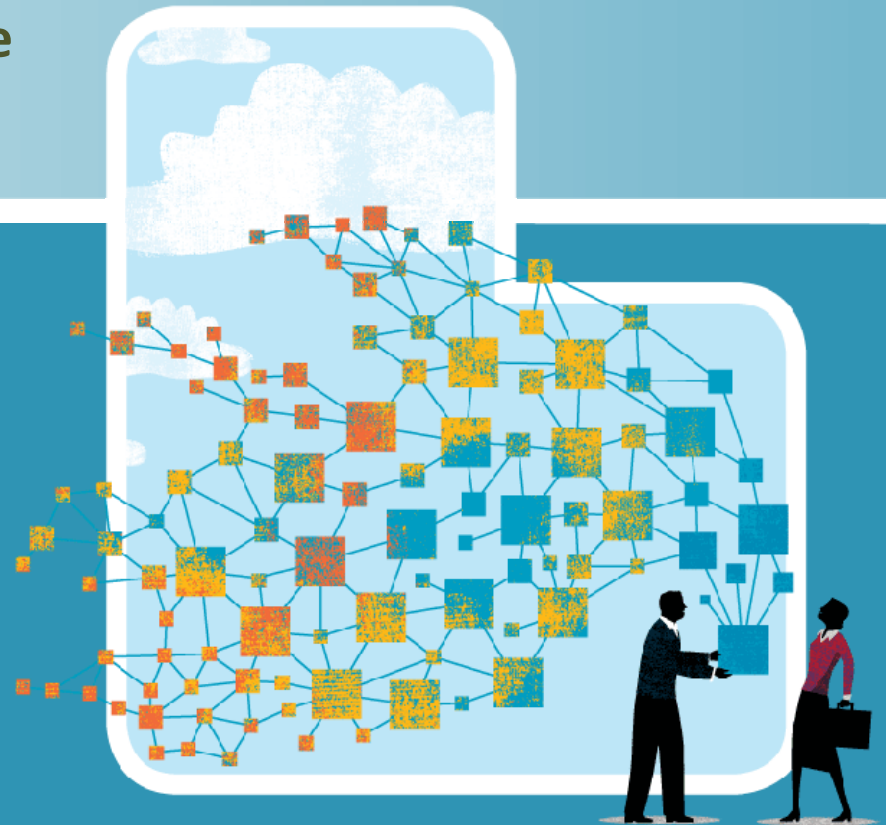


SANTA CLARA VALLEY WATER DISTRICT

Review of the Treated Water Revenue Collection Process

Findings and Recommendations

October 9, 2014



MOSS-ADAMS LLP

Certified Public Accountants | Business Consultants

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OVERVIEW

- Introduction
- Commendations
- CPAR Status
- Findings and Recommendations
- Peer Agency Practices
- Appendix A – Listing of Treated Water Meters



Introduction

STUDY PURPOSE

Evaluate the effectiveness of process improvements to the District's treated water processes including:

- Monitoring,
- Measurement, and
- Revenue collection.

STUDY METHODOLOGY

- Interviews – conducted interviews with various District staff within the Wells and Water Measurement, Treatment Plant Maintenance, Revenue Management, Engineering, and Asset Management Units, as well as with key customers.
- Document Review – reviewed a wide range of relevant documents including the CPAR; policies and procedures for the Wells and Water Measurement, Treatment Plant Maintenance, and Revenue Units; the Measurement Unit’s meter reading spreadsheets; and the Revenue Unit’s treated water billing spreadsheets and supporting documentation.

STUDY METHODOLOGY (CONTINUED)

- Observation – toured three treated water turnouts (Sunnyvale, Farndon, and Grainger), walked-through meter verification and treated water billing processes, and observed capabilities of asset management software and SCADA data reporting.
- Data Collection – reviewed meter measurement data collected between 2012 and 2014.
- Peer Agency Practice & Best Practice Research – Interviewed two peer agencies with similar treated water operations regarding equipment verification, measurement verification, meter reading processes, methods used to ensure accurate readings, and billing quality control processes. Researched industry best practice resources and organizations.

STUDY METHODOLOGY (CONTINUED)

- Analysis – evaluated CPAR progress, adherence, and effectiveness of documented policies and procedures, as well as resource issues, internal control gaps, and alignment with best practice; sought customer feedback; and determined overall opportunities for continued improvement.
- Deliverables – prepared draft report and final reports.



Commendations

COMMENDATIONS

- District Management and staff are dedicated to accuracy, transparency, and developing strong, trusting relationships with District customers.
- The District has created an open environment that enables staff to feel comfortable bringing issues forward to management, which fosters a proactive approach to determining root causes and finding effective solutions.
- The District has dedicated staff members who are able to make operational improvements despite staff shortages and resource limitations within some units.

COMMENDATIONS (CONTINUED)

- District staff has made significant progress in documenting procedures as outlined within the CPAR.
- Staff within the Measurement and Maintenance Units coordinate and collaborate well to achieve monitoring and maintenance goals.
- Revenue Unit staff perform additional analytic steps and communicate with Measurement Unit staff to better ensure data accuracy and to help prevent errors prior to sending invoices to District customers.



CPAR Status

CPAR – PROGRESS MADE

- ***Six policies and procedures were developed or revised as part of the CPAR.*** These documents incorporated the following notable improvements:
 - Treatment Plant Maintenance Unit (Maintenance Unit)
 - Documented the previously unwritten treated water meter replacement process
 - Added approval from the Control Systems Supervisor and Utility SCADA Engineer prior to meter equipment changes
 - Created the requirement to document meter parameters prior to installation or replacement
 - Placed log books at each turnout to record activity at each meter

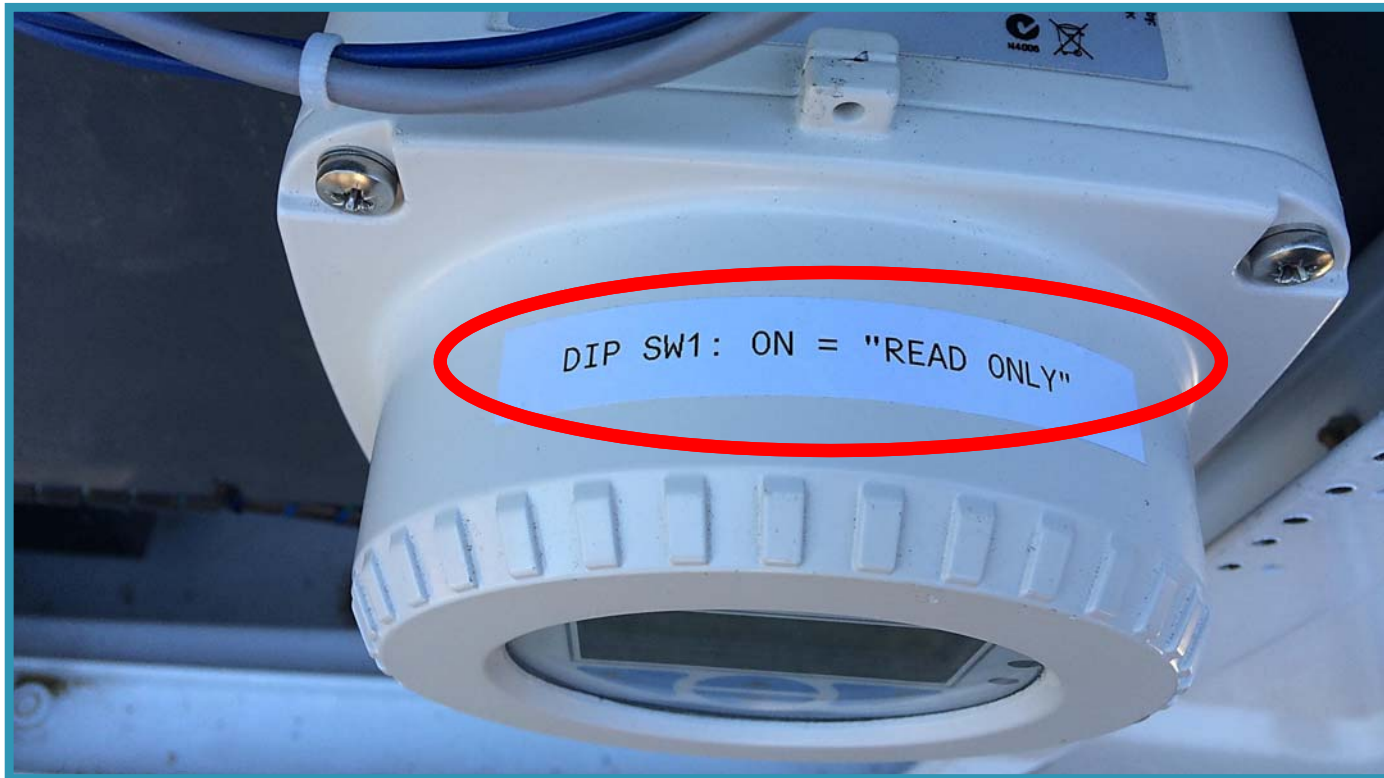
CPAR – PROGRESS MADE (CONTINUED)

- Wells and Water Measurement Unit (Measurement Unit)
 - Increased frequency of SCADA data comparison from monthly to weekly
 - Added weekly meetings between the Senior Water Measurement Technician and the Unit Manager to analyze the SCADA data comparison and to check for other data anomalies
 - Changed measurement or operational verification of meters from annual to semi-annual
 - Implemented three weekly tests following the replacement or new installation of a treated water meter

CPAR – PROGRESS MADE (CONTINUED)

- Revenue Management Unit (Revenue Unit)
 - Incorporated assurance of data quality into monthly billing process
- In addition, as shown on the following page, we observed implementation of the following improvements as a result of the CPAR:
 - Meters labelled by Maintenance Unit to communicate pertinent information to Technicians performing maintenance
 - Switched meters to read-only mode to avoid inadvertent changes of parameters

CPAR – PROGRESS MADE (CONTINUED)



CPAR – PROGRESS MADE (CONTINUED)

- Cut holes in most meter cabinets to allow meter readings without opening cabinets, thus, limiting the number of people who have access to make changes to the meters



CPAR – OPPORTUNITIES FOR FURTHER IMPROVEMENT

- Consistent adherence to the documented procedures within the Measurement Unit
- Coordination of meter parameter documentation with measurement verification testing, including thorough documentation of the results of both activities, as well as detailed policies and procedures of exactly how these activities should be conducted

CPAR – OPPORTUNITIES FOR FURTHER IMPROVEMENT (CONTINUED)

- Delineation of roles and responsibilities and accountability for data quality assurance clearly incorporated into written procedures for each unit. For example, the oversight role of the supervisor in the meter replacement process should be more detailed to ensure sufficient installation oversight. Further, procedures should be modified to specify that the Control Systems Supervisor is responsible for oversight over this activity.

CPAR – OPPORTUNITIES FOR FURTHER IMPROVEMENT (CONTINUED)

- District Management should consider a more holistic approach to the accepted variances in data throughout the treated water measurement process. The combination of accepted variances lead to multiple ways to view the accuracy of the flow data. For example, the portable flowmeter manufacturer's accepted variance, the Measurement Unit's accepted variance, and the accepted variation of the SCADA data may all result in different perspectives of overall flow data accuracy within the District.

CPAR – OPPORTUNITIES FOR FURTHER IMPROVEMENT (CONTINUED)

- The format of policies and procedures could be more user friendly. Additional clarity in the language could improve the effectiveness of these documents as guidance for both management and staff. The measurement verification testing process document should state the exact frequency of testing. For example, rather than stating that testing should occur, “semi-annually,” the document could state that the testing should occur, “every six months”. (According to the Measurement Unit Manager, this change was made to the procedures during our review.)



Findings and Recommendations

FINDINGS CATEGORIES

- Resources
- Communication & Coordination
- Strategic Action
- Oversight & Compliance
- Operations

RESOURCES – 1

Finding:

- ***Some critical treated water positions are vacant.*** Within the Maintenance, Revenue, Engineering, and Measurement Units, key positions related to treated water remain vacant. A total of nine positions that directly or indirectly impact treated water operations are vacant. Of those, at least seven, or 78 percent, are critical to treated water maintenance and measurement. During the annual budget process and recent long-term staffing process, two units also requested a total of five additional FTEs.

RESOURCES – 1

Finding (continued):

- Within the control systems function of the Maintenance Unit, which is responsible for servicing and maintaining the treated water meters, three of seven total positions, or 43 percent, are vacant.
- One of the Control Systems Technician II's is out on a long-term leave of absence.
- Another Control Systems II position is vacant due to promotion to Senior Control Systems Technician – a position that had been vacant for more than six months.

RESOURCES – 1

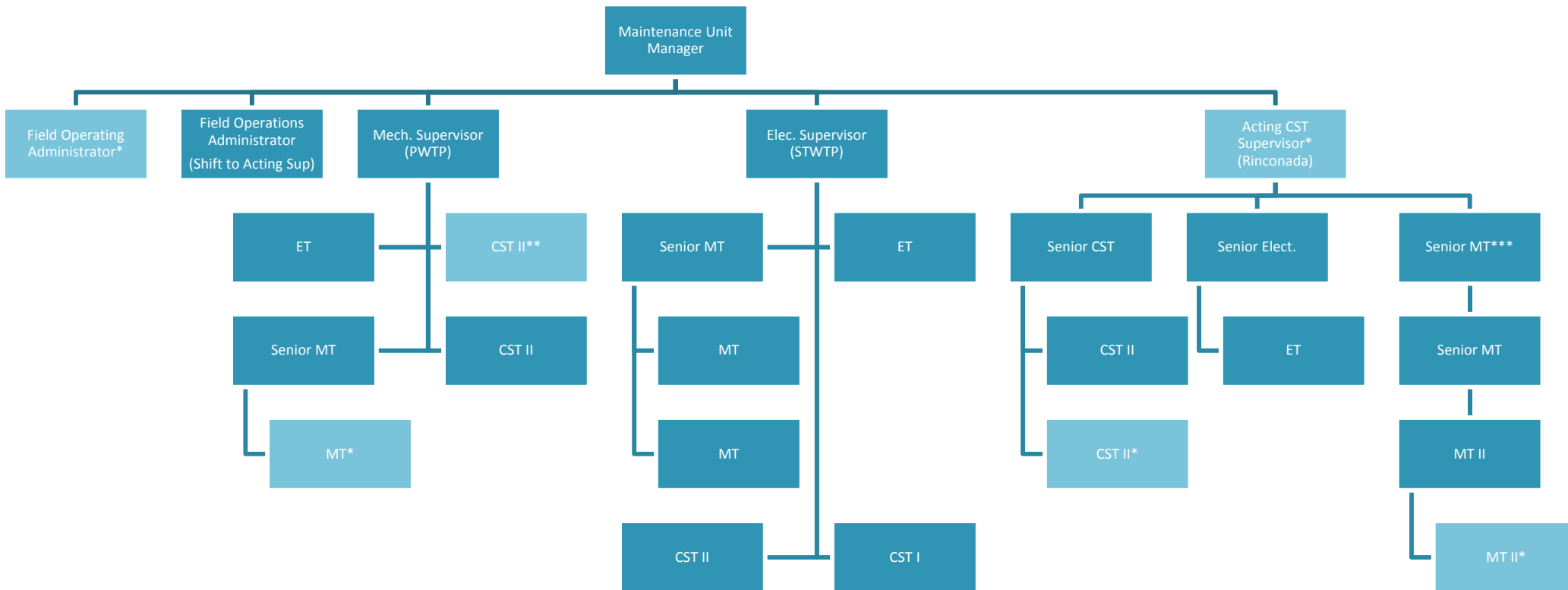
Finding (continued):

- The Control Systems Supervisor position, based at Rinconada, is vacant. As a result, one of the Maintenance Unit's Field Operating Administrator's recently took on the role of acting Supervisor.
- Vacancies and turnover in these control systems positions may lead to a lack of oversight and expertise on vital tasks such as overseeing treated water meter installation and replacement. These meters collect the flow data used for all billing. Without full staffing in these functions, the District risks faulty installation and maintenance of meters which could result in billing inaccuracies, over- or under- billing, and, ultimately, lost revenue.

RESOURCES – 1

Finding (continued):

Maintenance Unit Organizational Chart



Legend:

- * Vacancy
- ** Long-term Leave of Absence
- *** Upcoming Retirement
- Lighter color indicates full-time or temporary vacancy

RESOURCES – 1

Finding (continued):

- Within the Revenue Unit, there are two Senior Hydrologic Systems Analyst (Senior Analyst) positions and three Hydrologic Systems Analyst II positions. One Senior Analyst is responsible for tax calculations and the other Senior Analyst is responsible for treated water billing.
- One of the Senior Analyst positions is vacant due to retirement, leaving the remaining Senior Analyst to handle all of the tax and treated water billing tasks.
- While tax tasks typically peak within the months of May and June each year, there are tax-related tasks to be handled throughout the year, such as parcel tax amount and information verification.

RESOURCES – 1

Finding (continued):

- This vacancy may strain the remaining staff due to an increased workload and make it difficult for the lone Senior Hydrologic Systems Analyst to provide guidance or share knowledge with the Hydrologic Systems Analyst II's performing other functions.
- According to the Revenue Unit Manager, the District is in the process of recruiting for the vacant Senior Hydrologic Systems Analyst position.

RESOURCES – 1

Finding (continued):

- Within the Engineering and Measurement Units, there are vacant positions that affect the units' overall abilities to perform treated water activities.
- The Engineering Unit has had a vacant Assistant Engineer position for two years. An Associate Engineer position is unfilled because of an extended leave of absence. Additionally, as part of the District's recent resource planning project, the Engineering Unit estimated that it lacks two or three FTE's to perform its scheduled upcoming workload.

RESOURCES – 1

Finding (continued):

- The Engineering Unit Manager explained that Electrical and Control Systems Engineers, like Maintenance Unit personnel, are vital to ensure the ongoing operation of treated water plants and similarly respond to operation interruptions. Further, as new capital projects are initiated, demand for engineers increases.

RESOURCES – 1

Finding (continued):

- The Measurement Unit had two vacancies for the past few months within its Well Ordinance Program. In addition, to increase well compliance and enforcement efforts, the Measurement Unit Manager recently requested two additional FTEs work within the Well Ordinance Program. However, this request was not approved.
- While the vacant positions in the Measurement Unit do not have direct responsibilities for treated water functions, the remaining staff must dedicate time to ensure that the entire Unit's responsibilities are fulfilled thus indirectly straining the staff performing treated water functions.

RESOURCES – 1

Finding (continued):

- The Measurement Unit Manager stated that these vacancies, as well as insufficient overall staffing, affect his ability to attend weekly treated water review meetings and pay close attention to treated water. Moreover, vacancies and insufficient staffing lead the Unit Manager to perform staff work at the expense of managerial responsibilities.

RESOURCES - 1

Recommendation:

- ***The District should prioritize and fill vacant positions as well as place higher priority on the requested positions in the Engineering and Measurement Units.*** Given the significance of treated water as a revenue source for the District, maintaining adequate levels of staff in functions related to treated water is critical for the effective operations of the District. In particular, to continue implementing operational improvements, the District should focus on recruiting and hiring for vacant positions within the Maintenance, Revenue, Engineering, and Measurement Units. Additionally, the District should consider adding additional staff as workloads increase within the Engineering and Measurement Units.

RESOURCES – 2

Finding:

- ***The District lacks cross-training in key personnel functions that may significantly impact treated water measurement and other operations.*** Within multiple areas across the District, some key functions affecting treated water measurement are only performed by one individual. Without cross-training of additional personnel, staff absences and turnover within these functions pose a significant risk not only to the accuracy of the District's treated water measurement data, but also to its overall operations.

RESOURCES – 2

Finding (continued):

- For example, within the Revenue Unit, one position is responsible for the treated water billing function, as well as many other tasks, such as parcel tax verification and calculation. Due to the lack of adequate backup for the treated water billing function, sufficient time may not be consistently dedicated to verifying the accuracy of parcel taxes – another revenue source for the District. Additionally, the parcel tax verification process has yet to be documented with policies and procedures due to the time pressures on the position. Should this one employee with significant institutional knowledge be absent for an extended period of time or leave the District, operations in multiple areas may be negatively impacted.

RESOURCES – 2

Finding (continued):

- Similarly, within Maintenance, there is limited backup for the Senior Control Systems Technician (CST) who performs the majority of activities related to treated water meters. This employee also has a wealth of institutional knowledge. Without cross-training of other Maintenance staff, should the Senior CST be absent for a significant period of time or leave the District, valuable knowledge may be lost and treated water meter operations may be negatively impacted.

RESOURCES – 2

Recommendation:

- ***The District should develop and implement a cross-training program for personnel within each key function associated with treated water.*** To mitigate risks associated with staff absences and turnover, the District should implement or expand cross-training programs across the Revenue and Maintenance Units. Specifically, the Revenue Unit should continue to cross-train a second staff member on all aspects of the monthly treated water billing process. To remain capable of performing these tasks, the designated staff member should periodically assist in the performance of the monthly treated water billing process following the successful completion of cross-training.

RESOURCES – 2

Recommendation (continued):

- Additionally, the Revenue Unit Manager should learn the detailed process steps of the billing process for treated water. While the Revenue Unit Manager is intimately involved in communications about treated water billing, to best prepare for changes in staffing and assist in possible process improvement, it would be prudent if the Revenue Unit Manager also had a full understanding of the granular billing process as well. Further, this understanding would help to facilitate the implementation of more formally documented oversight of treated water billing, as discussed in *Oversight & Compliance – 1*.

RESOURCES – 2

Recommendation (continued):

- Similarly, the Senior CST should continue his efforts to develop the skills of the other CST's. In particular, the Senior CST should actively mentor a CST II to eventually serve as backup for complex treated water maintenance activities.

RESOURCES – 3

Finding:

- ***The primary tool for verifying the accuracy of treated water meters is more than six months overdue for calibration.*** The Measurement Unit uses one portable flowmeter in the field to verify the accuracy of meters installed at treated water turnouts. To ensure accurate measurement, this portable flowmeter should be independently calibrated every year. During a site visit to Sunnyvale to observe this testing process, we observed that the calibration is over six months over due.

RESOURCES – 3

Finding (continued):

- As the portable flowmeter is still the District's main source for testing the accuracy of treated water meters, maintaining the accuracy of the portable flowmeter is important. Without timely calibration, the accuracy of flowmeter readings could be compromised.
- Although a Senior Water Measurement Technician was aware of the calibration being overdue, the Measurement Unit Manager did not know about this issue.



RESOURCES – 3

Recommendation:

- ***The Measurement Unit should schedule and perform portable flowmeter calibration in a timely manner.*** In order to facilitate timely calibration, the Measurement Unit should prioritize this preventative maintenance activity, the calibration of the portable flowmeter, within the asset management system. By placing a higher priority on this activity in the asset management system, the Measurement Unit staff and Unit Manager increase the likelihood of timely completion. Moreover, the Unit Manager should proactively monitor the asset management system to ensure that the calibration occurs on time.

RESOURCES – 3

Recommendation (continued):

- In addition, given the importance of this tool, the Measurement Unit should consider purchasing an additional portable flowmeter to ensure that timely meter verification occurs as well as provide backup for the existing unit in the event of equipment failure.

RESOURCES – 4

Finding:

- ***The Measurement and Maintenance Units experience inefficiencies resulting from a lack of technology in the field.***
The Measurement Unit does not have laptops with software to perform field certification of the more modern flowmeters, ABB WaterMasters. Similarly, the Maintenance Unit Technicians do not have smartphones to take digital photographs despite installation procedures requiring photographs. Also, the Technicians do not have access in the field to the database of drawings and specification files.

RESOURCES – 4

Finding (continued):

- Using mobile technology in the field to reduce return trips to field offices, improve data accuracy and integrity, and integrate offsite processes with onsite systems in real time is a current best practice within the utility industry.

RESOURCES – 4

Finding (continued):

- Similarly, because the asset management system is not currently available to these units for mobile use, a significant amount of information is recorded on paper and must be entered manually into the asset management system. In addition, some records are only recorded on paper, including details of meter maintenance, and have never been transferred to the asset management system, which makes oversight and long-term tracking more challenging. Limited technology in the field increases the risk for human error, incomplete maintenance records, and, ultimately, of inaccurate meter readings and incorrect invoices.

RESOURCES – 4

Recommendation:

- ***To enhance the information available for oversight and long-term tracking, the Measurement and Maintenance Units should establish clear requirements for data entry and document upload into the asset management system.*** These units should identify the various types of records that are currently produced, such as meter maintenance and meter verification records, and develop policies and procedures for staff to follow regarding entering data or uploading paper documents. Once established, the supervisors and managers in these units should hold staff accountable for appropriately maintaining records electronically.

RESOURCES – 4

Recommendation (continued):

- ***To facilitate operational improvements and increase efficiency, the District should consider the following technology advancements :***
 - Continue the Measurement Unit's efforts to train staff and implement the use of laptops for field verification.
 - Provide Measurement and Maintenance Unit staff with smartphones or other handheld devices, such as tablets, with online access data and digital cameras. Additionally, the District should develop an organized file structure to digitally store these photographs.

RESOURCES – 4

Recommendation (continued):

- Providing secure mobile access to the database of drawings and specifications files, as well as exploring the possibility of secure mobile access to the asset management system.
- Pursuing the ability to enter meter readings, verification activity, and maintenance activity into the District's computer systems remotely. As detailed within the *Peer Agency Practices* section, other peer agencies use technology to fully automate the meter reading function.

COMMUNICATION & COORDINATION – 1

Finding:

- ***While numerous units within the District play roles in the treated water measurement and billing process, there is a lack of coordination between functions and clear delineation of responsibilities.*** Specifically, five separate units, (Revenue, Water Measurement, Plant Operations, Maintenance, and Engineering), have direct vested interests in the accuracy of treated water measurements. However, there is limited systematic collaboration across these units.

COMMUNICATION & COORDINATION – 1

Finding (continued):

- For example, the Measurement and Maintenance Units might communicate throughout the month about issues with a given meter. However, these issues may not be communicated to the Revenue Unit in the month end spreadsheet used for billing. If the Revenue Unit detects irregularities in the readings, they have to contact the Measurement Unit and then resolve issues before invoices can be prepared. This is a time-consuming process and has caused delays in billings. Per contract, invoices are required to be sent to customers within five business days.

COMMUNICATION & COORDINATION – 1

Finding (continued):

- Moreover, if anomalies in meter readings are not detected by the Revenue Unit, inaccurate bills could be sent to customers, resulting in challenges such as issuing refunds or trying to collect on under-billings.
- Similarly, the Maintenance and Engineering Units have faced challenges in coordinating tasks where responsibilities overlap. For example, requests for calculations from Engineering may delay installations by Maintenance. Similarly, if Engineering is busy with tasks for other units, Maintenance may install meters and submit specification drawings to Engineering after installation, which could result in additional work being necessary after the fact.

COMMUNICATION & COORDINATION – 1

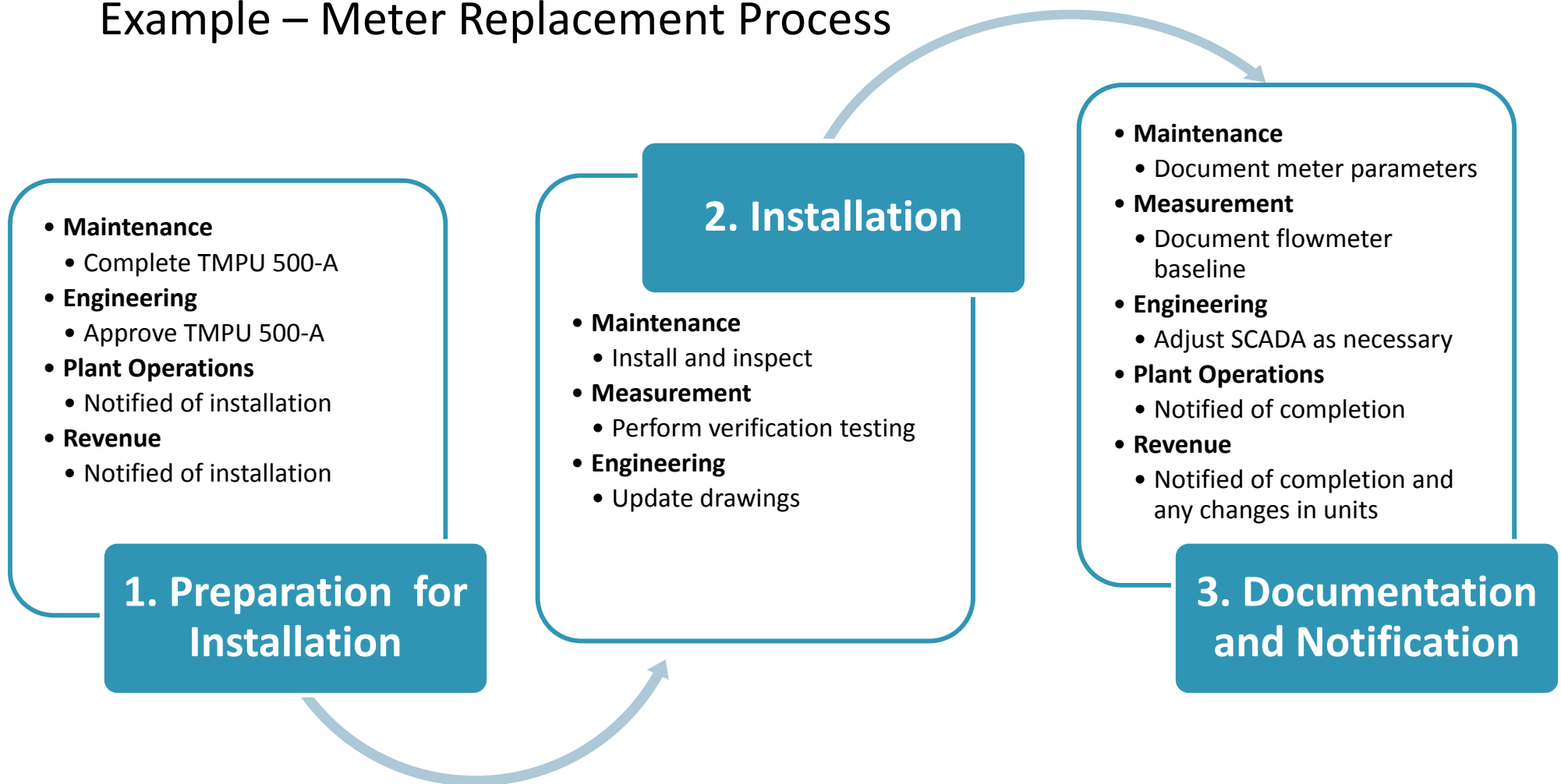
Recommendation:

- ***The District should clearly define roles and responsibilities of each of the five units that are involved in treated water functions, including Revenue, Measurement, Plant Operations, Maintenance, and Engineering.*** Delineation of responsibilities is particularly important for tasks that overlap such as assuring the accuracy of treated water data. The District should map out the key workflow processes within treated water to clearly identify roles and responsibilities for each of these units as well as when handoffs should occur. Once these processes have been mapped out, the District should link specific procedural steps or forms relevant for each unit to follow.

COMMUNICATION & COORDINATION – 1

Recommendation (continued):

Example – Meter Replacement Process



COMMUNICATION & COORDINATION – 1

Recommendation (continued):

- Roles and responsibilities should also address what to do when processes need to deviate from the norm. In particular, the District should establish processes to follow when challenges occur in coordinating with other units. For example, the District could implement a formal request system for service across units such as the comprehensive SCADA data requested by the Revenue Unit from the Engineering Unit. Similarly, the District should address how units should prioritize work and proceed when other units are busy with other activities. For example, this would inform how the Maintenance Unit should proceed with installation when the Engineering Unit is unable to perform specification drawing prior to installation.

COMMUNICATION & COORDINATION – 1

Recommendation (continued):

- ***The District should institute routine coordination meetings of the units involved in treated water functions.*** For example, the District could organize regular meetings between members of these units to improve collaboration as well as discuss additional opportunities for operational improvements. It was apparent that the cross-functional meetings held as part of this project were informative for multiple units. Facilitating coordinated communication across these functions, particularly at month end, may increase the District's efficiency.

COMMUNICATION & COORDINATION – 1

Recommendation (continued):

- Also, these meetings may allow the District to adopt a more proactive approach, rather than a reactive one, particularly in assuring data quality which could improve the speed with which data anomalies can be identified and addressed.

COMMUNICATION & COORDINATION – 2

Finding:

- ***Important information about treated water operations is not proactively communicated between units or to Executive Management.*** Executive Management relies on other units to inform them of problems or issues within treated water. Similarly, this information is not easily shared across units or across the organization. For example, the Measurement Unit tracks important characteristics of meters at each of the treated water turnouts within a standalone Excel spreadsheet.

COMMUNICATION & COORDINATION – 2

Finding (continued):

- Some of this information is also included in the District's asset management system, which Executive Management can access, and is discussed during certain meetings that focus on asset management, budgetary, or capital improvement matters for the District as a whole.
- However, without updating and sharing information affecting the operation of treated water on a more routine and consistent basis, rather than as issues occur or within more aggregate information, Executive Management may lack the relevant information to provide forward-thinking, effective, and direct oversight and decision making within treated water.

COMMUNICATION & COORDINATION – 2

Recommendation:

- ***The District should utilize technology and performance reporting to facilitate integrated communication and information sharing across the units involved in treated water functions and with the Executive Management.*** The District should explore technology options, including leveraging the capabilities of its existing asset management system, to facilitate greater collaboration and systematic communication. Increasing ongoing communication could significantly improve the data verification and billing process, as well as keep Executive Management informed of significant changes.

COMMUNICATION & COORDINATION – 2

Recommendation (continued):

- For example, a shared intranet site that interfaces with the asset management system could include Maintenance and Measurement Unit goals and accomplishments, regularly updated meter and maintenance data, links to request service or additional information, how to access additional information within the asset management system, and contact information. A group e-mail distribution list of key stakeholders could automatically notify all relevant individuals of page updates.

COMMUNICATION & COORDINATION – 2

Recommendation (continued):

- As part of the communication of goals and accomplishments, the Maintenance and Measurement Units should develop a simple report that shows the status of each treated water meter, the maintenance performed, and its functionality.
- These units should consider using an existing user-friendly report, such as the weekly report summarizing water movement, as a guide when developing this new treated water meter report. Once a report template is developed, the units should update and distribute this report regularly – no less than once per month.

COMMUNICATION & COORDINATION – 3

Finding:

- ***District customers would like more communication regarding treated water issues.*** Overall, the District's treated water customers spoke very highly of working with the District and appreciate the District's desire to continuously improve. One customer noted that communication over the last few years has improved and that there is more willingness on the District's part to collaborate on verifying totals together. The District also received praise for ongoing diligence and a willingness to bring reads that are out of the ordinary to customers' attention. At the same time, customers did have some ideas for improved treated water customer service that center on increased, consistent, and more formalized communication and coordination.

COMMUNICATION & COORDINATION – 3

Finding (continued):

- Customers mentioned that they would appreciate the inclusion of more measurement and billing education, timely construction notices, formal reporting, and capital improvement status updates via e-mail or during already established meeting opportunities, such as the Quarterly Retailer Meetings and treated water Subcommittee Meetings.

COMMUNICATION & COORDINATION – 3

Recommendation:

- ***The District should incorporate additional topics into existing meetings with customers, provide more consistent reporting, and ensure consistent communication about meter work that may affect customers.*** District customers appreciate the existing meeting opportunities available to them, but would like additional topic areas to be addressed during those meetings, including: how measurements are taken and how they are verified, discussion of future capital improvements, technology updates, the billing process, and an opportunity to meet their customer service contacts at the District.

COMMUNICATION & COORDINATION – 3

Recommendation (continued):

- Additionally, all customers surveyed mentioned the need for a regular report, on an annual or semi-annual basis (in line with the fiscal year), that provides verification that the meter readings received throughout the fiscal year were accurate. Some customers referred to this as a Water Audit or Water Balance.

COMMUNICATION & COORDINATION – 3

Recommendation (continued):

- Finally, the District needs to be consistent in its notification to customers of work it is performing on flowmeters that may affect a customer's monthly readings. While customers did report that the District's notification process is generally reliable, in the few instances that customers recounted notification not occurring, the additional work and disruption for customers during month-end processing and reporting were significant. For this reason, customers stated that when the District's normal process fails or it is an emergency, even a quick e-mail to customers would be appreciated.

STRATEGIC ACTION – 1

Finding:

- ***The District's Capital Improvement Plan may not be sufficient to fully address the District's needs and prevent future billing errors.*** While the implementation of the CPAR has improved treated water operations, outdated meters still pose a significant risk to the District. The District's most technologically advanced meters, ABB WaterMasters, are installed at 13 of the 26 turnouts. Troubleshooting diagnostics can be run on these meters using a laptop with software from the manufacturer. On seven of the remaining 13 meters, similar diagnostics and verification tests can be performed by a third party vendor.

STRATEGIC ACTION – 1

Finding (continued):

- For the remaining six meters, the Measurement Unit does not have a similar diagnostic tool to perform equipment testing that ensures these meters are functioning properly.
- Although a water balance could be used as a secondary verification measure to assist in assuring the reliability of flow data from all of the 26 meters, including the six remaining meters, it is difficult for the District to perform a reliable water balance due to some issues with the accuracy of flow data from the three plant meters. According to multiple sources, these difficulties are likely due to the plant meters being outdated.

STRATEGIC ACTION – 1

Finding (continued):

- According to Measurement Unit data, these six difficult to verify meters generate \$23.3 million, or 23.2 percent, of the District's annual treated water revenue and service three different customers.
- The Capital Improvement Plan calls for these six meters to be replaced by FY 2018. Without accelerating the replacement of these six outdated meters, the District risks continued data inaccuracies and possible billing errors in the interim.
- Unreliable meters at turnouts and plants will continue to create challenges in obtaining accurate data and may lead to further over- and under- billings, which could diminish customer confidence.

STRATEGIC ACTION – 1

Recommendation:

- ***The District should consider modifying its Capital Improvement Plan to accelerate the replacement of outdated meters at turnouts and unreliable meters at plants.*** By adjusting the plan's timeline, the District could more quickly improve the accuracy of its treated water operations. Without a more aggressive approach to these improvements, issues of inaccuracy and unreliable data will likely persist which may prove costly both financially and in terms of customer credibility.

STRATEGIC ACTION – 2

Finding:

- ***The District is not consistently using the most accurate forms of verification available for its meters.*** Meters should be tested in two ways: equipment and measurement verification.
 - Equipment Verification – this type of testing ensures the meter is functioning properly relative to its calibration when it originally left the factory. For the treated water meters, this testing is performed in-situ generally using the VeriMaster software on the laptop or by a third party vendor.
 - Measurement Verification – this type of testing verifies the volume of water flowing at the turnout with a secondary device, such as a portable flowmeter. The District also calls this operational verification.

STRATEGIC ACTION – 2

Finding (continued):

- Equipment Verification:
 - As noted within the prior finding, *Strategic Action – 1*, the District has no means to perform equipment testing on six of the District’s 26 treated water meters.
 - Of the 20 remaining meters, seven can be equipment tested by a third party vendor. However, the District has only pursued this third party testing on two of the seven meters as part of a troubleshooting process. Verifications through a third party vendor are not performed as part of a routine process and the remaining five meters have not been verified by the District.

STRATEGIC ACTION – 2

Finding (continued):

- Equipment testing may be performed on all of the remaining 13 meters utilizing VeriMaster software on a laptop that communicates with technology already installed on the meters themselves.
- As noted in the prior finding *Resources - 4*, the District only has one laptop with the VeriMaster software, and it is dedicated to the Maintenance Unit, not the Measurement Unit. However, the Measurement Unit is in the process of obtaining a laptop with this software.

STRATEGIC ACTION – 2

Finding (continued):

- For this reason, the Maintenance Unit is performing testing of the meters using its laptop with the VeriMaster software. Work orders are in place to complete testing on each of the 13 meters. Five of the 13 meters have been verified, or 38.5 percent, and all meters tested have passed. Testing is still in progress on the eight remaining meters.

STRATEGIC ACTION – 2

Finding (continued):

- Measurement Verification:
 - The District may not be performing measurement verification in the best way possible. Currently, the Measurement Unit uses a portable flowmeter that is accurate in the field within +/- 5 percent to verify that installed meters are measuring the flow volume of treated water accurately. All portable flowmeters are affected by human error as well as changes in accuracy relative to flow range. While these factors may never be entirely mitigated, some alternatives exist to reduce some of these issues.

STRATEGIC ACTION – 2

Finding (continued):

- Measurement Verification (continued):
 - For example, some new portable flowmeters, which advertise greater accuracy, also have advanced storage capabilities which may reduce the chance of human error.
 - In addition, as the revenue generating entity, the District may not be perceived as an unbiased source for measurement verification.

STRATEGIC ACTION – 2

Finding (continued):

- During fieldwork we observed the Measurement Unit staff verify the meter at the Sunnyvale turnout using the portable flowmeter. Given that this Sunnyvale turnout generates nearly \$6 million in annual revenue and experienced a prior billing issue, improving measurement accuracy at this meter by even a few percentage points may provide the District both with an earlier warning of flow deviation and mitigate the magnitude of errors, should they occur.

STRATEGIC ACTION – 2

Finding (continued):

- For example, instead of picking up on problems when deviations are +/- 8 to 10 percent; problems may be detected sooner, when deviations reach just +/- 3 to 5 percent.
- If an error in data measurement still did arise, the revenue impact of the error may be smaller if the accuracy of readings were increased overall through better verification.

STRATEGIC ACTION – 2

Recommendation:

- ***The District should pursue the most accurate forms of equipment and measurement verification available for its meters.***
 - Equipment Verification – The Measurement Unit should establish and adhere to a schedule to annually perform in-situ equipment verification. The Measurement Unit should schedule verifications with third party vendors or have Measurement Unit staff perform verifications with the VeriMaster software.

STRATEGIC ACTION – 2

Recommendation (continued):

- Measurement Verification – The District should investigate acquiring more technologically advanced portable flowmeters that may offer greater levels of accuracy and will reduce human error. In addition, the District should explore the option of outsourcing the measurement verification function to manufacturers or third-party vendors. Besides potentially providing a greater level of accuracy, outsourcing this function would ensure the District’s appearance of independence.

STRATEGIC ACTION – 3

Finding:

- ***Customer flowmeters have not been systematically leveraged to provide additional assurance.*** Some treated water customers have their own flowmeters that could provide critical backup to the District's Measurement Unit. However, efforts have not been made to systematically verify the accuracy of District flow data through the use of comparative customer flow data where available.

STRATEGIC ACTION – 3

Finding (continued):

- By coordinating with customers that have their own flowmeters to gain data on a consistent basis, the District could add additional checks to its flow data at little to no additional cost. However, according to the Measurement Unit Manager, there are some concerns about the accuracy of customer meters that may limit their usefulness in providing accurate secondary flow data.

STRATEGIC ACTION – 3

Recommendation:

- ***District management should coordinate with customers that have meters to receive customer flow data on a consistent basis to use for comparative analysis.*** While there are some factors that may render customer meter data more variable than District data, coordinating with District customers to receive that data on a consistent basis will provide the District with a secondary flow data source and may have the additional effect of building stronger customer relationships. Analysis of the difference between the amount water District meters measure as flowing to the customer versus the amount of water the customer records as received will provide a pinpointed control over one section of the treated water process.

STRATEGIC ACTION – 4

Finding:

- ***Data analysis of treated water flow measurements may not be performed frequently enough or with enough rigor to detect or prevent future billing errors.*** According to policies and procedures, the Measurement Unit is supposed to look for flow anomalies at the time of weekly meter readings. However, the procedures do not detail the information sources staff are expected to use for comparisons. Moreover, the extent of this analysis, such as the data reviewed, is not documented and only the staff's initials on the meter reading spreadsheet indicate if a review occurred.

STRATEGIC ACTION – 4

Finding (continued):

- While Operations/Water Quality Engineering performs ongoing monitoring of SCADA data and data trends, this monitoring is focused more on overall flows and water quality, including chemical dosages, residuals, and filter performance. Current practices within Operations/Water Quality Engineering are likely to detect very large changes in flow (20 to 25 percent changes in flow), but they would probably not pick up on more subtle changes because this has never been the focus of their data monitoring.

STRATEGIC ACTION – 4

Finding (continued):

- Based on documentation, it appears that the most rigorous treated water flow data analysis is being performed by the Revenue Unit on a monthly basis as part of the treated water billing process. While the implementation of this analysis is an improvement over prior billing practices, it would be more efficient and beneficial if more rigorous analysis is performed on a weekly basis by the Measurement Unit, positioning the District to detect anomalies earlier in the process allowing for a more proactive response and less errors reaching customers.

STRATEGIC ACTION – 4

Finding (continued):

- Addressing and resolving data anomalies throughout the month would speed up the billing process and allow the District to more proactively perform data quality assurance. Further, if the Revenue Unit staff did not have to perform extensive data quality assurance analysis, then staff would have more time to dedicate to other revenue-generating functions, such as parcel tax calculations.

STRATEGIC ACTION – 4

Recommendation:

- ***The District should document data analysis requirements for treated water flow measurements within the Measurement Unit.*** Given the complexity of the data analysis process for treated water measurements, as well as the potential subtlety of the possible anomalies, the Measurement Unit should adopt formalized guidance and documentation for these reviews. The guidance and documentation to perform these reviews should be detailed within the CPAR procedures and include the designation of staff roles and responsibilities for the conduct and review of the data analysis.

STRATEGIC ACTION – 4

Recommendation (continued):

- ***The District should leverage technology to automate the reading, analysis, and data transfer process for more accurate billing.*** Automatic reading of meters and totalizers with a cell tower relay is available. As detailed within the *Peer Agency Practices* section, other peer agencies use technology to fully automate not only the meter reading function, but also the detection of anomalies. Systems used for this type of automation are separate from SCADA and designed specifically to collect meter and totalizer data for billing purposes. While staff involvement is still necessary, the use of an automated system may improve the reliability of meter data and alert the District to variances earlier, and/or within a less significant rate of change.

STRATEGIC ACTION – 5

Finding:

- ***Key tasks have to be prioritized manually.*** Because of demanding workloads, limited staff resources, and a lack of fully automated systems, the Measurement, Maintenance, and Engineering Units must manually prioritize daily activities. For example, the District’s maintenance management system, which generates work orders, does not automatically assign any priority level for tasks beyond whether the task constitutes preventative or corrective maintenance. Without built-in codes to designate appropriate priority levels, the Maintenance Unit, and the District as a whole, depends on the three Maintenance Supervisors to appropriately prioritize all work orders.

STRATEGIC ACTION – 5

Finding (continued):

- While the CPAR does call for the assignment of four priority levels to tasks, it does not consider all of the robust data that is available regarding treated water meters and site specific considerations. Given the volume of work orders, this task is subject to human error or subjective choices in assigning priority. Similarly, the Measurement Unit is not adjusting its verification schedule according to the characteristics of the meters (i.e., age, history of reliability).

STRATEGIC ACTION – 5

Finding (continued):

- Without prioritizing treated water-related work orders based on a systematic risk-based plan, individual supervisors may make differing decisions about levels of priority that could delay corrective maintenance and affect the accuracy of treated water measurement.

STRATEGIC ACTION – 5

Recommendation:

- ***Based on the significance of treated water revenue, the District should clearly prioritize treated water operations and communicate this priority across the organization.*** Because many units within the District are responsible for both treated water functions as well as other functions, the District should communicate how competing responsibilities should be prioritized. For example, if Executive Management considers that treated water activities should take precedence over other tasks, the Maintenance, Measurement, Revenue and Engineering Units can adjust their workload and prioritize accordingly.

STRATEGIC ACTION – 5

Recommendation (continued):

- ***Given the significant variations among flowmeters and the magnitude of billings across treated water turnouts, the District should utilize a more comprehensive risk-based approach to maintenance, monitoring, and data quality assurance based on the varied the profile of treated water meters.*** The Measurement Unit compiled a list of all treated water meters, including their relevant characteristics, and ranked them (see Appendix A). The District should review this list and adopt or modify these rankings. Rankings could consider the age and type of meter, assurance about meter installation, possibility of meter verification, and amount of billing at each turnout. Once ranked, the District could more strategically allocate its finite resources.

OVERSIGHT & COMPLIANCE – 1

Finding:

- ***There appears to be a lack of oversight of and accountability for treated water functions.*** The Measurement, Revenue, and Maintenance Units all rely heavily on a few individuals to perform their work correctly, but there is limited supervision to ensure accuracy.
 - Measurement: Senior Technicians depend on Technicians to record meter readings accurately and enter data correctly. Similarly, the Unit Manager relies on Senior Technicians to perform measurement verification of meters appropriately and timely, but the Unit Manager does not routinely check the meter verification records.

OVERSIGHT & COMPLIANCE – 1

Finding (continued):

- Revenue: The Unit is heavily dependent on one individual, the Senior Hydrologic Systems Analyst, to assure that accurate treated water billings occur despite the complex manual process that is subject to human error. Managerial oversight is not incorporated into the billing procedures.
- Maintenance: Supervisors may not thoroughly inspect and ensure the quality of meter installation. At present, the District has some treated water meters that were not installed correctly.

OVERSIGHT & COMPLIANCE – 1

Recommendation:

- ***The District should increase oversight of and accountability for Measurement, Revenue, and Maintenance Unit functions within treated water to ensure the accuracy of meter read data.*** Enhance oversight and accountability as follows:
 - Measurement: Prior to the weekly meter reading meetings, the Senior Technicians should verify that the Technicians record and enter meter reading data correctly. This could include spot checking the route book or comparing to a photograph of the meter reading to ensure accurate data entry.

OVERSIGHT & COMPLIANCE – 1

Recommendation (continued):

- Similarly, the Measurement Unit Manager should check the maintenance system to ensure that meter verifications are being performed on-time. Periodically, the Measurement Unit Manager should pull a sample of meter verifications performed by each Senior Water Measurement Technician and review the documentation, including the comparison to the baseline, to ensure the verification was performed correctly.

OVERSIGHT & COMPLIANCE – 1

Recommendation (continued):

- Revenue: After learning the detailed treated water billing process, as discussed in *Resources -2*, the Revenue Unit Manager and Senior Hydrologic Systems Analyst should collaborate to modify current practices to incorporate a review by the Unit Manager or the senior staff member of billing data as well as prepared invoices.

OVERSIGHT & COMPLIANCE – 1

Recommendation (continued):

- Maintenance: The District should ensure that only the Control Systems Supervisor, Maintenance Manager, or other well-qualified Control Systems personnel inspects meter installation. Additionally, the Maintenance Unit should identify all meters with problematic installation and discuss with District Management how to prioritize addressing these installation issues.

OVERSIGHT & COMPLIANCE – 2

Finding:

- ***The Measurement Unit lacks some internal controls.*** For example, Water Measurement Technicians perform readings without supervision or rigorous documentation requirements thus making it possible for Technicians to record meter readings without actually visiting the meters. Similarly, the two Senior Water Measurement Technicians, who use the portable flowmeter to check the meters at turnouts, always visit the same turnouts.

OVERSIGHT & COMPLIANCE – 2

Finding (continued):

- Without regular rotation of assignments, mistakes in these verifications could go unchecked for long periods of time and the District is foregoing a valuable cross-training opportunity. Weaknesses in internal controls within the Measurement Unit could compromise the data quality and, ultimately, billing accuracy.

OVERSIGHT & COMPLIANCE – 2

Recommendation:

- ***The Measurement Unit should leverage management practices to strengthen internal controls.*** The Unit Manager should periodically switch the assignments of the two Senior Water Measurement Technicians so that these employees change the turnouts that they are verifying with the portable flowmeter. Similarly, if the Measurement Unit does not compare digital photos of meter readings as recommended in *Oversight & Compliance - 1*, the Measurement Unit Manager, or senior staff, should periodically check the work of the Water Measurement Technicians. These periodic reviews would be most effective if they were not announced beforehand to staff but are performed regularly; for example, at least once every two months.

OVERSIGHT & COMPLIANCE – 2

Recommendation (continued):

- ***The Measurement Unit should consider utilizing additional technology to build in greater internal controls.*** As detailed in *Resources - 4*, the Measurement Unit should explore the option of taking photographs of meter readings to serve as greater data verification. In addition, the District should investigate the technology available for remote meter readings and evaluate the costs and benefits of adopting this technology.

OVERSIGHT & COMPLIANCE – 3

Finding:

- ***Treated water measurement relies heavily on accurate fieldwork that is not thoroughly verified.*** Each week Water Measurement Technicians visit meters by themselves and record meter measurements on paper, as well as any problems or concerns noted at the site. Once the Technicians return to the office, they manually enter these measurements into an Excel spreadsheet. A Senior Water Measurement Technician approves the data entered.

OVERSIGHT & COMPLIANCE – 3

Finding (continued):

- Existing procedures do not define the approval process. While procedures specify that there will be weekly meetings between the Water Measurement Technician, Senior Water Measurement Technician, and Measurement Unit Manager to discuss the readings, there is no documentation to indicate that these meetings occurred.

OVERSIGHT & COMPLIANCE – 3

Finding (continued):



Step 1: Read Meter

OVERSIGHT & COMPLIANCE – 3

Finding (continued):

Santa Clara Valley Water District

TREATED WATER METER READING
FC 1758 (06-21-13)

YEAR 2014 STATION NAME Norwood

DATE	TIME	TOTALIZER READING	EXTRA METER	COMMENTS	TECH.
3/26/14	1205	530938			SD
3/28/14	1248	540630			SD
4-3-14	105	571194			EM
4-8-14	110	620645			EM
4-15	1255	647613			EM
4-21	118	692857			EM
4-20	1155	729354			EM
5/6	1300	755550			SD
5/13	1200	774070			SD
5/20	1305	809841			SD
5/27	1302	836232			SD
5-30-14	1230	750257			CJ
05-20-14	1226	877459			CJ
6-10	1227	892704			CJ
6-17	1235	914039			CJ
6-24	1242	971366			CJ
6/30	1300	1012077	6566046	10.57	SD
7-8	1135	1063552	6635118	4.31	EM

Step 2: Manually Record Reading

OVERSIGHT & COMPLIANCE – 3

Finding (continued):

YEAR		STATION							Date Reviewed	Reviewed By
2014		Rainbow T.O.								
Month & Day	Time	Billing		Production MG	SSWC reading	Production MG	Comments	Technician		
		Local Totalizer	Multiplier for MG							
12/31/13	901	91192	0.001		32351			CJ	1/2/2014	EW/MD
1/7/14	953	91270	0.001	0.078	32431	0.080		SD	1/13/2014	EW
1/15/14	928	91385	0.001	0.115	32552	0.121		SD	1/16/2014	EW/MD
1/22/14	923	91456	0.001	0.071	32627	0.075		SD	1/23/2014	MD
1/27/14	940	91517	0.001	0.061	32693	0.066		SD	1/28/2014	EW
1/31/14	907	91564	0.001	0.047	32741	0.048		CJ	2/3/2014	EW
2/4/14	908	91609	0.001	0.045	32789	0.048		CJ	2/6/2014	MD
2/11/14	914	91669	0.001	0.060	32853	0.064		CJ	2/14/2014	EW
2/18/14	855	91729	0.001	0.060	32917	0.064		CJ	2/20/2014	MD
2/25/14	904	91791	0.001	0.062	32982	0.065		CJ	2/26/2014	EW
2/28/14	858	91824	0.001	0.033	33018	0.036		CJ	3/3/2014	EW
3/4/14	915	91856	0.001	0.032	33056	0.038		SD	3/14/2014	EW
3/11/14	912	91926	0.001	0.070	33133	0.077		SD	3/14/2014	EW
3/18/14	935	91989	0.001	0.063	33201	0.068		SD	3/28/2014	EW
3/26/14	940	92088	0.001	0.099	33311	0.110		SD	3/28/2014	EW
3/28/14	928	92106	0.001	0.018	33332	0.021		SD	4/1/2014	EW

WPL More Ave MAPS More Flushing Campbell SC Distributory Congress Cox Rainbow Mann Barranca S

Step 3. Enter Reading
Step 4. Approve Reading

OVERSIGHT & COMPLIANCE – 3

Finding (continued):

- The Measurement Unit's reliance on fieldwork without periodic verification or validation makes the District susceptible to billing mistakes caused by simple human errors. The lack of specificity about the Senior Water Measurement Technician's approval process in the procedures makes its value unclear. Without documenting the weekly reviews of the meter reads, in the event of future billing issues, it will be impossible to determine whether or not these reviews occurred, making it more difficult to determine where and when in the process mistakes were made.

OVERSIGHT & COMPLIANCE – 3

Recommendation:

- ***Management should add a well defined verification and validation process to the Measurement Unit's meter reading fieldwork and data analysis procedures.*** The procedures for the collection, reporting, data entry, and analysis of meter read data by the Measurement Unit should include a defined verification, validation, and approval process. As part of this process, staff roles and responsibilities should be clearly defined. Existing documents could be used to clearly show that verification, validation, and approval occurred. For example, a Senior Water Measurement Technician could date and initial a document.

OVERSIGHT & COMPLIANCE – 3

Recommendation (continued):

- Additionally, procedures should also clearly indicate how current forms should be completed. For example, if a “comment” column exists, the Measurement Unit should specify what types of comments should be entered within it and which should not.
- By keeping accurate records of these steps having taken place, as well as consistently noting information about meters and meter readings as dictated by procedure, the District will be able to more efficiently and effectively investigate issues that may arise in the future.

OPERATIONS – 1

Finding:

- ***The Measurement Unit is not following all of its procedures established as part of the CPAR.*** By deviating from these procedures, the Measurement Unit may not be adequately ensuring the accuracy of flow data, which is necessary for accurate billing, or sufficiently preventing future costly billing errors like Sunnyvale.
- There are two types of weekly meetings that are supposed to occur according to procedures. The first weekly meeting concerns physical meter reads performed by staff, while the second weekly meeting concerns the examination of additional flow data to detect potential anomalies.

OPERATIONS – 1

Finding (continued):

- Weekly Meeting 1 – Physical Meter Readings: According to the procedures, the Water Measurement Technician, Senior Water Measurement Technician, and Unit Manager will meet weekly to discuss treated water meter readings, as well as any issues noted during the meter reads. However, the Unit Manager is not attending these weekly meetings and it is unclear whether the technicians are meeting weekly to discuss readings. Straying from this documented procedure reduces the amount of consistent oversight over the meter readings, may not adequately ensure the quality of data being used for billing, and may result in inadequate historical documentation of meter readings and investigation of reading anomalies.

OPERATIONS – 1

Finding (continued):

- Weekly Meeting 2 – Examination of Additional Flow Data: As a result of the CPAR, the Measurement Unit procedures were revised to include an additional weekly meeting between the Senior Water Measurement Technician and the Unit Manager to review total flow against historical flow totals, look for any anomalies, and review the plotted data from the Operations Data Management System (ODMS) for each turnout. Upon completing this review for each turnout, the review date will be added to each treated water meter reading spreadsheet. The Unit Manager stated that he does not review the data weekly with the Senior Water Measurement Technician but does on at least a monthly basis.

OPERATIONS – 1

Finding (continued):

- Based on our review of the treated water meter reading spreadsheets for December 31, 2013 to July 1, 2014, these reviews are not occurring on a monthly basis. We found that the last review with both the Senior Technician and Unit Manager occurred in January 2014. Looking at the West Pipeline, we found that for the 31 scheduled readings two reviews with both the Senior Technician and Unit Manager occurred and four reviews were performed by the Unit Manager alone.

OPERATIONS – 1

Finding (continued):

- While all of the scheduled weekly readings were reviewed by the Senior Water Measurement Technician in accordance with the procedure, the frequency of the Unit Manager's review does not follow the District's procedure.
- Given numerous types of anomalies to scan for and the manual nature of this review process, the Unit Manager's involvement is important both as a second set of eyes and to ensure that this review occurs.

OPERATIONS – 1

Finding (continued):

- By not reviewing data more rigorously on a weekly basis, in accordance with procedure, the Revenue Unit must perform additional work at the end of the month to ensure data quality rather than proactive data quality management occurring throughout the month as dictated by the CPAR.

OPERATIONS – 1

Finding (continued):

- The initial verification readings with the portable flowmeter provide the baseline for all future readings. Specifically, these readings establish the baseline, +/- 5 percent, of variation expected between the portable and installed flowmeter. Therefore, this baseline should be recorded in the site data for all turnouts. However, during our field visit to the Sunnyvale turnout, we observed that this was not the case. Instead, Technicians have been comparing the meter readings to the most recent reading to ensure that the readings are within the +/- 5 percent range. Therefore, the comparison is not to a baseline but to historical data. This deviation from procedure could allow gradual or subtle changes to go undetected.

OPERATIONS – 1

Site Data

Site Name: Sunnyvale T/O

Location: S Pendleton / E Freeway 85

Meter Information

Meter Make / Type: ABB Water Master	Multiplier / Units: X .001 MG
Serial No. (Control Box): 3K220000147297	Remote Multiplier:
Serial No. (Transducers):	Electronics Outputs (4-20, Freq, Other):
Serial No. (Remote Equip):	Meter Flow Range / Units: 0-20 MGD
Meter Size: 30"	Maximo Location: 94639027
Pipe ID:	Maximo Equipment: E54015

Panametrics Information

Date: 4/16/13
Panametrics: PT878
Transducer MHZ: .5 1.0
Pipe OD (meas-calc): 32.03"
Pipe Mat'l: Steel
Pipe Thickness: .250
Pipe Lining Mat'l: Mortar
Pipe Lining Thickness: .250
Sensor Distance: 27.636

Put Panametrics on spool after ABB meter.

Finding (continued):

- This is the site data for the Sunnyvale turnout. It details the meter information, as well as the appropriate settings for the Panametrics portable flowmeter. The baseline variation between the flowmeter upon installation and the portable flowmeter is not noted.

OPERATIONS – 1

Recommendation:

- ***The Measurement Unit should adhere to all of its procedures established as part of the CPAR.*** The Measurement Unit should consistently hold both types of weekly meetings with all attendees indicated in its procedures. The Unit should also establish a checklist for each of the meetings to document the required items discussed or the data sources reviewed. In addition, the Senior Water Measurement Technicians should follow procedures and record the baseline measurement upon meter installation and use this baseline for all subsequent comparisons. The Measurement Unit Manager should periodically check these meter verification records to ensure that procedures are being followed.

OPERATIONS – 1

Recommendation (continued):

Example - Weekly Meeting – Meter Readings Checklist

Date:	Attendees:	<i>Initials</i> WM Tech	<i>Initials</i> Sr. WM Tech	<i>Initials</i> Unit Mgr
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Items or Tasks	Done	Notes
Reviewed treated water Totalizer Route Book		
Reviewed treated water Meter Reading Spreadsheet		
Spot checked data accuracy <i>Route book or photo VS. spreadsheet</i>		
Discussed problems or concerns noted at meter (include examples)		
Discussed data errors detected on spreadsheet		
Signed off initial review on spreadsheet		

OPERATIONS – 1

Recommendation (continued):

Example - Weekly Meeting – Examination of Flow Data Checklist

Date:	Attendees:	<i>Initials</i> Sr. WM Tech	<i>Initials</i> Unit Mgr
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Items or Tasks	Done	Notes
Reviewed ODMS and checked for all of the following: 1) <i>Flow maxing out</i> 2) <i>Flow too steady</i> 3) <i>Flow bouncing too much</i> 4) <i>Flow not matching typical curve</i>		
Reviewed TW Meter Reading Spreadsheet and checked for: 1) <i>Meter readings going backwards</i> 2) <i>Resolution of problems or concerns noted</i>		
Reviewed SCADA Data and checked for: 1) <i>Flow totals above historical maximum at turnout</i> 2) <i>Flow totals above or below historical flows last year</i>		
Compared remote totalizer matching local totalizer		
Communicated relevant issues to Revenue Unit		
Signed off second review on spreadsheet		

OPERATIONS – 2

Finding:

- ***Despite process changes made in response to the Sunnyvale event, some weaknesses in meter verification practices persist.*** By December 2012, if a treated water flowmeter was replaced or installed, the Measurement Unit should perform measurement verification testing weekly for three consecutive weeks to confirm that the meter is operating correctly. However, during a field visit to the Sunnyvale turnout, we observed that meter verifications were not performed at this frequency.

OPERATIONS – 2

Finding (continued):

- Specifically, the new control box was installed at Sunnyvale on December 11, 2012. The meter was also verified on the same date. However, it was not verified again until February 26, 2013; April 15, 2013; and, again on August 13, 2013.
- The Unit Manager did not know that the Sunnyvale turnout had not been monitored according to the new schedule within the CPAR.

OPERATIONS – 2

Recommendation:

- ***The Measurement Unit should follow the meter verification schedule established in the CPAR.*** Adherence to this schedule should be considered a requirement for Senior Water Measurement Technicians. Further, as a critical control for ensuring accurate measurements upon meter installation or repair, the Unit Manager should monitor the timely performance of meter verifications and ensure that this schedule is followed.

OPERATIONS – 3

Finding:

- ***The new treated water billing process is labor intensive and could be more efficient.*** Although the new billing process provides greater assurance of accuracy, the process remains largely manual and time consuming. Treated water contracts stipulate that invoices must be sent to customers within five working days of the first of each month. Any delays in receiving and assuring the accuracy of this data may result in delayed billings and a possible breach of contract. Conversely, inadequate attention to data quality assurance may result in over- or under-billings, which can be costly to the District both financially and in terms of reputation and credibility.

OPERATIONS – 3

Finding (continued):

- For these reasons, the Revenue Unit must ensure that flow measurement data is accurate as well as prepare and submit invoices within an aggressive timeline. Without any automation or built-in controls, this process is subject to human error.
- Since the CPAR was created, the Revenue Unit documented this process. While the process documentation is thorough, it does not include details about all of the data assurance steps. Further, given the fiscal significance of this function (\$92 million in FY 2013), it would be prudent to test the procedures and ensure that written guidance is sufficient to enable another employee successfully perform this function.

OPERATIONS – 3

Recommendation:

- ***The District should consider short-term and long-term solutions to make accurate data collection and treated water billing processes less labor intensive and ultimately more effective.*** In the short-term, the District should improve the Excel templates it uses for meter reading and treated water billing. These templates should incorporate the relevant comparative SCADA data as well as formulas to automatically show differences in data. Unit or multiplier data should be locked to prevent inadvertent changes. Additionally, the District should improve the Excel workbook the Revenue Unit uses to show trends in treated water billing by building in formulas so that the spreadsheet will automatically populate to save staff time.

OPERATIONS – 3

Recommendation (continued):

- The District should investigate more comprehensive technological solutions to monitor trends in treated water data within both the Measurement and Revenue Units. Specifically, the District should consider utilizing computer software or in-house programming to detect certain anomalies in flow data. Similarly, the District should research how it could more comprehensively compare treated water usage over time and incorporate this analysis into the Revenue Unit's data assurance processes.

OPERATIONS – 3

Recommendation (continued):

- By adopting additional analytical technology in these units, the District would provide its staff with the tools necessary to consistently provide greater data assurance.
- An example of how a peer agency uses technology to automatically collect and analyze meter data for billing purposes is included in the *Peer Agency Practices* section.



Peer Agency Practices

PEER AGENCY PRACTICES

Peer Agencies

With assistance from the District, we interviewed two peer agencies with similar treated water operations within the State of California. We asked these peer agencies questions regarding equipment verification, measurement verification, meter reading processes, methods used to ensure accurate readings, and billing quality control processes. Each agency wished to remain anonymous and will be referred to in the following slides as Agency A and Agency B.

PEER AGENCY PRACTICES

Comparability between Peer Agencies and the District

In some cases, the specific tools or methods that work well for Agencies A and B may not be the best fit for the District for various reasons, such as meter equipment types in use or existing infrastructure. However, the types of practices and technologies employed by these agencies to deal with issues that are similar to those faced by the District may be worth exploring.

Peer Agencies Key Takeaways

The other agencies agree that it is difficult to find peers with whom to compare. They find that the AWWA is a good source for some standards and water quality issues, but does not generally provide good information for their large treated water operations.

PEER AGENCY PRACTICES

Peer Agencies Key Takeaways (continued)

Based on our interviews with two peer agencies, the District may want to pursue:

- Greater use of technology in the following areas –
 - Meter read data collection and measurement data analysis
 - Equipment and measurement verification processes
 - Collection of meter equipment/inventory data that feeds into a work order system and incorporates data from equipment and measurement verification
- The use of a third party to perform some equipment verification
- Membership in and professional information from the Society of Maintenance and Reliability Professionals (SMRP)

PEER AGENCY PRACTICES

Agency A

- Treated Water Equipment Types:
 - Most common diameter 48”, up to 144”
 - Use 4 types of meters
 - Magnetic
 - Orifice
 - Venturi
 - Propeller

PEER AGENCY PRACTICES

Agency A (continued)

- Overall Maintenance and Verification Processes
 - Error range – not available. The agency was not able to remember the exact range.
 - They use a Maintenance Management System and are in the process of creating a Maintenance Policy.
 - For every meter that the agency uses, especially billing meters, they are on a 3 to 6 month maintenance cycle.
 - The main equipment verification cycle is every 3 months, but they never go longer than 6 months. The agency verifies against the installed verification that the manufacturer provided and look for any degradation.

PEER AGENCY PRACTICES

Agency A (continued)

- The agency verifies that all parameters in the meter console are still the same and have not changed.
 - They annually check that the cables in ultrasonic meters are not degraded and inspect the sensors.
 - For magnetic meters, they use a diagnostic test to check the outputs.

PEER AGENCY PRACTICES

Agency A (continued)

- To perform equipment verification, Agency A uses a Beamex Calibrator. Using this device, all information goes into a database that purchased with the device.
 - This device allows the agency to perform calibration in situ
 - It works with all meter types
 - The database creates a forensic accounting of the meter and establishes an audit trail. It is the first place the agency looks when any issues arise with billing or a meter

PEER AGENCY PRACTICES

Agency A (continued)

- The agency stated that some meters cannot truly be calibrated – the agency really just verifies that the equipment has the appropriate settings. However, with many of Agency A's meters, they can actually test them using the Beamex device.

PEER AGENCY PRACTICES

Agency A (continued)

- For measurement verification, they do not perform flow tests on the Venturi meters. The Venturi meter is designed against a standard with a stainless steel ring that is fixed. The sensors can change and work by measuring pressure. Therefore, the agency introduces a known pressure to verify that the sensors are accurately measuring pressure within the pipe. The agency verifies measurement against a standard. If the variance exceeds a certain amount, they replace the sensors.
- The agency also uses the Beamex device to perform this testing and all of this information goes into the same database.
- The agency performs this measurement verification testing on the same schedule as equipment verification, every 3 to 6 months.

PEER AGENCY PRACTICES

Agency A (continued)

- The agency may perform a flow test as part of an investigation.
 - They do not consider portable flow meters to be lab quality measurements. Specifically, the agency does not believe these measurements are accurate enough for flow verification and is an area they are investigating.
 - There are some accurate portable flow meters, but they require their own verification. Agency A just received a flow meter a month ago that the manufacturer claims has a +/- 1% error rate. They plan to test it at a new meter that is not yet in service to determine the exact error rate before they start employing it.

PEER AGENCY PRACTICES

Agency A (continued)

- The agency thinks portable flow meters may be useful for larger gross errors – errors of 10% or more, or where errors are associated with fluctuating conditions. For example, you can take a measurement, change the condition, and take another measurement to see if that particular condition is what is affecting the flow.

PEER AGENCY PRACTICES

Agency A (continued)

- Use of Customer Data
 - The agency does not consistently collect customer meter readings, but they ask for them if there is an investigation. In some cases, the agency believes it would be useful to consistently collect these readings though.

PEER AGENCY PRACTICES

Agency A (continued)

- Billing Accuracy
 - In addition to SCADA, the agency's totalizers are read through an Automatic Meter Reading (AMR) system. The system reviews data in comparison to prior months, etc. and checks for any anomalies. The agency has an employee whose main task it is to review daily exception reports from the AMR system. Often, anomalies are just due to communication errors, but other times they are not. The AMR system is secure and separate from SCADA. The AMR system is designed to collect data as accurately as possible for billing. AMR does not convert data and data stays as raw as possible. SCADA is more focused on system status.

PEER AGENCY PRACTICES

Agency A (continued)

- The agency does have meters near one another and can verify meters against one another. All of their meters are also on SCADA. Therefore, they also have the ability to create virtual meters – meters on SCADA that do a master balance, or a comparison of all flows going into one feeder, subtracting out all others. They can then trend that data over a period of time to see fluctuations.

PEER AGENCY PRACTICES

Agency A (continued)

- Meter Reads
 - They do not have staff perform actual meter reads unless there is an investigation or a problem. Everything is automated.
- Communication
 - Each month, the agency provides a simple report to its management with a metric that shows all maintenance was completed according to plan. It utilizes color coding by each maintenance objective – green, yellow, and red – to indicate the whether an objective has been achieved.

PEER AGENCY PRACTICES

Agency A (continued)

- Professional Organizations/Standards Employed
 - Society of Maintenance and Reliability Professionals (SMRP)
 - In trying to find standards for maintenance and reliability, they found SMRP. While they did the same search and initially looked to AWWA and even the manufacturers, SMRP is where they ended up for most professional guidance.
 - Prompted agency to develop a Maintenance Plan and start writing policies and procedures.
 - Not cookie cutter – provides you the elements and you have to adapt it.
 - Very well known on the East Coast but less so on the West Coast.

PEER AGENCY PRACTICES

Agency A (continued)

- Professional Organizations/Standards Employed (continued)
 - AWWA
 - While they do look to AWWA, the agency finds the AWWA to be more relevant regarding water quality.
 - Agency A was curious about what SCVWD is doing, too.

PEER AGENCY PRACTICES

Agency B

- Treated Water Equipment Types:
 - Generally, 42” going into Cities with treated water
 - Have other meters, like 16”, 24”, and 36”
 - Non-billing meters between 96” and 104”
 - Turbine-style meters
 - Neptune Trident meters (mechanical), mainly
 - Some older Sensus meters

PEER AGENCY PRACTICES

Agency B (continued)

- Overall Maintenance and Verification Processes
 - Expect their meters to be within a +/- 1.5% error range- (98.5% to 101.5% accuracy).
 - Use a written Maintenance Management Plan that they install into Maximo (software). The agency has been using Maximo for about ten years.
 - Maximo reports dictate their maintenance routine.
 - Check calibration (equipment verification) at least every two years; however, the agency generally performs verification more frequently for most meters.

PEER AGENCY PRACTICES

Agency B (continued)

- Perform measurement verification every one to two years or as needed if they anticipate or suspect a problem. Agency B would anticipate or suspect a problem if:
 - Customers alert them.
 - Their own crew notices something while doing other types of maintenance
 - SCADA data shows a significant change.
 - Lower than expected output in month-to-month meter reads.

PEER AGENCY PRACTICES

Agency B (continued)

- For measurement verification testing the agency uses a portable flow meter and run 100 cubic feet of water through it and compare the readings.
 - They built their own portable flow meters. They have one from an old Sensus meter that they are phasing out because parts for it are no longer available. Another is from a Trident HPP turbine meter on a trailer. They drive it out to service connections. The agency only use the smart meter if they are doing an electronic calibration.
 - For large meters on the pipelines (non-billing), the agency uses electronic calibration with an insertion probe meter.

PEER AGENCY PRACTICES

Agency B (continued)

- If flow is off by more than 1.5% in either direction, and they cannot make adjustments in the field, they pull out the Unitized Measuring Element and replace it with a shop calibrated unit.
- The agency does not use dual meter measurement at any of their turnouts. They believe that because you will never get two meters to completely agree, that type of expensive installation would be a last resort.

PEER AGENCY PRACTICES

Agency B (continued)

- Use of Customer Data
 - The agency totalizes the water for each customer each month. They sync up the times so that they are exact on an annual basis for the fiscal year reporting.
 - Every now and then they get an inquiry from a customer about whether they are out of sync.
 - They do not regularly monitor customer data.

PEER AGENCY PRACTICES

Agency B (continued)

- Meter Reads
 - Staff read meters monthly.
 - For this particular type of meter, there are just under 200.
 - Meter readers just use a clipboard and record the read manually and bring it back to the office.

PEER AGENCY PRACTICES

Agency B (continued)

- Use of Vendors
 - The agency uses vendors to perform calibration of their large meters on transmission pipelines. These meters move water around their system from reservoir to reservoir and are anywhere from 36” to 104” and include Venturi and Mag Pros. The vendor performs a full calibration and maintenance check twice per year on those meters considered to be critical and once per year on all others. The vendor is Aqua Sierra Controls. They focus on plant process controls.

PEER AGENCY PRACTICES

Agency B (continued)

- Professional Organizations/Standards Employed
 - AWWA – the agency may use some of AWWA’s specifications. There are only a handful of agencies like Agency B and AWWA covers standards for the most common agencies. Therefore, the agency really sets up their own working rules and regulations to some extent. Regarding matters of water quality, the agency complies with AWWA. When it comes to maintenance and measurement, the agency might look to AWWA, but they are more likely to compare notes with other water purveyors at a water conference.

PEER AGENCY PRACTICES

Agency B (continued)

- Recommended conferences – the AWWA Conference does some times have good tracks, sessions, or committees that discuss or oversee water meter calibrations and maintenance.
- The State Department of Health is involved in the material that can make up water meters.
- The University of Southern California is big on back flow prevention and some very specific topics that can be helpful.
- Really though, the AWWA is where most people at least start.

PEER AGENCY PRACTICES

Agency B (continued)

- Other – the two most important things are:
 - Sizing and designing the turnouts/meters correctly. If they are not under or over-sized, meet the demands that the customer puts on the system, and are not under or over-worked, they should hold their calibration. So, if you plan it out correctly in the first place, you should not have calibration issues that often. Manufacturer specifications are for common usage, like an apartment complex. It is a lot of work in the beginning – on the engineering end. The agency does a lot of work and research on the buyer requirements, peak demands, and built around those demands.

PEER AGENCY PRACTICES

Agency B (continued)

- Other (continued)
 - Having a well-documented and well laid out maintenance plan that is based on an accurate record of the equipment and parts necessary to maintain it. You have to keep it accurate, up-to-date, and you have to look at it. Really look at it. Everyone has to be on the same page. If you really stay on top of maintenance and work from the same page with an approach that allows you to see what is coming, you will be in much better shape.

APPENDIX A – LISTING OF TREATED WATER METERS

Turnout	Pipeline	Customer	Meter Name	Meter Type	Size	Last Replaced	Scheduled Replacement	Retailer Meter	Annual Volume	Annual Revenue	Rank	Comparison Meter (Portable Meter or Customer)
Graystone T/O	STWTP	SJWC	Rosemount3 051C/D3/ DP	Differential Pressure	36	?	FY 2017	Insertion	14,976	\$10,812,751	1	Y
Cox T/O	WPL	SJWC	ABB Water Master	Full Bore Mag-Meter	30	3/14/2014	FY 2024	Booster Meter	12,522	\$9,041,216	2	Y
MAPS	More Ave PL	SJWC	ABB Water Master	Full Bore Mag-Meter	24	4/14/2014	FY 2024	No	11,487	\$8,293,448	3	Y
Hostetter T/O	MPL	SJWC	ABB Water Master	Full Bore Mag-Meter	20	3/30/2012	FY 2022	No	10,977	\$7,925,091	4	Y
Pinos T/O	SPL	SJWC	ABB Water Master	Full Bore Mag-Meter	18	9/11/2013	FY 2023	Propeller	9,102	\$6,571,991	5	Y
Sunnyvale T/O	SD	Sunnyvale	ABB Water Master	Full Bore Mag-Meter	30	1/11/2013	FY 2023	No	8,194	\$5,915,758	6	Y
Skyway T/O	SPL	SJWC	ABB Water Master	Full Bore Mag-Meter	18	9/20/2013	FY 2023	Insertion	7,857	\$5,672,422	7	Y
Alum Rock T/O	EPL	SJWC	ABB Water Master	Full Bore Mag-Meter	18	1/25/2013	FY 2023	No	7,691	\$5,552,844	8	Y
Congress T/O	WPL	SJWC	ABB Mag Master	Full Bore Mag-Meter	24	6/5/2010	FY 2020	Booster Meter	6,844	\$4,941,274	9	Y
Aborn T/O	EPL	City of San Jose	Marsh-McBirney 285	Insertion	24	12/1/2002	FY 2016	Full Bore Mag.	6,483	\$4,680,798	10	Y

Source: Measurement Unit

APPENDIX A – LISTING OF TREATED WATER METERS (CONTINUED)

Turnout	Pipeline	Customer	Meter Name	Meter Type	Size	Last Replaced	Scheduled Replacement	Retailer Meter	Annual Volume	Annual Revenue	Rank	Comparison meter (Portable Meter or Customer)
Ocala T/O	EPL	SJWC	ABB Mag Master	Full Bore Mag-Meter	20	11/13/2010	FY 2020	Insertion	5,953	\$4,298,413	11	Y
Campbell T/O	SCD	SJWC	ABB Water Master	Full Bore Mag-Meter	12	12/20/2012	FY 2022	No	4,685	\$3,382,296	12	Y
Norwood T/O	EPL	City of San Jose	ABB Mag Master	Full Bore Mag-Meter	16	11/13/2010	FY 2020	Clamp on Sonic	4,677	\$3,376,743	13	Y
Farndon T/O	WPL	California Water	Siemens 5100W	Full Bore Mag-Meter	20	10/12/2010	FY 2020	No	4,617	\$3,333,431	14	Y
Santa Clara T/O	SCD	City of Santa Clara	ABB Water Master	Full Bore Mag-Meter	12	12/19/2012	FY 2022	No	4,532	\$3,271,902	15	Y
Silver Creek T/O	SPL	City of San Jose	Marsh McBirney 284	Insertion	16	3/1/2007	FY 2016	Clamp on Sonic	3,641	\$2,629,091	16	Y
Milpitas Tank	MPL	City of Milpitas	Nusonics 8000A	Sonic	20	?	12/1/2014	No	3,435	\$2,480,395	17	Y
Mann T/O	WPL	SJWC	McCrometer 395L	Insertion	12	10/9/2013	FY 2018	Booster Meter	3,023	\$2,182,787	18	Y
Covington T/O	MVD	California Water	ABB Water Master	Full Bore Mag-Meter	12	1/16/2013	FY 2023	No	2,133	\$1,540,235	19	Y
Vallco T/O	SCD	California Water	ABB Water Master	Full Bore Mag-Meter	10	12/19/2012	FY 2022	No	1,409	\$1,016,973	20	N

APPENDIX A – LISTING OF TREATED WATER METERS (CONTINUED)

Turnout	Pipeline	Customer	Meter Name	Meter Type	Size	Last Replaced	Scheduled Replacement	Retailer Meter	Annual Volume	Annual Revenue	Rank	Comparison meter (Portable Meter or Customer)
Maybury T/O	EPL	SJWC	ABB Water Master	Full Bore Mag-Meter	16	2/1/2013	FY 2023	Insertion	1,237	\$892,796	21	Y
Granger T/O	WPL	California Water	Siemens 5100W	Full Bore Mag-Meter	20	10/14/2010	FY 2020	No	1,157	\$835,563	22	N
Mountain View T/O	MVD	City of Mtn. View	ABB Water Master	Full Bore Mag-Meter	12	12/19/2011	FY 2021	Yes, but not accurate	1,127	\$813,485	23	Y
Dutard T/O	PWTP	SJWC	McCrometer 395LC	Insertion	16	3/28/2013	FY 2015	Insertion	657	\$474,433	24	Y
Barranca T/O	SD	Sunnyvale	ABB Mag Master	Full Bore Mag-Meter	12	12/23/2008	FY 2018	No	517	\$373,512	25	Y
Rainbow T/O	WPL	SJWC	ABB Mag Master	Full Bore Mag-Meter	10	12/18/2008	FY 2018	Propeller	19	\$13,927	26	Y

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