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QUARTERLY

Pumping Stations: Heart of the System

BROWN AND CALDWELL

Illustration by Francisco Loureiro

Our too-often-ignored water and wastewater infrastructure has a heart which even industry professionals tend to overlook: the pumping station, which enables every part of the system to keep working.

QUARTERLY

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Issues and Ideas

Ask the Pumping Station Experts

Garr Jones, P.E., Rick Arbour, and Jim Courchaine have designed, inspected, or consulted on operations and maintenance for, collectively, thousands of pumping stations over more than a century's worth of combined activity. Here they take on a few fundamental questions.

What are the two most critical 'best practices' in pumping station design/O&M?

Garr Jones

- Full understanding of equipment capabilities—and selection of only those that will provide the best service life.
- Compliance with Hydraulic Institute Standards. This is fast becoming a critical issue if the owner is to enjoy full warranty rights and optimum equipment performance.

Rick Arbour

The two most critical O&M best practices are:

- A broad, up-to-current-standards preventive maintenance program that includes reliability-centered maintenance and predictive technology.
- A comprehensive Emergency Response Plan for when the station does fail.

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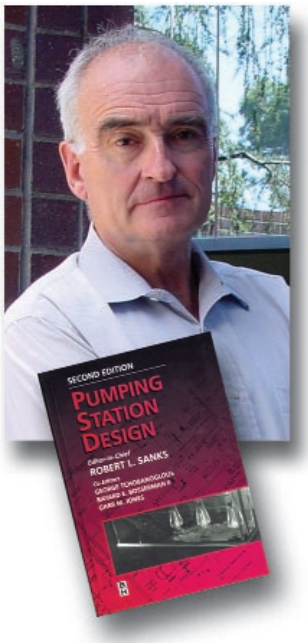
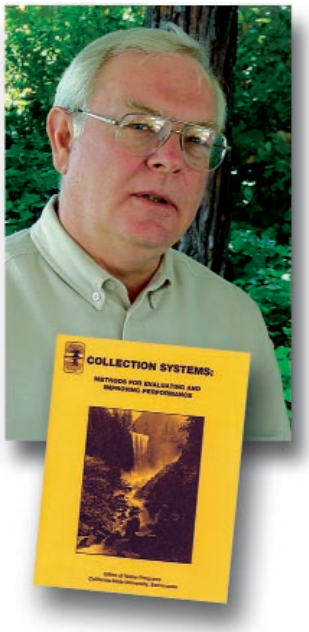
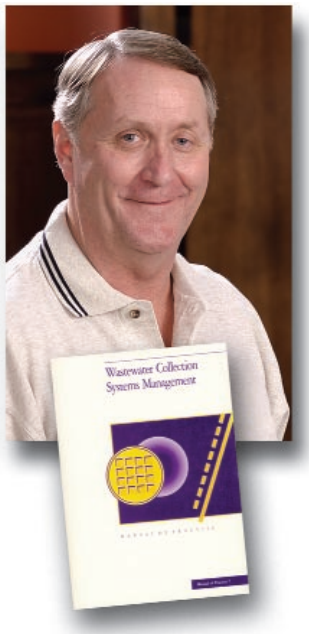
Garr Jones, P.E.



Rick Arbour



Jim Courchaine



The Pumping Station

THE HEART OF WATER AND WASTEWATER INFRASTRUCTURE

Our too-often-ignored water and wastewater infrastructure has a heart which even industry professionals tend to overlook: the pumping station, which enables every part of the system to keep working.

Those who expertly engineer, operate, and maintain pumping stations will tell you that every single pumping station is different. And that every pumping station design requires customized attention and a high level of skill.

Those who have a bird's-eye view across the country will also tell you that where such skill and attention have been lacking, pumping station failures are endless. The result is overflows. And, increasingly, the result is regulatory fines in the thousands of dollars, not to mention the exorbitant cost of patch fixes and incessant maintenance.

Meanwhile, a number of canny, forward-thinking pumping station designs have proven they can solve old problems, stave off new ones, and reduce the cost of operations and maintenance.

- How can a utility plan for rapid population growth without allotting precious capital to costly wastewater treatment plant expansion? A North Carolina utility pinpointed offline storage in a carefully calibrated solution.
- How do you design for no operational problems and no maintenance shutdowns? For one station in Washington, the answer is that you apply finite-element analyses developed for other industries to check for vibration and stresses under all conditions. And you make sure every piece of equipment is conveniently accessible.
- How does a new Georgia station economically push more than 10 million gallons (mg) of wastewater up 350 feet, while protecting against surges and minimizing maintenance?
- How does a raw water pumping station in Northern California save at least $600,000 in annual energy costs alone? It addresses inadequate power—along with wobbling pumps, variations in supply pressure, clam-filled water, and significant surge problems.

These well-designed workhorse hearts of our underground infrastructure don't need to be the exceptions—they offer design insights for other towns and regions.

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Because its North Creek Pumping Station is close to homes and businesses, King County, Wash., made sure that the design included noise and odor control, and that it reflected the county's policy of incorporating art into wastewater projects—in this case, via the architecture.

Photo by Steve Piccolo

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North Creek Station, Washington
The Latest in Pump Design, Ease of Maintenance

The new North Creek Pumping Station in King County, Wash., had to maintain the Department of Natural Resources' national reputation for outstanding reliability. To make sure it did, the design team applied the most advanced pump technology and vibration prevention methods.

And the designers and utility put extra attention on meeting operations and maintenance needs. "We included folks from O&M in our project team so their input could be incorporated," says **Dave Dittmar, P.E.**, conveyance program manager for the King County wastewater treatment division. "Not everyone does this."

The station, located in an office park, also stands out for its integration of art and architecture.

North Creek has been operating successfully since January 2000. With a capacity of 36 million gallons per day (mgd) and twin 5-mile-long force mains, North Creek diverts sewage out of one interceptor and delivers it to another to relieve flow to a downstream treatment plant. As a subconsultant to Tetra Tech/KCM Inc., Brown and Caldwell provided systemwide hydraulic modeling and capacity analysis, mechanical design, and construction management assistance.

Advanced tools to anticipate and avoid vibration problems

"What's most unique about this project is our use of the latest tools to anticipate potential problems and redesign accordingly," notes Brown and Caldwell Project Manager **Doug Schneider, P.E.** "These tools were developed for the petrochemical and nuclear industries and hadn't been applied yet to municipal pumping stations."

For example, computer-based, finite-element analyses of stress, torsion, and rotor dynamics revealed that the pump supplier's initial submittal—while it offered high-quality components that would meet all specifications—could have led to heavy vibrations and operational trouble under certain conditions. So the pumping unit was redesigned with a stiffer motor mounting plate, a different type of shaft coupling, and an intermediate shaft of different diameter and material. The pump manufacturer wrote Brown and Caldwell to thank them for requiring the analyses.

"The station is smooth and quiet over the complete range of operating speeds," says Schneider.

The station includes a self-cleaning wet well; standby power that achieves low emissions *and* limits harmonic distortion (a challenge when pumps run at variable speeds); and surge control without complex equipment, as a result of specification of just the right rotational inertia in the pump drive and proper location of certain force main valves.

Exceptional ease of maintenance

"It might seem obvious that operators need convenient access for equipment repair," says Schneider, "but it's amazing to discover the number of pumping stations where equipment can't be removed without shutting down all or part of the station. This might be caused by a tangle of piping right where you need access, no isolation valves, no way to drain large pipelines, no bypasses, or no way to lift heavy components."

At North Creek, in contrast, powered lifting equipment was installed for all components requiring servicing outside the station, such as jib cranes above sump pumps, a monorail for engine cylinders, and a bridge crane that can access any of the three pumps. Typically forgotten large valves were positioned to allow direct crane removal. Even conduits were artfully laid out to ensure access.

Integrating art, architecture, and odor control

Close to homes and businesses, North Creek was designed to please, with consideration of noise, appearance, and odor. The station benefited from the county's policy of incorporating art into wastewater projects: It has an inverted roof that funnels rainwater to cascade over a copper sculpture and into a rock basin below.

To control odor, first Brown and Caldwell modeled the sulfide generation in the new force main, then performed atmospheric modeling to determine odor levels beyond the fenceline. Using the results, the team designed a ferrous chloride system for liquid stream odor control and two carbon towers for foul air treatment.

A new SSO facility

North Creek was fashioned to accommodate operation with a raw sewage storage facility. Almost immediately after the station was built, planners identified the need to reduce peak flow and help prevent overflows until a new regional treatment plant is brought on line in 2010. Design of a 6-mg storage tank began. With design and permitting taking less than a year, the project recently went to bid. It includes an automatic cleaning system that will be activated following any overflow into the storage facility, a ventilation system, an innovative odor-control system, and public access to a landscaped park-like setting.

Jameson Canyon Station, California
Still Saving Money Eight Years Later

Eight years after installation, the Jameson Canyon Raw-Water Pumping Station in Vallejo, Calif., is "still saving the City a bundle of money, because operation and maintenance costs are so low," says the city's Deputy Water Superintendent **Franz Nestlerode, P.E.** The new station supplements the Cordelia Pumping Station, built by Vallejo in the 1950s.

What makes the station run so well? "We considered the whole range of operating conditions — not just peak, but normal too, and not just conditions at the time, but also 10 years hence and beyond," explains Brown and Caldwell Project Manager **Bill Faisst, P.E.**

And the team did what all too often is skipped over in rote design efforts: It tailored the pumping station to the project's unique circumstances and needs. The resulting design includes:

- An unusual trench-type wet well, with a control system that adjusts for variations in supply-source pressure
- The use of slow-closing ball valves on the pump discharges to solve a significant transient, or surge, problem
- A dedicated electrical substation so the city could buy power at transmission rates

If Nestlerode could offer two pieces of advice to other pumping station owners, they would be: "Put in the highest-efficiency pumps and motors you can find. And think about installing your own electrical substation."

Powerful but vibration-free

The 25-mgd pump station houses three, 800-horsepower (hp) vertical-turbine pumps with constant-speed motor drives. It has space for a fourth pump. The station delivers raw water from upstream pump stations to the city's water treatment plant. Brown and Caldwell also designed about 1 mile of 30-inch-diameter raw-water discharge pipeline and rehabilitation of the adjacent Cordelia Pumping Station.

"The 800-hp pumps match flows to system demands and bring down power costs," explains Faisst. "For the Cordelia station, the existing 600-hp motors kept burning out. We replaced them with custom 700-hp units. We also redesigned the motor supports and discharge piping to stiffen the mounting and better accommodate reaction forces."

Jameson Canyon is exceptionally vibration-free, due to strict specifications for the mounting plate and supports for the vertical-turbine pumps. "There are a lot of wobblers out there, but we didn't design them," says Faisst.

Customized wet well

The pumps draw suction from a narrow-trench wet well, once a radical concept but now incorporated into the new Hydraulic Institute intake standard. The self-cleaning well:

- Eliminates sediment and debris buildup (along with clams and exotic organisms in the raw water)
- Suppresses any vortexing
- Controls influent flow with a butterfly valve on the well inlet, which modulates to maintain a constant well level

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"Routine practice by many others is to build something big and oversize the wet well, and not consider solids deposition or cleaning," says Faisst. "Even now, the use of a trench is still a big paradigm shift, especially for raw or potable water. You have to be confident of your hydraulics to do it, and you have to understand flow metering."

Solving the surge control problem

Because the pumps discharge into a 55,000-foot-long raw water pipeline over a prominent ridge line, at a peak pressure of 200 pounds per square inch, surge control was a big issue. Brown and Caldwell carried out extensive hydraulic transient analysis using the Stoner model to develop alternative control methods. The team recommended the use of ball valves on the pump discharges with an extended closing time of as long as 8 minutes. This strategy allows water in the discharge pipeline to drain through the pumps into the wet well.

"The ball valve isn't a new feature, but it has to be applied correctly: a 2-minute closing time instead of 8 minutes could blow the pipe apart," explains Faisst.

Its own energy supply

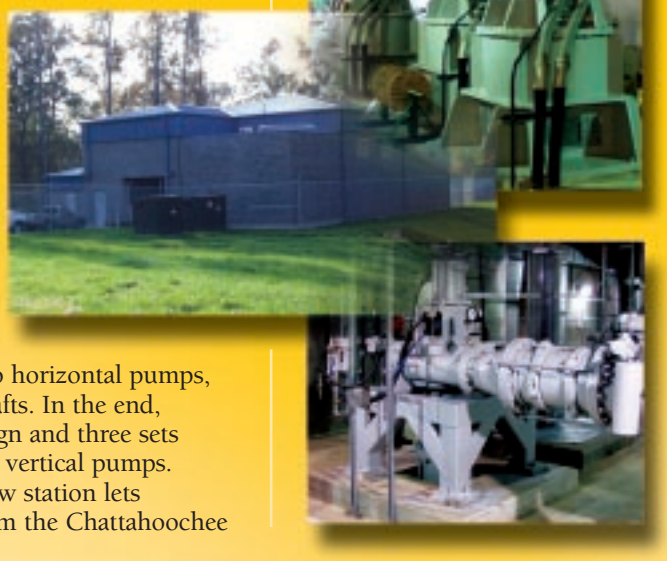
Because the stations are next to a 230-kilovolt (kV) transmission power line, the team designed a 230-kV/4.8-kV substation so the city could benefit from considerably lower rates. To gain 100 percent redundancy, the substation uses two polyphase transformers rather than the single-phase transformer that utilities supply.

"It's unusual for a city to install and own a substation, but it was well worth it—even though it cost $1 million," says Nestlerode. "On top of the substantial rebate we got from Pacific Gas & Electric, we expected a $600,000 annual savings from reduced energy costs alone. Last year the savings was $1.2 million." The energy savings result from substantially reduced head loss due to the new raw-water pipeline route as well as the switch to transmission electricity rates.

Suwanee Creek Station, Georgia
Custom Design of a Two-Stage, High-Head Solution

"That's high head," says **Roger Toebben, P.E.**, about the 350 feet of total dynamic head handled by the Suwanee Creek Pumping Station, which has been up and running since January 2001. "There are a few sewage pumping stations like this, but they're not real common."

Very high static head and a long force main (42,500 feet) led to the notably elevated dynamic head, which meant that a two-stage station—using two pumps back to back in the same line—was an economical choice.



Brown and Caldwell prepared 100 percent plans and specifications for the custom-manufactured pumps and the station. The team considered submersible and dry pit pumps, as well as layouts with horizontal pumps, one motor driving two horizontal pumps, and vertical pumps with extended shafts. In the end, the team recommended a dry-pit design and three sets of variable-speed, non-clog, two-stage vertical pumps.

Pumping 12.2 mg per day, the new station lets Gwinnett County, Ga., divert flow from the Chattahoochee Basin to its new water reclamation facility.

Flywheels provide surge protection for the station. "They're clean, they work really well, and they're low-maintenance," explains Toebben.

"When you lose electrical power in an outage and you're pumping, you have a real problem. We took a different approach to solving it. A motor not only powers the pump, it turns the flywheel, which is a heavy steel disk. During an outage, the flywheel keeps turning and provides power to the pump to avoid a surge. Most other people use a tank that sewage flows back to, but it requires a lot of unpleasant cleaning."

For energy efficiency, variable-frequency drives (VFDs) were used to run the pumps. "The VFDs prevent constant cycling of the pumps,

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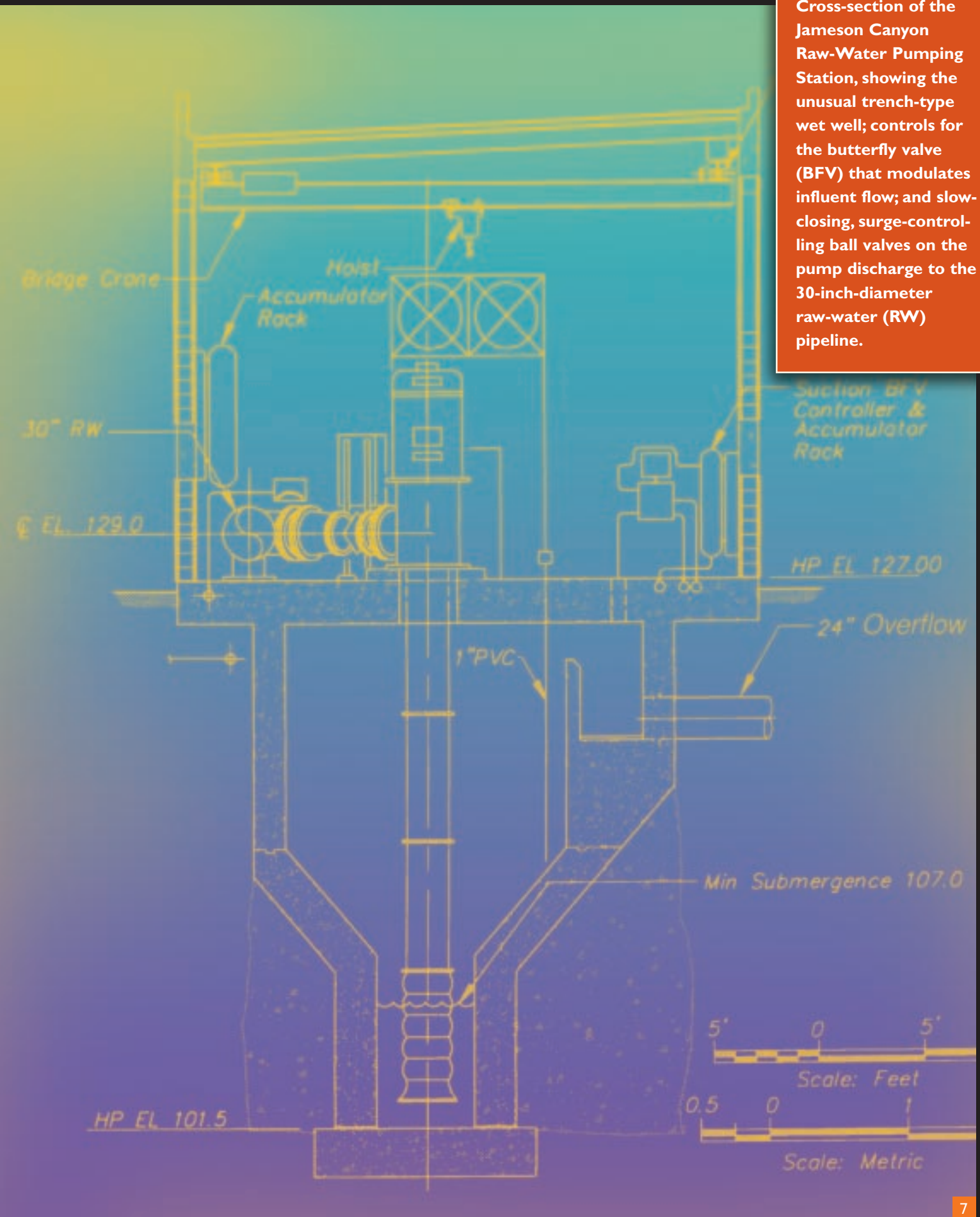

Cross-section of the Jameson Canyon Raw-Water Pumping Station, showing the unusual trench-type wet well; controls for the butterfly valve (BFV) that modulates influent flow; and slow-closing, surge-controlling ball valves on the pump discharge to the 30-inch-diameter raw-water (RW) pipeline.

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plus they further control surge," Toebben says.

Another operations-friendly feature is the self-cleaning, non-confined, ventilated wet well. "You can pump the well clean of all debris," says Toebben. "You don't appreciate it unless you're a worker who has to do that. For an owner it's a real benefit. Also, being fully ventilated, the wet well is classified as a nonconfined space, a great feature for worker safety."

Not only the safety, but also the knowledge and concerns of pumping station operators should be considered during design, believes **Conrad Gelot, P.E.**, the director of engineering and construction for the county Department of Public Utilities. "The designers sought out and utilized input from the operations staff, and their practical experience is reflected in the design. That's a measure of how well it's operating."

Gelot was surprised at the smooth construction of the Suwanee Creek Station. "It's a deep excavation, and we expected a somewhat complex construction. But it was fairly trouble-free, a tribute to a good design and construction team."

Long Creek Station, North Carolina
Upstream Storage Can Avoid Costly Downstream Expansion

Water and wastewater infrastructure nears capacity. Funding shortfalls persist, but raising customer rates remains unappealing. How can utilities find a creative solution?

Charlotte-Mecklenberg Utilities did. Instead of embarking on a mega-project to expand capacity systemwide, the utility realized it could build upstream storage into its replacement Long Creek Pumping Station.

Storing peak flows in its collection system would allow the utility to accommodate rapid population growth and development without inundating its facilities. Upstream storage would free downstream capacity to handle downstream peak flows, not only averting a costly expansion, but also reducing the risk of sanitary sewer overflows.

"Offsite storage is a fairly new way to shave the wet-weather peak, and my initial reaction to the concept was that it wasn't going to be cost-effective," says the utility's Chief Engineer, **Barry Shearin, P.E.** "But it's an economical way to reduce the amount of water you have to move at one time."

Flow projections point to capacity shortfall

Installed in the early '70s as a 4-mgd can-style pump station, Long Creek was at the end of its asset life. The North Carolina utility selected Brown and Caldwell in 1998 to assess the basin's needs and design a new pumping station and force main.

Brown and Caldwell's flow monitoring and hydrological sewer modeling showed that after construction of a new basin-long parallel sewer, flows would exceed 25 mgd in less than 10 years. Analysis of downstream facilities revealed that they would overflow at approximately 12 mgd, and that replacement or parallel facilities to convey the projected flow would cost more than $50 million.

"Our team suggested that we evaluate two alternatives in addition to the replacement pumping station," explains Brown and Caldwell Client Service Manager **Rick Carrier, P.E.** "One was constructing storage at Long Creek. The other was expanding the capacity of the pumping station and other downstream facilities.

"We discovered that storage at Long Creek would cost $20 million less, conservatively," says Carrier.

Integrated storage includes advanced features

Brown and Caldwell's storage system design includes:

- An integrated, 6-mg system of two tanks, with the smaller tank to handle 80 percent of storage events
- Advanced tank flushing features to minimize cleaning
- Real-time operation based on feedback regarding downstream capacity, indicating when the storage system should go offline and on line, and maximizing the rate of return without overloading downstream facilities

The station will pump to downstream facilities using relatively small, 8-mgd, two-stage export pumps for normal flows. The storage facility will be served by a low-head, 25-mgd station with vertical-turbine solids-handling pumps, housed in the same building as the export pumps.

To minimize maintenance costs, the pumping station design includes a self-cleaning wet well for the export pumps and a horizontal screening system, commonly used for combined sewer overflows, to prevent grit and floatables from entering the storage system during wet-weather events.

The design is being fine-tuned to respond to revised flood elevations recently released by the Federal Emergency Management Association (FEMA), as the pumping station will sit near the Catawba River. Brown and Caldwell originated a flood control concept for another client that was so well received by the county EPA that it's being considered for Long Creek: the use of a flood-proofing berm plus an automatic control valve to accomplish the double function

of flood control and spillage control. Another design option being explored is to flood-proof the station so it can operate if completely surrounded by floodwaters.

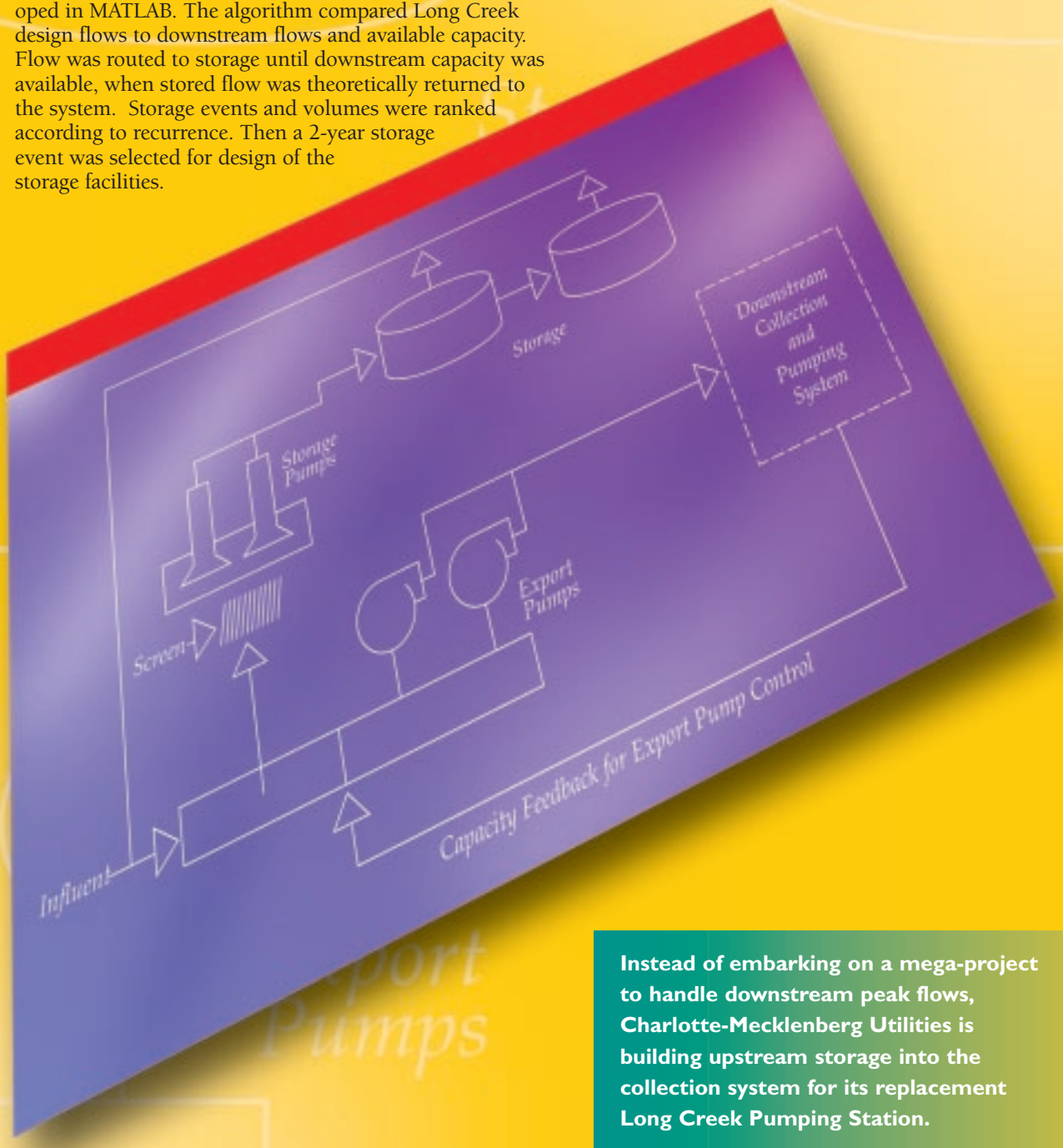
Storage volume based on systemwide capacity

To compute the wastewater storage required at the Long Creek station, the team used the Runoff Block of the USEPA's Stormwater Management Model and 26 years' worth of local, hourly rainfall data to yield output on wet-weather flow. These were analyzed in conjunction with hydrograph-based flow projections and an algorithm developed in MATLAB. The algorithm compared Long Creek design flows to downstream flows and available capacity. Flow was routed to storage until downstream capacity was available, when stored flow was theoretically returned to the system. Storage events and volumes were ranked according to recurrence. Then a 2-year storage event was selected for design of the storage facilities.

A solution for others?

Collection system storage may be a worthy solution for others. The same project team is completing a similar study for another utility in the Carolinas challenged by wet-weather overflows.

"As the cost of treatment system expansion keeps rising and CMOM regulations are implemented, more utilities will look toward flow management solutions," predicts Brown and Caldwell Project Manager **Jim Crowley, P.E.**



Instead of embarking on a mega-project to handle downstream peak flows, Charlotte-Mecklenberg Utilities is building upstream storage into the collection system for its replacement Long Creek Pumping Station.

Tougher Regulation of Nutrients:

The USEPA is developing quantitative limits on nutrients allowed in water bodies using a strategy of "ecoregions." Meanwhile, the idea of "adaptive implementation" is gaining ground. What does it really mean?

In our nation's waters, eutrophication, or excessive aquatic fertilization, is a high-priority problem, according to the USEPA. The agency has found that as many as half of surveyed waters do not adequately support aquatic ecosystems because of excess plant growth due to high nutrient concentrations.

Although many water-resource specialists and stakeholders dispute the severity of the eutrophication problem, regulatory change is on the horizon. The EPA plans to tighten the water-quality criteria behind its Total Maximum Daily Load (TMDL) programs, which determine the nutrient loads allotted to dischargers and other sources.

The federal agency has called for states to adopt numeric nutrient criteria by 2004. These new quantitative criteria will replace the narrative criteria that drive many current TMDLs.

While the development of nutrient criteria remains in its formative phase, many municipalities and public agencies have taken action—from regulatory negotiation to applying new treatment technologies—to respond to current TMDL processes and to help structure the next generation of criteria.

Upcoming nutrient criteria from EPA and the states

High phosphorus and nitrogen concentrations are at the biochemical root of eutrophication. But the dynamics of the problem vary with regional differences, including climate, geology, and aquatic species. Hence, the EPA has established a national strategy based on "ecoregions," or regions of relative ecological homogeneity. Rather than developing site-specific criteria to protect beneficial uses directly, the EPA has chosen a simpler route: quantifying existing conditions in either unimpacted waters or all waters for each ecoregion. The implication of this approach is that no nutrients, beyond those from natural sources, can be added to the nation's waters.

This approach has led to very restrictive criteria for the majority of waters across the country that are covered by the ecoregions. And the approach will require millions, and probably billions, of dollars to implement.

The agency is currently developing guidelines for 14 such regions, in the form of technical guidance manuals to generate criteria for four categories of waters: lakes/reservoirs, rivers/streams, estuaries/coastal waters, and wetlands. These guidelines aim to help states establish criteria and identify problem areas by comparing enriched nutrient levels with natural, background levels. The EPA proposes that states either adopt its outlined process or develop their own scientifically sound criteria through Regional Technical Assistance Groups.

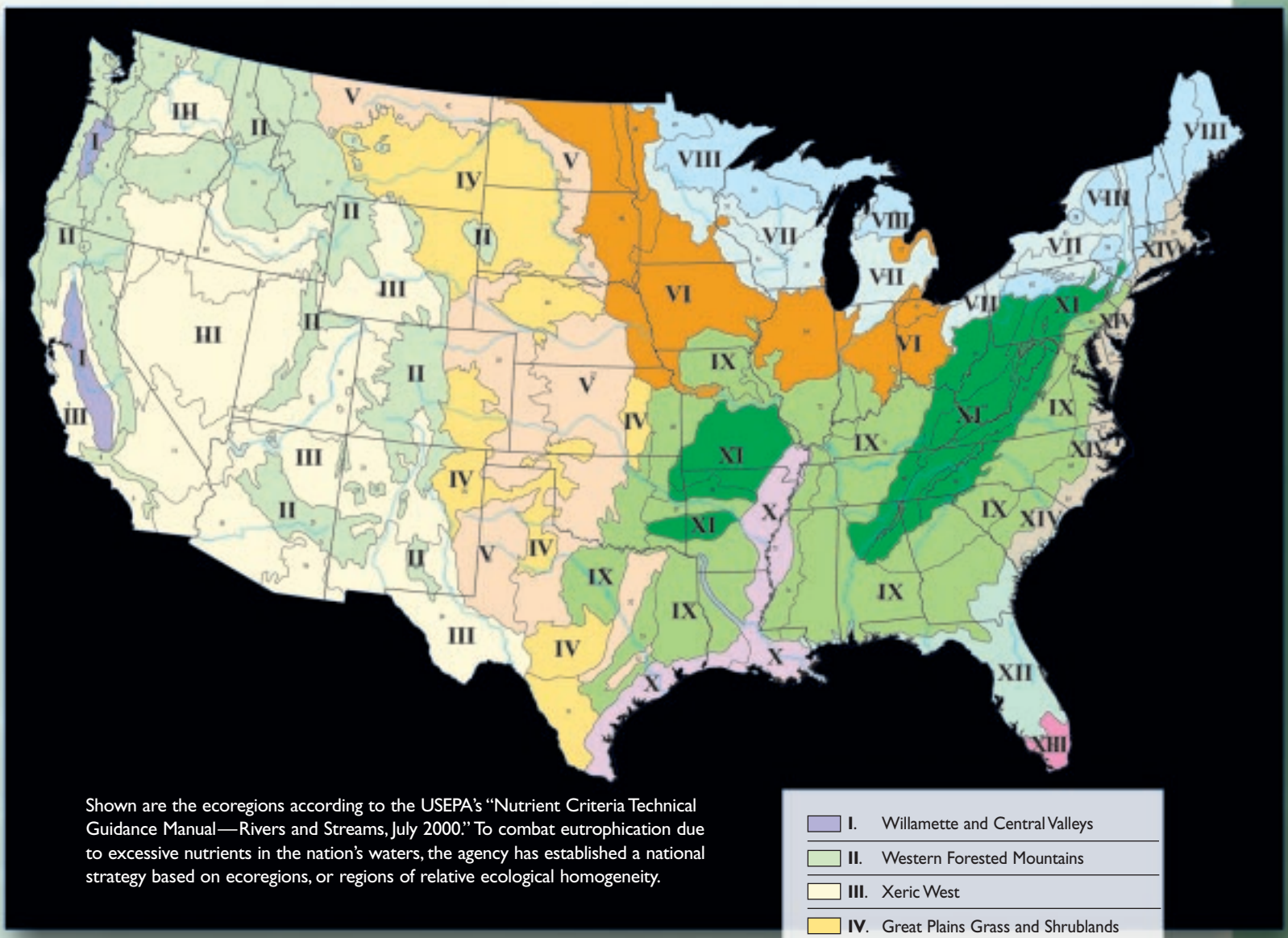
In 2000 and early 2001, the EPA released recommended nutrient criteria for rivers/streams and lakes/reservoirs in certain regions (see accompanying table). Recommended criteria for other types of waters may come out later this year. Four constituents are the basis of the criteria: total phosphorus, total nitrogen, chlorophyll *a*, and clarity (measured as turbidity in rivers/streams and as secchi depth in lakes/reservoirs).

EPA-Recommended Criteria for Four of the 14 Ecoregions

Parameter	Ecoregion II	Ecoregion III	Ecoregion VI	Ecoregion IX
RIVERS AND STREAMS				
Total Phosphorus (micrograms per liter, µg/l)	10	22	76	36
Total Nitrogen (milligrams per liter, mg/l)	0.1	0.4	2.2	0.7
Chlorophyll *a* (µg/l)	0.7	1.4	7.3	0.9
Turbidity (turbidity units, NTU)	1.3	1.8	9.9	7.0
LAKES AND RESERVOIRS				
Total Phosphorus (µg/l)	9	Not Available (NA)	38	20
Total Nitrogen (mg/l)	0.1	NA	1.7	0.4
Chlorophyll *a* (µg/l)	1.9	NA	8.6	5.2
Secchi depth (meters)	4.5	NA	1.4	1.5

To arrive at nutrient criteria for an ecoregion and category, the EPA determines simple percentile constituent concentrations for either "reference" (unimpacted) waters or all of the waters in each ecoregion. Critics of this approach fault it for being arbitrary and for producing unnecessarily restrictive criteria, arguing that it requires excessive expenditures to achieve goals that might not be appropriate in terms of either ecology or use. According to Brown and Caldwell Principal

How to Respond Now



Shown are the ecoregions according to the USEPA's "Nutrient Criteria Technical Guidance Manual—Rivers and Streams, July 2000." To combat eutrophication due to excessive nutrients in the nation's waters, the agency has established a national strategy based on ecoregions, or regions of relative ecological homogeneity.

Scientist **Bret Linenfelser**, "The EPA's percentile-based process of setting ecoregion criteria has come into question because large ecoregions don't adequately reflect site-specific considerations, and the process doesn't account for actual nutrient effects on water bodies or protection of beneficial uses."

Recommended by the National Research Council: 'Adaptive implementation'

In October 2000, Congress asked the National Research Council (NRC) to assign a committee of experts to evaluate the scientific basis of the TMDL program. The expert committee recommended review

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of use designations and water-quality criteria by state agencies early in the TMDL process, including consideration of site-specific conditions. The committee also concluded that water-quality assessment is best regarded as a continuous process of "adaptive implementation."

Adaptive implementation involves simultaneously taking action to improve water quality and monitoring to evaluate progress toward meeting water-quality standards. Applying treatment options begins with relatively low-cost, "immediate" actions—the most efficient options for improving water quality—followed by monitoring for success. If criteria haven't been met, then further treatment measures might be needed.

The idea of adaptive implementation is not entirely new; it has been referred to in the past as a "phased" or "iterative" approach to TMDLs. Support for the concept by the NRC committee will likely lead to more widespread application of phased, adaptive implementation by the states and the EPA.

Examples of adaptive implementation

Over the last several years, a number of cities and other public agencies have begun to apply the concept of adaptive implementation, which could be described as doing the things that make sense, in a logical sequence.

Cindy Paulson, Ph.D., P.E., Brown and Caldwell's national practice leader for water resources, identifies two initial, proactive steps. "One of the first things people can do is collect data. Go ahead and characterize the system—find out how it ticks—so we can go about improving it with a greater sense of certainty.

"The second thing is to collect information on what the state has done and what the listing is based on—basically making sure that the targets for the TMDLs are right, while proceeding with a strategy that includes sensible treatment or control technologies."

Here are some examples of effective adaptive strategies:

City of Lincoln, Nebraska

Site-specific ammonia criteria and targeted upgrade of wastewater treatment

The City of Lincoln focused on developing ammonia criteria that reflect the unique conditions in Salt Creek, the receiving water for the city's wastewater treatment facilities. Lincoln worked with Brown and Caldwell to develop ammonia criteria based on biological as well as chemical data. The team also implemented changes in permitting, such as flow-based seasonal ammonia limits, in close coordination with the state regulatory agency.

On the treatment side, the city converted activated sludge systems to biological nutrient reactors. The result: improved ammonia removal and significantly reduced nitrate discharge. The project included modifying the reactors from a traditional carbonaceous activated sludge system with inefficient aeration to one that operates more efficiently with fine-bubble diffusers. The reactors are designed so that the system removes ammonia in addition to selecting for specific microbes with better settling characteristics, thereby improving effluent quality and increasing reactor capacity. Other treatment changes include side-stream treatment and equalization of high-concentration belt-filter-press filtrate from the solids dewatering process.

Boise City, Idaho

Pretreatment phosphorus reduction and regulatory collaboration

In developing the Snake River and Boise River nutrient TMDLs, Boise City, with Brown and Caldwell's support, employed technical and regulatory strategies to find cost-effective solutions.

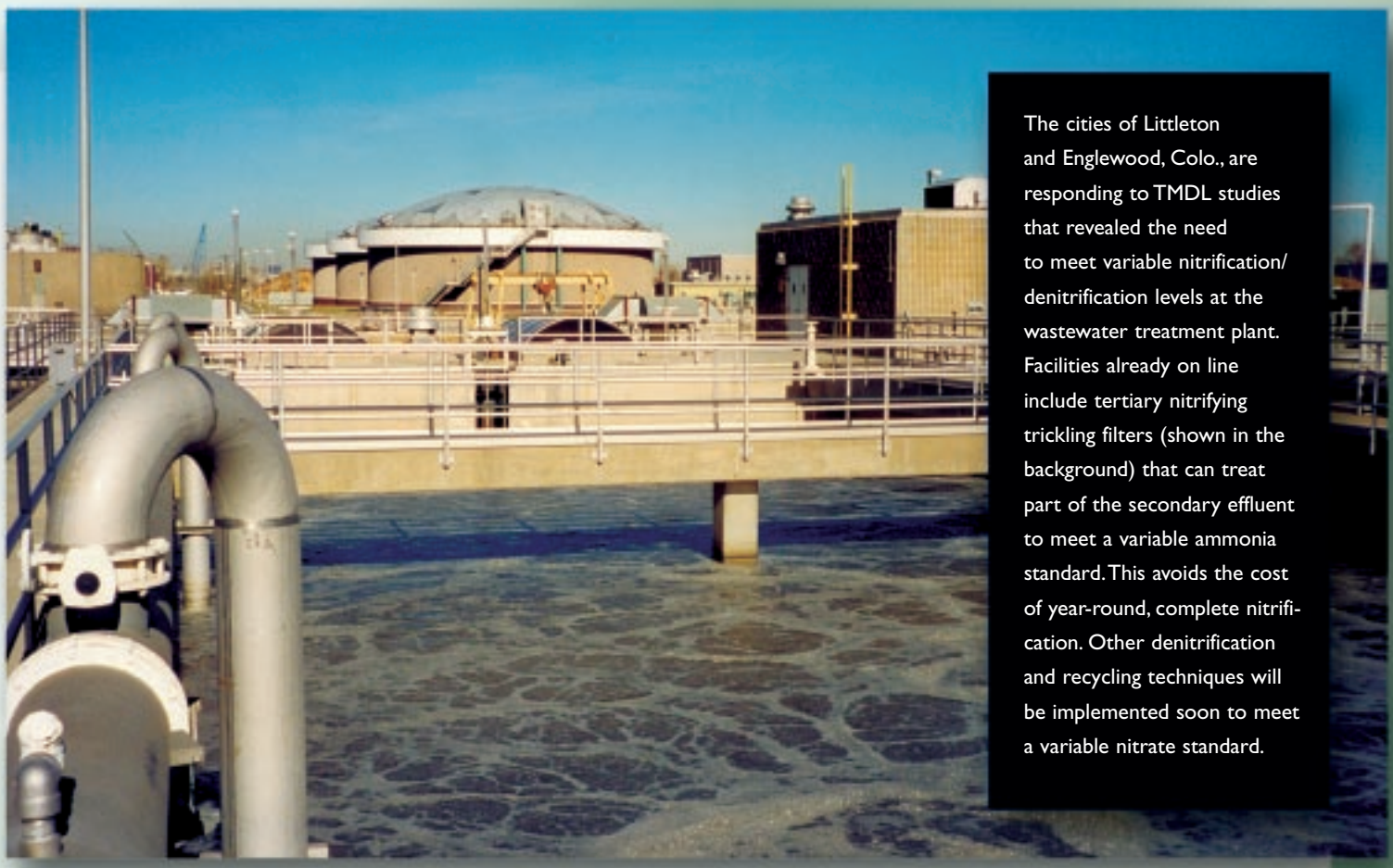
As part of the technical strategy, one of the city's dischargers was able to change its processes to decrease use of phosphorus-laden products, resulting in a significant reduction in daily phosphorus loading. On the regulatory level, Brown and Caldwell is helping Boise City present arguments to the state in support of more flexible implementation of criteria. State regulators are now looking at the effects of seasonality and considering variable criteria based on location within the reservoir.

Cities of Littleton and Englewood, Colorado

Wastewater treatment tailored for a range of effluent limits

Littleton and Englewood are preparing for future regulatory requirements through the master planning process. This effort includes evaluating several denitrification alternatives to meet a range of potential ammonia and nitrate effluent limits. In this work, Brown and Caldwell has found that the most efficient approach combines two techniques: denitrification with methanol and an innovative recycling of nitrifying trickling filter effluent back to the headworks, which will allow for flexibility and provide capital cost savings of $5.3 million.

Brown and Caldwell helped Boise City collect site-specific data on Brownlee Reservoir and the Snake River to help establish the nutrient TMDL.



The cities of Littleton and Englewood, Colo., are responding to TMDL studies that revealed the need to meet variable nitrification/denitrification levels at the wastewater treatment plant. Facilities already on line include tertiary nitrifying trickling filters (shown in the background) that can treat part of the secondary effluent to meet a variable ammonia standard. This avoids the cost of year-round, complete nitrification. Other denitrification and recycling techniques will be implemented soon to meet a variable nitrate standard.

Cherry Creek Basin Water Quality Authority, Colorado

Watershed management trading to cost-effectively improve water quality

In the Cherry Creek Basin, point source dischargers had already applied high levels of treatment for phosphorus, but the TMDL was still not being met because of significant loadings from nonpoint sources. To achieve its mission to protect the watershed for drinking-water supply, recreation, and fisheries, the Basin Water Quality Authority initially had to consider a growth moratorium. Subsequently, the Authority called on Brown and Caldwell to provide technical support for pollutant trading, and it developed a coordinated approach to nonpoint source management within the basin. This led to an innovative trading approach: removing some of the nonpoint source load through "pollutant reduction facilities" and allowing point sources to slightly increase loads to keep pace with growth within the basin.

Metropolitan Council Environmental Services, St. Paul, Minnesota

Biological phosphorus removal at wastewater treatment plant

Regulatory agencies required an upgrade of MCES's 250-million-gallon-per-day plant to meet an annual average total phosphorus requirement for effluent of 1 milligram per liter. To get the most out of existing facilities, Brown and Caldwell developed a plan that involved in-tank modifications for biological phosphorus removal and secondary clarifier modifications that increased capacity for additional solids loading. Testing on a quarter-plant scale, coupled with predictive modeling, showed that the tankage expansion foreseen by a previous plan could be eliminated for a capital cost savings of more than $100 million.

South Florida Water Management District

Using natural systems, instead of concrete and steel, to achieve low phophorus levels

The Everglades Forever Act of 1994 calls for significant reductions of phosphorus in stormwater runoff from the Everglades Agricultural Area and adjacent watersheds by the end of 2006. Concentrations of 100 to 200 µg/l will be reduced in an adaptive-implementation manner, in two steps—first to 50 µg/l and then to an unprecedented 10 µg/l (unless the Florida Department of Environmental Protection sets a different target). Brown and Caldwell has been helping to meet these goals, through design of a 6,400-acre constructed-wetland treatment area as well as through the evaluation of innovative treatment technologies. The wetland, which is sized to treat 3,370 cubic feet per second of stormwater runoff, consists of three filtration cells that remove phosphorus and other nutrients through plant growth and the accumulation of decomposing plant material in a layer of peat. Advanced treatment technologies currently being researched include stormwater treatment area (STA) optimization, periphyton-based STAs (PSTAs), submerged aquatic vegetation/limerock substrate, and chemical treatment with solids separation (CTSS).

QUARTERNOTES

Unique Pre-Purchase Analysis and Design Lowers Cost of Egg-Shaped Digesters

Brown and Caldwell's early cost analysis and predesign for Salt Lake City's Central Valley Water Reclamation Facility (CVWRF) showed that egg-shaped digesters could double capacity and decrease operation and maintenance costs at a competitive price.

In response to demand that is expected to surpass 100 million gallons per day (mgd) by 2013, CVWRF had hired joint venture partners Brown and Caldwell and DMJM, Inc., to augment five conventional anaerobic digesters at its wastewater treatment plant and increase the digesters' 65-mgd capacity. Brown and Caldwell headed mechanical, process, electrical, and instrumentation design and construction support, while DMJM handled structural design and construction management.

Early, competitive bidding yields lower price

Brown and Caldwell investigated several alternatives to increase sludge digestion capacity: remodeling of the five existing digesters, addition of new conventional or submerged fixed-cover digesters, and addition of new egg-shaped digesters. The highly efficient egg-shaped digesters were CVWRF's first choice, but an initial cost analysis proved them to be too expensive.

To test these results, Brown and Caldwell took the unique approach of analyzing procurement costs very early in the process. The analysis included predesign of the entire digester complex to verify piping and equipment configurations. The company then issued a pre-purchase proposal for two steel, egg-shaped digesters, assuming that if the egg-shaped tanks were indeed too costly, CVWRF would instead add digester capacity via concrete tanks.

"The steel egg-shaped tank fabricators were not only competing against each other," says **Tom Jacobs, P.E.**, Brown and Caldwell's project

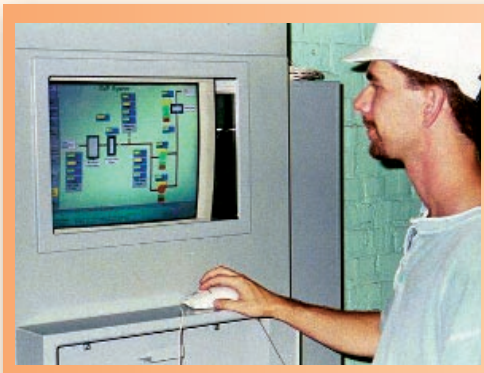
El Paso Corp. Pioneers Big-Picture Approach to Remediation

Departing from the traditional "investigate, design, and implement" model for remediation, El Paso Corp. has adopted a pioneering approach to its company-wide environmental remediation efforts. Focusing on total system savings rather than piecemeal accomplishments, "this approach might really be a model for others," says Brown and Caldwell Client Service Co-Manager **Tom Marrou, P.E.**

"El Paso's experience with remediation projects shows that developing a project life-cycle strategy early can promote significant cost savings," explains El Paso Director of Remediation **Marc Ferries**. "We have also found that just going through the process of looking at the big picture for each site has allowed us to better map project processes—and better measure management as well as consultant performance."

The approach involves bringing high-level expertise to bear on a site as early as possible; looking for the most efficient long-term solution; and emphasizing technical expertise at the start of a project to gain long-term cost savings and avoid drawn-out cleanup efforts.

"The site business plan is also a key part of our approach, because it allows the company and consultant to team together to develop far-reaching exit strategies and performance metrics for sites," adds Ferries. El Paso retains responsibility for making key decisions but expects its consultants to provide technical and implementation leadership.



A Brown and Caldwell staff member operates the air sparging and soil vapor extraction system that the company designed and built for El Paso Corp. at the FCX Superfund site in North Carolina. Brown and Caldwell's phased approach resulted in a system one-tenth the size of that originally estimated, saving more than $1 million

The FCX Superfund Site in North Carolina, where Brown and Caldwell previously managed remediation design and construction, showed the benefits of this approach, notes Client Service Co-Manager **Bob Norris, Ph.D.** The team communicated technical strategies and methods to El Paso's management team and implemented design and construction, while allowing El Paso to focus on key decision making and helping to communicate with agencies and the public. Costs were reduced, and the project met the accelerated schedule requested by the EPA. Brown and Caldwell currently operates the site remedy, an air sparging and soil vapor extraction system.

The new approach is supported by El Paso Corp.'s management style and structure: a centralized management team, rather than field-managed remediation by semi-autonomous business units, and rewards for overall cost savings, rather than emphasis on lowest bids for each phase of work. Also, each consulting firm is to function as part of the El Paso team, accepting some risk and receiving rewards for exceptional performance.

Brown and Caldwell is one of five environmental engineering consultants selected from across the nation in April 2001 to handle companywide remediation efforts. The program comprises gas stations; operating refineries, terminals, and chemical manufacturing sites; and discontinued facilities, including Superfund sites. Turnkey remediation will make up the majority of the work.

manager, "but also against the possibility that the egg-shaped tanks would be rejected if their cost was higher than the cost of concrete tanks. This dual level of competition secured an extremely workable price for a leading-edge treatment technology."

CVWRF General Manager **Reed Fisher** said that the approach took advantage of a recent drop in the price of steel, and that it allowed procurement of the tanks more than a year before the completion of engineering design and the consequent bid for construction. "That saved us a lot of money," he said.

Using external pumps instead of an internal mechanical mixer

Brown and Caldwell's final design of the two 1.6-mg digesters included an innovation in the mixer. Typically, egg-shaped digesters of this size require a mechanical mixer inside a 36-inch-diameter draft tube in the center of the tank and a large motor atop the digester to run the mixer. At CVWRF, this would have meant securing a motor some 80 feet above the ground, creating quite a maintenance challenge.

"Our design still made use of the 36-inch draft tube," said **Dru Whitlock, P.E.**, project engineer, "but we used screw impeller centrifugal pumps instead of a mechanical mixer to create the mixing action in the draft tube. Each tank has two pumps, which provide a combined capacity of 10,000 gallons per minute." Maintenance can be performed easily year round.

Startup of the two digesters began in August. The plant's ultimate sludge capacity has been increased to 125 mgd, more than enough for projected needs in the Salt Lake City area.

Smooth Startup for Complex Utoy Creek WRC

The $118 million Utoy Creek Water Reclamation Center (WRC) expansion and upgrade in Atlanta recently sailed through the end of a complicated startup. Now completely operational, the facility treats 44 million gallons per day—up from 36 mgd.

During the upgrade, the existing WRC had to stay on line, meeting its effluent permit. Meanwhile, every process unit had to be modified, expanded, or replaced.

"The key to the successful startup was the coordination and operational support provided by Brown and Caldwell working with the city staff and the contractor," said **Joe Porter,** Atlanta's director of wastewater services. In particular, a detailed construction and startup sequencing plan addressed the 12 major and eight minor startups. Each startup consisted of five phases: initial equipment check, functional equipment check, clean water testing, process tie-ins, and commissioning.

"The contractor submitted detailed plans for each phase," said **John Holland, P.E.**, Brown and Caldwell project engineer. "Each step was completed before we proceeded to the next step. That way, we avoided any process upsets."

Most startups required some sort of tie-in to integrate existing with new equipment. "We held initial meetings to help the contractor understand existing constraints—and then developed the detailed plan for startup and tie-in" said **Paula Rogers**, Brown and Caldwell startup engineer. Weekly startup meetings were held at 6 a.m. to avoid interfering with construction.

Meeting the state's deadline for filtration and UV disinfection

"Through tie-ins and major startups, we were able to bring a significant portion of the plant on line to meet the state-mandated date for filters and ultraviolet (UV) disinfection," said **Rod Pope, P.E.**, Brown and Caldwell project manager.

First online were Utoy Creek's five new secondary clarifiers, which replaced four smaller clarifiers. Startup of the clarifiers required two tie-ins. In one, the team had to

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Photo by Aerial Innovations of Georgia, Inc.

Smooth Startup

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connect a new outfall sewer to the existing outfall sewer some 500 feet away—one of several tie-ins completed around 2 a.m., when facility flows were lowest.

"Shortly after the secondary clarifiers proved to function properly, we brought the filter influent pumping station and the effluent filters on line," Holland said. "A sodium hypochlorite solution was installed for disinfection until the UV disinfection process went on line, which allowed us to demolish the chlorine disinfection facility and start building the new waste activated sludge (WAS) thickening centrifuge building. Once the pumping station and filters were proven out, we began flow through the UV disinfection process to prove *that* system out."

Another tie-in that kept the project on track involved Utoy Creek's new headworks area, including bar screens and vortex grit tanks. Brown and Caldwell used a tie-in to channel effluent around the old headworks to feed the primary clarifiers.

Good ideas during construction to speed progress and meet permit

Key aspects of the startup included these:

- Demolishing the administration and blower buildings to allow room to modify the existing biological phosphorus removal (BPR) tanks and the new WAS thickening centrifuges. This required construction of new aeration basins and a temporary ferric chloride system to remove phosphorus chemically.
- Taking the primary clarifiers and existing BPR tanks offline simultaneously to allow for reduced construction time that was requested by Western Summit, the contractor. First, Brown and Caldwell process expert **John Bratby, Ph.D., P.E., DEE**, modeled activated sludge operations to determine that the plant could still operate and meet permit requirements.

"The new Utoy Creek facility has easily met all the effluent permit requirements," said **Mike Shelhamer**, Atlanta's WRC manager.

Wastewater Effluent Serves as Coolant for Pacific Northwest Cogen Plant

In the mid-1980s, the City of Klamath Falls—in a region hit hard by the demise of the timber industry—began looking for a way to stabilize its revenue. One solution: build its own cogeneration power plant. Now, with Oregon pondering deregulation of its utilities industry, handling a drought, and facing a West Coast energy crisis, the city's decision seems especially timely.

The cogeneration plant required a low-cost, high-quality water source for its cooling towers, however—a tall task in a region impacted by complex total maximum daily load (TMDL) regulations and a continuing water-rights adjudication.

Treated effluent the only alternative

So Klamath Falls, on the headwaters of the Klamath River, hired Brown and Caldwell to design reliability improvements for the city's wastewater treatment plant that would make it possible to use plant effluent as coolant for the cogen plant.

"In Texas, Arizona, and New Mexico, treated effluent has proven to be a viable and reliable alternative for such plants," Senior Engineer **Jack Detweiler** says.

"During planning of the improvements, we looked for other sources of water and found none—all the water in the Klamath River is spoken for," Detweiler explains. The river is home for an endangered species, the shortnose sucker fish, that made national news this summer when federal agencies significantly reduced water allocations to regional farmers to protect it. "Treated wastewater effluent made the entire project possible."

Evolving design: chlorination, blow-down return, temperature control

Brown and Caldwell began design of a 5-million-gallon-per-day effluent pumping station and two 5-mile-long conveyance pipelines to the cogen facility. At the same time, the engineering team forged ahead on the treatment plant improvements—including modification of aeration basins to accomplish biological nutrient removal, a 110-foot-diameter secondary clarifier, effluent disinfection using hypochlorite, and a complete overhaul of the primary electrical supply.

Other design improvements included a raw sewage fine screen, dissolved air flotation thickener for waste activated sludge, a new control building, and a stormwater project to implement best management practices.

The treatment plant provides the cogen plant 2.8 million to 4.2 million gallons of water each day, with 60 percent of that amount being evaporated in the cooling towers. The remainder, called blow-down, is pumped back to the treatment plant, where it is cooled with potable water regulated by a temperature control system. The blow-down is then dechlorinated before being discharged into the Klamath River. Overall, the improvements cut the volume of discharged effluent by two thirds.

Mike Kuenzi, Klamath Falls public works director, stresses the project's focus on "increasing reliability and operational flexibility so the treatment plant can provide cooling water to the cogen plant 100 percent of the time. In essence, the city has stepped up from a typical POTW (publicly owned treatment works) discharger to a commodity producer. In addition, we added the ability to 'super-chlorinate' our effluent to mitigate potential algae growth in the conveyance pipelines, and we upgraded to biological nutrient removal to help avoid scaling at the cogen plant cooling towers."

The $305 million, 500-megawatt cogen plant was turned over to the city in mid-August and has been running at full capacity since. The quality of the effluent supplied to the cogen plant not only has pleased power plant operators, it has far exceeded the city's and regulators' expectations, containing, on average, concentrations of 5 milligrams per liter (mg/l) of biochemical oxygen demand (BOD) and total suspended solids (TSS), 0.6 mg/l of phosphorus, and less than 1 mg/l of ammonia.

The city anticipates that the cogen plant will generate between $5 million and $15 million per year—more than the city now collects in property taxes.

Phyllis Brunner Rejoins BC as Northwest Regional Manager

"My Dad said to me, 'You've come full circle. What gives?' " says **Phyllis Brunner, P.E.**, explaining her journey back to Brown and Caldwell after a decade serving as an upper-level manager at two other engineering firms.

"After being in business in the Northeast and having most of my career in the West, I know I love the frontier spirit here, the willingness to take more risks in business. And what's especially appealing are the regional governments and a regional way of looking for solutions."

And then there's the fact that Brown and Caldwell is "the best engineering firm I ever worked for in my career. It has an outstanding reputation for excellent engineering, high ethics, and incredible integrity." Those qualities—plus the company's commitment to fostering an organization that's cohesive, energized, and practice-oriented—helped attract her back as a senior vice president and the Northwest regional manager.

Brunner's 25-plus years of experience in civil and environmental engineering includes major rehabilitation of reservoirs, dams, pipelines, and large-diameter brick sewers. She recently managed the master planning and design of the Ocean Gateway Cruise Ship and International Ferry Terminal in Portland, Maine, the state's largest municipal infrastructure project. She also recently managed a multimillion-dollar flow monitoring evaluation for the Boston Water and Sewer Commission. Brunner has engineered and

managed many water, wastewater, and remediation projects as well. Holding bachelor's degrees in both civil engineering and geology, in 1998 she won the American Society of Civil Engineers Award of Excellence for her outstanding service to the ASCE Pipeline Division.

Brunner will be increasing Brown and Caldwell's involvement in Northwestern water resources and infrastructure projects along with supporting the company's ongoing wastewater and other municipal work. "I'm a believer in clients for life," she says.

Her well-known organizational and communication abilities will contribute to internal initiatives to draw more young talent to the firm and keep updating technology and training.

By her own description, Brunner combines the ability to "make the hard calls" in business and to foster a workplace that acknowledges "what is important in life, individual changes, and how we can live each day to the fullest." One can see this coexistence of business savvy and personal responsiveness in her view of Brown and Caldwell: "We have such great tools in the box. And such a real openness to diversifying that it's heartwarming."

Corona Avenue Vortex Facility: A First-of-Its-Kind Demo of Floatables Removal

New York City's Corona Avenue Vortex Facility is the first project to demonstrate, side by side, the use of three different vortex devices to remove floatables and other pollutants from wastewater. Hailed as a landmark project with both national and local implications, the Corona Avenue plant is helping the city meet a consent order for floatables abatement in New York Harbor.

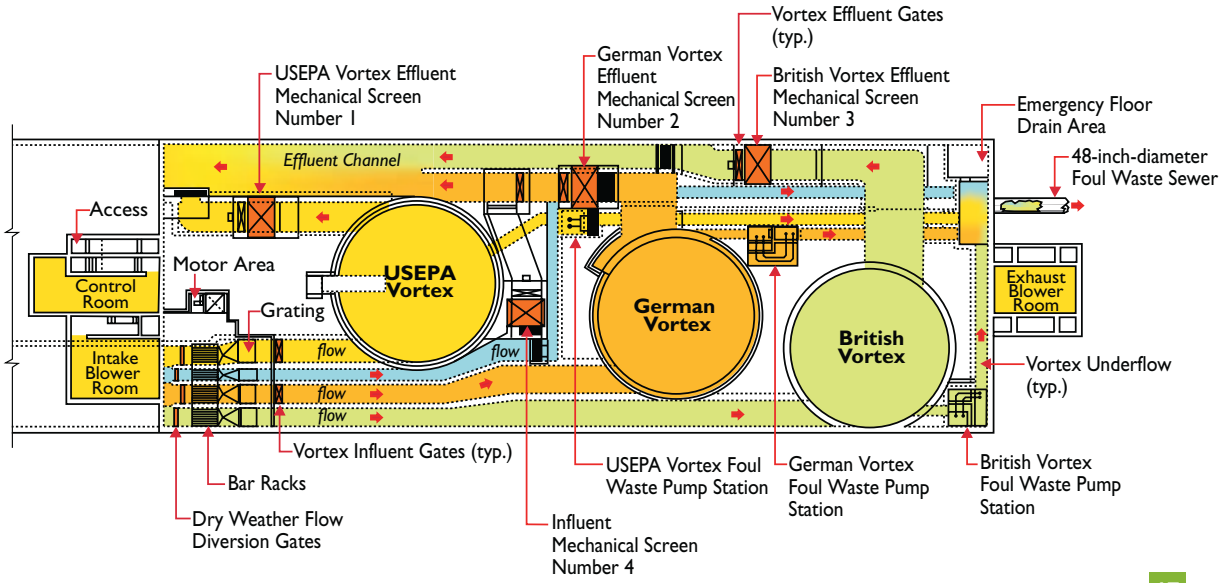
Brown and Caldwell, as a subconsultant to URS Corp., assisted in the design of the facility, developed the monitoring and sampling plan, and will evaluate the results.

The facility contains three 43-foot-diameter vortex units of varying depths. The three units—the Swirl Concentrator (USEPA), Fluidsep (Germany), and Hydrodynamic Separator (England)—have been tested in other locations, but never side by side. Each unit is designed for a peak rate of 129 million gallons per day, 200 cubic feet per second, or a surface overflow rate of 88,900 gallons per day per square foot (151 meters per hour).

"On a local level, the immediate project objective will be to evaluate the effectiveness of different vortexes for removal of floatables from combined sewer overflows (CSOs)," says Brown and Caldwell's **Peter Moffa, P.E.** "On a national level, it will prove which type of unit is most cost-effective for other pollutants as well."

Also, the results will be considered for application to floatables removal at more than 400 outfalls in New York City.

As part of design, Brown and Caldwell evaluated hydraulic conditions throughout the facility during various tidal conditions and selected the sampling and the supervisory control and data acquisition (SCADA) equipment.



New York City's Corona Avenue Vortex Facility is demonstrating how effectively three different vortex devices remove floatables and other pollutants from combined sewer overflow. The USEPA, Fluidsep of Germany, and Hydrodynamic of England each designed one of the devices, which have never been tested side by side.

State-of-the-Art Wastewater Recycling Study in Pristine Hawaii

To conserve more potable groundwater for drinking, the Honolulu Board of Water Supply (BWS) entered the water recycling business last year: It purchased the 13-million-gallon-per-day Honouliuli Water Recycling Facility and distribution system. The facility water is now irrigating Oahu golf courses and residential common areas on the dry side of the island, above brackish water or saltwater.

Since then, the BWS has broadened its strategy to include possible recycled-water irrigation of areas above *drinkable* groundwater. It called on Brown and Caldwell to study the use of recycled wastewater to irrigate landscaping and crops in central Oahu, above the island's principal potable water aquifer. The $2.8 million, three-year study is the first of such scope and magnitude in Hawaii.

Past experience shows due diligence is needed

For more than a century, chemicals controlled the weeds and pests in Oahu's sugar cane and pineapple fields—and some of these chemicals have been found in drinking water wells. According to **Clifford Jamile, P.E.**, BWS's manager and chief engineer, this detection raises the question of whether constituents in recycled irrigation water could also reach the potable water aquifer. Before recycled water is used above the potable aquifer, BWS wants to be sure it can be applied safely.

Hawaii is different

"Water recycling above drinking water aquifers has been practiced successfully for over 40 years in California," says Brown and Caldwell Project Manager **Woodie Muirhead, P.E.** "But what lies below the surface in California is different than what lies below the surface in Hawaii."

Oahu's geology originates from volcanic activity and mainly comprises basaltic rock, which is fractured and therefore porous. The benign rock causes little or no change to the water percolating down to the groundwater table. But sitting on top of the basalt is a relatively thin layer of soil, and the changes that occur to recycled water as it passes through this top layer is one of the key focuses of this study.

State-of-the-art evaluation

The study includes four major steps:

- Compare the chemical and microbiological characteristics of recycled water and of other potential irrigation sources, and identify constituents of concern
- Conduct field studies to determine the fate of those constituents as they pass through the top soil layer
- Perform laboratory soil-column studies and computer modeling to evaluate issues that can't be practically evaluated in the field
- Recommend appropriate levels of treatment and other water-quality criteria to protect public health and the potable aquifer

The study will evaluate a broad range of potential constituents of concern, including emerging compounds such as endocrine disrupters and NDMA.

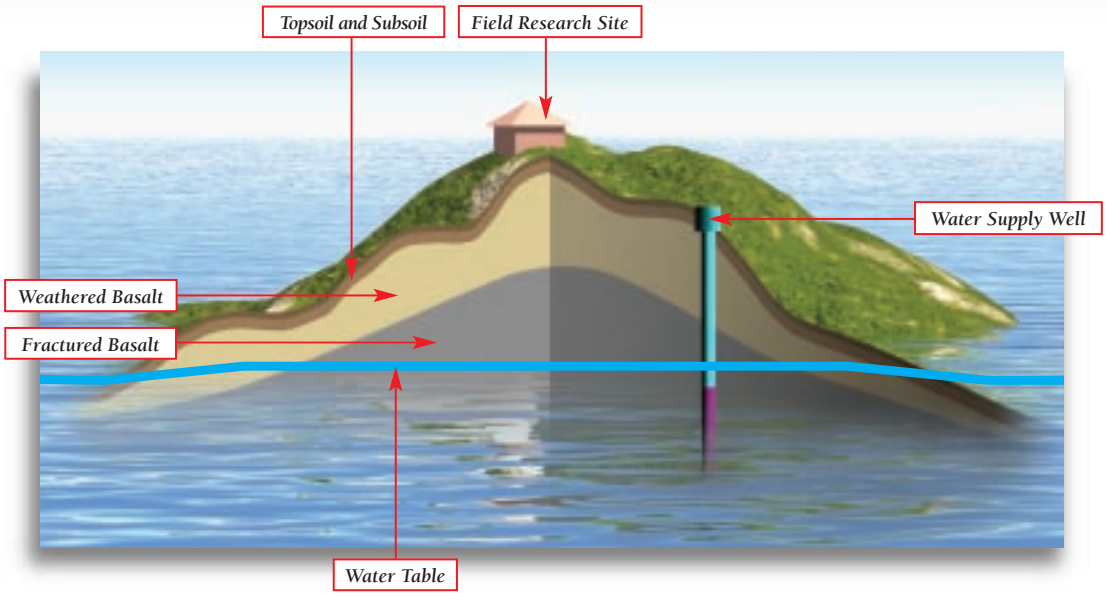
The investigation is a multidisciplinary effort, drawing on experts from Brown and Caldwell offices throughout the country. The distinguished team also includes international technical advisors and local subconsultants, such as **Takashi Asano, Ph.D.** (the 2001 Stockholm Water Prize winner), **Peter Fox, Ph.D.** (researcher at Arizona State University), and **Herman Bouwer, Ph.D.** (USDA and U.S. Water Conservation Laboratory researcher).

The public is always right

"Sound science is not enough," says **Ray Matasci, P.E.**, Brown and Caldwell's client service manager for BWS. "Recent experience both on the mainland and in Hawaii shows the importance of public outreach. We know of great projects that went awry because the public was not informed or provided ongoing information on progress. The BWS wanted to ensure that the public was made aware of the project from the very start."

The team is using focus groups, telephone surveys, and other tools to better understand the public's concerns and issues. Various communication modes will keep the public informed about purpose and progress over the three-year study.

Characterization of source and control water will proceed shortly. Once BWS and Brown and Caldwell choose the exact study site, field trials will begin to compare recycled water irrigation with groundwater irrigation. Final results will be delivered in September 2004.



The Honolulu Board of Water Supply hired Brown and Caldwell to lead a scientifically advanced study of the potential use of recycled wastewater for irrigation above Oahu's principal potable water aquifer. The island's geology originates from volcanic activity, comprising a thin layer of topsoil and subsoil above porous basaltic rock. Much of the top layer has been used for sugar cane and pineapple cultivation, and was subject to chemical control of weeds and pests. The study will evaluate the fate of constituents in the recycled wastewater as it passes through the top layer of soil. The results will include recommendations on water-quality criteria and treatment levels to protect the potable aquifer and public health.

Roy Herwig, P.E., Joins BC

With 30 years of experience as a regulator of both state and federal wastewater compliance programs, Roy Herwig, P.E., has joined Brown and Caldwell's Business Consulting Practice. Until October, Herwig had been the EPA's driving force, throughout Region 4 and nationally, in developing the agency's CMOM (capacity, management, operations, and maintenance) program for wastewater collection systems. He has been called the "father of MOM," referring to the program that is the basis of EPA's CMOM initiative.

Based in Atlanta, Herwig adds new dimension to Brown and Caldwell's infrastructure, asset management, and CMOM compliance capabilities. Plus, he has invaluable insights to offer any client facing regulatory compliance actions. To get a sense of his unique background and perspective, we asked Herwig three quick questions shortly before this issue went to press.

How did you become known as the father of 'MOM'?

In 1993, Rick Arbour and I were having a beer at the Sheraton Key Biscayne and asking ourselves, "How do we correct this SSO situation?" We knew that proper operation and maintenance was at the heart of the issue, but soon realized you can't have good O&M without good management. So we put management first and came up with "MOM" to help utility people focus on these basics.

As a regulator, I went round and round with utility managers who said, "We can't achieve zero overflows," and then asked, "if I have one, what are you going to do?" Now as a consultant, I believe regulators ought to take into account the quality of the utility's MOM program. Does the utility have a well-trained staff and adequate budget? Is preventive maintenance moving toward predictive maintenance, and is the contingency or emergency response program well communicated and executed when necessary? If the utility has problems with old infrastructure, is the condition of that infrastructure being assessed continuously, and have priorities been set for capital improvements?

This is the best response for an agency: to know its problems; have a written plan that is endorsed by its elected or appointed official; and to know what path is necessary to become a high-performing utility with fewer overflows. By doing this on their own, agencies will control their destinies.

What prompted you to become such an advocate of CMOM?

I've always viewed the utility, the consultant, and the regulator as having the same goal, if different roles. In the early '90s, regulatory people began to realize that just because utilities were meeting effluent limits, that didn't mean everything was fine. At the same time, I was working with WEF and participating on EPA's Federal Advisory Committee to assess the SSO problem. I attended a lot of meetings with many progressive utility executives who believed EPA had its head in the sand about the zero SSO rule. We debated the issues and, through that, became friends and altered our views. I began to understand the day-to-day problems that utility executives face, because it was clear we had the same goal.

The turning point came when we, as a group, recognized that an SSO is a symptom of a failed MOM program. And if we focused on improving the program, rather than just on SSOs, we would make progress. This is when we began to formulate what became Region 4's MOM, then the CMOM provision of the NPDES permit regulations. MOM's not really new — it just brings together a lot of commonsense thinking of the many friends I respect in the utility industry.

Why the move from EPA to Brown and Caldwell?

I clearly remember the day I went to the City of Atlanta's R.M. Clayton Water Reclamation Center for a demonstration of the systems Brown and Caldwell was putting in place to improve management and operations. Who wouldn't be impressed by a system that helps a utility with complex wastewater plants, a large inventory of equipment, and a large staff tie together plant operations to a computerized O&M manual that's accessible to everybody and helps them do their job better?

I thought to myself, "BC understands what MOM is about." Other consultants didn't seem to have that same understanding or foresight. There's a void within the utility industry, and we can create a business activity that will fill that need. BC is a good fit for me. To be successful, everybody needs to have the same values and beliefs, even if we differ in some opinions. Here is a firm that believes the things I believe, and that improves management, operations, and maintenance programs. That translates to value added to the customer.

You can reach Roy in the Atlanta office at (678) 298-5619, or by email at rherwig@brwncald.com.

Ask the Experts

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What makes a pumping station a really good one?

Garr Jones

- A thorough and complete understanding of the operating requirements, emphasizing conditions that will be encountered most often.
- Equipment correctly specified to match its application and to ensure reliability.
- Station environments that are well suited to the equipment—mechanical, electrical, and instrumentation—and to personnel needs.
- Simple design of controls and functional equipment layout, fully reflecting operator and maintenance needs.
- Consideration of all aesthetic issues: odors, visual effect, light emissions, and the local environment.

Rick Arbour

- Planning, designing, and constructing for O&M, focusing on life-cycle costs instead of one-time acquisition costs.
- Accurate hydraulic analysis, which leads to proper pump selection and application, including the force main (air relief valves, transient analysis, and odor and corrosion prevention).
- Detailed performance specifications for equipment and systems, including standardization, startup protocol, documentation (as-built drawings and O&M manuals, for example), and O&M staff training.
- Construction quality control using qualified inspectors to verify compliance with design standards and specifications.
- Sufficient resources to support an asset management O&M program that includes corrective, preventive, and predictive maintenance programs executed by skilled staff.

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What is the single, most common flaw or mistake you see in pumping station designs?

Garr Jones

- A poor understanding of steady-state and transient hydraulics and what their calculation actually means in the real world. The photo below tells the story: It shows an impeller after only about 1000 hours of operation.

Rick Arbour

You get two for the price of one on this:

- Inadequate hydraulic analysis resulting in wrong pump selection and misapplication of variable-speed systems.
- Design, construction, and/or O&M practices that cause excessive vibration in rotating equipment, especially pumps. This problem is the primary cause of premature pump component failures.

What one piece of advice would you share with pumping station designers?

Garr Jones

- The proper selection and specification of pumping equipment for a given application is far from the no-brainer it is thought to be. The subject is complex and fraught with pitfalls that can trap the unwary. Experience is doubtless the most important ingredient. One must fully understand the requirements for the application and the limitations and capabilities of available equipment. And one must appreciate the uncertainty that comes with the results of hydraulic calculations. There is no one-size-fits-all solution to pumping applications.

Rick Arbour

- Plan, design, and construct for O&M, especially in areas that will affect reliability, maintainability, and life-cycle costs.

The Pumping Station: Treat It Well

When asked what is the most important requirement for a good pumping station, I can answer from two different perspectives, but the answer will be the same: reliability, and the management of O&M.

As a former pumping station operator and superintendent of several water and wastewater divisions, and, more recently, a consultant, I speak from experience—experience with making mistakes and with doing it right, and experience with the many systems I have assessed throughout the country.

I would liken the pumping station and its conduits of piping to a human heart and its arteries. If you clog the arteries to a heart, dangerous pressures will result. And if you don't keep the pumping station influent lines free of debris such as grit, roots, and grease, flow will be choked off, causing surcharging conditions and unnecessary pressure on the piping joints.

Similarly, if you don't exercise your heart, it won't operate at its optimum efficiency, and bypass surgery may be necessary. This also goes for the pumping station. Pumps and motors must be greased, valves exercised, the wet well cleaned of grease and debris, the wet well operated at its optimum pumping range, and suction and discharge pressure gauges monitored, to name a few imperatives. Without all this and more, the integrity of the station will be compromised, and bypass pumping may be necessary.

Pumping station O&M has to be managed, and this means it has to be understood. As you familiarize yourself with good procedures, you will be able to diagnose problems as they develop and take corrective action before the risk of failure. Finally, keep good records, so you can develop a baseline and running history of O&M to help you make the right decisions should problems begin to develop.

—Jim Courchaine

Garr Jones, P.E., has been a practicing engineer with Brown and Caldwell for more than 42 years. During that period, he has been responsible for the design of more than 100 pumping stations, ranging from the 2.6-mgd Kirkland Pumping Station near Seattle to two 1,300-mgd stations serving the Everglades Restoration project. Rick Arbour, who joined Brown and Caldwell earlier this year, has more than 40 years of experience in pumping station operation and maintenance, on which topic he's developed and delivered scores of workshops and seminars in North America and Mexico for public agencies, teaching institutions, regulatory agencies, and the Water Environment Federation. Jim Courchaine, who recently joined the firm, has dedicated more than 30 years to water and wastewater management, operation, maintenance, and training in both the public and private sectors. He's performed thousands of operations inspections of pumping stations throughout the country.

Jones and Arbour were asked to separately answer the questions above, Jones from the perspective of design and Arbour from the standpoint of O&M. Perhaps not surprisingly, they found that their concerns dovetailed more often than they diverged. When Courchaine came to Brown and Caldwell, he weighed in with an addendum from his own multiple perspectives—independently characterizing the pumping station, as we did, as the system's heart, deserving of particular care.

Create Visibility with Asset Management

My family and I are among AOL's 30 million subscribers told in May that our monthly subscription fee would increase by 9 percent in July. By August, I could imagine Steve Case, AOL's chairman, kicking himself for not having increased rates sooner. Was there outrage or refusal to comply? No, it seemed to me that we all just paid our fees and continued about our business—trusting that, for now, Case got what he needed to keep the email, buddy lists, and Yahoo! coming.

In "Internet time," it would appear, households around the country are coming to regard these new digital pipelines to be at least as important as the physical ones linking their homes and businesses to vital public services. More interesting, perhaps, is how the Internet's new ratepayers value these services and, ultimately, how much more they'll be willing to pay for them.

Our last *Quarterly*'s "Buried Treasure" cover theme struck a chord with many readers, prompting much in the way of comment. The nation's infrastructure has been deprived due to the "out of sight, out of mind" syndrome and has only recently begun gaining the visibility and respect that it deserves. Directors and their staffs have long recognized the considerable effort and capital investment that will be required to restore and preserve these impressive and immense systems. But it will be an uphill battle without ratepayer support.

Multiple surveys from WIN, AMSA, AWWA, and others all concur that billions of dollars are needed for renewal of the country's water and wastewater infrastructure—and Congress is beginning to listen. However, who pays and from which pocket are questions without easy answers. In any case, proactive utilities and city governments will gain by playing the "value" card, seeking, much like AOL has, to cultivate an appreciation (or, at a minimum, no pushback) for the true cost of service among ratepayers.

Another perspective: Make these invisible assets much more visible and vivid in the public's mind. Ratepayers and politicians must see what we see: complex and intricate physical assets that, just like any publicly financed structure, must be preserved and maintained. This is a shift away from educating the public about how it all works to engaging in a dialog around long-term performance, its value, and accountability. The platform for this discussion is asset management.

Asset management creates visibility. Crises and the threat of looming catastrophe are a troubling way to win improvement funding. No one feels good about the expenditure, and questions by justly angered ratepayers often devolve into misguided blame and finger-pointing. In contrast, asset management provides a framework that helps us see the whole. Astutely executed, it delivers a compelling case, not just for renewal, but also for sustainability.

In short, asset management alters the fundamental approach by:

- Expressing problems/opportunities in terms of value: current assets, cost of ownership, replacement and preservation costs, etc.
- Recognizing the value of the whole system, rather than the individual projects that comprise its parts
- Defining useful life, such that renewal and replacement are integral components of the life cycle
- Enhancing management credibility by integrating critical utility functions, such as finance, O&M, and engineering

Courchaine, Herwig Join BC

As evidence of our continuing pursuit to make the nation's top infrastructure talent available to clients, we are very pleased that Jim Courchaine and Roy Herwig have made BC their company of choice. Both are nationally recognized experts in utility operations and CMOM, adding even more depth to our infrastructure capabilities and Business Consulting Practice. A bit of background:

Before entering consulting in 1998, Jim progressively managed all aspects of water and wastewater utilities for four Massachusetts municipalities. An accomplished trainer and current chair of New England's certification program for collection system operators, Jim has been at the forefront of CMOM regulations development. Please talk with him about his much-sought-after top-to-bottom management assessments of water, wastewater, and stormwater systems, as well as CMOM compliance plans and training in water distribution and wastewater collection system O&M.

We've seen a few double takes as word got out that Roy joined us in October. He's been EPA's driving force, both regionally and nationally, in the development of its new CMOM program. In his former capacity (of 30 years), utility staff may not always have enjoyed sitting across the table from him, but all soon learned to respect his skill and expertise. Today, as a consultant, Roy offers uncommon, top-level perspective and counsel to anyone facing a compliance action or contemplating evaluating or upgrading a MOM program.

— Craig Goehring, P.E., CEO

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