Many utility managers are looking to expand their water supply portfolio with alternative water sources, including water reuse, but are often confronted with two common questions – **Is it safe? Will my customers accept potable reuse?**

While each community should answer these questions for themselves, in regards to safety, the National Research Council’s report “Water Reuse: Potential for Expanding the Nation’s Water Supply Through Reuse of Municipal Water” concluded the intentional inclusion of properly treated wastewater into a public water supply did not inherently increase public health risk compared with many current supplies, and in some cases, the risks were much lower compared to existing supplies.

The answer as to whether water customers will accept potable reuse was answered in 1861 when Abraham Lincoln stated “... public sentiment is everything. With it, nothing can fail; against it, nothing can succeed.” Early, frequent and factual communication with water customers is key.

**Freeze and Nichols, Inc. (FNI)** is a national leader in this developing practice, assisting many clients in assessing appropriate reuse strategies for their particular circumstances and, where appropriate, implementing leading-edge solutions to provide a secure water supply.

FNI can help you evaluate and develop reuse and other appropriate water supply sources that meet your quality, reliability and cost criteria. We provide **customized solutions** and **high quality deliverables** from crafting appropriate combinations of strategies, whether involving potable or non-potable reuse, lake augmentation or conventional groundwater or surface water; to securing water rights and environmental permits; to assistance in obtaining state financing; to providing construction services to verify the final product is consistent with the agreed upon design.

**FNI Water™**

A key tenet of the FNI philosophy is stewardship of our clients’ assets and public resources. FNI Water™ is the framework for a process that helps our staff explore alternatives for sustainable water resources in the 21st century. FNI Water™ is an FNI initiative that incorporates sustainability, the water/energy nexus, water efficiency, water conservation, conjunctive use of groundwater and surface water, brackish water, and water reuse. FNI Water™ is also a way to demonstrate to our clients that resource sustainability and stewardship are important to us and will be considered in any endeavor we undertake.

FNI Water™ focuses primarily on two aspects of sustainability: the natural environment (water and energy) and life cycle costs. The idea is to take a holistic, environmentally responsible approach and implement best practices through every step of a water project, from planning to operations, to maximize the quantity and quality of water, protect ecosystem functions, minimize energy use, and minimize costs.

**WATER REUSE**

The following pages feature a collection of FNI’s water reuse case studies. The studies are grouped by type – Direct Potable, Indirect Potable, Industrial/Commercial and Turf Irrigational Reuse. Each study includes a chart highlighting the services provided, as seen in the table above.
The Colorado River Municipal Water District (CRMWD) recently began producing a new municipal water source using treated wastewater effluent. CRMWD’s Raw Water Production Facility diverts up to 2.5 MGD of effluent from the plant near Big Spring and treats it to near drinking-water quality.

The RWPF provides membrane filtration, reverse osmosis and ultraviolet oxidation to achieve a water quality superior to other raw water supplies controlled by the CRMWD. The product water is blended into the CRMWD’s Spence Pipeline east of Big Spring. This is the first facility in North America to blend reclaimed water directly in a raw water transmission pipeline.

FNI managed permitting, completed the design, and provided construction and startup services for this unique facility. CRMWD selected Freese and Nichols for a feasibility study to assess water supply augmentation with reclaimed wastewater. Three regional projects were evaluated to serve CRMWD’s member cities and key-customers. Following the feasibility determination, FNI was retained to navigate source-water approval by the Texas Commission on Environmental Quality and to provide Texas Pollutant Discharge Eliminating System and Section 404 permitting, pilot testing, design and construction phase assistance.

The project was featured in the Texas WET magazine’s November 2011 issue, Water Desalination Report’s January 2014 edition, and TWCA Confluence’s June 2014 issue. It also was selected as Water Reuse Project of the Year by Global Water Intelligence.

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The City of Wichita Falls has been at the leading edge in the implementation of direct potable reuse (DPR). Faced with intense, unprecedented drought conditions, the City developed a plan to utilize existing desalination treatment facilities to purify effluent from their River Road Water Resource Recovery Facility and blend it with surface water from their dwindling reservoirs prior to additional conventional treatment at their Cypress Water Treatment Plant. Following extensive full-scale testing and negotiations with the Texas Commission on Environmental Quality, they were granted a six-month authorization to operate the DPR facility, becoming only the second entity in North America to practice DPR (after the Colorado River Municipal Water District).

Facing continued low reservoir levels, the City turned to FNI to assist with emergency water supply planning and a two-pronged approach to extend and expand the City's temporary DPR program. UV DISINFECTION

A principal Texas Commission on Environmental Quality (TCEQ) condition for extending the DPR operation beyond the initial six-month authorization was addition of ultraviolet disinfection to provide an additional barrier to Cryptosporidium oocysts, protozoan pathogens resistant to chemical disinfection. Working collaboratively with a local firm, FNI assisted in identifying available reactor models which were already nearing TCEQ approval, obtaining supply bids, installation bids and startup within a seven-and-a-half-month time frame. FNI also navigated the project through a multi-step TCEQ approval procedure, enabling the City to continue using what had become a critical source of water supply. The UV disinfection facilities began full operation in mid-February 2015, and the DPR authorization has been extended through February 2016.

LAKE KEMP/DPR INTEGRATED DESALINATION

The membrane treatment facilities used to treat reclaimed effluent were originally constructed to desalinate water from Lake Kemp, a brackish reservoir on the Wichita River. During the early months of the drought, Lake Kemp was severely affected, dropping in level and exhibiting sharply increasing salinity. Forgoing this supply in favor of the more reliable effluent was a logical step then, but as the reservoir partially recovered, it remained unavailable. FNI was engaged to obtain approval to blend and concurrently treat both Lake Kemp water and reclaimed effluent. Initial approval was granted in May 2015 and would extend the availability of the City's freshwater reservoirs and gives the City much greater flexibility in using all their supplies as they are available. Implementation has been deferred due to rain in 2015, which restored the City’s supply reservoirs.
The Gulf Coast Water Authority (GCWA) engaged FNI to perform a study of potential long-term water supply strategies for meeting its combined industrial, municipal and agricultural needs across the three counties it serves. The project evaluated the potential for an expanded off-channel reservoir, purchase of water from a proposed regional reservoir, transfer of water from other basins, purchasing treated water from an existing regional treatment facility, and the development of a reclaimed water project to make use of water from an existing reuse permit owned by the City of Houston. Customer cost impacts of all alternatives were considered as well as potential risks associated with the development of each project.

The preliminary study indicated great potential for the reuse alternative. FNI performed an initial route study for the conveyance to GCWA’s system utilizing existing utility corridors to make possible the construction of a significant project through a developed, urbanized area. Pump station configurations were considered to take advantage of directly or indirectly divertible wastewater flows as well as a combined alternative to optimize water yield within the confines of the existing permit’s instream and bay and estuary inflow limitations.
In 2015, sources of raw water supply for the North Texas Municipal Water District (NTMWD) Wylie Water Treatment Plant complex included Lavon Lake, tertiary-treated wastewater from the Wilson Creek Wastewater Treatment Plant, East Fork Trinity River water and imported water originating in Lake Texoma, Lake Jim Chapman and Lake Tawakoni. NTMWD also received water from Dallas Water Utilities (DWU) through a water supply contract slated to expire in 2016. To meet future demands in its greater Dallas metroplex service area, the District continues to develop new sources of additional water supply, including the Lower Bois d’Arc Creek Reservoir (LBCR) project scheduled for completion in 2020.

Regional lake levels reached historic lows from June 2011 through January 2012; long-term forecasts suggested that the drought could persist for an extended period. Acknowledging the drought’s impacts on lake levels, NTMWD initiated Stage 2 of its adopted Water Conservation Plan on November 1, 2011. In an effort to expand its already diverse water supply portfolio, the District moved forward with the preliminary design of a temporary pump station on the main stem of the Trinity River. However, as the 2012 drought abated, fiscal resources were diverted to other critical infrastructure projects and design of the temporary pump station was halted.

As the deadline for the DWU water supply contract expiration approached, NTMWD again turned to the dormant temporary pump station project. With completion of the LBCR project still half a decade away, the District’s planners determined that the temporary pump station, now known as the Trinity River Main Stem Pump Station and Pipeline project, could play a key water supply role. In March 2014, the District contracted with FNI to begin preliminary design of a permanent pump station.

The Trinity River Main Stem Pump Station and Pipeline project will play an important role in the District’s raw water supply system. NTMWD draws water from the East Fork of the Trinity River through the Diversion Pump Station. This water is polished via naturally occurring processes in the East Fork Raw Water Supply Project – a constructed wetland – and then pumped via the Conveyance Pump Station through the 84-inch diameter East Fork Pipeline to Lavon Lake. The forthcoming Trinity River Main Stem project consisting of a pump station and large-diameter transmission pipeline will provide additional raw water to the East Fork Raw Water Supply Project and then, as described above, be further pumped to Lavon Lake and the Wylie Water Treatment Plant complex. This supply will not only bridge the gap between the forthcoming water supply contract expiration and initial deliveries of treated water from the LBCR project, but will secure and solidify another long-term water supply source for the District.

**CASE STUDY**

**Trinity River Main Stem Pump Station and Raw Water Pipeline, North Texas Municipal Water District**

**FAST FACTS**
- Client: North Texas Municipal Water District
- A growing service area and expiration of a water supply contract compelled the District to seek additional firm raw water supplies
- The Trinity River Main Stem project will enhance the District’s raw water supply portfolio, providing greater reliability to its customers

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**Rendering of proposed main stem pump station**
The City of Kerrville provides non-potable reuse water from its wastewater treatment plant for irrigation of golf courses and recreational areas. The City’s reuse program is so successful that 100 percent of the City’s summertime wastewater effluent flow is reused — and other potential customers have made requests for reclaimed water. The City turned to FNI to identify a solution that would expand the availability of this resource.

After completing a feasibility study, the FNI team is now designing a 105-million-gallon reuse water storage pond to capture wintertime effluent flow in order to utilize that resource in the summer when reuse demands are at their highest. The project also includes a new pump station and pipeline to deliver the water from the storage pond to the City’s reuse customers.

The City of Weatherford intends to capture reclaimed water from its wastewater treatment plant and transfer it to Lake Weatherford via a pipeline for indirect potable reuse. FNI has evaluated this project in the study phase, and is currently assisting the City with the implementation of the project, including the necessary permitting. FNI is also assisting the City with preliminary and final design of the reuse pump station, outfall and wastewater treatment plant upgrades.

Tasks in the project included water quality modeling, evaluation of treatment plant upgrades, evaluation of alternatives for implementing the project and development of an implementation plan. Pending tasks include preliminary design, final design, bid phase services and construction phase services.

The project is currently in the process of obtaining the necessary water right permit from TCEQ and is about to enter the preliminary design phase in May of 2015 with planned construction completion in the summer of 2017.
FNI developed a Reuse Master Plan and Capital Improvement Plan (CIP) in 2005 for the City of Frisco to utilize a total reuse capacity of 25 MGD at build-out. The phased plan maximized the use of reuse water from the Stewart Creek West Wastewater Treatment Plant and the more recently constructed Panther Creek Wastewater Treatment Plant, incorporating existing ground storage tanks and pumping facilities into the reuse infrastructure. FNI is in the process of updating the reuse master plan, as the projected demographics have changed significantly with the addition of multiple mixed use developments throughout the City.

FNI also developed a hydraulic distribution model of the City’s reuse system, identifying and evaluating potential customers, projecting future demands, evaluating potential cost savings in water-use augmentation and laying out a cost-effective, phased CIP. The extended period simulation model mimics system operation over a one-week period, as the customer demands in a reuse system vary more than a distribution system and can be challenging to manage.

FNI developed the plan to provide direction on where reuse lines were needed and the recommended phasing and sizing of new construction. As part of the master planning process, our team assisted the City in determining what compliance documentation and additional coordination was needed between the City, North Texas Municipal Water District and Texas Commission on Environmental Quality.

FNI has continued to conduct on-call modeling for the reuse system as potential customers are connecting into the system to evaluate pressures and develop an irrigation schedule specific to each customer. The current customers include city parks, master planned developments, the school district and a golf course. The City is in the process of expanding the reuse system to serve the new $1 billion Dallas Cowboys mixed use development.
The San Antonio Water System (SAWS) recycled water system was completed in 2001 as the largest reclaimed water system in the nation. In 2004, FNI partnered with SAWS to develop a Recycle Water System Model and Master Plan. To keep up with continued growth in reuse demands over the next five years, SAWS again contracted with FNI in 2009 to update and calibrate its recycled water system model in InfoWater software to properly reflect the impact of the changes experienced in the system. SAWS and FNI took a partnership approach to this project with FNI providing oversight, quality control, and training while SAWS Master Planning staff performed the majority of the detailed calibration efforts.

The project involved developing detailed QA/QC processes for updating the hydraulic model, in addition to field pressure testing at 32 locations and developing diurnal patterns for more than 100 reuse customers. FNI worked with SAWS to develop a sustainable model updating process linked with its internal GIS. Extended period simulation InfoWater model calibration was performed by SAWS staff with technical guidance provided by FNI in a focused one-on-one environment. The partnership between SAWS and FNI was truly a “win-win,” equipping SAWS with the tools to better maintain and analyze the recycled water model, as well as provide training to key staff members.

CASE STUDY
Reuse Water System Master Plan, San Antonio Water System

The West Loop Reuse Pipeline develops a reclaimed water pipeline on the west side of the City of Cleburne, which would join the existing east reclaimed water line serving the Brazos Electric Power Plant to form a looped system. The East Loop Reuse Pipeline has been in operation since 1996 and serves as a model strategy for water conservation and management that received the 2003 Texas Water Conservation and Reuse Award. The West Loop Reuse Pipeline will continue to build on the successful water supply management for the region and will implement a strategy identified in the City’s Long-Range Water Supply Study to supplement Lake Pat Cleburne through advanced treatment and permitting to meet the lake water quality standards.

The City’s reuse program through the East and West Loop pipelines meets industrial process and cooling water demands while also supplying the irrigation demands of the municipal sports and golf complexes, school and college campuses, and large institutional developments. Water demands met through the reuse program helps defer the need to develop additional water supplies, which at times can have significant higher costs than the local reuse available. Additionally, the drought tolerance of the reuse supply is another favorable consideration for the City’s customers.

CASE STUDY
Multi-purpose Reuse Water Supply Integration, City of Cleburne
Sandy Creek Power Partners managed construction of the Sandy Creek Energy Station, a nominal 900-MW, coal-fired electric generating station in Riesel, Texas. In 2008, FNI was contracted to assist with the design of a cooling water supply system for the new coal-fired plant. The system was required to transfer the Type II treated effluent from the existing chlorine contact basins at the Waco Metropolitan Area Regional Sewer System Wastewater Treatment Plant to the new energy station.

FNI designed a 15-MGD pump station at the wastewater treatment plant, 11 miles of HDPE pipeline, and a terminal storage pond for the energy station. The project design and construction was fast-tracked to accommodate the deadlines regarding completion of the power plant and power generation.

The pump station included three variable frequency drive vertical turbine pumps with space for a fourth in the future. The HDPE pipeline design utilized 36-inch PE4710 pipe and included two HDD crossings and one aerial crossing.

The terminal storage reservoir stores approximately 40 MG, split between two cells. The reservoir is separated by a 40-foot-tall earthen embankment and is lined with an HDPE liner and soil cement. The reservoir lining includes an underdrain system, which captures leakage through the HDPE liner and prevents contamination of the underlying earth. The soil cement provides protection from wave action, protects the geomembrane from long-term exposure to the elements, and allows the owner to clean out the sediment/solids that collect in the reservoir without compromising the integrity of the geomembrane. The reservoir design also included emergency outlet structures and piezometers.
**REUSE PROJECTS**

### Direct Potable Reuse
- Colorado River Municipal Water District - Regional Raw Water Production Facility
- City of Corpus Christi - Potable Reuse Feasibility Study
- Gulf Coast Water Authority - Regional Reuse Supply Development
- City of Irving - Water Supply Study Including Potable Reuse
- City of Lawton, OK - Potable Reuse Implementation Plan
- City of Wichita Falls - UV Disinfection for Potable Reuse
- City of Wichita Falls - Lake Kemp DPR/Desalination Study

### Indirect Potable Reuse
- Central Oklahoma Master Conservancy District - Lake Thunderbird Water Supply Augmentation
- City of Cleburne - Multipurpose Reuse Water Supply Integration
- City of Corpus Christi - Potable Reuse Feasibility Study
- Gulf Coast Water Authority - Regional Reuse Supply Development
- City of Irving - Water Supply Study Including Potable Reuse
- City of Lawton, OK - Potable Reuse Implementation Plan
- Lower Rio Grande Valley Development Council - Edinburg/McAllen Potable Reuse Feasibility Study
- North Texas Municipal Water District - East Fork Reuse Pump Station
- North Texas Municipal Water District - Main Stem Reuse Pump Station
- City of Weatherford - Lake Weatherford Augmentation

### Turf Irrigation
- City of Boerne - Champion Heights Reuse Line
- City of Cedar Park - Buttercup Reuse Line
- City of Cleburne - Multipurpose Reuse Water Supply Integration
- City of College Station - Reuse Master Plan
- City of Frisco - Reuse Master Plan
- City of Frisco - Panther Creek 24-Inch Reuse Pipeline
- City of Frisco - Stewart Creek Reuse Pump Station Expansion
- City of Killeen - Reuse Master Plan
- City of Kerrville - Reuse Storage Facility
- City of Liberty - Long Range Water Plan Including Nonpotable Reuse
- City of Round Rock - Freeman Reuse Line
- San Antonio Water System - Reuse Water System Master Plan (and model update)

### Industrial/Commercial
- City of Cleburne - East Loop Reuse Line
- City of Cleburne - Multipurpose Reuse Water Supply Integration
- City of College Station - Reuse Master Plan
- [Confidential Oil and Gas Client] - Produced Water Reclamation/Reuse
- City of Killeen - Reuse Master Plan
- San Antonio Water System - Reuse Water System Master Plan (and model update)
- City of San Marcos - Reuse Supply Line
- Sandy Creek Power Partners - Sandy Creek Energy Station Reuse Line
- Sealed Air Corporation - Iowa Park Cooling Water Supply

*bold, underlined type* indicates projects that are featured as case studies on the preceding pages
## REUSE PROJECTS

### Design Services

<table>
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<tr>
<th>Client</th>
<th>Integrated Water Supply Planning</th>
<th>Permitting</th>
<th>Water Quality Modeling</th>
<th>Master Planning</th>
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FNI has served as the trusted advisor for water-related issues since founder John Hawley became one of Texas’ first independent water and sewer engineers in 1894. In the 21st century, we have assisted clients implementing a variety of approaches to transform wastewater into a valuable part of their water supply. This has ranged from supply of treated effluent to power plants and golf courses to implementing the first recognized direct potable reuse facility in North America, Colorado River Municipal Water District’s Raw Water Production Facility in Big Spring, Texas.

FNI is a full-service professional consulting firm, delivering innovative solutions to clients across the country. Our vision reflects our commitment to client service and to technical excellence: Be the firm of choice for clients and employees. We have built our practice on a strong foundation of client service and a commitment to project excellence. Our outstanding reputation for quality work results in a high percentage of our work coming from repeat clients. Our primary focus remains being a trusted advisor for our clients.

In the past 5 years, we have:

- Designed, permitted and started up the first recognized direct potable reuse (DPR) facility in North America
- Assisted the City of Wichita Falls in extending operation of their DPR project (only the second in North America) through the addition of UV disinfection
- Assisted more than 20 clients with evaluation and/or implementation of water reuse as a supplemental source of water supply

FNI provides the following services as part of our integrated approach:

- Architecture
- Construction Services
- Program Management
- Electrical Transmission/Substation Engineering
- Environmental Assessments and Remediation
- Funding/Grant Applications
- Geotechnical Engineering
- Levee and Dam Evaluations and Design
- Mechanical, Electrical and Plumbing Engineering
- Oil and Gas Engineering
- Stormwater Master Planning and Design
- Structural Engineering
- Transportation/Infrastructure Planning and Design
- Urban Planning and Design
- Water and Wastewater Master Planning and Design
- Water and Wastewater Transmission
- Water and Wastewater Treatment
- Water Resources Planning and Facility Design

In the past 5 years, we have:

- Source Comparison
- Cost Evaluation
- Customer Identification
- Distribution Evaluation
- Storage Analysis
- Water Quality Maintenance
- Rate Studies
- Process Evaluation
- Disinfection Evaluation
- Pilot Testing
- Regulatory Coordination
- Public Information
- Diversion and Treatment
- Pump Stations
- Transmission and Distribution
- Storage

- Non-Potable Reuse Authorization
- Water Rights Permitting
- Potable Reuse Authorization
- Water Quality Sampling
- Water Quality Modeling
- Site/Route Permitting

About Freese and Nichols, Inc.

Our Services

Regulatory/Permitting

Facilities Design

In the past 5 years, we have:
QUALITY

QUALITY CONTROL
Quality Control (QC) at FNI involves technical review of all project components to verify accuracy and quality of studies, verify design calculations and details, and check constructability of construction documents. FNI considers QC to be the ongoing responsibility of each team member, but formal QC reviews are led by each project’s QC/QA Manager at key milestones throughout the project. The goal of a QC review is to check for sound technical principles and accuracy. Most reviews are multidisciplinary, and construction plans and specifications are also reviewed for constructability.

QUALITY ASSURANCE
Quality Assurance (QA) at FNI is an overall project review to determine whether an effective approach is taken for a project, confirm that project objectives are carried out, detect conceptual problems early, and verify that coordination and the QC functions and reviews have been performed. The QC/QA Manager will take responsibility for administering the QA process by submitting the appropriate information and materials to a QA Leader, who will be assigned by FNI’s Office of the President and be responsible for conducting a formal QA review after each formal QC review.

MALCOLM BALDRIGE
NATIONAL QUALITY AWARD

In November 2010, FNI was named a recipient of the Malcolm Baldrige National Quality Award, becoming the first engineering/architecture firm to receive this national honor. The award affirms our 15-year quality journey to develop FNI into a Baldrige-class firm.

The Baldrige award is the highest presidential honor given to U.S. organizations for performance excellence. It was established in 1987 to enhance the competitiveness of U.S. businesses in an ever-expanding, demanding global market. The Baldrige program promotes excellence in organizational performance, recognizes the achievements of U.S. organizations and publicizes successful performance strategies.

For more information, visit: www.freese.com/baldrige.

Baldrige by the Numbers
1,579 applicants
93 recipients
7 categories in Baldrige criteria
1 engineering/architecture firm receiving this honor: Freese and Nichols
MISSION
Innovative approaches
Practical results
Outstanding service

VISION
Be the firm of choice for clients and employees

GUIDING PRINCIPLES
We are ethical
We deliver quality
We are responsive
We add value
We improve continuously
We are innovative
We develop professionally
We respect others
We appreciate our employees and clients
We give back to our communities

www.freese.com