Texas Water Savers
News of Water Conservation and Reuse in Texas

Volume 5, Number 4, Fall 1999

Model matches industrial water discharges with input needs

Wastewater treatment and reuse within an industrial facility is commonplace, driven by the combination of rising water costs, heightened competition for supplies, and the need to comply with waste discharge permits. Most industrial wastewater reuse focuses on process modifications within one plant. Very little attention has been given to water exchange among industries, although the potential for reuse would be extended.

But research by a University of Texas engineering graduate student makes a compelling argument that the idea can be taken even a step further--recycling within an industrial complex.

It is feasible--and desirable--for treated wastewater to be reused by several different industries by matching water quality and quantity to industrial application. For example, a much higher quality water is needed for boiler feed or silicon wafer fabrication than is required for cooling tower make-up, acid scrubbers, or irrigation.

The industrial community was perhaps the first sector to realize the value of water--and wastewater--as a commodity in a fabrication process. Making maximum use from that commodity is a win-win situation, both from a financial and environmental standpoint.

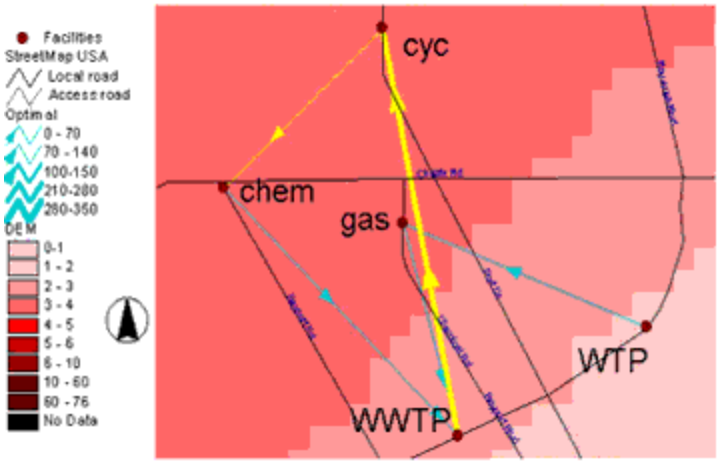
By matching by-products and wastes to other industries' input requirements, and analyzing optimal exchanges in a map-based display, industries can determine advantageous water exchange strategies using a model developed by Carolyn Nobel, who recently earned a master of science degree in environmental engineering.

Nobel's research, under the direction of David T. Allen of the University of Texas Department of Chemical Engineering, is couched in the emergent field of industrial ecology.

The University of Texas campus presents a good example of interplant use. A network of pipes (some retrofitted, now required all new construction) captures the flow from water-cooled research equipment, drinking water chillers, groundwater and even condensate from chilling station compressors for use as cooling tower make-up and for irrigation. Even groundwater captured in french drains from and swimming pool blowdown is used for irrigation, said Rusty Osborne of the university's Department of Utilities and Energy Management. A new system diverts cooling tower blowdown to a reverse osmosis unit,

where it is cleaned up an returned to the nondomestic recovered water system. Recovered water accounts for more than 8% of total university consumption.

San Patricio Municipal Water District is implementing a plan for serial industrial water use. A cogeneration steam electric generation plant pumps 6 million gallons per day (mgd) of raw Nueces River water for cooling tower makeup. About 2 mgd evaporates, and the 4 mgd balance is sent to Reynolds Metals for use as process water in its aluminum plant. (See related article, page 10.)



CHEM	chemicals and preparations
CYC	cyclic organic crudes
GAS	industrial gases
WTP	water treatment plant
WWTP	wastewater treatment plant

Scenario	Freshwater use (1000 gal/day)	Cost ($/day)
Without reuse	477	4,540
With reuse	86	3,696
Reduction	**82%**	**19%**

Water exchange network in which supply and demand constraints are met at minimum cost and maximum water reuse. Path widths on the map are graduated to correspond to flow rates. Table shows quantitative water and cost savings for the above scenario.

Industrial ecology is a framework for developing and analyzing integrated material flows. Interestingly, industrial ecology seeks to optimize materials exchange by mimicking closed-loop cycles of natural ecosystems.

Using that framework, Nobel has built a model that systematically identifies optimal cost- and water-saving scenarios for water reuse among industrial plants.

The model is both a quantitative and visual tool, generating data on costs and water savings, as well as displaying possible wastewater exchange opportunities on maps generated by a geographic information system (GIS). The maps can help clients visualize these exchange paths.

Integrating the optimization process with a GIS offers the benefits beyond those of visualization. "Since GIS analysis often suggests new insights and explanations that might go otherwise unrecognized, it can be vital to understanding and managing resources. GIS is commonly used as an analysis tool for decision-making," Nobel said.

Industrial ecology is a framework for developing and analyzing integrated material flows

"For example, conveyance and distribution systems make up the principal costs of water exchange projects; these costs depend primarily on geographic considerations such as distance between distributor and receiver, and elevation differences."

Model development involves three major steps: basemap construction, water exchange identification, and optimization.

The first step in any GIS project is to create a basemap consisting of data layers. Each layer has a corresponding table with descriptive information about each element, called themes. Themes important to reuse include water quantity and water quality, facility location, and relative elevation.

After a basemap is created, the model tests each feasible exchange, taking into account influent and effluent parameters. Matches are identified by a pathway on the basemap.

Industrial ecology seeks to optimize materials exchange by mimicking closed-loop cycles of natural ecosystem

Given all feasible options, the model determines optimal solutions for the network using a linear program, with the objectives of minimizing the costs to purchase, treat, and transport water through the arcs or to maximize reuse. Sometimes optimizing costs to reduce infrastructure expenses (and therefore fewer exchange paths) will result in slightly less water conservation, Nobel said.

"Industrial ecology tenets are beginning to be applied in the development of `eco-industrial parks' (EIPs)--complexes where by-products of material and energy use are seen as potential feedstocks instead of burdensome wastes," said Nobel.

For her research, Nobel applied the model to the Bayport Industrial Complex in Pasadena, Texas. The Bayport facility of the Gulf Coast Waste Disposal Authority supplied effluent quality and quantity data. A range of influent requirements was estimated based standard industrial category (SIC) codes.

In the example on page 1, a small network would realize a 82% decrease in water use and a 19% decrease in cost over a traditional use-and-discharge scenario. (See table.)

Nobel presented her findings at the Alternative Water Strategies Conference September in Austin.

By mimicking the closed-loop energy flows of natural ecosystems, industrial ecology promotes sustainable and efficient materials cycles. A systematic approach provides a quantitative structure to compare possible water reuse relationships.

The Brownsville Economic Development Council (BEDC) considered implementation of the proprietary "industrial symbiosis" model of Bechtel Consulting at its industrial park, but ultimately, the park was built in a conventional design.

Publicity about the industrial symbiosis idea generated a such great interest, however, that materials exchange is always a consideration when the BEDC considers new prospects interested in relocating. "The project did lead us to understand the synergies of symbiosis," said Marie McDermott, BEDC president. The Council is now working to attract another high-water-volume company by proposing to deliver reclaimed wastewater of a quality matched to the company's needs.

The Bechtel Consulting engineer in charge of the project, David Cobb, however, suspects that the detailed research and analysis required to arrive at operational exchanges may hinder projects.

"Each industry we recommend for a materials exchange need sto be researched in quite a bit of detail, and worked on as seriously as you would any other business prospect," said Cobb. "At the time, I thought a good idea like regional industrial symbiosis would generate enough interest in the BEDC to implement itself, but that was an incorrect assumption."

By matching wastes to other's input requirements, industries can determine advantageous water exchange strategies

The idea of developing an interfacility reuse network is a still-evolving technology. Resistance, at present, comes from the notion that resources are inexhaustible, from the prevailing myth that business profitability and environmental protection are incompatible, and from companies' fear of liability and loss of autonomy. By incorporating the the tenets of industrial ecology into industrial park design, both environmental protection and profit goals can be served.

Nobel can be reached at cnobel@mail.utexas.edu or (512) 232-4121. Her web site is http://www.ce.utexas.edu/stu/nobelce. David T. Allen can be reached at (512) 471-0049 or allan@che.utexas.edu.

County agents immersed in rigorous course

After a rigorous course in landscape water conservation, a handpicked group of County Extension Agents (CEAs) are poised to amplify the message of water-use efficiency throughout the state.

Eighteen CEAs picked by District Extension Directors spent 1.5 days learning about municipal water issues, turfgrass and plant selection, landscape maintenance for efficient water use, use of recycled water in the landscape, drip irrigation, irrigation auditing, and plant disease and pest management, and another 1.5 days learning something equally important--effective delivery methods. This professional development course is taught by an interdisciplinary team of horticulturists, an agricultural engineer, a landscape architect, a turfgrass specialist, and a water quality specialist.

"There had been an outcry for more specialized training, for more rigorous, hands-on professional development opportunities among county extension agents," Don Wilkerson, theTexas A&M University horticulturist who coordinated the course."We offered three days of very intensive training on a fairly specialized topic."

"The agents will return to their counties armed and fully loaded with methodologies, knowledge, and tools to conduct effective programming," said Wilkerson.

Among the tools agents take to their counties are catch-cans and data-recording sheets for irrigation audits, a slide set, news releases, publications for distribution in their counties, and a web site (http://aggie-horticulture.tamu.edu/greenhouse/new/training/training.html) custom-tailored to landscape water conservation needs of county agents.

News releases available to agents include: *Water Efficient Practices for Saving Your Landscape, Urban Water Conservation Strategies for Homes, Statewide Water Crisis Calls for Conservation*, and *Less Thirsty Landscapes*. A plant list is also included.

"Using the materials available on the web site, agents can cut and paste to create customized materials," said Wilkerson

For more information contact Wilkerson at 845-7341 or d-wilkerson@tamu.edu.

WRAP river basin simulation software available from TWRI

An updated user's manual and software for water availability modeling and the analysis of surface water rights is available from Texas Water Resources Institute.

The *Water Rights Analysis Package* is the system simulation modeling software chosen by the Texas Natural Resource Conservation Commission, after an international search, for modeling Texas' 22 river basins. The FORTRAN software is available on a 3.5-inch PC-compatible diskette.

Reference and User's Manual for the Water Rights Analysis Package (TR-180) by Texas A&M University Civil Engineering professor Ralph Wurbs simulates water resources management of a river basin or multiple-basin region under a priority-based water allocation system. The software assesses capabilities for meeting specified water management/use requirements during an unlimited period-of-analysis based on naturalized streamflows and reservoir net evaporation-precipitation rates.

To order *WRAP*, send check for $35 to Texas Water Resources Institute, 2118 TAMUS, College Station, TX 77843-2118.

Rally shows support for plumbing efficiency act

At a rally opposing repeal of uniform national plumbing standards, Sen. Buster Brown, pictured above, said, "The cheapest source of water is conserved water." Rally attendees directed a message to Texas' Congressional delegation urging support of the existing standards.

Despite serving as a fertile source of material for humor columnists, HR 623, better known as the Knollenberg Bill, is serious business.

In early November, about 100 state lawmakers, water industry professionals, environmentalists, large and small utilities, groundwater districts, and environmentalists gathered on the State Capitol steps, united in opposition of the bill repealing plumbing fixtures provisions of the 1992 Federal Energy Act. The November 3 press conference was covered by local and national media.

The U.S. House Bill would remove the law requiring 1.6-gallon-per-flush toilets and 2.5-gallon-per-minute showerheads, technology for which the plumbing industry retooled, whose use has proven large water savings, and with which customers report a high degree of satisfaction. Part of the resistance to these fixtures is, in some part, due to the inefficiency of older models.

The water conserved and associated energy savings resulting from use of these plumbing fixtures is significant. In Texas, long-term savings of 840,000 acre-feet per year (750 million gallons per day) are projected for 2050, enough water to serve the domestic needs of 12 million customers.

"As Texas goes, so goes the rest of the country," said Carole Baker, chair of the Conservation and Reuse Division, Texas Section American Water Works Association.. Texas' own plumbing standards law requiring 1.6-gallon-per-flush toilets and 2.5-gallon-per-minute showerheads was passed in 1991. One of the driving forces for a federal standard was to avoid 50 different state standards.

A "Texas-sized" letter signed by rally participants will be sent to the Texas delegation in Washington urging them to oppose H.R. 623. Texas Rep. Joe Barton serves on the House Subcommittee on Energy and Power, to which the bill is now referred.

Not only are plumbing standards at stake. According to the Texas Water Plan, 12% of projected demand is

expected to be met by conservation

As Sen. Buster Brown, the author of Senate Bill 1 said at the rally, "Texas is counting on conservation to supplement new supplies."

Rep. Ron Lewis, author of the House companion to SB1, said, "Let's not jeopardize our children's future by wasting water."

Rep. Robert Puente of San Antonio recounted how the San Antonio Water Systems toilet rebate program has saved 333 million gallons a year in just residential use.

Ed Archuleta of El Paso Water Utilities credited ULFTs with contributing to a 20% decrease in water use, from 201 to 164 gallons per person per day, one of the lowest per capita uses in the state.

San Antonio: doing business with less water

Eleven San Antonio businesses and governmental entities were named 1999 Best Practices Award winners for water conservation by the San Antonio Water System (SAWS). The program recognizes organizations that have developed means to further water-use efficiency, have created educational programs, or have designed and distributed new water-saving technology.

Northside Independent School District partnered with SAWS in a grant which allowed installation of computer-controlled irrigation systems at six campuses tied to a weather station furnishing weather and evapotranspiration data for more efficient irrigation. NISD was the first school district to implement SAWS' toilet retrofit program, committing to replace 508 toilets and urinals with low-flow fixtures. Both practices will save the district up to 10 million gallons of water annually.

Encino Park Homeowners Association passed recommendations supporting water-use efficiency, including a community education program, irrigation system retrofits, and incentives for installing water-wise gardens.

Kangaroo Court Restaurants of Texas replaced water-cooled ice machines with air-cooled models, saving almost 2 million gallons of water over an 8-month period.

Al's Master Lube and Car Wash designed their facility to capture rise water and reuse it for landscape irrigation and cleaning, saving 25,000 gallons per year.

Sony Semiconductor of America, for water reclamation processes and changes in its manufacturing process that saved nearly 65 million gallons of water between 1997 and 1998.

University Health System, for modifying cooling tower and chilled water systems, resulting in a savings of 4 million gallons of water annually. University Health System also inserts water-saving ideas into its weekly employee newsletter.

City of San Antonio Automotive Operation Division, for configuring all city-owned automated car washes to operate with recycled water, saving 150,000 gallons per month.

North Valley Mobile Home Community, for submetering water use, which allows residents to pay only for the water they use, and makes leak detection easily recognizable and a higher priority for residents. Since submetering, the community as experienced a 33% drop in water consumption.

W.B Waterless Car Wash, for using environmentally safe, biodegradable chemicals to clean the inside and outside of vehicles without the use of water.

Greywater Recycling, for installed a dual-piped, separated-waste-stream greywater reuse system in its Palladium Villas development. Water consumption data collected from May 1998 to March 1999 on a 2,400-square-foot living area with two occupants showed the system captured 47,000 gallons of greywater for landscape irrigation.

Ewing Irrigation, for developing a custom irrigation system. The home, sited on a hill, was exposed almost constantly to wind. To avoid the effects of evaporation, Ewing developed a system of drip irrigation and turf bubbler heads.

Six organizations were recognized with the "honorable mention" 1999 Water Saver Too awards: Habitat for Humanity of San Antonio, Alamo Concrete Pavers, International Bank of Commerce. V.K. Knowlton Paving Contractors, U.S. Brick, and Brooks Air Force Base.

Hoffman joins City of Austin staff

Bill Hoffman, a stalwart of the Texas water conservation for more than three decades, has left his position as chief of the Water Conservation Division at the Texas Water Development Board to become a water conservation specialist for the City of Austin.

Hoffman, who has served more than 26 years at TWDB, is known for his enthusiastic promotion of alternative water strategies, such as reuse, rainwater harvesting, desalting, and waterwise landscaping. His final position at TWDB was chief of municipal, industrial, and agricultural water conservation.

With degrees in chemical and environmental engineering, Hoffman brought problem-solving ability to his vision of challenges and their solutions bearing upon Texas' water future. He has been a veritable goodwill ambassador of water-use efficiency and reuse. He initiated TWDB's industrial, commercial, and institutional conservation programs, including the popular seminars benefiting the hospitality and health care industries.

Under his guidance, a statewide survey of industrial water use efficiency was commissioned.

"Bill Hoffman has truly been the ultimate champion of water conservation and reuse in Texas. Ideas he started out with 10 to 20 years ago are now standard procedures in the water industry, not only in Texas but throughout the United States. It is my belief that Texans would be much less prepared during times of drought, if not for the tireless, diligent efforts of Bill Hoffman," said Bill Mullican, Director of Water Resources Planning for TWDB.

Hoffman was recognized with the semiofficial "Water Conservation Guru" award for 1997 by the Conservation and Reuse Division, Texas Section, American Water Works Association. He is also a cofounder of the Division.

Hoffman and his staff have been in the national forefront of the development of guidelines for water conservation and drought contingency planning. Hoffman also originated the idea and secured initial funding for *Texas Water Savers,* this statewide newsletter covering water conservation and reuse.

TNRCC reviews larger system drought plans

by Bill Billingsley,
Program Administrator
Water Conservation and Drought Management Team
Texas Natural Resource Conservation Commission

Wholesale public water suppliers, irrigation districts, and retail water suppliers providing service to 3,300 or more connections were required to submit their drought contingency plans to the Texas Natural Resource Conservation Commission (TNRCC) by September 1. In addition, surface water right holders of 10,000 acre-feet or more for irrigation use and holders of

1,000 acre-feet or more for nonirrigation use per year were also required to submit water conservation plans. The TNRCC adopted these requirements (Title 30, Texas Administrative Code, Chapter 288) to carry out the mandates of Senate Bill 1, passed by Texas Legislature in 1997.

During the spring, the TNRCC and the Texas Water Development Board jointly conducted 16 drought planning workshops throughout the state to assist those entities required to prepare a drought contingency plan. More than 600 individuals representing 406 different entities participated in the workshops.

There has been an 80% compliance rate for the water conservation plan. Many of those not in compliance were unaware of the requirement to submit plans. The TNRCC Water Conservation and Drought Management Team has sent a notice of nonreceipt to those entities which have failed to submit their required plan. The letter states, in part, "The TNRCC recognizes that the great majority of the regulated community wants to comply with environmental laws. However, if entities required to submit a plan fail to adequately respond, the TNRCC will consider exercising the enforcement powers granted by the Texas Legislature to carry out its mission to protect human health and the environment."

Aside from compliance with State rules, water conservation and drought contingency planning is simply a part of the responsible management and operation of a public water supplier.

The TNRCC is reviewing the submitted plans to assure inclusion of the minimum required elements. The most common deficiencies found thus far are the lack of documentation of coordination between the entity and their Regional Water Planning Group(s), and lack of evidence of official adoption of the plan. A municipality's drought contingency plan must be adopted by ordinance in order to be enforceable; utility boards, districts, and river authorities adopt their plans by resolution. Some plans have failed to include procedures for granting variances or exceptions to the plan.

Another common omission is a description of the public's opportunity to provide input to the drought contingency plan. SB1 emphasized public involvement in water planning. Also, it makes sense to involve customers from the start so public entities can count on cooperation of the citizenry when most needed--during a drought.

TNRCC has prepared a Model Drought Contingency Plan. To receive a digital or print copy of the model plan, call the TNRCC Water Conservation and Drought Management Team, (512) 239-4730 or e-mail: bbilling@tnrcc.state.tx.us. Using the model as a template and adapting it to fit particular systems will insure meeting the minimum requirements for drought contingency plan contents.

Texas Administrative Code can be accessed at http://lamb.sos.state.tx.us/tac/.

Small Systems Drought Contingency Planning Help

While the 4,000 retail water utilities serving fewer than 3,300 connections are not required to submit drought contingency plans to the TNRCC, they are required to complete them by September 1, 2000.

The TNRCC is teaming with the Texas Water Development Board and the Texas Rural Water Association in a series of workshops around the state to assist smaller suppliers in developing drought contingency plans.

Each 4-hour workshop, targeted at directors, managers, and operators, will provide current information and guidance on the preparation of state-mandated drought contingency Plans. Senate Bill 1, passed by the Texas Legislature in 1997, requires all public water suppliers to prepare and adopt a drought contingency plan no later than September 1, 2000.

Each workshop participant will receive a drought plan template and a guide to public notification and education. Each workshop will include a peer exchange session for sharing successful strategies.

Workshop topics include--

- Conservation Planning v. Drought Management Planning
- Enforcement Procedures
- Contingencies: Drought/Emergency Demand
- Drought Response Stages
- Management Measures
- Water Management Strategies
- Public Notification and Involvement
- Customer Education and Notification
- Draft Plans and Examples
- Coordination with Regional Water Planning Groups

City	Date
Denton	Feb 10
Alice	Feb 17
San Marcos	Feb 24
Longview	Mar 7
Victoria	Mar 9
Dallas (TRWA)	Mar 16
Waco	Mar 21
Lufkin	Mar 23
San Antonio	Mar 30
Amarillo	April 4
Dallas (AWWA)	April 7
Odessa	April 13
Austin (TNRCC)	May 3

To register, call TRWA, (512) 472-8591, or visit the TRWA web site at http://www.trwa.org.

San Patricio squeezes reuse from new cogen plant

Don Roach of Patricio MWD inside a new microfiltration plant which will supply treated wastewater to a steam electric power generation plant.

As a result of creative resource sharing instigated by San Patricio Municipal Water District (MWD), raw water from the Nueces River will be doing double duty--serving cooling towers at an steam electric power generation plant, then pumped to a metals factory as process water.

The Coastal Bend of Texas is home to the second largest concentration of industrial processing plants in Texas. Industries need both power and water to operate, both of which are in short supply in the region. An innovative approach by a local utility helps to solve both problems.

A new cogeneration steam electric power plant in Gregory, across Corpus Christi Bay from the city of Corpus Christi, will pump 6 million gallons per day (mgd) of raw water from the Nueces River for its cooling towers, said Don Roach, assistant manager of San Patricio MWD. Of that amount, 2 mgd will evaporate, and 4 mgd of blowdown will be routed to the adjacent Reynolds Metals Plant.

Currently, Reynolds contracts with San Patricio MWD for 9 mgd to process alumina from bauxite, but does not require high-quality water. Cooling tower blowdown is of adequate quality for the plant's Bayer process, in which a chemical slurry, pumped in a continuous loop, serves as both a transport and extraction medium. In fact, Reynolds even captures stormwater with earthen impoundments for use as process water. Once the power plant comes on line, blowdown from the power plant will replace 4 mgd of potable water now coming from San Patricio MWD. An added environmental advantage is the zero-discharge designation of the Reynolds plant.

To further diminish the Reynold's freshwater needs, the groundwork has been laid to pump treated wastewater from the Portland Wastewater Treatment Plant to Reynolds Metals for use as process water and as irrigation for its tailing beds.

"The current scheme will have Portland blending in treated sludge about two days per week. On those days, we will irrigate the tailings beds with it," said Tom Ballou, environmental quality superintendent at Reynolds Metals. "The other five days, the water can go directly into our process water lake as a substitute for raw water from the regional system."

Even the tailings bed irrigation water is recaptured. Ballou expects that of the 2.5 million gallons per week applied to the tailings beds, nearly 60% will eventually leach down and be returned as process water.

In another example of a symbiotic relationship, Reynolds receives sludge and secondary treated wastewater from the Aransas Pass wastewater treatment plant six miles away for dust control and remediation of its tailings beds (*Texas Water Savers,* Summer 1998).

"Every gallon of wastewater Reynolds uses is a gallon of river water they don't have to use," Roach said.

At the Reynolds Alumina Plant, large impoundments capture rainwater for use in processing alumna from bauxite. The refining process does not require high-quality water, but cannot use saline water.

But there's more.

The Gregory Power Partners plant is a cogeneration plant, meaning that it will furnish not only electricity to the power grid, but heat in the form of steam to Reynolds, cutting down on the amount of heat the plant must produce, and therefore, lessening the plant's energy requirements.

Cogeneration refers to putting to productive use the waste heat generated in steam electric power plants<

In a power plant, after pressurized steam drives turbines, the same steam, under less pressure is considered a waste product.

The Gregory power plant will serve Reynolds Metals with power and will also distribute power over the grid.

A second cogeneration steam electric power plant to be served by San Patricio MWD recently came on line at the OxyChem manufacturing plant in nearby Ingleside. To supply water to this plant, San Patricio MWD has built a microfiltration plant to clean up 3.2 mgd of Nueces River water. This particular microfiltration technology was developed to filter irrigation water in Israel during World War II.

This plant will supply electricity to OxyChem, DuPont, and Conoco facilities, with enough power left over for 75,000 residences. In addition, OxyChem will employ steam generated in the plant's natural gas-fired boilers in its manufacturing process.

San Patricio MWD is also exploring the feasibility of pumping wastewater from the Ingleside wasteater treatment plant to another customer for use as process water. San Patricio is testing the possibility of reducing chloride content from the wastewater at a

pilot plant. Chloride in this case comes from the Ingleside Naval Station fire training operations.

San Patricio MWD is working with Texas Natural Resource Conservation Commission to redirect wastewater discharges from Corpus Christi Bay to the Reynolds plant. Portland wastewater outflows are figured into release calculations.

"In times of moderate drought, Corpus Christi would be forced to release more water from Lake Corpus Christi into Corpus Christi Bay," Roach said. "Over the course of an entire year, however, the water balance would indicate that the volume of river water being saved would more than offset the diminished outflows from the Portland wastewater treatment plant."

The permit process is still ongoing with TNRCC.

"This is a worthwhile project, one which we are very excited about, and which will result in a great net savings of water," Roach said.

Roach can be reached at (361) 643-6521or spmwd@inconnect.net.

Water Reuse 2000, San Antonio

San Antonio will serve double-duty as both the host and the backdrop for Water Reuse 2000, a conference showcasing state-of-the-art reuse technology and international reuse projects January 30-February 2.

Jointly sponsored by the American Water Works Association and the Water Environment Foundation, the conference, which for the first time will feature a products and services exhibition, has been designed for professionals involved in all aspects of water reclamation and recycling, including golf course managers and agronomists.

Water Reuse 2000 closes with behind-the-scenes tours of water reclamation projects that have, according to the Journal of the American Water Works Association, "recycled water on a Texas-size scale, protected San Antonio's downtown from flood, and transformed a wastewater treatment project into a constructed wetland."

Presenters from the United States, Australia, Belgium, France, Japan, Saudi Arabia, Jordan, Mexico, and Spain promise to lend an international perspective to the conference.

Kicking off the dozen technical sessions on Sunday are workshops dealing with golf course irrigation, wetlands restoration, public education, and aquifer storage and recovery.

Other sessions focus on agricultural reuse, reuse planning, regulatory effects, water quality issues, environmental enhancement, reuse treatment technologies, project economics, indirect potable reuse, and dual distribution systems.

More information is available at http://www.awwa.org/00reuse/overview.htm.

Environmental awards laud water use efficiency

Three Texas entities were honored with 1999 Texas Environmental Excellence Awards for projects which conserved or recycled water.

The Governor's Texas Environmental Awards encourage stewardship of natural resources by recognizing voluntary, innovative, and effective programs.

North Plains Potential Evapotranspiration Network

The three agencies operating the North Plains Potential Evapotranspiration Network received the award for agriculture for a network of 10 weather stations situated across the North Plains providing daily evapotranspiration and weather data.

The North Plains Potential Evapotranspiration Network (NP-PET) (*Texas Water Savers*, Fall 1998) faxes data and analysis on rainfall, air temperature, humidity, wind speed, soil temperature, and solar radiation to 325 subscribers--growers, consultants, and the media. Using these data, growers are in a better position to make wise choices about the timing and frequency of irrigation.

The NP-PET network is a cooperative effort between the Texas Agricultural Experiment Station and the Texas Agricultural Extension Center at Amarillo, along with the US Department of Agriculture's Agricultural Research Service at Bushland.

The users of the NP-PET network (http://amarillo2.tamu.edu/nppet/petnet1.htm) manage 400,000 irrigated acres. Network officials estimate an annual groundwater savings of 62,500 acre-feet (more than 20 billions gallons) per year from the Ogallala Aquifer.

Motorola, Austin

Motorola's Austin fabrication plant reduces water use in three phases of its semiconductor manufacturing process.

First, Motorola squeezes more ultrapure water from its reverse osmosis (RO) process by forcing RO reject through a nanofiltration membrane using residual pressure remaining at the completion of the conventional RO process, according to Dana Lyon, plant services chemical engineer.

RO reject amounts to about 25% of the 600 gallons per minute continual flow of city water input to the RO process. By processing the discarded waste stream and feeding it back into the RO process instead of discharging it to the sanitary sewer, this system recovers and reuses an additional 86.7 million gallons per year. This reject-recovery system can be installed on to an existing RO system.

Second, by reducing rinse time and eliminating rinse steps. Motorola achieved a savings of 69.4 million gallons of water per year. A planned water recycling system will allow for great collection of an additional 10.5 million gallons per year.

And third, the manufacturer's facilities systems implemented several projects to reuse wastewater in cooling towers and scrubbers, netting a savings of 56.8 million gallons per year.

Motorola has transferred these technologies to plants in Arizona, Virginia, and China. Motorola was also recognized with the 1997 Bob Derrington Water Reclamation Award by the Conservation and Reuse Division of the Texas Section, American Water Works Association. (*Texas Water Savers*, Summer 1998)

Habitat Suites, Austin

The managing partners of Habitat House created an inviting hotel which at the same time supported their vision of a sustainable future. Their award-winning hotel is a model of environmental consciousness for its use of resource conservation, waste reduction, and recycling.

The hotel achieves water-use efficiency outdoors with a native- and adapted-plant landscaping. Indoors, low-flow plumbing fixtures are installed in each suite. Guests have the option of reusing linens. Such measures save almost 2,400,000 gallons of water per year.

Habitat Suites employees are rewarded for taking the initiative to suggest new "green" programs. An "Eco-Brochure" detailing programs is provided to guests, potential corporate client, other hotels, and environmental organizations.

Austin irrigation ordinance aims to cut peak summer demand

An ordinance change designed to reduce the City of Austin's peak day water demand and to ease summertime stress on the water system went into effect September 6.

From May 1 to September 30, Stage 1 provisions have been modified to include the following water use restrictions.

Irrigation by a permanently installed automatic sprinkler system is prohibited between 10 a.m. and 7 p.m., with the following exceptions--

- at a single-family residence
- at a commercial plant nursery
- using treated wastewater effluent or raw water
- during testing or repair of an irrigation system
- during and within 7 days of a new landscape installation

For all customers, wasting water is also prohibited, evidenced by the following--

• failure to repair a controllable leak, including a broken sprinkler head, a leaking valve, or a leaking faucet.
• operating a permanently installed irrigation system with a broken head, a head that is misting, or a head out of adjustment and spraying more than 10% of its spray onto a street or parking lot
• allowing irrigation water to run off a property or to pond in the street or parking lot to a depth of more than 1/4 inch.

In addition, all customers are encouraged to follow the city's voluntary five-day schedule during Stage 1.

"We are looking for the new watering ordinance to encourage customers to irrigate efficiently, thereby reducing peak day demand and overall consumption during the summer," said Water Conservation Manager Tony Gregg.

The City of Austin joins the City of El Paso in charging violators with a Class C misdemeanor with the possibility of a standard fine of $200.

The City of Austin offers free irrigation system audits that check for system leaks, water application rates, adequate landscape coverage, and help determine an efficient watering schedule specific to the location.

Study recommends fewer tiers, deeper steps

Compare the clear signal the price of gasoline sends to consumers versus that of the monthly water bill.

Gasoline is sold at a single, well-advertised retail price per commonly understood unit, and usually for a single end use. Consumers readily notice--and their consumption is often influenced by--a dramatic price increase.

Contrast the happily motoring public with the privately grumbling water customer who receives a monthly bill in difficult-to-understand units for a commodity with many end uses. Compound that with an increasing block rate structure, so that the marginal price is not known at the time of use.

Average water rate seems to have more impact than the tiered structure on discretionary water use

General Types of Customers Regarding Water Pricing		
Pricing Sensitivity and Knowledge	**Description**	**Approx. %**
Unconcerned and unaware	Water cost not important, does not track historical use, not knowledgeable of water rate structure, unaware of water/sewer link	25
Concerned but unaware	Water cost important, follows historical water use, not knowledgeable of water rate structure, unaware of water/sewer link	50
Concerned and somewaht aware	Water cost important, follows historical water use, somewhat knowledgeable of water rate structure and water/sewer link, not aware of average or marginal price	18
Concerned and aware	Water cost important, follows historical water use, knowledgeable of water rate structure and water/sewer link, aware of average or marginal price	7
Source: Whitcomb, John, *Water Price Elasticities for Single-Family Homes in Texas, Boulder, Colo., August 1, 1999*		

Marginal price is the amount paid for the next additional unit of water. In an increasing block rate structure, the next additional unit would have the highest per-unit cost.

It is no surprise, therefore, that more than three times the customers surveyed in three Texas cities reported more familiarity with gasoline prices than with water prices. But more important to rate structures is the fact that most customers are more aware of the average price of water than they are of the marginal price; that is, the cost per unit for the last unit of water used.

A study contracted by three Texas cities to assess the relationship between water use and price among single-family residential customers found that of those customers who made water-use decisions based upon their bills, most focused on the total bill amount. Only 3% of customers reported paying attention to marginal price in an increasing-block rate structure.

The cities of Austin, Corpus Christi and San Antonio Water contracted the study, *Water Price Elasticities for Single-Family Homes in Texas*, to test the hypothesis that block rates increase the price signal sent to customers to conserve water.

John Whitcomb, of Stratus Consulting, Boulder, Colo, who conducted the study surmised that the difficulty in understanding a tiered-rate structure compounded by indifference is responsible for the lack of a price signal. The increasing block is loosely termed a "conservation rate" structure, although customers' somewhat muddy perception of the concept seems to dilute its conservation signal to customers.

Whitcomb found a composite elasticity of -0.21. This figure means that for every 1% increase in the real cost of water, customers show a 0.21% decrease in water use. Despite the less than one-to-one relationship between price and conservation, pricing can still be a significant policy tool, Whitcomb said.

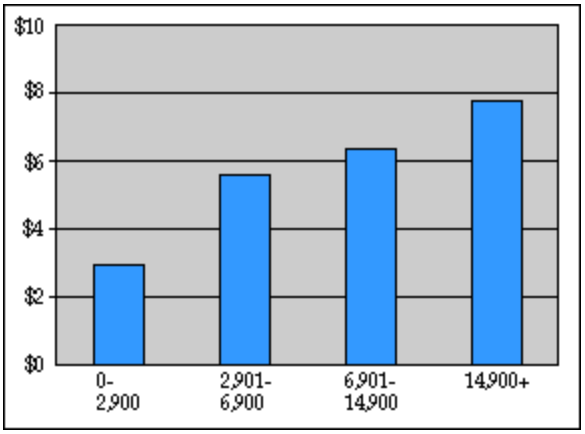
"Just because demand is inelastic, use of price as a tool to effect conservation is not trivial," said Whitcomb.

Customers have limited knowledge regarding the amount of water given to a variety of end uses.

Conclusions from the study include:

• Marginal water price is not known at the time water use decisions are made.
• Water is sold in hard-to-fathom units (usually thousand gallons)
• The water bill accounts for only a small fraction of disposable income, often less than 1%, and only 20% to 30% of the total utility bill.
• Very few customers realize that sewer fees are based upon winter water use.

City of Austin Water and Wastewater Rate Structure



Water use across the three cities, however, did indeed seem to obey the first law of economic theory, which states that as the price of a commodity goes up, the quantity demanded goes down.

With the highest rates of the three cities, Austin also showed the lowest average home water use during the period 1990 through 1997. SAWS, with the lowest rates, showed highest household water use.

The study controlled for variations in demographics, housing, income, and weather to isolate changes due to price alone.

In appears that although consumers do respond to price according to economic theory, the impact of water use on the monthly bill seems loosely linked in the minds of customers.

"Market research indicates that people are more or less oblivious to pricing structure, but not oblivious to the bottom line on their bills. The total monthly water bill, however, does impact how much turf area they have," said Whitcomb.

According to research results published in 1996 by Michael Nieswiadomy of the Department of Economics, University of North Texas, 30% of Texas utilities use increasing block structures, 62% use flat rates, and 8% use decreasing block rates.

Whitcomb recommended three steps to get customer to respond to marginal water rates--

• Simplify the rate structure. The study found that fewer than 25% of customers report understanding and considering the four- to six-block water structure employed by their agency. Almost one-third could not calculate a bill given a volume of use when provided with block thresholds. Whitcomb recommends a two-block rate structure with a more dramatic price difference and with a second block threshold set low enough that a majority of customers would be impacted.
• Promote knowledge of end-user water consumption. The report recommends water agencies provide customers with typical end-use volume information, such as installation of ultra-low flush toilets and irrigating in response to evapotranspiration rates.
• Improve water bill information. The water bill can be an important educational vehicle. Whitcomb recommends including the entire rate structure, rather than the cumulative effect of rate blocks. In addition, including historical water use may help customers better understand water use patterns. Specifically, it may help them assess the change in water use resulting from specific actions, such as more efficient use of landscape irrigation. The latter effect would also serve to decrease peak usage.

Tony Gregg, water conservation manager for the City of Austin, said his department was surprised at the lack of awareness of threshold of the highest block. "Since it is a significant rate increase at 14,900 gallons, we thought more customers would be responsive to that rate when determining summer irrigation."

The City of Austin Water and Wastewater Utilities is also proceeding with the fewer blocks recommendation.

"We learned from the study that a large number of customers did not understand our current four-block structure. The study and several other factors influenced us to explore recommending to our City Council a three-block rate structure instead of the five-block structure proposed by our rate consultant," said David Anders, rates and charges manager.

"With this simplified structure, we hope to draw more of a distinct break between domestic water use and irrigation. The first two blocks will account for almost all domestic use, with a rate that is actually lower than our cost of service. The third block will have a significant rate jump."

Since much outdoor water use is considered discretionary, it is hoped the top block will serve as an incentive for efficient water use outdoors and thereby reduce peak water demand.

The real cost of water as a fraction of disposable income is also a factor to be considered. "The other finding for Austin was that the real cost of water was declining during the study period. The lesson is that if utilities do not raise rates at least by the inflation rate, the effectiveness of conservation rates will be undermined to some degree," Gregg said.

Whitcomb can be reached at (303) 381-8000 or jwhitcomb@stratusconsulting.com.

Price and nonprice incentives effective in tandem

When it comes to using water, single-family residential customers respond to a mixture of price and nonprice incentives, according to a study funded by the American Water Works Association Research Foundation.

In an 11-year study of seven western urban areas, *Effectiveness of Residential Water Conservation Price and Nonprice Programs,* the highest demand elasticity (demand sensitivity to price) water utilities could expect was a 20% decrease in water use with a doubling of water rate. (This finding is similar to the 21% water use decrease for a doubling of water use found in a Texas study, page 6.)

Customer behavior among the 11 cities was similar enough that the least specific of the three models predicted water demand with a high degree of accuracy. More generalized models, however, enjoy the flexibility to incorporate more variation of data elements.

The seven urban areas studied from 1984 through mid-1995 were Los Angeles and San Diego, Calif.; Broomfield and Denver, Colo.; and Albuquerque, Las Cruces, and Santa Fe, N.M. A variety of water use patterns, prices and rate structures, climatic conditions, and socioeconomic characteristics provided a cross-section of cities in the southwestern United States. All cities had arid or semiarid climates in which evapotranspiration exceeded rainfall.

The study also found that nonprice conservation programs appear to be most effective when the water utility achieves a critical mass of programs. In other words, customers get the message when exposed to a variety of programs conducted over a long period of time.

Nonprice programs included were: education in public schools, public information programs such as bill stuffers and media announcements, plumbing retrofit programs, landscape irrigation ordinances, speakers' bureaus, demonstration gardens, mandatory emergency restrictions, conservation hotlines, and media coverage of evapotranspiration rates.

Even given the high inelasticity of demand, that is the relative insensitivity of consumer response to water rates, the researchers determined that the combination of fixed service charges with a uniform or increasing block structure may, in fact, effectively result in declining average prices as consumption increases.

Utilities interested in incentive rates, therefore, might consider reducing or even eliminating the fixed charge component of their rates structure.

Utilities need to know the effectiveness of consumer response to conservation programs to forecast long-term demand, manage water supplies, plan future supply acquisitions, make financial management decisions, and integrate resource management and planning.

Reference: Michelsen, Ari M., Washington State University; J. Thomas McGuckin and Donna M. Stumpf, New Mexico State University, *Effectiveness of Residential Water Conservation Price and Nonprice Programs* and *Residential Water Use, Rate, Revenue, and Nonprice Conservation Program Database,* American Water Works Association Research Foundation, 1998.

Ari Michelsen is now resident director of Texas A&M University's El Paso Agricultural Research and Extension Center. He can be reached at (915) 845-9111 or a-michelsen@tamu.edu.

Meetings and Conferences

Texas Water Utilities Association Annual School, March 5-9, College Station, including trends in technology for water and wastewater professionals. See http://www.twua.org/AnnualSchool.htm or call (888) FOR-TWUA.

Satellite Teleconference, March 9, **Taste and Odor in Drinking Water, Texas Section, American Water Wo**rks Association, 11 locations, approved for 4 TNRCC Operator Certification Hours. See http://www.tawwa.org/teleconf.htm or contact Mike Howe, (512) 238-9292 or mikhowe@aol.com for more information.

Rivers, Lakes `n Bayous Trash Bash, March 25, 12 locations. Call (281) 486-9500 to register or for extensive recorded information or see http://www.trashbash.org.

Yardwise Training, March 27-28, Brownsville. Training for community coordinators of backyard composting, waterwise demonstration gardens, and the TNRCC "Don't Bag It" program. Contact Karen Overgaard (281) 367-6084 for more information.

Texas Water 2000, **April 4-7**State Conference, Texas Section, American Water Works Association and Water Environment of Texas, , Adam's Mark Hotel, Dallas. See http://www.tawwa.org.

National Water Quality Monitoring Council Annual Conference, **April 25-27**, Austin, to address issues regarding water quality and remediation of the surface, ground, estuarine, and coastal waters. See http://nwqmc.site.net.

6th National Volunteer Monitoring Conference, April 26-29, Austin, to address issues such as building state/watershed/regional partnerships, developing and using quality

assurance/quality control plans, role of volunteer monitors in water pollution control. For more information, see http://www.epa.gov/owow/monitoring/notice.html.

The 2000 Southwest Focus Ground Water Conference, May 17-18, Austin. Focus on Regional Water Planning: Senate Bill 1 and Water Quality Issues Associated with Drinking Water, sponsored by National Ground Water Association. For more information, see http://www.ngwa.org/education.