THE EXCELLENCE IN ENVIRONMENTAL ENGINEERING® competition of the American Academy of Environmental Engineers exists to identify and reward the best of today’s environmental engineering. Its criteria define what it takes to be the best in environmental engineering practice: a holistic environmental perspective, innovation, proven performance and customer satisfaction, and contribution to an improved quality of life and economic efficiency.

The competition, begun in 1989, is organized around the normal phases of development and implementation of environmental management projects and programs: research, planning, design, and operations and management. This year’s entrants to the competition displayed a wide range of projects from innovative designs in waste treatment plants to new water treatment technologies to a one-of-a-kind Superfund site cleanup. At the same time, we see that today’s engineers are more and more becoming significantly integrated in a team/project approach, allowing for greater flexibility and efficiency in project management. The application of new technologies combined with experienced environmental engineering practices make these projects the award winners they are.

Those chosen for prizes in 2008 by an independent panel of distinguished experts, addressed the broad range of modern challenges inherent in providing life-nurturing services for humans and protection of the environment. They are but a small percentage of the many projects involving environmental engineers around the world. Nevertheless, their innovations and performance illustrate the essential role of environmental engineers in providing a healthy planet. These award winners testify to the genius of humankind and best exemplify the Excellence in Environmental Engineering® criteria.
The Kay Bailey Hutchison Desalination Facilities project is an $87 million, state-of-the-art project that is named after United States Senator Kay Bailey Hutchison. The team of Camp Dresser & McKee and Moreno Cardenas, Inc. served as the primary consultants and designed the 27.5-million-gallon-per-day project, which was jointly implemented by the El Paso Water Utilities and Fort Bliss U.S. Army base.

This project, North America’s largest inland desalination project, uses reverse osmosis membranes to treat the high salinity groundwater, taps brackish groundwater beneath the desert floor, converting it into a new and sustainable drinking water supply for the city of El Paso and Fort Bliss.

constructed for $2.07 per gallon per day of RO skid capacity, the project will deliver water for considerably less than other options that have been evaluated by EPWU, such as indirect potable reuse of reclaimed water or importing supplies from remote areas in western Texas.

The project’s benefits extend beyond water treatment. The region’s new long-term water supply served as a key factor in the Army’s decision to increase personnel and operations at Fort Bliss under the Base Realignment and Closure Process. Because Fort Bliss heavily influences the local economy, base expansion was “a true turning point” for the city, according to Senator Hutchison, supporting continued economic development for a bright future.

This flagship project demonstrates a holistic water supply approach, integrating fresh groundwater, brackish groundwater, and surface water to maximize limited supplies. The project will preserve fresh water resources and improve the quality of life for this growing desert community, as well as serve as a model and center of learning for other communities that are looking for sustainable options to meet their long-term water needs.
Glendale Water and Power, which services 200,000 people of the City of Glendale, faces a problem that plagues approximately 30 percent of water utilities in the United States — nitrification. Nitrification is the microbial process in which ammonia is oxidized to nitrite and potentially to nitrate. Its adverse effects on drinking water include loss of total chlorine residual, release of free ammonia, increase in nitrite and nitrate concentrations, decrease in pH, increase in corrosion rates, and increase in microbiological activity.

The City of Glendale, in a collaborative effort with Malcolm Pirnie, conducted a demonstration-scale study to determine the effectiveness of chlorite ion for nitrification control by directly feeding sodium chlorite to a selected area of the Glendale distribution system — first full-scale nitrification control study in California feeding sodium chlorite as the source of chlorite ion. Previous studies were conducted at pilot scale in a simulated distribution system. With upcoming deadlines in compliance schedules of the Stage 2 D/DBP Rule, more water utilities are likely to switch to chloramines as their secondary disinfectant. Therefore, study results will provide these utilities with significant, valuable information confirming chlorite’s effectiveness in preventing nitrification in vulnerable systems.

Study findings were shared with nearly 80 interested drinking water decision-makers at an open house in Glendale last week, establishing a benchmark for cutting-edge research in new nitrification control strategies for other utilities to follow. Glendale has established a benchmark for cutting-edge research in new nitrification control strategies for other water utilities to follow. Based on the results of this investigation, Glendale is considering the application of sodium chlorite to their entire system. City leaders recognize that providing Glendale’s residents with a dependable supply of safe, affordable drinking water is a key to the community’s viability.
In search of a green alternative to disinfecting water mains after installation, Denver Water and CDM collaborated on a three-year study researching the use of ozone as a disinfectant. The industry standard of using a chlorine-based disinfectant has proven to be time consuming, expensive, and potentially harmful to the environmental as chlorination often requires onsite preparation of hazardous chemicals or transport of chlorine gas cylinders. Additionally, chlorinated water must also be dechlorinated before it is discharged to prevent harm to the environment and aquatic life.

The complex research project involved three stages: laboratory, pipe-loop testing, and full-scale field trials. The study proved that ozone is very efficient when combined with an innovative high-pressure spray wash pre-cleaning system, which targets the bacteria attached to pipe walls. Ozone is completely safe for the environment, converting into oxygen within 1 hour. It requires 50 percent of the labor needed for the equivalent chlorine method, resulting in reduced operating costs for pipeline disinfection. Ozone disinfection also saves time, taking 20 to 30 minutes, while chlorine-based disinfection takes 24 hours and requires an additional step, 24-hour dechlorination.

Based on the research results, Denver Water has incorporated a trailer-mounted high-pressure pre-wash and ozone disinfection system into their standard distribution system disinfection processes. Several other utilities are now looking to implement these green technologies. And, while no federal regulations currently exist for the disinfection of water mains, trends focusing on water quality in the distribution system indicate that it is only a matter of time. CDM is working with the American Water Works Association and the U.S. Environmental Protection Agency to establish ozone disinfection of water mains as a best practice.

**TOP LEFT**
**Schematic:** Process flow schematic detailing Denver Water’s trailer-mounted ozone disinfection system.

**TOP RIGHT**
**Clean pipeline:** The interior of this pipeline has been cleaned with the high-pressure spray wash. It is now ready for ozone disinfection.

**BOTTOM RIGHT**
**Ozone disinfection system:** The ozone used for disinfection is generated onsite by this trailer-mounted electrical ozone generation system. The inlet and outlet fire hose connections are located at opposite sides of the trailer floor.
The Water Works and Sewer Board of the City of Birmingham (BWWSB) operates four drinking water treatment facilities with a combined capacity of 188 million gallons per day and serving approximately 750,000 consumers. With limited funds available for capital improvements and system growth, BWWSB needed an affordable approach for complying with the upcoming federal Stage 2 Rule mandating removal of disinfection byproducts (DBP) in drinking water. Malcolm Pirnie was retained to develop a new and cost-effective strategy by identifying an application of granular activated carbon and free chlorine to achieve this goal. In addition to allowing BWWSB to meet upcoming regulatory deadlines, it could potentially save the utility $35 million in construction costs.

Although GAC has been used in filters for many years, none of the facilities surveyed in the study used biologically active GAC for organics removal and regulatory compliance without the use of ozone. Malcolm Pirnie’s GAC pilot study, comparing GAC biofilters (without ozone) and traditional dual media filters, proved their viability for achieving regulatory compliance with both low filtered water organics and effluent turbidity.

This study included performance benchmarking, a review of planned capital improvements, a nation-wide survey of water utilities using GAC, best technology short-listing, a year-long pilot scale evaluation of alternatives, an evaluation of construction and operational costs, and a recommendation for implementation. It also found that with limited modifications to planned filter upgrades, the GAC biofilters could be incorporated into the existing treatment plants for relatively little capital cost. Few operational changes would be necessary to manage the GAC biofilters, resulting in little additional operator training. Given the growing demand on water utilities to replace aging buried infrastructure, supply water to growing populations, and limit water rate increases, the application of these results to utilities across the country has gained national interest.
The City of Albany plans to improve the water quality of the Willamette River by creating an integrated wetland treatment system. Assisted by CH2M Hill, the City of Albany developed this innovative approach in partnership with the City of Millersburg, Weyerhaeuser and Wah Chang Teledyne. Using natural treatment processes, the project will create and restore wetlands along the river and enhance wildlife habitat while reducing the temperature of wastewater treatment effluent discharging to the watershed. This project is expected to provide greater overall environmental benefits than traditional approaches as well as addressing Willamette River total maximum daily loads for temperature and other water quality issues.

On the basis of a screening of potential technologies and alternatives, which included a preliminary cost comparison of individual wetland treatment systems with an integrated wetland treatment system, an integrated wetland treatment system was identified as the alternative with the greatest promise.

Temperature reduction was evaluated using the Heat Source model. The model was used to predict effluent temperatures from the constructed wetland complexes. The excess thermal loads predicted from wetland effluent temperatures were evaluated against waste load allocations for thermal load to determine whether the wetlands could maintain effluent temperatures so that the resulting thermal loads are within permit requirements.

The constructed wetlands were found to be effective in reducing the temperature of wastewater effluent. Emergent wetland vegetation provides shading of the water surface to minimize solar heating while radiant heat loss and evaporative cooling help to dissipate energy.

Water balance, water quality treatment, potential water law issues, initial water quality monitoring results for the oxbow lakes, outfall site, and diffuser concepts were all also evaluated as part of the project.
The Hampton Roads Sanitation District (HRSD) faced an aggressive regulatory schedule and a complex technical challenge. First, to upgrade the York River Treatment Plant by 2011 to meet “limit of technology” nutrient reduction goals established for tributaries of the Chesapeake Bay by the Virginia Department of Environmental Quality. The second, to double the capacity of the York River Plant from 15 to 30 mgd by 2016 to meet the wastewater treatment needs on the Lower Virginia Peninsula.

Additionally, HRSD needed to provide on-site biosolids disposal facilities in accordance with their District-wide biosolids management plan. Options considered for the York River Treatment Plant included building either an incinerator, dry-pelletizing facility, or composting facility.

Enlisting Malcolm Pirnie, Inc. as their consultant, HRSD developed an innovative solution — a step-feed BNR process for nitrification and partial denitrification, chemical addition for phosphorus removal, denitrification filters to provide “limit of technology” nutrient removal, and a biosolids processing facility in a beneficial, cost-effective, environmentally sound and publicly acceptable manner.

The biosolids processing facility successfully addresses biosolids management issues by converting about 50,000 pounds per day of biosolids into a product already marketed by HRSD as a beneficial soil conditioner and plant food supplement under the Nutri-Green® label.

The York River Plant expansion will sustain economic development on the Lower Virginia Peninsula over the next 20 years while protecting water quality in the York River and Chesapeake Bay for future generations. State-of-the-art odor control facilities will result in no off-site objectionable odors. Construction of the project is being phased over an eight year period to reduce the financial impact on the rate payers by spreading the project cost over several years.

**ENTRANT:** Malcolm Pirnie, Inc., and Hampton Roads Sanitation District

**ENGINEER-IN-CHARGE:** James P. Noonan, P.E., BCEE

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Facing extensive droughts and continued population growth, the Orange County Water District (OCWD) and the Orange County Sanitation District (OCSD) implemented an innovative solution for providing safe drinking water to the citizens and business in Orange County. This 70 mgd, $480 project was designed by CDM.

OCWD hired CDM to design a solution that minimized the impact of extended area droughts and met the increased demand for potable water. The GWR System is expanded to 130-mgd and treats effluent with a multi-barrier approach – microfiltration for pretreatment, reverse osmosis for purification, and ultraviolet light for disinfection – removing bacteria, emerging contaminants, chemicals, and viruses. Following treatment, the purified water is injected into an underground seawater barrier or percolated into aquifers before becoming part of the drinking water supply for the county’s residents. Taking advantage of a water source that was formerly discharged into the ocean helps protect the environment and maximizes a readily-available supply.

As part of the project, CDM also designed supporting chemical systems, onsite buildings, an electrical substation, three water pumping stations, more than 13 miles of pipeline to transport the water to recharge basins, 3 miles of barrier pipelines, and 16 injection wells on eight different sites. CDM performed groundwater modeling to determine the optimum placement of injection wells used to prevent seawater intrusion. In addition, the firm provided bidding support and construction services – preparing seven major construction contracts on time and on budget – operations and maintenance services, operator training, and assisted in facility startup.

This pioneering advanced water purification facility helps drought-proof Orange County while providing safe, potable water to a growing population in an environmentally friendly and energy efficient way.

**TOP LEFT**
The stainless steel air manifold connects to each MF membrane module with a flexible hose. During the MF backwash operation, air is forced through holes in the bottom of the membrane modules, gently agitating or “scouring” the surface of the membranes to remove debris.

**TOP RIGHT**
Orange County Water District’s new $480 Groundwater Replenishment (GWR) System, which will provide indirect reuse potable water from treated effluent to more than 144,000 households in Orange County, California.

**BOTTOM RIGHT**
During the final phases of disinfection, UV light combines with hydrogen peroxide to create an advanced oxidation reaction that breaks down any organic compounds.
With the completion of the $660 million Contract 35, part of the $3.5 billion “mega” upgrade of the Newtown Creek Water Pollution Control Plant, the New York City Department of Environmental Protection has complied with federal deadlines on its single largest project to date. Under a Consent Order to meet USEPA secondary treatment standards at the 310 mgd capacity Newtown Creek Plant, new treatment and conveyance facilities are being built. The joint venture design team of Greeley and Hansen, Hazen and Sawyer and Malcolm Pirnie are responsible for Contract 35, which includes phased construction of the new North Battery and reconstruction of the north half of the Central Battery.

The challenge of completing construction and placing the new Batteries into operation in less than 40 months to meet the Consent Order, while maintaining continuous operation and treatment performance of the existing Batteries, required creative planning strategies and extensive teamwork between design, construction, and operations teams. With expansion capabilities limited, Malcolm Pirnie’s state-of-the-art in-house Hydraulic Profile model simulated the complicated interactions between new and existing facilities, enabling the team to develop, test and modify, and redirect loading and flow to balance startup of new tanks with others taken off line.

Design services were provided on-site during construction by design engineers who reviewed drawings and submittals, made design changes, and prioritized design response to pending issues. With the timely startup of the North Battery, the engineers were able to confirm the effectiveness of an enhanced “Track 3” process, developed to produce secondary treatment without building new primary treatment tanks. This will ultimately save $600-800 million in tankage not constructed, and preserve space for future facilities.

To accommodate shortened delivery times, the engineering team developed new Construction Services Information Systems that support team collaboration and provided timely access to critical project information.
Like California and other arid western states, the water supply in Redwood City is critically important. Redwood City decided that the most sustainable way to meet the city’s current and future water supply needs was to increase conservation efforts and implement a recycled water program.

It took the Redwood City seven years to take the water recycling program from pilot project to city-wide delivery system. In that time, the city dealt with public opposition, joint-ownership by two public agencies, and difficult design issues to solve the city’s water supply problems. During the approval process, a group of residents from Redwood Shores objected to “mandatory use” of recycled water in residential areas, parks, and schools and launched a campaign to stop the use of recycled water. The City Council revised its mandatory use ordinance and formed a community task force comprised of community residents, who were for and against the project study, to study the issues. The Task Force met for a year, gathering recommendations for achieving the Redwood City’s water supply goals and meeting the concerns of the community.

Kennedy/Jenks Consultants was the prime consultant that led the construction of treatment, disinfection, storage, pumping, and pipeline facilities and the on-site retrofit of customer irrigation systems. Additionally, Kennedy/Jenks were able to convey the complex water qualities to both the City Council and the community.

The project included innovative design features such as construction of the water reclamation facility 20-feet below ground in bay mud. To improve filtration at the Water Reclamation Facility, Kennedy/Jenks replaced the existing media with large-scale moni-media to significantly increase filter run times. Another innovative feature was the design of a pipeline that passed through a national wildlife refuge and wetland, a major highway, and a built-up industrial area.
At the 22,000-acre Massachusetts Military Reservation, the team of Massachusetts Military Reservation for the Air Force Center for Engineering and the Environment (AFCEE) and CH2M Hill operates and manages 8 major groundwater extraction, treatment and re-injection/infiltration/discharge systems, treating 16 million gallons of contaminated water daily. In addition to its environmental restoration objectives, the team stresses continuous, program-wide optimization, minimizing taxpayer costs while enhancing cleanup efficiency.

This Superfund site is located within the boundaries of three towns and boarders on a fourth with a sole source aquifer that provides drinking water for 200,000 permanent and 500,000 seasonal residents of Cape Code. Multiple plumes, containing an estimated 20 billion gallons of contaminated groundwater, extend outward from their source. Thousands of monitoring wells and complicated models are used to predict the fate and transport of the contamination and measure the effectiveness of the treatment systems.

The energy costs to operate the 100 extraction and re-injection wells and eight groundwater treatment plants to treat the over 16 million gallons of VOC-contaminated water per day through forty five 20,000 pound GAC units utilized for cleanup exceeds $1 million annually. The AFCEE/CH2M Hill team designed a wind turbine generator to utilize Cape Cod winds to reduce the project’s energy footprint. This generator will provide green, sustainable energy that will reduce the systems’ energy consumption up to 25 percent in addition to eliminating over 6.7 million pounds of CO₂ annually and reducing other air emissions produced in electricity generation.

The AFCEE/CH2M team continues to seek ways to streamline process, improve quality, and reduce costs. Optimization initiatives over the last two years have saved AFCEE approximately $1 million to $4 to day. The team takes an aggressive approach to LTM optimization, negotiating reduced sampling and hydraulic frequency monitoring and increase on-site lab capabilities for drinking water methods.
Containing no river or ocean outlet, Palmdale faced a complex challenge regarding its wastewater. The Palmdale Water Reclamation Plant (PWRP) had traditionally practiced land disposal of its 8 million gallons per day of effluent produced oxidation ponds. Due to the nitrogen impacts on shallow groundwater reservoirs in this area, this practice was no longer acceptable.

The Sanitation Districts of Los Angeles County (District) was tasked with providing an innovative and cost-effective solution that promoted sustainability through the use of local resources in the community, integrated protection of local water resources with reduced energy usage, and provided flexibility for future growth. The District developed a plan to maximize agricultural reuse of its water in the short term, while developing the infrastructure to provide high-quality recycled water in the long term.

The principal benefit of the program was to bring the facility into regulatory compliance while accommodating ongoing growth in the community. The use of recycled water for growing hay also improved the local water supply by supplanting the use of groundwater for this purpose elsewhere in the valley. Irrigation of perennial crops with recycled water on previously farmed farmland resulted in the creation of wildlife habitat and greatly reduced fugitive dust. The benefits to the local farmers who have partnered with the District on this program include savings in energy costs of 95% over pumping groundwater and 99% over importing surface water for irrigation of crops. This energy savings represents a greenhouse gas production decrease of approximately 20,000 tons per year of carbon dioxide over alternative water supply. The 12,000 tons of valuable crops produced as part of the program contribute to the success of the valley’s farming community by providing jobs and fulfilling a growing market demand at local dairies.
Researchers at Iowa State University have come up with a novel way to make corn-to-ethanol plants more efficient. Corn ethanol plants in the US currently produce 8 billion gallons of ethanol per year while consuming about 35 billion gallons of water. Using a fungal cultivation process, these researchers have found a way to address all of these shortcomings.

Stillage from fermentation, followed by distillation, contains fiber, yeasts, and dissolved organics in water, measured as total chemical oxygen demand (COD) of nearly 100 g/L. Most solids are removed by centrifugation and dried to distillers dried grain (DDG). The centrate, thin stillage is partially recycled directly to the fermentation process, but limited to 50% to prevent build-up of total and dissolved solids. The remaining thin stillage is currently concentrated by flash evaporation and blended with DDG, producing DDG with solubles (DDGS). DDGS is used for livestock feed, but is low in essential amino acids, which limits its usage, particularly for hogs and chickens. Fortunately, thin stillage contains biodegradable organic compounds, sufficient micronutrients, at pH 4.5, which makes thin stillage an ideal fungal cultivation feedstock.

A fungal treatment process for thin stillage allows for energy savings by avoiding stillage evaporation, recovery of protein-rich fungal biomass, and potential for water recycling of treated effluent. Solids separation and removal of organic materials are important for recycling the effluent as process water. This research investigated the cultivation of the food-grade fungus Rhizopus microsporus on thin stillage and the potential for water recycling.

Energy savings from eliminating stillage evaporation could save $800 million/year nationwide and reduce water consumption by 10 billion gallons per year. The potential revenue from high-quality livestock feed production is expected to be worth another $400 million/year while leading to healthier meat products. This process (Fungal) is being patented.
Jordan receives an average annual rainfall of less than 8 inches and with desert covering more than 75 percent of its area, this fast-growing, arid nation’s demand for water exceed its supply by 150 billion gallons in 2005.

The Reuse for Industry, Agriculture, and Landscaping (RIAL) project, funded by the U.S. Agency for International Development (USAID) and implemented by CDM, aims to meet Jordan’s water use challenges and provide models for reuse application that can be replicated throughout Jordan.

Addressing the needs of agricultural, industrial, and municipal uses, the project advances Jordan toward its goal of 100-percent reuse of its wastewater through practical projects and educational programs. The project sets examples that can be easily duplicated—and that provide immediate benefits—such as millions of dollars in cost savings for businesses, increased crop yields for farmers, and new parks for citizens’ enjoyment.

CDM developed precedent-setting water reclamation projects that address agricultural development, industrial applications, and urban landscaping, delivering an effective, integrated approach that provides water reuse models nationwide. Additionally, CDM implemented various water and money-saving measures at five industrial facilities: a petroleum refinery, mining site, clothing factory, dairy, and beverage plant. Planned future improvements include a centralized industrial wastewater treatment plant that will reduce energy consumption, conserve water, and recycle 300,000 gallons of wastewater per day.

Reclaimed water is a critical component to ensuring sustainable water resources for Jordan. Located in the heart of the Middle East, this progressive, fast-growing nation is one of the ten most water-deprived countries in the world. Despite its advantages, water scarcity threatens the public health of citizens, prevents economic development, and limits future possibilities. The successful implementation of the 3-year RIAL project ensures sustainable water reuse practices will continue to grow and benefit the citizens of Jordan.

**Reuse for Industrial, Agriculture, and Landscaping (RIAL)**

AMMAN, JORDAN

**ENTRANT:** CDM

**ENGINEER-IN-CHARGE:** Mehran Meserlian

**TOP LEFT**

With an annual rainfall of less than 8 inches per year and desert covering more than 75 percent of its area, Jordan’s demand for water is projected to exceed supply by 53 billion gallons per year by 2020.

**TOP RIGHT**

The purple pipes in this view of urban landscaping on “Environment Street” in Amman are a standard sign of reclaimed water use.

**BOTTOM RIGHT**

RIAL team members conducted a public education campaign featuring a newly-created cartoon character, Tartoush (the Arabic word for “Splash”), who is decorated on backpacks, pens, jigsaw puzzles, coloring books, and other items to remind schoolchildren to “keep our water clean.”
South Bethany is planning to flush its polluted inland canals with seawater using a pump system powered by a 100-percent renewable energy— the tides. The team of Oceaneering International Inc. and KCI Technologies Inc. evaluated the feasibility and developed preliminary designs for the innovative tidal pump, which will move water from the polluted dead-end canals to the Atlantic Ocean and return clean seawater through a network of underground pipes.

Poor water circulation and flushing, sediment accumulation, low oxygen levels, excessive nutrients, and pollution have led to declining shellfish communities, pungent and harmful algae blooms, and fish kills.

Based on a concept developed by former councilman and retired engineer, Lloyd Hughes, the team explored possible scenarios for alignment, configuration, materials and construction methods to define the operability of a tidal pump. Effective hydraulic analysis posed a crucial design challenge because the average tidal difference between the canals and the ocean is only two feet, causing the system to operate at extremely low velocities. To deliver the required circulation through the pipes, each component had to be optimized for flow performance by reducing friction wherever possible. Site conditions and environmental factors such as wave force, scour, ocean depth, storm and wave frequency, and marine growth were closely considered and modeled.

The tidal pump will utilize almost two miles of underground pipes with two ocean outfalls located 30 feet below sea level. Since the tidal heights of both bodies of water work in opposition, water will alternately flow back and forth without the use of man-made energy. Once constructed, residents could see improvements in water quality in as little as a month. The tidal pump will fully circulate the water in the canals every 30 days.

**TOP**
The first of its kind, the tidal pump system will utilize almost two miles of underground piping, two ocean outfalls located 30 feet below sea level, and an innovative diffuser system configured to dissipate velocity during the exchange.

**BOTTOM RIGHT**
Engineers explored alignments, configurations, materials and construction methods to further define the tidal pump concept, its potential cost and implementation schedule. The team proposed a fully-closed system, similar to a low pressure water distribution system. To improve flow integrity and reduce head loss, pipes will remain full at all times, while the tidal head provides the pressure to move ocean and canal water through the system.