Division of Planning and Local Assistance
Department of Water Resources

Chapter 4: Case Studies in Efficient Water Management by Businesses

Retail businesses, manufacturers, and institutions in many parts of North America have implemented successful, cost-effective water management projects. This chapter describes practical examples of successful water management programs often conducted with energy and waste water discharge reduction programs. To assist readers in implementing their own efficiency improvements, each example provides references for additional information.

Automotive Paint Manufacturer Reduces Contaminated Waste Water

Disposing of contaminated waste with little impact on the environment is one of the biggest challenges facing industry today. In particular, this applies to the automotive coatings manufacturing industry which produces large quantities of contaminated waste water from the manufacturing process. One such manufacturer, PPG Industries, Inc., has developed a way to reduce the amount of contaminated waste waterproduced. By implementing a new energy-saving technology at its Cleveland, Ohio manufacturing plant, the company reduced its effluent from 400,000 gallons of contaminated water each year to 20,000 gallons per year.

Challenge-- Automotive coatings and paints include both solvent-based and water-based products. To ensure the quality of water-based coating products, the manufacturing equipment must be cleaned regularly. This requires using thousands of gallons of water each week. If the contaminates are not removed from this water, it must be disposed of as a hazardous waste.

Solution—In 1991, a team of PPG engineers investigated ways to minimize this waste. With assistance from a U.S. Department of Energy and U.S. Environmental Protection Agency grant, the team designed and installed a combined ultrafiltration/reverse osmosis (UF/RO) process to clean up the waste water. Combining these two membrane-based technologies to form a progressive filtering system cleaned the waste water effectively enough for reuse in equipment cleaning operations.

UF/RO System—The UF/RO process is capable of recovering 95 percent of the waste water. First, the water is prefiltered to remove large solids. Then it is moved to the ultrafiltration unit where suspended solids and high-molecular-weight particles are removed. The smallest impurities are removed in the reverse osmosis unit.

Although the final water still contains ketones and other impurities in low concentrations, it is suitable for cleaning. It is then pumped into a storage tank for reuse. The remaining 5 percent generated by the UF/RO system is highly concentrated waste water that can be

easily handled under the plant's current waste management procedures.

Energy Savings—PPG has experienced significant energy savings by reducing contaminated waste water. Reduced fuel for transporting waste and for incineration, and less deionized water treatment yield energy savings of 3.6 billion Btu per year.

Economic Savings—The total cost of PPG's UF/RO system installation was $454,000. The annual net savings from the system are $205,000—equal to $380,000 of water disposal costs savings less $175,000 for unit operating costs.

Environmental Benefits—The environmental benefits of PPG's UF/RO system are substantial. Not only has the volume of hazardous waste been reduced from 400,000 gallons to 20,000 per year, but atmospheric emissions from waste incineration are also lower by several million kilograms per year.

Emissions are also lower because of the reduced transportation of waste. In the past, tanker trucks traveled 350 miles to the waste energy recovery facility 65 times each year. Now, only four trips are necessary—reducing annual emissions by several hundred thousand kilograms.

Applications—PPG and the State of Ohio are working to increase industry awareness of this energy-saving technology through various types of publicity. If the technology is adopted by other automotive coatings manufacturers, the annual national energy savings could equal 66.3 million Btu.

The UF/RO system was installed at the PPG Cleveland plant in April 1992. Construction and installation of the new equipment did not require changes in the plant's production processes and did not affect the manufacturing rate.

Sources:

Reducing Contaminated Waste Water from Water -Based Paint," by Niki Malenfant, National Renewable Energy Laboratory, U.S. Department of Energy, October 1993.

Ruth Gonsen, Ohio Department of Development, P.O. Box 1001, Columbus, Ohio, 43266 - 0101

Maura C. Tinter, Environmental Coordinator, PPG Industries, Inc., 3800 West 143 Street, Cleveland, Ohio 44111

Avoid Cost with New Manufacturing Techniques

Water efficiency, waste reduction, and other forms of conservation have been slow in coming. Government restrictions have forced many companies to take serious action in conservation. As a result, companies found that using new technologies to meet the government demands have resulted in an added bonus—reductions in production costs. After implementing new manufacturing techniques to avoid installing expensive conservation and pollution control equipment, companies experienced lower production costs and higher returns.

Motivation for companies to reduce pollution and waste control could also be applied to water efficiency. The high demand for water use and limited water supply have resulted in increased rates. Implementing simple water-saving methods could reduce production costs immediately.

Some companies have already experienced some noticeable savings:

- Clairol Co. decreased water use by insertng foam balls into pipes to clean the pipes. They saved $240,000 by reducing waste water 70 percent.
- Carrier Corp. eliminated toxic lubricants from its manufacture of air conditioners. They spent $500,000; they saved $1.2 million.
- AT&T stopped using an ozone-depleting compound in its circuit-board manufacture. They saved $3 million in annual costs.
- Whyco Chromium Co. replaced harmful byproducts from the process of coating nuts and screws with a new alloy. They saved 25 percent in production costs.
- 3M Corp. developed an adhesive for box-sealing tapes and eliminated the need for $2 million in changes to control pollution. They saved $41 million in three years.
- Polaroid Co. eliminated mercury from their batteries so they could be recycled and streamlined photographic chemical plants. They saved $250,000 by reducing waste by 31 percent.

George Wenger, of AT&T's materials and process group, said environmental standards were tightening so rapidly that AT&T is not going to wait to see how hard it will be to adopt new technologies, because these technologies will put the company in a competitive position in the long run.

The 3M company estimated that its 2,500 different manufacturing changes since 1975 have saved $500 million and cut their toxic emissions in half.

Mark Hyner, President of the Thomaston, Connecticut company that developed the new coating for Whyco, said small companies can't afford to do this research under pressure of compliance deadlines. "Most of our time and resources are spent dealing with regulations." He would like EPA to say "Let's see how we can do things differently," or for the government to offer tax incentives for innovative technologies.

David Berg, EPA Director of Technology Innovation and Economics, said "the current environmental legislation creates disincentives" for companies to undertake pollution-prevention technologies.

A fundamental consideration that keeps many companies from adopting "clean" manufacturing technologies is the customer's long-established "specifications." Even though the new technologies won't affect product quality, suppliers are afraid their customers won't buy.

Source:
"Many Companies Cut Pollution By Altering Production Methods," Amal Kumar Naj, ***Wall Street Journal***, December 24, 1990.

Boiler Water Blowdown Recovery

A major food processing company with sites throughout the United States has 22 boilers which operate at pressures of 250 to 600 pounds per square inch and generate approximately 6.5 million pounds of steam per hour. Their makeup water is provided by either municipal water (purchased) or clarified river water (provided by company's own pumped well or river supply) depending on the site locations, and all then use sodium zeolite softening. Steam generation systems are all designed very well including process heat recovery, blowdown flash tanks, and blowdown heat exchangers. Because of the excellent heat recovery, the company immediately concluded that water conservation, not energy conservation, was the major factor to consider when justifying its projects.

An operator, a shift foreman, the utility manager, the plant engineer, and a Cyrus Rice Consultant Group (CRCG) representative formed a team at each site. They first defined the major areas of water usage and discharge. The CRCG engineer and one of the team members then performed a more in-depth audit of each system(s). This process usually took three to five days, though not necessarily consecutively. The gathered information on water flow rates, temperatures, qualities, theoretical volumes required versus actual, and flow reduction available through operating modifications and localized water reuse. The summarized findings and related comments were in a preliminary report for each team member to review and then either support, refute, or add comments relative to the work. This summary also included assumed costs for power, water, fuel, regenerants, chemical additives, and related items, so purchasing or other site personnel could update them if required.

After reviewing the report, the teams again met and agreed that eliminating excessive blowdown would lead to the highest measurable water reduction and should be the first project undertaken. The corporate staff confirmed similar savings should be equally available for all their sites. The original site was selected to confirm whether these theoretical savings could actually be achieved, because the site was the most involved and its manufacturing levels and utility costs were about mid range to the others,

Due to the low energy losses, boiler blowdown rates were maintained at a conservative 15 to 20 percent of makeup to be sure carryover would not cause problems or damage to the super heaters, turbines, or downstream processes. Since most boilers of their size and design can be operated at blowdown levels of at least 12 percent, a steam purity study was performed on each of their five boilers to confirm the conditions for carryover.

Each boiler was tested over a three-day period under varying steam loads, drum levels, boiler water solids levels, and firing conditions, including various combinations of these conditions, to determine maximum and minimum safe operating conditions. Interestingly, although the boilers were identical in design and operation, their safe operating conditions were quite different, requiring different control levels for each. Testing revealed that one of the boilers had a mechanical problem, since whenever the steam load was increased or the drum level dropped below a certain level, carryover was noted. A later inspection confirmed

the feedwater line had rotated and was spraying directly up into the steam separators at high feedwater rates or during low drum levels. Site personnel later stated this finding alone paid for the entire evaluation at all sites.

The data developed from the test demonstrated that original estimates were very conservative. Actual savings would be about 25 percent above original estimates. The next step included developing specifications for automatic blowdown controls and proportional chemical injection equipment to help assure the new limits would be maintained. The equipment was then purchased.

This project, which had been discussed for five years but never implemented, took less than 12 months to complete from the first meeting until the equipment was installed and savings confirmed. The first site demonstration indicated a reduction in water consumption and sewer water discharge by over 31 million gallons per year, well above the original goal set. When salt, boiler and condensate treatment products, and energy savings are also added in, the cost savings achieved are $186,000 annually for a one-time cost of less then $45,000 including consultant fees, engineering, equipment rental for steam purity analysis, and purchase of the automated blowdown and chemical feed systems.

The company is now completing the same studies and system designs at each of its other sites now that the project approach has been defined and savings potential determined.

Source:
"Water Conservation and Reuse Programs Can be Self-Supporting" by Albert Owens of Cyrus Rice Consulting Group of Pittsburgh, Pennsylvania. This paper was presented at WATERTECH '92, November 11-13, 1992 in Houston, Texas. These portions are reprinted with permission of Tall Oaks Publishing Inc. of Littleton, Colorado, the conference organizer.

California Linen Rental Recycles

The California Linen Rental Co., Inc. (Cal Linen), of Oakland, California, rents laundered linens, clothing and other washable items to small businesses in the San Francisco Bay area. They process approximately 50,000 pounds per work day and employ 112 workers in the plant. They have nine automated 400-pound computer-controlled washers. The batches use wash formulas and operate according to a schedule.

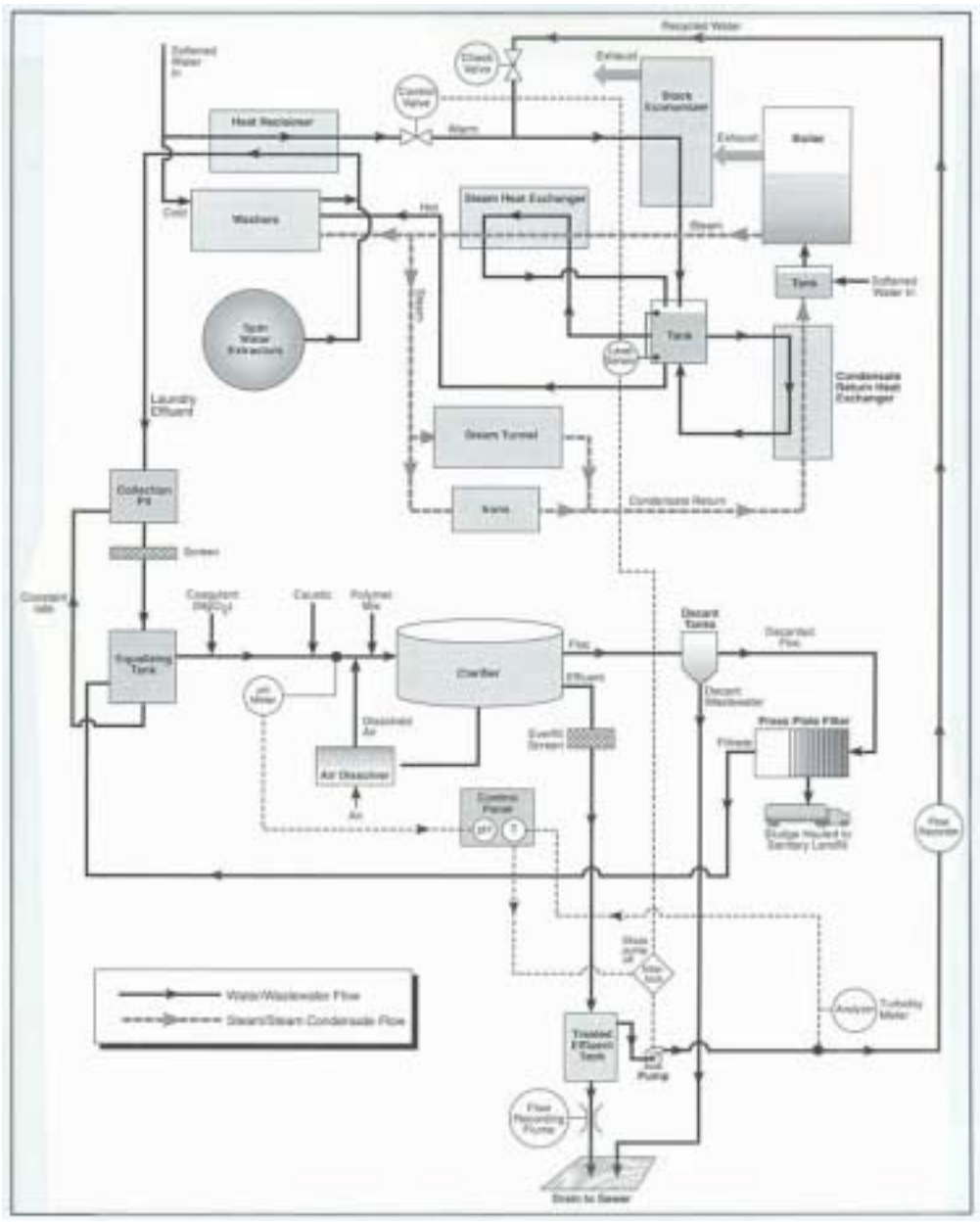
Cal Linen purchases their water from the East Bay Municipal Utility District which also provides waste water services.

Cal Linen discharged oil and grease from soiled laundry goods which did not meet with waste water discharge regulations. In order to comply with these standards, the linen company installed a system to pretreat its waste water prior to discharge. In 1992, Cal Linen successfully modified the waste water treatment and began operating the system that recycled treated effluent.

Cal Linen now recycles up to 50 percent of its treated effluent stream by injecting caustic to reduce hardness, reducing particulate matter, and controlling automatically a pumping system. Warm, recycled water is routed back into the hot water system, saving heat energy

and up to 11 million gallons of water per year (see diagram on page 50, **Laundry Pretreatment System with Recycling Components**).

Laundry Pretreatment System with Recycling Components



Dissolved air flotation tank at Cal Linen.

At the 50-percent effluent recycling level, the annual benefits from the recycling pretreatment system are projected at $28,345, compared to the annual costs without recycling of $16,248. With a capital outlay to make recycling possible of $37,137 at 1992 prices, this represents a payback of just under one and a third years. With the cost of water and waste water services rising faster than most other goods and services, this financial picture is likely to become even more favorable for Cal Linen. With the growing trend for water utilities to introduce use restrictions and higher inclining rate structures, water intensive industries such as commercial laundries will find effluent recycling systems increasingly cost effective.

This case study illustrates how the annual savings from recycling significantly contribute to the repayment of unavoidable pretreatment system capital costs. However, when viewed as a whole, the current and projected future savings of Cal Linen's pretreatment and recycling system could not be considered cost effective purely on the basis of the overall avoided costs. If it had not been a mandatory requirement of waste water compliance, the combined system would most likely have been rejected due to the approximately 18 -year payback it requires.

Source:
A Case Study of the Recycling of Pretreated Process Effluent Water at a Commercial Laundry Facility in Northern California, prepared by East Bay Municipal Utility District for DWR, June 1992.

Circle K Stores—Symptoms for Retail Chains

The city of Mesa, Arizona, sponsored water audits at fourteen Circle K stores for 12 months. The water audits demonstrated cost -effective ways to save water for a small commercial water user with multiple facilities.

The water use varied not just from store to store but within the same store from month to month. The city discovered five stores had water leaks which lost a total of approximately one million gallons in 12 months. Circle K possibly lost more with leaks that were undetected.

The audit's recommendations to avoid further major water losses and to maintain water efficiency were:

Store managers—Because water bills were sent to the main office, store managers were not aware of the water consumption at their store.

Corporate offices need to provide water use data to store managers and stress the importance of prompt leak repair.

Repairs—When repairing water-use equipment, replace with water-efficient equipment.

Landscape design—All four of the stores that had landscaping used a timer on their drip irrigation system. All maintenance work was contracted out. The recommendation was:

- Install only low-water-use design for future stores with landscaping.

Source:
Water Audit—Circle K, City of Mesa, Arizona, and the Circle K Corporation, September 1988.

Computer Models Identify Savings for Dairy Plant

The Maplehurst dairy plant in Indianapolis, Indiana is a medium-sized plant, which produces fluid milk, orange juice, cottage cheese, and ice cream. Maplehurst participated with Purdue University and the U. S. Environmental Protection Agency in a series of efforts to identify measures to reduce water and energy consumption while still considering environmental and economic factors.

The initial efforts measured water consumption, waste water discharge, and energy use at the dairy. Then efficiency measures were recommended and in many cases implemented. The more recent efforts produced the WEEP, FOODS, and BATCHES computer models which simulate food processing operations and quantify the effectiveness of potential efficiency measures.

Dairy Efficiency Measures

Allocation of the Maplehurst's utility requirements to products yielded the following values per 1,000 pounds of finished products.

Process Utility Requirements per 1,000 Pounds of Finished Products

Product	Steam (lb)	Electricity (kwh)	Water (gal)
Fluid Milk	195	23	226
Cottage Cheese	1,153	91	3,420

Ice Cream	650	584	979

The observations indicated opportunities to increase the process efficiency by designing better water and energy reuse and recovery techniques. These were:

Steam Use *—The plant used steam in the heating system, hot water system, cheese vats, and sanitation process. The recommendations were:*

- Insulate all of the steam lines. Also insulate the building.

- Change to a hot water boiler system to eliminate the flash and blow-down losses. (The plant used an injected steam system which recirculated through the heating section.)

Waste methods—All of the waste streams are originally mixed together before being disposed. Several different designs could correct this, but the technical and economic alternatives need to be evaluated. The potential recommendations were:

- Segregate the waste streams to recycle the high-quality waste water obtained from the lactose purifying method.

- Capture all the sludge discharge, product waste, and rinse water from the equipment (with the exception of any water that has detergent wash). Direct this stream to a separate tank. With the reverse osmosis system, the streams recover the milk solids and capture and recycle the clean water.

- Reduce biological oxygen demand content by treating the detergent wash stream, floor cleaning, etc., with an anaerobic treatment before discharging into the sewer. Then use the by-product for ground fertilizer or incinerated for energy production.

- Install self shut-off nozzles on all of the clean up hoses to reduce the energy usage by 25 percent as well as reduce the water being discharged to waste.

Computer Models
Waste, Water, and Energy Estimating Program (WEEP) was recently developed by the Agricultural Engineering Department at Purdue University to estimate the distribution of waste, energy, and water over the different operations in a multi-product dairy plant. WEEP takes the plant's monthly production, utility bills, and municipal bills as the input data. It can then identify specific areas where water efficiency and energy usage could be improved or waste reduced. WEEP is presently being converted to a spreadsheet program for PC's. Modification is easy for particular situations, and it will automatically update the results. The spreadsheet allows more menu options to present output. By providing the distribution of energy, water, and waste for the plant manager through WEEP, the plant manager can get an idea how the plant's efficiency compares to similar plants.

Food Operations Oriented Design System (FOODS) is a program which can be used for various liquid food materials to determine preliminary process designs and economic

analysis of those designs. FOODS was originally developed in FORTRAN, and is being converted for use on personal computers.

The user chooses a series of unit operations needed to produce the desired product. The program sizes the unit operations and calculates capital and operating costs with consideration for costs of energy, water, and waste efficiency. The process is optimized to minimize total costs. FOODS can be used to test preliminary designs quickly and easily.

BATCHES is a computer simulation of a plant's minute-to-minute operation to try and expose scheduling problems which FOODS does not consider. BATCHES identified various equipment, calculations, and flow rates for all the streams.

Source:
Environmental Protection Agency Study On A Dairy and Development of Environmentally and Economically Sustainable Food Processing Systems with Emphasis on Extreme Water and Energy Conservation: Water Compliance Branch, Progress Report; May 1, 1992, October 1, 1992, February 1, 1993, and June 18, 1993; EPA #T955188-01-0; Martin R. Okos, Ph.D., Principle Investigator and L.F. Huggins, Department Head, Agricultural Engineering Department, Purdue University.

Concrete Mixing with Low-Cost Water Supplies

The concrete industry is a major user of water. The primary uses are washing aggregate, mixing concrete, and controlling the rate that concrete cures. Since water is a significant part of the industry's product, the availability and cost of water is of primary importance.

The concrete industry may use non-potable water. These supplies usually cost less than potable water and are available in some communities as treated municipal waste water.

The chemical quality of treated municipal waste water is generally acceptable for concrete. To confirm that the quality is acceptable, the concentrations of the salts contained in the water must be known. The information is available from the local waste-water treatment facility which maintains accurate records of its product.

Standards exist to guide the concrete producer to assure acceptable strength and color of concrete. Since the standards vary depending on the types of impurities present, use the guidelines only as a quick reference before determining if a specific water sample is acceptable. The best method is to perform a mortar strength test first.

Here are a few examples of some of the specifications:

- The California Department of Transportation's ***Caltrans Standard Specifications*** of 1988 (Section 90, Part 2.03) states that all water used in mixing and curing of concrete should be free from oil. There are additional requirements for water used in reinforced and non-reinforced concrete. For example, non-reinforced concrete should not contain more than 2,000 parts per million (ppm) of chlorides as Cl and 1,500 ppm sulfates as SO4. Also, reinforced concrete should not contain more than 1,000 ppm of chlorides as Cl and 1,300 ppm of sulfates as SO4. If concrete is to be prestressed, then concentrations of impurities will be limited to 650 ppm of chlorides as Cl and 1,300 of sulfates as SO4.

- The ***Indian Concrete Journal*** told of the tolerable concentrations of impurities:

1. Sodium and potassium carbonates and bicarbonates	1,000 ppm
2. Sodium Chloride	20,000 ppm
3. Sodium sulfate	10,000 ppm
4. Calcium and magnesium bicarbonates	400 ppm
5. Calcium chlorides	2% by weight of cement in plain concrete
6. Iron Salts	40,000 ppm
7. Sodium Iodate, phosphate arsenate and borate	500 ppm
8. Sodium sulfide	even 100 ppm warrants testing
9. Hydrochloric and sulfuric acids	10,000 ppm
10. Sodium Hydroxide	0.5% by weight cement if set not affected
11. Salt and Suspended particles	2,000 ppm

- The American Society for Testing and Materials (ASTM) has standards regarding ready-mix concrete, Designation C 94-98. It states that if there are no "service records or information" of concrete made with the water in question and the water is not clear or apparently clean, it should undergo an initial batch testing. The batch tests indicate which water samples are safe for use in mixing and curing. The minimum compressive strength requirements used by the ASTM for the ready-mix batch tests are 90 percent.

- The ***Danish Concrete Manual*** made definite statements on organic waste in the water for production of concrete by saying, "humic acids and other organic acids should be avoided" due to the destabilizing nature (McCoy 517).

- The book ***Influences on Concrete*** by A. Klienlogel also supports this point by saying that "humus, peat fiber, coal particles, sulfur, or industrial wastes containing fat or acid" should not be used in mixing water.

Concrete producers who consider other sources of water that will meet the standards of concrete production could cut the cost of concrete production considerably.

Sources:

California Department of Transportation, ***Caltrans Standard Specifications***, Section 90, Part 2.03, 1988 edition.

Klienlogel A., ***Influences on Concrete***, Frederick Ungar Publishing Co., New York City, New York, Page 158, 1950.

McCoy, W.J., "Mixing and Curing Water for Concrete," ***Significance of Tests and Properties of Concrete and Concrete-Making Materials***, American Society for Testing and Materials. 1966.

Plum N.H. et al, ***Danish Concrete Manual, Bulletin No. 39***, Copenhagen, Denmark, 1944.

(author unknown), "Requirements of Mixing Water for Concrete," ***Indian Concrete Journal***, March 1963, Pages. 95, 98, 113.

Doubletree Hotel Continues to Improve Water Efficiency

In 1991, the city of Ventura, California provided a consultant to help major business customers reduce their operating costs. The consultant provided on-site surveys to identify efficiency measures. The focus was to improve water use efficiency, improve energy efficiency, and reduce waste water discharge.

The Doubletree Hotel is a full service hotel and includes 285 guest rooms, full banquet facilities, a pool and jacuzzi area, restaurant, and an in-house laundry facility. The hotel operates 365 days per year.

All water used at the hotel was purchased from the city at the rate $1.278 per hundred cubic feet, or $1.71 per thousand gallons. The waste water rates were $1.71 per hundred cubic feet, or $2.29 per thousand gallons.

Average water consumption was approximately 39,000 gallons per day. If all of the new efficiency measures recommended in the survey were implemented, the reduction in annual water consumption would be more than 2.5 million gallons, worth over $10,000 per year.

The major water uses and measures to achieve these savings are described below. In some instances, a choice of savings measures is offered.

Domestic Uses - Approximately 13,100 gpd (34 percent of the hotel's daily consumption) was used for domestic purposes: toilet flushing, sink use, and showers used by the guests. The recommendations for water efficiency were:

- Install aerators on faucets. Potential savings would be a 45-percent reduction in water volume used, more than 1,000 gpd, worth $1,500 per year. The capitol cost would be $3,000. The payback period would be 2.0 years.

- Install 1.6 gallons-per-flush toilets. Potential savings would be 50 percent of water usage, over 3,000 gpd, worth $4,500 per year. The capital cost would be approximately $42,750. The payback period would be 9.5 years.

- Install water-filled plastic containers as displacement devices in the toilets. This could be an alternative approach to 1.6 gallons-per-flush toilets. Potential savings would be over 351,000 gallons annually, worth $1,400. Capitol cost would be less than $1,500. The payback period would be 1 year.

Laundry—A 300-pound washer extractor and a 65-pound washer extractor processed approximately 3,000 pounds of laundry per day. The recommendations for water efficiency

were:

- Install a waste water reclamation system. Sixty percent of the water would be saved and reused, which would be almost 7,000 gpd. This would be a total savings, including energy and chemical savings, of over $11,450. The capitol cost would be $80,000. The payback period would be 7.0 years.

- Install a rinse water recycle system. Twenty-five percent of the water used, which would be 2,700 gpd, would be reused. This would provide a savings of $3,940 per year in water and waste water costs. The capital costs would be $12,000 and the payback period would be 3.0 years.

Source:
Water/Energy Conservation Study—Doubletree Hotel, Black & Veatch for the City of Ventura, California,May 1992.

Gangi Brothers Packing Company

Gangi Brothers Packing Company, San Jose, California, is a major water user that processes and cans tomatoes. The company uses water for fluming tomatoes from trucks, tomato rinsing, vacuum-pump seals, boiler makeup, and cooling. Since the canning industry typically uses large quantities of water, some recycling and reuse of water has been implemented in the past. The motivation for Gangi Brothers was a general concern for efficiency.

In order to increase water efficiency at Gangi Brothers, the following five techniques were implemented:

1. Recycling water within one process.
2. Reusing water in another process.
3. Installing cooling-tower loops.
4. Modifying processes to use less water.
5. Monitoring operations to control water use.

Flume water at the plant is recycled, thus conserving large quantities relative to the previous one-use fluming approach. Water from one flume is recycled to the bin and back to the flume again. Recycling fluming water is a readily transferrable conservation measure, adaptable to other canneries and food processing facilities that use water to transport material.

The amount of fluming water used was reduced by modifying the bin discharge valves. By using intermittent discharges of short duration, but high volume, less water is needed to remove the tomatoes from the bins.

For additional water conservation, Gangi Brothers operates three evaporative cooling towers in lieu of once-through cooling. This constitutes significant water savings.

The company has also implemented a strong employee training and monitoring program.

Employees are made aware that water conservation is a company policy. Supervisors watch for waste, such as running hoses left unattended.

The total water reduction at Gangi Brothers in 1989 was 94 million gallons a year or 63 percent of the company's 1983 water use. The company's estimated annual dollar savings is $130,000. Gangi Brothers significantly decreased the ratio of water used, per ton of tomatoes processed, from 1,200 gallons per processed ton to 300 gallons per processed ton. The payback period on the equipment and modifications was less than one year.

Source:
Case Studies of Industrial Water Conservation in the San Jose Area**,** City of San Jose, Brown and Caldwell Consultants and DWR, February 1990.

Gillette Shaves Water Use

The Gillette Company produces blades and razors, toiletries and cosmetics, stationery products, Braun electric shavers and small appliances, and Oral-B care products. The company operates 51 facilities in 26 countries.

In 1972 they started their energy and water conservation programs; as a result, Gillette reduced energy consumption worldwide by 35 percent and water consumption from 30 to 94 percent. For example, the South Boston Manufacturing Center produces razor blades with 94 percent less water; the Santa Monica Manufacturing Center produces the Paper Mate pens with 90 percent less water.

Gillette continues to reduce pollution, improve recycling methods and reduce packaging materials. They reduced chlorofluoro carbons (CFCs) in their aerosol formula but still use the chemical CFC-113, which is used to coat finished blade edges. Gillette worked with the DuPont Company and found an environmentally safe replacement for CFC -113 that still maintains their quality standards. The plants in the United States use the replacement totally. International plants are phasing it in over the next two years.

Another chemical Gillette is trying to eliminate is trichloroethylene for cleaning metal parts before coating. The coating is vital to Gillette's quality. The company's South Boston Manufacturing Center, after nine years of research, replaced the washing with an aqueous wash process. The aqueous wash process is an environmentally safe metal cleaner for super-clean surfaces needed in the metal finishing industry.

Source:
A Status Report on the Environment, Gillette Company, Boston, Massachusetts, 1991.

Medical Center Improves Water Use Efficiency

In 1991, the city of Ventura provided a consultant to help major businesses reduce their operating costs. The consultant surveyed sites to identify measures that would focus on water use efficiency, energy efficiency, and waste water discharge.

The Ventura County Medical Center is a full service general hospital with 222 beds, operating room, physical therapy, radiology, laboratory, morgue, and in-patient and out-

patient care. In addition to the hospital facilities, the Medical Center has on -site food service, a central heating plant, and a laundry facility that serves various county facilities in the area.

All water used at the medical center was purchased from the city at the rate of $1.278 per hundred cubic feet, or $1.71 per thousand gallons. Waste water charges were $1.472 per hundred cubic feet, or $1.96 per thousand gallons.

Average water consumption was about 76,900 gallons per day. If all of the recommended efficiency measures were implemented, overall water consumption would be reduced 11 percent, worth $10,617. Energy savings would be an additional $11,150. Total savings would be $21,767 per year.

The major water uses and water-saving measures used are described below.

Domestic Water Use—Approximately 41 percent of the water used in the medical center was for domestic purposes. This included toilet flushing, sink use, and shower use by patients. The recommendation for water efficiency was:

- Install flow-reduction devices on flush valves. Potential savings in water and waste water would be 5,000 gallons per day, worth $6,600 per year. The capitol costs would be $785. The payback period would be 0.12 years.

Laundry—Two 400-pound washer extractors processed as much as 6,180 pounds of laundry per day. The recommendations for water efficiency were:

- Install a rinse water recycling system to reuse the second and third rinse cycles. Potential water and waste water savings would be 1 million gallons per year, worth $3,985. Energy savings would be $2,400 per year. The savings total would be $6,385 per year. Total capital costs would be $30,000. The payback period would be 4.7years.

- Install a valve in the steam supply line to the laundry to shut off the steam when the laundry is idle. Capitol costs would be $200.

Steam and Water Leaks—Steam leaks in the cafeteria, laundry, and physical plant accounted for 77 pounds per hour of actual energy consumption. Water leaks were found in faucets, valves, and pipe fittings. Energy savings would be 7,595 therms, worth $1,880 per year.

Repair Condensate Receiver Pump Set—Condensate from about 280 pounds per hour of steam was routed directly to the drain instead of being returned to the boiler for reuse. The energy loss was worth $1,316 per month. Repair costs would be approximately $1,500. The payback period would be 1.25 months.

The Ventura County Medical Center is planning to remodel major portions of its aging structures. The medical center has included many of the recommendations in the remodeling plans. This fortuitous timing further reduced the cost of implementing many of the efficiency measures.

Source:
Water/Energy Conservation Study *—Ventura County Medical Center*, Black & Veatch for the City of Ventura, California, May 1992.

Newsprint Made with Recycled Water

The Smurfit Paper Company in Pomona, California is a model of the industrial use of reclaimed municipal waste water. All of the processes at Smurfit use 100 percent reclaimed water which add up to 3.6 million gallons per day.

Smurfit produces newsprint from recycled paper. Waste paper from various recycling centers is transported to the Smurfit facility. The used paper is separated from large contaminants, mixed with 18,000 gallons of reclaimed water, then de-inked and turned into pulp.

The advantages of using reclaimed water are many. It is two and one-half times less expensive than potable water. The purity of the recycled water equals that of domestic water for process purposes. In times of water shortages, using recycled water eases the demand for potable water. Also, recycled water can be used more than once.

Smurfit recycles 25,000 gallons per day from its own treatment system. The company plans to recycle all of its own water and get as close as possible to a closed-water-loop system.

Smurfit Paper Company currently purchases water from the city of Pomona, but manages the waste water and solid waste itself. After recycling the water several times, the plant's five primary effluent clarifiers remove most of the solids from the waste water before discharging it to the sewer. It takes the solid waste (the sludge) and sends it through screw presses to remove the water, and then sends the waste to landfills. Smurfit management plans to sell the material as a soil amendment. This would help supplement costs.

Source:
OWR News, City of Los Angeles Office of Water Recycling, and David J. Lyons, Smurfit Newsprint Corporation, Pomona, California, 1992.

Norton Grinds Waste Away

Norton Company in Worcester, Massachusetts employs 3,000 people and produces industrial ceramics and grinding wheels used in machine tooling operations. Water is used by the company to wash raw abrasive materials, to float out ultrafine particles, to mix with the product when making grinding wheels, and to cool equipment and the working space. Less than 5 percent of Norton's water use is for sanitary or domestic purposes.

The cooling system was the first target of the conservation program at Norton. Between 1979 and 1982, three cooling towers were installed to save water that previously had been discharged after being used in a once-through cooling cycle. The cooling towers enabled Norton to convert the cooling cycle to a closed-loop system where the water can be reused approximately 20 times. No water is directly discharged from the closed-loop system, and makeup water must be added to compensate for evaporation. An investment of $320,000

for the cooling towers resulted in savings of 152 million gallons per year.

Processes in other buildings were later hooked into the closed-loop system, using the cooling towers. There are five recirculating cooling systems dependent on the three cooling towers. Norton also reduced its dependency on the municipal water supply by sinking an on-site well. The cooling towers now use well water instead of municipal water for makeup, and some process cooling was converted to use well water.

Other conservation measures include changing some product washing operations to a dry process, installing thermal regulators on water-cooled equipment, and using low-flow showerheads. In an effort to make each division aware of the volume and expense of water used in their area, Norton implemented an internal charge-out system for municipal water. Continuous leak detection and repair is part of regular maintenance to reduce water waste.

Norton Company has practiced water conservation for the past 10 years and in doing so has cut water consumption by 60 percent. It has also cut operating costs by reducing water and sewer use, as well as reducing the discharge of heated effluent. The company indicated that cost increases in water, sewer, energy, and discharge permitting will likely lead to further conservation efforts.

Source:
Massachusetts Water Resources Authority, Boston, Massachusetts.

Ontario, Canada Greens Workplace

Located just an hour from Lake Ontario, it is hard to believe the Kitchener-Waterloo area in Ontario would ever experience a water shortage. However, wells have gone dry and restrictions on lawn watering and car washing are common in the summer months. Water consumption increased so much that the provincial government and municipalities are facing the possibilities of a new water treatment plant and pipes to carry water and sewage. To control this water consumption, the Ministry of Natural Resources announced in August 1991 a strategy to hold Ontario's water consumption to current levels until the year 2011.

The Ministry of Government Services has already made changes to manage water consumption at government facilities. It started with new approaches to landscaping in gardens. Secondly, washrooms in office buildings were retrofitted to demonstrate modern low-flow plumbing equipment.

The gardens feature drought-tolerant plants and an in-ground drip irrigation system. Each plant group is labelled so people can learn about it and know what to buy for their own garden. More paths and benches will be added to encourage people to wander around and use the garden. Government employees are even encouraged to pick the herbs grown there.

The source of water for the drip system is rain water collected in large tanks. The underground system eliminates the need for watering the garden with potable water and cuts the moisture lost through evaporation that occurs while watering during the day.

Washrooms have been retrofitted with low-flush toilets (1.6 gallons or less per flush), computer controlled flushing of urinals, and flushometers that control the amount of water

used in flushing. The faucets are operated by infra-red beams, and provide a measured amount of water when hands are placed under the tap. Each toilet replaced with the modern low-flush type can save enough water (over 3 gallons) to supply drinking water for four adults for one day. These conservation measures save water and reduce the amount of waste water that must be cleaned.

By presenting demonstration projects at the provincial buildings, the Ministry of Government Services hopes to promote water conservation at work and at home.

Source:
Brian Opitz, Ontario Ministry of Government Services Water Management Project, "Water Efficient Projects Conserve Precious Resource," ***Spectrum***, 1992.

Palo Alto Helps Ice Cream Plant and Pharmaceutical Company

The city of Palo Alto, California is a full service municipal utility. The Utilities Department, Energy Services Division, offers a variety of programs and services to assist customers in managing their utility costs. These include assignment of a utility resource advisor to provide customized technical assistance, consultant services, and equipment loans.

In September 1991, the city of Palo Alto introduced a pilot water efficiency program. The water efficiency program offered up to $10,000 per utility account for reductions in indoor uses for potable water supplied by Palo Alto. As part of the program, free water audits were offered to assess the potential for additional cost-effective water efficiency improvements in other business facilities.

There were three main objectives for the audits: (1) to evaluate the potential water conservation volume and associated cost for the city of Palo Alto, (2) to provide customers with an initial evaluation of specific conservation measures for their facilities, and (3) to gain insight regarding customer water quality needs.

The city invited high-water users with industrial process discharges to receive free indoor water audits. The city retained the services of a waste minimization expert to address the customers' process water quality needs. The audit team then met with facilities managers to describe the city's program and to learn about each customer's primary water-related concerns.

Ice Cream Facility

In the first meeting with the plant manager, the audit team was asked to focus on reducing waste water costs. Sewer-discharge costs had risen from $20,000 in 1989 to $70,000 in 1991, and were forecast to increase to $120,000 in 1992.

The audit correlated waste water flows and loads to production operations. The results showed that most of the waste load was generated during cleaning of mix-preparation vats and storage tanks, rather than in the freezers and the packaging machines.

Daily meter readings at the beginning of the water audit helped identify leaks. These leaks were repaired quickly. Another very important result from the audit was the identification of several uncontrolled, once-through cooling loops that were contributing almost 55 percent of the waste water volume. Closing these loops through the existing cooling towers could

easily eliminate 90 percent of the waste, conserving 2.3 million gallons per year (gpy).

Clean-in-place (CIP) systems were identified to successfully reduce waste loads by 50-80 percent and allow the recovery of usable product.

The following table shows that the largest savings from a combined CIP/recovery system at the ice-cream plant would be a reduction in organic loading. Recovery of cleaning chemicals would be the second largest savings.

Savings from CIP/Recovery System for Ice Cream Plant

	50% Recovery 3 million gpy $1,000/year	75% Re 3.4 milli $1,000
Waste Water Organic Load	47.3	70.
Water/Waste Water Flow	11.8	13.
Cleaning Chemicals	26.5	38.
Product Recovery	12.0	18.
Total Savings	$97.6	$14(
Installation Costs	$200,000-$3000,000	

Pharmaceutical Company

Prior to the audit team arrival, the facilities manager measured and identified the major water users and initiated a project to recirculate cooling water, which was the largest user. He requested that the city's audit team focus on an animal facility and a cream and lotion production process.

The pharmaceutical company has an animal research facility that keeps a variety of species in 170 rooms with cages. The cages were cleaned every day by a 15-person crew using "garden hose" spray guns. The flow rate through the guns was seven gallons per minute (gpm), for approximately 30 minutes in each room. Although the water temperature was set at 120ºF, the water ran cold after 45 minutes due to limited heater capacity (the gas burner operated at full rate, but could not meet the instantaneous demand for hot water).

Since the cleaning relies on impact to remove dried urine and feces, the audit team recommended replacing the existing spray guns with water-efficient models (2-3 gpm) that would also provide higher impact by concentrating the spray into a well-defined fan. Another possible alternative was to purchase 15 portable high-pressure, low-flow rinsers (1-2 gpm at 1,000 pounds per square inch) for each crew member to provide even higher impact.

Installing more efficient spray guns would save 9.3 million gpy of water, and 1,935 million Btu per year of gas together worth $27,400 per year. Installation costs are $17,000 which yield a payback period of 7.5 months.

The animal facility also had a large cage-washing machine, designed with both water and energy conservation features. Final rinse water replenished the first rinse, and provided makeup for the cleaning solution. Heat exchangers were used to recover heat from waste streams.

Even with these features, closer examination revealed conservation opportunities. Due to eroded and damaged spray nozzles, the measured flow rate was 40-80 gpm rather than the 16 gpm specified by the manufacturer. Replacing all the spray nozzles in the machine with new quick-change, positive-alignment nozzles meeting the manufacturer's original design would have a payback of less than one month. The new nozzles cost $16,300. Improved water efficiency saved 3.3 million gpy worth $6,600. Heat savings were 2,130 million Btu per year worth $9,700.

In the cream and lotion production plant, approximately 10,000 gpd of hot water — approximately half tap-water and half deionized water—are used for cleaning tanks and piping. The most obvious improvement was to install an automated clean-in-place system instead of the manual fill-and-dump procedures, which might reduce water consumption by 90 percent.

Unfortunately other operational issues made such a proposal infeasible: (1) Food and Drug Administration validation analyses would add at least $50,000 to the project; and (2) the deionized water system required additional storage capacity and pumps, for which the fire department had already requested major access modifications (for a previous capacity expansion plan to meet current levels of production), which could add approximately $100,000 to the project.

On the other hand, the reduction in demand for cleaning water could reduce the size of the tanks and pumps required for the expansion, eliminating the need for the fire-access modifications, and perhaps even a need for a contemplated plant relocation. As outsiders, the audit team was not privy to these considerations.

Several less-intrusive measures were identified to reduce water consumption by approximately 50 percent:

- Provide extension lances, rotary nozzles, and a booster pump for high-pressure, low-volume spray cleaning of tanks. Besides reducing the volume of water used during spray cleaning (and over-spraying onto the floor), effective spray rinsing could replace at least 1 fill and dump cleaning cycle (approximately 1,500 gpd of deionized water).

- Replace all spray nozzles in the parts washer with new quick-change, positive-alignment nozzles.

The total potential savings was $10,300 per year at an installation cost of $5,000.

Source:
Audit Results from the City of Palo Alto's Water Efficiency Program for Industry, by Virginia Waik, City of Palo Alto Utilities, Energy Services Division, P. O. Box 10250, Palo Alto, California, 94303, and John Rosenblum, Ph.D., Rosenblum Environmental

Engineering, 3502 Thorn Road, Sebastopol, California, 95472. Reprinted with permission.

Pepsi-Cola Bottling of Ventura

In 1991, the city of Ventura, California provided a consultant to help major business customers reduce their operating costs. The consultant provided on site surveys to identify efficiency measures. The focus was to improve water use efficiency, improve energy efficiency and reduce waste water discharge.

The Pepsi-Cola Bottling of Ventura produces Pepsi-Cola and other carbonated soft drinks, bottled in cans and bottles, as well as tanks of concentrated product formula.

All water used at the plant was purchased from the city at the rate of $2.142 per hundred cubic feet, or $2.86 per thousand gallons. Waste water charges averaged $11.28 per thousand gallons due to the high concentrations of biochemical oxygen demand from sugars in the waste water.

The plant's average water consumption was more than 67,000 gallons per work day (gpwd). If all of the recommendations were implemented, the savings would be more than 4.5 million gallons of water per year, approximately 92,000 kilowatt hours of electricity per year, and 11,000 therms of natural gas per year. The savings were worth more than $18,860 due to decreased water and waste water volume, $6,660 from biochemical oxygen demand reductions, $1,500 in reduced chemical consumption, and $14,740 from energy conservation. The total savings were $41,760.

The major water uses and measures to achieve these savings are described below.

Purification of Water Recovery—Approximately 500 gpwd of slurry was discharged, and a total of 1,000 gpwd of water was consumed in the purification process. The recommendation for water and waste water efficiency was:

- Provide a second clarifier to recover water from the slurry and also provide a Granular Activated Carbon (GAC) filter backwash. The solids withdrawn would be barreled for disposal as solid waste, and all of the water from the GAC filter would be recovered. Capital cost of the slurry treatment system and GAC filter system would be approximately $9,000. Operation of the slurry transfer pump would require about 3 kilowatt hours of electricity, which would cost $4 per year. Equipment maintenance costs requirements would average about $100 per year. Solid waste charges (13,000 pounds per year at $0.51 per pound) would be $6,600. Potential water/sewage savings averaged 156,400 gallons per year. With all costs considered, including the different sewage rates and less water usage, the total savings would be more than $7,000 per year. This would have a payback period of 1.3 years.

Vacuum Pump Water Recycling—Total water consumption was 7,800 gpwd. The recommendation for water efficiency was:

- Catch waste water and pump it to the flocculating clarifier. Capital cost would be

approximately $500. Potentially over 1.6 million gallons per year would be saved, worth $6,200. The payback period would be 0.1 year.

Bleed-Off from Evaporative Condensers—About 23,000 gpwd was bled from the evaporative condensers to prevent a buildup of salts in the water. The average concentration ratio was 1.65. The recommendation for water efficiency was:

- Change the concentration ratio to 3, and reduce bleed-off to 4,500 gpwd, worth $7,450 per year. Chemical savings would average approximately $1,500 per year. The capital cost would be $2,000 to keep the pH level. The payback period would be 0.2 year.

Washer Spray Control—The amount of water consumed in washing cans, trays, and bottles could be reduced by installing a switch to run the water spray for washing only during production. This has a potential savings of more than 88,000 gallons per year, worth $330. The payback period would be 1.2 years.

CO2 Pipe Thaw—Replace the hot water used to keep CO2 pipes from freezing with heat tape to potentially save $1,040 of water/waste water and $1,560 of energy. With a capital cost of approximately $400, the total savings would be $2,600 per year. This has a payback period of 0.2 year.

Pump Seal Water Recovery—Three hundred gpwd of water was used to seal pumps in the bottle filling room. By collecting and sending this water to the condensers, approximately 1,200 gpwd would be saved, worth $960 per year. The capital cost for this would be about $750 giving a payback period of 0.8 year.

High-Pressure Hose Nozzles—Replacement of regular hoses with high-pressure nozzles would reduce the current use of 2,400 gpwd by one-third. The capital cost would approximately be $450, giving a short payback period of 0.7 year.

Source:
Water/Energy Conservation Study—Pepsi-Cola Bottling of Ventura, Black & Veatch for the City of Ventura, California, May 1992.

Positive Cash Flow Financing

Many government agencies and institutions have experienced severe budget cuts in the past few years. As a result, they do not have funds to implement conservation measures which are cost effective.

Many times installing more efficient equipment results in financial savings, but money to replace existing equipment is unavailable.

Several innovative funding options are available to fund water and/or energy saving projects that would otherwise go undone due to tight budgeting. Each option employs an outside financing agent or investor. The expenses budgeted for the water and energy are predetermined. The savings generated from conservation would provide the funds to payback the investors.

Local residents, businesses, and all members of the community would benefit directly from the institution's action on water conservation by the immediate reduction in use of water and energy and future reduction in operating expenses.

The key to obtain these benefits is to develop the most effective financing method for both the institution and investor. Payments for these services are based on a negotiated split of the actual cost savings from water, sewer, and associated energy reductions.

The Positive Cash Flow Financing program would offer four basic types of funding.

1. **Finance lease**— The lessee makes a firm commitment for a fixed number of payments.

2. **Municipal lease**— This is a conditional sales contract or installment purchase contract. A predetermined lease payment is setup with clear principal and interest components. Ownership would pass to the lessee.

3. **Guaranteed savings program**— The savings in reduced utility costs and all expenses would pay for the project. The end-user would share the net savings.

4. **Shared savings plan**— The split of the savings is predetermined. No cash investment is required by the user. The savings are used to pay the debt.

The idea of third-party financing provides another option for the institutional sector. By sharing the utility cost savings generated, the third-party source assumes the debt obligation along with the engineering and financial risks.

Any of these options could save millions of dollars in direct costs to schools and institutions, so whole communities would benefit. Development through this kind of public/private partnership resolves some of the financial problems for institutions when trying to meet the present conservation standards.

Source:
David Horne, Wendy Corpening, "Positive Cash Flow Financing," ***Water Conservation News,*** DWR, January 1992. Conservation Solutions, 725 Arizona Avenue, Suite 206, Santa Monica, California, 90401; (310) 395-6767.

Restaurant Efficiency Methods

Water is a significant part of the restaurant service. It is used for cooking, cleaning, food production, customer consumption, and sometimes for landscaping. Therefore, efficiency is important to keep costs down.

Here are some examples of how restaurants have become more water efficient across the United States.

Seattle, Washington
A survey sponsored by the Seattle Water Department in March 1990 noted the major water uses in restaurants were dish washing, ice-making, and plumbing fixtures. Thirty-seven

percent of restaurant owners agreed that water and sewer costs were significant. The recommendations to increase water efficiency were:

- Smaller restaurants without automatic dishwashers should presoak and wash larger loads rather than one piece at a time. Also use low-flow faucets and repair any leaks.

- Operate ice machines correctly to maintain efficiency. Make sure the valves controlling condenser cooling water are operating properly.

- Install a displacement dam or bag in each toilet and/or replace with 1.6-gallons-per-flush toilets; install restrictors and/or low-flow faucets. By just changing to 1.6-gallons-per-flush toilets, the restaurant would reduce water use by 36 percent.

- Increase employee awareness and efficiency, and improve maintenance of both equipment and water support systems.

- Health Codes may limit reuse of water. One option is to route sanitized rinse water back to the next wash cycle or to the garbage disposal.

Los Angeles, California
In February 1971, on-site surveys done by the consultants for the Los Angeles Department of Water and Power made recommendations to two restaurants:

- El Cholo Restaurant serves 900 meals a day. Restaurant employees could reduce the prewash time before putting dishes into the dishwasher. This would save 142,000 gallons per year, with cost of water at $3.18 per thousand gallons worth $450 annually. The payback period would be immediate.

- Little Joe's Restaurant serves over 700 meals per day. Restaurant employees could eliminate the automatic prewash sprayer on the dish washing system and install a manual hand sprayer. This would save 734,000 gallons per year, with the cost of water at $3.18 per thousand gallons, worth $2,330. The capital cost would be $400; the payback period would be 0.2 year.

Phoenix, Arizona
In 1991, the city of Phoenix published a ***Water Conservation Guide for Restaurants*** suggesting cost-effective water savings. The recommendations were:

- Operate dishwasher equipment properly—this is critical. Run full loads, and limit water flow rate within the equipment. Reuse the final rinse for prewashes, garbage disposal, or food scraper. Stop the water in the conveyor-type dishwasher when the dishes are not present.

- Eliminate the garbage disposal. Since garbage disposals require frequent repair, eliminating them would also reduce maintenance costs. By replacing disposals with a garbage strainer and rinsing the garbage with recycled water, the business would reduce water use about 3 to 6 gallons per minute.

Brockton, Massachusetts
In 1989, the Tip Top Restaurant in Brockton implemented the suggestions very quickly due to a severe drought and experienced immediate savings in both water and waste water fees. The actions taken were:

- Installed automatic shutoffs on water faucet's in restrooms.
- Switched to tankless toilets.
- Installed an automatic shutoff conveyor system on the dishwasher.
- Installed water restrictors on all other faucets.
- Posted signs for customers and employees to conserve water.

By following the recommendations, the Tip Top Restaurant saved 60,000 cubic feet of water per year, a 30-percent decrease in the consumption rate, worth $300. The financial savings would have been higher but water rates and sewer costs rose considerably due to the urgency of water conservation. Even with increased rates, the payback period for all these changes was 0.8 year.

Sources:
Water Conservation Guide for Restaurants, prepared by Black & Veatch for the City of Phoenix, Arizona, 1991.

Opportunities for Water Conservation in Seattle's Restaurant and Shipbuilding Sectors, prepared by Synergic Resources Corporation for the Seattle Water Department, May 1990.

Water Conservation Report—El Cholo Restaurant, and Water Conservation Report—Little Joe's Restaurant, prepared by Black & Veatch for the City of Los Angeles Department of Water and Power, February 1991.

Massachusetts Water Resources Authority, Boston, Massachusetts.

Supermarkets Improve Water Efficiency

Boys Market
Employs approximately 90 employees and operates between 6 a.m. and 2 a.m. daily. The sales floor is approximately 30,000 square feet.

The market purchased all of their water from the City of Los Angeles at the rate $3.67 per 1,000 gallons. The market's annual water consumption was 3.2 million gallons, costing $11,745.

The following areas describe the recommendations made based on the information gathered from the water use inventory, the process that identifies the quantities,

characteristics, and uses of all water on the site:

Evaporative Condenser —The total daily evaporation was approximately 2,810 gallons, operating with a concentration ratio of 2.0. This was 60 percent of the market's total daily water consumption. The recommendation was:

- Operate the tower at 3.0 cycles of concentration. Potential savings would be 514,650 gallons per year, worth $1,890 a year. In addition the market would save $400 per year in chemical costs. Total savings for the year would be $2,290; since there were no capital costs, the payback would be immediate.

Restrooms—The market had four restrooms for employee use and no public restrooms. The total daily consumption with faucet and toilet use was 620 gallons, approximately 6 percent of total daily water consumption. The recommendations were:

- Install flow restrictors or low-flow faucet aerators to limit water flow to a maximum of 1.5 gpm. Potential savings would be 40,150 gallons per year, worth $147 annually. The capitol cost would be $25; the payback period would be 2 months.

- Install 1.6 gallons-per-flush toilets to reduce flush volume by 1.0 gallons. Potential savings would be 54,750 gallons per year, worth $200 annually. The capitol cost would be $500 (this includes a $100 rebate per toilet.); the payback period would be 2.5 years.

Bottle Water Vending Machine—An outside company owned and operated two water filtration vending machines located in front of the store, but the market provided the water. Total estimated daily water consumption was 800 gallons per day. The recommendation was:

- Route the discharge from the vending machines to the evaporative condenser. Potential savings would be 600 gallons per day or 219,000 gallons annually, worth $804. The capitol cost would be $500; the payback period would be 0.6 year.

Major Supermarket
Employs 200 people and operates twenty-four hours a day. The store size is approximately 50,000 square feet.

The market purchased their water from the City of Los Angeles at the rate of $3.67 per 1,000 gallons. The annual water consumption was 6.2 million gallons costing $22,754.

The following areas describe the recommendations made based on the information gathered from the water use inventory, the process that identifies the quantities, characteristics, and uses of all water on the site:

Evaporative Condenser—The total daily consumption was approximately 8,655 gallons, operating with a concentration ratio of 2.5. This was 50 percent of the market's total daily water consumption. The recommendation was:

- Operate the tower at 3.0 cycles of concentration to save approximately 880 gallons per day or 321,200 gallons per year, worth $1,178. This would also have an additional chemical savings of $400 per year. The total savings would be $1,578 per year. With no capital costs, the payback would be immediate.

Restrooms—The market had two restrooms for employee use and no public restrooms. The total daily consumption with faucet and toilet use was 1,330 gallons, approximately 7 percent of total daily water consumption. The recommendations were:

- Install flow restrictors or low flow faucet aerators to limit water flow to a maximum of 1.5 gpm. Potential savings would be 47,000 gallons per year, worth $175 annually. The capitol cost would be $25; the payback period would be 0.1 year.

- Install 1.6 gallons-per-flush toilets to reduce water flush volume by 1.0 gallons. Potential savings would be 151,475 gallons per year, worth $555 annually. The capitol cost would be $300 (this includes $100 rebate per toilet.); the payback period would be 0.5 years.

Garbage Disposal—At the time of the audit, water flow to the produce garbage disposal failed to stop when the disposal was not in use. This problem cost an estimated 2,880 gallons of water a day with a potential cost of $3,860 per year. Repairing the flow valve to the disposal as quickly as possible would lead to substantial savings.

Sources:
Water Conservation Report—Boys Market and Water Conservation Report—Major Supermarket, prepared by Black & Veatch for the City of Los Angeles Department of Water and Power, February 1991.

Toyota Motor Manufacturing

Toyota Motor Manufacturing USA, Inc. (TMM) manufactures Toyota automobiles at Georgetown, Kentucky. The plant is attempting to improve water efficiency by approximately 87 million gallons per year.

Some of the modifications to achieve these savings are described below.

Steam condensate recovery—Approximately 40 percent of the steam uses are indirect steam which can be recovered for use as boiler feed water. TMM is currently recovering only 20 percent.

- Plans are to recover 35 percent by the end of 1993. The estimated water savings by 1994 is 8.5 million gallons per year.

Deionized water—TMM uses a wet sand process which requires deionized water. Past practice has been to send the used deionized water to waste treatment.

- A recycle system is being designed to reuse all of the deionized water. The estimated water savings is 59.4 million gallons per year.

Assembly shower test—The test stand sprays water on new cars for a final leak test. The water is captured in a 15,000-gallon pit and recirculated; however, the water picks up trace contaminants of oil and dust. This requires a 40-gpm water blowdown and makeup to keep water fresh.

- Over the July shutdown, TMM will install an ultraviolet sanitizer which will save 30 gpm of makeup water. The estimated water savings is 15.7 million gallons per year.

Boilers—They required a release of water called "blowdown" to maintain boiler water chemistry at a specific control set point.

- Existing set points could be adjusted along with additional controls to reduce blowdown by approximately 2.3 million gallons per year.

Direct steam injection—temperatures of processes have been controlled by injecting steam into the process.

- Using heat exchangers allows recovery of this water. The estimated water savings is 500,000 gallons per year.

Deaeration—This equipment uses live low-pressure steam, vented to the atmosphere.

- Installing new control valves and reducing pressure will reduce steam use by 23,000 pounds per day, which requires 19,000 pounds per day of fresh water makeup. The estimated water savings is 830,000 gallons per year.

Source:
Information provided by Rick Lancaster, Facilities Engineering, and Alice Woosley, Environmental Department, Toyota Motor Manufacturing USA, Inc., Georgetown, Kentucky, May 1993.

Ventura Coastal Citrus Processor

In 1991, the city of Ventura provided a consultant to help major business customers reduce their operating costs. The consultant provided on-site surveys to identify efficiency measures. The focus was to improve water use efficiency, improve energy efficiency, and reduce waste water discharge.

The Ventura Coastal Plant processes citrus fruit to produce a variety of products including frozen juice concentrate, citrus oils, animal feeds, and dried peel. The plant's basic process involves receiving fruit by truck, washing the fruit, extracting juice, separating peel and pulp,

concentrating and freezing juice, refining oils, and processing pulp and residual peel solids. The plant also prepares juice products by blending juices and other ingredients prepared elsewhere.

All water used at the plant was purchased from the city at the rate of $1.278 per hundred cubic feet (ccf) or $1.71 per thousand gallons. Waste water charges were $1.47 per ccf or $1.96 per thousand gallons.

Average water consumption was about 112,450 gallons per day. If all of the efficiency measures recommended in the survey were implemented, the water/waste water costs would be reduced by more than 2.5 million gallons per year, worth $9,210, and energy costs would be reduced by $8,300. These savings, with other cost reductions, would yield a net savings of $19,510 per year.

The major water uses and measures to achieve these savings are described below.

Fruit washing—Approximately 5,500 gallons of water per day was used cleaning the fruit for processing. The recommendation for water efficiency was:

- Reduce the flow of water used to wash the fruit. Potential savings would be 950 gallons per day, worth $1,270. Because of the minimal cost, the calculated payback period would be immediate. ***Evaporators***—Juice was concentrated by three evaporators. Evaporators took the water removed from the fruit and mixed it with condensed steam. The combined total discharge was 35 gallons per minute of condensate. Together the steam condensate and water from the fruit amounted to approximately 30,000 gallons per day. The recommendation to use the resultant mix was:

- Install a reverse osmosis treatment to purify the water system. Potential savings would be 27,000 gallons per day, with a net value of $31,020. The capitol costs would be $134,000. The payback period would be 4.3 years, which was too long for the measure to be recommended at this time.

Evaporative condensers and cooling towers—Ten evaporative coolers and cooling towers served evaporators, hydraulic systems, and the ammonia refrigeration system. Total water use for this was approximately 31,000 gallons per day. The recommendation for water efficiency was:

- Increase the concentration ratio to 5 by decreasing bleed-off by 50 percent, a savings of almost 5,200 gallons per day, worth $6,940 per year. The capital cost would be $5,000 for a payback period of 0.6 year.

Steam and refrigerant piping insulation—Approximately 500 feet of steam pipe and 500 feet of refrigerant pipe needed insulation. Potential savings would be 19 therms per foot, with a net savings of $6,860. The payback period would be 0.6 year.

Domestic—Low-flow aerators would save approximately 71 percent of the 1,050 gallons per day used by faucets. Potential savings would be $1,310 per year and a cost of $100 for a payback period of 0.1 year.

Source:
Water/Energy Conservation Study—Ventura Coastal Corporation, Black & Veatch for the City of Ventura, California, May 1992.