innovation Recommendations.....	56
5.3.3	Cost Savings	58
6.	Organizational Structure	60
6.1.	Principles of Organizational Structure	60
6.1.1.	The Functional Structure.....	60
6.1.2.	The Product Structure	61
6.1.3.	The Hybrid Structure	61
6.1.4.	Phoenix Water Department’s Organizational Structure	62
6.1.5.	Span of Control and Layers of Management.....	62
6.2.	Comments Regarding Department Organization	65
7.	Call Center Evaluation.....	70
7.1.	Overview of Current Situation and Opportunities.....	70
7.1.1.	What is Working Well.....	70
7.1.2.	Areas for Improvement.....	71
7.2.	Data, Reporting and Metrics Findings.....	71
7.3.	Customers Service Findings	72
7.3.1.	Getting Calls Answered	72
7.3.2.	Customer Experience.....	73
7.4.	Call Handling Skills.....	73
7.5.	Leadership & Supervision	74

7.5.1.	Organizational Structure	75
7.5.2.	Supervision	75
7.6.	Technology	76
7.6.1.	CC&B	76
7.6.2.	Avaya & Telephone	76
7.7.	Other / General Current Situation Findings	77
7.7.1.	Quality Assurance.....	77
7.7.2.	Attendance	77
7.8.	Recommendations.....	77
7.8.1.	Add Temporary Staff (Customer Service)	78
7.8.2.	Address General Skill Gaps (Efficiency and Customer Service)	78
7.8.3.	Supervisor Development (Efficiency and Customer Service)	78
7.8.4.	Control Back Office Work.....	79
7.8.5.	Reporting & Metrics (Efficiency and Customer Service).....	80
7.8.6.	Technology (Efficiency, Customer Service, and Innovation).....	80
7.8.7.	Organizational Review (Efficiency)	81
8.	Water and Wastewater Capital Project Planning Process	82
8.1.	Current State Assessment	82
8.1.1.	Overview of Current Department Process	82
8.2.	Recommendations for areas of improvement	85
8.2.1.	What the Department Does Well.....	85
8.2.2.	Opportunities for Improvement.....	86
8.2.3.	Areas that Need to be Reorganized to Gain Efficiencies.....	86
9.	Budget to Actuals Expenses	89
9.1.	Review of Current Budgeting Process.....	89
9.1.1.	Zero-based Budgeting.....	89
9.1.2.	Department Wide Budget	89
9.2.	Identifying Potential Areas for Savings	89
9.2.1.	Department Wide Budget	89
9.2.2.	Department Top Expenditures	90
9.2.3.	National Indices.....	91
9.2.4.	Budget to Actuals Variance Analysis	91
10.	Technology Review	93
10.1.	Technology Road Map.....	93
Appendix A – Water System		96
Appendix B – Wastewater System		116

LIST OF ACRONYMS

AAD	average annual day
ACD	automatic call distribution
ac-ft	acre feet
APS	Arizona Public Service
CAP	Central Arizona Project
CMMS	computerize maintenance management system
CO	change out
CO2	carbon dioxide
CS	Customer service
CSAT	Customer Satisfaction
D/DBP	Disinfectants and Disinfection Byproducts
DVWTP	Deer Valley Water Treatment Plant
EMTF	Energy Management Task Force
EPA	Environmental Protection Agency
EUM	Effective Utility Management
FTE	Full time equivalent
FW	filtered water
FY	fiscal year
GAC	granular activated carbon
HAA5	haloacetic acids
HVAC	Heating, ventilation, and air conditioning
HP	horsepower
IT	Information technology
IVR	Interactive voice response
JOC	Job Order Contract
kW	kilo Watt
kWh	kilo Watt hours
LPWTP	Lake Pleasant Water Treatment Plant
LRAA	locational running annual average
MCLs	maximum contaminant levels
MG	million gallons
MGD	million gallons per day
NPDES	National Pollutant Discharge Elimination System
NPV	Net Present Value
PDH	professional development hour
PLC	programmable logic controllers
R&R	Rehabilitation and Replacement
RTU	remote terminal units
SCADA	supervisory control and data acquisition
SHF	solids handling facility

SRP	Salt River Project
STF	solids thickening facility
TOC	total organic carbon
TOU	time of use (utility rate)
TTHM	total trihalomethanes
UHWTP	Union Hills Water Treatment Plant
USEPA	US Environmental Protection Agency
VVWTP	Val Vista Water Treatment Plant
WAS	waste activated sludge
WSAP	Water Services Advisory Panel
WRF	water reclamation facility
WSD	Water Services Department
WTP	water treatment plant
WWTP	wastewater treatment plant
µg/L	micro-grams / Liter
ZBB	Zero based budgeting

Executive Summary

Through a competitive procurement process, the City of Phoenix (City) retained Black & Veatch Corporation (Black & Veatch) for \$194,800 to assess its Water Services Department (Department). Specifically, the City tasked Black & Veatch with reviewing the Department's organizational structure and operations to determine areas of operational efficiencies and / or cost savings.

Black & Veatch's scope of work for the Innovation and Efficiency Study commissioned by the City includes the following elements, which are to be completed within 90 days of receipt of a Notice to Proceed.

1. Evaluate the operational efficiencies, process, and staffing levels in all areas of the Department
2. Evaluate the process for developing the water and wastewater capital plan
3. Evaluate the overall Department organizational structure
4. Provide performance metrics and efficiency improvement recommendations with associated cost savings.
5. Conduct a review of the Department budget and actual expenses to identify areas of potential savings
6. Review technology and other methods to improve efficiencies.

The compressed schedule associated with this Study necessitated a high-level review of many areas of the Department and Black & Veatch has noted as appropriate areas that may require further study.

In conducting our analysis, Black & Veatch interviewed more than 100 people involved with the Department's activities; held three focus groups and two workshops; and reviewed more than 500 pieces of data pertaining to the Department. From this Black & Veatch has identified over 100 items to be evaluated by the Department. Some of these evaluations will result in efficiency gains while others will have annual cost savings. A potential cost savings of up to \$9 million could be possible. However, about \$2 million in expenditures may be required in order to achieve some of cost savings. Overall, Black & Veatch observed the following key items.

Areas of Excellence

1. **Staff and Management:** The Department is fortunate to have competent staff, knowledgeable and dedicated management.
2. **Best in Class Performance:** The Department exhibits "best in class" performance in the area of sanitary sewer overflows, water quality, and system reliability.
3. **Chemical Optimization:** Water and wastewater treatment chemical use is optimized relative to balancing treatment goals, chemicals use and costs.
4. **Treatment Automation and Optimization:** The wastewater treatment staff is adept at utilizing their monitoring and control system to collect and trend key treatment performance data then optimizing treatment to lower costs example: Oxygen sensors at 91st Avenue WWTP to reduce costs for blower energy.

5. **Low Water Loss Rate:** The distribution system is well maintained resulting in a very low unaccounted-for- water loss rate.
6. **Water Resource Management:** Water resources are well managed and will provide a sustainable supply into the future.
7. **Sampling and Testing:** The water and wastewater sampling and associated testing and chemical testing quality assurance programs are well managed and rigorous.
8. **Use of Technology:** The Department uses technology and is willing to invest in it to help improve work processes.
9. **CIP Methodology:** Projects on the Capital Improvement Program (CIP) are chartered and undergo a methodical ranking process.
10. **Budgeting:** Zero-based budgeting is being implemented within the Operation and Maintenance budget to help manage costs.

Areas of Potential Improvement, Efficiency Gains, and Potential Cost Savings

1. **Call Center Customer Service:** Customer service levels at the Call Center have dropped to undesirable levels. Customer complaints are up and hold times are exceeding several minutes. In Black & Veatch’s opinion, rectifying the situation at the Call Center is the number one priority for the Department. Some of our recommendations to help with this issue include:
 - Hire temporary staff (or authorize overtime) to get calls answered and the backlog of back office work cleared. Black & Veatch believes that up to 20 FTEs may be needed on a temporary basis.
 - Re-design the work processes to match the business process that the CC&B system uses.
 - Invest in the development of several “super” screens to reduce the number of screens that customer service representatives need to navigate during a call.
 - Increase training and coaching of staff.
2. **Public Education and Communication:** The reality of recent scandals in other areas of the country and general discontent with the national economic environment results in more scrutiny of government activities. The Department has successfully provided water and wastewater services to its rate payers for more than 100 years. However, for the majority of this period, rate payers have not had a clear understanding of the Department’s mission, goals, and activities. The increased demand for transparency in government means that the Department should actively engage in a public education and communications program to inform those outside of the Department of its activities. As part of this program, Black & Veatch recommends the following:

- Continue to utilize the Water Services Advisory Panel (WSAP) as advisors to the Department. The WSAP would provide guidance and external oversight on budget, CIP, and rate matters. Council members would select WSAP members.
 - Develop a management report for the WSAP that reports on the progress of activities including:
 - Strategic plan initiatives;
 - Capital improvement plan programs (e.g., completion of condition assessment of small diameter mains; master planning efforts); and
 - Innovation, efficiency, and cost saving ideas outlined in this Report.
3. **Strategic Planning:** The Department is one of the largest in the nation and serves as a model to many of its peers. To maintain this standing, the Department needs to engage periodically in strategic planning activities to make sure to validate its vision and align its tactical plans with execution of the strategy. In November 2009, LL Decker & Associates issued a draft report entitled *A Strategic View of the Business Enterprise* for the Department (Draft 2009 Business Plan). The Department is moving forward to address issues raised in the Draft 2009 Business Plan.

Black & Veatch suggests that the Department provide routine updates on progress made against the Draft 2009 Business Plan activities and further, commit to engaging in strategic planning activities on a bi-annual basis. Moreover, Black & Veatch suggests that the Department adopt an implementation plan and schedule to help guide its strategic activities. Some specific recommendations that the Department should include as part of its process include the following key elements:

- Begin the strategic review with a formal evaluation of the plan’s status to-date.
- Identify and revise, as necessary, the list of critical success factors and strategic initiatives. Strategic initiatives should support critical success factors.
- Assign a champion for each critical success factor. It is the responsibility of each champion to assemble a team to help implement the assigned critical success factor.
- Tie the Strategic Plan to the long-range financial plan for the Department.
- Develop and report on performance measures that address the ten attributes of an effectively managed utility as outlined in the EUM:
 - Product quality;
 - Customer satisfaction;
 - Employee and leadership development;
 - Operational optimization;
 - Financial viability;
 - Infrastructure viability;

- Operational resilience (i.e., risk management, safety, emergency preparedness);
 - Community sustainability;
 - Water resource adequacy; and
 - Stakeholder understanding and support.
 - Report on a monthly basis the status of each strategy within a strategic initiative.
 - Define a clear planning schedule with deadlines.
 - Communicate the final strategic plan to all stakeholders.
4. **Energy Management Task Force:** The Department recently formed an Energy Management Task Force (EMTF). Actions implemented to-date by the EMTF are described in Section 4.3.1. The EMTF should continue to develop and implement the Department’s Energy Management Plan throughout the Department’s facilities. In addition the Department and EMTF should:
- Designate an Energy Champion to lead energy management strategic and operational initiatives for both water and wastewater operations. In recognition of the importance of this initiative to the on-going operation of the Department, Black & Veatch suggests that the energy champion be a full-time Energy Management Team Leader position. The Energy Champion would lead the EMTF as well as play a key role the Executive Energy Management Team.
 - Continue to develop, formalize and implement the Department’s Energy Management Plan that ties into the Department’s Strategic Plan and City-wide sustainability goals. This Plan provides the overarching strategy, vision and goals to guide efficiency and innovation efforts and decisions. The plan should be communicated throughout the Department and to other stakeholders. This is a best practice recognized and recommended by the industry.
 - Train staff on energy optimization and provide Department operators with guidelines addressing high-energy demand avoidance.
 - Develop and implement additional tools to help the Department operations trend distribution system key performance indicators so areas of additional energy efficiency and cost savings can be identified and implemented.
5. **System-wide Distribution System Operations Optimization Software:** Evaluate implementing system-wide distribution system operations optimization software. Other large US utilities have experienced energy costs savings of about 8 to 15% with high functioning distribution system operations optimization software.
6. **Lake Pleasant Water Treatment Plant Operations:** Explore opportunities to optimize costs and efficiencies for the Lake Pleasant Water Treatment Plant (LPWTP) operations contract.

7. **Biogas Cogeneration:** Move forward with biogas cogeneration at the wastewater treatment plants.
8. **CIP Planning:** While improved, the CIP planning process could be further enhanced by incorporating more economic analysis elements as well as adding development of an enterprise-wide risk profile. For example, the Department should consider the following:
 - Requiring all project charters to include budget information for all personnel (inspectors, etc.), including those outside of the Department. Project managers should fill out project charters consistently by project managers and for all projects being considered.
 - Adding economic analyses for all projects greater than \$250,000. At a minimum, two project alternatives plus the “do nothing” option should be evaluated. Economic analyses may include benefit-cost analysis; net present worth evaluations; and / or triple bottom line impacts.
 - Initiate periodic evaluation of projects to check that the design parameters / conditions are still valid. Evaluations could be performed when a significant amount of time has elapsed between design and actual construction of the project.
 - Target no more than a 15% carry-over balance from year to year. Consistently carrying over a large portion of the CIP may have a negative impact on possible rate increases. Improvements to project schedule and resource estimates could narrow the variance between actual and budgeted CIP expenditures, which would lead to a more accurate estimate of rate increases needed. Similar to performance metrics pertaining to accuracy of budgeting activities, encouraging more accurate projections increases project management skills, provides better information for resource allocation, and reinforces fiscal discipline.
 - Continue to stress that project needs should be initiated by Operations and then managed by Engineering to make sure that operational projects are also on the CIP and appropriately prioritized.
9. **Job Order Contracts:** Job Order Contracts (JOCs) are a very valuable tool that the Department needs to deliver services. However, the Department should re-assess how it currently uses JOCs. The cost of services provided via JOCs may be higher because contractors must provide these services “on demand” and as such, may charge a premium for this availability. Over the last few years, the use of JOCs has increased within the Department. Black & Veatch recommends that JOCs should only be used for emergency services and the dollar ceiling for these JOCs be reduced to perhaps a \$2 million level. Further, Black & Veatch suggests that for JOC services in excess of \$2 million, a limited number of competitive bids from JOC contractors be obtained so that the Department can demonstrate that it is getting the most for its money.

10. O&M Tech Program: The Operations and Maintenance (O&M) Tech program requires further modifications. The Department consider some of these options:

- Coursework for field-based skills need to include a practicum as well as a minimum number of hours in the field before the skill level is “passed.” Additionally, a required number of maintenance and operational hours at each skill block level should be satisfied prior to “passing.”
- The intent of the O&M Tech program is to have cross-trained skilled employees. Maintenance of these skills is critical to the on-going sustainability of the program and so, rotating employees through different crews/service areas will help to keep learned skills sharp.
- Parallel increased pay for skills with increased responsibility and accountability for performance to the new job level standards.
- Pay advancement based on attaining new skills occurs when a position is available. For example, a person meeting the Level 3 skills is not promoted until a position becomes available. Attaining the necessary skills is required for promotion, but receiving the promotion is based on availability of positions.

11. Department Leadership: Recruit a new permanent Director with water/wastewater industry experience with a utility of similar size and complexity.

Recommendations

The following summarizes the recommendations herein and are categorized as potential efficiency gains (a productivity increase), innovation opportunities (capital investment that produces efficiencies and / or cost savings), and cost savings (direct savings):

	Recommendation	Type	Savings Goal
1.	Hire temporary staff to address Call Center needs while working on improving work processes and implementing system enhancements.	Efficiency and Innovation	Improved customer service and satisfaction. Goal is to achieve standard call center metrics after work and business processes have been updated.
2.	Explore opportunities to optimize the LPWTP operations contract.	Efficiency	
3.	Evaluate implementing system-wide distribution system optimization software.	Innovation	8 to 15% of Distribution System Energy Costs Reservoir management and water quality improvements
4.	Evaluate the use of JOCs.	Cost Savings	Limiting the JOC contract annual ceiling and use for only emergency services may provide savings about \$1M to 3M per year.

The Department has initiated several task forces, operational evaluations, and operational changes to increase overall efficiency. Black & Veatch recognizes and concurs with the Department's efforts to-date and recommends the Department periodically review the planned operational changes, work completed and system operations to assess effectiveness relative to implementation timelines and efficiency gains.

The Department has begun reviewing many of the items outline within this study and has started on implementing several items such as review of the Lake Pleasant Water Treatment Plant contract, conducting Energy audits, and beginning the process to acquire Call Center Training assistance.

Currently, the Department has reduced the FY 11-12 operating expenditures by almost \$19 million from the adopted budget in the water and wastewater programs. This represents a 6.9 percent expenditure reduction for this fiscal year. The Department expects to achieve an additional \$4-6 million in savings by implementing suggestions in this study. These savings represent less than 2 percent of the annual O&M budget.

	Programs to Continue	Type	Savings Goal
1.	Continue updating the Strategic Plan and develop an implementation schedule and communications program for progress reporting.	Efficiency & Cost Savings	Aligning the work force to achieve the Department’s stated and communicated strategic goals within a defined timeline provide efficiencies in that duplicate and / or non-productive activities may be minimized.
2.	Continue Energy Management Plan Implementation	Efficiency & Innovation	5 % of Total Distribution System Energy Costs
3.	Implement biogas cogeneration at the WWTPs.	Innovation	Less than 10 year payback period is estimated based on previous 1995 Study
4.	Continue to use the WSAP as a “sounding board” for CIP, budget, and rate matters.	Efficiency	Increasing transparency regarding what the Department does and how it does it will establish credibility with the public and City Council.
5.	Continue refining the CIP prioritization process to incorporate information from the WAM system and enhance financial evaluations	Innovation	Including information provided by the WAM system (once fully implemented) will help the Department to (1) refine R&R funding levels and (2) establish the risk of deferring maintenance activities. Furthermore, adding business case elements to the project charter will enhance the prioritization process and provides for a more complete evaluation of a project’s impact on the Department.

The following table categories the recommendations provided in this Report based on Black & Veatch’s assessment of implementation: Short-term (one year or less) or Mid- to Long-Term. The purpose of the table is to help the Department determine what recommendations, if implemented provide short-term gains, while identifying those activities that require further study and possible investment to provide longer term efficiencies.

Recommendation	Estimated Annual Savings
Phase I Actions – Short-term (1 year or less) ⁴	
Evaluate Five-Start Reporting System	Undefined
Reduce Sanitary Sewer Cleaning Crews	Reallocate Staff
Further Evaluate Staffing in a Number of Operations	Undefined
Continue to Reduce the Recycled Water Rate at Val Vista WTP	\$498,000
Continue with Plan to Solar Dry 91 st Avenue Biosolids	\$500,000 ⁵
Maximize 24 th Street WTP Production While Reducing Other WTPs Production	\$206,000 ⁸
Operate WTP Solids Dewatering Centrifuges On-Off Peak	\$95,000
Discontinue Use of Lift Station No. 66	\$17,800
¹ Energy Management Measures: <ul style="list-style-type: none"> • Designate an Energy Champion • Develop a Department-wide Energy Management Plan • Provide Additional Staff Training • Evaluate Distribution Site Electric Rate Structure • Evaluate and Trend Pump Station Energy Use • Provide Guidance and Tools for Operators to Avoid High Demand Use and Identify Additional Cost Savings • Replace Inefficient Facilities with More Efficient Ones • Lower Energy Costs by Switching to Time-of-Use Rates in Facilities • Implement a System-wide Energy Use Dashboard 	\$350,000 ²
¹ Continue to Optimize Distribution System Operation and Production Source: <ul style="list-style-type: none"> • Continue to Evaluate DBP Stage 2 Compliance Strategy • Continue to Reduce Distribution System Reservoir Storage on a Seasonal Basis • Continue to Verify and Monitor Distribution System Valve Positions to Reduce Water Age • Reduce GAC Fluff Backwash Frequency Usage and Avoid Treating Mesa Water at Val Vista WTP • Re-evaluate Cogeneration and Wet Scrubber Versus Biological Odor Control at the WWTP • Continue to Optimize GAC Usage at VV WTP⁴ 	

Recommendation	Estimated Annual Savings
<p>Organizational Changes:</p> <ul style="list-style-type: none"> • Continue Strategic Planning efforts and include the following elements: <ul style="list-style-type: none"> ○ Identify list of critical success factors and strategic initiatives ○ Assign a champion for each critical success factor ○ Tie the Strategic Plan to the Department’s long-range financial plan ○ Develop performance measures that address the ten attributes of an effectively managed utility ○ Report on a monthly basis on the status of each strategy within a strategic initiative ○ Define a clear planning schedule with deliverables ○ Communicate the plan to all stakeholders • Continue to utilize the WSAP as advisors to the Department 	Undefined
Phase II Actions – Mid- to Long-term	
Evaluate Implementing System-wide Distribution System Optimization Software	\$600,000 ⁶
<p>Reform the CIP Process³</p> <ul style="list-style-type: none"> • Project Initiation Reflects the Operation Needs and is According to the Master Plan • Adding Risk-Analysis and Financial Alternatives into Project Charters • Re-evaluate Projects at Different Stages • Establish Consistent Contingency Guideline at Planning Stage • Provide Executive Oversight to On-Call and Job Order Contracts to Reduce Excessive Use • Reduce All CIP Projects Carry-Over From Current 30% to 15% • Engage WSAP into CIP Planning 	Undefined
Employee Cross-Training	30% of Overtime Costs (\$1,300,000)
Reform O&M Tech Program	30% of Overtime costs (\$1,300,000)
<p>¹Downsizing Production / Operational Facilities</p> <ul style="list-style-type: none"> • Combine remote sites • Streamline work processes for field customer services, distribution, and collections • Close 23rd Avenue WWTP and divert all flow to 91st Avenue WWTP 	<p>50% of the Facilities Annual Operations Cost</p> <p>\$630,000⁷</p>

Recommendation	Estimated Annual Savings
Implement Biogas Cogeneration at WWTPs	< 10 year payback
Outsource Compacting Services	Reduction of up to 2 FTEs (\$150,000)
Review Use of JOCs and Reduction of Dollar Ceiling	\$1,000,000
Review and Improve Employee Performance Measurements	Increase in Productivity and Accountability
Reform the Call Center per Provided Recommendations	Undefined
Incorporate CIP Prioritization Recommendations	Undefined
¹ Organizational Changes: <ul style="list-style-type: none"> • Recruit a Permanent Director • Implement an Internship Program for Staff Engineers • Reclassify / Re-evaluate Management / Supervision Positions to Increase Direct Reports 	Organizational Efficiency

¹ These items would likely involve initial investment. Some items, such as an energy champion, would require a new position or reallocation of existing positions.

² The estimate for energy savings is conservatively based on the various recommendations’ savings percentages presented in the Report. Full savings potential will require multiple years as budget and rebate opportunities become available to replace inefficient equipment and implement programming and additional power monitoring at a limited number of large pump station sites.

³CIP reforms, including reducing carryover, may not generate hard savings since projects are funded as work is completed. CIP reforms should result in a tighter process.

⁴ Many recommendations do not have actual costs savings attached. This is due to the large number of variables that have to be evaluated prior to implementation of the recommendation.

⁵ The biosolids hauling contract is up for bids in fall 2011. The estimate provided is conservative based on discussions with WWTP operations.

⁶ Based on the lowest reported savings from five existing installations serving a population ranging from 0.4 M to 1.8 M. A feasibility study is recommended to further quantify potential savings and other operational benefits such as reduced water age.

⁷ Further evaluations area required as it may require substantial capital investment to implement. Savings based on energy and chemical cost reductions using current chemical and energy costs.

⁸ Estimated savings if reduce flow from DVWTP by 1/3 and increase 24th Street WTP flow by an equal amount. Savings is based on pumping energy costs for distribution pumping at the DV WTP.

Department Actions to Date

Since the start of this Study, the Department has started and/or continued on a number of efficiency and cost saving measures as part of its commitment to continuous improvement. As of November 30, 2011, the Department has engaged in the following activities to address recommendations outlined in this Report:

- Developed a Department Action Plan to identify and track the recommendations or observations contained within this Report. The Action Plan identifies a Department

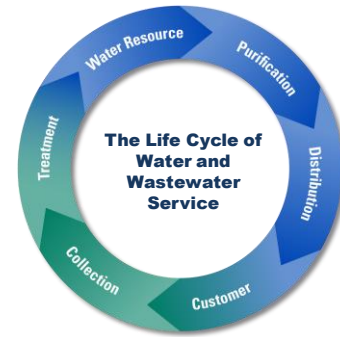
champion and team for each item, a prioritization of items, milestones, and a tracking mechanism.

- Expanded the Department's Water Energy Management Task Force to include work groups within the entire Department. A work plan has been developed and the Department is moving forward on several items with a goal to achieve 3% in energy savings for the FY11-12 Water energy budget (\$420,000).
 - Evaluated electric rate structures for high demand water facilities and worked with the power providers to switch to more optimal rate.
 - Initiated a process to conduct energy audits at water and wastewater facilities.
 - Started pursuing an energy audit for 91st Avenue WWTP.
 - Reviewed solar opportunities and preliminary agreement discussions are underway for 7.5 MW of solar power development at the LPWTP.
 - Initiated a power monitoring audit at the Water Production Facilities.
 - Entered into voluntary utility demand reduction programs with both local electrical utilities.
 - Initiated a process to develop software analytical tools that evaluate energy usage in the water distribution system.
- Initiated several Customer Call Center improvements and efficiencies including:
 - Established and tracked a busy rate goal of less than 10% - average busy rate is currently at 4%.
 - Implemented all inclusive teams to improve efficiency in handling customer calls.
 - Implemented weekly reporting of manual back office controls.
 - Created a seven person team responsible for credit counseling and higher level payment arrangements.
 - Identified performance metrics and implemented reporting.
 - Contracted with vendor to provide support for Avaya telephone and reporting software.
 - Implementing opportunities for faster payments and automated pay plans.
 - Received approval to fill vacant full-time and part-time customer service assistance positions to help meet or exceed the service metrics.
 - Continue to implement the automated meter reading program, which requires fewer staff to read meters.

- Developed an RFP for biogas usage at the 91st Avenue WWTP. A Request for Proposal (RFP) for the 23rd Avenue WWTP biogas was released previously in conjunction with work being performed by the Public Works Department.
- Completed an assessment of wastewater flows for Lift Station 66 and approximately 90 percent of the flows have been diverted to the gravity sewer to reduce energy consumption.
- Increased solar drying of sludge at the 91st Avenue WWTP over the summer and reduced the projected solids hauling expenditures by \$600,000.
- Reviewed and is adjusting water and wastewater treatment plant operator schedules to avoid schedule overlap and overtime and will be saving \$360,000 per year once fully implemented.
- Closed the Verde Water Treatment Plant and saved \$1.4 million per year by absorbing the treatment demand at other plants.
- Completed discussions with the City of Mesa to bypass GAC treatment of Mesa’s water at the Val Vista WTP and begun initiation of the project to split the flows, which will result in a \$2.8 million reduction in annual O&M costs starting in FY17/18.
- Completed an RFP and negotiations of an agreement to outsource the regeneration of GAC from the water plants which will reduce previously projected operating expenditures by \$700,000 per year.
- Consolidated the procurement process for most major chemicals used by the department, saving an estimated \$2.3 million through large-scale bidding.
- Reduced FTEs by 32 positions in fiscal year 2011/12 to save approximately \$1.9 million annually due to efficiency initiatives, adjusting workloads and a review of the organizational structure.
- Outsourced bill printing to save \$200,000 annually and enhance bill paying options for customers starting in FY12/13.
- Pursued the sale of McMullen Valley property, which will net a savings of over \$100,000 per year in operating costs, \$3 million per year in debt payments, and could generate \$1-5 million in one-time land sale income to the Water Fund.
- Terminated participation in the Granite Reef Underground Storage Project (GRUSP), which will save \$550,000 in annual operating costs and could generate up to \$1.5 million in one-time asset sales income to the Water Fund.
- Retained the AAA bond rating from S&P and refinanced existing water and sewer bond debt, which will save about \$43 million in reduced interest payments.

1. Introduction

The City of Phoenix (City) retained Black & Veatch Corporation (Black & Veatch) to perform an Innovation and Efficiency Study (Study) of the City's Water Services Department (Department) to determine whether the organizational structure and staffing levels are appropriate and to recommend modifications to maximize operational efficiencies. When evaluating these services, the full life cycle of the resource must be considered. Changes in one part of the cycle may affect the level of service provided in another part. The objective is to provide your customers, the citizens of Phoenix, with improved levels of service in all elements of the life cycle in the most economical manner.



1.1. SCOPE AND PURPOSE

Black & Veatch's scope of work for the Innovation and Efficiency Study commissioned by the City includes the following elements, which are to be completed within 90 days of receipt of a Notice to Proceed.

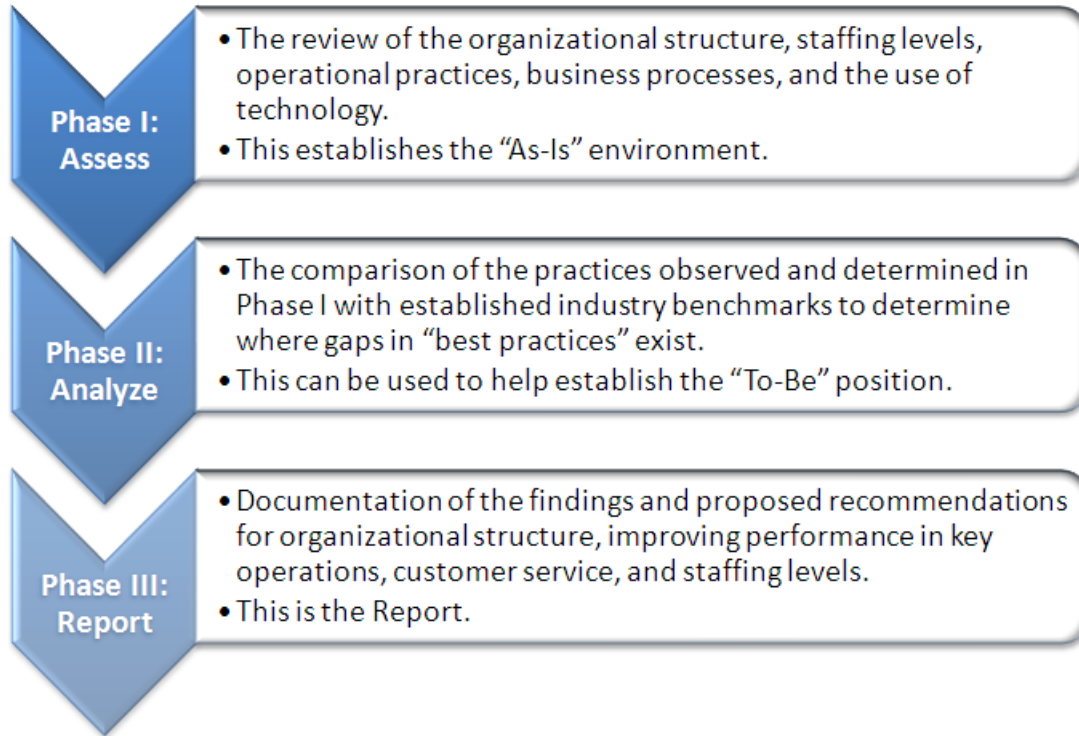
1. Evaluate the operational efficiencies, process, and staffing levels in all areas of the Department
2. Evaluate the process for developing the water and wastewater capital plan
3. Evaluate the overall Department organizational structure
4. Provide performance metrics and efficiency improvement recommendations with associated cost savings.
5. Conduct a review of the Department budget and actual expenses to identify areas of potential savings
6. Review technology and other methods to improve efficiencies.

The compressed schedule associated with this Study necessitated a high-level review of many areas of the Department and Black & Veatch has noted as appropriate areas that may require further study.

The purpose of this report (Report) is to present the findings and recommendations from Black & Veatch's study of the City of Phoenix's Water Services Department. The study examines the organizational and operational conditions of the Department to assess areas for potential efficiency gains (a productivity increase), innovation opportunities (capital investment that produces efficiencies and / or cost savings), and cost savings (direct savings).

1.2. METHODOLOGY

The methodology used in the performance of this Study consists of three phases.



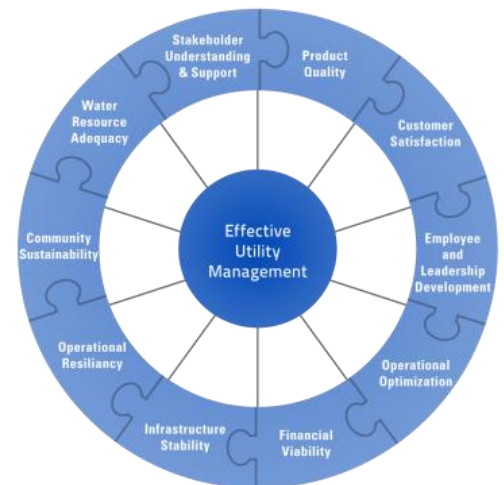
1.3. TOOLS AND TECHNIQUES

Our Methodology utilizes a number of tools and techniques that we have found to be effective when doing similar assessments of other water and wastewater utilities. Examples include the following:

1.3.1. Effective Utility Management (EUM)

In response to financial and organizational challenges facing the water industry, a consortium of water industry technical and organizational associations joined forces to sponsor and publish a primer to promote effective utility management. The associations worked with a Utility Advisory Group consisting of 16 representatives from the public and private water sector. The results of their efforts - *Effective Utility Management - A Primer for Water and Wastewater Utilities*, was published in June of 2008. The purpose of the Primer is to provide water and wastewater utility managers with a framework and guidelines to develop processes for making practical, systematic changes to achieve excellence in utility performance.

The Primer recognizes that good utility operation addresses more than financial and organizational goals. Ten attributes have been identified that provide reference points to



help utilities maintain a balanced focus on all-important operational elements of a utility. The attributes include:

1. Product Quality
2. Customer Satisfaction
3. Employee and Leadership Development
4. Operational Optimization
5. Financial Viability
6. Infrastructure Stability
7. Operational Resiliency
8. Community Sustainability
9. Water Resource Adequacy
10. Stakeholder Understanding and Support

Review of the attributes recognizes the challenges an effective utility faces when balancing the demands and needs of

- a) internal and external stakeholders
- b) operational and financial business units
- c) growth and sustainability
- d) line employees and management

The methodology used in this Study recognizes the attributes and has incorporated them into our assessment of the Department.

1.3.2. Interviews with Managers and Employees

To gain insights into the operating conditions, current policies and procedures, available equipment, use of technology, existing organizational strengths, opportunities for improvement and other considerations, the Black & Veatch team interviewed over 100 Department employees, 10 City staff personnel from outside of the Department, and 3 representatives from the labor unions; conducted 3 focus groups and 2 workshops and visited water and wastewater treatment, collection, and distribution facilities. We also reviewed and analyzed more than 500 pieces of data related to the Department's activities. All of these activities occurred over a 3-week period. Follow-up interviews were conducted with select staff to gain clarification or additional information on an as needed basis. Meetings with the Water Services Advisory Panel (WSAP) were also attended to share information on the progress of the Study, answer questions regarding the Study, and obtain information on external stakeholder concerns.

1.3.3. Benchmarking as a Tool to Support the Analysis

As part of the Study, Black & Veatch used industry-benchmarking information where available to establish a baseline for comparing the overall organization, staffing and operation of the Department with the experience of other similar utilities. For some areas, benchmarking data

were limited and so informal phone surveys of comparably sized utilities were used to provide information. While benchmarking is useful to help a utility establish goals (do you want to be “best in class” or just in the middle?), it should be recognized that it is simply a tool, and not the “answer” to how a utility should be organized or run.

Black & Veatch believes that it is also important to note that other factors, such as the geographic area served by a utility, water quality, energy costs and other factors can further skew benchmarking comparisons.

1.4. DISCLAIMER

In conducting our study, we reviewed the books, records, agreements, capital improvement programs, and customer sales and financial projections of the Department, as we deemed necessary in the circumstances. While we consider such books, records, documents, and projections to be reliable, Black & Veatch has not verified the accuracy of these documents.

The projections set forth in this report below are intended as “forward-looking statements”. In formulating these projections, Black & Veatch has made certain assumptions with respect to conditions, events, and circumstances that may occur in the future. The methodology utilized in performing the analyses follows generally accepted practices for such projections. Such assumptions and methodologies are reasonable and appropriate for the purpose for which they are used. While we believe, the assumptions are reasonable and the projection methodology valid, actual results may differ materially from those projected, as influenced by the conditions, events, and circumstances that actually occur. Such factors may include the Department’s ability to execute the capital improvement program as scheduled and within budget, regional climate and weather conditions affecting the demand for water, and adverse legislative, regulatory or legal decisions (including environmental laws and regulations) affecting the Department’s ability to manage the system and meet water quality and / or wastewater discharge requirements.

2. Current Operating Conditions

Existing conditions, including performance levels, strengths, and opportunities for improvement were evaluated. In addition to facility visits, interviews with Department operations and engineering staff were conducted. Multiple documents on the existing system, the operating costs and studies supporting operations and future planning were reviewed.

2.1 FACILITY VISITS

As part of this study, Black & Veatch personnel visited the 91st Avenue Wastewater Treatment Plant and the 24th Street Water Treatment Plant to review operations and current processes.

2.2 REVIEW OF WATER AND WASTEWATER OPERATIONS

2.2.1 Overview of the Current Process – Water Treatment and Distribution

The water system serves 403,104 customer service connections within a 540 square mile service area. According to the 2010 Census the City’s population is about 1,445,600. The Department currently has six operating surface water treatment plants (WTPs) and twenty-one active groundwater wells. The City’s surface water treatment plants, their supply source and rated treatment capacities are described in Table 2.2.1-1

Table 2.2.1-1 Water Production Capacity

Water Treatment Plant	Rated Production Capacity, MGD	Supply Source ¹
Verde	50	SRP
24 th Street	140	SRP
Deer Valley	150	SRP
Val Vista	130 ²	SRP
Union Hills	160	CAP
Lake Pleasant	80	CAP
Groundwater Well Production, AAD	4.5 – 7	N/A
Notes:		
1. SRP = Salt River Project. CAP= Central Arizona Project		
2. Val Vista WTP has a total capacity of 220 million gallons per day (MGD) the City’s portion is 130 MGD. Mesa has a 90 MGD share.		

Overall, the City water demands have decreased. In 2009, the average annual water demand was 282 million gallons per day (MGD) and in 2010, it was 269 MGD.

The 24th Street Water Treatment Plant was toured. It is a conventional treatment WTP that uses ferric chloride as the coagulant to facilitate sedimentation and removal of total organic carbon; the process also includes filtration followed by pH adjustment and chlorination. The plant is clean and well maintained.

The 24th Street WTP, Verde WTP and Val Vista WTP use similar treatment processes. The Deer Valley WTP uses a high rate flocculation / sedimentation process (sand ballasted). Union Hills WTP utilizes presedimentation followed by direct filtration.

The water distribution system is comprised of:

- 109 booster pump stations
- 62 different pressure zones.
- 90 pressure reducing valve stations



24th Street Water Treatment Plant Chemical Storage Area

The City has treated water storage reservoirs at their water treatment plants and in the distribution system. There are a total of 47 water storage reservoirs. Storage at the water treatment plants provides needed water containment for disinfection contact time as well as provides storage for distribution supply. Storage in the distribution system is provided to meet diurnal peaks, fire and emergency demands.

Over twenty years ago, the Department implemented a supervisory control and data acquisition (SCADA) system to help monitor and control the water distribution systems from a central command center. The Department is currently replacing the obsolete Water Distribution HSQ SCADA system software with Control System International UCOS software. This is part of a department-wide initiative that will provide a common hardware and software platform across all water and wastewater facilities. Having a common hardware and software platform will enable the department to efficiently and cost effectively maintain their process control systems utilizing in-house staff, in turn increasing overall system reliability. In addition, the new software supports current networking technology that supports interconnectivity between facilities and a centralized database for historical data archiving and reporting. It is also capable of interfacing with other information systems, software and databases to meet future needs. The initial installation of the new water distribution SCADA software will generally provide similar monitoring and control functionality and is based upon an open software platform that is easy to program and configure. While a few of the facilities are controlled manually through the SCADA system, the majority of the pumping stations are started and stopped automatically based on system pressure or tank level. The automatic controls are incorporated into remote terminal units located at each site. This type of automatic control is typical for water distribution systems similar to the City of Phoenix. After the new software is installed, the City will be able to start a phased replacement program for the RTUs that are nearing the end of their lifecycle. The replacement hardware will provide increased reliability and monitoring and control functionality.

There are approximately 6,955 miles of water transmission and distribution piping . The piping consists of various materials (steel, cast iron, ductile iron, asbestos cement, concrete cylinder, etc.). The Department has an ongoing distribution system pipeline rehabilitation and replacement program. The water distribution system has a very low unaccounted-for water loss percentage.

2.2.2 Overview of the Current Process – Wastewater Treatment and Collections

The Department operates the following two wastewater treatment plants (WWTP) and one water reclamation facility (WRF).

Table 2.2.1-1 Wastewater Treatment Facilities

Treatment Plant	Rated Treatment Capacity, MGD
23rd Avenue WWTP	63
91 st WWTP	228.5 ¹
Cave Creek WRF	8 ²
Note: 1. Phoenix has partial ownership in 91 st Avenue and is responsible for the plant operations. 2. Cave Creek WRF is not currently in use.	

Due to the recent economic slowdown in the Phoenix service area, flows in the once projected high-growth northern drainage basins are lower than anticipated. To reduce operational costs the Department has removed the Cave Creek WRF from service. Flows that were being treated at the Cave Creek WRF are now treated at the Department’s two other WWTPs.

As part of the interviews with the wastewater treatment personnel at the 91st Avenue Wastewater Treatment Plant (WWTP) a windshield tour of this facility and the wetlands to which the secondary effluent is pumped was completed. This plant uses well-established processes to treat the wastewater and resulting residuals.



91st Avenue WWTP Process Basins

This plant also uses solar energy to evaporate moisture from sludge after centrifuge dewatering. This additional step results in a significant savings in hauling costs. The liquid stream processes include primary sedimentation, activated sludge, secondary sedimentation, chlorination and wetland treatment. Ancillary processes include wet scrubber odor control units. The 228.5 MGD capacity treatment plant currently has an average annual flow of 140 MGD.

Treated effluent from 91st Avenue is provided to Palo Verde Nuclear Generating Station and utilized for cooling water. Typically, about 40-50 MGD is provided in the winter and 70-80 MGD is provided during the summer to the Generating Station. The rest of the plant effluent is provided to the Tres Rios Wetlands and the Buckeye Irrigation District. Compliance with the National Pollutant Discharge Elimination System (NPDES) permit was reported to be excellent with a few exceptions that were a result of instrumentation or equipment failure.

The US Environmental Protection Agency (USEPA) has mandated extensive sampling and testing of the wetlands influent and discharge that goes beyond what would be expected of a wastewater treatment plant effluent. Employees commented that the wetland facility is a test bed for the State and Federal agencies participating in the project and requires extensive sampling.

The 23rd Avenue Wastewater Treatment Plant is a tertiary plant that employs effluent filters in place of wetlands for tertiary treatment. It was designed for an average flow of 63 MGD and it is operating at a 32 MGD flow rate. As a part of a water rights settlement agreement, this plant provides irrigation water to the Roosevelt Irrigation District for crop irrigation as part of an exchange agreement.



Tres Rios Wetlands

The Department's wastewater collections and treatment system consist of over 4,980 miles of sewer lines, force mains and interceptors, 28 wastewater lift stations serving 18 major sewer drainage areas with a total of 192 sub-basin drainage areas. Collection system inflow and infiltration is not a significant issue in Phoenix for obvious reasons; minimal rainfall within the service area of around 7 (seven) inches/year. The Department televises approximately 9.5% and cleans approximately 33% of the total collection system each year. This cleaning program has resulted in minimal wastewater overflows of one occurrence per 100 miles of collection piping.

2.3. STAFFING LEVELS AND PERFORMANCE MEASURES

2.3.1. Field Interviews

As part of the facility visits Black & Veatch personnel conducted field interviews in four areas of the Department: Water Production, Water Distribution, Wastewater Collection and Treatment. Existing conditions, including performance levels, strengths, and opportunities for improvement are discussed. Black & Veatch reviewed the existing staff's ability to perform future maintenance requirements to conform with stricter regulations and to maintain desired levels of service. We also determined if changes in staffing levels might be necessary to meet these preventative maintenance requirements. Twenty-two employees provided their time and insight of the utility, over three days. The classification of participating employees included:

- Assistant Superintendant
- Facility Supervisor
- Operation and Maintenance (O&M) Supervisor
- Operation and Maintenance Technician
- Electrical Foreman
- Utility Supervisor

- Utility Foreman

Discussion with each employee focused on efficiency, service levels, cost of service, use of technology, organizational structure, operations and maintenance budgets, capital improvements budget, renewal and replacement budget, work schedule, water quality, customer satisfaction, age of infrastructure, safety, maintenance practices, performance metrics, and other items of interest, specific to the employee’s area of responsibility.

All employees interviewed were professional, courteous, and forthright. The overall sentiment of these employees and their outlook for improving the utility was very optimistic.

2.3.2. Performance Measures

The most current industry benchmarking data available is the *2007 Benchmarking: Performance Indicators for Water and Wastewater Utilities* by AWWA (Benchmarking survey). The Benchmarking survey tracked the performance of 350 water and wastewater agencies over four years. Of particular importance for the City is that the survey examines the performance of 14 combined (water and wastewater) agencies serving populations over 500,000. AWWA has tentatively scheduled the next update to this survey for 2012.

The primary objective of the benchmarking data is to provide a performance measurement specific to the Phoenix water and wastewater utilities, compared to the AWWA survey. These measures are designed to help organizations improve their operational efficiency and effectiveness. Utility managers use this information to determine where their utility's performance compares to the industry peer group.

In order to compare current (2010) costs to those used in the Benchmarking survey, Black & Veatch escalated the Benchmarking survey data using the Consumer Price Index for all US Cities as follows: 2.8% for 2007, 3.8% for 2008, -0.4% for 2009, and 1.6% for 2010. A summary of the benchmarking performance indicators is summarized in Table 2.3.2-1.

AWWA 2007 Benchmarking Survey Participants

Operational Summary			
Water Only			60
Wastewater Only			14
Combined Operations			106
Total Participants			180

Regional Summary			
Region I		Region V	
Northeast		Canada	
Water	6	Water	2
Wastewater	2	Wastewater	0
Combined	8	Combined	2
	16		4
Region II		International	
Midwest			
Water	23	Water	0
Wastewater	5	Wastewater	0
Combined	17	Combined	2
	45		2
Region III		Total	
South		180	
Water	12		
Wastewater	2		
Combined	50		
	64		
Region IV			
West			
Water	17		
Wastewater	5		
Combined	27		
	49		

Size of Population Served			
0-10,000		More than 500,000	
Water	3	Water	0
Wastewater	0	Wastewater	6
Combined	7	Combined	14
	10		20
10,001-50,000		Total	
		160	
Water	19		
Wastewater	0		
Combined	18		
	37		
50,001-100,000			
Water	6		
Wastewater	1		
Combined	17		
	24		
100,001-500,000			
Water	22		
Wastewater	6		
Combined	41		
	69		

In using benchmarks to compare performance, Black & Veatch notes that there are difficulties comparing utilities to one another due to unique regional conditions. Some of the local issues that may contribute to skewed benchmarking in Table 2.3.2-1 include:

- A very large service area, which requires more facilities to distribute the water and more staff to maintain the facilities;
- Warm water and the large distribution system, which makes treatment and distribution more susceptible to generation of disinfection byproducts; and
- Wastewater discharge permit requirements that include consideration of wetlands preservation.

Benchmarking is a comparison at one point in time. Accordingly, benchmarking is just one tool to assess performance and cannot be used solely for decision-making.

Table 2.3.2-1 Benchmarking Results

City of Phoenix		Area of Evaluation	Populations Over 500K		
Score	Ranking		Top Quartile	Median Quartile	Bottom Quartile
37.7	Top	Training Hours per Employee	31.8	16.8	12.3
482.5	Median	Customer Accounts per Employee (Water)	794	653	428
592.6	Median	Customer Accounts per Employee (Wastewater)	688	548	457
0.32	Median	MGD Water Delivered per Employee	0.51	0.34	0.24
0.27	Median	MGD Wastewater Processed per Employee	0.36	0.25	0.18
711.9	Bottom	O&M Cost per Account (Water)	176.0	251.6	344.5
2,461.3	Bottom	O&M Cost per MG/Yr (Water)	955.6	1,425.3	1,797.9
695.2	Bottom	Direct Cost of Treatment per MG/Yr (Water)	126.3	325.0	558.3
337.6	Bottom	O&M cost per account (Wastewater)	129.6	225.7	327.2
2,048.1	Bottom	O&M cost per MG/Yr (Wastewater)	978.3	1,619.7	2,007.3
768.3	Median	Direct cost of treatment per MG/Yr (Wastewater)	614.4	729.9	1,065.8
0.5	Top	Sewer Overflow Rate	1.79	6.09	9.72
0.5	Top	Collection System Integrity	6.2	15.0	41.6

Based on data provided by the Department, Black & Veatch notes that both Water and Wastewater Operations rank in the lower quartile for O&M costs per account and O&M costs per MG/year. Wastewater Operations ranked in the top quartile for sewer overflow rate and collection system integrity. Both Water and Wastewater Operations rank in the top quartile for training hours per employee. More information regarding the performance metrics may be found in Appendix C.

2.3.3. Findings

- **Staffing.** In Black & Veatch’s opinion, interviews with staff and our observations suggest that the Department employs competent people who are capable of carrying out their assigned tasks. A review of the Department’s organizational charts and a comparison to the AWWA Benchmarking data indicates that Water and Wastewater Operations are in the median quartile with respect to staffing levels. This finding simply indicates that the overall

number of positions for each utility may be sufficient to meet the Department's goals, but individual divisions and / or units may be over- or understaffed.

Water Operations reports a figure of 482.5 customer accounts per employee. This statistic is between the median and bottom quartiles, and suggests that just using benchmarking data, the water utility should target 403,104 accounts / 653 accounts/employee = 617 water employees to hit the median benchmark. The water utility currently has 835.4 FTEs. For the wastewater utility, to hit the AWWA median benchmark figure, the wastewater utility should target 373,123 accounts / 548 accounts / employee = 680 positions. The wastewater utility currently has 629.6 FTEs. As noted above, Black & Veatch **does not** recommend using benchmarking data alone for management decision-making.

Black & Veatch suggests that the Department examine the following areas in more detail to assess workloads:

- Design and Construction Management - Water
 - Continue to explore assigning only one supervisor for pipelines and water main replacement.
 - Share Administrative assistants and secretaries with Operations in co-located areas. Black & Veatch recommends that the Department conduct an in-depth evaluation of the level of administrative assistance needed for different positions and sections. To the extent possible, sharing of these resources across co-located sections should be encouraged.
- Design and Construction Management - Wastewater
 - Assign only one supervisor for collection and construction. This would bring the number of direct reports to seven under this new consolidated position, with a total unit staff of ten. As discussed later in this Report, this ratio of supervisor to direct reports is more in-line with current business management guidelines.
 - Share Administrative assistants and secretaries with Operations in co-located areas.
- Environmental Services
 - Examine number of inspectors necessary for Industrial Pre-treatment Program and Commercial. The possibility of sharing inspectors with Public Works or other City Departments may allow for some cost savings in this area.
- Process Control Technology Support
 - Examine the number of Information Technology (IT) Analysts / Programmers to make sure that the Department has adequate resources to maintain different IT programs and systems.
 - Evaluate the need for nine User Technician Specialists and whether some of these positions could be reclassified to other areas of the Department that may need staffing.

- Water Production
 - Where skills sets and equipment use are similar, consider the feasibility of sharing the electrical I&C, heavy-duty mechanics, and administrative staff with wastewater operations.
- Wastewater Collection
 - Examine the need for 21 employees under Warehouse. If the Department considers centralizing warehousing, then some additional FTE savings could be realized in this area. A specific FTE savings requires examination of the warehouse operations for the entire City. The recommendation that some FTE savings would be realized is based on the fact that positions are duplicated when operations are decentralized. Efficiencies will be gained through economies of scale and reducing redundant positions.¹
- **Combining collection and distribution yards.** The Department has a number of separate collection yards and distribution yards throughout the service area. The size of the Department's service area does support the concept of some remote facilities to reduce "windshield" time. The Department is currently performing a detailed cost benefit analysis for reducing the number of yards by combining them and perhaps moving towards a four-quadrant service area approach (divide the City into four quadrants, each of which is serviced by a combined collection/distribution yard). With respect to the remote sites, there are a number of these facilities located throughout the service area.

2.3.4. Recommendations

The following recommendations are presented for discussion as items that may warrant additional evaluation to determine if overall improvements could be achieved.

2.3.4.1 Efficiency Recommendations

- **Utilize internal resources (people and equipment) to perform specific task that are currently outsourced to private contractors.** Staff should be given the opportunity to demonstrate that performing these tasks with internal resources is competitive with current practices. A pilot program may be considered for each scenario where time, materials and cost are tracked and compared against current practices. Quality of end product and customer satisfaction (internal and external) should be included in the overall evaluation. In the case of the Department, if

¹ Black & Veatch notes that since the start of this Study, the number of warehouse employees has been reduced to 19 positions and the Department is currently proposing to eliminate one more position. Consolidation of warehousing activities may still produce additional cost savings.

contracting mechanisms such as Job Order Contracts (JOCs) are used to perform tasks, it may be more cost-effective to perform the work in-house provided that resources are available. The balance of doing work in-house versus contracting out should consider available resources, skills, and current levels of backlog activities.

- **Re-evaluate the use of Job Order Contracts.** JOCs are a very valuable tool that the Department needs to deliver services. However, the Department should re-assess how it currently uses JOCs. The cost of services provided via JOCs may be higher because contractors must provide these services “on demand” and as such, may charge a premium for this availability. Over the last few years, the use of JOCs has increased within the Department. Black & Veatch recommends that JOCs should only be used for emergency services and the dollar ceiling for these JOCs be reduced to perhaps a \$2 million level. Further, Black & Veatch suggests that for JOC services in excess of \$2 million, a limited number of competitive bids from JOC contractors be obtained so that the Department can demonstrate that it is getting the most for its money. Potential cost savings from this recommendation may range from \$1M to \$3M annually.
- **Evaluate specific elements of the Five Star Safety Program for applicability.** Specific requirements of the program may not be applicable for the current operation. Reporting may be excessive and therefore results in lost time. The benefits of the Five Star Safety Program should be continuously communicated to staff, particularly those in the field. At present, staff is not able to see the benefits of the program compared to the level of effort necessary to achieve a five star rating.
- **Assign Staff Engineers to the Operating Divisions (Water Division and the Wastewater Division).** Currently the Engineers are staffed within an Engineering Division that is independent of the Operating Divisions. Implementing this recommendation, which is intended to be similar to an internship program, will provide new staff engineers with practical field experience, and coordination between field personnel and the engineers would likely improve.
- **Implement a revised Work Schedule where feasible.** Currently, the Department’s operators work 10-hour shifts which results in a doubling up of hours/shifts on Wednesday. Clearly, this is not an efficient schedule, not only because two 2-hour gaps exist (that are covered via scheduled overtime), but also because decreased productivity is realized during this overlap. The industry standard is to use 12-hour shifts; however, the use of an 8-hour schedule is also an effective option. Black & Veatch realizes that changing shift hours and schedules requires union participation and staff involvement. Department Management is already working with union representatives to address this issue. The schedule should target greater customer coverage time, utilizing employee straight time, minimizing overtime (scheduled and nonscheduled) and overlaps, and target greater productivity, seven days per week.
- **Encourage Employee Cross Training and Use.** Many employees received cross training; however, they continue to function within one target area. The goal is to reduce the need for additional employees by making best use of existing employees.

For example, the skill set for pipeline maintenance is fairly transferrable between water distribution and wastewater collection (with some training). As such, staffing needs on the wastewater side could be met by having additionally trained water personnel reclassified and vice versa. In our experience, the following job classes have the same general skill sets: mechanics, maintenance people, technicians, and equipment operators. Encouraging cross-training for these job classes helps make the best use of existing employees; reduces the need to hire additional staff; reduces the need for duplicate equipment; and streamlines maintenance processes.

- **Revise the O&M Tech Program.** The Department has an O&M Tech program that provides cross-training of O&M technicians. This program has undergone several revisions and refinements since its implementation in the early 2000s. The current O&M Tech program has an extensive on-line and classroom on-the-job training requirement in three areas (maintenance, operations, and environmental health and safety). After completion of these areas, the employee receives a pay increase. Next, the program allows the employee to choose which other six courses they should complete. As Department Management has already recognized, the problem with this approach is that the majority of employees do not choose to pursue any further work in Operations – which is generally, where the greatest need for O&M technicians exists within utility organizations. Reasons provided include the undesirability of shift and weekend work. Since every training block completed results in a pay increase, there is no incentive for an employee to pursue a “more difficult” course of training to get the same pay increase.

The roll-out of an extended cross-training program should also address the following issues:

- **Practical demonstration of mastered skills.** Coursework for field-based skills need to include a practicum as well as a minimum number of hours in the field before the skill level is “passed.” Additionally, a required number of maintenance and operational hours at each skill block level should be satisfied prior to “passing.”
- **Skill levels should be maintained via rotations.** The intent of the O&M Tech program is to have cross-trained skilled employees. Maintenance of these skills is critical to the on-going sustainability of the program and so, rotating employees through different crews/service areas will help to keep learned skills sharp.
- **Increase accountability.** Increased pay for skills implies that there should be increased responsibility and accountability for performance to the new job level standards.
- **Pay advancement based on attaining new skills occurs when a position is available.** For example, a person meeting the Level 3 skills is not promoted until a position becomes available. Attaining the necessary skills is required

for promotion, but receiving the promotion is based on availability of positions.

- **Combine and reduce the number of remote sites.** In a similar fashion as for the collection/distribution yards consolidation reviews underway by the Department, a detailed analysis should be performed looking at reducing the number of remote sites.
- **Evaluate the viability of streamlining processes involving Field Customer Service, Distribution and Collections.** From the customer's perspective, the process of fixing a leak may appear to be inefficient, and thus, if there is a way to streamline the work processes involved, cost savings may be achieved. To understand how this could work, consider the following example: Currently, when a customer calls in a water leak, customer service sends out a customer service representative to examine the leak. The representative then makes a determination if the leak is a water distribution problem or a customer issue. If the leak is a water distribution matter, then the representative calls water distribution and leaves the site. The distribution foreman then goes to the site to assess the situation, completes a work order, and calls Blue Stake. The foreman then leaves the site and a distribution tech arrives and executes the work order. For the customer, this means that they may see up to three different people before the leak is fixed. If the work processes or these three service areas are combined, and cross-training is provided, then the number of people going out to a site is reduced (thereby improving customer perceptions) and more work orders can be completed on a daily basis. There is also the possibility that the number of Managers needed to oversee staff can be reduced by up to 25%.

As an added benefit, cross-training the technicians would allow distribution crews to help the collections people during their peak times (winter season) and vice versa (summer season for higher distribution needs). Shifting staff in this manner could support staff reductions; however, Black & Veatch suggests that additional specialized crews could be formed to address other preventative maintenance needs.

While the number of Managers may be reduced when combining Field Customer Service, Distribution and Collections, the number of foremen and supervisors may need to increase to allow for adequate supervision of fieldwork.

- **Conduct scenario-planning runs for wastewater plant staffing levels.** Prior to 2008, the standard for determining staffing levels at wastewater treatment plants was the USEPA manual, *Estimated Staffing for Municipal Wastewater Treatment Facilities*. However, as improvements and changes have occurred in the wastewater industry, the USEPA manual has become outdated. In 2008, the New England Interstate Water Pollution Control Commission (NEIWPCC) published *The Northeast Guide for Estimating Staffing at Publicly and Privately Owned Wastewater Treatment Plants*. This new guide, has become a widely used reference and its primary benefits are a series of charts that cover several different operating configurations (one shift plants; 24/7 plants; and one-shift plus plants) for plants treating 0.25 MGD to over

20 MGD. Black & Veatch suggests that given the number of possible re-staffing configurations that the Department may wish to consider, the most effective way to determine over/under staffing impacts would be to run different scenarios using NEIWPC’s model. Both the guide and the excel spreadsheets are available free from the NIEWPCC website: <http://www.neiwpcc.org/technicalguides.asp>

- Consider consolidating the 91st Avenue lab with the 23rd Avenue lab.** The 23rd Avenue lab is a fully certified State lab that has the capacity to handle additional work. While there is a need to have benchtesting capabilities at the plants for water quality / wastewater tests, there does not appear to be sufficient work for two labs. Unless the Department considers offering laboratory services to other surrounding communities, there is excess capacity in the area of laboratory services. Black & Veatch suggests that the Department maintain process-testing capabilities at the 91st Avenue lab but consider moving all other testing to the 23rd Avenue lab.
- Re-evaluate water plant staffing levels as impacted by automation.** Within the water industry, the implementation of automation has decreased the need for staffing at water treatment plants. Representative staffing levels, as illustrated in the table below, provide a benchmark for which the Department may assess target staffing levels at water treatment plants. Black & Veatch notes that the higher the level of automation, the fewer personnel may be required for operations, but more instrumentation technicians are needed. Likewise, the more complex the treatment processes, the more personnel will be needed to operate and maintain the systems. Currently, the Department includes multiple water and wastewater facilities with varying levels of automation. Overall, the level of automation in the Department could be characterized as ranging between semi-automatic and fully automatic. Some facilities and processes are fully automatic while others are currently manual or semi-automatic. The Department CIP includes funding for process control optimization projects that upgrade the older manual or semi-automatic systems to provide more fully automated systems.

Black & Veatch recommends that the Department continue to fund the process control improvements to achieve highly automated systems and consider initiating a system-wide assessment and feasibility study, including a cost-benefit analysis to determine the long-term implications of full automation.

Estimated Staffing Requirements (Full-Time Equivalents)				
Position	50 MGD		5 MGD	
	Semi-Automatic	Fully Automatic	Semi-Automatic	Fully Automatic
Plant Manager	1	1	1	1
Operations Supervisor	1	1	0	0
Maintenance Supervisor	1	1	0	0
Operator	15	5	5	1
Instrument Technician	2	3	0	1
Electronics Technician	2	2	1*	1*

Source: *Water Treatment Plant Design, Fourth Edition (Adapted from Table 25)*

**This position is split between electrical and instrumentation duties.*

- Continue to evaluate outsourcing compaction testing work.** The Department currently has a staff of 4 dealing with a highly specialized skill. Consideration should be given to cost savings that could be achieved if this activity were contracted out as needed. The Department does have on-call services with a number of geotechnical testing firms for this service, so reducing staff to one or two full time equivalents (FTEs) would provide savings about 50 percent of current levels, less the cost of outsourcing the activity.

2.3.4.2. Cost Savings Recommendations

- Evaluate the feasibility of using a call box instead of manning entrances.** The gates to facilities are automated and have call boxes. The Department should consider the costs that can be saved by using a call box instead of personnel at the entrances. Even during construction events, re-directing construction personnel to obtain badges (if not cleared prior) would still provide some savings versus having a guard on duty. We note that the use of a call box instead of guards may result in a decrease in security. Black & Veatch estimates that savings would be one FTE for this position.

The following table summarizes cost savings goals related to the above recommendations. The goals noted below are based on reported savings achieved by other large utilities.

Recommendation	Type Savings	Savings Goal
In-house vs. Outsource	Cost Savings	30% of Outsource Cost plus \$1M to \$3M for JOCs
Five Star Safety Program	Cost Savings	
Engineers moved to Operations	Efficiency	
Revised Schedule and Cross Training	Cost Savings	30% of Current Overtime

3. Water Resources

3.1. PURPOSE

In order to assess opportunities for cost efficiency, Black & Veatch reviewed the Department’s Water Resources Master Plan, and water resource costs relative to water resource demand and use.

3.2. FINDINGS

- Overall water resource use trends.** The City’s service area demands decreased slightly in 2010 compared to 2009. The water demands were about 309,122 ac-ft (100,721,750,000 gallons) in 2009 and 301,486 ac-ft (98,236,100,000 gallons) in 2010. Figures 3.2-1 and 3.2-2 show the water production and treatment plant / well resources for years 2009 and 2010. Declining water use results in reduced water revenues.

Figure 3.2-1 2009 Production Data

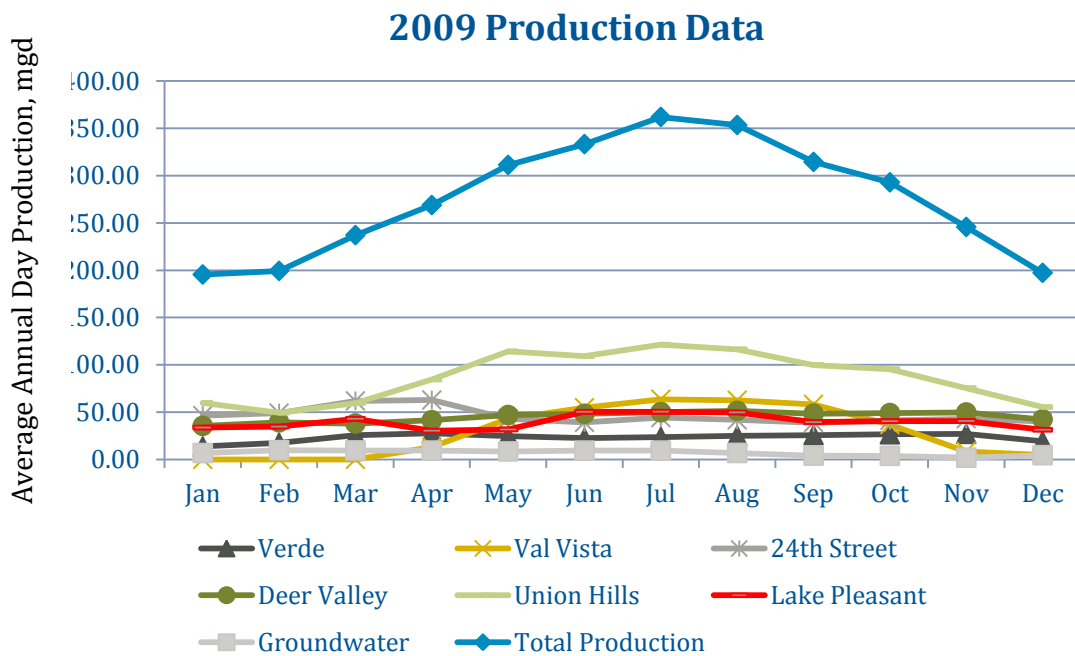
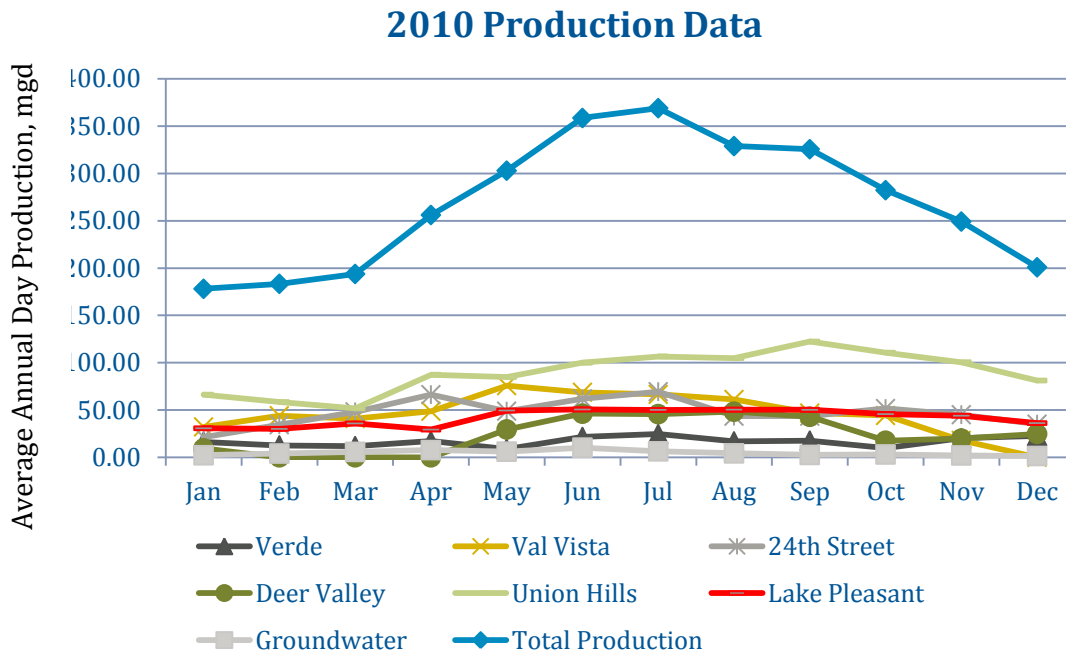


Figure 3.2-2 2010 Production Data



- Water Resources Used.** About 98 percent of the City’s water supply is from water treatment plants (WTPs). These WTPs treat surface water delivered by Salt River Project (SRP) and the Central Arizona Project (CAP) operated by the Central Arizona Water Conservation District. The Department does utilize groundwater wells in limited areas and as a source of backup water supply. In 2009 and 2010, about half of the surface water supply was from SRP and the other half was from CAP.
- Surface Water Supply is a Large Operating Cost Component.** The two water providers SRP and CAP control the raw water costs charged to the Department. In FY 2009, \$22.2M was spent on water supply. Eighty percent of that twenty two million, about \$17.8 M, was used to purchase CAP supply. The SRP supply is less expensive per acre-foot of water than CAP supply. However, SRP supply requires a greater amount of treatment chemicals to meet the Department’s treated water TOC goals compared to water supplied through the CAP. Section 4 has a summary of the combined costs for the Department’s surface water resources and water treatment.
- Resource Constraints.** There are some constraints on the Department’s water resource portfolio. The Groundwater Management Act limits the amount of groundwater that the City can withdraw. In addition, there are restrictions on SRP water resource use. For example, agencies can only use SRP water to satisfy demands from “on-project” lands. The Department cannot deliver unused SRP allocations for use off-project unless there is an exchange agreement with SRP. With an exchange agreement, the Department can use SRP water to satisfy off-project demands; however, it must be replaced on-project with an equal amount of non-SRP water. This gives the Department some flexibility relative to its supply source.

- **Resource Management.** The Department has a well-managed water resource portfolio. They have adequate supply for current water demand conditions as well as supply for future growth and resources for watershed drought conditions.

3.3. RECOMMENDATIONS

3.3.1. Efficiency Recommendations

- **Continue to evaluate opportunities to optimize water resources as conditions change each year.** For example if runoff from the areas damaged by the Wallow fire results in high organic carbon in the SRP water supplies the Department should continue to evaluate the cost tradeoffs between utilizing less SRP supply, and increasing CAP supply. In this example, the Department would compare the costs for the additional treatment of water with a high organic loading to the higher resource costs for CAP supply, the costs to move water from off-project areas onto on-project areas and potential water quality changes within the distribution system.

4. Water System Opportunities

4.1. PURPOSE

Black & Veatch reviewed the Department's water distribution system operations and water treatment plants to evaluate possible opportunities for efficiency and innovation gains as well as cost savings. This section presents an overview of our findings and summarizes our recommendations for the water system. Additional information on the water system findings and recommendations is included in Appendix A.

4.2. WATER SYSTEM GENERAL

In addition to the raw water costs discussed in Section 3.2., the major cost components of any water system with surface water as its primary resource are:

1. Labor
2. Energy
3. Chemical

The cost for labor comprises 17 percent of the Department's annual operating budget. Potential opportunities for added labor efficiency are addressed in Section 2 of this Report. The combined costs for chemicals, energy and water are about 15 percent of the Department's annual water system operating budget. Information on energy and chemical efficiency and innovation is included in the following.

4.3. FINDINGS

4.3.1 Energy Management Task Force

In April 2011, the Department management established a list of goals with a target to reduce energy and lower energy cost. The goals are as follows:

- Achieve a minimum of 3% in energy savings in FY 11/12
- Check that all facilities are on the optimum utility schedule
- Track energy demand and consumption for every site
- Determine baseline efficiency of every pump at all sites
- Implement efficiency testing, including vibration analysis, power factors, repair / replacement schedules
- Rank electrical efficiency of each site for prioritization purposes
- Develop operational strategies with energy savings and water quality in mind

To achieve these goals, the Department put together an Energy Management Task Force (EMTF). The purpose of the EMTF is to investigate ways to reduce energy cost within distribution system remote facilities and water treatment plants. To reduce energy use and energy costs, the Task Force is studying:

- Electrical use patterns
- Pump Efficiency and response to water demand
- Energy optimization by conducting a rate analysis and system operations studies.

The EMTF meets monthly and is made up of leaders in both water distribution and production. Members of the EMTF are included in Appendix A.

The EMTF also meets monthly with an Executive Energy Management Team. Members of the Executive Energy Management Team are described in Appendix A. The goal of the monthly status meetings is to maintain focus on the overall objectives of reducing energy and lower energy costs. The current status and established EMTF action items are reviewed at the Executive Energy Management Team meetings.

Actions implemented by the EMTF to-date include:

- Engaging an energy consultant to conduct energy audits of existing distribution system motors and explore potential energy rebate programs available to the Department to replace older energy inefficient motors and pumps.
- Evaluating the current energy rate structure at all water distribution and production sites to determine if the rate plan for the site is cost effective.
- Identifying the highest energy users in the distribution system and gathering past operational data and energy billing information for those sites.
- Working on a plan to monitor energy use at the top energy demand sites.

4.3.2 Distribution System Energy Efficiency, Use Reduction and Costs

- Energy efficiency and the status of the Department's implementation of energy efficient strategies are described in Appendix A.
- Table 4.3.2-1 shows the total costs to distribute water using booster pump stations and wells based on the Department's energy cost data. Since the majority of the City's water supply comes from surface water treatment plants, the majority of distribution energy costs come from booster pump stations at remote sites and at the Department's surface water treatment plants and not the wells. A range of cost savings from 3 to 15 percent reduction in distribution system energy used, as well as the kilowatt-hour and carbon emissions reduction for the same percentage reduction in energy are presented in Table 4.3.2-1 for illustrative purposes.

Table 4.3.2-1 Potential Distribution System Energy Costs and Resulting Cost and Carbon Emission Savings

Year and Total Energy Costs ¹	Total kWh / year	% Reduction	Resulting Annual Energy Use Reduction ¹ kWh/ yr	Resulting Annual Cost Savings Reduction ^{1,2} \$/ yr	Resulting Annual CO2 Emissions Reduction ^{1,3} Tons/yr
2008 - \$7,990,000	87,918,000	0 %	-	-	-
		3%	2,637,500	\$ 239,700	1,714
		5%	4,396,000	\$ 399,500	2,857
		10%	8,791,800	\$ 799,000	5,715
		15%	13,187,700	\$1,198,500	8,572
2009 - \$8,844,000	89,830,000	0 %	-	-	-
		3%	2,695,000	\$ 265,300	1,752
		5%	4,491,500	\$ 442,200	2,919
		10%	8,983,000	\$ 884,400	5,839
		15%	13,474,500	\$ 1,326,600	8,758
2010 - \$7,548,000	73,963,000	0 %	-	-	-
		3%	2,219,000	\$226,500	1,442
		5%	3,698,000	\$377,000	2,404
		10%	7,396,000	\$755,000	4,808
		15%	11,094,500	\$1,132,000	7,211
Notes:					
1. Total for water treatment boosters pump stations, distribution booster pump stations, wells and other distribution system facilities.					
2. At energy pricing for year cost incurred.					
3. According to the EPA Power Profiler information (http://www.epa.gov/cleanenergy/energy-and-you/how-clean.html), each megawatt hour of power results in 0.65 tons of carbon dioxide (2004 average APS/SRP.)					

- As shown in Table 4.3.2-1, by reducing the energy used the Department will be saving money and helping the City meet its goals for reducing its greenhouse gas emissions to 5 percent below 2005 levels by 2015 as set in the City’s 2009 *Climate Action Plan*.

4.3.3 Stage 2 Disinfectants and Disinfection Byproducts Rule Requirements

The Stage 2 Disinfectants and Disinfection Byproducts (D/DBP) Rule requires water in all designated distribution system THM monitoring locations to comply with disinfection byproduct maximum contaminant levels (MCLs) established by the United States Environmental Protection Agency (EPA). The Stage 2 D/DBP Rule MCLs are 80 µg/L for total trihalomethanes (TTHM) and 60 µg/L for haloacetic acids (HAA5). Compliance with Stage 2 D/DBP Rule is based on meeting the TTHM and HAA5 MCLs using a locational running annual average (LRAA) calculated at each designated distribution system disinfection by-product monitoring point.

- Complying with Stage 2 D/DBP Rule is a major challenge for the Department for the following reasons: (1) the distribution system is spread out over a large area which results in long distribution system detention times in some service areas, (2) the majority of the water supply is from surface supply sources with naturally occurring organic carbon which when mixed with chlorine used for disinfection forms disinfection byproducts such as THMs and some HAA5, and (3) higher water temperature increases chlorination requirements and THM production.
- The Department has planned for and implemented or is implementing multiple strategies at the water treatment plants and in the distribution system to meet the Stage 2 D/DBP Rule Requirements. These include:
 - Developing a system Water Production Utilization Plan.
 - Changed the WTP coagulant to ferric chloride.
 - Installing post-filter granular activated carbon (GAC) contactors at the Val Vista WTP.
 - Installing granular activated carbon (GAC) filtration at the Deer Valley WTP.
 - Implementing biological active carbon filtration at 24th Street WTP and Union Hills WTP.
 - Installed chlorine dioxide preoxidation systems at the WTPs.
 - Developing a Reservoir Management Plan including aeration at some reservoir sites.
 - Developing a Distribution System Optimization and Chlorination Strategy / Plan.
 - Undertaking updates to the distribution system Zone Operating Guide.
- The Department continues to look for opportunities to optimize the water production and distribution system to meet the upcoming Stage 2 Disinfectants and Disinfection Byproducts Rule (Stage 2 D/DBP Rule). Black & Veatch concurs with the Department's approach to the Stage 2 D/DBP Rule compliance relative to continuing to improve system efficiency. These approaches are described in Appendix A.

4.3.4. Water Treatment Plant

The water production and treatment costs for the Department's water treatment plants were compared for fiscal years 2008/2009 and 2009/2010 and are shown in Figures 4.3.4-1 and 4.3.4-2. These fiscal years most closely reflect future operations at the WTPs because they include operations with ferric chloride as the primary coagulant for raw water TOC and turbidity removal. Prior to FY08/09, the Department was using aluminum sulfate as the primary coagulant. The treatment costs for water at LPWTP are not included in the unit cost comparison figures because the City has a negotiated rate for the water treatment at the LPWTP and specified water quality goals. The LPWTP negotiated rate does not include the costs for raw water or the energy costs. The total unit cost for water supply (negotiated rate + raw water + energy) from LPWTP varies between \$0.90 and \$1.00 / 1,000 gallons.

Figure 4.3.4-1 FY08/09 Water Treatment Plant Unit Production / Raw Water Costs

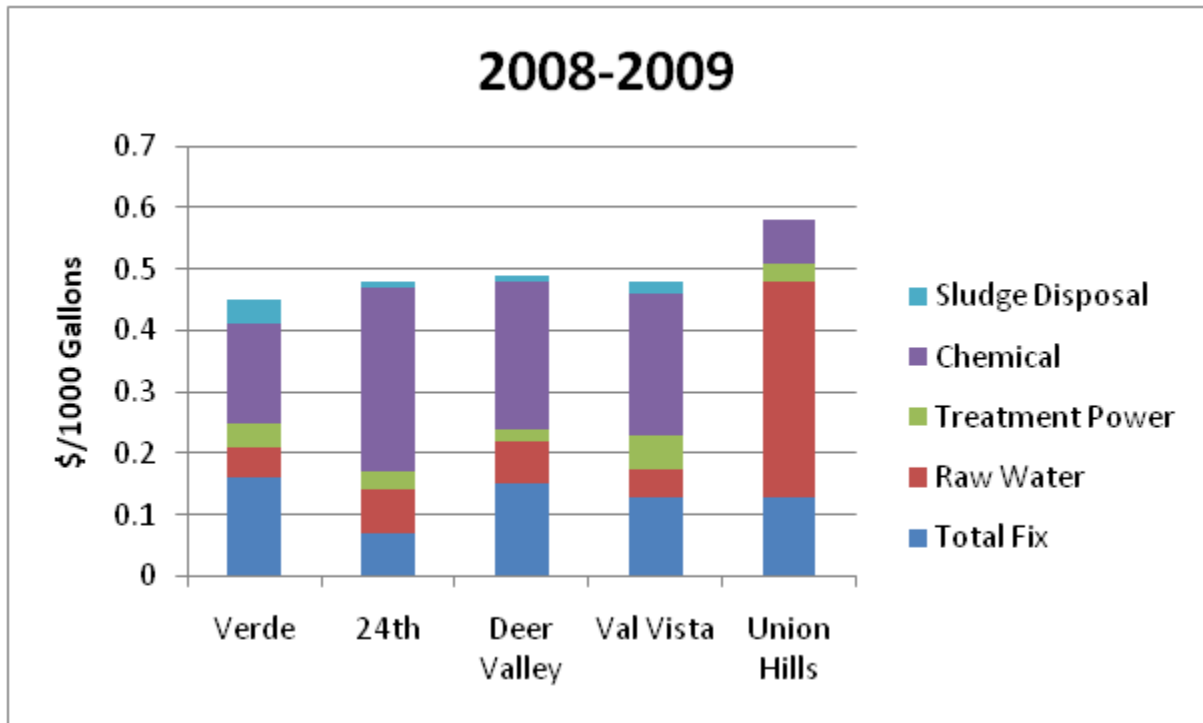
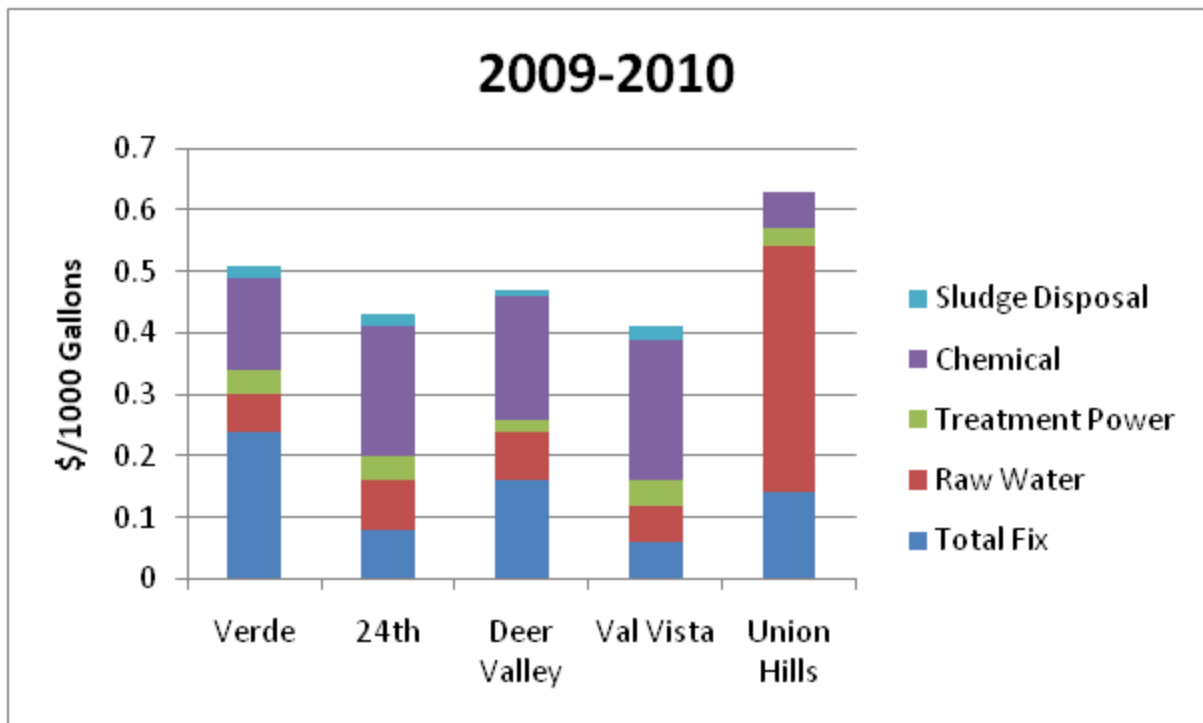


Figure 4.3.4-2 FY09/10 Water Treatment Plant Unit Production / Raw Water Costs



- The Verde WTP was constructed on land leased from the Salt River Pima – Maricopa Indian Community. The lease will end in December 31, 2014. Since there is adequate

water production capacity and additional enhancements to reduce water TOC for disinfection by-product control have not been installed at the Verde WTP, the Department intends to mothball the Verde WTP prior to the lease agreement end date. The Department is currently in negotiations with the Salt River Pima – Maricopa Indian Community and hope to mothball the Verde WTP by the third or fourth quarter of 2011. The Department estimates that there will be annual operating savings of \$1.4 million by shifting water production from the Verde WTP to other water treatment plants. Therefore, for purposes of this study the Verde WTP was not evaluated for further efficiency and innovation opportunities. Black & Veatch is in agreement with removing the Verde WTP from service, as there is sufficient capacity at other WTPs available to meet water demands.

- The following water treatment plants treat water from the SRP system: 24th Street WTP, Deer Valley WTP and Val Vista WTP. The 24th Street WTP and Val Vista WTP use similar treatment processes and the unit costs, chemical and solids handling (sludge disposal) at those WTPs are very similar. The Deer Valley WTP uses a high rate flocculation / sedimentation process (sand ballasted). Unit costs for water treated at the Deer Valley WTP are slightly higher than the 24th Street WTP and the Val Vista WTP in FY09/10 likely due to startup and some optimization of the new sand ballasted flocculation process.
- The total unit cost for Union Hills WTP water supply is greater than the unit costs at the Department's SRP surface water source treatment plants, but lower than the unit costs for water from the Lake Pleasant WTP. The largest Union Hills WTP unit cost component is the costs for raw water supply from the CAP. The Department does not have control over the CAP raw water costs. They cannot shift all production to the other lower unit cost WTPs to meet demand because of the limitations on the use of SRP sources to on-project lands. The treatment costs, chemicals and solids handling (sludge), at the Union Hills WTP are less than the treatment costs at the SRP WTPs.
- Optimization and selection of water treatment chemicals utilized at the Department's WTPs has been addressed by numerous recent water quality studies, and the Department has been utilizing the recommended chemicals to meet water quality goals particularly to reduce total organic carbon (TOC) and turbidity. Data comparisons between 2008 and 2010 show that the Department staff has optimized treatment to reduce the amount of the chemicals utilized and meet water quality goals.
- The water treatment plant production is balanced for supply of on-project and off-project demands.

4.4. RECOMMENDATIONS

4.4.1 Efficiency Recommendations

4.4.1.1 Energy Management Task Force

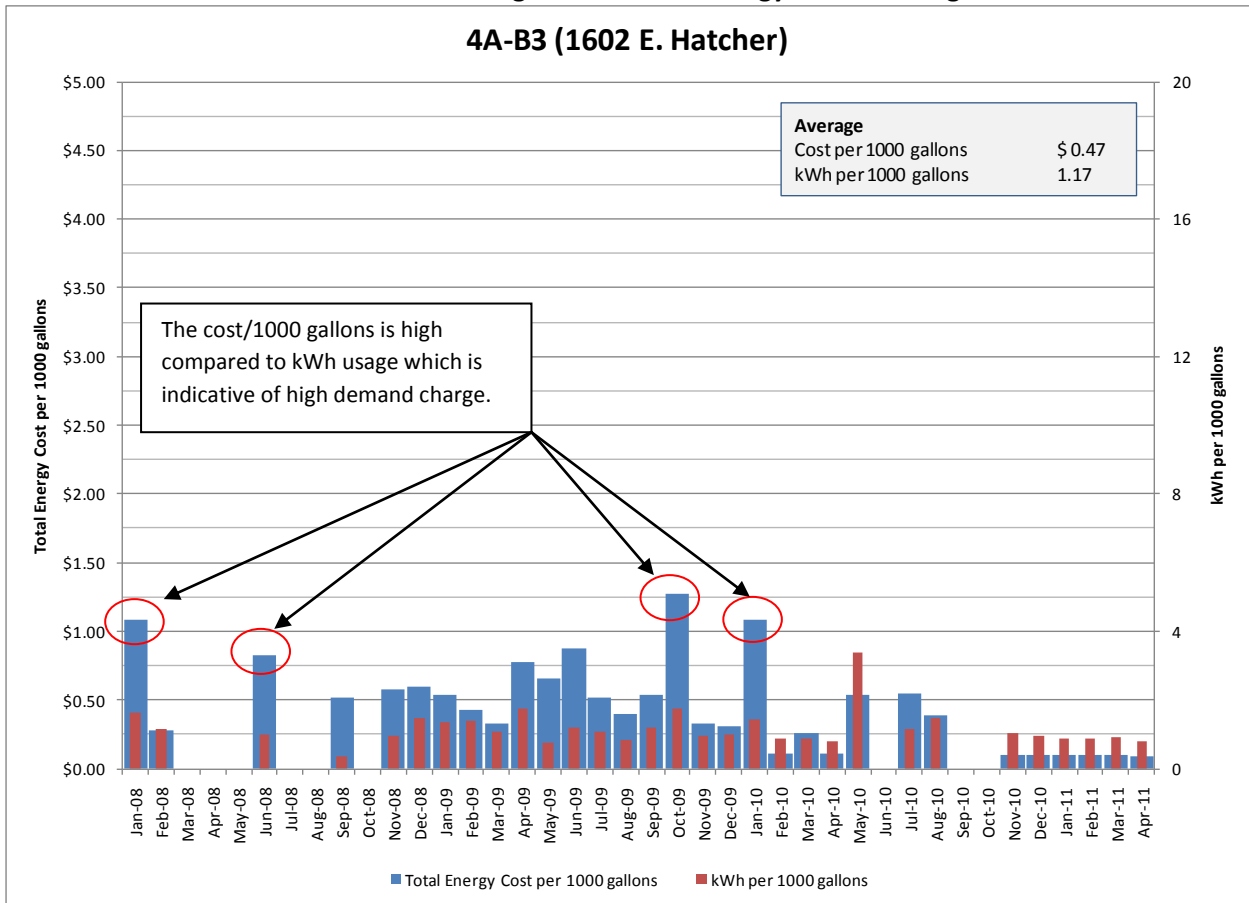
- **Energy Champion:** A single person needs to be designated as the energy champion to serve both as a visionary and as the leader for implementing and sustaining energy management strategic and operational initiatives for both water and wastewater operations. The Energy Champion should be a dedicated Energy Management Team Leader position. The other members of the EMTF should be representatives from the other areas of the Department who are not dedicated full time to energy management.
- **Continue to develop, formalize and implement the Department’s Energy Management Plan that ties into the Department’s Strategic Plan and City-wide sustainability goals.** This Plan provides the overarching strategy, vision and goals to guide efficiency and innovation efforts and decisions. The plan should be communicated throughout the Department and to other stakeholders. This is a best practice recognized and recommended by the industry.
- **Clear, concise communication of energy information** is critical to the success of the energy management strategy and the EMTF. Additional recommendations are included in this section for facilitating communication.
- **Continue to utilize the EMTF meetings** as a valuable energy management forum.
- **Assign Facility Leaders and Ad hoc Working Groups.** One staff member representing each of the key water treatment plants should be designated to serve as the facility leader for their respective facility. In addition, on an as needed basis, depending on the energy initiative or program that is or implemented, cross-functional ad hoc working groups should be formed for the life of the program or initiative.
- **Develop and maintain a defined distribution list of stakeholders** (to include Assistant Directors and Deputy Directors, WSAP members, key operations staff and administration personnel) that could benefit from timely energy management highlights. An “Energy Highlights of the Month” type email blast describing few specific issues, initiatives, findings, achievements, etc. can then be communicated to the members in the distribution list.

4.4.1.2 Energy Reduction and Unit Cost Reduction

- **Provide additional staff training on energy optimization** including strategies to reduce energy consumption and energy costs. Many utilities and companies provide training for free or at very low cost. A listing of potential vendor resources is included in Appendix A.
- **Educate operators on strategies to avoid high demand charges and higher ratchet tier charges.** The training should increase awareness of rate structure and application of electric utility demand charges.

- **Develop and implement operating guidelines addressing high demand avoidance.** An example guideline is to monitor peak demand and avoid starting pumps or use smaller pumps to avoid a higher demand charges at those pumping station sites with power monitoring equipment.
- **Provide electric bills to operations staff.** Review bills monthly for anomalies in power usage that may indicate other issues such as high kWh demand charges as illustrated in Figure 4.4.1.2. -1

Figure 4.4.1.2-1 - Energy Cost Trending



- **Continue with programming efforts to trend the short-term energy use and pumping information using existing software.** The Department has plans to trend distribution system energy key performance indicators. The recommended information to be trended includes pumped volume, kWh/1000 gallons and kW. Trends should be relative to last month's and last year's information, for boosters and wells in same zone. The Department can use the SQL Server database to store the historical operating data and existing software for accessing data and trending. Additional staff time would be required to correlate energy use information with distribution site operational data as energy data is not captured by existing

supervisory control and data acquisition system at most sites. Figure 4.4.1.2 -1 is an example trend.

Table 4.4.1.2 -1 summarizes the estimated costs and annual savings for implementing energy reduction and unit cost reduction recommendations.

Table 4.4.1.2 -1 Distribution System Energy Reduction and Unit Cost Reduction Recommendations

Recommendation	Estimated Costs	Estimated Savings
<ul style="list-style-type: none"> Provide staff training on energy optimization. Educate operators on strategies to avoid high demand charges and higher ratchet tier charges. Provide electric bills to operations staff. Develop and implement operating guidelines addressing high demand avoidance. Until the recommended longer term dashboard technology can be implemented, trend information using existing software. 	<p>Training: \$13,000/yr</p> <ul style="list-style-type: none"> Superintendent 2 days/yr Operators 4 days/yr Supervisor 2 days/yr <p>Zone operating Guideline (ZOG) Modifications: \$20,000</p> <p>Trending Tool Development with existing software: \$25,000</p> <p>Cost First Year: \$58,000 Costs subsequent years: \$13,000</p>	<p>Estimate about 1% of total Distribution Power: \$73K-\$88 K/yr (<1 yr payback) the first year.</p>

4.4.1.3 Water Treatment Plant

- Explore opportunities to optimize costs and efficiencies for the LPWTP operations contract.** Within the next few years, the Department’s operations contract for the LPWTP is coming up for renewal. This renewal period presents the Department an opportunity to renegotiate terms and conditions to address changed environmental/economic conditions and provides the Department with greater flexibility in terms of produced water quantity and quality. For example, water production constraints result in water from the LPWTP pump station being pumped to a higher pressure zone then pressure reduced to lower pressure zones, which is not energy efficient. Additional, the water quality goals such as the THM limit in the LPWTP contract may not always reflect overall distribution system water quality requirements and may at times result in the Department paying for water treated to a level that is not needed which is inefficient.

4.4.2 Innovation Recommendations

4.4.2.1 Improve Equipment Efficiency

- **Improve motor, pump, blower, and other equipment efficiency and utilize rebate programs to replace inefficient equipment.** The EMTF and its consultants are developing a program to test and evaluate remote distribution site equipment efficiency. This program includes:
 - Conducting remote site energy audits.
 - Developing system and pump curves.
 - Pump Efficiency Testing.

Once the testing and evaluations are complete, the EMTF and its consultants will evaluate the cost effectiveness compared to potential savings for the following:

- Repairs needed to increase efficiency.
- Rehabilitation needed to increase efficiency (such as rewinding motors).
- Replacement of equipment with more efficient equipment.

APS and SRP encourage and offer rebates to replace inefficient motors and other electrical equipment with more efficient equipment. Currently APS offers rebates up to \$500,000. SRP offers rebates up to \$200,000 to \$300,000. Black & Veatch recommends the Department continue with their plan to conduct energy audits starting with the largest pump stations and older pump first. The Department should also take advantage of other available rebate programs. Additional information regarding this recommendation is included in Appendix A. Estimated costs and savings are included in Table 4.4.2.1-1. Implementing equipment rehabilitation and replacement will take several years to complete.

Table 4.4.2.1-1 Replace Equipment with More Efficient Equipment

Recommendation	Estimated Costs	Estimated Savings
<ul style="list-style-type: none"> • Improve motor, pump, and other equipment efficiency and utilize rebate programs to replace inefficient equipment. 	Energy audits: \$150K-\$200K Other costs depend on audit findings and value of rebates received compared to costs.	Depending on number of sites improved, up to 3% of total Distribution Power Savings/yr = \$220K-\$265 K/yr.

4.4.2.2 Implement Limited Energy Use Trending

- **At select large energy, use sites add energy monitoring and develop programming to allow operations to trend energy use relative to equipment utilized.** Programming and equipment to allow operations and management to easily monitor and trend energy use relative to pumping utilized should be developed for a limited number of the Department’s largest energy use site. Appendix A has a listing of the largest energy use distribution system and WTP booster pump station sites. Remote sites for this recommended implementation

program should be selected from this list of largest energy users. The programming inputs and outputs should be uniform across sites monitored and should promote the use of normalized energy information and key performance indicators including:

- kWh/1000 gallons or kWh/MG,
- \$/kWh
- Maximum kW demand
- On-Peak / Off-Peak Usage Ratio
- Demand / Ratchet fees

This is a longer-term recommendation that will require additional time and money. As remote site switchgear and motor control, center equipment is replaced with more efficient equipment the power-monitoring program should be expanded to monitor these sites.

- **Complete software programming to monitor existing Eaton power monitors currently installed at some of the large water treatment plant booster pump stations and other larger treatment plant equipment and trend the data.** The programming to monitor these co-located booster pump station site pumps should be completed in the short term. SCADA and plant control system programming should be completed to log and trend the following data from the power monitoring at 15 minute intervals:

- Kilowatts
- Kilowatt-hours
- Power factor
- Current (amps) for each phase
- Voltage for each phase
- Harmonics (current and voltage)
- Operating hours when metering is dedicated to a load
- In addition to the information aggregated by equipment, this information should also be summed by process area, example raw water pump station, and also by facility, example Deer Valley WTP and by pressure zone for those WTPs with multiple pressure zone pump stations.

Estimated costs and savings are included in Table 4.4.2.2-1.

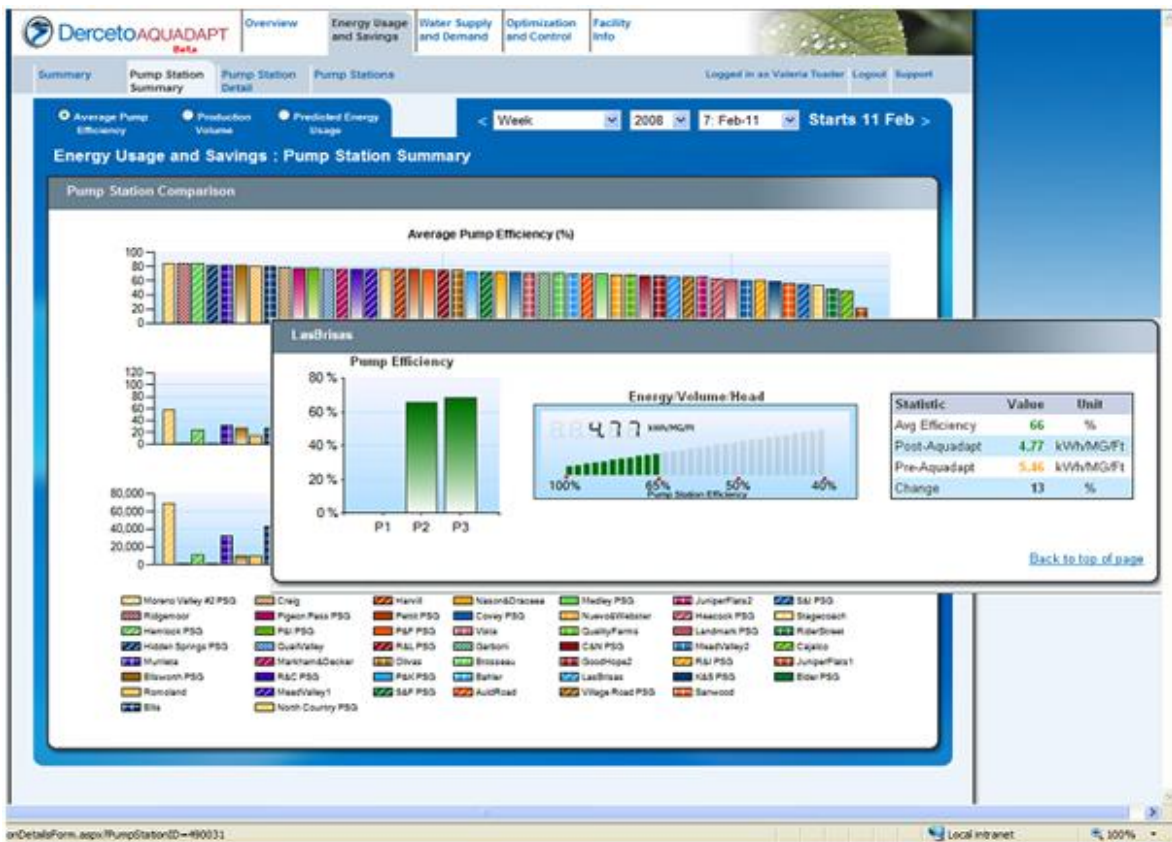
Table 4.4.2.2-1 Monitoring and Trending Energy Use

Recommendation	Estimated Costs	Estimated Savings ¹
<ul style="list-style-type: none"> • Add energy monitoring and develop programming to allow operations to trend energy use at a limited number of the Department’s highest energy use sites. • Utilize the information to implement strategies to avoid high demand charges and ratchet rate increases. 	<p>Programming for sites with existing equipment can cost up to \$10K per site.</p> <p>Costs for additional power monitoring equipment at sites selected depends on equipment at those sites as well as number of sites selected.</p>	<p>Savings can be up to 5% of a pump station site¹ annual energy costs.</p>
<p>¹Savings noted is at each site where implemented not total distribution energy savings.</p>		

4.4.2.3 Implement a System-Wide Energy Management Dashboard

Data driven decisions result in economical and cost effective management. A system-wide energy management dashboard is recommended for efficient review of energy use and to process data through interfaces with other applications used at Department facilities. Figure 4.4.2.3-1 is an example dashboard that is commercially available as part of a real-time distribution system operations optimization software package.

Figure 4.4.2.3-1 Example Energy Use Performance Dashboard (Courtesy of Derceto Inc.)



- The dashboard should utilize the energy and process data captured and auto generate normalized data to facilitate effective benchmarks across facilities.
- Key information to include in the dashboard for every facility should include pumps operating, flow per pump and pump station total flow, kWh/1000 gallons, (or kWh/MG), kW, energy cost / 1000 gallons.
- The dashboard tool should have the functional capability to aggregate the facility level energy use and cost data into functional level energy use such as pumping and treatment cost metrics.
- The dashboard tool should automatically generate trending over time for the normalized data.

4.4.2.4. Evaluate Implementing System-Wide Distribution System Operations Optimization Software

The Department's distribution system consisting of wells, booster pump stations, reservoirs and pressure reducing stations is an operationally complex, interconnected system. Changes in one part of the system affect other parts of the system in terms of water supply, pressure and water quality.

Energy and operations optimization software designed specifically for water distribution systems is now commercially available. The software can be categorized by two different approaches. The first approach develops an off-line daily operating plan that is carried out by the system operator. The second approach interfaces directly to the SCADA system, monitoring real-time data and developing pumping and valve schedules that adapt to changing conditions through the course of the day. Both approaches incorporate hydraulic models or skeletonized hydraulic models and incorporate strategies to shift pumping to periods of lower energy cost, avoid kW demand charges, utilize lowest cost water sources and utilize the most efficient pumps or combination of pumps while maintaining system pressures and volumes. Both programs aid distribution system operators in making decisions on distribution system operations and optimization. In addition, some also have the capability to effectively manage distribution storage and water age by maintaining reliable emergency and operational storage, and minimizing water age. This helps limit disinfection byproduct formation and reduces the quantity of disinfection chemical required to maintain a disinfectant residual.

While it is possible some of the cost saving ideas, such as operating cost effectively using time-of-use energy rates, could be incorporated into the Department's existing SCADA software, it would require additional investment in programming and would not be able to provide system-wide multi-variable optimization that would maximize potential cost savings and distribution system operations efficiency.

Since this is a relatively new technology, information on potential cost savings is limited. Derceto, Inc is a leader in the water distribution optimization software market with five installations in the US. Cost savings data from these five installations is shown in Table 4.4.2.4-1 as an example of the potential savings that the Department could expect. Each of these installations had a payback period of three years or less.

Table 4.4.2.4-1 Real-time Software Energy Savings¹

Installations	Total Utility Population Served	Annual Savings (\$)	Energy Cost Savings (%)
East Bay Municipal Utility District, Oakland CA (2004)	1.3M	\$360K	12%
Eastern Municipal Water District, Perris CA, Stage 1 (2006)	0.7M	\$120K	10%
Eastern Municipal Water District, Perris CA, Stage 2 (2007)	0.7M	\$190K	15%
Washington Suburban Sanitary Commission, Laurel MD (2006)	1.8M	\$865K	11%
WaterOne, Johnson County KS (2006)	0.4M	\$745	14%
Gwinnett County, GA (2009)	0.8M	\$460K	8%
¹ Adapted from AZWater 2011 Automation for Energy Optimization in Water Distribution Systems			

It is highly likely the Department could attain similar savings by implementing a system-wide energy and operations optimization software. A feasibility study is recommended to confirm the potential savings and evaluate software alternatives.

4.4.2.5 Continue Other Department Innovation and Efficiency Efforts

The Department has initiated operational evaluations, system operational studies, and operational changes to increase overall efficiency. Black & Veatch recognizes and concurs with the Department’s efforts to-date and recommends the Department periodically review planning, operational changes, work completed and system operations to assess effectiveness relative to implementation timelines, efficiency gains and cost savings. The ongoing Department innovation initiatives are summarized in Table 4.4.2.5. -1. Additional information is included in Appendix A.

Table 4.4.2.5-1 Continue Other Department Innovation Efficiency Efforts

1.	Continue to evaluate the cost effectiveness of installing micro-turbines at some of the larger PRV stations with higher constant flow
2.	Continue to Evaluate Reducing Average Distribution System Chlorine Residual.
3.	Continue to utilize THM removal strategies, such as reservoir aeration at a limited number of sites.
4.	Continue to optimize distribution system operations and production source to limit water age
5.	Continue with plans to bypass GAC treatment of Mesa’s flows at the Val Vista WTP.

4.4.3 Cost Savings Recommendations

4.4.3.1. Switching Engine Generator Exercise Schedules

Shift remote site engine generator exercise schedules to coincide with high peak energy needs to offset power cost. This will require an evaluation of air quality permit limitations to this strategy, and if it is feasible relative to air quality permitting then system operational guide changes should be developed and implemented.

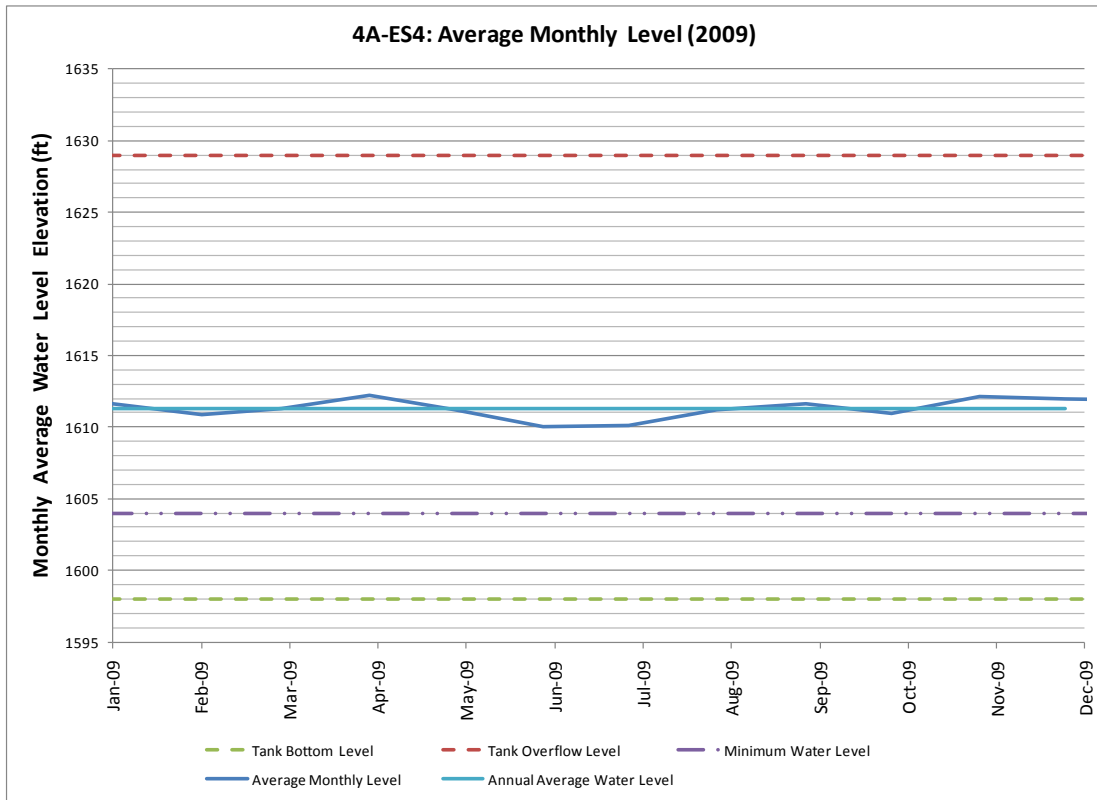
Table 4.4.3.1 -1 Engine Generator Exercise Schedule Changes

Recommendation	Estimated Costs	Estimated Savings
<ul style="list-style-type: none"> Shift remote site engine generator exercise schedules to coincide with high peak energy needs to offset power cost. 	Additional Staff time to evaluate the generator operating durations relative to air quality permitting constraints. Staff time to change the zone operating guidelines.	Depends on durations engine generators can be operated.

4.4.3.2. Seasonally Adjust Average Reservoir Volumes and Lower Levels in the Winter

Review of reservoir volume trends in years 2009 through May 2011 throughout the distribution system shows that the reservoir volumes are relatively constant throughout the year for example as demonstrated in Figure 4.4.3.2.-1 for Reservoir 4A-ES4.

Figure 4.4.3.2 -1 Example Average Tank Volume



To further reduce water age during the lower demand periods it is recommended that the target average reservoir water level be reduced during low water demand seasons. Reducing water age in the distribution system will reduce THM formation resulting in potentially less treatment (and costs) both at the WTPs and in the distribution system, and reduces chlorine residual degradation (reducing costs for rechlorination).

4.4.3.3 Operate Solids Dewatering Centrifuges at Off-Peak Time-of-Use Hours

The centrifuges at the 24th Street WTP, Deer Valley WTP and Val Vista WTP should be operated during off-peak utility rate periods. Additional information on implementation of this recommendation is included in Appendix A. The potential energy cost savings for the three WTPs totals about \$95,000 / year after subtracting the cost for the shift work differential.

4.4.3.4 Continue Other Department Cost Saving Strategies

The Department has initiated operational evaluations, system operational studies, and operational changes to reduce operations costs. Black & Veatch recognizes and concurs with the Department’s efforts to-date and recommends the Department periodically review planning, operational changes, work completed and system operations to assess effectiveness relative to

implementation timelines and cost savings. Ongoing Department initiatives are summarized in Table 4.4.3.4.-1. Additional information is included in Appendix A.

Table 4.4.3.4.-1 Continue Ongoing Department Cost Saving Efforts

1.	Continue to Evaluate and Switch a Limited Number of Additional Distribution System Sites from Flat Rate to Time- of-Use Rates
2.	Continue to Evaluate Reduction of Average Distribution System Chlorine Residual
3.	Continue with strategy to utilize Reservoir aeration at a limited number of distribution sites.
4.	Continue to optimize distribution system operations and production source to limit water age
5.	Continue with plans to bypass GAC treatment of Mesa’s flows at the Val Vista WTP
6.	Continue Distribution System Valve Position Verification and Monitoring
7.	Continue to use 1-B4 (Hayden) and 1-ES1 (64th Street Res) as Priority Supply for North Zone 1 instead of 1-B3 North PS (Rio Salado)
8.	Continue to evaluate reducing average reservoir storage volumes
9.	Continue to evaluate removing some distribution storage reservoirs from service
10.	Continue to evaluate seasonal operation of reservoirs aeration systems
11.	Continue to evaluate maximizing production at the 24th Street WTP.
12.	Continue to reduce the recycle flow volume at Val Vista WTP
13.	Continue to evaluate reducing the Val Vista WTP GAC fluff backwash frequency
14.	Continue to evaluate reducing the GAC usage rate at Val Vista WTP

5. Wastewater System

5.1 PURPOSE

Black & Veatch reviewed the Department’s wastewater collection system operations and wastewater treatment plants to evaluate possible opportunities for efficiency and innovation gains as well as cost savings. This section presents an overview of our findings and summarizes our recommendations for the wastewater system. Additional information on the wastewater system findings and recommendations are included in Appendix B.

5.2 FINDINGS

5.2.1 Wastewater Collection System

- The flow pumped by the collection system lift stations in 2009 and 2010, and the unit costs for energy at these stations is shown in Table 5.2.1-1.

Table 5.2.1-1 Lift Station Flows and Unit Costs

	FY09	FY10
Total, gallons	6,083,306,371	7,002,226,345
AAD, MGD	16.67	19.18
Total Energy Costs for Lift Stations	\$416,000	\$423,000
Unit Energy Cost, \$/1,000 gallons	0.068	0.060

- Comparing FY09 flows and unit energy costs with FY10 flows and energy costs, the Department has reduced the unit costs for pumping about 12 percent between FY09 and FY10.
- The Department cleans about 1,680 miles of sewer line each year and CCTV inspects 400 miles of sewer line each year. In addition, about 76 miles of CCTV sewer line inspection is completed with an outside vendor. This translates into a cleaning rate of 0.33 miles/ mile per year and an inspection rate of 0.09 miles / mile per year. The 2003 Optimizing Operation, Maintenance, and Rehabilitation of Sanitary Sewer Collection Systems Guidance developed through a grant from EPA references a 1999 EPA funded study showing a 5-year average U.S. large sewer system sewer cleaning frequency of 0.27 miles / mile per year and inspection frequencies of 0.07 / mile per year. The Department has a higher than average sewer line cleaning and inspection frequency.
- The Department reports 1 sanitary sewer overflow (SSO) incident / 100 miles. The top quartile under the AWWA benchmark for SSO is 1.79 incidents/100 miles.

5.2.2 Wastewater Treatment Facilities

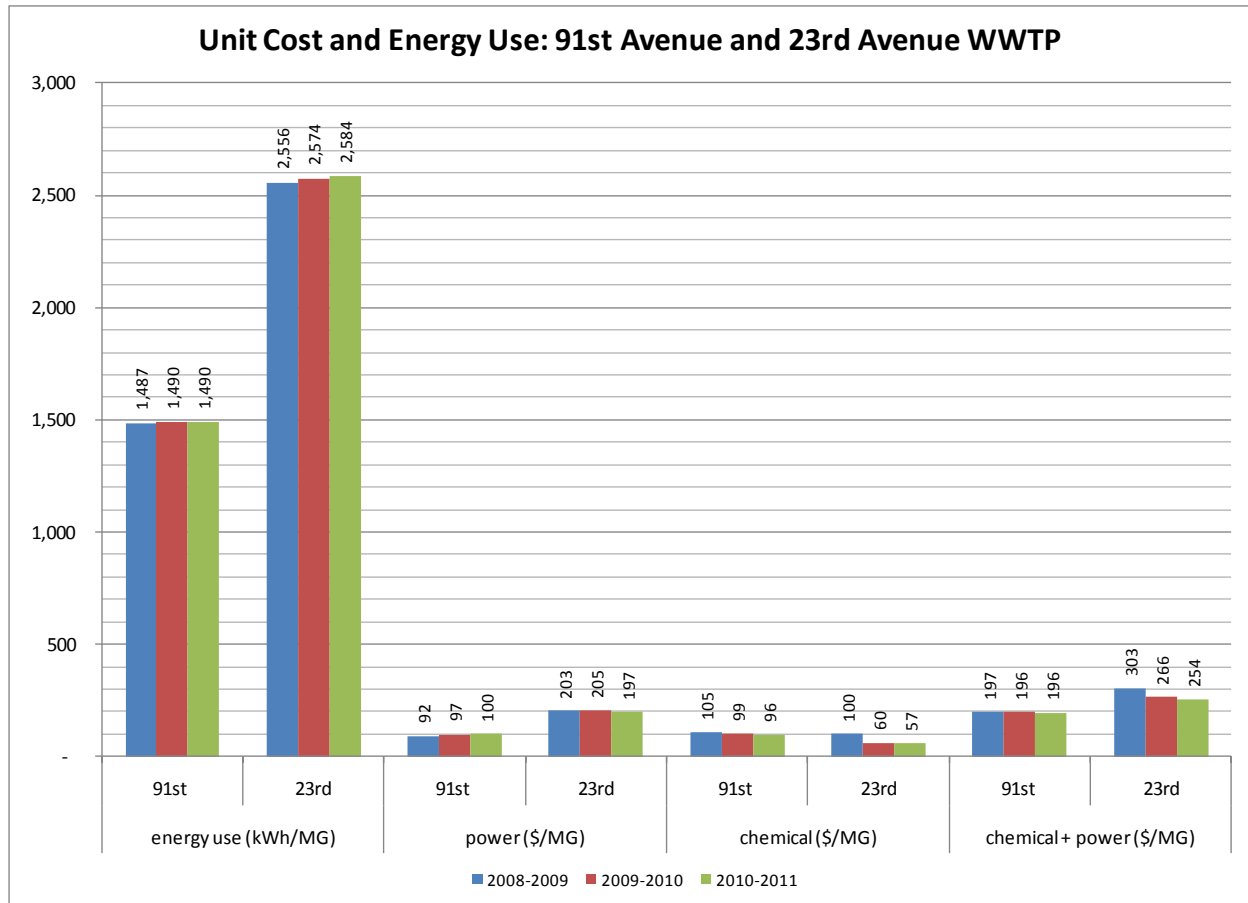
- Flows in the Department’s wastewater services area are down from previous years. In FY02, the cumulative wastewater flow was 72,000,000,000 gallons per year. In FY10, the cumulative wastewater flow was 63,000,000,000 gallons per year, a 12.5 percent decrease in 8 years. Wastewater flow in FY10 was up 1.6 percent compared to FY09.
- While the wastewater flows have decreased over the last decade, the biosolids loading has increased about 5 percent over 8 years.
- The 23rd Avenue and 91st Avenue WWTPs have a high degree of process control system automation. Operations at both WWTPs trend and use the process data to help identify and implement treatment optimization and cost savings opportunities.
- The energy costs are a large percentage of the WWTP operating costs. Table 5.2.2-1 summarizes annual kWh usage and energy costs at the 91st Avenue WWTP and the 23rd Avenue WWTP.

Table 5.2.2-1 WWTP Energy Use and Costs

FY	91st kWh kWh/yr	91st Energy \$/yr	23rd kWh kWh/yr	23rd Energy \$/yr
08-09	73,846,662	\$ 4,553,495	34,834,760	\$ 2,760,490
09-10	74,204,300	\$ 4,847,393	30,272,980	\$ 2,411,501
10-11	76,701,298	\$ 5,140,409	29,607,460	\$ 2,262,253

Figure 5.2.2-1 shows energy use and costs for the 91st Avenue WWTP and the 23rd Ave WWTP on a unit basis, kWh/MG and \$/MG.

Figure 5.2.2.-1 Energy Use and Costs for 91st Avenue WWTP and 23rd Ave WWTP



- The 23rd Avenue WWTP uses 70 percent more energy per million gallons and has almost double the unit energy costs per million gallons compared to the 91st Avenue WWTP.
- The 23rd Avenue WWTP operations staff has been making a concerted effort to reduce energy costs by reducing their demand charge. The Department has dedicated time and money installing power monitoring at the plant and installing programming at the WWTP to monitor and trend energy usage.
- The unit energy use and costs at the 23rd Avenue WWTP are higher than at the 91st Avenue WWTP as a result of the following:
 - The 23rd Avenue WWTP utilizes an influent lift station for all flows into the WWTP. The 91st Avenue WWTP does not require pumping of the WWTP influent flows.

- The 23rd Avenue WWTP was designed for an average flow of 63 MGD and it is operating at a 32 MGD flow rate. In 2008, the Department made the decision not to operate the Salt River Outfall (SRO) Lift Station; prior to that, the average annual flow to the 23rd Avenue WWTP was 47 MGD. The 23rd Avenue WWTP equipment is sized for the higher design flows and is less efficient at the reduced flows.
- The 23rd Avenue WWTP blowers are oversized at lower flows and the blowers account for nearly 1/3 of the total energy usage at the plant.
- The 23rd Avenue WWTP is in the APS energy service area and the 91st Avenue WWTP is in the SRP energy service area.
- The 23rd Avenue WWTP unit chemical costs are about 40 percent less on a \$/MG unit cost basis than chemical costs at the 91st Avenue WWTP. This is due to the following:
 - Lower flow through the plant provides additional flexibility in the process and a more stable operation from a chemical addition standpoint.
 - The 23rd Avenue WWTP bypasses secondary sludge to the 91st Avenue WWTP thereby reducing treatment costs at the 23rd Avenue WWTP but increasing the biosolids loading and treatment costs at the 91st Avenue WWTP.
- Black & Veatch evaluated the feasibility and cost effectiveness of operating the 23rd Avenue WWTP solids dewatering centrifuges at off-peak time of use hours. The 23rd Avenue WWTP is on APS E-34 rate, which does not have a time-of-use rate structure. The potential savings by switching the dewatering and thickening centrifuges to a time-of-use utility rate and operating the centrifuges on off-peak periods was evaluated. The evaluation shows there is about \$12,000 annual savings by switching the dewatering centrifuges to time-of-use rate and off-peak operation and essentially no savings for switching the thickening centrifuges. In addition, since the blowers and influent pump station must operate 24/7 and they account for a large portion of the total energy used at the WWTP, the additional costs by switching the entire WWTP to the time-of-use rate and operating the blowers and influent pumps during on-peak hours would be greater than the savings from switching the dewatering centrifuges to time-of-use.

5.3 RECOMMENDATIONS

5.3.1 Efficiency Recommendations

- **Utilize the same EMTF for optimizing wastewater system operations.** Section 4.4.1.1 recommends a Department-wide Energy Management Team Leader. This energy champion as well as the EMTF should continue to evaluate and address opportunities for improving wastewater system energy efficiency.

5.3.2 Innovation Recommendations

5.3.2.1 Collection System Recommendations

- **Conduct energy audits at wastewater collection system lift stations.** Replacing older inefficient pumps with newer pumps equipped with high efficiency motors. The Department's energy audit programs will help identify pumps and motors that are candidates for these upgrades. Additional information on energy audits and rebate programs is included in Section 4.4.2.1.

5.3.2.2 Wastewater Treatment Plants

- **Move forward with biogas cogeneration at the 91st Avenue WWTP and the 23rd Avenue WWTP.** Currently when ambient temperatures are less than 100 degrees F, about 10 percent of the digester gas is used to as an energy source for boilers, which heat the digesters. The remaining gas is not utilized and flared (burned). The Department has had studies in the past including the *1995 Digester Gas Utilization Study for the 91st Avenue WWTP* by Black & Veatch where the cost effectiveness of utilizing digester gas for cogeneration was evaluated and found to have a less than 10 year payback period. The Department has also explored the cost effectiveness of selling the surplus digester gas to a third party for their use. In 2009, the Department received a cost effective price proposal from a vendor for digester gas from the 91st Avenue WWTP but the vendor withdrew the proposal before negotiations were completed. The Department working with Public Works have selected a developer and are negotiating for utilization of the 23rd Avenue WWTP biogas and landfill gas. The Department also indicates they plan to issue a request for proposals for biogas utilization at the 91st Avenue WWTP in the fall of 2011. Evaluating the current cost effectiveness of digester gas cogeneration or biogas sale is beyond the scope of this study. It is recommended that the Department pursue additional studies and proposals for WWTP biogas utilization. One important point to note is that WWTP biogas cogeneration will require substantial upfront capital investment, but the payback period may be relatively short.
- **Continue with evaluating shutting down the 23rd Avenue WWTP and treat all wastewater flow at the 91st Avenue WWTP.** As discussed in Section 2.2.2, the 91st Avenue WWTP has available excess treatment capacity and sufficient capacity for the 32 MGD average annual flow that is currently treated at the 23rd Avenue WWTP. The Department is currently evaluating shutting down the 23rd Avenue WWTP and sending all of the City's wastewater flows to the 91st Avenue WWTP. While there could be up to a \$630,000 annual savings each year at today's energy and chemical costs by doing this there may not be sufficient capacity in the existing wastewater infrastructure to transfer the wastewater flow from the 23rd Avenue WWTP to the 91st Avenue WWTP particularly during storm related high flow events. Likewise, the evaluation of shutting down the 23rd Avenue WWTP must consider the impact to the water rights settlement agreement. Additional evaluation beyond the scope of this study needs to be completed to determine if the existing wastewater infrastructure between the two WWTPs is sufficient to handle high wet weather flows. If needed

additional wastewater infrastructure could be constructed to implement this option. However, the payback period may be substantial.

- **Evaluate utilizing biogas driven blowers at the 23rd Avenue WWTP during low demand periods.** At low flows (early in the morning), the existing electric blowers turn down limitations requires that the plant blower system blow off excess air for about 3-4 hours in order to keep the aeration basin air supply header pressure within a manageable range. There are three small blowers at the WWTP, but they are too small to keep up with the plant loads. There are also three medium sized blowers that could be used to avoid any need for air blow-off. These medium blowers are natural gas/ biogas fired. These blowers are 20 to 30 years old and have not been in use for the last 10 years. They were mothballed due to County air emission constraints. Using the gas fired blowers for 3-4 hours per day with digester gas as the energy source the potential annual savings to operate the blowers is estimated to be \$43,000. In addition to the electric energy savings, the plant also has the option to use the waste heat from the blower heat exchangers to heat the digesters. If the two open waste gas flares at the 23rd Avenue WWTP were enclosed the plant may be able to stay below the permitted emissions limits and could also utilize the gas fired blowers. The estimated cost for the flare enclosures is \$125,000. Assessing the condition of the existing unused gas engine drives and blowers is not included as part of this study. However, there may be extensive rehabilitation efforts needed to bring the units up to operating condition. If no work on the existing blowers was required, the payback period would be three years.
- **Evaluate operating the 91st Avenue WWTP solids dewatering centrifuges at off-peak time of use hours .** The Black & Veatch team evaluated the feasibility and cost effectiveness of operating the 91st Avenue WWTP solids dewatering centrifuges at off-peak time of use hours. Findings shows that the potential annual savings could range from \$69,000 to \$320,000 depending on the units selected. However, the implementation costs would be considerable and the payback period could be relatively long. Additional details about this recommendation are included in Appendix B.
- **Continue evaluating wet scrubbers verses biological odor control.** Replacement of the wet scrubbers with biological odor control is currently under investigation as the annual operating cost for biological scrubbers is significantly lower than wet scrubbers. Utilizing biological scrubbers at the 91st Avenue WWTP is estimated to save about 80 percent of the costs for sodium hydroxide and sodium hypochlorite, which is about \$900K per year. At the 23rd Avenue WWTP the estimated chemical cost savings is about \$ 175K per year. However, there will be substantial capital costs required. The number of biological odor control scrubbers that would need to be installed will be far greater than the number of existing chemical scrubbers currently in use. In addition, the biological scrubbers also require the capital investment for GAC polishing scrubbers to reduce odors not removed by the biological odor control.

5.3.3 Cost Savings

5.3.3.1 Collection System

- Decrease frequency of sewer line cleaning and inspection work.** The Department's sewer line inspection and cleaning frequencies and the noted sewer overflow rate are summarized in Section 5.2.1. The sewer line inspection and cleaning frequencies are above the national average and the SSO is in the top quartile. Thus, the Department could likely reduce inspection and cleaning operations and still be in the top quartile compared to peers. A cleaning rate of 0.27 miles/ mile per year and a CCTV inspection rate of 0.07 miles/ mile per year is a recommended starting point for reduced cleaning and inspection schedules. Black & Veatch notes that implementing reduced schedules would allow the Department to shift personnel to other maintenance activities and provide additional shift flexibility and would not necessarily provide cost savings.
- Continue with plan to discontinue use of Wastewater Lift Station 66 North Gateway.** The North Gateway Lift Station (No. 66) currently pumps to a sewer interceptor near the Cave Creek WRF. The Department is currently evaluating if the sewer downstream of this lift station has sufficient capacity for the current sewer flows historically pumped by the North Gateway Lift Station. If there is sufficient available flow capacity, then the North Gateway Lift Station will be mothballed until flows increase in the sewer drainage basin. The energy costs for the North Gateway Lift Station are not currently aggregated from other wastewater collections facilities co-located with the lift station. It is known that the lift station had an average flow of 566 gallons per minute (gpm) in 2010. Based on the \$0.060/1,000 gallon average lift station energy costs this will result in a savings of about \$17,800 per year. Black & Veatch recommends the Department proceed with this evaluation and plan to mothball the North Gateway Lift Station provided there is sufficient downstream sewer capacity.

5.3.3.2 Wastewater Treatment Plants

- Continue with WWTP biosolids solar drying at the 91st Avenue WWTP.** Black & Veatch recommends the Department continue with solar drying of biosolids as it not only reduces costs for hauling, it reduces CO₂ emissions because the number of trips for the same quantity of biosolids is greatly reduced as the wet volume decreases with the moisture content of the solar dried product. Black & Veatch also recommends that the Department continue to quantify operations costs associated with the increased handling of the biosolids to identify the optimal level of solar drying quantities. The Department estimates after rebidding their savings from solar drying may be up to \$1 M year. A percentage of this savings is offset by the additional labor required for the solar drying operations including hauling biosolids to the on-site solar drying areas, periodic turning of the biosolids and loading the dried biosolids. Additional information on solar drying of biosolids is in Appendix B.
- Continue with evaluating sending the 23rd Avenue WWTP primary sludge to the 91st Avenue WWTP.** Currently secondary sludge from the 23rd Avenue WWTP is

sent to the 91st Avenue WWTP for treatment. The Department has recently started evaluating if the primary sludge can also be sent to the 91st Avenue WWTP for treatment. Additional evaluation beyond the scope of this study needs to be completed to determine if the solids dewatering equipment at the 91st Avenue WWTP has sufficient capacity for the additional biosolids dewatering.

- **Assemble a Task Force of employees responsible for regulatory compliance, operations and engineering to review Wastewater Treatment levels.** The Task Force should evaluate treatment levels and recommend a limit that meets/exceeds permit and also provides a reasonable level of safety. Safety, public health and level of service should not be compromised. For example, when permits come up for renewal the Department could work with regulators to renegotiate permit conditions. In this manner, the Department may be able to renegotiate compromise situations to reduce the cost of compliance, such as the extra WWTP effluent sampling for the flows entering the wetlands from the 91st Avenue WWTP. Consider the following: Tucson Water used this approach to address groundwater well sampling in the event of an E Coli outbreak and it saved them approximately \$200,000.

6. Organizational Structure

As part of this Report, the City tasked Black & Veatch with examining the Department's current organizational structure. The purpose of the review is to assess the effectiveness of the structure in meeting the Department's goals. The following sections discuss Black & Veatch's observations concerning the Department's organization.

6.1. PRINCIPLES OF ORGANIZATIONAL STRUCTURE

In the United States, utilities are typically organized following one of two predominant approaches: a functional organizational structure or a product / line-of-business organizational structure. A few utilities also deploy a hybrid structure, which will be discussed as well.

6.1.1. The Functional Structure

A functional organizational structure generally follows the value chain of the utility. Employees are grouped together based on their common experience and responsibilities. In a manufacturing setting, this typically results in the design of groups like production, sales & marketing, finance, etc. In the case of water utilities, the value chain consists of production, distribution and customers. Within a utility setting, the design of groups like engineering, treatment, customer management, and finance are examples of functional design.

Benefits associated with functional organizational structures include synergies gained through sharing of common experiences and approaches. This type of structure fosters an environment of specialization and expertise development. As an example, engineers can adopt key learnings from each other regarding how to approach a common issue, which can lead to productivity advantages. Management efficiency is also usually a result of the functional structure. Because organizations are designed around specialties, a greater degree of managerial control typically results, as these organizations are typically led by individuals with in-depth knowledge of that particular specialty. As an entity grows or expands, additional specialty areas are added, in effect growing the "horizontal span" of the organization. Finally, a functional structure typically does not encounter redundancy in functions across groups as can be found in other structures.

Functional organizational structures are not without challenges. As entities grow and expand, and a greater diversity of activities (or specialties) is required to meet goals, organizations arranged functionally can actually suffer a loss of strategic control. Difficulty in coordinating activities can result as communication efforts and strategic alignment becomes more complicated. The greater the horizontal span, the more likely elements of the organization will adapt their activities to best address the challenges in their specialty area, and the greater the risk of separation from the strategic vision of the entity. This can lead to a "silo" phenomenon where differences in priorities among groups cause issues in overall execution. Some elements of the organization may prioritize short-term objectives, while others may take a longer-term outlook. Communication styles can vary across organizations and create barriers. In short, functions can find it increasingly difficult to communicate and coordinate with each other, and execution can suffer.

As organizations increase in complexity, measuring performance can also become more difficult in a functionally oriented structure. It can be difficult to enforce accountability because determining which function is responsible for a particular issue can be difficult. Finally,

management's efforts can become consumed with trying to solve coordination and communication problems, which can contribute to overall inefficiency and a dilution in the effectiveness of organizational strategy.

6.1.2. The Product Structure

The product or line-of-business organizational structure advocates organizing around product lines, therefore grouping organizations together based on the similarities or differences among products. For the Department, the lines of business are Customer Service and Asset Management. Support functions, such as engineering, finance, procurement, or others, may be centralized. However, it is not uncommon for employees within the centralized departments to specialize in one of the product areas, which minimizes communication problems throughout the product line.

Advantages of this structure include a general reduction in the communication and control problems that can emerge as business complexity overwhelms the functional organizational structure. The reduction in communication and control issues generally stems from increased focus on the needs of the product rather than the individual function, and leads to better coordination within the product. Performance measurement and cost attribution can be more easily accomplished under this structure as goals and objectives associated with specialized products are easier to track and manage. It is also typically easier to determine accountability. When compared to the functional organizational structure, this structure introduces an additional management level in that each product would need a dedicated leader assigned to manage product activities. This increased management can enable product line leaders to focus on day-to-day execution and give top line managers more time for strategic planning and broader initiatives. Finally, competition can result between lines of business that can be a healthy motivator and contribute to a positive work environment.

While the product or line-of-business organizational structure does address some of the concerns from the functional organizational structure, there are disadvantages as well. The cost of operation can be higher than the functional structure in terms of increased management, and the risk of redundancy in functions increases. This structure also can experience diminished development of expertise when compared to the functional structure. Finally, while competition between lines-of-business can be a healthy motivator, it needs to be managed such that lines of business do not ultimately increase the cost of business by competing for employees with specialized skills or even "robbing" employees from one line of business to another.

6.1.3. The Hybrid Structure

A hybrid approach is sometimes deployed which organizes by function at one level and by product at another. Because the hybrid approach combines elements of both the functional and the line-of-business structures, it is sometimes selected as a transition from a prior structure when a change is implemented. This approach may also be selected in an attempt to minimize the shortcomings of the functional or line-of-business approaches.

Under this approach, organizations that could benefit the most from specialization, such as engineering, procurement, and finance, remain centralized and functionally oriented. However, in areas that do not have much redundancy risk, or that require additional organizational visibility, or

need additional accountability, product orientations can be made underneath the functional department.

Shortcomings of the hybrid approach can include coordination and communication, as is consistent with the functional approach. Additionally, roles and responsibilities can become unclear when priorities of the functional groups and the product groups are not in alignment. Finally, accountability can be difficult to manage, particularly as it relates to product management.

6.1.4. Phoenix Water Department’s Organizational Structure

The Department’s current organization reflects the characteristics of a Hybrid Structure. Over the last few years, the Department has undergone numerous reorganizations to address staff attrition, retirements, and the operating philosophies of new (interim) Directors. The present structure consists of one Director and three Assistant Directors (Water, Wastewater, and Administration). In turn, the various divisions of the Department are headed by Deputy Directors (8) or Administrators. Beneath the Administrators are Superintendents and Supervisors. The Department has a total of 21 divisions, which are further separated into sections. The number of sections presents a challenge to both staff and management to make sure that projects / activities are coordinated; that lines of communication exist; and that “silos” do not develop.

6.1.5. Span of Control and Layers of Management

Span of control and management layers are components of organizational structure. It is important to study organizational structure and the span of control because they affect communication, decision-making, flexibility, employee morale, and resource allocation. Prior to the 1950s, classic span of control theory believed that supervisors needed to maintain close control over their direct reports. The current best management practice holds that organizations with small spans of control are inefficient and that flatter organizations with wider spans of control could lead to organizational efficiencies. The basis for this shift in practice in public sector organizations is recognition by industry experts of the following trends:

- Generational differences in the worker population – Today’s workers are more independent and there is a greater focus on individual worker performance.
- Streamlining of management ranks – To help manage costs, organizations have reduced the number of managers and supervisors. As a result, the role of the supervisor has changed from “control” to “support”.
- Cross-functional teams and decentralization – Highly specialized workforces are becoming outdated. Today’s workers are encouraged to engage in cross training, which in turn reduces the number of direct supervisors needed.

Table 6.1.5-1 summarizes the recommendations from management experts on desired spans of control.

Table 6.1.5-1 Recommended Spans of Control

Author	Recommended Span of Control	Comments
President Bill Clinton	1:14	
Peter Drucker		Concluded that more staff per manager and few management layers lead to improved management and organizational performance.
National Commission on States and Local Public Services		Recommends increasing supervisory spans and flattening bureaucracy to increase accountability and save money.
James O'Toole	1:10	University of Southern California professor whose span of control studies concluded that an average of 1 supervisor to 10 staff was sufficient.
Tom Peters	1:25+	Business author who recommends that high-performance organizations should not have less than a 1:15 staffing ratio. Greater than 1:25 is recommended.
US Government National Performance Review	1:15	In the 1990s, changed from 1:7 recommendation to 1:15. Guiding principles include organizing work around results and creating flexible relationships that focus on serving customer needs and empower employees to do their jobs.

Span of control is defined as the number of employees a supervisor oversees. For this Study, Black & Veatch considered all positions defined as management or supervisor – with or without direct reports – included in the Department’s organizational charts as part of the analysis. We calculated the span of control ratios by counting the number of subordinates supervised by any one individual. The number of staff was based on budgeted full-time equivalents (“FTEs”) and does not include any temporary employees, interns, volunteers, or staff shared with other departments.

Table 6.1.5-2 summarizes the Department’s estimated span of control based on 2011 figures. About 15.8 percent of the Department’s regular employees have some supervisory responsibilities, including some, but not all, of the Department’s Management/Professional staff. Management study experts advocate increasing supervisory spans of control to enhance organizational efficiency and effectiveness. Using an FTE basis, Black & Veatch estimates that the Department-wide staff to supervisor ratio is about 6.3 to 1, though this ratio varies from division to division. We note that the type of work performed by a division or section may affect what makes for an appropriate span of control. For example, sections that use more technology and have more systematic processes may benefit from broader spans of control. Further, due to the limited duration of this study, Black & Veatch did not quantify a breakdown of supervisory positions with a ratio of less than five direct reports. As a point of comparison, Table 6.1.5-3 demonstrates how the Department’s span of control compares to several other large water utilities.

Table 6.1.5-2 Department’s Current Span of Control

Division	Number of Levels	Span of Control	# Direct Service Delivery Positions (1)	# Supervisory Positions (2)	# Management Positions (3)	# Administrative Positions (4)	Total Number of Positions
8410 - Administration (includes Public Information and Water Quality)	3	2.0	0.0	2.0	6.0	8.0	16.0
8414 - Human Resources	5	5.5	0.0	4.0	0.0	18.0	22.0
9415 - Management Services	5	4.4	0.0	4.0	1.0	17.0	22.0
8416 - Water Res Plan & Develop	5	4.8	23.0	12.0	1.0	26.0	62.0
8421 - Water Customer Services	6	8.3	241.1	33.0	1.0	6.0	281.1
8422 - Water Production	7	7.1	136.0	22.0	1.0	5.0	164.0
8423 - Water Distribution	8	7.3	251.0	41.0	1.0	14.0	307.0
8424 - Wastewater Collection	7	6.4	136.0	27.0	1.0	14.0	178.0
8425 - Wastewater Treatment	7	7.3	145.0	23.0	1.0	7.0	176.0
8426 - Environmental Services	6	4.7	94.0	26.0	1.0	7.0	128.0
8434 - Security Management	5	5.5	5.0	2.0	0.0	4.0	11.0
8435 - Process Control	5	7.0	24.0	4.0	0.0	0.0	28.0
8436 - Technology Services	6	5.8	0.0	4.0	1.0	24.0	29.0
8441 - Water Eng & Const Mgmt	5	3.6	4.0	9.0	1.0	22.0	36.0
8442 - Wastewater Eng & Const Mgmt	5	4.0	0.0	4.0	1.0	15.0	20.0
TOTAL DEPARTMENT	8	6.3	1059.1	217.0	17.0	187.0	1480.1

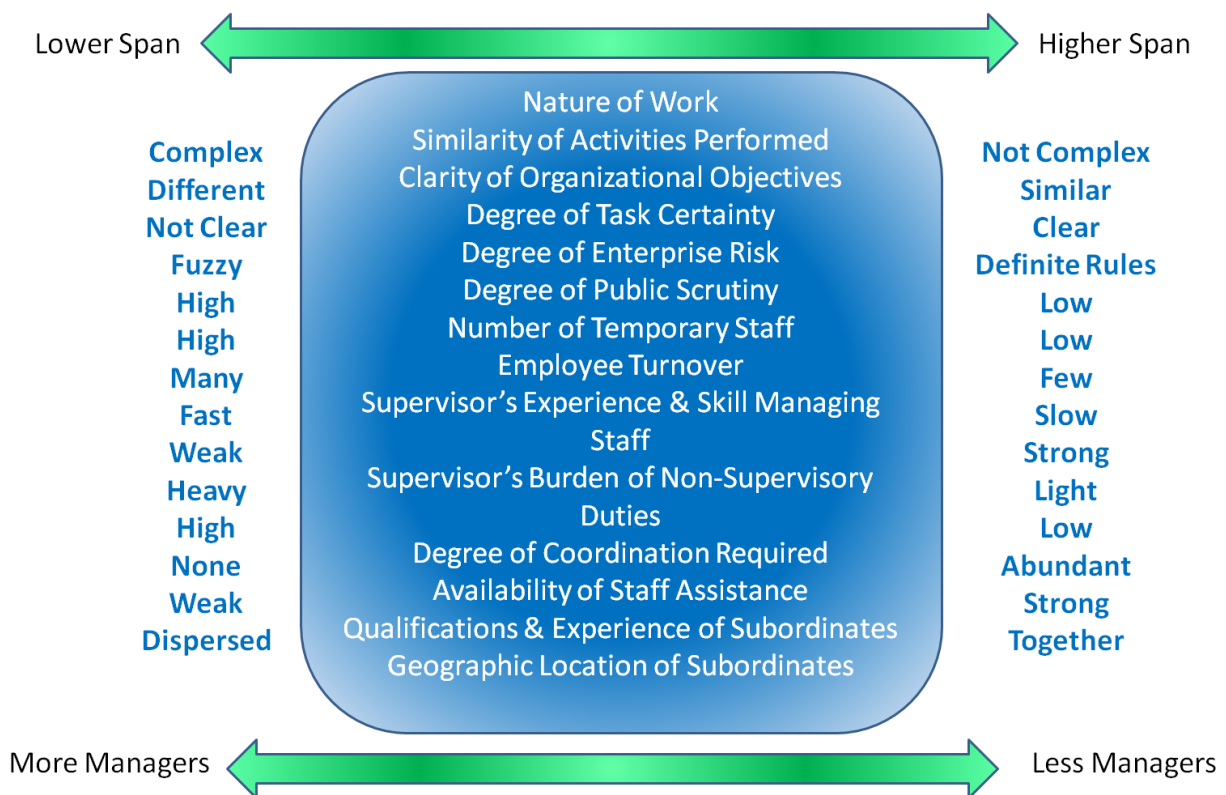
- *Leader is defined as anyone in a supervisory or management position.
- (1) Direct Service Delivery Positions are positions that provide direct service delivery (front line employees)
- (2) Supervisory are positions with supervisory responsibilities
- (3) All Middle Managers and Executives must be counted in the Management Category.
- (4) Administrative Positions are positions that perform internal staff functions, (i.e. human resources, budget, fiscal, IT, etc.)

Table 6.1.5-3 Comparison to Other Utilities

Utility	Average Span of Control	Comments
Palo Alto, CA	7:1	Combined water, wastewater, electric utility
Tacoma, WA	6:1	Combined water and wastewater utility
Long Beach, CA	8.5:1	Combined water, wastewater, gas utility
Tucson, AZ	4.88:1	Water Utility
Portland, OR	6.75:1	Water Utility
Seattle, WA	5:1	Water Utility
Marin, CA	7.5:1	Water Utility
Alameda County, CA	9:1	Water Utility
Philadelphia, PA	6.5:1	Combined water and wastewater utility

Although there is no ideal ratio of supervisors to staff (it varies from organization to organization), Black & Veatch suggests that the Department could set goals and targets for expanding the span of control. Figure 6.1.5-1 illustrates the advantages and disadvantages for expanding spans of control.

Figure 6.1.5-1 Span of Control Advantages and Disadvantages



Layers of management is defined as the highest number of layers the non-supervisory staff would have to report through to reach the top manager. Black & Veatch used this calculation to determine the longest leg separating frontline staff from the Director's office. Under the current organization, there are six layers of management. Based on an informal survey of other large utilities, the Department's figure of six is comparable to its peers.

6.2. COMMENTS REGARDING DEPARTMENT ORGANIZATION

Benchmarking staff levels for operations has been previously covered in section 2 of this Report and call center needs are addressed in section 8. In this section, Black & Veatch presents observations and recommendations regarding the Engineering and Administrative Support divisions of the Department.

Black & Veatch offers the following observations and recommendations concerning the Department's organization:

- The current split between water and wastewater areas is functioning well. Despite concerns of possibly creating silos between the two areas, staff has worked well together to keep lines of communication open. Staff has recognized the increased communication and coordination efforts at the upper most levels of the organization.
- The reality of recent scandals in other areas of the country and general unhappiness with the national economic environment results in more scrutiny of government activities. The Department has successfully provided water and wastewater services to

its rate payers for more than 100 years. However, for the majority of this period, rate payers have not had a clear understanding of the Department's mission, goals, and activities. The increased demand for transparency in government means that the Department should actively engage in a public education and communications program to inform those outside of the Department of its activities. As part of this program, Black & Veatch recommends the following:

- Continue to utilize the WSAP to serve as advisors to the Department and provide guidance and external oversight on budget, CIP, and rate matters. City Council would select WSAP members. Establishing such an advisory committee would increase transparency in the rate-setting/budgeting process and increase the public's understanding of the Department's activities.
- Develop a management report for the WSAP that reports on the progress of activities including:
 - Strategic plan initiatives;
 - Capital improvement plan programs (e.g., completion of condition assessment of small diameter mains; master planning efforts); and
 - Innovation, efficiency, and cost saving ideas outlined in this Report.
- The Department is one of the largest in the nation and serves as a model to many of its peers. To maintain this standing, the Department needs to engage periodically in strategic planning activities to make sure to validate its vision and align its tactical plans with execution of the strategy. Such an exercise would not only be a team building activity, but would help provide staff guidance. It also provides a framework from which the Department can make capital planning and operational decisions and develop strategies. Black & Veatch suggests that Department Management should continue with strategic planning efforts. In November 2009, LL Decker & Associates prepared a draft report entitled *A Strategic View of the Business Enterprise* for the Department (Draft 2009 Business Plan). The Department is moving forward to address issues raised in the Draft 2009 Business Plan; however, the current status of the implementation plan is not known.

Black & Veatch suggests that the Department provide routine updates on progress made against the Draft 2009 Business Plan activities and further, commit to engaging in strategic planning activities on a bi-annual basis. Moreover, Black & Veatch suggests that the Department adopt an implementation plan and schedule to help guide its strategic activities. Some specific recommendations that the Department should include as part of its process include the following key elements:

- a. Begin the strategic review with a formal evaluation of the plan's status to-date.

- b. Identify and revise, as necessary, the list of critical success factors and strategic initiatives. Strategic initiatives should support critical success factors.
 - c. Assign a champion for each critical success factor. It is the responsibility of each champion to assemble a team to help implement the assigned critical success factor.
 - d. Tie the Strategic Plan to the long-range financial plan for the Department.
 - e. Develop and report on performance measures that address the ten attributes of an effectively managed utility as outlined in the EUM:
 - i. Product quality;
 - ii. Customer satisfaction;
 - iii. Employee and leadership development;
 - iv. Operational optimization;
 - v. Financial viability;
 - vi. Infrastructure viability;
 - vii. Operational resilience (i.e., risk management, safety, emergency preparedness);
 - viii. Community sustainability;
 - ix. Water resource adequacy; and
 - x. Stakeholder understanding and support.
 - f. Report on a monthly basis the status of each strategy within a strategic initiative.
 - g. Define a clear planning schedule with deadlines.
 - h. Communicate the final strategic plan to all stakeholders.
- The optimal direct report to supervisor ratio varies from industry to industry. However, it is generally recognized that positions such as Deputy Director will have a minimum of two to three direct reports. The Department should consider reviewing and potentially reclassifying any staffing positions that have very few (or no) direct reports (too small a span of control) to make sure that these positions meet the City’s job classification requirements.
 - During the real estate growth period from 2005 through 2007, the Department added about 35 engineers to support engineering needs. Under the current national economic decline, management has not significantly reduced the engineering staff levels and a hiring freeze is in place. Instead, the Department has chosen to pull back in-house engineering work that would typically have been contracted out to consultants. For example, the Water Resources group is now handling the Water Master Plan update in-house. Similarly, Water Engineering has performed some small design projects in-house. However, the Department must ensure it has the expertise to efficiently complete

- in-house studies and design work. In pulling work back in-house, the Department is potentially saving money.
- Nationwide, the trend of outsourcing activities is growing as financially challenged cities and agencies struggle to close budget deficits. As evidenced with recent headlines such as the City of Costa Mesa, California laying off half of its work force; the City of Santa Ana, California outsourcing over 10 City departments, including parks, the library, and the jail; and the bankruptcy of the City of Harrisburg, Pennsylvania, cities are all looking for ways to reduce costs. The Department continues to look for outsourcing opportunities and other arrangements that would help provide potential cost savings. Due to the short-time frame for this Study, Black & Veatch did not conduct a full analysis of areas for outsourcing; however, in our experience, the following utility areas are ones that are often candidates for outsourcing and /or shared services.
 - Meter Reading and Billing Activities
 - Laboratory Services
 - Inspection Activities
 - Street Sweeping
 - CIP Program Management
 - IT
 - Safety Training
 - Well Maintenance
 - Facilities Maintenance (landscaping, janitorial)
 - Fleet Maintenance
 - Security
 - Operations / Management Contracts for WTPs and / or WWTPs.

- Black & Veatch notes that the best services for outsourcing should be complete, discrete activities that an outside organization can perform more efficiently. A full economic analysis for each opportunity should be conducted to assess cost savings, efficiency gains, and net impact on the Department. Finally, Black & Veatch notes that the Department does actively seek outsourcing/partnering opportunities. The Lake Pleasant WTP management contract is an example of outsourcing.
- The engineering staff in the Department primarily serve as Project Managers. Comments from staff and observations of business practices indicate that they would benefit from additional project management training, particularly with respect to financial systems.
 - The number of secretaries and clerical staff compared to other positions in the Department seems high. In general, we agree that Division heads and above need the administrative support (secretaries or administrative assistants). The Department

- should consider using a secretarial / admin pool to provide support to other groups, particularly in areas where divisions are co-located.
- Currently, City Finance handles procurement of non-services (chemicals, etc.) The Department handles procurement of services. The Department should consider working with City Finance to revise the procurement process. There is frustration expressed by staff over the length of time it takes to acquire goods and services when budget line items have already been approved and allocated. Black & Veatch recommends more coordination with the City's Finance Department to improve the procurement process and for compliance with City policies and regulations.

7. Call Center Evaluation

Customer Service is a key function within a utility. For many citizens, interaction with the City's customer service group represents their first encounter with the City. As such, service quality is of significant concern to the City and Department. As part of this study, the City has asked Black & Veatch to evaluate the Department's Customer Service organization including Billing, Remittance Processing, and the Call Center. It is our understanding that there is a strong desire on the part of the City to improve customer service, while also managing cost more efficiently. Our assessment identified both areas of progress and opportunities for improvement in service and delivery.

Black & Veatch used the following approach to collect information about the Department's call center operations:

- Reviewed historic call center data including customer call logs, reporting structures, employee performance metrics, and budget to actual costs
- Performed a literature search and review on call center best management practices. Conducted three focus group meetings
 - Approximately 10 employees who were formerly assigned to billing and are now part of consolidated customer service teams (their responsibilities now include answering calls during part of the day)
 - Approximately 10 employees that are primarily call takers
 - Approximately 10 employees that were formerly assigned to remittance processing and are either now or soon will be on the combined teams with some amount of call taking duties.
- Held meetings with four key managers
- Interviewed three supervisors
- Interviewed Training representatives
- Observed calls and back office work being performed and discussed observations with employees

The purpose of these activities was to obtain information concerning how the Call Center operated in the past, the affect of the new customer information system, and assess areas for improvement.

7.1. OVERVIEW OF CURRENT SITUATION AND OPPORTUNITIES

Black & Veatch used what we learned from data, interviews and observations to determine the following key findings about overall customer service performance and primary opportunities for improvement.

7.1.1. What is Working Well

The Department's Customer Service organization has the foundation to provide effective service. Following are several observations that indicate there is a foundation for improving Customer Service performance.

- We would characterize the Customer Service staff as genuinely caring about customer service and about their performance for their customers and for the City.
- Customer Service management is aware of the issues described in this report, and they are taking actions and have plans for addressing them. Among the plans that the division has implemented includes the formation of cross-sectional teams – full service teams that include phone and billing representatives working together to address customer issues.
- Implementation of the CC&B system and the Avaya telephone switch provides a technology platform that will take the call center well into the future.
- We found no hold-over evidence that the CC&B implementation created significant problems for the call center. Many utilities have encountered substantial issues during large-scale Customer Information System implementations, and the City is to be congratulated on a relatively smooth implementation.
- We found several very knowledgeable people in key positions.
- Management has recognized the problems they face, and has demonstrated a willingness to be creative with solutions as evidenced by the recent consolidated organization.
- The call center is making investments in training with a full time trainer.

7.1.2. Areas for Improvement

From an overall customer service perspective, the Department’s call center is experiencing challenges that cause customer service complaints. For example, not all calls are answered in a timely manner; call abandonment rates are high; and too many calls appear to be blocked (meaning the customer hears a busy signal because other callers occupy all available telephone system trunks.) Not all call takers are using consistent practices. Some back office work has been delayed.

From an efficiency perspective, there are opportunities to improve operations and help manage cost. For example, many employees and managers reported that “Average Handle Time” has increased since implementing CC&B. Average Handle Time is a very significant measure of efficiency. Even with the impact of the new system, there is evidence that some call takers are much more efficient than others are. There are also opportunities for streamlining several manual back office processes.

Black & Veatch suggests that senior management consider the cost and value of adding temporary staff to accommodate the workload until the Department can implement business process improvements.

7.2. DATA, REPORTING AND METRICS FINDINGS

Black & Veatch discovered that there are some shortcomings in the Department’s call center reporting capabilities. Because performance management in call centers relies heavily on metrics, Black & Veatch considers this a key area for focus and improvement. Several of our findings are documented below.

- Management has discontinued producing employee scorecards as a result of suspect Avaya data.
- The reporting derived from the Avaya telephone switch is supported by an outside vendor. Management reported that they need more support from the vendor.²
- The IVR must provide information about the disposition of calls in the interactive voice response (IVR) system. The Department reports that approximately 50% of calls are handled by the IVR. If true, this is an extraordinary IVR call completion rate, and we suspect the number includes a significant percentage of calls abandoned within the IVR without customers receiving value from the IVR experience. Management indicates that there is a CIP project to replace the IVR system this current fiscal year. The current IVR is no longer being supported by the vendor as of December 2010.
- Call volume related data is inconsistent between current reports. (This includes reconciliation between calls received, calls answered and calls abandoned.)
- Historic call volume (prior to installation of the new Avaya switch in 2010) and call volume beginning the month of installation is significantly different.
- Management reported that they believe Average Handle Time data from reports needs improvement.
- General call center metrics are not currently tracked in a dashboard style report, but there are plans to do so in the future.³

7.3. CUSTOMERS SERVICE FINDINGS

7.3.1. Getting Calls Answered

The most visible customer service problem is the difficulty customers experience trying to get through to a call taker in the Department's call center. Difficulties include long hold times in queue waiting for the next available agent and busy signals when all telephone trunks are occupied by other callers.

Common industry practice is to answer 80% of calls in 30 seconds or 90% of calls in 60 seconds. A secondary consequence of extended hold times is that many customers get frustrated waiting for their call to be answered and abandon the call. Industry norms would indicate a call abandonment rate of 4% is acceptable, but data indicates that the Department's abandonment rate

² Since the start of this Study, Department Management is in the process of obtaining these professional services to manage and enhance Avaya's capabilities.

³ As of September 2011, a dashboard-style report is being implemented that includes attendance rates and other general call center metrics.

is between 12% and 14%. Black & Veatch notes that a more in-depth analysis of the Customer Service Division is needed in order to determine the best remedies for these issues.

7.3.2. Customer Experience

Our observations indicated that the Department's representatives are generally courteous and professional when talking to customers. However, a number of factors detract from the overall customer experience. Examples include the following.

- A lack of employee understanding of policies and procedures result in inconsistent answers to customers. An excellent example involves credit policies where there was a wide range of beliefs among employees interviewed about the criteria for issuing payment plans vs. escalating a customer to a Credit Counselor for a payment arrangement.
- With the new Customer Service organization, Billing and Remittance staff has been moved into consolidated teams with call center staff. The back office staff has been assigned to several hours of call answering duty each day in order to get phones answered. As a result, some of the back office work has become seriously backlogged. For example, delays in processing adjustments or researching payments may mean that the customer's next statement is incorrect, even after they talked to a call center representative about the problem days or even weeks earlier. Black & Veatch found a number of such backlogged work items that may cause customer complaints.
- Some calls are delayed due to unavailability of leads, supervisors and Credit Counselors for escalated calls.
- Some Department employees have difficulty answering customers' questions. Examples include explaining bills (especially when adjustments are involved) and explaining sewer rate increases.
- While "First Call Resolution" data is not available, many of the staff interviewed indicated that it is low. First Call Resolution is a key driver of customer satisfaction. When customers do call back, this adds a significant incremental workload on the call center.

7.4. CALL HANDLING SKILLS

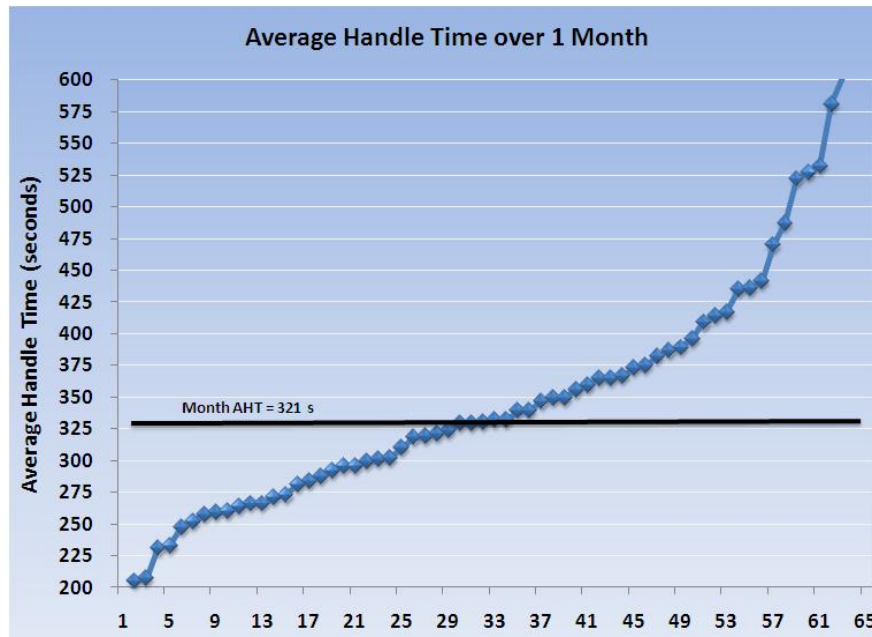
Call taking in a water utility is a complex process requiring a broad and deep set of skills for success. Consider the host of policies, processes and system interfaces that a call taker needs to be thoroughly familiar with in order to do their job effectively. The degree of skill with which calls are handled greatly affects both customer experience and productivity. It is common in call centers for agent skill levels to vary; however, Black & Veatch observed a notable lack of consistency in the Department's agent performance.

Average Handle Time by call type shows a wide deviation between agents. An analysis of monthly average handle time for English speaking agents answering a statistically significant number of calls produced the following results. Figure 7.4-1 illustrates the frequency of AHT times.

- Average for all 66 agents in this group was 321 seconds;

- 15 agents were very productive (when looking only at this metric) with under 275 seconds Average Handle Time; and
- On the other hand, 15 agents had Average Handle Time above 400 seconds.

Figure 7.4-1 Average One-Month Handle Times



While further analysis is needed, Black & Veatch believes there are significant opportunities to sharpen call-handling skills for a large number of agents thus lowering Average Handle Time and improving productivity. It should be noted that solutions that improve Average Handle Time will simultaneously address other issues affecting customer service and cost.

Black & Veatch discovered a wide gap in understanding of various policies and procedures. Below are two examples.

- There was confusion about when a customer no longer qualifies for a payment arrangement based on their violation of previous arrangements. Some agents thought the number of violated arrangements for disqualification was as low as three occurrences while others thought it was as high as nine occurrences.
- A large number of agents reported difficulty explaining information such as the disconnect process, sewer rates and how adjustments are calculated and represented on bills.

7.5. LEADERSHIP & SUPERVISION

Black & Veatch observed that each of the leaders and supervisors interviewed appear to be truly interested in improving customer service and overall performance. Several of the leaders are highly experienced and appear to be competent.

7.5.1. Organizational Structure

- The Department's Customer Service Organization needs to be re-evaluated. Consider the following.
 - Within Customer Service, there is Deputy Director with the Field and Office organizations (plus a few support individuals) reporting to her.
 - Within the Office organization, there is an Assistant Administrator with three operational Supervisor II's reporting to her. (Note that the Office organization is transitioning from three separate units (billing, remittance and call center) into consolidated teams (discussed below.)
 - Reporting to the three Supervisor II's are eleven Supervisor 1's.
- The organizational structure is made up of combined teams that include call center, billing and remittance staff. Each of these teams are structured as follows.
 - One supervisor
 - One lead (non-supervisory position)
 - Ten staff members that share call taking duties and perform back office (billing & remittance) work

While the entire organization may appear to be top heavy, the structure of the teams is of particular concern due to the small span of control. It should be noted that most call centers operate with a 15:1 to a 20:1 ratio of call takers to supervisors.

7.5.2. Supervision

In our opinion, Supervisors are a key factor in the overall performance of a call center. Their number one job should be developing skills and behaviors of their team members. In well run call centers, supervisors spend 40% to 60% of their day in side-by-side call monitoring sessions, providing feedback on recorded / evaluated calls, in team meetings, or otherwise interacting in a constructive way with their team members. From our discussions with supervisors and their team members as well as our observations, supervisors spend very little time with their agents today.

Several leaders and supervisors told us that the trainer has primary responsibility for identifying and correcting agent skill gaps. In Black & Veatch's experience, successful call centers do not employ this approach. Our recommendation is that supervisors should be accountable for team performance and responsible for individual agent skills development. The trainer should focus on formal event training such as new hire training, system / process change training, and creation and delivery of broadly needed curriculum.

In Black & Veatch's opinion, improved supervisory coaching will produce measurable performance improvements for the Department.

With the transition to integrated teams, supervisors now have responsibility for both call takers and back office work. We found that many of the back office work processes are manual. In several cases, we found the manual processes have little or no controls established. Supervisors are not always aware of who has what work on their team, how much of that work is in the queue, and

how old the work is becoming. This creates a control problem, and we found some back office transaction work that was quite stale.

Our findings indicate that supervisors spend little time providing effective feedback to agents about improving call-taking practices.

- Industry standards would include providing two coaching sessions per month providing effective feedback about previously evaluated calls.
 - Effective feedback during call coaching includes a description of what the agent did well on the call, what they could have done better and specific suggestions about how to improve (including an action plan.)
- Industry standards would also include at least one side-by-side coaching session per month with each agent.
 - During the side-by-side coaching session, the supervisor will periodically stop the agent between calls to provide constructive feedback.

7.6. TECHNOLOGY

During the last two years, the Department has implemented CC&B and a new Avaya telephone switch, which will provide a useful platform for long-term service. As with any major initiative, both of these have room for ongoing improvement. We will address that and other technology related topics in this section.

7.6.1. CC&B

As stated earlier, there is consensus that implementation of CC&B has caused Average Handle Time to increase. This affects operational costs and is affecting the Department's ability to get calls answered in a timely manner. Management reported that CC&B requires the collection of a great deal of additional information and data entry during calls. Black & Veatch believes the impact should be much less severe. There appears to be opportunities to streamline CC&B and related call taking performance by addition of super screens, implementing more built-in business rules, additional workflows, and some general clean-up of the system's problems. One specific example of a system problem that needs to be addressed is the way adjustments are represented on bills. Adjustment representation is confusing, and often causes customer calls that are difficult for agents to explain. Field observations note that an additional 3 to 5 minutes per call may be spent trying to explain billing adjustments or rate changes.

Management provided a lengthy list of proposed CC&B enhancements and system changes. At this stage of immaturity of a major new system implementation like CC&B, more IT resources are needed to make improvements that will affect both customer service and productivity.

7.6.2. Avaya & Telephone

The new Avaya telephone switch has the capability to support the Department's telephone needs. It does not currently have enough trunking capacity, but we were told this issue is being corrected with the addition of trunks. Support for automatic call distribution (ACD) reporting is a bigger problem. Avaya has a reporting suite that can be tailored to meet the Department's needs, but it requires technical support.

7.7. OTHER / GENERAL CURRENT SITUATION FINDINGS

Black & Veatch observed several other opportunities for improvement including the following.

7.7.1. Quality Assurance

The current call recording system does not have the capability to capture screen & keystroke activity for call quality evaluation. As a result, when supervisors and others evaluate calls, they are unable to answer important questions such as the following:

- Was data entered correctly;
- Did the agent effectively use the system and go to appropriate screens in an efficient manner;
- Did the agent overlook important information that should have caused the call to be handled differently?

In addition, the quality evaluation form being used by the Department does not provide a thorough evaluation of calls and does not effectively identify agent skill gaps.

7.7.2. Attendance

Almost all the leaders and employees we talked with indicated that absenteeism is a major problem for the Department's Customer Service organization. Because first priority is given to answering phones, when employees are absent, the back office work is most likely to suffer.

Management does not track attendance as a key metric. Records are maintained only at the individual employee level, and there is no general reporting of monthly overall attendance statistics, which might help bring the problem into focus.⁴

7.8. RECOMMENDATIONS

Following are several recommended solutions for helping the Department improve performance. Each of these recommendations addresses either "Efficiency" or "Customer Service" or both as noted in headings. There are no recommendations included in this section that address "Innovation" (requiring capital investment). In addition, none of the recommendations specifically addresses "Cost Savings"; however, each recommendation associated with "Efficiency" will have an indirect impact on "Cost Savings".

⁴ As noted previously, the Department is implementing a dashboard-style report in September 2011, which will include attendance metrics.

It should be noted that the recommendations in this section do not include estimated cost savings. Without effective and reliable call center reporting and an in depth analysis of that data, it is not possible to quantify hard or soft dollar savings.

7.8.1. Add Temporary Staff (Customer Service)

Adding staff is an expensive decision. However, Black & Veatch believes the City should consider adding temporary staff to the Department's Customer Service organization until service levels stabilize and other productivity improvements begin to pay dividends. A preliminary observation is that up to 20 FTEs may be needed on a temporary basis. We note however that some process improvements that Management has already put into place may reduce this number.

In addition, Department staff reported to us during the focus group sessions that there are only three Credit Counselors and that due to absenteeism or vacation schedules, there are many times when only one Credit Counselor is available for transfers. Black & Veatch recommends that the City consider expanding this group or empowering other staff members to set up payment plans. With the latter option, the City avoids the cost of ramping up staff levels, but does incur increased training costs.

7.8.2. Address General Skill Gaps (Efficiency and Customer Service)

The call center should implement an ongoing process to identify and rectify skill / knowledge based issues affecting a large number of calls or agents.

Management should appoint a small team with responsibility to rectify one or two issues per month. The general process would start with identifying issues that a number of agents seem to be having with a large number of calls. Prioritization should take into consideration the ease of correcting the problem (cost) and the impact of correcting the problem in terms of improved efficiency or customer service (benefit). Next, the team should determine the best solution, which might include simple scripts, a list of talking points, training, etc. A determination should then be made about the best method for rolling the solution out to the call takers. This might include classroom training, coaching provided by supervisors, communication in team meetings, etc. Finally, management should implement a plan to measure and manage adoption to ensure benefits are realized. This might include evaluation during quality monitoring or side by side coaching sessions.

7.8.3. Supervisor Development (Efficiency and Customer Service)

Supervisors should be held accountable for the performance of their teams. However, supervisors typically receive very little training to make them effective call center supervisors, and often, they do not have the skills to effectively manage team performance. Following are key components needed for making the Department's supervisors more effective leaders.

7.8.3.1. Redesign Job Duties and Address Time Management

Supervisors seem busy, but they are not spending time on their highest priority work – coaching and developing their agents' skills and behaviors. An initiative should be undertaken to identify how they are spending their time, and then redesigning their work. Other people may better perform some of their duties. Some tasks can be done less frequently, and others not at all.

The outcome of this exercise should be to migrate supervisors' duties to a point where they spend at least three hours a day developing their team members' skills and behaviors.

7.8.3.2. Develop Coaching Skills

Supervisors often spend too much time "coaching numbers". For example, you might hear, "Your average handle time is too high." or "That call took 12 minutes and our standard is 4 minutes." You might hear "Your Quality Score averaged 82% this month, and our standard is 95%"

However, effective coaching is not about numbers. Supervisors should be held accountable for their numbers, but they should manage their numbers by coaching skills and behaviors. Supervisors should listen to calls (pre-recorded or during side by side coaching sessions), and they should be able to identify skill gaps. Then they must apply effective coaching techniques to help their agents build skills.

7.8.3.3. Create Accountability for Results

Senior management should set expectations for supervisors to improve their teams' performance. Management should select a few focus areas where overall performance improvement is desired, and then make sure that the associated metrics are within the supervisor's control. Examples might include the following:

- Average Handle Time
- Average quality scores
- Attendance
- Schedule conformance

Performance accountability meetings should be held monthly. Management should set clear expectations for performance improvement and review progress in these meetings. Team and individual team member scorecards should be designed and reviewed in these meetings.

7.8.4. Control Back Office Work

Some back office workflows are managed through the "To Do" feature of CC&B and its queue management reporting. However, many tasks remain manual with work inputs coming from various sources and flowing to various employees. Some supervisors track and manage several of the manual work queues through spreadsheets or other control mechanisms. Others' back office work queue's are not tracked and controlled. We found a number of examples of backlogged work of which supervisors and managers were unaware. These create great potential for customer dissatisfaction and incremental calls.

Black & Veatch recommends that the Department undertake an inventory of all back office tasks along with a determination of where the work comes from, whom it goes to and how it is inventoried, controlled and managed. For those work types that are inadequately controlled, an effort should be made immediately to establish an accounting of existing work and develop a control and management process. In the short term, it could be as simple as supervisors doing a daily desk check of their team members to examine work stacked up on desks. Creating manual tracking sheets and an associated manual workflow process is a reasonable intermediate term

process. However, consideration should be given to automating workflows for higher volume or more critical work.

7.8.5. Reporting & Metrics (Efficiency and Customer Service)

Black & Veatch believes that the ability to measure performance is foundational to improving it, and the Department should correct reporting problems as well as effectively track metrics. Following are our recommendations.

- Perform an in depth analysis of current call center reporting coming from the telephone switch and reporting capabilities associated with the existing workforce management system. This analysis needs to be done by an individual with a thorough understanding of telephone reporting and call center metrics. It should start with reconciliation of numbers between reports and a sanity check of the numbers reported. The outcome of this analysis should include both the identification of inaccurate data and the definition of additional reporting needs not currently being met.
- Undertake an initiative, in conjunction with the vendor, to correct inaccurate data and to determine if the current reporting solutions are capable of providing the data needed. It is likely that many of the issues can be corrected without a great deal of effort. For the more complex requirements, a decision can be made about making any necessary investment.
- Establish a general management process that includes comprehensive dashboards, monthly reviews of metrics, status and performance with executives and team and individual scorecards.
- The metrics that are being measured currently are generally appropriate, though indicators such as Average Handling Times should be measured in seconds not minutes.
- Perform periodic CSAT surveys (for example, every 2 years) to monitor customer satisfaction and service levels. These surveys will also provide feedback on what customers consider to be important to them.

7.8.6. Technology (Efficiency, Customer Service, and Innovation)

The new CC&B system is a major step forward for the Water Department's CIS needs, and the Avaya telephone switch can support future telephony needs. However, as with any new system, there are many opportunities to refine these systems, making them more efficient. Examples of possible technology improvements are listed below.

- Revise the customer bill to make it more easily understood and to correct errors such as misrepresentation of adjustments.⁵
- Design and implement super screens to support key call taking processes.
- Design and implement more back office workflow capabilities and associated control mechanisms to create consistency.
- Integrate more business rules into CC&B, especially regarding payment plans and agreements.
- Create more “to do” workflows. (An example would be creating a payment research item.)
- Implement virtual hold technology that tells the customer how long their queue wait time will be and offers a call back rather than making the customer wait on hold.)
- Implement the capability in the quality assurance system to capture screens and keystrokes.

7.8.7. Organizational Review (Efficiency)

Management should consider evaluating the entire leadership structure to see if any positions could be consolidated. Specific attention should be paid to the Office organization where spans of control seem quite limited compared to other organizations.

Black & Veatch suggests that the City delays streamlining the leadership staff size until the new merged organizational structure has settled and until management has reviewed and revised supervisors’ duties allowing them time to learn how to manage larger teams. At that time, the Department should consider increasing span of control at each leadership level and possibly eliminating several positions.

⁵ The Department is currently in the process of examining the feasibility of outsourcing bill printing and web services. Management plans to incorporate any bill redesigns at the time of vendor selection and anticipates that this outsourcing will be completed by the end of 2012.

8. Water and Wastewater Capital Project Planning Process

The Capital Improvement Program (CIP) represents a huge cost element for the Department. Consequently, the process used to select projects for the CIP is of critical importance. In this section, Black & Veatch presents a summary of our review of the Department's capital planning process.

8.1. CURRENT STATE ASSESSMENT

Black & Veatch conducted a half-day workshop with City engineering, operations, and planning managers and leadership to discuss the City's capital planning organizational structure, staffing, and processes, and culture. The discussion centered on both the capital planning and capital project execution aspects of the Capital Plan. During the workshop, data requests were made of the City. Workshop attendees included representatives from all appropriate Department divisions.

8.1.1. Overview of Current Department Process

In developing the CIP that is funded in the Budget, the Department uses a three-phase process that combined gives the Department a listing of prioritized projects.

The first phase is to develop project charters for all the potential projects planned by the Department. The project charter documents the description, the need, the costs, and other basics. These charters contain the fundamental elements that will be used in the prioritization process.

The second phase consists of the prioritization process, which is done concurrently with the annual budgeting process. The prioritization process ranks the projects based on select criteria using the Simple Additive Weighting (SAW) method to assign scores. There exist 9 criteria. Within the criteria, a rating of 0 to 10 is assigned for the specific criteria. Traditionally, the higher the rating, the more important the criteria. The criteria are:

- Regulatory Compliance
- System Replacement/Rehabilitation
- System Reliability
- Operation Flexibility
- Project Magnitude
- Customer Service
- System/Project Benefits
- System Growth
- System Security

Once the ratings are assigned to the projects, the SAW method is utilized. The SAW multiplies the weighting of the criteria with the rating to arrive at a score. The scores for all the criteria are added together to arrive at a total score as shown in Figure 8.1.1-1.

Figure 8.1.1-1 Sample Project Score Card

Project Score			
Criteria (j)	(w) Weight	(r) Rating	(e) Score
Regulatory Compliance	0.160	2.0	0.320
System Replacement / Rehabilitation	0.140	10.0	1.400
System Reliability	0.120	8.4	1.008
Operation Flexibility	0.140	5.0	0.700
Project Magnitude	0.090	8.3	0.747
Customer Service	0.100	7.5	0.750
System / Project Benefits	0.120	0.7	0.084
System Growth	0.060	4.0	0.240
System Security	0.070	9.4	0.658
Project Total	1.000		5.907

The weightings are predetermined and are constant for all projects. After the process has been done to all projects, then the total scores are ranked from highest to lowest to get a ranking as shown in Figure 8.1.1-2.

Figure 8.1.2-1 Sample Prioritized Rankings

Project	Score	Rank Criteria Priority
Project C	9.1235	1
Project F	8.2650	2
Project G	7.8893	3
Project J	7.8851	4
Project H	6.5442	5
Project I	6.3527	6
Project B	5.2208	7
Project A	4.3361	8
Project D	3.2102	9
Project E	3.2000	10

The third phase consists of fine-tuning the ranking based on budgets constraints. In any specific year, there exist budget constraints that limit the amount of funds available to be used for projects. When the constraints are incorporated, projects shift along the ranking to accommodate the budget. Upon arriving on a CIP that meets the budget constraints, it is submitted for approval. The consequences of deferral for the projects must accompany the listing. All projects are prioritized, but those that are under construction and / or mandatory are given a higher priority than others are. Mandatory projects could be a project driven by a regulatory requirement.

Each year, the capital plan is approved through the three-phase process, with a five-year capital plan conceptual approval each year. The five-year capital plan is subject to the next year's budget constraints and fine-tuning. An annual workshop is held to incorporate any new identified projects into the CIP, and categorize the projects in one of 13 priority categories.

8.1.1.1. Cost-Benefit and Alternatives Analysis

The charter process includes the ability to incorporate a cost/benefit analysis of proposed projects. Of the three sample projects provided in response to the data request, only one of the three had reference to a quantitative cost-benefit analysis. While this one example did reference cost-benefit analysis work, the analysis only listed potential cost savings. Best management practice for this type of economic analysis is to calculate a project net present value (NPV) or benefit-cost ratio to assess its financial impact to the utility. Of the three example projects provided in response to the data request, none had any type of detailed comparison or analysis of alternatives.

Black & Veatch notes that it is possible that the detailed alternatives analysis will have been completed by the project manager as part of another project. However, should this be the practice, Black & Veatch recommends that the project charter form should be expanded to include references (document links) to other project charters or studies where such analyses may be found. Ideally, a single project charter should contain all references and relevant information necessary for senior managers to render an opinion on the importance of the project to the Department.

8.1.1.2. Capital Plan Information Technology Systems

The City utilizes WaterWorks to store data and information pertaining to its capital plans and accounting data. This system stores each project's charter, as well as project accounting data such as budget totals, actual historical expenses for the project, and forecasted future expenditures. Project change requests can be executed through WaterWorks, and projects are managed and controlled through the system.

WaterWorks leverages Primavera CM13 as its project schedule software. Project schedules developed in Primavera are attached to the project charter.

The Department is currently in the process of implementing Oracle WAM, with a go-live date of the end of September 2011. It is the Department's intent to populate Oracle WAM with current asset information and then update the condition of assets on an ongoing basis. Updated asset conditions will provide Department staff with information necessary to project rehabilitation and replacement (R&R) needs that are more reflective of actual conditions and develop a risk profile for the utility. Finally, SAP is utilized at the City for project accounting, with some type of integration with WaterWorks for queries.

8.1.1.3. System Planning

The City has an in-house master planning group that performs analysis and planning for distribution and collection systems. The City utilizes outsourced engineering expertise to complete water and wastewater treatment plant planning studies and long term needs assessments.

8.1.1.4. Cost Estimating and Contingency Planning

Cost estimating is performed using a combination of project manager judgment, past bids on similar projects, and a unit cost manual developed in 2009. It does not appear from our workshop interviews that the city has well-defined procedures or processes established for cost estimating or contingency allocation and draw-down.

Contingency levels are currently managed at the program budget level, not the project level. This means that if a project is executed for less than its budgeted amount, any savings could then be used by the program manager to pay for potential overruns in a different project within the program budget.

8.2. RECOMMENDATIONS FOR AREAS OF IMPROVEMENT

8.2.1. What the Department Does Well

The current CIP planning process used by the Department reflects several years of development and is a well-developed approach. The Department's use of criteria for ranking projects places it well ahead of the majority of its peers.

To the City's credit, utility managers have a firm grasp of the current capital planning and execution process and procedures in place at the City. A strong level of commitment and engagement was evident during the workshop as utility managers explained the current planning process and how the water and wastewater teams collectively provided input into that process and system.

The City has a comprehensive and well-defined set of planning criteria by which projects are ranked. Issues such as security, regulatory, and reliability are incorporated to help define utility priorities for its system and planning.

The City has a well-defined procedure for carrying out its planning process. Data is stored electronically within WaterWorks and the WaterWorks system is utilized to develop and then manage the capital plan on an on-going basis. This demonstrates the City has made past investments in improving knowledge management, which can only serve to benefit the City in the future as utility management carries out its duties of planning and as turnover inevitably occurs.

Having an in-house master planning and modeling group gives the City benefits of understanding its existing system and where its system is vulnerable with respect to aging infrastructure. This helps the utility allocate its R&R budgets appropriately to those areas of the system that require higher levels of spending.

The recently identified, cross-division value engineering initiative underway at the City is a positive development. This initiative brings together a cross-functional team of experts from different areas of the city to focus on how to optimize and gain cost efficiencies from significant capital and O&M expenditures that the City faces. This type of value engineering process is one that can identify important ways to add value to the City by increasing capital efficiency.

8.2.2. Opportunities for Improvement

While the current prioritization procedure is well defined, it could be improved in two areas as noted below. Black & Veatch notes that these refinements to the process will take time to implement and thus, should be implemented in the next planning cycle.

- Economic alternatives analysis (e.g. net present value (NPV), benefit-cost analysis)
- Risk analysis

Both of these are alluded to in the aforementioned 'System/Project Benefits' definition, but the example project charters and procedure definition do not appear to include the appropriate financial templates to carry out the analysis. For example, while the project charter includes a table to estimate future project costs by year, it does not calculate a project NPV. Further, while it has a blank to estimate future O&M costs, these were not estimated for the example projects provided, and no project NPV was calculated.

Finally, no alternatives analysis appears to be required by the project charter process. Requiring an alternatives analysis would help the utility identify ways of optimizing its long-term costs by fully identifying and vetting out potential O&M alternatives to capital projects. This alternatives analysis can begin as early as the planning stage of projects, and need not wait until later stages of the project development process. By including a planning-level alternatives analysis, cost-saving ideas can be developed prior to the team getting set on one alternative without fully defining and considering less intuitive, but perhaps more efficient, alternatives. As noted previously in this section, even if these analyses are conducted in prior studies, they should be referenced in the project charter so that the project record is complete.

The current project charter and prioritization process does not explicitly define risk for each project. While it does have criteria for reliability, it does not answer the following question: what level of risk does the City take on if a project is delayed? Asking this fundamental question and then quantifying or at a minimum describing qualitatively what risks a utility has from a project delay is an important planning question that should be incorporated into the City's prioritization and planning processes. The current procedure does not highlight this step enough.

Black & Veatch notes that the Department is in the process of completing condition assessments of its facilities (underground and aboveground). Additionally, the Department has been working on dedicating dollars to R&R work in accordance with schedules developed by consultants several years ago. This is a positive step in the right direction, but the Department needs to couple this activity with updating the condition of assets as maintenance / rehab activities occur so that the resulting R&R schedule can be updated as well. This becomes important when decisions to move out CIP projects are made due to resource constraints. Without complete R&R schedules and risk profiles, the Department cannot assess the consequence of (asset) failure should projects be delayed. The Department anticipates that the updating of the R&R schedules can be accomplished when the WAM project goes live at the end of September 2011.

8.2.3. Areas that Need to be Reorganized to Gain Efficiencies

- Performance management is carried out at the division / program level. Recommend adding individual performance metrics for project managers and individuals to drive

- greater accountability. Keeping the group/division goal and performance metrics is good and helps promote a team-based culture, but some level of individual performance management is needed at the City to increase accountability. Examples of individual metrics include number of change orders issued; budget-to-actuals measurement; and schedule adherence.
- The majority of projects on the CIP are generated by Engineering staff. Consider having operations staff identify needed projects and then having engineering work from that list. This would help make sure that operational projects are on the CIP and not mis-prioritized.
 - Continue to implement the policy that Finance holds on to project “savings”, not program managers. Project Manager’s need to be held to their budgets and not allowed to move program money around without Finance approval.
 - Strengthen risk analysis and financial alternatives analysis of projects > \$250,000 in cost. Managers should fully vet O&M alternatives to capital spending. Add the following questions to the project charter:
 - What alternatives to this project exist?
 - What O&M activities or projects will allow this project to be delayed?
 - What risk does the City take on by delaying this project?
 - Economic NPV analysis of the top 2 alternatives plus a “do nothing” option, should be required prior to funding for any project >\$250,000 in cost
 - Continue to stress that CIP projects will be re-evaluated at different stages of its lifecycle. Specifically, re-examine the viability of the project at the design phase and again at the pre-construction stage. If the project analysis indicates that the project is not feasible then it should be shelved and / or removed from the CIP.
 - Consider evaluating projects from a program or Master Plan perspective.
 - Continue to have an Executive Review team that has the final say for CIP projects. Members of this team could include the Assistant Directors and the Director. Members of the Executive Review team do NOT participate in any of the project ranking / vetting process conducted prior.
 - Establish targets to minimize CIP carry-over amounts. Utilities with consistent CIP carry-over rates over 30% demonstrate that they have difficulty executing the CIP and are over-scheduling projects. Consistently carrying over a large portion of the CIP could have a negative impact on possible rate increases. Improvements to project schedule and resource estimates could narrow the variance between actual and budgeted CIP expenditures, which could lead to a more accurate estimate of rate increases needed. The Department should consider aiming for no more than a 15% CIP carry-over rate and adjust the next fiscal year’s CIP budget accordingly. Similar to performance metrics pertaining to accuracy of budgeting activities, encouraging more accurate projections increases project management skills, provides better information for resource allocation, and reinforces fiscal discipline.

- Consider taking the CIP to the WSAP for review before going to City Council. This provides staff with an opportunity to explain the components of the CIP in a public forum.
- Add to WaterWorks and/or its replacement the ability to see project actuals vs. budget with a 'one-click' button. This is not possible with the current system.

9. Budget to Actuals Expenses

In conducting a review of the Department's budget to actual expenses, Black & Veatch focused on a two-step approach of 1) reviewing the current budgeting process and 2) identifying potential areas for savings.

9.1. REVIEW OF CURRENT BUDGETING PROCESS

9.1.1. Zero-based Budgeting

The City of Phoenix uses a modified Zero-Base Budgeting (ZBB) budgeting process. Each summer, the Department submits an estimate of the costs associated with providing service in the subsequent fiscal year. This budget goes through a series of technical reviews before submittal to the Mayor and City Council. The budgeting process is under review and modification by the City's Budget and Research Department. As a result, Black & Veatch did not comprehensively evaluate the previously used process. It is our understanding that the City desires to move further towards a ZBB approach.

9.1.2. Department Wide Budget

In a large organization such as the Department the feasibility of implementing the ZBB approach can be cumbersome. The Department currently has 221 cost centers. While the cost centers can be grouped to form a decision unit, the reality is that there will be many decision units. In addition, the ZBB process generates alternatives for each decision unit that will result in an even greater number of decision packages. If the Department seeks to implement ZBB, the Department should either:

- Select the top 5 or 10 cost centers based on costs to perform ZBB. The intent is to examine the largest expenditures within the Department.
- Select 5 to 10 cost centers each year on a rolling basis to perform ZBB. The remaining cost centers will continue to budget using the existing method. The intent is to capture all cost centers every five years.

9.2. IDENTIFYING POTENTIAL AREAS FOR SAVINGS

In reviewing the Department's expenditures, the Department has 221 cost centers and 448 accounting number accounts within the cost centers. To identify potential areas for savings, Black & Veatch examined both budget and actual expenses for the past 5-years, as well as projections for fiscal years 2011-12 and 2012-13. The analysis consisted of four-steps: 1) review the total expenditures as a whole, 2) review the top 5 cost centers and top 5 accounting number accounts, 3) compare the top 5 to national indices, and 4) compare the 2011-12 appropriations to the 2011-12 estimated expenditures and the estimated appropriation for 2012-13. By focusing on the top expenditures, the Department can identify the areas that have the greatest impact on savings.

9.2.1. Department Wide Budget

Prior to examining the details, it is important to review the Department as a whole to see how well the Department has fared to the budgeted amounts. This review represents a 10,000-foot level view of the Department. Table 9.2.1-1 represents the budget expenditures, the actual expenditures, and the percent of actual to budget.

Table 9.2.1-1. Total Expenditures

	Fiscal Year				
	2007	2008	2009	2010	2011
Total Expenditures - Budget	379,677,608	403,187,225	410,940,369	473,253,336	477,386,052
Total Expenditures - Actual	343,544,319	409,311,513	388,810,176	431,854,879	417,332,327
Actual to Budget	90.5%	101.5%	94.6%	91.3%	87.4%

Over a 5-year period, the average of actual values were only 93% or about \$30.7 million per year lower than the average of budgeted. These actual expenditure levels provided savings to the City.

9.2.2. Department Top Expenditures

To examine the areas within the total budget that can provide the largest areas of savings, Black & Veatch took data provided by the Department and averaged the total actual expenditures for each cost center and accounting number and ranked them by percentage of total. We note that the 91st Avenue and Val Vista facilities treat more than just the City of Phoenix and have contracts in place to help recover costs of providing service to other communities. Tables 9.2.2-1 and 9.2.2-2 represents the top 5 expenses for the Department.

Table 9.2.2-1. Top 5 Actual Expenses by Cost Center

Cost Center	5-Year Average	
	(\$)	(%)
8425302000 - 91st Operations	28,608,124	7.2%
8422302000 - UH WTP Ops	21,509,442	5.4%
8435301000 - Wtr Distr Remote Fac	11,759,938	3.0%
8425202000 - 23rd Operations	10,893,041	2.7%
8422602000 - V V WTP Ops	10,518,247	2.6%
Top 5 Total	83,288,791	20.9%

Table 9.2.2-2. Top 5 Actual Expenses by Accounting Number

Accounting Number	5-Year Average	
	(\$)	(%)
500110 - Salaries-General	68,402,151	17.2%
520805 - Chemicals	21,885,743	5.5%
520890 - Raw Water Purchases	20,555,581	5.2%
510345 - Electricity	20,488,604	5.1%
502315 - City Industrial Insurance-Fi	12,580,632	3.2%
Top 5 Total	143,912,711	36.1%

Based on the ranking, the top 5 costs centers represent 20.9% of the Department’s expenditures and the top 5 accounting numbers represent 36.1% of Department’s expenditures. It is important to note that the debt service cost centers and account numbers, which account for roughly 40 percent of all expenditures, were excluded due to the Department’s inability to reduce.

9.2.3. National Indices

In further analyzing the expenditures, Black & Veatch examined the annual percent changes for Salaries, Chemicals, Electricity and Health Insurance and compared them to national indices. Table 9.2.3-1 represents actual expenditure percent change, the national index, and the 4-Year Compounded Annual Growth Rate (CAGR). In general, the Department performed better than the national indices.

Table 9.2.3-1. Growth Compared to Indices

By Accounting Number (%)	Fiscal Year				
	2008	2009	2010	2011	CAGR
500110 - Salaries-General					
Actual	7.2%	4.8%	4.7%	-10.2%	-0.5%
Index [1]	5.0%	-1.4%	1.1%	3.6%	1.0%
500320 - Group Health Insurance Program					
Actual	6.4%	-2.3%	6.0%	9.8%	4.4%
Index [2]	5.6%	5.0%	2.6%	4.7%	4.1%
520805 - Chemicals					
Actual	-0.4%	25.4%	-6.0%	-22.1%	-2.8%
Index [3]	30.0%	-21.2%	13.4%	29.7%	5.1%
510345 - Electricity					
Actual	10.5%	6.4%	-8.2%	-11.1%	-4.6%
Index [4]	4.0%	1.9%	4.0%	-0.1%	1.9%
[1] Bureau of Labor Statistics Consumer Price Index					
[2] Kaiser Permanente Foundation - Kaiser/HRET Survey of Employer-Sponsored Health Benefits, 1999-2010.					
[3] Bureau of Labor Statistics Producer Price Index - Industrial Chemicals					
[4] Bureau of Labor Statistics Producer Price Index - Electric Power					

9.2.4. Budget to Actuals Variance Analysis

As a final analysis of expenditures, Black & Veatch reviewed the variances between the fiscal year 2011-12 Operating Appropriation and the 2011-12 Estimated Operating Expenditures, as well as the 2011-12 Estimate Operating Expenditures and the Estimated 2012-13 Operating Appropriation request by the Department. Based on our review of the variances, Black & Veatch did not note any instances where cost savings or reductions result in the hampering of operations or the deferring of significant maintenance items. Similarly, operating budget increases appear reasonable based on our understanding of the Department's operations, market and other efficiency measures put in place by the Department. The most significant difference in appropriations compared to estimated expenditures for fiscal year 2011-12, lies with the cost estimate for GAC. Black & Veatch notes that after the fiscal year 2011-12 appropriation was adopted by City Council, the cost of GAC dropped from previous estimates. The decrease in commodity cost is the primary reason for the GAC cost variance. Additionally, the Department outsourced some billing functions, which resulted in estimated expenditure decreases as compared to the fiscal year 2011-12 contractual services appropriation.

In comparing the fiscal year 2012-13 appropriation request to the fiscal year 2011-12 estimated expenditures, Black & Veatch notes that several issues affect the Department's request. First, the cost decrease in GAC operating costs, as described above, has decreased the appropriation request. Black & Veatch notes that although GAC operations will increase cost on an overall basis, the magnitude of the increase is less than previously estimated. Moreover, estimated water demand continues to decrease. This results in a decrease in raw water costs, energy costs, and chemical costs, in addition to decreased sales. Combined with the decrease in GAC costs, the fiscal year 2012-13 commodities request is less than previously anticipated.

10. Technology Review

Alignment of business processes with the appropriate technology provides an organization with efficient means of conducting its business. When a utility does not use technology appropriately or does not maintain its technology, inefficiencies may result. In this section, Black & Veatch summarizes its observation on the use of technology within the Department. Where applicable, specific technology applications and their impact on performance are discussed within the appropriate Report section.

10.1. TECHNOLOGY ROAD MAP

The Department makes use of a numerous software applications as part of its day-to-day operations. What is interesting about the City is that it is most likely the only entity around to employ two of the largest enterprise systems in existence: Oracle and SAP. The City uses SAP for its financial system and the Department uses Oracle for its work orders (WAM) and CIS billing system. Despite this unusual arrangement, the City developed interfaces from Oracle to SAP to help automate data transfer into the financial systems.

Table 10.1-1 summarizes the Department's current software and hardware scheduled for upgrade. As can be seen from the table, the Department is planning on a number of system upgrades over the next two years. Black & Veatch notes, that while the City has a good track record of successfully implementing the actual software (such as with the CC&B implementation), the City should consider implementing change management and business process reviews earlier in the upgrade. In the case of the CC&B implementation, the lack of re-designing the business process to match the new software has contributed in part to the current call center issues. Black & Veatch suggests that an integration and implementation work plan be developed prior to software system upgrades / change-overs. As part of the plan, training for all affected staff should be included, as well as follow-up refresher training sessions.

Table 10.1-1 Current Department Software and Hardware Planned Upgrades

Application Name	Description	Comments	Date of Planned Upgrade
LibertyNet	Document imaging application	By mid-2012 this version of application will no longer be supported by the vendor. We are currently investigating alternatives to purchasing the upgrade.	TBD
InMagic	Library Tracking System	There are no business drivers that require an upgrade to the application at this time.	TBD
ITRON/MVRS	This is a meter reading application that is supplied by the manufacture of the AMR equipment. It used by staff to read water meters. The output is feed to CC&B to bill our customers.	Staff is working with the vendor to develop and implement a plan to upgrade ITRON/MVRS application to the latest release. The project will start in August and complete within 6 months.	January of 2012
Customer Care & Billing (CC&B)	Customer information and billing system used for water, wastewater and solid waste services.	CC&B 2.1 was implemented in February of 2010 as part of the CIS Project. In the next few months we will begin developing plans to upgrade CC&B to 2.4 or higher release. We are targeting the 2013-14 timeframe to complete the upgrade.	2013-14
Mobile Workforce Management (MWM)	Field work order scheduling system used by Customer Services and Public Work staff. MWM automatically schedules and routes field work orders based on business rules.	MWM 1.4 was implemented with the CIS Project, which went live in February of 2012. Once the ITRON/MVRS upgrade is complete, a project will begin to upgrade MWM to Release 1.5. It will take approximately six months to complete the upgrade.	September of 2012
DOC1	Application that formats the municipal utility bills. A copy of the formatted bills is routed for printing and another is stored online for viewing.	This is a difficultly application to use, and it is costly to maintain. Thus, we are pursuing a strategy to outsource formatting, printing, mailing and electric bill display. A outsource vendor was selected through an RFP process.	Eliminate need for application through outsourcing, April-June 2012
Oracle Work and Asset Management (WOAM Project)	Asset management and workorder system (WAM Release 1.9)	WOAMP Project - Phase I will implement WAM 1.9 for Water Distribution and Wastewater Collections. Once Phase I is completed, we will begin Phase II to migrate the treatment plants to the same WAM instance. We have not decided if an upgrade to WAM application will be part of Phase II or done afterwards.	WOAM project go-live is in September of 2011
Oracle Work and Asset Management (treatment plants)	Asset management and workorder system (WAM Release 1.7). Note, WAM 1.7 is no longer supported by Oracle.	We currently have two WAM implementations, one for the WOAM Project and a legacy implementation that supports the treatment plants. Once WOAM goes live we will begin Phase II to migrate the treatment plants to same instance of WAM. Anotherwords, the entire department will be on one unified WAM system once Phase II is complete.	Eliminate this WAM instance when WOAM goes live

Application Name	Description	Comments	Date of Planned Upgrade
HANSEN (CMMS)	Asset and field Work order management for Wastewater Collections Division	WAOM Project will eliminate the need for this application.	Eliminate this application when WOAM goes live
MAPS	Mobile Field Work Order Management for Wastewater Collections and Water Distribution Divisions	WAOM Project will eliminate the need for this application.	Eliminate this application when WOAM goes live
Riva	Asset condition analysis and forecasting tool (works in collaboration with WAM)	Similar functionality will be provided by WAM application.	Eliminate this application when WOAM goes live
Oracle Primavera CM13 and P6	Project management and contract management system	We upgraded Primavera CM13 and P6 to latest release in fall of 2010. Currently there are no business drivers that require an upgrade to this application.	TBD
eDward	Web based electronic drinking water regulatory compliance database application.	This is a custom application that was built by RedOak. They delivered that latest release of the application to CoP in 2011. Similar releases of the application were delivered to two other cities in the metro Phoenix area. We are pushing Red Oak to make this a commercial product and provide support like other off-the-shelf applications.	TBD
Servers	Approximately half of the servers used by WSD for business applications are virtual servers running on infrastructure provided by ITS. The remainder are physical servers that WSD staff manages. All of these servers will reach end of life in the next 2-4 years.	Our strategy is to migrate our entire server infrastructure to Virtual Servers supported by ITS. All new server requests are deployed as virtual servers. Likewise, we use virtual servers to replace our physical servers as they reach end of life.	Transition to Virtual Servers over the next 2-4 year.
Laptop and Desktop PCs	There are approximately 1400 PCs and 300 laptops deployed throughout the department. Several hundred of these devices reach end of life each year and must be replaced.	ITS and WSD are developing strategies to replace laptops and desktop PCs with Virtual Desktop Infrastructure and cloud computing technologies. We expect significant savings using these strategies versus the traditional approach of providing powerful desktop devices loaded with office automation tools (MS Office, etc)	Transition to Virtual Desktop Infrastructure and cloud computing technologies over the next several years.
Interactive Voice Response (IVR) system	The IVR system supports the WSD Call Center and automatically handles approximately half of all customer calls.	The IVR vendor announced support for this product will end on December 31, 2011. We are currently working with ITS to develop a replacement strategy that will align with the IVR strategy for the City.	January of 2012
Avaya Automatic Call Distribution System (ACD)	This systems routes customer calls that are not automatically processed by the IVR to Customer Service Representatives at the WSD Call Center	The Avaya Automatic Call Distribution System (ACD) was implemented in July of 2010. There are no business drivers at the current time that require we consider upgrading or replacing this system.	TBD

Appendix A – Water System

A1.1 Energy Management Task Force Additional Information

In April 2001 the Department management established a list of goals with a target to reduce energy and lower energy cost. They also formed an Energy Management Task Force (EMTF). The following is a summary of additional information on the Department energy goals and the EMTF. The Department's energy goals are as follows:

- Achieve a minimum of 3% in energy savings in FY 11/12
- Check that all facilities are on the optimum utility schedule
- Track energy demand and consumption for every site
- Determine baseline efficiency of every pump at all sites
- Implement efficiency testing, including vibration analysis, power factors, repair / replacement schedules
- Rank electrical efficiency of each site for prioritization purposes
- Develop operational strategies with energy savings and water quality in mind

To achieve these goals, the Department put together the EMTF. The purpose of the EMTF is to investigate ways to reduce energy cost within distribution system remote facilities and water treatment plants. To reduce energy use and energy costs, the Task Force is studying:

- Electrical use patterns
- Pump Efficiency and response to water demand
- Energy optimization by conducting a rate analysis and system operations studies.

The EMTF meets monthly and is made up of leaders in water distribution and production. The EMTF includes:

- EMTF Team Leader from Engineering
- Engineering Department Engineer
- Water Facilities Supervisors (two)
- Water Modeling Engineer
- System Operators Lead
- Operations and Maintenance Technical Specialist
- Operations and Maintenance Supervisor
- Budget Analysts (two)
- Accountant

The EMTF also meets monthly with an Executive Energy Management Team. The Executive Energy Management Team includes:

- EMTF Team Leader
- Assistant Director Water
- Deputy Director Water Production
- Deputy Director Water Distribution
- Deputy Director Water Engineering
- Deputy Director Water Quality
- Deputy Director Development Planning

The Executive Energy Management Team meetings have been established to review the current status and develop action items for the following month.

A1.2 Largest Distribution System Energy Use

The water distribution system is described in the Report. Table A 1.2-1 is a summary listing of those water distribution facilities with the highest average monthly electrical costs. Achieving a small percentage of savings on the highest energy cost facilities will have a proportionally larger impact than potential savings from the same percentage reduction on lower energy use facilities. The energy costs for these 47 sites combined represent 90% of the total distribution system energy costs. They would be the best candidates for future energy audits and efficiency optimization as they would provide the higher rate of return compared with sites that have lower energy costs.

Table A 1.2-1 Water Distribution Facilities with Highest Monthly Electrical Costs						
Facility Name	Capacity, MGD	Utility Rate	Flat or TOU ²	2008 Ave. / mo.	2009 Ave. / mo	2010 Ave. / mo
24th Street WTP ¹ 4A-B1/B8	40	SRP-32	T	\$ 47,131	\$ 45,345	\$ 41,775
DVWTP ¹ 1-B2/2A-B1/3D-B2	65 /45/ 25	SRP-65	T	\$ 51,922	\$ 51,993	\$ 57,291
UHWTP ¹ 4A-B4 /5E-B4	40/ 45	APS E-35	T	\$ 137,345	\$ 136,655	\$ 105,591
LPWTP ¹	80			\$ 86,930	\$ 147,591	\$ 70,841
1-B3 Rio Salado North & South	135	SRP-61	T	\$ 31,180	\$ 33,615	\$ 40,681
1-B4 (Hayden)	40	SRP-36	F	\$ 3,325	\$ 2,927	\$ 8,919
2S-B4/3SE-B4 / 4SN-B1 So. Mtn	7 / 56 / 1.6	SRP-36	F	\$ 14,277	\$ 16,142	\$ 13,880
2A-W218	1.61	APS E-221	F ^P	\$ 7,868	\$ 7,545	\$ 1,629
2A-B3	4.32	SRP-47	F ^P	\$ 2,019	\$ 1,592	\$ 1,105
2A-B5	4.32	APS E-221	F ^P	\$ 4,457	\$ 2,544	\$ 1,994
2A-B6	5.76	SRP-47	F ^P	\$ 6,693	\$ 5,062	\$ 4,384
2A-B7	2.88	SRP-36	F	\$ 4,428	\$ 4,804	\$ 3,143
2A-B8	3.88	SRP-47	F ^P	\$ 3,692	\$ 4,997	\$ 4,785
2A-B9 /2C-B3	3.88 / 1.58	SRP-47	F ^P	\$ 6,183	\$ 4,784	\$ 4,356
2C-B1/3B-B1 (64th & Thomas)	19 / 14	SRP-61	T	\$ 20,336	\$ 20,539	\$ 21,226
2S-B2 ALTA Vista	7.2	SRP-47	F ^P	\$ 3,887	\$ 4,026	\$ 2,889
2S-B3/3SE-B1 Highline	10 / 40	SRP-61	T	\$ 28,320	\$ 29,107	\$ 30,537
3A-B2	20	APS E-221	F ^P	\$ 1,707	\$ 1,249	\$ 1,669
3C-B1 Caballo	2.41	APS E-32	F	\$ 7,254	\$ 12,385	\$ 10,300

Table A 1.2-1 Water Distribution Facilities with Highest Monthly Electrical Costs

Facility Name	Capacity, MGD	Utility Rate	Flat or TOU ²	2008 Ave. / mo.	2009 Ave. / mo	2010 Ave. / mo
3C-W232	0.95	APS E-32	F	\$ 5,750	\$ 5,141	\$ 4,390
3C-W233	1.15	APS E-221	F ^P	\$ 6,168	\$ 5,092	\$ 3,191
3S-B1 745 Mineral	3.74	SRP-47	F ^P	\$ 2,460	\$ 2,524	\$ 2,175
3SE-B2/3SE-B3 Ray Rd Booster	28 / 5.5	SRP-47	F ^P	\$ 1,917	\$ 3,455	\$ 4,105
4A-B2	7	APS E-221	F ^P	\$ 1,325	\$ 1,381	\$ 3,287
4A-B3	7	APS E-221	F ^P	\$ 352	\$ 516	\$ 1,601
4A-B7/3D-W256	20 / 1.20	APS E-221	F ^P	\$ 514	\$ 2,739	\$ 3,113
4A-W166	0.29	APS E-221	F ^P	\$ 2,151	\$ 1,731	\$ 1,300
4A-W261	3.2	APS E-221	F ^P	\$ 11,894	\$ 8,663	\$ 4,939
4A-W275		APS E-32	F	\$ 5,729	\$ 5,408	\$ 4,673
4SA-B1	4	SRP-47	F ^P	\$ 2,001	\$ 2,015	\$ 1,907
4SC-B2	2.5	SRP-47	F ^P	\$ 1,834	\$ 2,012	\$ 1,963
5ED-B1/PRV 4A-R2	45	APS E-221	F ^P	\$ 1,919	\$ 2,424	\$ 2,306
5E-B2/4A-W244	6 / 0.8	APS E-221	F ^P	\$ 9,210	\$ 7,939	\$ 7,237
5E-W264	1.8	APS E-221	F ^P	\$ 893	\$ 4,659	\$ 3,905
6A-B1/PRV 5E-R2 Cave Creek	30	APS E-221	F ^P	\$ 9,055	\$ 10,403	\$ 12,781
6A-B2/4A-ES4/PRV 4A-R4	20	APS E-221	F ^P	\$ 13,110	\$ 9,955	\$ 3,577
6A-W295	3.3	APS E-32	F	\$ 1,084	\$ 3,804	\$ 12,960
6B-B1/PRV 5ED-R1/PRV 6B-R1/PRV 7B-R1	45	APS E-221	F ^P	\$ 1,698	\$ 2,049	\$ 1,906
7A-B1/PRV 6A-R1	30	APS E-221	F ^P	\$ 7,665	\$ 8,661	\$ 8,542
7A-B2/7A-W290/7A-GS1	2.2	APS E-32	F	\$ 271	\$ 2,048	\$ 5,813
7B-B1/8B-B1	11.81	APS E-221	F ^P	\$ 3,142	\$ 3,828	\$ 3,887
8A-B1/PRV 7A-R3	16	APS E-221	F ^P	\$ 7,882	\$ 8,138	\$ 7,151
8A-B2/8A-W276/8A-GS1	4.5	APS E-221	F ^P	\$ 2,066	\$ 4,645	\$ 5,117
8A-W288	1.4	APS E-221	F ^P	\$ 7,236	\$ 4,628	\$ 2,417
8A-W289	1.6	APS E-221	F ^P	\$ 1,482	\$ 2,247	\$ 2,312
9A-B1/9A-W280/9A-GS1	3 / 2.7	APS E-221	F ^P	\$ 16,045	\$ 13,499	\$ 12,143
Reclaimed Water Cave Creek		APS E-32	F	\$ 4,121	\$ 4,667	\$ 4,856

Notes:

1. WTP booster station energy costs are estimated based on subtracting estimated raw water low lift cost and a percentage of total costs for treatment from total energy bills.
2. F^P is a flat pumping rate

A1.3 Energy Optimization Training Resources

Energy efficiency work by other water / wastewater municipal departments has shown that by providing training on strategies to reduce energy consumption and reduce energy costs and promoting use of strategies through goal setting and operational performance metrics can result in 3-20% energy reduction. Many utilities and consulting companies provide training for free or at very low cost. The following is a list of potential utility, water and wastewater associations and

vendor resources the EMTF and Department leadership may want to explore. Black & Veatch recommends the Department utilize some of these free and no or low cost training opportunities to focus the distribution system and water treatment plant operators on energy efficiency, utility rate structures, avoiding high demand charges and managing energy ratchet charges.

ENERGY STAR Training, Tools and Guidance

ENERGY STAR is a joint program of the USEPA and US Department of Energy helping businesses, utilities and home-owners save money and protect the environment through energy efficient products and practices. ENERGY STAR has developed programs, training, tools and guidelines that are applicable to any industry, but they have also developed programs specific to the water and wastewater industry. Below is a link to the ENERGY STAR homepage.

<http://www.energystar.gov/index.cfm?c=home.index>

Training

ENERGY STAR offers free online training to help water utilities improve the energy performance of their organizations. The training focuses on lowering operating costs, improving energy management programs and expanding professional development and is available in several formats including:

- Live web conferences
- Animated presentations
- Pre-recorded training available 24/7
- Portable self-guided presentations

Below is the link to ENERGY STAR Training web page:

http://www.energystar.gov/index.cfm?c=business.bus_internet_presentations

Tools and Guidance

Below is a link to ENERGY STAR’s Wastewater Plants and Drinking Water Systems Web page that includes links to resources.

http://www.energystar.gov/index.cfm?c=water.wastewater_drinking_water

Portfolio Manager – includes tools to help measure and track energy use

http://www.energystar.gov/index.cfm?c=evaluate_performance.bus_portfoliomanager

Guidelines for Energy Management – a step-by-step collection of best practices for improving energy and financial performance

http://www.energystar.gov/index.cfm?c=guidelines.guidelines_index

American Water Works Association Webcasts

The American Water Works Association (AWWA) provides webcasts on a number of topics relevant to the water industry. Frequently these topics include energy management and efficiency.

Organizing these webcasts through AZWater is a low cost way to provide this learning experience to a larger number of department staff. The cost for an individual AWWA Member to attend the webcasts is \$95.00, while a group site license is \$295. Below is a link to an example AWWA webcast “How Energy Management Can Pay for Itself”.

<http://www.awwa.org/Conferences/WebcastsDetail.cfm?ItemNumber=56946>

Water Environmental Federation Webcasts

Similar to the AWWA the Water Environmental Federation also provides webcasts on relevant topics including energy management and efficiency. Below is an example of a past energy management web cast.

http://www.wef.org/Conferences/page_webcasts_details.aspx?id=8990&terms=energy+management

Consulting Engineers

Consulting engineers frequently offer no cost educational seminars and webcasts relevant to energy management in the water industry.

Arizona Public Services (APS)

APS Solutions for Business Program

APS has developed technical workshops on a wide range of energy efficiency topics. They offer a 50% tuition discount to non-residential customers whose job relates to their company’s energy use. Workshops include:

- Custom Solutions 101
- Energy Simulations
- Codes and Standards
- Energy Controls
- Pump Systems
- Fans and Motors/VSDs

<http://www.aps.com/main/services/SolutionsForBusiness/training.html>

Salt River Project (SRP)

SRP does not provide training formal training, but their website offers tips and advice and links to ENERGY STAR training. <http://www.srpnet.com/energy/powerwise/business/default.aspx>

Department of Energy (DOE) – Federal Energy Management Program

DOE has developed an energy management training program for federal agency managers. Visitors to the website can view several on-demand presentations on-line any time at no cost. While the DOE developed the website specifically for federal managers, several topics would apply to Water Services Department energy management initiatives and staff training.

<http://apps1.eere.energy.gov/femp/training/index.cfm#results>

USEPA - Guidelines, Tools and Best Practices

The USEPA has developed and collected a number of tools, guidelines and best energy practices to help Water and Wastewater utilities. Below is the link to USEPA's Water: Sustainable Infrastructure: "*Cutting Your Energy Usage and Costs*" web page which includes numerous links to external resources.

http://water.epa.gov/infrastructure/sustain/cutting_energy.cfm

Determining Baseline Energy Use

http://water.epa.gov/infrastructure/sustain/baseline_energy.cfm

Water and Wastewater Energy Best Practice Guidebook (2006)

<http://www.werf.org/AM/Template.cfm?Section=Home&TEMPLATE=/CM/ContentDisplay.cfm&CONTENTID=10245>

Ensuring a Sustainable Future: An Energy Management Guidebook for Wastewater and Water Utilities (2008)

http://www.epa.gov/owm/waterinfrastructure/pdfs/guidebook_si_energymanagement.pdf

Evaluation of Energy Conservation Measures for Wastewater Treatment Facilities (2010)

<http://water.epa.gov/scitech/wastetech/upload/Evaluation-of-Energy-Conservation-Measures-for-Wastewater-Treatment-Facilities.pdf>

Improving Pumping System Performance (2006)

<http://www1.eere.energy.gov/industry/bestpractices/pdfs/pump.pdf>

Association of Energy Engineers

The Association of Energy Engineers (AEE) provides training seminars for energy engineers in a wide variety of formats on a wide variety of energy efficiency topics. These programs are geared toward energy professionals seeking certification or professional development credits but some individual courses may be of interest to the Water Services staff but are higher cost than other training opportunities. Formats include live seminars, real-time on-line seminars, 24/7 on-line seminars and self-study. The costs of the 24/7 on-line seminars are approximately \$100 per one (1) Professional Development Hour (PDH). Real-time on-line seminars are approximately \$900 for one eight-hour seminar. Live seminars range between \$1300 - \$1900. Below is a link to the Association of Energy Engineers web site.

<http://www.aeecenter.org/i4a/pages/index.cfm?pageid=1>

Association of Energy Engineers (higher cost opportunity)

The Association of Energy Engineers (AEE) provides training seminars for energy engineers in a wide variety of formats on a wide variety of energy efficiency topics. These programs are

geared toward energy professionals seeking certification or professional development credits but some individual courses may be of interest to the Department. Formats include live seminars, real-time on-line seminars, 24/7 on-line seminars and self-study. The costs of the 24/7 on-line seminars are about \$100 per 1 PDH (professional development hour). Real-time on-line seminars are \$900 for 8-hour. Live seminars range from \$1300 - \$1900.

<http://www.aeecenter.org/i4a/pages/index.cfm?pageid=1>

A1.4 Other Available Rebate Opportunities

As summarized in the Report APS and SRP encourage and offer rebates to replace inefficient motors and other electrical equipment with more efficient equipment. In addition to utility rebates, Arizona Water Infrastructure Authority (WIFA) has Grant money available for energy projects for all size utilities. Up to 20% of WIFA's Federal monies go to a Green Project Reserve Fund for projects that qualify as "Green Projects." Examples for water and wastewater "Green Projects" include replacing inefficient motors with premium energy efficiency motors, installing micro-turbines, energy audits and energy management planning. Grants are provided for planning and design phases only and are limited to \$35,000 per project. The rest of the money for construction is given out as very low interest loans. WIFA currently has almost \$1 million left for "Green" projects this fiscal year. At this time, they don't know how much money they are getting from the Federal government for next fiscal year. To get a Grant or loan it would need to be submitted to WIFA and it would be ranked by WIFA along with the other applications. The ranking depends on how "green" the project is and the competition. Grant applications are due the last day in April and October.

A1.5 Current Progress on Distribution Energy Cost Reduction Opportunities

As part of the ongoing EMTF efforts the Department is moving forward investigating energy cost reduction opportunities. Implementation of some of these opportunities, such as evaluating facility rate structures to determine if they are the most economical, is already in progress. Short term in Table A 1.5.-1 is defined as changes that can be implemented within one year. Long term indicates implementation that will require more than one year to implement.

Some shorter term opportunities such as implementing time-of-use (TOU) rate and pumping schedules may only be readily implemented at a few sites due to the complex nature of the distribution system and additional control programming that may need to be completed prior to wider implementation. Depending on the Department's course of action for implementing distribution programming changes, the value of the energy savings may vary.

Table A 1.5-1 Distribution System Energy Cost Reduction Opportunities and Current Efforts					
NO.	Energy Saving Opportunity	Implementation Needs	Short Term	Long Term	Department Current Efforts / Other Comments
1	Provide training to staff on energy optimization in the W/WW industry, strategies to reduce energy consumption and reduce energy costs. Include examples from other utilities and industry research	<ol style="list-style-type: none"> Contact and engage available no cost and low cost training resources. Staff or consultant time to coordinate. Staff time for training. 	X		<ol style="list-style-type: none"> Many utilities and companies provide training for free or at very low cost. A listing of potential vendor resources is included in this Appendix.
2	Provide electric bills to operations staff. Review bills monthly for anomalies in power usage that may indicate other issues. Periodically review rate structures to ensure most appropriate rate is applied.	<ol style="list-style-type: none"> Provide tools to trend information such as: Compare kWh/1000 gallons and kW, with last month's, last year's, for boosters and wells in same zone. 	X		<ol style="list-style-type: none"> Currently the Public Works Department, in partnership with Department, is reviewing bills to identify potential errors and anomalies. The EMTF is evaluating software that may help with this effort. See example trend graph in this Report.
3	Increase awareness of rate structure and application of electric utility demand charges. Monitor peak demand and avoid starting pumps or use smaller pumps to avoid a higher demand charge.	<ul style="list-style-type: none"> Operator training. Development of operating guidelines addressing high demand avoidance. Additional monitoring and SCADA programming. 	X		<ol style="list-style-type: none"> The EMTF has indicated they will look into this recommendation.
4	Improve motor, pump, blower, and other equipment efficiency.	<ol style="list-style-type: none"> Additional study to determine current efficiency, feasibility and payback period for improvements. 	X	X	<ol style="list-style-type: none"> The EMTF is currently developing a program to test pump efficiency at remote facilities and water treatment plants. This will include establishing system / pump curves, conducting energy audits and utilizing Power Utility Rebate Programs for testing, repairs and Engineering services.
5	Add monitoring and develop programming to allow operations to trend energy use relative to pumping utilized.	<ol style="list-style-type: none"> Installation of power monitoring equipment at largest energy use sites. SCADA Programming of key performance indicators: kWh/MG, kW, On-Peak / Off-Peak Usage Ratio, Demand / Ratchet. 	X	X	<ol style="list-style-type: none"> The EMTF is currently reviewing how to implement this functionality into SCADA and UCOS at sites with existing power monitoring. EMTF is reviewing how HARS can be used to generate monthly energy trending reports and provide historical archiving of energy records.

A1.6 Other Department Innovation Efficiency Efforts Recommended for Continuation

A1.6.1 Continue to Evaluate Installing Micro-turbines at some of the Larger PRV Stations with Higher Constant Flow

As a result of the currently negotiated Lake Pleasant WTP (LPWTP) 40 MGD average annual day water baseline production and the current demand in the City’s northern pressure zones averaging 16 MGD, there is water that is transferred from the higher northern pressure zones supplied by LPWTP into lower pressure zones including Zone 5ED, 4A and 3D. Table A1.6.1-1 is a summary of the current average flow through pressure reducing stations 3D-R11, 4A-R2 AND 5ED-R4, costs for designing and installing one micro-turbine per site and estimated payback period. Additional microturbines could be installed at each site but the payback period would be substantially extended. While this shows a moderate payback period, Black & Veatch recommends the Department evaluate the feasibility the potential payback period against the fact that demand will eventually increase in the City’s northern pressure zones and most of the LPWTP flow may not flow down-zone to supply the micro-turbine flow. It should be noted that the Department has studied and even designed a micro-turbine facility at a large PRV station at the 24th Street WTP.

Table A1.6.1.-1 Micro-Turbine Costs and Payback

Pressure Reducing Station	Average Differential Pressure,psi	Average Annual Day Turbine Flow, MGD	Conceptual Cost ¹	Estimated Payback Period ² , yrs
5ED-R1	37	24	\$ 351,000	<10
4A-R2	44	24	\$ 351,000	<10
3D-R11	43	18	\$ 351,000	<10
Note: 1. Conceptual costs are -30% + 50%, including design, construction, permitting and construction phase engineering services. 2. Payback is based on \$0.10 / kWh and average flow and pressure conditions.				

A1.6.2 Stage 2 D/DBP Rule Distribution System Efforts to Continue

- **Continue to Evaluate Reducing the Average Distribution System Chlorine Residual.** The Department indicates the current minimum chlorine residual goal in the distribution system is 0.3 mg/L. The Department also indicates that they are reevaluating lowering this level to 0.2 mg/L, as this will reduce costs associated with chlorination at the WTPs as well as reduce the costs of remote site booster chlorination. Black & Veatch is in agreement with evaluating and potentially implementing a lower minimum distribution system chlorine residual because it will reduce distribution system disinfection byproducts including those regulated in the Stage 2 D/DBP Rule. In addition, Black & Veatch agrees that the Department should:
 - Continue to evaluate seasonally adjust the distribution system chlorine residual
 - Continue with efforts to implement closed loop control for chlorine as new distribution system SCADA programmable logic controllers (PLCs) are installed.

Table A1.7.2-1 shows implementation needs and costs for implementing lower distribution system chlorine residual.

Table A1.6.2.-1 Average Distribution System Chlorine Residual Reduction

Implementation Requirements	Estimated Costs	Estimated Savings
<ul style="list-style-type: none"> • Continue to replace sodium hypochlorite and tablet chlorination systems with double contained chlorine gas systems at remote facilities for more precise control of chlorine residual. • Continue to make PLC changes to implement chlorine residual feedback control. • Install intermediate chlorine monitoring stations in some locations such as in the southern pressure zones. • Continue to change the Zone Operating Guide to reduce minimum chlorine residual requirements. 	<ol style="list-style-type: none"> 1. About \$740K per site to convert to dual contained chlorine facility, PLC and PLC programming for feedback control. 2. About \$11K per intermediate monitoring station assuming located at an existing facility. 3. Minimal costs for Zone Operating Guide changes. 	<p>The cost savings resulting from implementing this recommendation is difficult to estimate because it depends greatly on the variable surface water quality characteristics. Any reduction in THM formation will reduce the Department’s costs to comply with the Stage 2 D/DBP Rule.</p>

- **Continue with plans and provide CIP funding to utilize reservoir aeration for THM removal at a limited number of distribution sites.** The cost effectiveness of aeration at distribution system reservoirs for THM reduction at specific high THM

areas is based on the hypothesis that it will be less costly to operate the aeration systems and treat the water only in these limited areas than treat all of the water through a WTP to a lower TOC goal in order to avoid high THMs in limited areas. There are four distribution system reservoirs where aeration for THM reduction has been or will be installed.

Table A1.6.2-2 shows implementation needs and costs for implementing aeration at a limited number of reservoirs sites.

Table A1.6.2-2 Aeration at a Limited Number of Distribution System Reservoirs

Implementation Requirements ¹	Estimated Costs	Estimated Savings
<ul style="list-style-type: none"> Continued funding in existing CIP for aeration at limited distribution system reservoirs. Add funding to CIP for aeration in Reservoir 2 at 1-ES1. 	<ol style="list-style-type: none"> Capital Costs estimates for aeration as follows: <ul style="list-style-type: none"> 1-ES1 Res 4: \$3.6M 1-ES3: \$1.4M-\$2.2 M 1-ES4: \$1.4M-\$2.2 M 2-ES1: \$0.65 M Est. Annual Operating costs (energy + maintenance) <ul style="list-style-type: none"> 1-ES1 Res 4: \$216K/yr 1-ES3: \$143K/yr 1-ES4: \$143K/yr 2-ES1: \$22K / yr 	<p>The savings resulting from implementing this recommendation are difficult to estimate because it depends greatly on the variable surface water quality characteristics. Any reduction in treatment at the WTPs to limit distribution system THM formation will reduce the Department’s costs to comply with the Stage 2 D/DBP Rule.</p>
<p>Note: 1. The Department is implementing or has plans to implement aeration at the listed limited number of distribution system sites. It is recommended that CIP funding be approved for Reservoir 2 and 1-ES1 and funding be continued at the other listed reservoir sites so aeration can be implemented and operated as planned.</p>		

• Diffused Aeration at 1-ES1 for THM Removal

A diffused aeration system has been recommended for Reservoirs 2 and 4 at Site 1-ES1. The following is in support of this recommendation. The annual energy costs for diffused aeration are typically higher than the costs for surface aeration therefore a more detailed review of the recommendation to use diffused aeration was completed. The consultant’s report for aeration of 1-ES1, other information provided by the Department and the conceptual costs were reviewed. The data provided shows the following:

- The capital costs for diffused aeration is \$2.7 M less than the capital costs for surface aeration assuming the design THM removal efficiency is 60 percent.
- The energy costs for diffused aeration is \$76,000 /year greater that the energy costs for surface aeration.
- The 20-year present worth costs for diffused aeration are \$1.67 M less than the 20 year present worth costs for surface aeration.

- In addition the following are noted:
 - Over the previous four-year period the reservoir operating levels for extended times were 5 feet or less. With the thickness of the concrete base supports required for the aerator mooring posts and the operating requirements of the aerators, the low level cut off for the units was likely 5 feet. Therefore, there were going to be periods of time when the surface aerators could not be operated. The diffused air option did not have this limitation, so no modifications to reservoir operations would be required.
 - Surface aeration is dependent on air exchange in the head space above the water surface in the reservoir. The head space in ES-1 Reservoirs 2 and 4 is a large volume compared to typical reservoir facilities. The air exchange required for surface aeration would require large roof mounted ventilation fans and likely ductwork inside the reservoir to provide effective dispersion of the air. This would have added additional cost to the surface aeration option.
 - The reservoir roof is constructed with a raised-seam metal decking that is not rated for load, including foot traffic, unlike the precast double tee concrete roof that exists at Reservoir 1-ES3 and other Department reservoirs. Installation of walkways, hatches, and additional support beams are required for each equipment component and associated power supply in the surface aeration system. The diffused aeration option did not require any structural modifications to the existing reservoir roof system and thus saved on capital costs for diffused aeration.

Based on the information provided, diffused aeration is the cost effective option for THM reduction through aeration at 1- ES1 when compared to surface aeration.

- **Continue to optimize distribution system operations and production source to limit water age.** The Department continuously reviews water production and distribution system to optimize distribution system operation to reduce water age and THM formation by maximizing flow through the shortest route to service zones. The following are examples:
 - Maximize use of Booster Pump Stations 3SE-B1 / B2 (if needed) and use only smallest pump at Booster Pump Station 3SE-B4 to route flow to the west to keep pipe fresh.
 - Continue to take treatment plants off line seasonally to match current demand projections and limit distribution system detention times. For example the cost effectiveness of seasonally taking the Deer Valley WTP off line and increasing production at the 24th Street WTP should be evaluated as the unit treatment costs at both WTPs are about equal, but since all water treated at the Deer Valley WTP must be pumped into the distribution system compared with 24th Street WTP which can serve zone 1 without pumping should be evaluated.
 - Distribution system operators can do this optimization based on knowledge of the system and supply sources. However, the City's water distribution system is large in terms of number facilities and overall size. In addition operators must

balance with water quality goals and water supply requirements both in terms of pressure and quantity. For best day-to-day system optimization that can continuously react to changing conditions an automated system-wide distribution system software that links real time data with the water model would be needed. This software would utilize the real time data, the water model and Department set constraints to help operators make better decisions balancing water quality, supply and energy optimization. This software also gathers and trends the system reaction to changes so operators and other leaders can assess overall distribution system performance relative to goals and requirements. Implementing this type of real-time operational software would require CIP funding to support software acquisition and implementation; however the payback both in energy savings and costs and distribution system Stage 2 D/DBP compliance would be relatively short on the order of three years or less. Additional information on the real-time operational software is included in Section 4.4.2.4.

A1.6.3. Continue with plans to bypass GAC treatment of Mesa’s flows at the Val Vista WTP

The Val Vista WTP GAC Contactors and treatment plant are designed to treat a total 220 MGD flow with up to 130 MGD for the City of Phoenix and 90 MGD for the City of Mesa. The City of Mesa has indicated that they do not require reduction in the WTP effluent TOC. The Department is finalizing an agreement to split the flow after the filters with Mesa’s portion of flow bypassing the GAC Contactors as well as Reservoir 3 and the Val Vista Transmission Main. The cost effectiveness and potential payback period will depend on the costs for the needed WTP infrastructure modifications and the costs for the dedicated Mesa transmission main, which may or may not be paid by the City. The Department estimates the costs for the WTP flow split infrastructure at the WTP site is about \$6M. Based on these costs and the potential to decrease GAC usage so that the GAC change-out frequency is once per two years instead of once per year then the payback period would be between two and three years. Black & Veatch concurs with this approach.

A1.7 Other Department Cost Saving Efforts Recommended for Continuation

A1.7.1 Lower Energy Costs by Switching Additional Sites to Time-of-Use Rates Examples

The following is additional information in support of the Report recommendation for changing a limited number of additional distribution sites to a time-of-use rate structure. For example Figure A 1.7.1-1 shows Booster Pump Station 6A-B2 and Reservoir 6A-ES1 level. Booster Pump Station 6A-B2 is currently on an APS Flat Pumping Rate schedule E-221. However, it could be switched to a TOU rate such as the APS E-221-8T and as illustrated by Figure A1.7.1-1 operations could be easily shifted to periods outside of the on-peak hours and adequate zone pressure and reservoir volume could be maintained. With the APS E-221-8T rate structure the on-peak period is any consecutive eight hour period between 9 a.m. and 10 p.m. daily. The on-peak period is a mutually agreed upon time between the customer and APS. Comparing the flat APS E-221 rate to the TOU APS E-221-8T rate for year 2008 energy use, the same year as the week graphed in Figure A1.7.1-1, the annual savings opportunity was estimated as \$15,600 assuming pumping was shifted to off-peak hours.

Figure A1.7.1-2 shows booster pump station 3S-B1 and reservoir 3S-ES1. 3S-B1 is on a Flat Pumping Rate SRP E-47. It could be switched to a time-of-use rate such as SRP E-32 and adequate zone pressure and reservoir volumes could be maintained. SRP E-32 On-peak hours from May 1 through October 31 consist of those hours from 2 p.m. to 7 p.m., Monday through Friday, Mountain Standard Time. Shoulder-peak hours consist of those hours from 11 a.m. to 2 p.m. and 7 p.m. to 11 p.m., Monday through Friday, Mountain Standard Time. All other hours are off-peak. On-peak hours from November 1 through April 30 consist of those hours from 5 a.m. to 9 a.m., Monday through Friday, Mountain Standard Time. Shoulder-peak hours consist of those hours from 5 p.m. to 9 p.m., Monday through Friday, Mountain Standard Time. All other hours are off-peak. Comparing the flat SRP-47 rate to the TOU SRP-32 rate for year 2010 energy use, same year as the week graphed in Figure A1.7.1-2, the annual savings opportunity was estimated as \$8,000 assuming pumping was shifted to off-peak hours.

Figure A1.7.1-1 – Example APS Rate Booster Station Time-of-Use Application

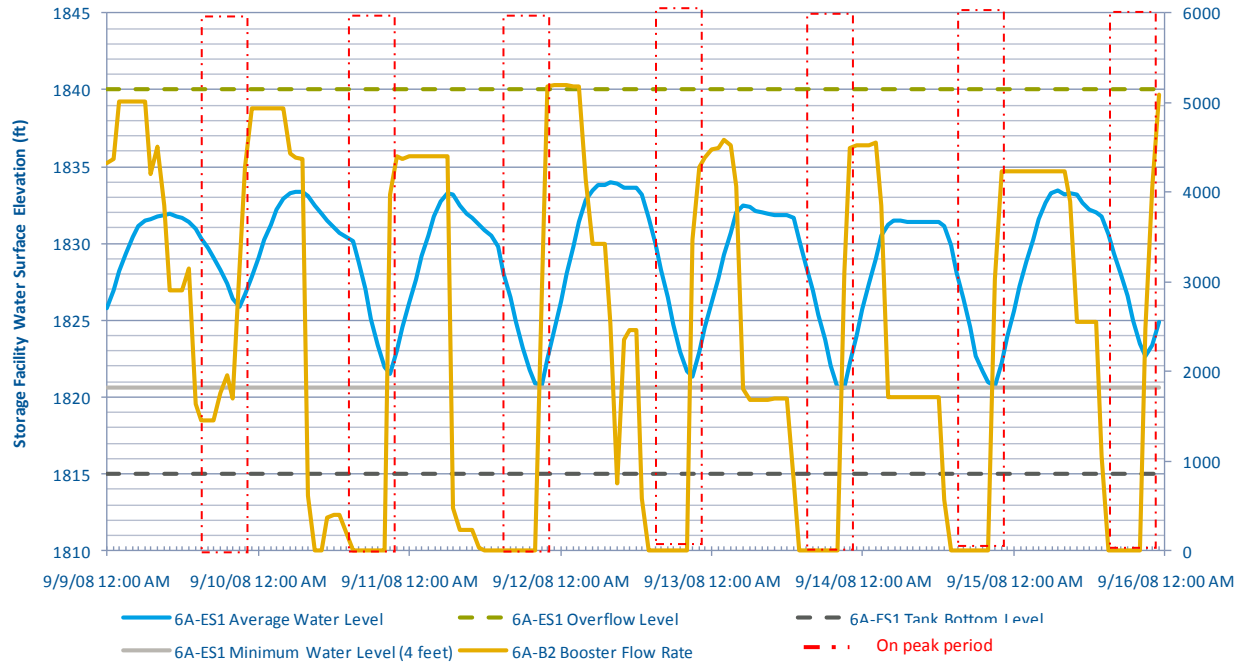
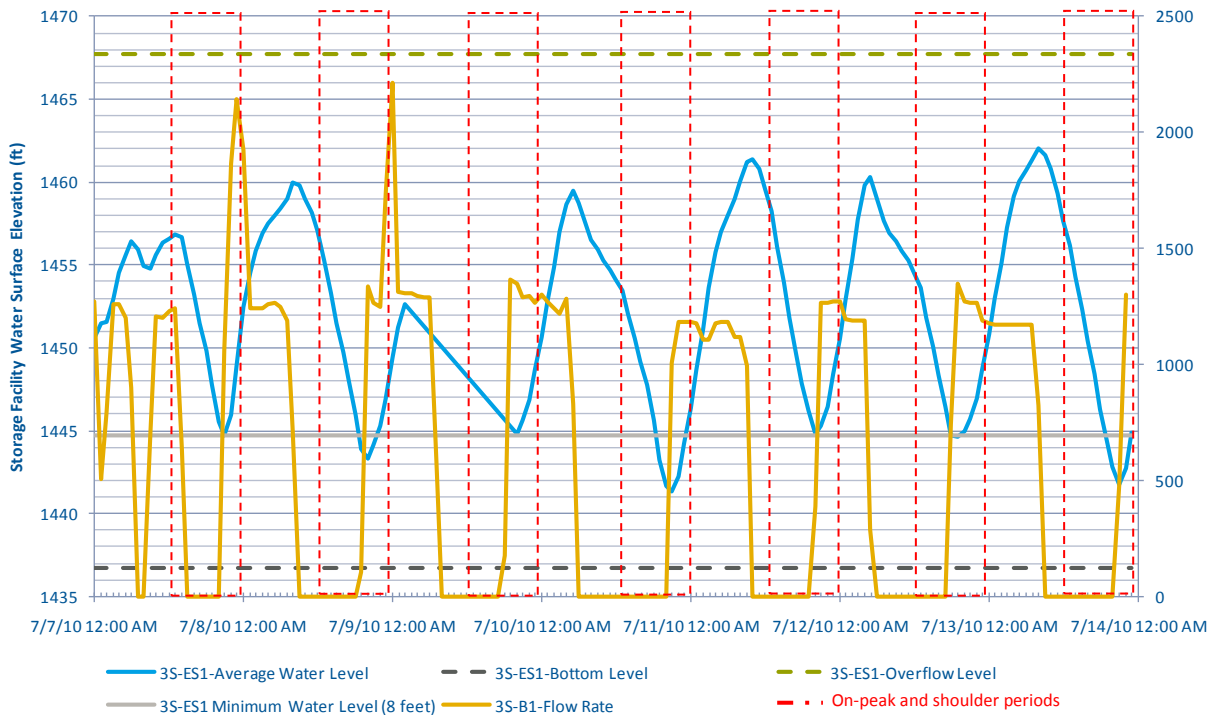


Figure A1.7.1-2 Example SRP Rate Booster Station Time-of-Use Application



- Evaluate staggering the time-of-use operation for a limited number of sites within zones in APS services areas.** Additional savings could be realized if the Department were to stagger the time-of-use operation for a limited number of sites within zones in APS services areas. Using Zone 6A boosters 6A-B1 and 6A-B2 which are both on an APS E-221 flat rate as an example: The time-of-use peak period chosen for 6A-B1 could be between 9 a.m. and 5 p.m., and for 6A-B2 could be between 2 p.m. and 10 p.m. This leaves a period that is off-peak for 6A-B1 and on-peak for 6A-B2 and a period off-peak for 6A-B2 and on-peak for 6A-B1. This section describes placing 6A-B2 into TOU rate and operation and a potential annual savings of up to \$15,600. The 2010 energy use for 6A-B1 is similar on a monthly basis as 6A-B2 in year 2008. Placing both in TOU operation and operating them in staggered TOU periods would increase the annual savings further.

Black & Veatch recommends the Department continue to evaluate a limited number of other potential larger pump station sites for switching to staggered time-of-use rates and operation providing other system goals such as water quality, pressure requirements and demand management permit such changes. We recommend the Department implement the programming and Zone Operational Guide modifications to allow the Department to implement time-of-use operation initially at a limited number of sites. Potential cost and savings are included in Table A1.7.1-1.

Table A1.7.1-1 Continue to evaluate Implementing TOU at Select Sites

Recommendation	Estimated Costs	Estimated Savings
<ul style="list-style-type: none"> Continue to evaluate utilizing TOU power rates and off-peak pumping at select well and booster pump station sites. Take advantage of TOU rates in APS service areas by staggering TOU periods for booster stations in same zone and operating in a staggered manner (8 hr period between 9:am- 10:pm) REF: APS E-221-8T. 	<p>Programming for sites can cost up to \$20K per site.</p> <p>Staff time to make zone operational Guideline changes.</p>	<p>Depends on number of sites selected and success at limiting operation to off-peak TOU periods. Savings can be from 5% to 15% of site annual energy costs for those sites switched to TOU. Estimate a 1 to 2 yr payback period per site.</p>

A1.7.2 Distribution System Valve Position Verification and Monitoring

The Department should continue to regularly check distribution system valve positions in order to reduce the potential for unintended flow or restrictions resulting in increased pumping costs and main breaks; distribution system valves should be opened or closed to provide the optimal efficiency. The Department has plans to implement a valve position assessment program in fall 2011. Black & Veatch recommends this be implemented in fall 2011 as well as on an on-going scheduled basis.

Table 1.7.2 -1 Valve Position Verification and Monitoring

Recommendation	Implementation Requirements	Estimated Savings
<ul style="list-style-type: none"> Continue to regularly check distribution system valve positions in order to reduce the potential for unintended flow or restrictions resulting in increased pumping costs and main breaks. 	<ul style="list-style-type: none"> Conduct program to identify and verify closed zone-break valves. 	<p>Depends on findings from the Department’s valve position assessment program in fall 2011.</p>

A1.7.3 Continue to use 1-B4 (Hayden) and 1-ES1 (64th Street Res) as Priority Supply for North Zone 1 instead of 1-B3 North PS (Rio Salado)

When the Verde WTP and Verde Main are placed out of service, the Department has indicated that they will use Booster Pump Station 1-B4 as the priority supply for Zone 1 North instead of Booster Pump Station 1-B3 North because Booster Pump Station 1-B4 has a lower lift into Zone 1 North compared to Booster Pump Station 1-B3. Black & Veatch agrees with this operational strategy as this will save the Department money as estimated in Table A1.7.3-1 and result in lower kWh usage.

Table A1.7.3 -1 Use 1-B4 (Hayden) and 1-ES1 (64th Street Res) as priority supply for North Zone 1

Estimated Costs	Estimated Savings
Staff time to change the zone operating guidelines. < \$1,000.	\$81K per year assuming average 10,000 gpm flow shift from 1-B3 North to 1-B4.

A1.7.4 Stage 2 D/DBP Rule Savings Recommendations

- Continue to evaluate reducing average reservoir storage volumes.** Black & Veatch evaluated average storage volumes in reservoirs for years 2009, 2010 and 2011 through May. The evaluation shows many reservoirs have had the average volume reduced as recommended in the *2008 Reservoir Management Plan*. However, there are a few where additional reductions should be reviewed and potentially implemented these include:

Reservoir Name	Reservoir Volume, MG	% Volume 2009-2011 (May)
2A-ES1 Shaw Butte	10	56%
2C-ES1 Papago	3	54 %
3S-ES1 Upper Mineral	1	50%
6A-ES1 Happy Valley	5.2	60%
8A-GS1	1	52%
9A-GS1	1	68%

Continuing to reduce average storage volumes to those required for fire flow, diurnal and operational storage requirements will reduce water age and system THMs. The savings resulting from implementing this recommendation are difficult to estimate because it depends greatly on the variable surface water quality characteristics. However any reduction will reduce level of treatment required and costs.

- Continue to evaluate removing some distribution storage reservoirs from service.** As recommended in the *Reservoir Management Plan* the Department is evaluating removing some reservoirs from service. Black & Veatch agrees with this strategy as it will reduce (1) the overall water storage volume in the distribution system, (2) reduce THM production and (3) reduce treatment requirements and costs to comply with the Stage 2 D/DBP rule requirements. The cost savings resulting from implementing this strategy is difficult to estimate because it depends greatly on the variable surface water quality characteristics.
- Continue to evaluate seasonal operation of reservoirs aeration systems.** Depending on the effectiveness of other distribution changes such as limiting reservoir storage volumes and reducing chlorine residual, aeration in distribution reservoirs may not be required at all times. Surface aeration and diffused aeration requires a fairly substantial amount of energy and will result in higher energy use

and costs. Therefore, it will be important that the Department continues to evaluate the effectiveness of these THM reduction strategies and determine if reservoir aeration needs to be utilized at all times or can it be operated seasonally. Black & Veatch concurs with seasonal reservoir aeration if found feasible relative to THM goals and other treatment costs cost effectiveness. Table A1.7.4-1 shows implementation needs, costs and savings for seasonal reservoir aeration.

Table A1.7.4-1 Seasonal Distribution Reservoir Aeration Operation

Implementation Requirements	Estimated Costs	Estimated Savings
<ul style="list-style-type: none"> • Trending of collected THM data. • Data visualization showing location in distribution system. • Zone Operating Guide (ZOG) update. 	<p>Low compared to potential savings.</p>	<p>Savings from not operating aeration 3 months/ yr estimate ~ \$131K/yr</p>

A1.7.5 WTP Savings Efforts to Continue and Recommendations

- **Continue to evaluate maximizing production at the 24th Street WTP.** The Department is preparing a WTP Utilization Strategy balancing supply, water quality and costs parameters. A production capacity of up to 120 MGD could be supplied to a large area of the distribution system from the 24th Street WTP without additional pumping compared to water from the Deer Valley WTP and Val Vista WTP, which require additional pumping to supply the distribution system. A higher level of production from the 24th Street WTP will need to be weighed against the Department’s water quality goals particularly if reduction in flow from the Val Vista WTP is contemplated as the Val Vista WTP GAC Contactors provide a higher level of treatment relative to reducing distribution system disinfection byproducts (THMs) compared to the treatment provided by the biological activated carbon filters at the 24th Street WTP.
- **Off Peak Operation of WTP Solids Dewatering Centrifuges.** The following is additional information in support of the Report recommendation for operating WTP solids dewatering Centrifuges during off-peak energy rate periods: The turbidity removed from the raw water at the water treatment plants along with the treatment chemical residuals must be partially dewatered and removed from the treatment plant sites. The Department has permanent dewatering centrifuge installations at the 24th Street, Deer Valley, and Val Vista WTPs and a temporary dewatering centrifuge at the Union Hills WTP. Sludge treated at Union Hills WTP is usually thickened and then hauled to City Property for sludge injection. The temporary centrifuge at Union Hills WTP is operated on a less frequent basis when sludge injection is not available.

As described in the Report there is a potential for cost savings at 24th Street, Deer Valley, and Val Vista WTPs if the centrifuges are operated during the off-peaks utility rate periods. There is sufficient centrifuge system capacity available to do

this. The centrifuges would be operated during off-peak hours and the hauling bins / trucks would be filled during off-peak periods (primarily at night). Then during on-peak hours the centrifuges would be off and the Department’s sludge hauler would haul the sludge loads to the landfill so by the time off-peak energy rate times roll back around the bins are empty and ready for filling during the off-peak hours. If implementing this opportunity the Department would need at least two operators at the WTP during the off-peak period. Currently VVWTP has two operators at night (off-peak) shift but Deer Valley WTP and 24th Street WTP do not. If Verde WTP is mothballed as planned then there is a potential for operators to be shifted to Deer Valley WTP and 24th Street WTP to take advantage of this opportunity. The potential energy cost savings for the three WTP totals about \$95,000 / year after subtracting the cost for the shift work differential.

- Continue to reduce the recycle flow volume at Val Vista WTP.** When water is filtered the filter media captures turbidity and other particles. Periodically the water treatment plant filters must be backwashed to remove the solids trapped by the filters. This backwash water is captured and treated to thicken the solids, and the water remaining is recycled back to the start of the treatment process. In addition water is a large part of the sludge flow that is removed from WTP pre-sedimentation and sedimentation basins. To recapture as much water as possible the WTPs have treatment basins to thicken the sludge and recycle the water removed through the treatment process. The percent recycle water flows at the Department’s WTPs was compared for the months operating with ferric chloride as the coagulant and is shown in Table A1.7.5.-1.

Table 1.7.5-1 WTP Recycle Water Comparison

Parameter	24th Street	DVWTP ¹	VVWTP	UHWTP
Percent Return Water, since Ferric, %	5.3%	7.19%	15%	5.0%
Note 1. Reflects operation with sand ballasted flocculation process				

As shown in Table 1.7.5-1 the amount of recycle water at the Val Vista WTP is two to three times more than the recycle water at the Department’s other WTPs. The percentage of recycle water at the other Department WTPs is below the rate typical of other WTPs using the similar processes. A recycle rate of about 10 percent is typical at other conventional treatment WTPs. The other Phoenix WTPs recycle rate is less than typical rates likely due to the centrifuge dewatering operations and the Department’s optimization of their treatment process. The Department and VVWTP staff are aware of the high rates at VVWTP and corrective actions are being taken including repairing leaking valve and gate seats and seals, and adjusting the sedimentation basin sludge draw-off timing based additional monitoring information.

If the Department were to reduce the recycle water rate at the VVWTP by half of what it is today, the potential savings is \$498,000 per year based on the total

WTP flow (Phoenix and Mesa), current recycle rate and current treatment chemical costs.

- **Continue to Evaluate Reducing the Val Vista WTP GAC Fluff Backwash Frequency.** The amount of time between “fluff” backwashes depends on the GAC media loading rates, which is controlled by the amount of flow treated. The initial recommendation for contactor run-time between fluff backwashes will be every four weeks. Through operation of the contactors and measuring GAC media compaction, the duration between fluff backwashes could be increased. If it were increased to each cell once every 6 weeks the cost savings in recycle water retreatment would be \$6,000 / year.
- **Continue to Evaluate Reducing the GAC usage rate at Val Vista WTP.** The post-filter GAC contactors at the Val Vista WTP are under construction and schedule to be operational by January 2012. The Department has a consultant reviewing operational strategies for the GAC contactors to optimize the use of the GAC based on influent TOC and the target effluent TOC goals. The consultant is also charged with developing a spreadsheet or other tool to assist Val Vista WTP operators with making decisions on GAC contactor flow and contactor operations to achieve the target WTP effluent TOC at the lowest GAC use rate. Based on previous water quality studies the GAC contactor change out frequency at Val Vista WTP was estimated to be one contactor per month resulting in a staggered GAC contactor bed exhaustion rate and an overall change-out frequency of once per year. Utilizing the Department’s current bid for GAC regeneration of \$0.595/lb, the cost for GAC at Val Vista is \$5 M per year at the once per year change-out rate. If the GAC usage rate is reduced, the savings realized could be substantial. However, the savings will be highly variable due to the highly variable nature of the raw water quality. Conditions, such as the Wallow Fire, may actually increase the required treatment and will substantially decrease potential savings. However any optimization of the GAC usage will help reduce potential treatment costs.

Appendix B – Wastewater System

B1.1 Wastewater Collection Lift Stations

The Department's wastewater collections system operations are described in the Report. Unlike the water distribution system there are no real opportunities to utilize time-of-use rates for sewer lift stations. This lack of savings opportunity is because there are no sewage storage / equalization basins available to store wastewater until off-peak utility rates are available. For comparison purposes, the total energy cost for the Department's sewer lift stations is 0.5% of the total energy cost in the water distribution system. There may be opportunities for some efficiency gain at lift stations, such as evaluating pump efficiency and replacing older inefficient pumps with newer pumps equipped with high efficiency motors. The Department's energy audit programs will help identify pumps and motors that are candidates for these upgrades.

B1.2 Wastewater Treatment

A summary of efficiency opportunities for the 23rd Avenue and the 91st Avenue Wastewater Treatment Plants and the Department's current efforts as well as other comments is included in Table B1.2-1.

B1.2.1 Continue with Solar Drying of Biosolids at the 91st Avenue WWTP

The following is additional information in support of the Report recommendation for solar drying of biosolids at the 91st Avenue WWTP. The dewatering centrifuges at 91st Avenue WWTP dewater digested biosolids to approximately 20% total solids. The WWTP has a contract with a biosolids hauler to take the dewatered biosolids to landfills or other land application sites. The daily biosolids production ranged between 400 and 600 wet tons/day in 2009 and 2010. After conducting an extensive pilot testing program, the Department applied for and received permission from the County to start full scale solar drying of the dewatered biosolids at the 91st Avenue WWTP. The Department has modified their air permit to allow for this. Data shows that up to 100 percent of the biosolids can successfully be solar dried in the summer and about 50 percent in the winter. The optimal dryness for the solar dried biosolids product is approximately 50-60 percent. The Department's current biosolids hauling contract is based on a rate structure that incorporates haul miles as well as the weight of biosolids hauled. As the number of daily tons decrease the unit cost / mile increases. The contract expires in the fall 2011. The Department estimates after rebidding their savings from solar drying may be up to \$1,000,000/year. A percentage of this savings is offset by the additional labor required for the solar drying operations including hauling biosolids to the on-site solar drying areas, periodic turning of the biosolids and loading the dried biosolids. The Department uses existing equipment for the additional handling. The total costs for the additional labor is currently unknown; however operations staff is undertaking a detailed study to quantify these costs.

Table B 1.2-1 Wastewater Treatment Plant Efficiency Opportunities					
NO.	Saving Opportunity	Implementation Needs	Short Term	Long Term	Department Current Efforts / Other Comments
1	Solar dry the dewatered solids at 91 st Avenue WWTP to save on sludge weight, volume and hauling costs.	<ul style="list-style-type: none"> Rebid the contract when it is up for renewal in fall 2011. 	X		<ul style="list-style-type: none"> After conducting an extensive pilot testing program. The Department applied for and received permission from the County to start full scale air drying. The Department has modified their air permit to allow for this.
2	Send primary sludge from 23 rd Avenue to 91 st Avenue.	<ul style="list-style-type: none"> Potentially more dewatering capacity at the 91st Avenue WWTP. 		X	<ul style="list-style-type: none"> 91st Avenue WWTP operations is evaluating.
3	Utilize digester gas engine driven blowers at portions of the day when lower oxygen supply needed.	<ul style="list-style-type: none"> Flare Shrouds to meet air quality permit Assessment and likely rehabilitation of existing currently mothballed gas engine drives and blowers. 		X	
4	Evaluate operating 91 st Avenue centrifuges at off-peak time-of-use hours.	<ul style="list-style-type: none"> Shift Differential for operators Additional Conveyors and Centrifuges Waste activated sludge storage basins with aeration 		X	<ul style="list-style-type: none"> The Department is evaluating reliability and true redundancy of existing centrifuge system / conveyor equipment.
5	Implement biogas cogeneration at the WWTPs	<ul style="list-style-type: none"> Additional cogeneration equipment. 		X	<ul style="list-style-type: none"> The Department has issued or is planning to issue requests for proposal for additional study and design of this if proven feasible.
<p>Note: Short term is defined as changes that can be implemented within one year. Long term indicates implementation that will require more than one year to implement.</p>					

B1.2.2 Evaluate Operating the 91st Avenue WWTP Solids Dewatering Centrifuges at Off-Peak Time-of-Use Hours

The following is additional information regarding operating the 91st Avenue WWTP solids dewatering centrifuges during off-peak energy rate periods: The 91st Avenue WWTP is on SRP E-65 rate structure, which is a time-of-use rate. The Department currently operates a Solids Handling Facility (SHF) and a Solids Thickening Facility (STF) at the 91st Avenue WWTP during on-peak and shoulder peak energy rate periods. The SHF dewateres digested sludge using the dewatering (D-x) centrifuges. They have five dewatering centrifuges, with three running continuously under most conditions. At times all five dewatering centrifuges run, in order to keep up with plant loads. Currently, the Department does not have the opportunity to load shift dewatering operations primarily due to reliability issues with the dewatering centrifuges and a lack of conveyor capacity for dewatered sludge loading if they went to off-peak use only.

The thickening (T-x) centrifuges are located in the SHF and are currently used to thicken primary sludge. The Department has a project currently underway to convert one of the thickening centrifuges to a dewatering centrifuge. The project also includes master planning the facility to eventually convert all of the thickening centrifuges in the SHF to dewatering centrifuges. This will provide additional standby capacity for dewatering and allow for off-peak dewatering centrifuge operation. The plant has sufficient digested sludge storage to allow off-peak operation. The loading conveyors on the roof of the SHF have limited capacity. They can handle the current sludge loads if they are spread out over the day. The loading conveyors' capacity is insufficient for the accelerated production schedule which would be required if the solids loading is accelerated (same quantity over a shorter duration). Increased loading rates would be expected if the plant shifted to off-peak operations since they would have to process the day's sludge in a shorter period of time. Therefore, the Department would need to expand the loading conveyor capacity at the SHF. The implementation of solar drying enhances the opportunity for off peak operations because the hauling contract would not have to be adjusted for off-peak operation.

Additional thickening (TH-x) centrifuges are located in the STF facility and currently only thicken waste activated sludge (WAS). The Department recently installed booster pumps to convey primary sludge to some of the STF centrifuges and are currently working with Westfalia to optimize the TH-x centrifuges for thickening primary sludge. The capacity of the thickening centrifuges should allow for off-peak thickening operation, but would require a primary and WAS storage basin with aeration for mixing.

Based on current sludge thickening, thickening centrifuge throughput and use rates, the annual savings shown in Table B 1.2.2-1 could be realized by shifting the 91st Avenue WWTP centrifuge operations to off-peak time of use hours. However, there would be considerable capital investment to implement off-peak processing. This is a longer term consideration.

Table B 1.2.2-1 91 st Avenue Centrifuge Operations Summary		
Unit Name	Potential Annual Savings, \$/yr	Implementation Needs
SHF Dewatering Centrifuges, D-x	\$146,000	High 1. Conversion of additional T-x centrifuges 2. Additional dewatered sludge conveyor capacity and facilities.
SHF Thickening Centrifuges, T-x	\$105,000	Medium 1. Conversion of T-x Centrifuges to Dewatering.
STF Thickening Centrifuges, TH-x	\$69,000	High 1. Continue the project to optimize the TH-x centrifuges for thickening primary sludge. 2. A primary and WAS storage facility with aeration.