MORE THAN A DECADE AGO, Spokane County, Washington, determined that it had a critical need for additional wastewater treatment capacity, primarily to meet anticipated population growth, eliminate reliance on septic systems, and meet the effluent water quality requirements set by the Washington State Department of Ecology. Today, those needs are being met by the new Spokane County Regional Water Reclamation Facility (SCRWRF), a complex completed in 2012. The 8 mgd facility is improving water quality and the environment by reducing the levels of phosphorus and other nutrients discharged into the Spokane River. Not only does it combine aesthetic characteristics appropriate to the region with state-of-the-art treatment technology and odor control; it also serves as a catalyst for revitalization of the area while being a good neighbor to existing businesses.

The process began when the county determined that it needed additional wastewater treatment capacity, a need reflected in a wastewater facilities plan that the county adopted in February 2002. The plan recommended construction of a new treatment plant in the western part of the Spokane River’s valley to accomplish the following:

- Meet population needs and eliminate septic systems;
- Protect public health;
- Provide reliable wastewater treatment over the long term (50 years);
- Protect and improve the region’s water resources (both surface water and groundwater);
- Provide cost-effective solutions for county ratepayers.

The total population currently served by the county’s Spokane Valley Sewers is about 100,000. That population is expected to increase to 167,000 by 2026. By 2050, the planning period covered by the wastewater facilities plan, the population is predicted to be 218,000. Adding to this challenge are the many water quality and water resource issues in the area around the Spokane River and the Spokane Valley—Rathdrum Prairie Aquifer, which extends across Idaho and Washington and is the sole source of drinking water for more than 400,000 people.

The Washington State Department of Ecology established strict water quality standards for the new facility, which must also meet National Pollutant Discharge Elimination System (NPDES) permit requirements. Some of the effluent limitations are among the most stringent in North America. For example, the seasonal average limit on phosphorus levels is less than 50 μg/L (50 parts per billion); the ammonia limit in the summer season is 0.25 mg/L (0.25 part per million); and the carbonaceous biochemical oxygen demand limit is less than 2 mg/L.

Spokane County has been expanding its wastewater collection system to replace septic tanks since the early 1980s. The goal of this program is to reduce the possibility of contaminating the aquifer. The program is responsible for the addition of more than 20,000 connections to the county sewer system, and the county anticipates an additional 9,000 connections by the time the program ends, in 2015.

The county’s wastewater facilities plan listed several alternative sites for a new facility in the western part of the Spokane River’s valley. After evaluating 20 potential sites, the former site of the Old Union Stockyards was chosen and purchased in June 2004. The 20-acre brownfield site was ripe for redevelopment and was ideally located between the existing Spokane Valley and North Valley interceptor sewers and near the Spokane River. It also offered room for expanding the treatment facility to accommodate at least 50 years of growth in the region.

With the site chosen, the focus turned to the design of the treatment facility. One of the county’s goals was an effective, efficient design that would accommodate future additions to the facility with minimal disruption to neighbors and plant operations. In its initial plans, the county wanted the SCRWRF to be an advanced treatment facility with membrane filtration that would provide an initial 8 mgd of capacity for the region and would lend itself to expansion in phases up to 24 mgd. In its request for proposals, the county specified that the design not only comply with all of the effluent regulations but also stay within a predetermined budget of $143 million and meet specified operating costs. Moreover, the plant had to be operational within three and a half years.

A design/build/operate (D/B/O) approach was chosen to minimize short-term capital expenses and long-term operating costs while providing the greatest possible value. The procurement process for the SCRWRF was conducted in accordance with Washington State’s Water Quality Joint Development Act. In addition to conferring cost and schedule benefits, the D/B/O approach provided optimal risk allocation, competitive design selection, clear assignment of performance responsibilities to a single contracting entity, and long-term facility operations and maintenance efficiencies. Another benefit was that it relied on a fully integrated team of design, construction, operations, and quality assurance personnel in all aspects of project development. Having a single-entity D/B/O provider delivering all phases of this project assured the county that one company would be responsible and accountable for meeting project deadlines, wisely managing public resources, and protecting the local environment.

Spokane County hired CH2M HILL, of Englewood, Colorado, to design, construct, and operate the facility for up to 20 years. This approach was projected to save the county up to 15 percent on the total design and construction cost compared with a conventional design/bid/build approach.

After the D/B/O contract was awarded, a series of partnering sessions with a third-party facilitator helped to further define the SCRWRF project goals and establish critical milestones for overall project success. These partnering sessions solidified the commitment of all involved to make sure that all project issues were resolved in a collaborative manner. Extensive interaction between the D/B/O team and Spokane County continued as the design was developed. The project owners, the relevant regulatory agencies, and other stakeholders all offered input on the engineering. There was open communication, and documents were freely shared during meetings, reviews, and workshops to ensure that the facility met the needs of all parties. Key project team members were collocated with county personnel so that meetings could be quickly convened to resolve issues or explore creative ideas. The stakeholders included the Spokane County Board of Commissioners, Spokane County’s Utilities Division, the City of Spokane, and the Washington State Department of Ecology.

The design phase began in January 2009, and the construction phase began in June of that year. CH2M HILL performed most of the design functions itself, including the mechanical, electrical, structural, civil, architectural, and geotechnical work and the work pertaining to instrumentation and controls and to the process design for the wastewater treatment portion of the project. The CH2M HILL team also performed the permitting work and the construction management for the entire project, and the team is now into its second year of the operation and maintenance contract, including on-site and off-site biosolids treatment.
Although the D/B/O contract did not require the use of local businesses, more than 95 percent of the project’s work was awarded to businesses in the state. In fact, in addition to CH2M HILL, the D/B/O team included more than 50 local subcontractors that in total provided 380,000 hours of construction labor.

One unique aspect of the D/B/O approach was that it enabled the team to take advantage of the expertise of the local subcontracting community for the project’s publicly accessible buildings, known as the Water Resource Center (an educational facility) and the Treatment Operations Facility (which houses the main offices, a laboratory, and the control center). These structures were designed and built under the leadership of the subcontractor Garco Construction, which is based in Spokane, with design services led by ZBA Architecture, also of Spokane, and the latter’s engineering subconsultant—the Spokane office of Coffman Engineers—under a design/build contract. This established the unique situation of managing a design/build subcontract within the primary D/B/O contract.

From the beginning, the overriding motivation for the project was meeting the stringent effluent discharge requirements. A commitment to technical innovation was required for this and for solving the many complexities of the new plant’s design, including minimizing the project’s environmental footprint, safeguarding public health, and producing effluent water of high enough quality (“class A”) to be reused in irrigation, commercial and industrial processes, wetlands restoration, indirect groundwater recharge, and streamflow augmentation.

The Spokane River (to which the SCRWRF would discharge) and the river reservoir Lake Spokane had been plagued by algal blooms and dissolved oxygen limitations, prompting strict limits on such nutrients as phosphorus and ammonia and on biochemical oxygen demand, as stated above. A membrane bioreactor (MBR) application was one of the first options considered for the project because it would best balance life-cycle costs with the level of performance required by these limitations. The team also considered conventional biological phosphorus removal, but this was quickly dismissed because of its complexity, large footprint, and high capital costs. However, the challenge remained to fully develop a phosphorus treatment process capable of reaching the limit of less than 50 μg/L. The solution that arose was chemically enhanced primary treatment followed by a step-feed MBR system that would employ metal salts (ferric chloride) to precipitate phosphorus. This integrated approach of combining chemically enhanced primary treatment with MBR is extremely novel, and the SCRWRF is one of the first facilities in the United States to use this process to attain such low phosphorus levels.

As part of the design, the team developed a site plan that minimized yard piping, made it possible for multiple facilities to be constructed concurrently, left ample room for future expansion, and streamlined operations and maintenance activities. The team located the actual treatment process facilities along the eastern half of the site and placed the buildings that would be open to the public on the western half of the site.

The process facilities start with preliminary treatment at the headworks facility, which screens out the components that could harm the downstream processes and equipment. The first step in the chemically enhanced primary treatment is conducted here with the initial introduction of ferric chloride, which reduces phosphorus and odors. An aerated grit removal system then provides chemical mixing and flocculation and removes grit prior to primary clarification.

From the headworks, the influent flows to the primary clarifiers, where sludge is removed and sent to the solids-handling facility for thickening, anaerobic digestion, and gas production. The primary clarifiers are fully capped by low-profile covers, and the enclosed area is ventilated to control odors.
Secondary treatment consists of four aeration basins arranged in a single circular bioreactor tank. The circular tank configuration minimized the footprint of the facility as well as the amount of concrete needed in comparison with a rectangular shape. Primary effluent is split into two different locations within each basin to improve the distribution of nutrients and oxygen demand and to improve effluent quality. This is the step-feed system mentioned above, and it maximizes the facility’s ability to remove both ammonia and nitrates from wastewater. The secondary effluent is then pumped from the bioreactor to the membrane tanks, which separate the treated liquids from the solids.

This is the step at which the innovative MBR offers several benefits, from construction through operation. MBR requires a smaller footprint than is the case with traditional methods, and an MBR facility requires less construction. These characteristics reduced construction costs and made it easier to adhere to the schedule. The MBR design consists of six membrane trains that remove pathogens and turbidity from the process flow by preventing contaminants from passing through the surface of hollow-fiber membranes. MBR also provides a high degree of solids removal. And despite its smaller size and lower cost, it achieves exceptionally low levels of effluent phosphorus and produces water that, after disinfection, meets class A reuse standards.

The process also creates biosolids suitable (“class B”) for beneficial land application and recycles the digester’s biogas to provide energy via a cogeneration system at the facility; this energy is used to power electrical and heating equipment at the site.

One of the project’s publicly accessible buildings, the Water Resource Center, has three separate areas for educational purposes and meetings. Because of the county’s strong commitment to the principles of sustainable development, the center was constructed in a way that paid special attention to its water and energy efficiency. The Water Resource Center and the adjacent Treatment Operations Facility have earned silver certification in the U.S. Green Building Council’s Leadership in Energy and Environmental Design (LEED) program.

To obtain this certification, the two buildings had to achieve a number of goals. The construction activities related to the buildings followed local standards and codes for erosion and sedimentation, strictures more demanding than the NPDES program requirements. Parking capacity was designed so as not to exceed the minimum local zoning requirements, and there is adequate parking for those participating in car pooling arrangements. Vegetated open space accounts for 48.7 percent of project’s site area.

What is more, the facilities’ storm-water management plan results in no net increase in the rate and quantity of runoff in comparison with the calculated preproject conditions for a two-year, 24-hour peak discharge. The storm-water plan also reduces impervious cover, promotes infiltration, and captures and treats runoff from 90 percent of the average annual rainfall.

The heat island effect from the facilities’ roofing is mitigated by the use of roofing materials that have a minimum solar reflectance index of 78 for 100 percent of the roof surface. Light pollution is reduced internally and externally by the use of automatic controls, and power densities, that is, the amount of power used per square foot of the facility, do not exceed 80 percent of ASHRAE recommendations. The site’s irrigation systems use only reclaimed water, and potable water use is reduced by 45.7 percent through dual-flush water closets, low-flow urinals, and ultra-low-flow lavatories.

As an added feature, 100 percent of the building’s energy cost is offset by energy generated on-site from renewable sources. The occupied buildings include areas for recycling cardboard, paper, glass, plastic, and metals, and more than 98 percent of the construction waste from the project was diverted from landfills and recycled. More than 25 percent (by weight) of the total building materials used were manufactured from recycled materials. On the basis of the energy cogeneration facilities and the LEED-certified buildings, Spokane County secured about $500,000 in energy rebates from local utility providers.

The Water Resource Center serves an important public education function in that its displays and interpretive exhibits highlight the important features of the SCRWRF and of the county’s regional water cycle. Educational programs there are tailored for elementary, middle school, and high school students and are aligned with curriculum standards on such topics as the Spokane Valley–Rathdrum Prairie Aquifer, water in engineered systems, and the entire water cycle from aquifer to tap. Information is also provided on careers in water resources and water treatment. Signs in the outdoor areas at the SCRWRF that are open to the public provide information designed to give visitors an insight into the benefits of xeriscape concepts and techniques and the use of low-maintenance irrigation.

Through the integration and collaboration established by the D/B/O partnership, the SCRWRF was delivered at a cost nearly $1 million under the facility’s capital budget, and construction was completed seven months ahead of schedule. Commercial operations began in December 2011, and the facility has consistently met the NPDES permit requirements. The effluent returned to the Spokane River during the nutrient removal season has consistently been below the 50 μg/L
The treatment facility combines aesthetic features characteristic of the region with state-of-the-art treatment technology and odor control. The two public buildings, the Treatment Operations Facility and the Water Resource Center, were designed and constructed in accordance with the principles of sustainable development. The buildings have earned silver certification in the U.S. Green Building Council’s Leadership in Energy and Environmental Design (LEED) program.

total phosphorus requirement. Indeed, from a 12-month influent average of 5.9 mg/L, it has fallen to a range of 0.035 to 0.045 mg/L. Furthermore, ammonia effluent levels are less than 0.25 mg/L (from 30 mg/L) and biochemical oxygen demand is less than 2 mg/L (from 179 mg/L). Another benefit is that thousands of septic systems have been taken out of service for good.

In December 2012 the SCRWRF was honored for its leadership in innovation in the Washington Industrial Energy Leaders program. Chris Gregoire, who was then the governor, presented the program’s Utility Sponsor Award to Spokane County, CH2M HILL, and the Spokane-based utility Avista at a ceremony held at the Washington State Legislative Building on December 5. The program recognizes Washington industries that demonstrate leadership and make a firm commitment to energy efficiency. It also pays tribute to highly innovative energy projects, including emerging technologies and projects that use existing technologies in a new way or change a process in a way that results in significant energy savings. In other honors, the Design-Build Institute of America recognized the SCRWRF with its 2012 National Design-Build Award in the water and wastewater category, hailing the team’s exemplary integrated approach in delivering design and construction services under one contract with a single point of responsibility.

**PROJECT CREDITS**

**Owner:** Spokane County, Washington

**Design/build/operate lead and design lead (including mechanical, electrical, structural, civil, industrial, commercial, architectural, geotechnical, and process design; permitting; construction management; and operations and management):** CH2M HILL, Englewood, Colorado

**Commercial building design/build contractor:** Garco Construction, Spokane, Washington, with assistance from ZBA Architecture, Spokane, Washington, and Coffman Engineers, Spokane, Washington

**Landscape architecture:** SPVV Landscape Architects, Spokane, Washington

**Earthwork and underground piping:** Halme Construction, Inc., Davenport, Washington

**Electrical contractor:** Power City Electric, Spokane, Washington

**Mechanical contractor:** University Mechanical & Engineering Contractors, Spokane, Washington

**Membrane bioreactor equipment supplier:** GE Water & Process Technologies, Feasterville-Trevose, Pennsylvania

**Dennis Nelson** is a design/build project manager with CH2M HILL and works in Bigfork, Montana. Rick Smith, P.E., is a program manager, senior project manager, and senior mechanical engineer with CH2M HILL’s global water business group in Spokane, Washington.