

Tapping a Reliable Raw Water Supply



Nation's largest horizontal collector wells provide utility's raw water supply.

By Jim Ladesich

In their presently depleted condition, it is difficult to imagine that the drought-sapped reservoirs along the upper Missouri River were once gorged with runoff that helped fuel the Great Midwest Flood of 1993. The damage that epic event caused to a filter building at an aging water plant—combined with more recent low river flows—changed the course of the raw water supply for the Kansas City Board of Public Utilities (BPU) in Kansas City, KS.

The 54-mgd Nearman Water Treatment Plant features a design that responds both to recent low water flows and future floods along the Missouri River. Although still dependent on the river as the water source, the plant draws from a more reliable source that taps the underlying aquifer and is immune to the problems confronted by the three surface intakes that served an earlier plant known as Quindaro Water Processing Facility. This alternative—two, high-capacity horizontal collector wells—should ensure a reliable supply for the municipal utility's 157,000 water customers.

The plant supports the growing western part of the service area where the Kansas Speedway, a NASCAR track, has spurred surrounding development. Most importantly, the plant will allow the utility to eventually close the 36-mgd Quindaro plant. The Quindaro facility has presented a variety of operational challenges and could face severe problems with solids disposal and regulatory compliance in the future, according to Don Gray, BPU Manager of Water Operations.

"Dealing with surface water issues associated with the Missouri River has made the management of the Quindaro

plant increasingly complicated during my career," Gray emphasized. "We contend with a river that has unpredictable flow, high levels of silt and sand, as well as decayed vegetation, herbicides, and pesticides whenever it floods upstream. Floods also bring down all kinds of debris that can become entangled in the traveling screens at the intakes. Even under normal conditions, the screens require a lot of maintenance. Add to these issues the serious threat of icing on the river."

Fickle River Flexes Its Muscles

The Missouri River crested at a record level of more than 48 ft on July 27 during the Great Flood as it muscled past the filter building complex at the Quindaro Water Processing facility. BPU-led crews battled in vain to save Filter Building #1, a structure comprised of segments built in 1910, the 1940s, and the 1960s. The swollen river eventually bore under the foundation,



Shaft of the central caisson, which extends about 18 ft above grade to protect the well from flooding, is housed in a pump station.

and breached a seam between two segments. Deep layers of sediment were left in its wake and a building so acutely damaged that it was unsafe for continued operations.

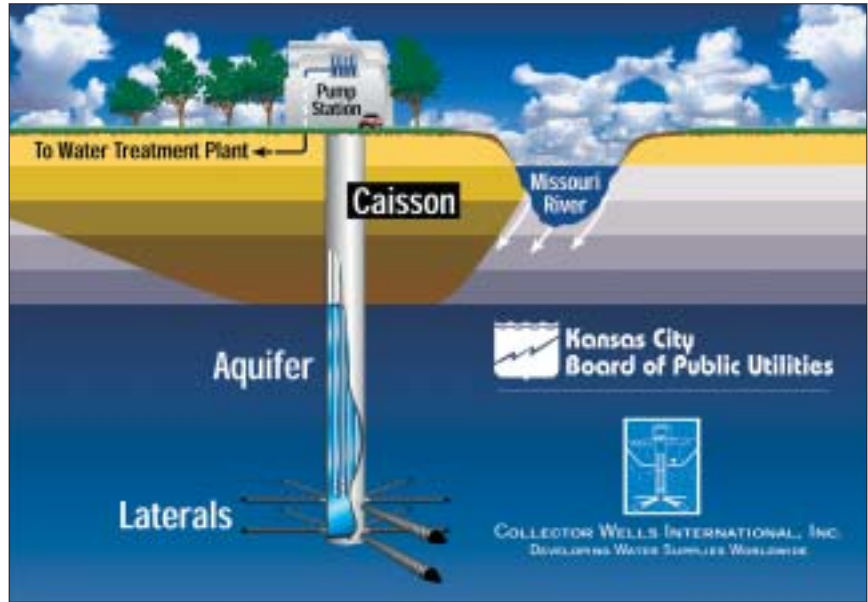
“The 1993 flood took out Filter Building #1 at the Quindaro plant and with it some 36 mgd of capacity,” recalls Lanny Uden, BPU Director of Civil Engineering. “Fortunately, a recent modernization of the second filter building had improved its capacity from 24 mgd to 36 mgd. That was sufficient to remain operational as we examined our recovery alternatives.”

BPU could either rebuild or replace the facility with a new plant located along the river, but above the 500-year flood plain, he noted. A \$17-million insurance settlement, a FEMA payment, and federal, state, and local grants brought the total in hand to about half the cost to build a new plant. Since BPU owned enough land near the Nearman Creek Power Plant, it made more sense to apply the money toward the \$55-million replacement facility.

Ups and Downs of the “Big Muddy”

Conditions have indeed changed along the Missouri River since the high water of 1993. Reduced river levels, particularly during winter months, frequently expose surface intakes that threaten the very lifeblood of some water and electric utilities. Several other factors have contributed to the problem, including the continuing degradation of the river channel, the lingering drought across the Upper Missouri River Drainage Basin, and more conservative water releases from the flood-control reservoirs managed by the U.S. Army Corps of Engineers. Even if heavy snows and spring rains eventually recharge the thirsty impoundments along the 2,619-mile Missouri River and its tributaries, utilities will still confront physical changes in the nation’s longest river.

The normally seasonal release through the six flood control dams the Corps manages along the Missouri River, and 75 others along tributaries, provide immensely valuable irrigation, flood control, drinking, cooling, and process water, as well as recreation and



Natural filtration replenishes the water in the aquifer as it is being pumped out by wells. As the collector well pumps water, a cone of depression forms around the central caisson, causing groundwater to flow toward the laterals.

wildlife habitat resources. The various interests have been at odds for years as the Corps of Engineers developed a sustainable management policy. The practices are now formalized in a Corps management manual.

However, the levee systems, the tighter throttle on seasonal releases, and years of dredging to preserve the navigation channel for commercial barge traffic will likely contribute to unpredictable flows. The containment of this one-time meandering—and flood prone—river also narrowed the channel through scouring action. As the navigation channel became deeper, the water depth grew shallower at the throats of intakes along the shoreline. Several neighboring water utilities have resorted to supplemental pump systems to offset the depressed flow conditions. They are only part of an estimated \$286-million worth of investment likely to occur beyond 2009 unless the eight-year drought loosens a grip on the Missouri River. Even then, utilities will still confront the other contributing issues.

The 54-mgd BPU plant built near the Nearman Creek Power Plant incorporates an important

element to avert future supply problems.

More Immune to the Problem

Black & Veatch (www.bv.com), BPU’s engineering consultants, studied the utility’s options in raw water sources



Working together the two collector wells can deliver nearly 100 mgd of water.



Caisson is poured in 12-ft increments following excavation for each segment.
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for the replacement plant. The analyses compared the economic, tangible, and intangible benefits of surface intakes, traditional vertical wells, and the latest generation of horizontal collector wells.

Although surface intakes historically provided a sufficient source under ideal flow conditions, this type of infrastructure remained potentially vulnerable to upstream ice jams, stingier seasonal releases by the Corps, flashy water quality changes due to rain events that impacted treatment performance, unpredictable drought cycles, and the degrading river channel. Black & Veatch concluded further that higher operating costs faced the utility because of the river's notorious turbidity and stricter EPA regulations addressing contaminants.

Vertical wells would eliminate the most obvious negatives associated with surface intakes but yield much harder water. A large wellfield was needed to deliver sufficient capacity and the more intrusive footprint also would impact environmentally sensitive areas, such as wetlands.

These factors favored horizontal collector wells, which Gray praises as a far-sighted decision. The Missouri River has fed an underlying aquifer along its banks for millennia through the natural process of infiltration. The process induces water to percolate slowly through the alluvial strata that enables a natural filtering of suspended material,

microscopic particles, and possibly even harmful organisms. Beyond reduced operating costs, the other benefits favoring horizontal collector wells were the higher yields per site, minimized property acquisition, and elimination of presedimentation basins, advanced treatment processes, and other construction normally required for surface water plants drawing from "The Big Muddy."

Tech Transfer Taps Another Vital Resource

Collector well technology originated in the oilfields of the 1920s near Malta,

OH, and introduced the art of drilling horizontally into the strata. The approach earned application for industrial water and potable water plants in later years. More than 500 of the wells, often referred to as radial wells, have been built in Europe and North and South America.

Black & Veatch teamed with the personnel of Collector Wells International (www.collectorwellsint.com) for the initial well to supply the plant. The Columbus, OH, specialty contractor has designed and built more than 40 collector wells in a market with few competitors.

The BPU plant was originally thought to need three collector wells to tap the aquifer, but production exceeded expectations. Soon after the first well entered service in 2000, BPU demand increased with development in the service area and changes in the utility's long-range planning strategies.

A contract for a second well was quickly issued to Collector Wells International. A subsidiary, International Water Consultants, Inc., conducted an extensive hydrologic evaluation and four exploratory wells before recommending a site located about 1,250 ft downstream from the first well. This newest well entered service at the end of 2005. Both units are designed for 25 mgd with a 48-mgd peaking capacity. The volume by these two units




Workmen at one lateral in the caisson.
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pumping in unison eliminated any foreseeable need for a third collector well, saving the BPU an additional \$8 million associated with expanding the plant. When operating in tandem, the two wells can deliver nearly 100 mgd. The water is excellent quality and comprised of 65 to 90 percent river water blended in situ with groundwaters.

The central caisson presents an impressive 20-ft inside diameter with 30-in. thick reinforced concrete walls. The shaft extends about 18 ft above grade to protect the well from flooding. The eight-ft thick, reinforced bottom seal extends 143 ft below ground. The construction required 1,330 cu yd of concrete. Crews used a weight-assisted sinking method that added as much as one million pounds of pressure to the top of the caisson to ensure reaching the specified depth while maintaining plumb.

Two tiers of 12-in. screened horizontal laterals project 200 ft out from the bottom of the caisson at elevation 632.80 and 640.08. The seven stainless steel screens on each tier expose nearly a half-mile of screen surface to the aquifer. The 2,800 lineal ft of laterals can draw an immense amount of water as the caisson is pumped at an extremely low (less than two ft/minute) velocity. This reduces the operational energy requirement and ensures a long screen life.

With both wells operational, the utility plans to deactivate the Quindaro Plant in 2007. The damaged filter building is cleared and a plan in place to hold the old plant in reserve. Meanwhile, the Nearman Water Treatment Plant has attracted attention from other utility planners eager to see the world-class facilities.

“These wells present admirable examples of this technology,” observed Jim French, a vice president with Collector Wells International. “BPU has an exceptional aquifer consisting of more than 100 feet of uniform sand and gravel, which permits the extremely high yields. We will likely see this type of advanced well adopted by many other utilities that depend on the Missouri River or other surface water intakes subject to flow problems.” 

Mr. Ladesich is a freelance writer and marketing publicist based in Shawnee, KS.