The project was necessitated because the District received a total phosphorous limit of 1 mg/L in its TPDES permit. The new limit was very rare for the region and due to the plant’s outfall into Lake Conroe was deemed unacceptable. The project was a wastewater treatment plant with biological nutrient removal (BNR) sized for 0.95 million gallons per day average daily flow. The project included rehabilitation of the existing influent lift station piping and controls, construction of a concrete headworks with a mechanical step screen and screenings wash press, two carrousel-style main process units with a flow splitting structure, a concrete junction box to allow operational flexibility between trains and the addition of chemical coagulant for effluent polishing, two secondary clarifiers, two cloth-media filters, two chlorine contact basins, conversion of the existing clarifier into an aerobic digester, and additional aerobic digesters to meet digester volume requirements. An orthophosphate analyzer and alum feed system were constructed to serve as a backup to the BNR and to assist the BNR process in the event plant upsets or influent loading spikes. This project also included new electrical service, a 600-kW diesel generator and 2,000 gallon fuel tank, and a new control building. The existing outfall pipe and outfall structure was utilized. The design incorporated the reuse of existing equipment wherever practical.

Original or Innovative Application of New/Existing Techniques
The project was necessary to replace an aging wastewater treatment facility, provide the ability to meet amended nutrient removal requirements, and meet the increased capacity for future development. Due to the condition of the aging facilities and the need for a nutrient removal process to meet the discharge permit requirements of the TPDES permit, a new wastewater treatment plant was proposed as a replacement to existing facilities. The plant’s main process unit is a carrousel-style plant utilizing the anaerobic/anoxic/oxic (A2O) process for biological phosphorous removal. This process has the added benefit of denitrification, or reducing the amount of nitrogen (another nutrient) that is discharged to Lake Conroe. The plant is the first BNR process in this area, thus demonstrating the successful application of a plant of this type meeting the TPDES requirements, both from an operational standpoint and from a financially viable perspective.

Future Value to the Engineering Profession
The plant is the first installation of biological nutrient removal in the Houston metro region and will set the example for other local/regional plants as total phosphorus limits are mandated in future TPDES permits. Lessons learned while building, commissioning, and operating this initial plant will be invaluable to the local engineering and operating community as compliance requirements begin to roll out in the future.

Social, Economic, and Sustainable Design Considerations
The plant discharges into Lake Conroe. Top quality effluent into this important and heavily used body of water contributes to healthy and safe recreational waters for the community to enjoy. A primarily biological process keeps onsite chemicals to a minimum and reduces the frequency of chemical delivery trucks to the site. The chemicals selected, bleach and alum, are safer for storage than other
available options such as chlorine gas and ferric.

As the client had limited funds for such a major undertaking, we were extremely cognizant of the need to spend money judiciously where it was most worthwhile. To stretch resources and provide engineering solutions that were economical but provided real value, we recommended investing in SCADA controls for the BNR process control and corrosion-resistant materials, but also found a way to reuse the existing lift station and convert the existing clarifier into a digester, realizing cost savings. We were able to gain additional cost savings over the long term by selecting a BNR process with chemical polishing over a full chemical treatment system yielding substantial savings over the life of the plant through the purchase of less chemicals and reduced sludge hauling expense.

**Complexity**
The District first evaluated rehabilitation of the existing facility and retrofitting it for either biological or chemical nutrient removal. The existing wastewater treatment plant facility was a 0.95 MGD activated sludge process plant operated in the single-stage denitrification mode. It had a steel main process unit, a concrete chlorine contact basin with moderate structural deficiencies, communitors with no screening equipment, and the existing steel aeration tankage was in poor condition with severe corrosion. Retrofit was possible, but required extensive rehabilitation, at a significant cost, to a single process train plant. BNR retrofit was not possible without building additional tankage.

After preliminary investigation, the District determined the material and operational costs associated with chemical treatment and the safety concerns with storing large volumes of chemical onsite, combined with the cost of rehabilitating an aging plant, rendered this option infeasible. Further, converting the existing plant to a BNR plant would require an expansion of the existing plant in addition to the rehabilitation, also infeasible. The District then evaluated constructing a new plant. The lifecycle costs and safety concerns associated with chemical nutrient removal eliminated the option of a new plant with full chemical nutrient removal facilities. Therefore, the District determined that the most feasible solution was to construct a new BNR plant, reusing existing equipment and facilities where possible and appropriate. Since this would require a complete replacement of many of the plant’s process basins and equipment, it would not be possible to have the new plant designed, built, and in service in time to comply with the effective date of the new permit. A temporary chemical removal system was retrofitted to the existing plant to ensure timely compliance while design and construction were in progress. In an effort to determine the effectiveness of chemical treatment for phosphorous removal and to confirm which chemical would be used for the permanent plant’s backup chemical system, a 30-day full-scale pilot test was performed. Alum was selected as the most advantageous treatment. Dosing curves were also developed from the pilot test. We determined the temporary system (with the less than optimal mixing and equipment layout) could produce results and would allow us to meet the permit requirements. A temporary system with a diaphragm pump, bulk tank, and PVC piping was set up and injected alum into the effluent drop box at the end of the aeration basin. Complications also involved the continuous operation of the existing wastewater treatment plant while the replacement plant was under construction. Further, the layout of the proposed treatment facilities was particularly challenging due to existing facilities being located in the center of the site, and the floodplain and flood way occupying more than a third of the remaining usable site. Access to existing support facilities also had to be maintained. An additional challenging component of the project was that the new facility had to be designed to a much more stringent set of permit limits than what is typical for the region, namely the 1 mg/L total phosphorus limit.

**Exceeding Client/Owner Needs**
A committee of the District Directors (client), District General Manager, District Operator, District Engineer (JC), and Project Manager/Design Engineer were engaged as the overall team from preliminary planning, through design and construction, to startup and commissioning and project closeout. This same team is engaged to make ongoing adjustments and optimize operations. JC remains the District Engineer, and therefore will continue supporting the project and the client.

In observance of our client’s financial situation, we chose the lower lifecycle cost project. We spent money where we needed to and saved where it made sense, as outlined under Question #4, Complexity. We fully met client goals and expectations, and they are extremely satisfied with the final product and outcome.

**ORIGINAL BUDGET ESTIMATE:** $8.8M  
**ACTUAL COST:** $7.791M
**ORIGINAL SCHEDULE:** October 29, 2013

**ACTUAL DELIVERY:** October 2, 2014

Wastewater treatment and permit compliance could not be compromised at any point in this project. To address any possible issues that could impact project schedule and delay installation such as permitting, compliance, weather, contractor delays, etc., we approached this project proactively considering all potential contingencies that could occur. We designed, installed, monitored, and secured the temporary system to serve as a fail-safe backup to address this possibility. This initiative was tested when the project delivery schedule was delayed.

JC met all permit requirements and kept the system operational to maintain service at all times. Further, the design schedule from kickoff to 100% complete design was accomplished within 393 days; 39 days short of our projected estimate. Contractor-encountered delays and changes in power requirements impacted the overall delivery timeline.