Figure 2. Pumping and Chemical Feed (Photograph by Bill Ferguson 2004, with permission from County of Santa Barbara Public Works, CA)

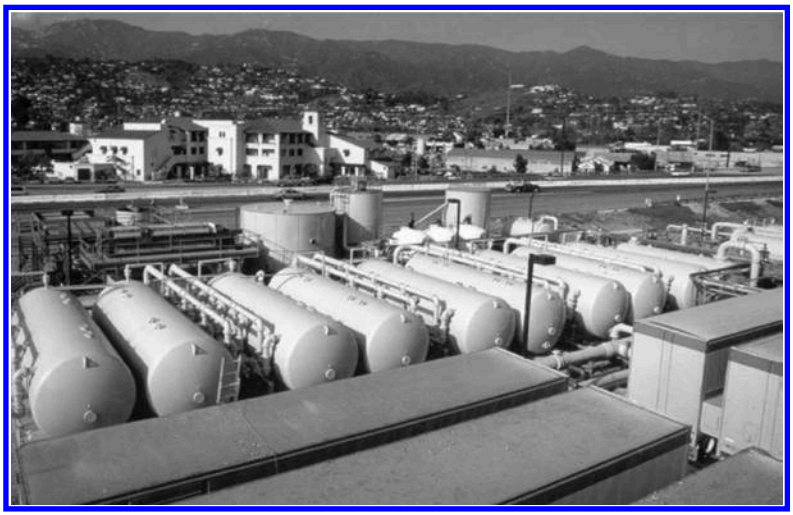

Figure 3. Pre-filtration Tanks with Desal Trailers in Foreground (Photograph by Bill Ferguson 2004, with permission from County of Santa Barbara Public Works, CA)

Figure 4. Modular Capacity: One Membrane Trailer (Photograph by Bill Ferguson 2004, with permission from County of Santa Barbara Public Works, CA)

Acknowledgement

Malcolm McEwen developed original case study on the City of Santa Barbara in 2008.

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Appendix A-2

Sanitary Sewer and Surface Water Disposal Case Studies

Joe Mullins Reverse Osmosis Water Treatment Facility - Melbourne, FL
Berrin Tansel

Ormond Beach WTP Low Pressure Reverse Osmosis (LPRO) Expansion – Ormond Beach, FL
Khalil Z. Atasi and Colin Hobbs

Pilot-Research Membrane Treatment of Non-Irrigation Season Flows in the Rio Grande River – El Paso, TX
Fahy, et al.

ASCE/EWRI Task Committee
CONCENTRATE MANAGEMENT IN DESALINATION
Case Study

Management Approach: Discharge of Concentrate to Brackish Surface Waters

Committee Member(s): Berrin Tansel

Project Contact(s): Fred Davis, Superintendent
Phone: (321) 255-4622, Fax: (321) 255-4636

Project Name: Joe Mullins Reverse Osmosis Water Treatment Facility, Melbourne, Florida

Project Location: 5980 Lake Washington Road Melbourne, FL 32934

Desalination Process: Reverse osmosis of brackish groundwater

WTP Information:

- Rated Capacity: 6.5 MGD
- Max. Concentrate Flow: 6.5 MGD
- Typical Production: 5 MGD
- Typical Concentrate Flow: 1.5 MGD

Abstract

The Joe Mullins Reverse Osmosis Water Treatment Plant was put into operation in 1995 with a 6.5 MGD capacity and a 4.0 million gallon ground water storage tank. Concentrate from the RO plant is discharged into the Eau Gallie River, a Class III marine water body, through an outfall. The outfall is approximately two feet in length and depth, and located approximately 100 feet downstream of the salinity control barrier. The facility currently has the discharge permits by the Florida Department of Environmental Protection (FDEP) and National Pollutant Discharge Elimination System (NPDES). Permits for the treatment facility granted mixing zones for various water quality parameters including dissolved oxygen, total nitrogen, chlorides, specific conductance, pH, gross alpha activity, and combined radium (226+228). Bioassays were conducted for the NPDES permit. Samples were collected for toxicity and algal growth tests. The 96-hour acute definitive toxicity tests were conducted per the permit requirements. The algal growth potential tests showed levels (1.89 mg dry wt/L of *Dunaliella tertiolecta*) which were below the threshold for concern (10 mg dry wt/L of *Dunaliella tertiolecta*). In the near future, the City will need to spend more than $ 19.3 million to expand the treatment capacity of the RO plant to 13.0 MGD.

Process Design and Configuration

Reverse osmosis membrane system treats water obtained from the Lower Floridan Zone of the Floridan Aquifer. Raw water is withdrawn through three 16-inch diameter wells which are approximately 650 to 900 feet deep. The raw water is sent to the Reverse Osmosis Plant for treatment. The filtered groundwater is pumped through a 12" R/O Product Transfer line where filtered waters from both the Joe Mullins Reverse Osmosis Water Treatment Plant (RO WTP) and a Surface WTP are combined and pumped into a baffled contact basin for chlorine disinfection and blending prior to final disinfection and distribution (Kirmeyer, 2004). Addition of fluoride, anhydrous ammonia, and sodium hydroxide (for pH adjustment) occurs within the 45 foot long, 42 inch diameter blended water line connecting the contact basin and baffled reservoir. After post treatment, water is pumped to a secondary unbaffled storage reservoir (4 MG) until distribution.

Concentrate from the current RO plant is discharged into the Eau Gallie River (a Class III marine water body) through an outfall located west of where the river meets the Indian River Lagoon.

The process equipment specification and operational data are provided below (http://www.melbourneflorida.org/watercon/RO%20Details.htm):

Process Equipment Specifications	
Pre-Filter Data: Housing Quantity: 2 Material: 316 stainless steel; 150 psi code stamped Number of pre-filters per housing: 156 Pre-filter Housing: 4' long, 39-1/4" Type of Pre-filter: 5 micron polypropylene	**High Pressure R.O. Pump Data:** Quantity: 2 Type: Vertical turbine multi-stage Material: 316 stainless steel Flow Rate: 2270 gpm Motor: 350hp, 1775 rpm
RO Train Data: (M/L 17455) No. of Trains: 2 No. of Pressure Tubes Per Train: 72 Staging Array: 48/24 Elements per Train: 504 Elements per Pressure Tube: 7 Material: Thin film composite polyamide Size: 8" diameter by 40" long	**Operating Data:** Number of Trains: 2 Inlet Flow Rater per Train: 2125 gpm Product Flow per Train: 1700 gpm Concentrate (brine) Flow per Train: 425 gpm

Well Water Analysis:	**Permeate Water Analysis:**
pH: 7.7	pH: 6.8
Alkalinity: 120	Alkalinity: 11
Total Hardness: 630	Total Hardness: 10
Chlorides: 754	Chlorides: 34
Color: 6	Color: 1
TDS: 1615	TDS: 69
Conductivity: 2956	Conductivity: 127

Project background:

Melbourne is responsible for providing water to some 150,000 customers. The Joe Mullins Reverse Osmosis Water Treatment Plant (Figure 1 below) was put into operation in 1995 with a 6.5 MGD capacity and a 4.0 million gallon ground water storage tank. To meet future demand, construction of a second phase of the reverse osmosis plant is anticipated in the future, which will provide capacity to accommodate a 100 percent build-out of the current service area (http://www.melbourneflorida.org/pub/pub-pdf/drinkwater.pdf)

Description of the proposed solution:

Concentrate from the RO plant is discharged into the Eau Gallie River, a Class III marine water body, through an outfall. The outfall is approximately two feet in length and depth, and located approximately 100 feet downstream of the salinity control barrier.

Assessments conducted by the City of Melbourne and Reiss Environmental, Inc. showed that gross alpha and combined radium were two parameters for which permit limits were being exceeded. Woods Hole Group, Inc. conducted a comprehensive study using a phased approach to evaluate whether a mixing zone could be permitted within the existing water quality regulations (http://www.woodsholegroup.com/project-descriptions/04-125_Melbourne.pdf).

An extensive mathematical modeling effort was conducted for the continued evaluation of the City of Melbourne's reverse osmosis concentrate discharge into the Eau Gallie River. A three-dimensional model of the river was developed using the Environmental Fluid Dynamics Code (EFDC) to simulate the hydrodynamics and particulate transport within the estuarine system. The EFDC model incorporated the parameters for defining the geometry of the system, as well as the conditions at both upstream and downstream boundaries of the Eau Gallie River, the atmospheric conditions, and the concentrate discharge into the model domain. Existing conditions were simulated and the model was calibrated and verified with field data. The model was used to simulate DEP specified design flow conditions to characterize the

concentrate dilution and the extent of mixing zones for the parameters of interest (http://www.whgrp.com/bios-long/shultz-bio.pdf).

A consent order granted the facility mixing zones that extend 1,500 feet downstream from the point of discharge and 50 feet upstream from the point of discharge but downstream from the salinity control barriers (DEP, 2004). The mixing zones are monitored to determine if the concentrate disposal causes any environmental damage. The US Environmental Protection Agency and the Florida Department of Environmental Protection are considering Melbourne's applications for permits to allow the by-product to be discharged into an injection well at the D.B. Lee Wastewater Treatment Facility (http://www.melbourneflorida.org/pub/pub-pdf/drinkwater.pdf).

Data Collection Procedures:

Permits for the treatment facility granted mixing zones for various water quality parameters including dissolved oxygen, total nitrogen, chlorides, specific conductance, pH, gross alpha activity, and combined radium (226+228). The parameters are being monitored as defined in the permit.

Permitting and regulatory overview and procedure:

The facility currently has the discharge permits by the Florida Department of Environmental Protection (FDEP) and National Pollutant Discharge Elimination System (NPDES). Bioassays were conducted for the NPDES permit. Samples were collected for toxicity and algal growth tests. The 96-hour acute definitive toxicity tests were conducted per the permit requirements. The algal growth potential tests showed levels (1.89 mg dry wt/L of *Dunaliella tertiolecta*) which were below the threshold for concern (10 mg dry wt/L of *Dunaliella tertiolecta*). The analytical chemistry data showed that concentrate was phosphorus limited. The concentrate samples were not acutely toxic to the fish but acutely toxic to the mysid. The cause of the toxicity was partially due to the high levels of calcium.

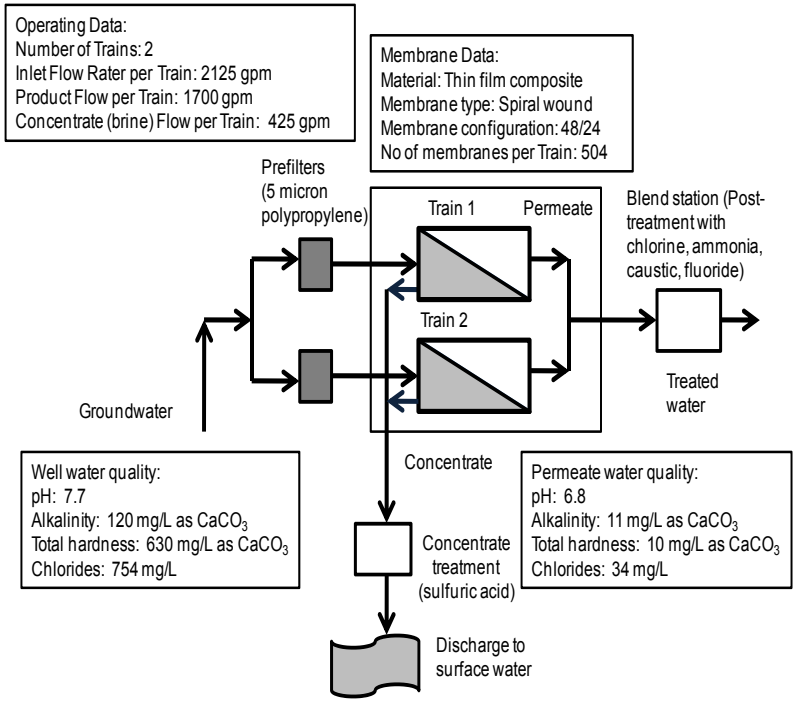
Analyses of plant concentrate:

N/A

Economic Evaluation:

In the near future, the City will need to spend more than $ 19.3 million to expand the treatment capacity of the RO plant to 13.0 MGD. (http://www.ctrlink.com/success/watertreatment.htm)

Figure 1. Schematic of Joe Mullins Reverse Osmosis Water Treatment Facility, Melbourne, FL (Courtesy of BerrinTansel)



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DEP, 2004, Individual Environmental Resource Permit and State Lands Approval Technical Staff Report, APPLICATION #: 4-061-75850-2 (State of Florida Department of Environmental Protection/Div of Rec & Parks C/O Bureau of Design & Recreation Services).

ASCE/EWRI Task Committee
CONCENTRATE MANAGEMENT IN DESALINATION
Case Study

Management Approach: Hybrid Zero Liquid Discharge/Surface Water Discharge – Discharge into an existing Public Access Reuse System which provides the ability to reuse all/or a portion of the concentrate for land application or to discharge all/or a portion of the concentrate to a surface water body (Halifax River).

Committee Member(s): Khalil Z. Atasi and Colin Hobbs

Project Contact(s): Colin Hobbs

Project Name: Ormond Beach WTP Low Pressure Reverse Osmosis (LPRO) Expansion

Project Location: Ormond Beach, Florida

Desalination Process: Low Pressure Reverse Osmosis
WTP Information:

- Rated Capacity: 12.0 mgd/4.0 mgd (Maximum permitted capacity of the facility is 12.0 mgd which consists of 8.0 mgd of lime softening capacity and 4.0 mgd of LPRO capacity.)
- Max. Concentrate Flow: 1.0 mgd/0.7 mgd (Maximum permitted concentrate flow is 1.0 mgd, however, the maximum design concentrate flow is 0.7 mgd.)
- Typical Production: Approximately 2.3 mgd (2009)
- Typ. Concentrate Flow: Approximately 0.4 mgd (2009)

Abstract

Faced with increasing potable water demands and deteriorating raw water quality, the City of Ormond Beach, Florida (City) retained CDM to design a 4.0-mgd low pressure reverse osmosis (LPRO) expansion to supplement their existing 8.0-mgd lime softening facility. The design of the LPRO expansion was completed in February 2006 and the expansion was placed online in January 2008.

The most innovative aspect of this project focused on concentrate management. Through a collaborative effort, the City, the Florida Department of Environmental Protection (FDEP), and CDM successfully permitted and implemented an innovative and sustainable method of managing a maximum of 1.0-mgd of concentrate. This unique method of concentrate management blends the concentrate with reclaimed water at the City's Wastewater Treatment Plant (WWTP) and allows the City to augment reclaimed water supplies with this previously unutilized resource without consuming WWTP treatment capacity.

Data collected since 2008 demonstrate the success of this innovative and sustainable approach to concentrate management. Since the startup of the LPRO expansion, the City increased reclaimed water supplies by 0.4-mgd and reclaims 100-percent of the concentrate during periods of high reclaimed water demand.

Process Design and Configuration

Pretreatment for the LPRO process consists of sulfuric acid addition, antiscalant addition, and cartridge filtration. LPRO treatment is provided by four 1.0 mgd permeate capacity skids operating at 85 percent recovery and an average flux of 14.9 gfd. Post treatment consists of degasification (with subsequent odor control) and free chlorination for primary disinfection. Free chlorinated permeate is blended with filtered and disinfected softened water prior to chloramination, fluoridation, stabilization, corrosion control, and storage.

Project background:

Increases in the City's population and service area placed increased demands on the City's existing lime softening WTP and necessitated an increase in the City's potable water treatment capacity. An expansion consisting of additional lime softening units was not feasible due to the gradual intrusion of salt water into the City's groundwater supplies. In order to provide increased potable water treatment capacity and ensure adequate treatment of the City's deteriorating groundwater supplies, the City elected to supplement the existing lime softening WTP with an LPRO expansion, thus necessitating a method of concentrate management. This project commenced in August of 2003 with the initiation of a pilot study and a preliminary design report for the proposed LPRO expansion and concluded when the LPRO expansion was placed online in January of 2008.

Description of the proposed solution:

A preliminary permitting meeting with the FDEP, the City, and CDM was held in February of 2004 to present and discuss the potential methods of concentrate management. At the conclusion of the meeting, all parties agreed that blending the concentrate with the effluent at the WWTP was the most favorable alternative. CDM subsequently completed a detailed analysis of this alternative, consisting of a blending analysis to predict potential blended effluent water quality. The results of this analysis were submitted to the FDEP along with the required permit forms to modify the WWTP in October of 2004. In November of 2004, CDM received one request for additional information (RAI) from the FDEP related to the significance of saline irrigation supplies, specifically pertaining to their effects on vegetation and soils. The FDEP received and reviewed CDMs responses and the FDEP granted the requested modifications to the WWTP in March of 2005.

Please note the project originally called for a 2.0 mgd, expandable to 4.0 mgd, LPRO expansion. During the construction of the LPRO expansion, the City elected to