Developing Potable Reuse for El Paso, Texas: The Most Direct Approach

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Drought conditions are constraining surface water supplies at the El Paso (Texas) Water Utilities (EPWU), requiring increased groundwater production (coupled with conservation) to meet customer demands. In 2012, EPWU initiated an assessment of potable reuse options to further diversify its water supply portfolio and bolster drought support efforts with a locally controlled and reliable supply. The initial feasibility study resulted in a recommendation to pursue direct potable reuse (DPR).

Greater El Paso has endured drought conditions for more than a decade. The drought has caused regional reductions in surface water availability, and the major regulating reservoirs along the reach of the Rio Grande River serving El Paso, Elephant Butte, and Caballo reservoirs in New Mexico have seen reductions in storage to levels at or below 10 percent of combined capacity. These conditions have caused delayed deliveries of water to El Paso, resulting in shutdown of the EPWU surface water treatment plants during months that the plants have traditionally been able to operate. For example, the Jonathan Rogers Water Treatment Plant (JRWTP) produces up to 60 mil gal per day (mgd) of treated surface water, but only operates when Rio Grande water is available, which during prevailing drought conditions has been only a few months each year. As a result, EPWU has relied on increased groundwater production and conservation to meet customer demands.

Groundwater supplies are pumped from the Mesilla Bolson and the Hueco Bolson, which underlie portions of New Mexico; Texas; and Chihuahua, Mexico. Brackish groundwater is treated at the Kay Bailey Hutchison Desalination Plant to provide 27.5 mgd of fresh water to augment EPWU and the potable water supply at Fort Bliss.

Figure 1 shows the 2014 potable supply forecast and peak demand forecast. For the majority of the year, EPWU utilizes groundwater to meet its water supply needs; however, for a two-month period between June and July, when

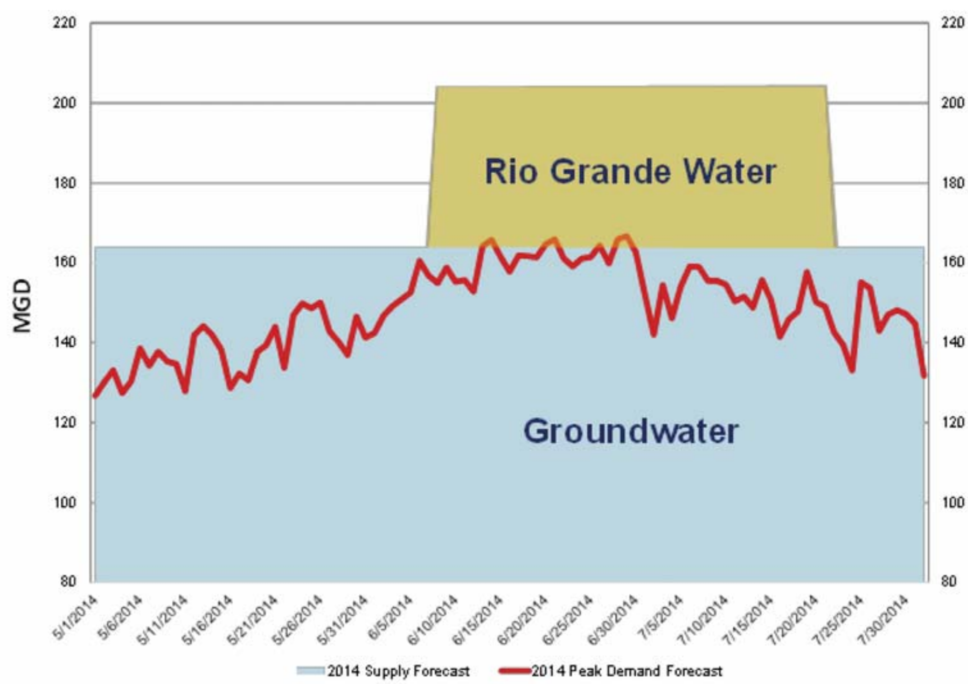

Figure 1. 2014 Potable Supply Forecast and Peak Demand Forecast

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flows in the Rio Grande are sufficiently high, surface water may be used to meet water supply needs. Under normal, nondrought conditions, up to 60 mgd of surface water may be available from the Rio Grande, but under the drought conditions experienced in 2014, less than half (approximately 20 mgd) was allotted to EPWU.

To help make up the potential gap in supply, EPWU recently constructed additional wells to help meet peak summer demands, and the groundwater production capacity is now 160 mgd; however, EPWU continues to rely on operation of its surface water treatment plants to meet summer demands. The EPWU recognized that utilization of wastewater effluent as an additional source water supply throughout the year would further diversify its water resource portfolio and bolster its drought support efforts with a locally controlled and reliable supply. This approach would also support the utility's strategies for conjunctive use of surface water and local groundwater supplies, while helping to defer more expensive, long-range plans, like groundwater importation.

A 2012 feasibility study evaluated the potential for indirect potable reuse (IPR) in the vicinity of EPWU's Bustamante Wastewater Treatment Plant (WWTP), the JRWTP, and the Rio Bosque Wetlands Park, also adjacent to the plants. Figure 2 shows an aerial image of the site. The IPR concept was to treat Bustamante WWTP, which produces approximately 27.5 mgd of treated effluent that is discharged to the Riverside Canal and is owned and operated by El Paso County Water Improvement District No. 1 (District).

The IPR concept was also to divert a portion of the effluent from the Bustamante WWTP and treat it for use as an additional supply to JRWTP, augmenting available supply from the Rio Grande. However, EPWU discovered significant challenges due to local hydrogeologic limitations and recognized the advantages of instead pursuing DPR, leveraging the unusual proximity of the wastewater treatment plant and the water treatment plant, the existing water distribution infrastructure at the site, and advanced treatment technologies that are increasingly enabling progress in DPR applications in the water industry.

The EPWU is in the process of developing and implementing a 10-mgd advanced purified water treatment plant (APWTP) to realize the advantages of DPR in its water reliability efforts. The treatment concept has been designed to ensure protection of public health and has been tailored to the unique setting and challenges of this inland and arid Southwest community. The APWTP concept includes diverting a portion of the Bustamante WWTP effluent for additional treatment, which will undergo a purification process at the APWTP prior to entering the drinking water distribution system.

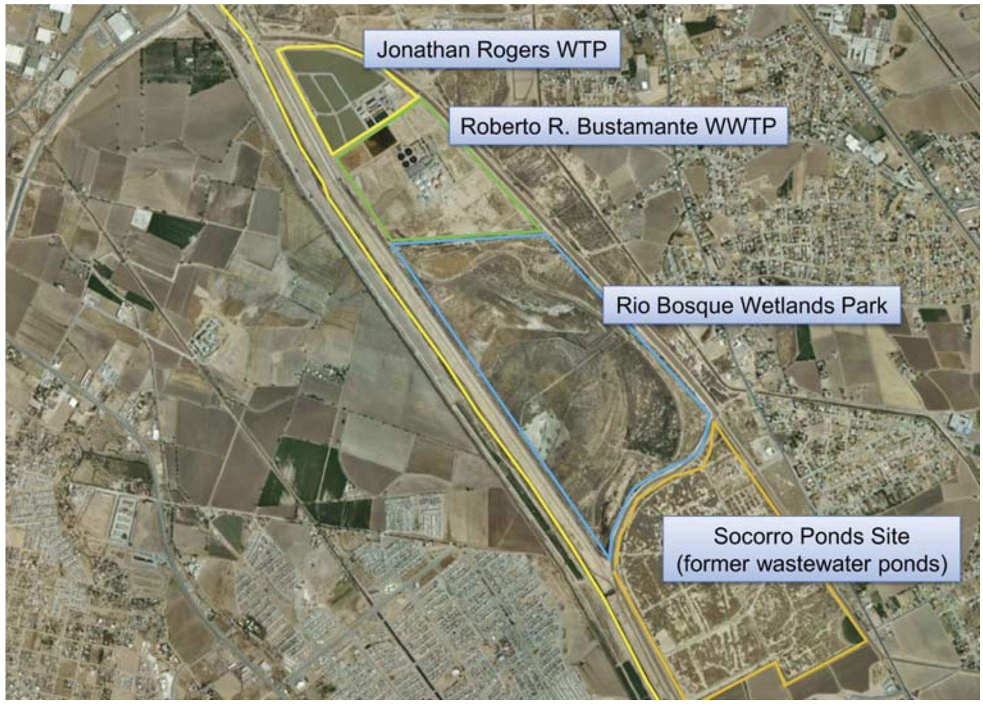

Figure 2. Aerial Image of the Site

Water Balance and Demands

The flow rate and volume available from the Bustamante WWTP for the APWTP source water was evaluated based on a review of WWTP influent flow data and projections, EPWU's contractual obligations to the District, and other projected demands for reclaimed water from the WWTP. The Bustamante WWTP has a permitted design capacity of 39 mgd (average dry weather flow) and currently discharges an average of 29.2 mgd. During the District's eight-month irrigation season (February 15 through October 15 of each year), EPWU is contractually obligated to discharge approximately 17.9 mgd to the Riverside Canal. Taking this obligated discharge into account, along with water planned for discharge to the Rio Bosque Wetlands Park and to customers of EPWU's reclaimed water (purple pipe) system, approximately 7.8 mgd remain available to use as source water to the APWTP during irrigation season. During the nonirrigation season, there is no discharge requirement, and the APWTP will be designed to produce up to 10 mgd during these months. Figure 3 provides an overview of the APWTP concept.

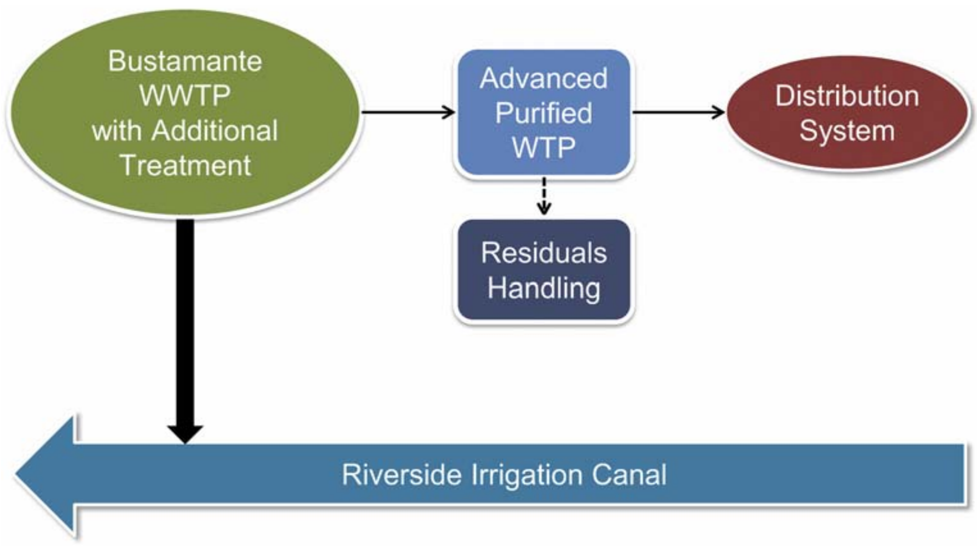

Figure 3. Advanced Purified Water Treatment Plant Concept

Water Quality and Goals

Historical water quality data were reviewed to assess current treatment performance at the Bustamante WWTP, additional treatment needed at Bustamante WWTP to provide target feed water quality to the APWTP, and preliminary treatment requirements for the APWTP. While EPWU conducts extensive analyses of Bustamante WWTP raw and effluent quality, additional sampling was needed for parameters that are not routinely monitored for regulatory purposes and are of importance to this project. The data provided important information for an evaluation of treatment and residuals handling alternatives and development of conceptual design criteria. The data also facilitated regulatory discussions with the Texas Commission on Environment Quality (TCEQ) regarding treatment requirements for the APWTP and residuals handling options.

Specific water quality goals for the APWTP were developed to address regulatory requirements, to meet EPWU's goal to provide high-quality water that is aesthetically acceptable to its customers, and to provide a margin of conservatism to assure compliance with specific water quality standards. Table 1 presents water quality parameters, rationale, and numeric goals for finished water that were developed based on federal and state drinking water standards, quality of existing drinking water supplies, and practices of other IPR/DPR facilities.

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Additional Regulatory Considerations

No one set of regulations governs requirements for potable water reuse applications in Texas (or nationwide). As such, TCEQ has reviewed each of the state's potable reuse projects (i.e., Big Spring, Wichita Falls, and Brownwood) on a case-by-case basis. Key regulatory considerations to implement the APWTP project include:

- A review of the industrial pretreatment program
- Application for a reclaimed water permit under Title 30 of the Texas Administrative Code (TAC) Chapter 210 for diversion of effluent from the Bustamante WWTP to the APWTP
- TCEQ Water Supply Division requirements for approval of a new APWTP, including:
  - Pilot testing to meet requirements under 30 TAC §290.42(g)
  - Source water characterization
  - Plan review for 30 percent design and final review
  - Concentration-time (CT) study to establish requirements for chemical disinfection
  - Residuals discharge permitting

The schedule for implementing the APWTP will need to consider permitting time frames, with milestones to submit required permit applications. Continued discussions with TCEQ in subsequent phases of the project will be essential to facilitate timely information exchange on key permitting considerations.

Table1. Proposed Finished Water Quality Goals for the El Paso Advanced Purified Water Treatment Plant

Parameter	Rationale	Numeric Goals
General		
Primary Drinking Water Standards	Comply with federal/state drinking water standards	USEPA/TCEQ Maximum Contaminant Levels (MCLs)[1] with exceptions for more stringent targets noted below
Stability (corrosion control)	Comply with Lead and Copper Rule (LCR) Prevent colored water due to disturbance of existing corrosion scale and iron release	Generally[2]: Langelier Saturation Index (LSI) > 0 Calcium Carbonate Precipitation Potential (CCPP) between 4 and 10 pH ≥ JRWTP finished water
Aesthetics	Provide water of comparable aesthetics to existing water supplies	See USEPA and TCEQ Secondary MCLs (Appendix D), and existing water quality from EPWU's groundwater supply and JRWTP
Physical and Chemical Parameters		
Particulates	Comply with federal/state drinking water standard	0.3 Nephelometric Turbidity Units (NTU) for 95 percent of samples (1 NTU maximum)
Total Organic Carbon	Comply with Stage 1 and 2 Disinfectants and Disinfection Byproducts (DBP) Rule (80 percent of MCLs or lower)	TTHM ≤ 64 µg/L HAA5 ≤ 48 µg/L
Mineral content – Total Dissolved Solids (TDS)	TDS goal is based on compliance with the TCEQ SMCL of 1,000 mg/L and providing water of comparable quality to other existing sources	≤900 mg/L
Nitrogen (Nitrate, Nitrite, and Ammonia)	Comply with federal/state drinking water standard (60 percent of MCLs or lower for operational reliability)	Nitrate < 6 mg/L as N Nitrite < 0.6 mg/L as N Ammonia < 0.1 mg/L as N
Microbiological[5]		
Viruses[6]	Based on one in 10,000 risk of annual infection. Surface Water Treatment Rule for *Giardia*, LT2SWTR for *Cryptosporidium*, and Regli et al. (1991) for viruses.	Log removal/inactivation to achieve concentration < 2.2×10^{-7} MPN/L
Cryptosporidium		Log removal/inactivation to achieve concentration < 3.0×10^{-5} oocysts/L
Giardia		Log removal/inactivation to achieve concentration < 7.0×10^{-6} cysts/L
Total Coliform, Fecal Coliform, *E. coli*	Meet Total Coliform Rule (TCR) requirements	No more than 5 percent of sample total coliform positive in a month. Fecal coliform and *E.coli* absent in all samples.
Unregulated Contaminants		
NDMA/Nitrosamines	Potential 10 nanogram per liter (ng/L) future Federal standard for NDMA (conservative estimate)	
Contaminant Candidate List 3 (CCL3) Pathogens	Multiple barriers to remove / inactivate future regulated viruses, protozoa, and bacteria	
Microconstituents and Refractory Chemicals	Diverse treatment mechanisms consistent with current water industry practice for potable reuse	

[1] See summary of USEPA National Primary Drinking Water Regulations and 30 TAC §290.105(b) Summary of Secondary Standards in Appendix D.
[2] Continued review throughout project, including pipe loop testing during pilot testing using harvested service lines from the distribution system.
[3] Based on pilot study data assessing DBP formation in APWTP product water under simulated distribution system conditions.
[5] In addition to the goals stated, the treatment train is intended to provide robust and redundant barriers for pathogens.
[6] MPN – most probable number.

Process Evaluation and Recommended Treatment Train

Based on the current water quality, water quality goals, and regulatory requirements, treatment at the Bustamante WWTP and at the APWTP needs to include the following:

- Nitrification/denitrification
- Reduction of total dissolved solids (TDS)
- Multiple barriers for pathogen removal/inactivation
- Removal of disinfection byproduct (DBP) precursors
- Removal of microconstituents, including pharmaceuticals, personal care products, and other trace chemicals, that could be introduced through upstream industrial and municipal discharges.

Candidate treatment alternatives for potable reuse of effluent from the Bustamante WWTP were developed to meet the water quality goals and probable regulatory and permitting requirements. An alternatives evaluation for the individual unit processes was conducted to identify the candidate treatment train for conceptual design. Based on the results of that evaluation, the recommended treatment train is shown in Figure 4.

A sidestream from the Bustamante WWTP secondary clarifiers will be treated with denitrification filters for nitrate removal. Additional treatment at Bustamante WWTP includes improvements to achieve full nitrification and prevent ammonia breakthrough. Unit processes at the APWTP include microfiltration/ultrafiltration (MF/UF), nanofiltration and reverse osmosis (NF/RO), ultraviolet and advanced oxidation processes (UV AOP), granular activated carbon (GAC) for hydrogen peroxide quenching, permeate stabilization, and chlorine disinfection. Potential ozone and/or coagulant addition locations and dosages will also be considered during pilot testing for potential application during full scale.

The recommended approach for discharge of the MF/UF backwash and NF/RO concentrate is to discharge to the Riverside Canal under a Texas Pollutant Discharge Elimination System (TPDES) permit. Other residuals handling options could be considered in the future if regulatory constraints or District specifications hindering disposal to the Riverside Canal are identified during subsequent phases of the project.

Figure 5 shows the treatment-effectiveness table for the candidate treatment train to graphically illustrate the treatment components and the relative effectiveness of each component at removing classes of contaminants. The graphical illustrations also show the potential multiple barriers for each class of contaminant. The primary removal mechanism is indicated with a green dot, while a potential removal mechanism is indicated with a yellow dot. Partial removal is indicated with quarter, half, and three-quarter-full circles, depending on removal effectiveness; an empty circle indicates no removal. Water quality parameters considered include particulates, total organic carbon (TOC), nitrogen compounds, mineral content (hardness and TDS), microconstituents, pathogens, and viruses.

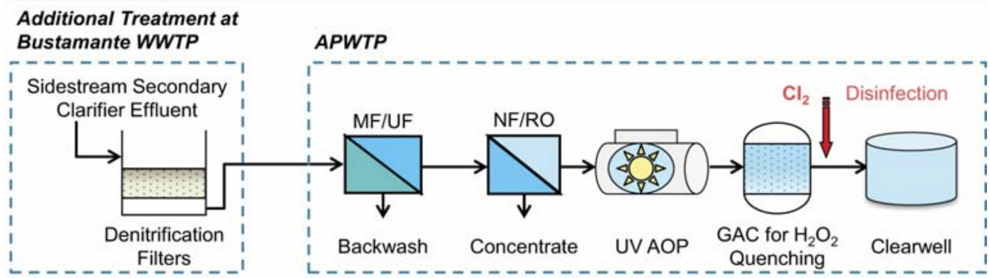

Figure 4. Candidate Treatment Train

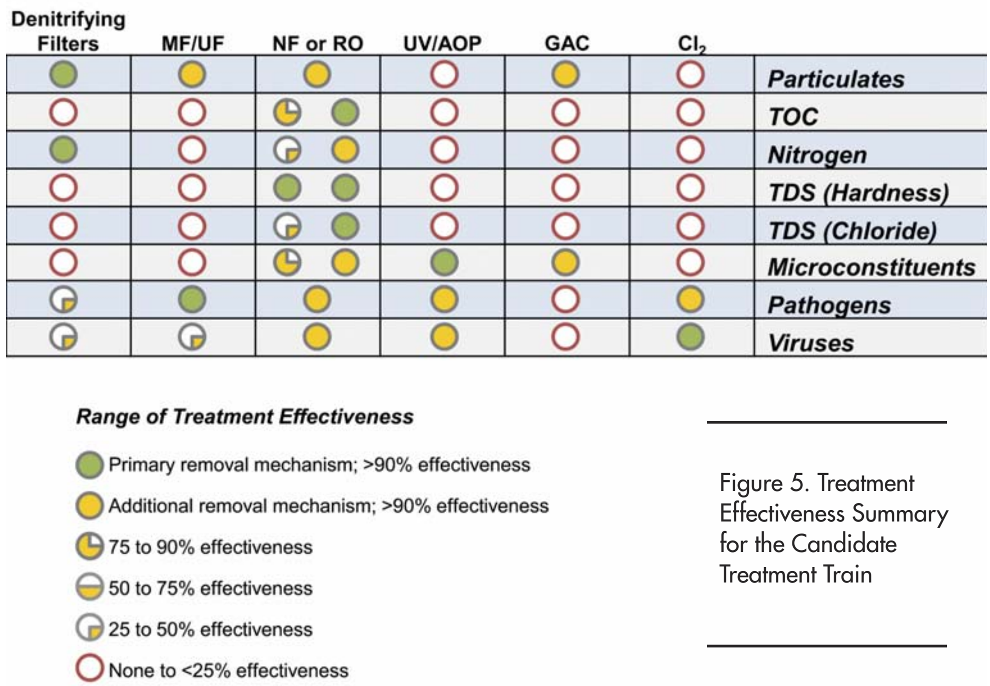

Figure 5. Treatment Effectiveness Summary for the Candidate Treatment Train

Summary and Conclusions

Implementation of the APWTP will be a key step in EPWU's efforts to continue diversifying its water resource portfolio for long-term water sustainability and drought support by providing high-quality potable water from a local, reliable water resource. The APWTP will treat clarified secondary effluent from the Bustamante WWTP for use in the potable water distribution system by employing a state-of-the-art water purification approach that includes multiple barriers for pathogens, diverse treatment for chemical microconstituents, on-line monitoring approaches to assure process performance, and robust compliance with all drinking water standards. The APWTP will operate year round, but its production will be subject to available volumes of source water after fulfillment of discharge obligations to the Riverside Canal and demands for reclaimed water from the Bustamante WWTP. During the non-irrigation season, the APWTP will have the capability to produce approximately 10 mgd of finished water for the potable water distribution system. Projected production will be at a reduced level estimated at approximately 5.6 mgd during the irrigation season.

The project includes a treatment approach employing denitrification filters for clarified secondary effluent at the Bustamante WWTP and conveyance of the denitrified effluent to the proposed APWTP, which will employ a process train of MF/UF membranes, NF/RO membranes, UV AOP, and GAC contactors for excess hydrogen peroxide quenching, permeate stabilization, and chlorine disinfection. On-line monitoring for critical parameters with control set points will also be incorporated. Storage will be included and sized to provide response time for diversion of potentially off-specification water. Ancillary systems include residuals handling, plant service water, miscellaneous chemicals, compressed air system(s), and various supporting systems provided with the membrane process equipment packages.

Some modifications to the existing treatment at the Bustamante WWTP will be required to optimize the treatability of source water at the APWTP. These modifications include relocation of chlorine feed from the secondary clarifier effluent wiers to downstream of the clarifiers, modifications to improve consistency of complete nitrification, additional automation and supervisory control and data acquisition (SCADA) controls, and upgrading the existing electrical service to the treatment plants (JRWTP, Bustamante WWTP, and the future APWTP share a single electrical feeder to the combined property).

A conceptual schedule for project execution includes the following major activities: pilot testing and preliminary engineering, detailed design, equipment procurement and onsite construction, start-up, and commissioning. The pilot testing and preliminary engineering began in March 2015 and are anticipated to end the first quarter of 2016. Detailed design is anticipated to commence at that point and require 12 months to complete. Construction duration is expected to be approximately two years and conclude with a three- to six-month period of sequenced start-up, performance testing, and commissioning.