Final Report Overview

September 12, 2016

Study 3a – Model Public Communication Plan for Advancing DPR Acceptance

4.2 Introduction

a) Overview

In order to develop the communication plans, the project team conducted the following:

1. An extensive literature review of previous research related to potable reuse acceptance and communication approaches.
2. A series of one-on-one meetings with individuals involved with potable reuse projects to gain an understanding of communication challenges and successes they experienced. Interviews were also conducted with legislators, health professionals and special interest groups to learn about their attitudes, perceptions, and support toward potable reuse.
3. Findings from the above were used to develop a set of messages that were tested in focus groups and telephone surveys in two model communities identified by the Project Advisory Committee.

b) Findings & Conclusions

The key findings of the combination of the literature review, one-on-one meetings, and public opinion research indicate that public acceptance of potable reuse can be achieved by implementing a coordinated, consistent, and transparent communication plan. Some of the key findings to achieving public acceptance include:

1. Develop trust (build relationships, offer plant tours)
2. Be consistent with outreach (start early, continue throughout project)
3. Provide information about potable reuse and where it is in use to increase familiarity
4. Be consistent with messaging and terminology
5. Instill confidence in the quality of water (talk about the treatment process)
6. Be transparent (discuss costs, water quality, safety, environment)
7. Be prepared for tough questions and misinformation

A key finding of the focus groups and telephone survey showed that after receiving additional information about potable reuse and the multi-stage treatment process used to make the water safe to drink, most participants became more comfortable with the idea of potable reuse. In addition, the use of "purified water" was favored by participants in the focus group as a term to describe the potable reuse water.

c) Participating Entities

1. City of Lubbock - review messaging and outreach materials, evaluate for relevancy to stakeholders and taxpayers
2. City of Phoenix - review messaging and outreach materials, evaluate for relevancy to stakeholders and taxpayers
3. City of Scottsdale - review messaging and outreach materials, evaluate for relevancy to stakeholders and taxpayers
4. Denver Water - evaluate the draft plan and recommended strategies and tactics for relevancy to our stakeholders and ratepayers, review messaging and outreach materials
5. El Paso Water Utilities - evaluate the draft plan and recommended strategies and tactics for relevancy to our stakeholders and ratepayers, review messaging and outreach materials, gauge the local opinion of DPR

6. Orange County Water District - review messaging and outreach materials, evaluate for relevancy to stakeholders and taxpayers
7. San Francisco Public Utilities Commission - review messaging and outreach materials, evaluate for relevancy to stakeholders and taxpayers
8. Santa Clara Valley Water District - review messaging and outreach materials, evaluate for relevancy to stakeholders and taxpayers
9. Singapore PUB - review messaging and outreach materials, evaluate for relevancy to stakeholders and taxpayers
10. Southern Nevada Water Agency - review messaging and outreach materials, evaluate for relevancy to stakeholders and taxpayers, assist with development of surveys and focus groups
11. Tucson Water - review and development of key stakeholder lists, reviewing project deliverables
12. West Basin Municipal Water District - review messaging and outreach materials, evaluate for relevancy to stakeholders and taxpayers
13. Water Services Association of Australia - review messaging and outreach materials, evaluate for relevancy to stakeholders and members

4.3 Cost Summary

a) Cost Summary

Throughout the life of this project, a total of $300,000 in costs were incurred with $300,000 being disbursed to the project team.

b) Comparison of Planned vs. Actual Budget

There were no cost overruns as part of this project with the costs incurred and disbursed in the planned budget equaling the costs incurred and disbursed in the actual budget.

4.4 Schedule Summary

a) Summary of Tasks Completed

1. Task 1 (Administration) has been completed.
2. Task 2 (Release RFP and Select Contractor) has been completed.
3. Task 3 (Implementation of Research) has been completed.
4. Task 4 (Progress, Final, and Long-Term Reporting to Metropolitan) is nearing completion. This final report serves as the final progress update, and the long term post-project update will be submitted one year from now.

b) Comparison of Planned Schedule and Actual Schedule

This project was completed on schedule with no delays.

4.5 Project Results and Analysis

a) Analysis of Results

A summary of findings can be found in section 4.2a above. The final report is attached here as an addendum and will provide in-depth analysis of the results and findings in detail.

b) Goals and Objectives

Overall, we are confident that the goals and objectives of this project have been met. This research has greatly influenced subsequent research that the Water Environment & Reuse Foundation has sponsored and has been a resource in developing outreach efforts at individual

utilities. There have been several conference presentations on this project and it has been requested by many utilities looking to develop an outreach program.

c) Problems

There were no specific problems identified throughout the life of this project.

d) Application of Findings

This project provides the industry with a roadmap for a robust public outreach effort that is needed to communicate to decision makers (CA legislators, health officials and regulators), stakeholders, and the general public about the abilities of advanced water treatment, real time monitoring, and the safeguards the water industry will undertake to produce safe drinking water from wastewater. And while the focus of the research and state-level plan development has been driven by the regulatory timetable in California, this is a model for other states and countries to follow.

4.6 Conclusion

a) Lessons Learned

The report *Model Communication Plans for Increasing Awareness and Fostering Acceptance of Direct Potable Reuse* demonstrates strategic methods to introduce and communicate the concept of potable reuse and its importance in meeting our future water supply needs. It provides communities and agencies or utilities with guidance to be more successful in advancing public acceptance of potable reuse.

b) Next Steps

Completion of Phase I lays down the strategic groundwork for Phase II of the Water Environment & Reuse Foundation's approach to fostering public acceptance of potable reuse. Phase II will take the information gleaned from Phase I and use it to begin creating and refining outreach materials (such as fact sheets and frequently asked questions (FAQ), videos, etc.) and methods. Phase I drew the outline of the plans, and Phase II will create the tools that can be used immediately at the statewide level and in local communities that are considering direct potable reuse.

Study 3b – Critical Control Point Assessment to Quantify Robustness and Reliability of Multiple Treatment Barriers of a DPR Scheme

4.2 Introduction

a) Overview

This project was tasked with applying the hazard analysis and critical control point (HACCP) methodology to identify critical control points (CCPs) and assess the reliability of those CCPs to manage acute and chronic health risks in direct potable reuse (DPR) applications. The objective was to identify CCPs and then use full scale operating data from facilities around the world to quantify the ability of those CCPs alone and in series to removal chemical and biological contaminants in potable reuse. An evaluation of process monitors and operational response was also included.

b) Findings & Conclusions

The overall conclusions from this project indicate that both membrane- and non-membrane-based potable reuse systems are capable of managing microbial and chemical contaminants of concern, and that the current monitoring and removal credit is highly conservative relative to actual process performance. Through full-scale testing we were able to validate that when membrane integrity is breached in reverse osmosis and microfiltration membranes, current monitoring systems are able to detect breaches before log removal goals are compromised. As a result of this project, a series of process-specific response procedures were developed to manage alerts (indicating a need for potential corrective action) and alarms (indicating a need for immediate shutdown of a unit process within a facility), providing guidance to design and operations teams looking at implementing potable reuse. An additional aspect of this study demonstrated a process for evaluating the reliability of process monitors and provided a means to determine where double or triple redundancy may be required for the process monitors.

c) Participating Entities

1. West Basin Municipal Water District, CA - provided access to operational and maintenance data from a variety of water treatment processes
2. Orange County Water District, CA - provided access to operational and maintenance data from a variety of water treatment processes
3. City of Scottsdale, AZ - provided access to operational and maintenance data from a variety of water treatment processes
4. Veolia Water - provided access to operational and maintenance data from a variety of water treatment processes
5. Australian Water Recycling Center of Excellence - provided access to operational and maintenance data from a variety of water treatment processes
6. Windhoek Goreangab Operating Company - provided access to operational and maintenance data from a variety of water treatment processes
7. Additional Anonymous Utilities in the United States and Australia - provided access to operational and maintenance data from a variety of water treatment processes

4.3 Cost Summary

a) Cost Summary

Throughout the life of this project, a total of $300,000 in costs were incurred with $300,000 being disbursed to the project team.

b) Comparison of Planned vs. Actual Budget

There were no cost overruns as part of this project with the costs incurred and disbursed in the planned budget equaling the costs incurred and disbursed in the actual budget.

4.4 Schedule Summary

a) Summary of Tasks Completed

1. Task 1 (Administration) has been completed.
2. Task 2 (Release RFP and Select Contractor) has been completed.
3. Task 3 (Implementation of Research) has been completed.
4. Task 4 (Progress, Final, and Long-Term Reporting to Metropolitan) is nearing completion with the technical review complete. The draft report is currently under editorial review and the technical content is not expected to change in any significant way. This final report serves as the final progress update, and the long term post-project update will be submitted one year from now. The long term post-project update will be submitted one year from now.

b) Comparison of Planned Schedule and Actual Schedule

The actual schedule did run a bit longer than the planned schedule for a variety of reasons. During the life of this project, the project team was coordinating with the California Expert Panel on DPR to ensure that this project was meeting their needs and answers any questions that they had. This did not require a change to the scope of work but did slightly impact the schedule. In addition, time was needed to review draft reports with the Project Advisory Committee to ensure that there was proper peer review on the project.

4.5 Project Results and Analysis

a) Analysis of Results

A summary of findings can be found in section 4.2a above. The draft report is attached here as an addendum and will provide in-depth analysis of the results and findings in detail. The report is not yet published but has through a complete technical review. Once a final editorial review and formatting has been complete it will be published and sent to MWD.

b) Goals and Objectives

Overall, we are confident that the goals and objectives of this project have been met. This research has greatly influenced subsequent research that the Water Environment & Reuse Foundation has sponsored and has been of great use to the California DPR Expert Panel. There have been several conference presentations on this project and it has been cited as crucial for moving the safe adoption of direct potable reuse moving forward.

c) Problems

Aside from the above mentioned schedule delays, there were no specific problems identified throughout the life of this project.

d) Application of Findings

This report provides an overview of the HACCP process as it applies to a DPR setting. In this report readers are provided with information on the principles of HACCP, the selection of CCPs to manage risks in DPR, a quantification of the performance of CCPs to remove pathogens and chemicals from recycled water systems using Monte Carlo analysis, an evaluation of process monitoring reliability, and a series of response procedures for handling alerts and critical alarms during treatment. Full-scale design considerations are also discussed, as is an evaluation of

induced failure events at full scale. In short, this report provides evidence of the full-scale reliability and robustness of multiple processes for chemical and microbial contaminant control and demonstrates their resilience to perturbations and their combined redundancy when used together in a DPR scheme to achieve water quality goals and public health protection. This report can therefore be used in a variety of regions using a variety of treatment options in support of DPR.

4.6 Conclusion

a) Lessons Learned

The determination of critical control points in a DPR system can provide an effective way to focusing on the most important parts of a treatment facility in regards to public health. This can be especially effective for operations staff as well as training programs. Future operator certification programs will likely look to the processes in a DPR system most important for public health as the processes most important for certification. As no utility has unlimited resources, critical control points can provide an effective method for determining the most important steps in the DPR treatment process and therefore target resources to best protect public health.

b) Next Steps

Several gaps were also identified throughout the modelling exercise that point to a need for future monitoring and data collection at IPR and DPR facilities:

1. Facilities with UV–AOP don't typically collect information on UV dose via ongoing actinometry measurements or other means that can be used to back calculate achieved chemical removal (and disinfection). Such monitoring would be helpful in future characterization and modelling exercises.
2. The pathogen removal data across the sedimentation and filtration process is overly conservative in the current approach and could use other surrogates to validate and observe actual log removal over time during full-scale operation. However, better surrogates for pathogen removal by flocculation–sedimentation–filtration are needed.
3. More sensitive measures for RO removal of pathogens would allow greater ability to model true removal rather than via a chemical surrogate that may not reflect particle removal mechanisms.

3c – Evaluation of Source Water Control Options and the Impact of Selected Strategies on DPR

4.2 Introduction

a) Overview

The primary objectives of this project were to evaluate upstream wastewater treatment impacts on DPR source water and downstream advanced treatment processes, and assess the impact of hydraulic control mechanisms on influent water quality and flow variations that may stress advanced treatment processes for DPR applications.

Variable influent water quality and the extent of source control strategy implemented in a community have a direct impact on the performance of an IPR/DPR treatment process train. In addition, utilities that own and operate wastewater treatment plants (WWTP) and advanced water purification facilities (AWP) are often separate entities with different treatment objectives (e.g. a WWTP treats to comply with discharge requirements to a water body while the AWPF treats to meet drinking water standards). A successful and reliable DPR system requires the two entities working together, not only to meet their individual treatment objectives, but also to complement each other to provide a safe potable supply. In a utility that houses both water and wastewater treatment facilities, it may be necessary to overcome the inherent cultural differences between the two departments to achieve a reliable DPR supply.

The project team conducted a literature review to collect performance data and operation practices, identify constraints/challenges of upstream unit process performance on DPR processes, assess impact of source control strategies on effluent water quality, and evaluate system dymamics and the impact of spike loading of pollutants on treatment. Next, control strategies and source control mitigation measures to maintain DPR quality (considering Hazard Analysis and HACCP) were identified. Four case studies that cover a wide range of source waters delivered to an existing IPR treatment system were chosen for analysis.

b) Findings & Conclusions

This report points out that source control is in the eye of the beholder and that as a utility embarks on establishing their program they should fully understand the interrelationships and differences between conventional pretreatment programs and source control. One of the key elements that differentiates a pretreatment program from source controls is a shift in focus from meeting discharge limits (pretreatment programs) and becoming part of an integrated water supply program (source control.)

Chapter 4 provided guidance related to the configuration, process design and operation of a WWTP compatible with AWP for potable reuse. WWTPs have been historically designed and operated to achieve a high quality effluent suitable for environmental discharge. Such end-point targets are readily achieved with a wide range of secondary and tertiary treatment alternatives. However, integration of an AWP in the scheme requires a paradigm shift in the operation of WWTPs because the treated effluent is the supply water for the AWP facility. A number of principal objectives were identified for WWTPs expanding to integrate AWP were identified and discussed. Some of the principal objectives for WWTPs expanding to integrate AWP include:

1. Production of a consistently high quality supply water suitable for further treatment in the AWPF.
2. Ability to detect poor quality supply water and divert flow away from the AWP process.

3. Produce steady consistent flow

c) Participating Entities

1. Orange County Sanitation District - provide operational water quality data and information on operational challenges associated with source water, assist in case study development
2. Orange County Water District - provide operational water quality data and information on operational challenges associated with source water, assist in case study development
3. West Basin Municipal Water District - provide samples from Advanced Treated Water Recycling Facility, water quality and operational data, review deliverables
4. City of Los Angeles Bureau of Sanitation - provide operational water quality data and information on O&M practices relating to wastewater treatment processes, provide information on target effluent quality, and provide information on operational challenges
5. City of San Diego - provide operational water quality data and information on O&M practices relating to wastewater treatment processes, provide information on target effluent quality, and provide information on operational challenges
6. Singapore Public Utilities Board - provide operational water quality data and information on O&M practices relating to wastewater treatment processes, provide information on target effluent quality, and provide information on operational challenges

4.3 Cost Summary

a) Cost Summary

Throughout the life of this project, a total of $149,980 in costs were incurred with $149,980 being disbursed to the project team.

b) Comparison of Planned vs. Actual Budget

There were no cost overruns as part of this project with the costs incurred and disbursed in the planned budget equaling the costs incurred and disbursed in the actual budget.

4.4 Schedule Summary

a) Summary of Tasks Completed

1. Task 1 (Administration) has been completed.
2. Task 2 (Release RFP and Select Contractor) has been completed.
3. Task 3 (Implementation of Research) has been completed.
4. Task 4 (Progress, Final, and Long-Term Reporting to Metropolitan) is nearing completion. This final report serves as the final progress update, and the long term post-project update will be submitted one year from now.

b) Comparison of Planned Schedule and Actual Schedule

This project was completed nearly on schedule with approximately a six month delay due to the project completing four case studies instead of the single case study that was initially planned on.

4.5 Project Results and Analysis

a) Analysis of Results

A summary of findings can be found in section 4.2a above. The draft report is attached here as an addendum and will provide in-depth analysis of the results and findings in detail. The report is not yet published but has through a complete technical review. Once a final editorial review and formatting has been complete it will be published.

b) Goals and Objectives

Overall, we are confident that the goals and objectives of this project have been met. This research has been useful to concurrent Foundation projects. There have been several conference presentations on this project and we expect the report will be referenced in the works of ongoing projects.

c) Problems

There were no specific problems identified throughout the life of this project aside from the delays previously mentioned.

d) Application of Findings

This Guideline was designed to assist a wide range of utilities at all stages of implementing IPR or DPR programs. Some utilities may have no formal IPR program and only are thinking about IPR/DPR. Others may be evaluating an IPR program at the study, planning or implementation level or are in the final stages of planning for DPR. The case studies and the conclusions drawn from them as well as other material gleaned from the literature and other sources should allow an increasing number of communities to plan for and implement a safe IPR/DPR program.

4.6 Conclusion

a) Lessons Learned

Each chapter in this Guideline provided a variety of insights into how upstream wastewater from the collection system can impact not only the WWTP and its impacts on DPR source water but downstream advanced treatment processes. Also examined was the impact of hydraulic control mechanisms on influent water quality and flow variations that may stress advanced treatment process for DPR applications.

b) Next Steps

This research project has taken many paths over the course of its development. As a result, there are many avenues of additional investigation and research that might be explored to further refine strategies for source control.

1. Separate collection systems for Source Water Treatment Plants versus current standards for collection systems for WWTPs
   - Urine picked up from holding tanks by truck
   - Greywater recycled in homes as appropriate
   - Blackwater (and greywater when not recycled) to existing collection system
   - Industrial wastewater treated in separate satellite plants which is then piped directly to SWTPs
2. Federal standards for DPR
3. Research on new sensors and monitoring technologies both in-plant and within the collections systems
4. Development of additional surrogates/indicators for DPR supply monitoring
5. Research on in-home toilet technology (e.g. Gates Foundation Reinvent the Toilet Challenge) for alternative strategies to reduce blackwater to the WWTP
6. Research on how technologies being developed in the United States may be transferred to other areas of the world, some of which lack the resources available to construct facilities as described in this Guideline
7. Regulations on the use and development of new chemicals in personal care products which may enter the DPR source water supply

8. Shift the design paradigm that would consider the combination of wastewater, AWP and water treatment plants into one integrated facility to produce potable source water
9. Develop scalable strategies for DPR for smaller utilities that do not have the same level of resources as larger utilities

Study 3d – Development of an Operation and Maintenance Plan and Training and Certification for Direct Potable Reuse (DPR) Systems

4.2 Introduction

a) Overview

This project was developed in response to the need to provide meaningful, actionable advice to the DPR initiative at the WateReuse Research Foundation (now the Water Environment & Reuse Foundation) and to provide information that can assist the Expert Panel, CDPH, and SWRCB in making DPR a reality for California. Specifically, there was an opportunity to provide input on permitting structure, operations and maintenance protocols, and training and certification programs as well as to develop some of the content/curriculum that can be used in a training and response setting. In order to address the gaps in training, certification, and permitting programs and to support the California DPR initiative, the objective of this project was to develop a standard operations and maintenance plan framework for various DPR treatment processes and to develop a DPR Training and Certification framework for DPR system operators.

b) Findings & Conclusions

The overall output from this study is the outline of an operational framework for DPR. The framework incorporates risk management principles and in particular the HACCP (Hazard Analysis and Critical Control Point) methodology considering a holistic review of operational requirements. These included a review of the following important operational elements:

1. Health risk management
2. Safety management
3. Asset management
4. Critical control point selection and operational integration
5. System validation
6. Operational monitoring and reporting
7. Operational response procedures
8. Water quality monitoring
9. Management at operational interfaces (source water -wastewater-advanced treatment-drinking water)
10. Incident and Emergency Management
11. Change Management
12. Operating Manuals and Procedures

In addition, a detailed gap analysis of California's Code of Regulations governing both recycled water and drinking water were reviewed to determine what changes are required to accommodate DPR. Key recommendations are included in the report.

Key operational procedures and requirements were further developed in the report, based on both an RO based treatment train for DPR (MF/RO/UV-H_2O_2-Cl_2) and a non-RO treatment train (Ozone/Floc-sed/BAC/GAC/UV/Cl_2). For each process key operating parameters, operating procedures, key maintenance requirements, and critical control point response procedures were outlined in the context of DPR. These can be adopted for site-specific operational plans.

A staffing analysis for DPR systems was also considered including a review of roles that will be required in the context of a DPR system. A staffing assessment was made of a theoretical DPR system to demonstrate a method of assessment. This included both operations and maintenance roles.

A last, but very significant, part of the report is a development of an operator certification framework for DPR. With a review of existing operator certification and training systems across the United States and internationally, this part of the report provides recommendations for a future DPR operational and training certification system.

c) Participating Entities

1. City of Los Angeles Bureau of Sanitation - provided access to operational planning material, training material and other operational management systems and processes
2. Orange County Water District - provided access to operational planning material, training material and other operational management systems and processes
3. Suez Environment - provided access to operational planning material, training material and other operational management systems and processes
4. West Basin Municipal Water District - provided access to operational planning material, training material and other operational management systems and processes
5. Trojan UV - provided access to operational planning material, training material and other operational management systems and processes
6. Separation Processes Inc. - provided access to operational planning material, training material and other operational management systems and processes
7. Santa Clara Valley Water District, CA - provided access to operational planning material, training material and other operational management systems and processes

4.3 Cost Summary

a) Cost Summary

To date, a total of $213,427.06 in costs have been incurred for this project with $213,427.06 being disbursed to the project team. The project team has completed work and is expected to submit their final invoice shortly

b) Comparison of Planned vs. Actual Budget

There were no cost overruns as part of this project and the project is expected to come in under budget.

4.4 Schedule Summary

a) Summary of Tasks Completed

1. Task 1 (Administration) has been completed.
2. Task 2 (Release RFP and Select Contractor) has been completed.
3. Task 3 (Implementation of Research) has been completed.
4. Task 4 (Progress, Final, and Long-Term Reporting to Metropolitan) is nearing completion with the technical review complete. The draft report is currently under editorial review and the technical content is not expected to change in any significant way. This final report serves as the final progress update, and the long term post-project update will be submitted one year from now. The long term post-project update will be submitted one year from now.

b) Comparison of Planned Schedule and Actual Schedule

The actual schedule did run a bit longer than the planned schedule for a variety of reasons. During the life of this project, the project team was coordinating with the California Expert Panel on DPR to ensure that this project was meeting their needs and answers any questions that they had. This did not require a change to the scope of work but did slightly impact the schedule. In

addition, time was needed to review draft reports with the Project Advisory Committee to ensure that there was proper peer review on the project.

4.5 Project Results and Analysis

a) Analysis of Results

A summary of findings can be found in section 4.2a above. The draft report is attached here as an addendum and will provide in-depth analysis of the results and findings in detail. The report is not yet published but has through a complete technical review. Once a final editorial review and formatting has been complete it will be published and sent to MWD.

b) Goals and Objectives

Overall, we are confident that the goals and objectives of this project have been met. This research has greatly influenced subsequent research that the Water Environment & Reuse Foundation has sponsored and has been of great use to the California DPR Expert Panel. In addition, the California/Nevada Section of AWWA has a committee on advanced water treatment certification that has drawn on much of this work. There have been several conference presentations on this project and it has been cited as crucial for moving the safe adoption of direct potable reuse moving forward.

c) Problems

Aside from the above mentioned schedule delays, there were no specific problems identified throughout the life of this project.

d) Application of Findings

This report provides a comprehensive review of operational requirements in the consideration of a DPR facility. The operational framework may be used as a whole, or in part to inform and support operational planning for future DPR as well as IPR facilities. It will support designers, operators and regulators in ensuring the appropriate level of design and operational planning requirements.

The operations and training certification element of this report can provide additional material for consideration for the development of certification and training programs. This can add and support other efforts currently underway in California and elsewhere.

4.6 Conclusion

a) Lessons Learned

Throughout the life of this project it became clear that there are clear gaps between current wastewater and drinking water certification programs. While investigating certification programs across the country as well as abroad we were able to determine that there isn't necessarily a one size fits all approach to developing a certification program. The complete report for this project reflects this reality as well as the need for adequate training materials to support advanced treatment technologies and certifications. To further support operations and maintenance of DPR facilities, the Water Environment & Reuse Foundation has a project underway to develop curriculum and training materials or operators.

b) Next Steps

This report provides an outline operational framework which despite providing significant detail in some areas nevertheless can continue to be refined. Further areas of study that will be of benefit include:

1. Development of operating procedure and response procedures for process units other than those considered in this report (e.g. Membrane Bioreactors)
2. Greater consideration of integration of asset management principles to DPR, with a particular close attention to failure analysis and reliability
3. A more detailed set of curricula for gaps identified in this report for operational training material