Preserving the Environment by Increasing Reuse Supplies: Blending Nanofiltration Concentrate & Treated Effluent

Eric Stanley, D. Albrey Arrington, Richard C. Dent, Daniel G. Burden, and Robert B. Taylor

The Northwest Fork of the Loxahatchee River was federally designated as a 'Wild and Scenic River' in 1985, and remains one of only two Wild and Scenic Rivers in Florida. Large amounts of natural areas within the watershed have been preserved, including cypress swamp, pine uplands, scrub, freshwater hammock, mangrove swamp, seagrass beds, oyster reefs, and coastal dune habitats. The 260-square-mile watershed supports threatened and endangered species such as the manatee and woodstork and includes the communities of Jupiter, Tequesta, Juno Beach, Jupiter Island, Jupiter Inlet Colony, Jupiter Farms, Hobe Sound, and Palm Beach Gardens (Loxahatchee River Environmental Control District, 2009).

In addition to preserving the Loxahatchee River's ecological and aesthetic quality, good stewardship of this resource also is vital to preventing degradation of high-quality surface water and groundwater from saltwater intrusion. Basin modifications and drainage over the years have altered the hydrology and ecology of the area significantly, causing the encroachment of saltwater into some surface waters and the underlying aquifer; consequently, available freshwater resources have been reduced, and a saltwater-tolerant mangrove community has moved into the once-freshwater, bald cypress-dominated floodplain (Loxahatchee River Preservation Initiative, 2009).

The Loxahatchee River Environmental Control District is dedicated to preserving the river and its natural habitats by designing innovative wastewater solutions, furthering river research efforts, and fostering environmental stewardship. The district's wastewater treatment facility in Jupiter serves the municipalities of Jupiter, Tequesta, and Juno Beach, along with the unincorporated areas of northern Palm Beach and southern Martin counties. The district recently completed an expansion and upgrade project, bringing the treatment plant to average annual daily flow (AADF) capacity of 11 million gallons per day (mgd).

The district's reuse program was founded in 1983. Today this program provides nearly 7 mgd of reclaimed water to residential communities, golf courses, public parks, and recreational facilities. The district operates an extensive network of reuse lines throughout the Jupiter and Tequesta communities, with more than 30 miles of reuse water mains.

The district's reuse program has garnered numerous awards from state and national environmental managers for its safety and innovation. Approximately 90 percent of treated effluent from the wastewater treatment facility is delivered to the reuse system and used for landscape irrigation; however, demand for reclaimed water in the local communities continues to exceed supply, and additional sources of reclaimed water appear limited (Loxahatchee River District, 2009).

The nearby town of Jupiter's water treatment plant has a 29-mgd capacity, serving more than 80,000 customers in Jupiter, Juno Beach, Tequesta, and unincorporated areas of Palm Beach and Martin counties. Jupiter's drinking water system presently blends the product of three treatment methods: 13.5 mgd of lime softening effluent, 1.8 mgd of ion exchange effluent, and 13.7 mgd of reverse osmosis (RO) effluent.

Eric Stanley, P.E., is a principal engineer with the engineering firm Hazen and Sawyer. D. Albrey Arrington, Ph.D., is the executive director of the Loxahatchee River District. Richard C. Dent is the past executive director of the district. Daniel G. Burden, Ph.D., P.E., and Robert B. Taylor, P.E., are senior associates with Hazen and Sawyer. This article was presented as a technical paper at the 2009 Florida Water Resources Conference.

A major component of Jupiter's community investment program is the implementation of a 14.5-mgd nanofiltration treatment facility, which will begin to replace the older, conventional lime softening water treatment facility in 2010 (Town of Jupiter, 2009). Replacing the lime treatment process will eliminate the need to dispose of lime sludge and reduce the generation of disinfection byproducts in the product water.

The new nanofiltration process will also reduce the concentration of total dissolved solids (TDS) in the product water. The process will generate a byproduct of approximately 3.0 mgd of demineralization concentrate (nano-concentrate) that contains elevated concentrations of TDS, which presents a disposal challenge.

As a solution to dispose of the nano-concentrate and increase reclaimed water supply, it was proposed that nano-concentrate from the Jupiter water treatment facility be blended with treated effluent from the nearby Loxahatchee River District's wastewater treatment facility and beneficially reused as reclaimed water.

Under Rule 62-610.865 F.A.C. added to Chapter 62-610 F.A.C. in 1999, the Florida Department of Environmental Protection (FDEP) allows disposal of demineralization concentrate in a manner that does not cause environmental harm. By blending Jupiter's nano-concentrate with the district's treated effluent, reuse supplies would be increased and distribution of this additional reclaimed water for landscape irrigation would continue to preserve local groundwater

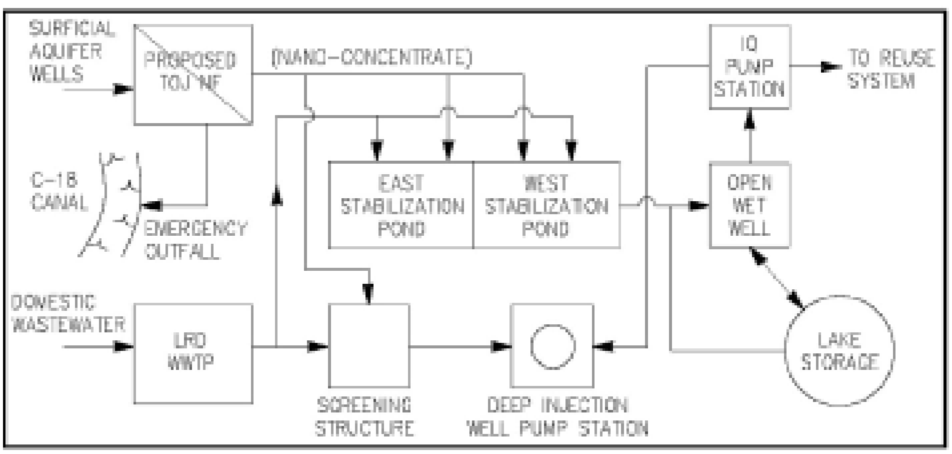

Figure 1 – Blending Process Flow Diagram

resources for the Loxahatchee River.

Specifically, this innovative proposal would allow the district to provide an alternative water supply to help alleviate the need for new irrigation wells at two proposed development locations in close proximity to the Wild and Scenic Northwest Fork of the Loxahatchee River. Initially it was well received by the FDEP and the South Florida Water Management District in 2003.

Two main regulatory hurdles had to be overcome to permit the proposed blending scenario. First, it was necessary to provide technical documentation to the FDEP that demonstrated the blend would not impair soil or groundwater quality or affect landscape vegetation negatively at application sites. This process is similar to obtaining permission for land application of typical reclaimed water without a concentrate blend, but with some special considerations.

Second, it was necessary to gain permission from the FDEP to dispose of the nano-concentrate down the district's deep injection well during wet-weather events (i.e., periods of low reuse demand), or when storage capacity for the blend reaches capacity. Since the Loxahatchee River District facility was the first in the state to propose disposal of nano-concentrate down a well not specially constructed with tubing and packer to receive industrial waste, the FDEP has taken an extremely cautious approach.

Rule 62-610 F.A.C. deals with land application of reclaimed water. The FDEP added Rule F.A.C. 62-610.865 in 1999 to govern land application of concentrate blending. FDEP Program Guidance Memo DOM-00-04 gives guidance on land application of blended concentrate and reclaimed water in accordance with Rule F.A.C. 62-610.865. Drinking water standards as set forth in Rule 62-550 F.A.C. must also be met. This article outlines the efforts made by the Loxahatchee River District and the town of Jupiter to comply with these rules in order to reach the goal of increasing reclaimed water supply by blending Jupiter's nano-concentrate with the district's reclaimed water.

Methods & Results

Proposed Blending Method

The district obtained a modification to its operating permit in October 2005 which allowed for the blending and land application of 3.0 mgd maximum daily flow of nano-concentrate from Jupiter's new nanofiltration water treatment process. The town's new improvements are presently under construction and are scheduled to be completed by the spring of 2010.

The concentrate will be treated for removal of hydrogen sulfide through a degasifier and chlorinated at the water treatment plant prior to being pumped to the district's wastewater treatment facility. Under normal operating conditions, the concentrate will be pumped to the district stabilization ponds, blended with treated wastewater effluent, and delivered to the district's reclaimed water distribution system.

As an emergency disposal option, the nano-concentrate may be discharged with the town of Jupiter's RO concentrate at an outfall into the nearby C-18 canal for up to 30 days per year (the permit allowing disposal to the C-18 canal was received in April). Under wet-weather conditions when reuse is not feasible, or when the district's on-site effluent storage capacity is limited, the concentrate will be disposed of down the district's deep injection well.

It is expected that the nano-concentrate will be blended before disposal down the injection well. Although disposal of the blend down the well has not yet been permitted, in June the FDEP issued a draft permit authorizing disposal of the blend down the district's deep injection well. A process flow diagram of the blending process is shown in Figure 1.

Vegetation Water Quality Constituents of Concern

It was necessary to demonstrate that the blend would not have a negative impact on the vegetation to which it will be applied. In accordance with FDEP rules, water quality criteria for landscape vegetation specific to the district's service area was developed. Based on literature and interviews with reclaimed water customers and a local turfgrass consultant, it was determined that Bermuda grass was not only the most abundant vegetation in the service area, but also the most sensitive receptor for constituents in the reclaimed water.

All golf courses within the district service area have one or more varieties of Bermuda grass as their turfgrass; accordingly, the tolerance of Bermuda grass for the constituents of reclaimed water was used to develop the vegetation water quality goals as a conservative measure (Duranceau et. al, 2003).

The TDS tolerances of plant species irrigated with district reclaimed water were researched and compared with Bermuda grass. The majority of the vegetation falls into the categories of good to moderate salt tolerance (Knox and Black, 1999). All the reported salt tolerance data are based on the worst-case scenario of no rainfall. While noting that Bermuda grass is identified as moderately salt tolerant, other research shows no loss in yield at TDS values of 3,800 milligrams per liter (mg/L) (almost four times the estimated TDS value of the proposed blend) (Kaffka, 2001).

Based on projected levels in the blend, it was determined that TDS, the soil adsorption rate (SAR), calcium, magnesium, potassium, and

Continued on page 54

Table 1 – Vegetation Water Quality Goals for Constituents of Concern in the Loxahatchee River District Service Area

Parameter	Range of Water Quality Acceptable for Bermuda Grass
Soil Adsorption Rate (SAR)	3 to 7
Calcium (mg/L)	40 to 120
Magnesium (mg/L)	6 to 20
Potassium (mg/L)	0.5 to 10
Sodium (mg/L)	0 to 50
Iron (mg/L)	2 to 5
Alkalinity (mg/L)	0 to 100
Chloride (mg/L)	177 to 355
Sulfate (mg/L)	0 to 414
TDS (mg/L)	1,000 to 1,500
Boron (mg/L)	0.2 to 0.8

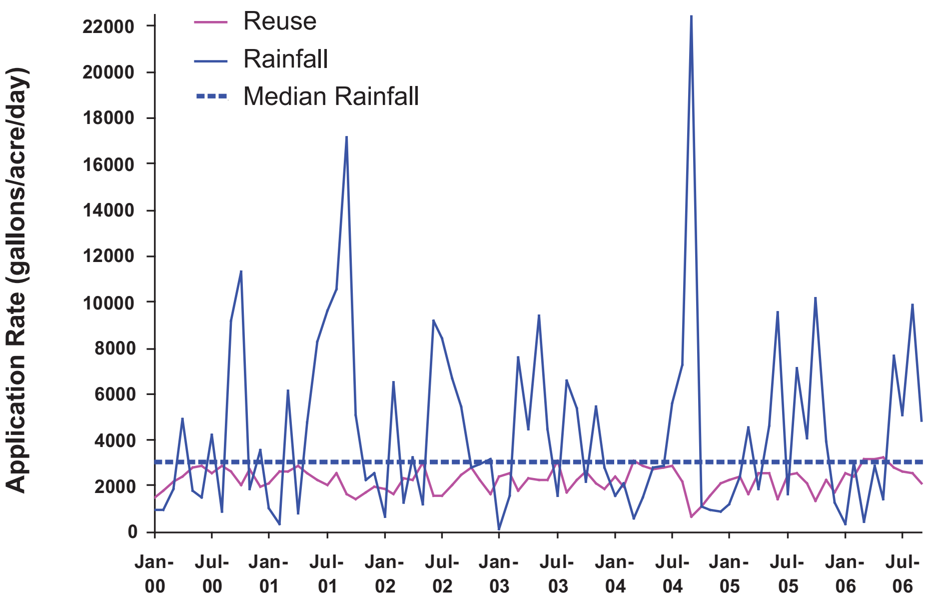

Figure 2 – Mean monthly rainfall rate and reuse application rate for the period 2000 through 2006. Note that rainfall exceeded reuse irrigation rate during 59 percent of the period.

Table 2 - Groundwater Quality Goals for Constituents of Concern at the Loxahatchee River District Service Area

Parameter	Maximum Concentration Goal
Primary Drinking Water Standard	
Sodium (mg/L)	160
Secondary Drinking Water Standard	
TDS (mg/L)	500
Chloride (mg/L)	250
Sulfate (mg/L)	250
Iron (mg/L)	0.3
Manganese (mg/L)	0.05
Odor (TON)	3

Continued from page 53

sodium were parameters of potential concern to manage for proper care of turfgrass at the local golf course facilities. The constituents of concern that were determined for the district's service area are provided in Table 1 with their corresponding range of acceptable water quality.

One of the most important constituents for consideration listed in Table 1 is the SAR, which is a composite of sodium, calcium, and magnesium constituents. The SAR equation is

$$SAR = \frac{Na}{\sqrt{\frac{Ca + Mg}{2}}}$$

shown as Equation 1, below, where Na, Ca, and Mg are measured in milliequivalents per liter:

(Equation 1)

The SAR is of concern because higher values of SAR increase the rate at which sodium will replace calcium and magnesium in the clay particles of soil. This reaction reduces the infiltration capacity of the soil. While SAR is of great concern in areas with soils that have high clay content, it is less of a concern in sandy soils, such as those typical in South Florida and also underlying the district's service area.

The effects of SAR are also mitigated by leaching when soils are regularly flushed with water with a low sodium content. This can also be expected in the district service area, which is within a coastal tropical climate zone that experiences a relative regular frequency of rain events. Historical records of rainfall versus reuse application rates compiled for a 2008 district study (Arrington and Dent, 2008) are presented in Figure 2, which demonstrates high levels of rainfall relative to reuse application rates for the years 2000 through 2006 within the district service area.

Groundwater Quality Constituents of Concern

The land application of reclaimed water must also be designed to meet primary and secondary drinking water standards as set forth in FDEP Chapter 62-550. The Loxahatchee River District's permit exempts its land application of reclaimed water from meeting the drinking water standards of turbidity, corrosivity, and color. The constituents in the drinking water standards that were identified in appreciable amounts in the projected blend of Jupiter's nano-concentrate with the district's reuse effluent are listed in Table 2 with their corresponding maximum concentration goal.

Compliance with drinking water standards at the point of discharge (the sprinkler head or

Continued on page 56

Continued from page 54
storage pond discharge) is not required. Rather, standards must be met at the edge of a zone of discharge, which is defined by FDEP Rule 62-520.200 (23), F.A.C. as "a volume underlying or surrounding the site and extending to the base of a specifically designated aquifer or aquifers, within which the opportunity for the treatment, mixture, or dispersion of wastes into receiving ground water is afforded."

According to the FDEP's Guidance Memo that gives guidance on land application of blended concentrate and reclaimed water, the zone of discharge extends approximately 100 feet radially from the edge of the area of land application (Drew, 2000). This leaves a relatively small buffer in which the land-applied reclaimed water can dilute with the ambient groundwater to satisfy the criteria.

Characterization of Reclaimed Water/Nano-Concentrate Blend

The district reuse effluent water quality was characterized using the average water quality results from four annual effluent sampling events taken between December 1998 and December 2001. When the town of Jupiter's NF plant comes online, a 25-percent reduction in TDS and other associated parameters in the district effluent is projected as a result of improved quality of the used potable water entering the district sewage collection system. The district wastewater treatment facility flow was assumed to be a minimum of 7.75 mgd AADF, based on current usage (Duranceau et. al, 2003).

The Jupiter nano-concentrate water quality had to be derived because the NF plant has yet to be constructed and no empirical sampling data could be obtained. This was accomplished by taking the average values for the most recent round of primary and secondary water-quality sampling results from the surficial water supply wells and inputting the values into two high-pressure membrane computer models (Koch Membrane Systems, Inc., ROPRO Version 7.0, and Hydranautics, System Design Software Version 6.2), assuming a worst-case 85-percent product / 15-percent concentrate ratio. The average results of the two models were used to project the nano-concentrate water quality.

The town of Jupiter plans to start the NF facility in 2010, which will result in an initial concentrate discharge of 2.6 mgd that will increase to a maximum flow of 3.0 mgd by the year 2011. For projecting blend characteristics, a 3.63-mgd, worst-case concentrate flow volume was assumed, based on a worst-case 14.5-mgd NF plant with 80-percent product/ 20-percent concentrate ratio (Duranceau et. al, 2003). The projected blend water quality is shown in Table 3.

Table 3 – Concentration of constituents in the Loxahatchee River District reuse effluent and town of Jupiter nano-concentrate were used to determine characteristics of the blend. Water quality of the blend was then compared to Bermuda grass standards and Primary and Secondary Drinking Water Standards per FDEP Chapter 62-550.

Parameters	District Effluent[1] (7.75 mgd)	Projected Nano-Concentrate[2] (3.63 mgd)	Blended Water Quality (11.38 mgd)	Goals
Bermuda Grass Goals				
Calcium (mg/L)	32	588	209	120
Magnesium (mg/L)	3	29	11	20
Alkalinity (mg/L)	240	1,072	505	100
TDS (mg/L)	316	2,241	929	1,500
Sodium (mg/L)	73	98	81	50
Chloride (mg/L)	96	272	152	355
Sulfate (mg/L)	42	334	135	414
Iron (mg/L)	0.19	2.3	0.9	5
Potassium (mg/L)	8	11	9	10
Boron (mg/L)	<0.05	<0.05	<0.05	0.8
pH	6.8	7.7	7.1	7.6
SAR	3.3	1.1	1.5	3-7
Primary Drinking Water Standard				
Sodium (mg/L)	73	98	81	160
Secondary Drinking Water Standard				
TDS (mg/L)	316	2,241	929	500
Chloride (mg/L)	96	272	152	250
Sulfate (mg/L)	42	334	135	250
Iron (mg/L)	0.19	2.3	0.9	0.3
Manganese (mg/L)	0.02	0.1	0.05	0.05
Odor (TON)	7	-	-	3

[1] 7.75 mgd, adjusted by 25 percent to account for improved wastewater quality due to TOJ's switch from lime softening to nanofiltration.

[2] 3.63 mgd worst-case flowrate, based on 14.5 mgd TOJ nanofiltration production at an 80% product / 20 percent concentrate ratio.

Projected Blend Water Effects on Landscape Vegetation

Table 3 demonstrates that from a Bermuda grass goal standpoint, calcium, sodium, and alkalinity goals are not attainable because these parameters exceed the goals prior to blending.

The projected sodium concentration in the blend is about 62 percent greater than the goal for Bermuda grass. The sodium level of the blend, when compared to the existing district treated effluent, increased by only about 10 percent. Since reuse has been utilized by the existing reclaimed water users for the past 15 years without any significant problems, it was concluded that this small increase in sodium levels was insignificant.

Similar to the predicted sodium level with respect to the goal for Bermuda grass, the projected concentration of calcium is about 74 percent greater than the goal; however, the projected concentration for calcium is about seven times higher than the existing reuse concentration. As such, allowance for the higher concentration of calcium required additional justification.

The targets for calcium and sodium are important insofar as they relate to the total calculation of the SAR and overall TDS. Because of the well-drained, sandy soils and consistently heavy annual rainfall in this area, the SAR and long-term accumulation are not a concern. The SAR and long-term build-up are much more of a concern where irrigation (from an elevated sodium source) is the overriding source of water for the vegetation.

In this case, irrigation with reclaimed water is supplementary to rainfall. Mean monthly rainfall rate exceeded reuse application rate for 59 percent of the time period from January 1, 2000, through December 31, 2006, as demonstrated in Figure 2 (Arrington and Dent, 2008).

The second area of importance regarding calcium and sodium is their part in overall TDS. Based on literature review, the effects of irrigation water with a TDS less than 1,100 mg/L was found to be negligible. A TDS range of 1,100 to 2,200 mg/L may have growth effects on the most sensitive plants; however, this effect is greatly reduced by leaching (Weinberg, 2004). In the case of South Florida, high annual rainfall provides frequent, consistent leaching events that prevent potential negative impacts from TDS levels projected for the blend.

Pre-blend reuse alkalinity levels of around 240 mg/L exceed Bermuda grass goals. The projected blend alkalinity concentration of 505 mg/L indicates more than a two-fold increase in alkalinity concentration, and required further justification.

Similar to TDS and SAR, the elevated alkalinity levels in this range are not a major concern because of the frequent, consistent leaching events provided by rainfall in the area. Also, calcareous soils are commonplace in the Loxahatchee River District service area and throughout South Florida because of the ubiquitous underlying limestone. Vegetation of concern in the service area would necessarily have resistance to alkaline conditions (Weinberg, 2004). As such, the elevated levels of alkalinity in the projected blend water quality were not a concern in this case.

Projected Blend Water Effects on Groundwater

From a groundwater standards standpoint, TDS, iron, and odor goals are not immediately attainable at the point of discharge (sprinkler head), but dilution with ambient groundwater quality will dilute the blend water further. A geoscience consultant performed geochemical and groundwater modeling of the proposed reclaimed blend at affected golf courses. Modeling results indicated that groundwater concentrations will not exceed the 500 mg/L TDS standard at locations 100 feet down-gradient of the blend application areas, in conformance with Rule 62-610 F.A.C (JLA Geosicences, Inc., 2004); therefore, groundwater standards should not be violated when assessed at the zone of discharge.

District treated effluent does not meet the secondary drinking water standard for odor. Since odor is not a mass-based water-quality

Continued on page 58

Continued from page 57

parameter, it was not projected for the blend concentration; however, district treated effluent has been land applied for over ten years without significant complaints from customers regarding odor. Since Jupiter nanoconcentrate will be treated by degasifiers before being blended and is consequently expected to have very little odor-causing volatile constituents such as hydrogen sulfide, it is anticipated that the blend will decrease odors.

Operational Constraints

In accordance with FAC Rule 62-610.865(6)(d), a minimum blend ratio of treated effluent to nano-concentrate will be equaled or exceeded at all times before land application. The flow of nano-concentrate and the flow of district treated effluent will be measured continuously so that the blend ratio is continuously monitored. A minimum blend ratio of 3:1 has been agreed upon for the operational permit based on a maximum TDS concentration of 1,500 mg/L in accordance with FAC Rule 62-610.865(6)(a), and a SAR of 7. Following the startup of Jupiter's new water treatment plant and after a significant amount of operational data has been obtained, the FDEP may require that the minimum blend ratio be revised appropriately (FDEP, 2008).

The blend will be monitored continuously for TDS by measuring specific conductance. A setpoint for specific conductance of 3,000 micromhos per centimeter (umhos/cm) for the blend has been established, based on a TDS concentration of 1,500 mg/L. At levels equal to or below the TDS setpoint, the blend may be sent to the reuse distribution system. At levels above the TDS setpoint, the blended effluent shall be delivered to the deep injection well or maintained in the storage ponds, where further dilution can be achieved through blending with additional treated effluent.

Deep well disposal will occur when the district has no remaining available storage capacity, and when the concentrate/reclaimed water blend has a chloride concentration less than 355 mg/L (FDEP, 2008). The 355 mg/L chloride limit was derived from evidence that suggests the presence of chloride is the component of TDS most likely to promote corrosion of well construction materials. Blended effluent will likely be disposed down the deep injection well approximately 90 days per annum, based on historical operating data that demonstrates approximately 25 percent of annual effluent disposal occurring through the district's deep injection well.

Under true emergency conditions, the concentrate stream may be discharged to the C-18 canal, as provided in the town of Jupiter's RO concentrate disposal permit. Expected triggers for use of this emergency backup disposal will be:

1) The blend does not meet criteria of 355 mg/L chloride water quality level, (based on blend projections, this is not expected to occur).
2) There are problems with or damage to the conveyance pipeline from the Jupiter plant to the district plant.
3) Storage is unavailable in the district pond/lake system.
4) The district plant is off-line or experiencing an upset and not generating reuse water.

Water Quality Monitoring Requirements

A geoscience consultant assembled and reviewed background groundwater concentrations of TDS and chloride for the region from a variety of sources. Monitoring data collected near area golf courses indicated saline influence from the Loxahatchee River and Florida's Intracoastal Waterway on groundwater quality in the area. Background groundwater concentrations from samples collected from Jupiter production wells indicated average TDS values already at or above the 500 mg/L groundwater standard in the ambient groundwater (JLA Geosciences, Inc., 2004). This situation presented a challenge for developing the groundwater monitoring program, since typical groundwater monitoring schemes for land application of reclaimed water generally focus on monitoring TDS levels.

A modified groundwater monitoring program based on monitoring chloride levels was recommended because:

1) Chloride is a chemically conservative element that does not react with aquifer solids via dissolution, precipitation, or sorption like other constituents that contribute to TDS.
2) Historical district monitoring data clearly show a correspondence between chloride concentrations measured in source water and reclaimed water delivered to area golf courses.
3) Chloride represents more of a challenge than TDS to remove via conventional water treatment methods.
4) Chloride monitoring data would provide a more representative indicator than TDS of potential adverse impacts to groundwater from application of the blend (JLA Geosciences Inc., 2004).

Consequently, the network of existing surficial groundwater monitoring wells at major user golf courses will be sampled annually for TDS and chloride, along with other typical parameters used to monitor sites irrigated with reclaimed water.

Permitting Deep Injection Well Disposal of Blend

A secondary disposal option for the nano-concentrate during wet-weather events (periods of low reuse demand), or when storage capacity for the blend reaches capacity at the district, was needed as part of the overall operational plan for the district. The existing Jupiter RO concentrate outfall into the nearby C-18 canal is available for 30 days of wet-weather concentrate disposal, though its capacity is not rated. Eliminating the construction of a deep injection well at the town of Jupiter facility to receive the nano-concentrate stream, represents a significant cost avoidance if the nano-concentrate (or blend) can be disposed of down the district's existing deep injection well.

A regulatory problem was encountered in trying to gain permission to dispose of the nano-concentrate down the district's well. In Florida, concentrate is defined as an "industrial discharge" and cannot be disposed of down a typical injection well used for treated domestic wastewater. The FDEP requires that a deep injection well be constructed with tubing and packer or an alternative casing material if it is to receive industrial discharge (e.g., nano-concentrate).

The obvious solution to this problem was to inject the blend down the injection well, since the nano-concentrate loses its identity as an industrial waste and resembles a typical treated wastewater effluent when diluted with the district treated effluent (except for slightly elevated TDS levels).

The FDEP is taking a cautious approach to permitting the disposal of the blend down the deep injection well, since this method has not been allowed previously. For this reason, permitting this facility to allow disposal of the blend would set a statewide precedent for utilities. The department recently informed the Loxahatchee River District and the town of Jupiter that a variance from the United States Environmental Protection Agency (EPA) would not be required for disposing of the blend down the domestic wastewater deep injection well, and that the requirement for alternative well construction was strictly under the FDEP's jurisdiction.

The updated domestic wastewater facility permit was reissued in November 2008, allowing distribution of the blend to reuse customers; however, the permit stipulates that allowance for disposal down the well is conditional on the district receiving official approval from the FDEP Underground Injection Control (UIC) Program (FDEP, 2008). In June the FDEP issued a draft permit (FILE: 0138774-187-UO (IW-1)) authorizing disposal of the blend down the district's deep injection well.

The major point of justification made in the request to the UIC program is that the projected water quality of the concentrate and effluent blend falls within the typical range for a treated domestic wastewater, except for the TDS levels in the 1,000-mg/L range, compared to the high-range value of 850 mg/L for typical domestic wastewater; however, based on average-year 2004 TDS concentrations for 26 municipal injection well facilities located on the Florida east coast and

Lake Okeechobee area, the district's proposed disposal of blend would be lower than the TDS levels found at five other facilities currently in operation (Fort Lauderdale, Plantation Central, Palm Bay, Hollywood, and Pahokee).

Supported by data showing that the projected TDS and chloride levels for the district blend are lower than many similar South Florida municipal injection wells, it was argued successfully that the alternative well construction for receiving industrial waste should not apply. Nonetheless, one of the specific conditions included in the draft UIC permit is that the TDS value for the blended injectate is not to exceed 1000 mg/L.

Conclusions

A combined approach of engineering, hydrogeological, and environmental analyses provided the technical documentation needed to permit the reclaimed water/nano-concentrate blend as a viable alternative water supply. As a result, the town of Jupiter and the Loxahatchee River Environmental Control District were able to implement a mutually beneficial plan, whereby nano-concentrate would be blended with treated effluent and beneficially used as reclaimed water.

An important regulatory hurdle is being overcome by working with the FDEP for the allowance of injection of the blend down the district's existing domestic wastewater deep injection well, which heretofore has not been permitted. The final regulatory approval from the FDEP UIC program is expected shortly.

The implications of this case should be instructive for other utilities facing similar scenarios and can potentially save hundreds of millions of dollars statewide that otherwise would have been required for constructing additional deep injection wells adequate for receiving industrial waste. This creative project represents a win-win-win for utility customers, utilities, and the environment.

References

- Arrington, D.A and Dent, R.C. "Maintenance of Groundwater Quality throughout Twenty Years of Reuse." Water Practice, Vol. 2, No. 3. Water Environmental Federation, 2008
- Drew, M. "Program Guidance Memo – DOM-00-04", Florida Department of Environmental Protection. July 7, 2000.
- Duranceau, S.J. et. al., "Town of Jupiter – Blending of Concentrate With Reclaimed Water – Engineering Report", March 17, 2003, Boyle Engineering Corporation, Orlando, FL.
- Florida Department of Environmental Protection, State of Florida Domestic Wastewater Facility Permit No. FL0034649-036-DW1P-NR, Permitee: Loxahatchee River Environmental Control District, November 18, 2008
- JLA Geosciences, Inc. "Town of Jupiter – Proposed Reuse/Concentrate Blend Influence on Groundwater Quality.", September 2004, Jupiter, FL.
- Kaffka, S. "Salt Tolerant Forages for the Reuse of Saline Drainage Water." Proceedings, 31st California Alfalfa and Forage Symposium, University of California, Davis.
- Knox, G.W., Black, R.J. "Salt Tolerance For Landscape Plants for South Florida." 1999, Department of Environmental Horticulture, Florida Cooperative Extension Service, Institute of Food and Agricultural Sciences, University of Florida.
- Loxahatchee River District, "About the River". 2009. **http://www.loxahatcheeriver.org/about_ the_river.php**
- Loxahatchee River Preservation Initiative, "Loxahatchee River Preservation Initiative – 2009 Legislative Appropriations Brief". 2009. **http://www.lrpi.org/2008/2009Brief_Av2.pdf**
- Town of Jupiter, "Water Utilities". 2009. **http://www.jupiter.fl.us/Water/Drinking-Water-Quality.cfm**
- Weinberg, E., Memorandum, July 14, 2004, EW Consultants, Stuart, FL.