Roadmap for the Wisconsin Municipal Water and Wastewater Industry

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FIRST RELEASE

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Input Encouraged

This Roadmap for the Wisconsin municipal water and wastewater industry is a living document, starting with the first release. To continue improving the efficiency and competitiveness of the Wisconsin municipal water and wastewater industry, we need your continued input. If you would like to discuss industry needs or potential solutions for items within the Roadmap, contact the Focus on Energy municipal water and wastewater industry advisors:

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Introduction

The municipal water and wastewater industry faces significant challenges stemming from changing regulations, political winds, pressures to reduce costs, global competition, new and unfamiliar technologies, and the growing drive for sustainability. For an individual utility, these challenges could prove insurmountable. In these situations industries often develop joint action plans to tackle the problems they share, resulting in a calculated, concerted response that can be enormously effective.

One way to achieve that response is an industry technology "roadmap." A roadmap—created by the industry—outlines research and development needs and describes the activities necessary to achieve an industry vision. It identifies likely barriers and methods to overcome them, available resources, and strategies for using these resources to achieve desired goals. It also shows how the elements of the roadmap cross energy, environmental, and productivity boundaries.

Roadmapping begins when industry names its vision and then identifies the paths to meet that vision. These paths are incorporated into a strategic plan, which identifies a logical progression of activities from research & development to delivery of new technologies and methods at industry facilities. Roadmaps are dynamic documents, requiring periodic revision to accommodate new information and new goals.

A roadmap provides five main benefits:

1 A common vision

2 Actions aligned with strategic objectives

3 Rationale and resources to conduct research and incorporate new technology

4 Leverage to gain funding and technical assistance

5 A means to an individual company's sustainability

Typically a roadmap will address the following kinds of activities that can help achieve the industry's vision:

- Identifying funding and collaboration opportunities
- Performing market research
- Conducting product R&D
- Measuring and verifying emerging technologies
- Performing technology demonstrations
- Identifying and demonstrating public and social benefits
- Acquiring public program support
- Taking advantage of education and training
- Developing public image
- Complying with environmental, human health, safety, and security standards
- Networking and consensus-building on vision and strategies

The roadmap galvanizes support for the vision—individual companies and trade organizations can use the roadmap as a tool to unify and communicate their goals to local, state, and national government and organizations. In this way, a roadmap helps bring industry, university expertise, and government resources together to pursue common goals.

This document, the Wisconsin Municipal Water & Wastewater Roadmap, addresses four key areas of concern that industry representatives have identified: energy use and supply, aging plants and infrastructure, sustainable water supply, and waste-product reuse. For each area, the roadmap lays out the steps necessary for industry to address the issue.

Overview

When we hear “industry roadmap” we may envision a real geographical map with starting points, destinations, and the routes connecting them. This Wisconsin Municipal Water & Wastewater Roadmap (MWWR) contains all of these elements, showing us the milestones we must pass on the road to a sustainable water and wastewater industry of the future.

Water utilities already have their own plans, decision points, and strategies. Likewise, state and federal officials who watch the industry have their visions of how the industry should perform. But recently the concept of a unified industry roadmap has gained acceptance. Such a consensus-built vision and strategy appeals to many in an era of dwindling resources, increasing customer demand, and new technological options.

A consortium of water and wastewater treatment industry leaders met in late 2001 (see *Appendix A*). They developed an industry-wide roundtable to provide the roadmap foundation. Water treatment and wastewater treatment representatives identified mid-term requirements to improve energy efficiency, cost-effectiveness, and sustainability in the context of growing demand, system design, equipment selection, capital improvements, operational strategies, infrastructure needs, safety and security, environmental protection, public funding and governmental cost controls, and public image. In this way, the roundtable considered routes to sustainability in the full context of industry issues and developed this MWWR accordingly.

MWWR seeks to:

- Identify the needs of the Wisconsin water and wastewater industry, with special attention to energy issues.
- Identify general strategies and resources to address these needs.

This document serves two primary functions:

1 MWWR guides research and development relating to technology, education, training, and other resources useful to the industry.

2 MWWR is a reference for managers and operators providing technical resource listings, program resource listings, and a matrix of opportunities and technologies addressing their needs.

Overarching Industry Vision

The overarching vision of the MWWR includes four action paths and three "cross-cutting" functions, summarized below and described in detail in subsequent pages of this document.

Vision

In 10 years the Wisconsin municipal water and wastewater industry will be an acknowledged leader in protecting public and environmental health; it will be a sustainable participant in Wisconsin’s economy and in the quality of life of Wisconsin residents.

Mission

The mission of the Municipal Water and Wastewater Roadmap is to

- identify the needs of the Wisconsin water and wastewater industry;
- facilitate technical and financial partnerships between industry, government, and researchers who seek to implement projects; and
- identify and link resources to address these needs and help make them accessible for project implementation.

Action Paths

The vision includes action paths in four major areas:

1 Energy Use & Energy Supply

2 Aging Plants and Infrastructure

3 Development and Maintenance of Sustainable Water Supplies

4 Beneficial Reuse of Waste Products

Cross-cutting Functions

Three "cross-cutting functions" are important to all four action paths:

- Public Image
- Common Sense in Environmental Compliance
- Research and Development (R&D) in New Technologies

The Water & Wastewater System

This roadmap focuses on processes that extract, treat, and distribute water and other materials through water and wastewater systems, from water source to discharge. Figure 1 shows the flow of water and other materials through a water and wastewater system. All processes that create this flow require energy.

Beginning with extraction from a groundwater or surface source, utilities pump raw water, treat it, and perhaps store it before distributing it to customers. Water sources vary considerably. Groundwater aquifers are present in limestone, sandstone, shale, and other porous or cracked rock, and occur at varying depths. Utilities also pump surface water from Lake Michigan, Green Bay, and other lakes.

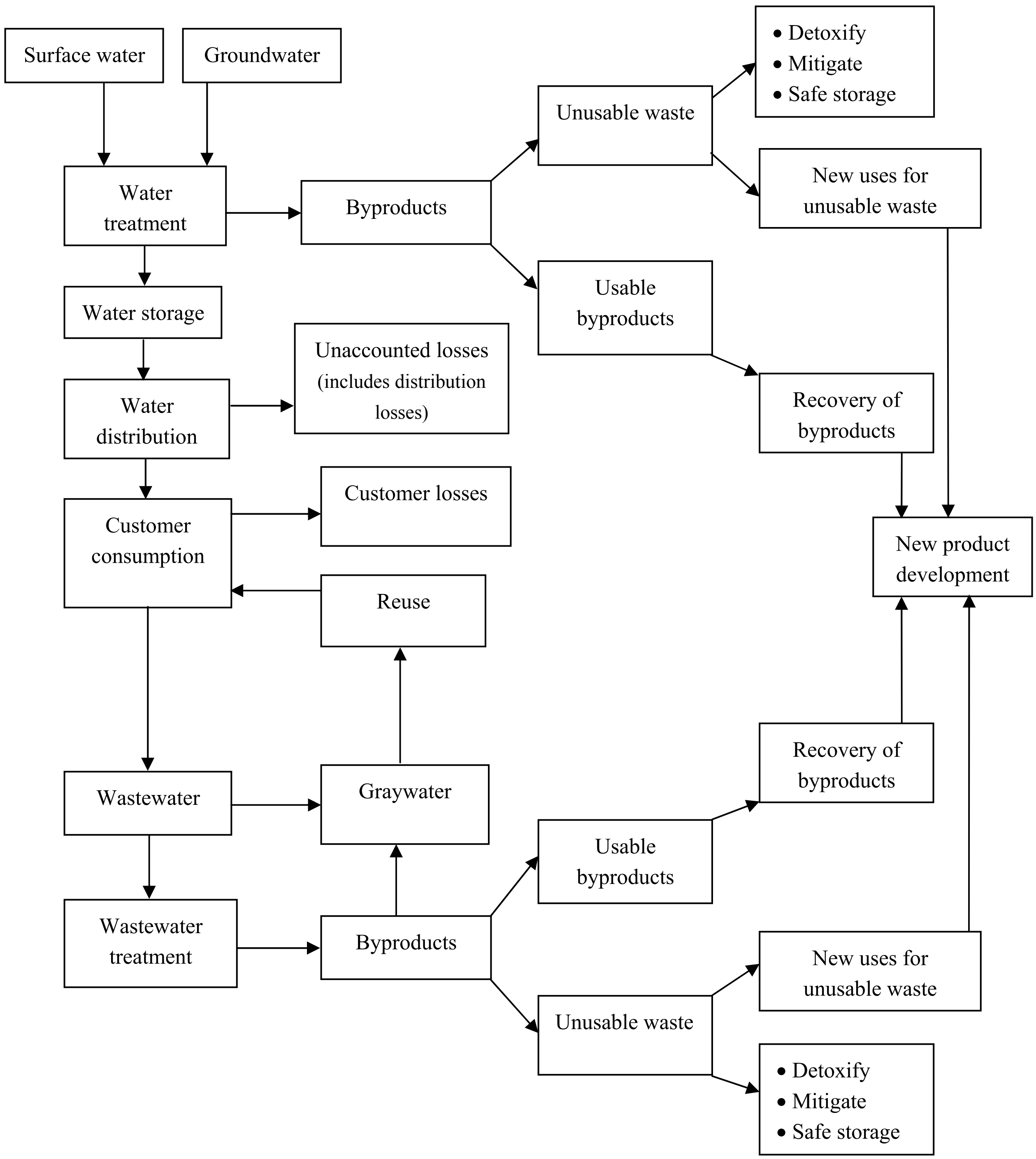
Every source requires its own type of treatment to remove whatever unwanted organic and inorganic compounds, minerals, radionuclides, and biological contaminants may be present. As a water table is drawn down, new treatments may be required to reduce increased concentrations of minerals and radionuclides.

Throughout the distribution system utilities lose water through unaccounted losses—such as leaks and fire department use—causing water losses of between 9.6 and 12.6 percent for Wisconsin utilities.

Used water, along with sewage material, returns to a wastewater treatment facility. These facilities screen influent to remove solid debris and then apply processes to eliminate phosphorous, nitrogen, biological oxygen demand (BOD), biological pathogens, and other contaminants. The utility then delivers cleaned wastewater to the environment, or in rare cases where there is infrastructure to it, cleaned wastewater ("graywater") is reused for tasks such as cleaning. Recovered sludge and other solid waste may be converted to usable byproducts or stored in a way that protects the environment and human health.

Appendix B lists resources and organizations that have a stake in Wisconsin water and wastewater issues. Alliances with these organizations are critical to implementing roadmap strategies.

Figure 1: Water and wastewater system overview



Action Path 1: Energy Use & Energy Supply

Vision

Facility operators and managers have the best information available on the performance and economics of energy efficient water and wastewater systems: they choose the best options and operate them properly. Training, technical assistance, financial assistance, and supply chains provide excellent support.

Discussion

Energy Use

Water and wastewater treatment account for three percent of total nationwide electricity use. Within the industry, pump and compressor motors account for 80 to 90 percent of total electricity use.

Water suppliers use pumps to lift water from aquifers or move water laterally from surface reservoirs, to force raw water through filtration systems, and to distribute treated water to customers. Table 1 profiles energy use and cost for water treatment utilities in Wisconsin. A national comparison showed a significant difference in energy consumption between surface water utilities (1.4 kWh/kgal) and groundwater utilities (1.8 kWh/kgal). But another study from the University of Wisconsin (Elliott, et al, 2002a) showed little difference between the two types in Wisconsin, both consuming about 1.5 kWh/kgal (Class AB only). That study also showed Class AB utilities (13% of all utilities) use 74% of the energy used by all water utilities in Wisconsin: 265 million kWh/year. Water loss alone accounts for about 37 million kWh/year statewide.

Table 1: Wisconsin water treatment utility energy profile, by class (median population values for 1997-2000)*

Class	Average kWh/kgal pumped	Average $/kWh	Average energy $/kgal pumped	Average kgal pumped/year	Average energy $/year
AB	1.51	0.053	0.084	2,390,000	3,810,000
C	1.85	0.065	0.113	253,000	471,000
D	1.89	0.075	0.151	41,000	76,000

* UW Department of Civil and Environmental Engineering study prepared for Focus on Energy, based on data from the Public Service Commission of Wisconsin.

Wastewater treatment facilities use pumps to bring influent to holding reservoirs and push wastewater through treatment processes. Compressors force air through aeration devices. Table 2 shows the energy consumption rates for different types of wastewater treatment facilities.

Table 2: Energy consumption rates for wastewater treatment facilities (national, weighted average by capacity)*

Wastewater treatment facility type	Energy Consumption (kWh/kgal)	Range (kWh/kgal)
Lagoons	0.8	0.3 - 1.2
Trickling filter	1.0	0.7 - 1.6
Activated sludge	1.3**/1.7	1.3 - 2.4
Advanced treatment	1.5**	Not available
Advanced treatment, with nitrification	1.9**	Not available
Oxidation ditch / extended air plant	2.9	1.8 - 3.9

* Electric Power Research Institute, 1994

** Electric Power Research Institute, 1996

A benchmarking study in progress by Focus on Energy is surveying several Wisconsin water and wastewater utilities to determine what these utilities already have in place. The study is looking at motors, processes, and system types, and includes counts, sizes, and purposes of equipment in these facilities. Once complete, this data will help index utility energy performance, design future programs to serve the industry, and estimate program benefits.

Focus on Energy has also conducted market research to assess industry trends and energy behaviors with respect other industries in Wisconsin. See *Appendix C* for an industry overview.

Current Opportunities to Save Energy

Water utilities consider energy use to be high in their facilities, but energy costs are given low priority in overall operations. Although operators are aware of overall energy use, many are not aware of energy efficient options nor how to take advantage of power rate structures. Tables 3 and 4 list energy efficiency best practices for water and wastewater systems.

Many water supply facilities can improve motor efficiency. These opportunities range from operations-level measures that involve very little or no expense, component-level measures that replace inefficient motors with higher-efficiency models (which can cut total energy use by 20 to 50 percent), and systems-level measures such as optimizing pump and motor sizes and installing variable frequency drives (VFDs). Measures at the highest level may require consultation with engineers and a substantial investment.

Taking advantage of power rate structures, utilities can reduce energy costs by switching production to off-peak times, avoiding periods of the highest electricity demand charges. In ideal situations where large storage capacities are available, utilities can operate systems at a relatively constant rate throughout a 24-hour period, avoiding a costly swell of production during the day. As engineering assistance is generally unnecessary, these changes are relatively inexpensive. Through controls like SCADA systems and an understanding of the electricity rate structure, facilities can significantly reduce demand charges.

Table 3: Best practice energy efficiency opportunities for water treatment

General end uses	Recommendation
All motor applications (raw water pumping, mixing, aeration, treated water pumping)	Replace motors that are either at or near end of life with high efficiency motors.
All pumping applications	Pump evaluation and servicing. Pump and motor combined efficiencies are typically 75 to 85 percent. Even for groundwater systems, the energy cost of pumping treated water to customers is approximately 10 times the cost of bringing raw water to the plant.
All motor drive applications where flow is variable (pumping, aeration)	Install variable/adjustable speed drives (VSDs or ASDs) on driving process equipment; if unit horsepower is greater than 1000, consider installing smaller motors that can be staged to meet smaller loads.
Motor drive applications with large flows (required horsepower above 1000) and where flow is variable (pumping, aeration)	Stage motor runs to follow flow (load) on driving process equipment; may require variably sized motors that can be turned on and off to meet instantaneous load requirements.
Systems that carry fluids where flow dynamics can be improved (fluid delivery)	Optimize performance of pumps, blowers, fans, and other fluid drivers. Performance optimization reduces turbulence inefficiencies, sizes equipment to meet loads, employs best practices and appropriate equipment strategies; pump impellers may be trimmed to accommodate reduced loads.
Systems that require scheduling of equipment and feeds and responses to variable factors such as power costs (any process)	Improve process instrumentation and control to optimize process needs and power costs. Include education and training on utility rate structures. This recommendation ties directly to motor staging, storage, application of VSDs, and back-up generation.
Systems with demand-ratcheted power charges and with available space for storage	Increase storage to provide opportunities to adjust flow to either equalize power demand costs or take advantage of off-peak rates; typically, storage is beneficial if it precedes energy-intensive processes that would naturally occur during power utility peak demand periods.
Backwashing	Use automatic, controlled backwash filters.
Pumping requirements for distribution	Detect and repair pipe leaks detection and repair (typical leakage is 9.6 to 12.6 percent).
Radionuclide treatment	In-situ radionuclide treatment uses less energy than surface treatment.

Table 4: Best practice energy efficiency opportunities for wastewater treatment

General end uses	Recommendation
All motor applications (thickening, mixing, centrifugation, aeration, vacuum filter, conveyance, compressors)	Replace motors that are either at or near end of life with high efficiency motors (3-5 percent savings)
All pumping applications	Pump evaluation and servicing. Pump and motor combined efficiencies are typically 75 to 85 percent.
All motor drive applications where flow is variable (pumping, aeration)	Install variable/adjustable speed drives (VSDs or ASDs) on driving process equipment; if unit horsepower is greater than 1000, consider installing smaller motors that can be staged to meet smaller loads. (15-50 percent savings).
Motor drive applications with large flows (required horsepower above 1000) and where flow is variable (pumping, aeration)	Stage motor runs to follow flow (load) on driving process equipment; may require variably sized motors that can be turned on and off to meet instantaneous load requirements.
Systems that carry fluids where flow dynamics can be improved (fluid delivery)	Optimize performance of pumps, blowers, fans, and other fluid drivers. Performance optimization reduces turbulence inefficiencies, sizes equipment to meet loads, employs best practices and appropriate equipment strategies; pump impellers may be trimmed to accommodate reduced loads.
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Systems with demand-ratcheted power charges and with available space for storage	Increase storage to provide opportunities to adjust flow to either equalize power demand costs or take advantage of off-peak rates; typically, storage is beneficial if it precedes energy-intensive processes that would naturally occur during power utility peak demand periods.
All electrical end uses	Generate electricity through biogas cogeneration and use it to drive mechanical, lighting, and other electrical processes.
Processes that require heat (heat treatment and conditioning, anaerobic digestion, pasteurization, drying, evaporating, incineration, etc.)	Use heat recovery from biogas cogeneration to drive the process or to boost the heat before direct heat is required.
Aeration processes	Replace coarse bubble aeration with fine pore diffusers (9-40% savings) or with dissolved oxygen control. Adjust design and controls to control aeration.
Backwashing	Use automatic, controlled backwash filters.
Biosolids dewatering	Replace vacuum filters with belt filter presses.
Pumping	Reduce flow to minimize storm water drainage and other infiltration into treatment ponds.
Pumping and aeration	Reduce load to minimize the treatment requirements of influent.

Current Opportunities to Produce Energy

To avoid peak electric demand charges, water and wastewater utilities should consider back-up self-generation to handle peak loads. Although fossil-fired generators are available, wastewater utilities can also use methane produced in their anaerobic digesters to generate electricity. Digester biogas provides cheap and renewable energy for operations and high quality heat for plant processes. In activated sludge systems, where the biological phase accounts for 30 to 80 percent of a facility's power costs, cogeneration is highly beneficial. New technologies such as fuel cells, microturbines, and Stirling engines that can use biogas even more efficiently are also available. Furthermore, security interests create a greater demand for self-reliance and less dependence on centralized power systems, making on-site cogeneration even more attractive.

Future Opportunities to Save Energy

New regulations to meet health, safety, and environmental requirements will force utilities to look at new technology options. Utilities may choose from ultrafiltration, ultraviolet (UV) disinfection, ozonation, and using new chemicals. Each technology carries a capital cost and energy charge that will affect life-cycle costs and decisions. See *Common Sense in Environmental Compliance* in the *Crosscutting Functions* section later in this document for a list of technologies that support environmental compliance in water treatment.

The University of Wisconsin (Elliott, et al, 2002a) determined average energy costs per million gallons per day, according to treatment type:

- Microfiltration: 252 kWh/MGD
- Ozonation: 269 kWh/MGD
- Ultrafiltration: 950 kWh/MGD

Additional research (Mackey, et al, 2002) provides additional energy cost estimates:

UV Disinfection

- LPHO (low power output) UV: 50 kWh/MGD
- MP (medium power): 150 kWh/MGD

Ozonation (@6 kWh/lb O_3)

- Dose of 3 mg/L: 150 kWh/MGD
- Dose of 12 mg/L: 600 kWh/MGD

Microfiltration and Ultrafiltration

- Low-head membrane (9 PSI): 150 kWh/MGD
- Standard membrane (30 PSI): 500 kWh/MGD

Utilities need more information about energy costs and guidance in selecting the best technologies for specific situations. Utilities may also choose from an array of new designs as they expand to meet demand or replace outmoded facilities with new ones. Design considerations include: water source; levels of various chemical, biological, and radiological contaminants; effluent and biosolid byproduct requirements; space availability; and capital and operating costs. In order to give full treatment to the life cycle costs of options, the costs of energy and other operating costs must be included with capital costs.

The following checklists outline design considerations that may make sense for future energy efficient plant design.

Design Considerations Checklist—New Water Treatment Facilities

☐ Provide ample storage capacity and flow flexibility to accommodate demand costs

☐ Specify high efficiency motors and pumps

☐ Include control system with software

☐ Consider low-energy backwashing system options

☐ Optimize chemical requirements

☐ Install baffled flocculation tanks instead of mechanical flocculators

☐ Use staged, load-adjusted, small air compressors for air-fed ozone systems

☐ Consider alternative solution mixers that are nonmechanical (static or hydraulic jump)

☐ Consider the concept of minimal energy with respect to spatial layout of a new water extraction and treatment system to minimize pump distance and head requirements

☐ Select water treatment system technology that reflects the best life-cycle economics, with respect to environmental compliance

☐ Use lower friction pipes (estimated 6-8 percent energy savings)

☐ Apply not-quite-potable, treated wastewater to:

- recharge aquifers
- support industrial processes
- irrigate certain crops
- augment potable water

☐ Institute customer program measures (demand-side management)

- Toilet dams or other water displacement devices
- Ultralow-flow toilets
- Low-flow showerheads
- Efficient faucet aerators
- Water-efficient clothes washers
- Water-efficient dishwashers
- Xeriscaping
- Drip irrigation
- Water reuse (graywater use)
- Leak repairs
- Automatic shut-off nozzles
- Process water recycling
- Time-of-use rates

Design Considerations Checklist for New Wastewater Treatment Facilities

- ☐ Use attached-growth type of secondary treatment (trickling filters or biological contactors) in lieu of activated sludge for medium-sized plants to reduce energy costs
- ☐ Provide ample storage capacity and flow flexibility to accommodate demand costs
- ☐ Specify high efficiency motors and pumps
- ☐ Include control system with software
- ☐ Employ initial removal of large debris in lieu of comminutors to avoid increased secondary treatment costs
- ☐ Consider low-energy backwashing system options
- ☐ Optimize chemical requirements
- ☐ Apply baffled flocculation tanks vs. mechanical flocculators
- ☐ Use staged, load-adjusted, small air compressors for air-fed ozone systems
- ☐ Consider alternative solution mixers that are nonmechanical (static or hydraulic jump)
- ☐ Apply fine bubble aeration instead of coarse bubble
- ☐ Consider UV for disinfection instead of chemical or ozonation
- ☐ Minimize infiltration of groundwater and rainwater into sewage collection system to reduce pumping requirements (seal joints, use PVC pipe, bypasses, etc.)

Action Path

1 Identify industry needs with respect to energy use and energy supply.

Energy efficiency programs may respond by providing best practices for new equipment retrofit and system replacement technologies. Facility energy surveys and benchmarking provide the baseline for individual facilities and the industry as a whole. The experience and collaboration of peers, industry association information and education programs, electric utility assistance, and consumer education support the adoption of best practices. Performance verification and field demonstrations help support new technologies that can more effectively meet industry needs.

2 Match industry needs to the technical, financial, and program resources available.

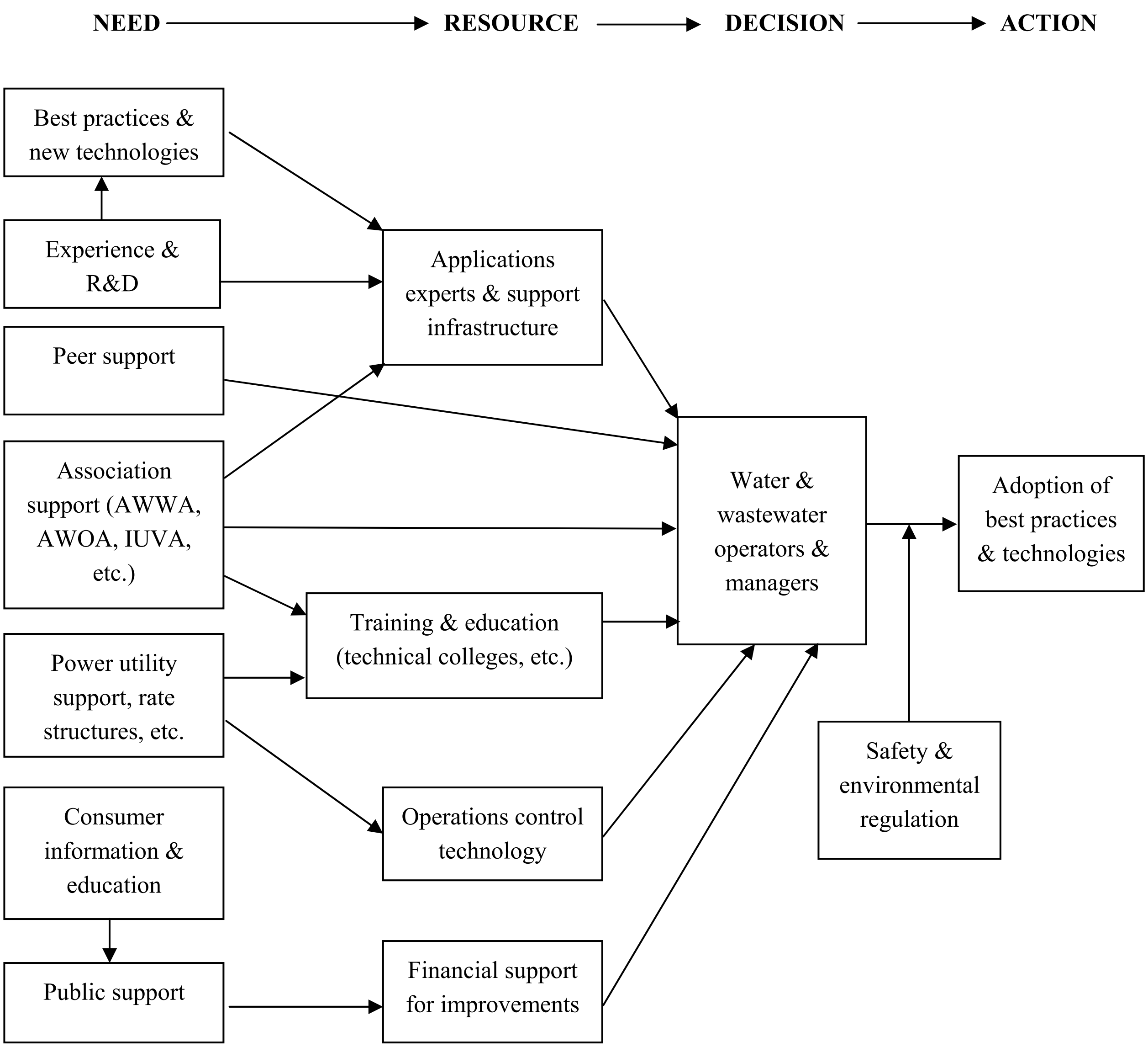
Programs to address energy use and supply issues include (1) well-trained and informed application experts, (2) equipment and operations support services, (3) education and training on utility rate structure, (4) fully integrated operations control technology, and (5) financial support for decisions involving capital improvements. For this to work, the program trains and informs technical consultants, equipment providers, and system operators and managers on the best technologies for optimizing energy use. Water and wastewater utilities should collaborate with electric utilities, individually and through associations, to make the most of power utility rate structures and synchronize the needs of both types of utilities.

3 Obtain public support for water and wastewater operator and manager decisions.

Equipped with appropriate resources and compliant with safety and environmental regulations, utility decisions are more likely to enjoy public support for capital outlays and operations.

Figure 2 presents the roadmap for achieving optimal energy use at municipal water and wastewater utilities.

Figure 2: Action Path 1—Energy use and supply



Additional Concerns

Industry representatives have particular concerns about four important energy issues, which must be considered in any detailed development of this roadmap segment.

Risk Reduction

Because managers and operators work in the public eye—they respond to utility commissions and city leaders—they tend to make choices that minimize financial and political risk. State budget constraints create additional challenges. Therefore, managers must seek public support for their decisions. To do this they need balanced, reliable, and up-to-date information about their options, with will help them reduce their risks. They must also be able to network with peers, take advantage of education and training opportunities, and form partnerships with utility and state programs.

Manager/Operator Education and Training

Managers and operators want education and training on power rate structures and contracts. Power utilities have system and customer data essential to understanding the nature of demand on the water and wastewater system. Cooperation between water and wastewater utilities and the power utilities that serve them is mutually beneficial. Water and wastewater utilities must evaluate and use data from computer monitoring systems and have a communication structure tied to their power utilities. This requires collaboration and technical support.

Managers and operators want training, education, and technical support in energy efficient equipment and practices. This also helps achieve employee acceptance of technical solutions. Of course, staff training in installation and operation of new equipment requires an investment in time, a very important commodity. Time invested up front in training and education usually pays big dividends in operation and maintenance savings down the line.

One valuable resource is the technical college system. Future collaboration in the training and development area will produce new education programs about working with power bills and about operating new efficient technologies. Industry leaders should provide guidance in coordination with industry associations, program resources, and technical experts.

New Technology Transfer for Industry Allies

Designers, equipment vendors, and consultants also require information on the best technologies. As consultants are often in long-term relationships with water and wastewater utilities, education and training should focus on best choices for the specific utility applications. This may mean that consultants will have to expand their technology repertoires.

Capital Financing

Water and wastewater utilities also need financing to invest in better equipment and infrastructure in order to meet upcoming environmental and security standards, and to replace aging infrastructure. Some state program assistance exists for technical review of energy efficiency opportunities and for financial support.

Action Path 2: Aging Plants/Infrastructure

Vision

To protect human health, safety, and the environment, aging plants and distribution systems are routinely replaced by new and efficient plants that use the best technologies and achieve optimal lifetime economics. Existing plants, that will remain in operation for many years, receive upgrades that apply best practices to achieve optimal lifetime economics.

Discussion

Driving Forces

Most water and wastewater treatment systems in Wisconsin need to be improved or replaced. The driving forces for these changes are (1) failing structures, (2) new regulations, (3) growth in customer demand and plant capacity requirements, and (4) cost containment.

Failing structures include leaking distribution systems, worn equipment, and outmoded operations. Most failures occur in the distribution system, accounting for 70 to 80 percent of major capital investment. Some equipment failures cause noncompliance with health, safety, and environmental standards.

Surface water and groundwater quality is declining, increasing treatment costs. Contamination threats are emerging from biological agents, organic compounds, heavy metals, radionuclides, and disinfection byproducts. Environmental agencies are promulgating new regulations for water supply sources and treatment, wastewater effluent, biosolids distribution and handling, and disposal of toxic waste. These regulations will affect new operations, equipment, and plant selection.

Population growth and development spur customer demand, while water customers still expect a high-quality product. In areas like the western suburbs of Milwaukee, the Fox River Valley, and Dane County, aquifers are being drawn down below historic low levels. This issue is exacerbated by new pressures from water bottling companies to develop Wisconsin's water resource and pressures to privatize municipal water and wastewater utilities.

Cost containment has new meaning with the current budget deficit and the potential for reduced local control. New technology, repairs, and capacity expansion are expensive. Energy costs, due primarily to pumping, are on the rise. Real-time customer demand results in low flexibility in pumping and vulnerability to energy cost swings. While we are fortunate to have a good scientific understanding of water quality, consumer awareness and sensitivity are heightened by it. This increased sensitivity places more pressure on utilities to improve water quality.

Each utility will manage these forces in ways that reflect the local politics, degree of infrastructure failure, and local geophysical and environmental conditions.

Needs Assessment

For this Action Path, industry needs include (1) system replacement, (2) operation upgrades, (3) equipment upgrades and plant expansion, and (4) customer water conservation.

System Replacement

Water and sewer systems are wearing out. At some point the cost to maintain the plant becomes greater than the cost to replace it. A limited amount of funding is available to communities to replace aging plants. Utilities will need to budget limited funds to replace system assets. Good budgeting requires long-term planning and data. Asset replacement planning must be coordinated with other departments, such as police, fire, and street departments. Utility personnel need to be trained in making decisions based on system data.

Operation Upgrades

Water and wastewater systems often operate at high peak-to-average ratios, so that much of the plant is not being used much of the time. Flow equipment should be sized for peak loads. If sufficient storage capacity is in place, along with adjustable flows, flows can be levelized and equipment sized smaller. Similarly, loads should be adjusted to take the best advantage of the equipment in place. On the energy side, flows may be adjusted to optimize power costs with operations. Finally, as water is a necessity, utilities may install reliable standby power.

Equipment Upgrades and Plant Expansion

Upgrades may be needed to replace worn or inefficient equipment, to increase plant security, or to comply with new environmental and safety standards. Improved disinfection systems need to meet health and safety standards.

Customer Water Conservation Programs

Utilities should promote customer water conservation and time-of-use programs. Efforts should include implementing measures that save water or move loads to off-peak times and days, such as alternate watering times, rate incentives, conservation, and graywater reuse. Measures may involve new infrastructure to support these initiatives.

Technical Criteria

Customer demand, environmental standards and cost parameters should define system technical requirements. Specific criteria may include: limited space; geophysical characteristics and qualities; disinfection level requirements; inorganic material removal requirements; management of multiple objectives, such as response to power rates and customer demand; and taste, color, and odor.

Technical Options and System Improvement Strategy

The technical criteria guide utilities in their selection of technical options for future upgrades and replacements. Most options will include a combination of technologies and improvement strategies. Utilities can find value in a portfolio of options, including hybrid solutions, to address their specific needs.

Action Path

1 Identify Wisconsin water and wastewater utility plant/infrastructure replacement and upgrade needs.

Peer experience teaches utilities how to examine and define their particular system challenges. A database that inventories utility infrastructure problems, lists options considered, and lists selected solutions will provide a basis for future utility decision-making.

2 Identify available technologies to meet infrastructure needs.

This step identifies the best replacement options for worn equipment. It identifies the alternatives to conventional water delivery and waste return systems, and quantifies the potential impacts on water conservation. The best options (technologies and systems) meet the following objectives:

- Reduce peak-to-average ratios (optimize on power rate structure and capacity needs)
- Meet new environmental regulations
- Minimize security risks
- Minimize energy costs
- Optimize all of the above for a specific utility application

3 Identify relative costs and financial barriers to adopting new systems and technologies.

Determine the costs and rate impacts of the various plant upgrades needed, including those of alternative strategies. Realistically, this includes intangibles like political costs (or how to manage them). Decision-makers will need selection criteria that are relevant to the individual utility's needs and vision. Criteria will include available financial resources to capitalize the improvements, power utility contract data, environmental and safety compliance requirements, and geophysical constraints.

4 Select the best upgrade option.

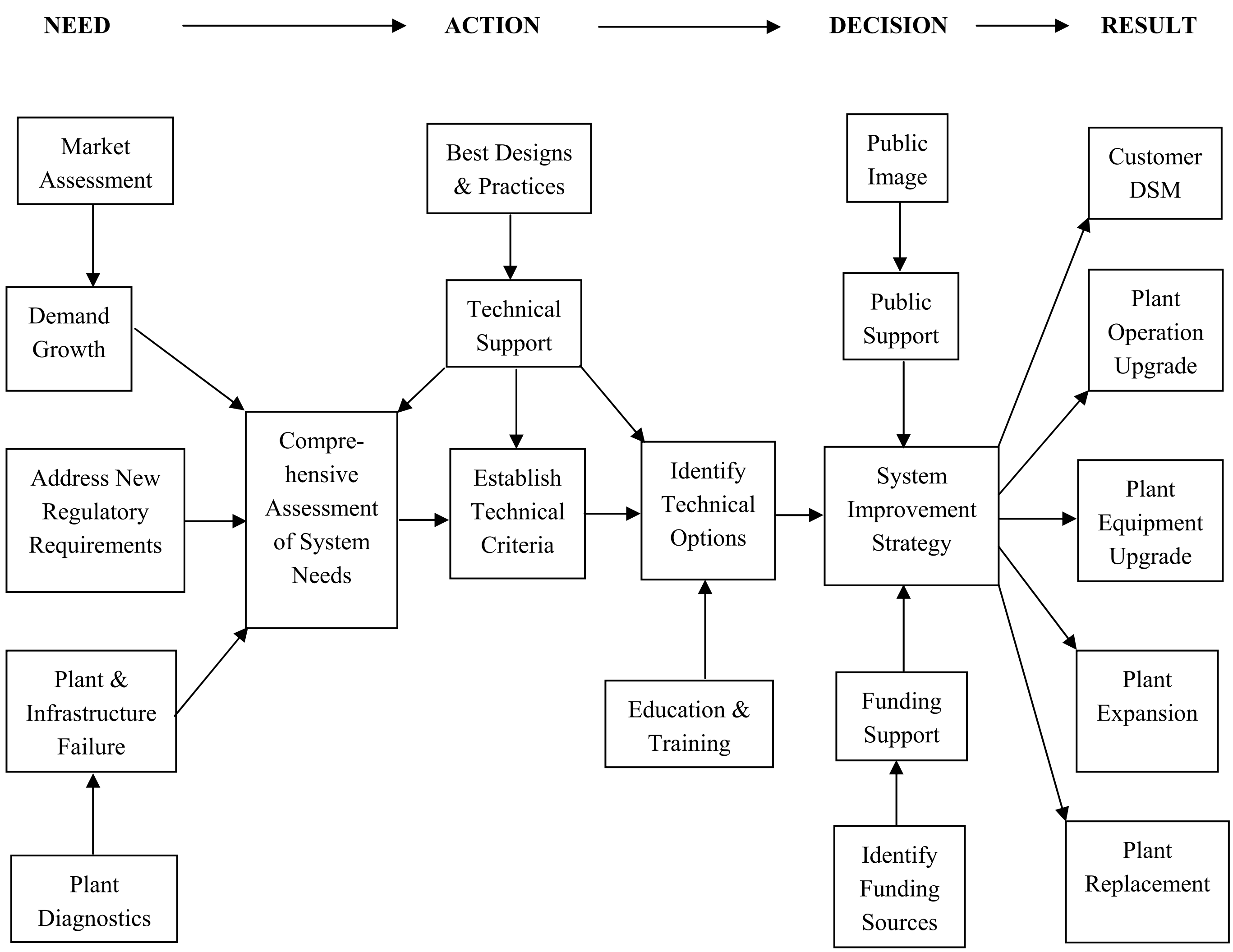
This step will assess the level of community support, address citizen and policy-maker questions, generate awareness and education on the relevant issues, ensure confidence and understanding of the proposed improvements among operations staff, and crystallize political support for the best choice. Support from peers, state officials, and objective technical experts may be required.

5 Educate taxpayers about infrastructure needs, benefits, and costs.

Ongoing public support for construction, maintenance and operation of the new system, and support of community conservation is critical. Training operations personnel, educating commissioners, city officials, and utility managers present opportunities to show benefit to the public. Operations data and information on program status also contribute to constructive public relations.

Figure 3 shows a standard path that a utility may take to determine its system improvement strategy. The process gets support from market assessment, plant diagnostics, best designs and practices, education and training, public image development, and funding. At a statewide level, we recommend these actions to (1) inventory, characterize, and profile existing structures; (2) assess utility needs, options, and barriers to implementation; and (3) secure political and funding support for the selected system improvement strategy. Education, training, peer networking, and access to technical consultants will serve all steps.

Figure 3: Action Path 2—Aging plants/infrastructure



Action Path 3: Developing and Maintaining Sustainable Water Supplies

Vision

Wisconsin sustains its water supply and water quality at levels that support a healthy ecosystem, a healthy economy, and human health. Water conservation, efficient water use—including graywater reuse—and maintaining a high quality of treated wastewater contribute to this result.

Discussion

Many forces affect Wisconsin's water supply. Unchecked, these forces threaten to degrade both the quality and quantity of water available to the state. Most important of these forces are pressures from Wisconsin consumers and out-of-state businesses to drain supply while agricultural runoff, municipal runoff, and industrial effluent contribute to source contamination. To sustain a high-quality water supply so that health, safety, and environmental standards are met, utilities should establish structures that incorporate proper treatment, reuse of treatment byproducts, groundwater recharge, detoxification, safe storage, and mitigation of unusable byproducts.

Utilities must meet consumption pressures with water conservation strategies targeting consumers. Some experts argue that current customer rates do not reflect the true cost of water, that is, what the price of water would be if all market forces applied. But most municipal and many private water and wastewater utilities behave as "natural monopolies," rate-regulated by taxpayer commissions. Tax subsidies allow them to operate at the behest of the communities they serve, controlling and developing nonduplicative plant and infrastructure. The precept that local, necessary resources belong primarily to the local citizenry forms the basis of this policy. Commissions act on behalf of the community to preserve and protect the resource. Commissions allocate costs based on infrastructure replacement, environmental impact, unaccounted leaks, administration, meter reading and billing, long term planning, and regulatory compliance. However, in some less-regulated water markets—such as bottled water—marketing, packaging, and distribution generate much higher prices than what we see at the tap.

Demand for fresh water from Wisconsin aquifers and the Great Lakes is increasing. This market pressure creates a dilemma and debate for water policymakers. Controversial business initiatives underline the need for public appreciation of water supply and quality issues, the need for conservation and reuse, and an understanding of the potential social cost of poor water quality and supply.

At the same time, Wisconsin needs an effective policy that fairly distributes responsibility for point and non-point pollution, such as agricultural runoff, municipal storm water, development runoff, and effluent. That policy will support positive strategies to maintain the purity of natural systems and mitigate losses.

As aquifers in Milwaukee's western suburbs, the Fox River Valley, and Dane County experience draw-down, pressure to use Lake Michigan water and river water will increase. This result will certainly affect groundwater recharge. This shift will also profoundly influence capital investment in new infrastructure and energy consumption by water utilities. Taking water from distant sources greatly adds to pumping energy costs. Add the cost of treating surface water for *Giardia* and *Cryptosporidium* and the energy costs begin to escalate dramatically. New regulations will require more energy-intensive technologies for most treatment plants.

In this scenario, the adage "water conservation equals energy conservation" assumes a stronger meaning. Water users need information on these trends to consume water wisely and to support appropriate policy on Wisconsin water issues. Lower consumption translates into reduced pumping, treatment, and distribution energy costs; it may also defer system capacity needs.

Action Path

1 **Convene a representative group of industry leaders and policy-makers to identify needs, resources, and solutions, including the proper avenues for policy action.**

Leaders from industry associations, state government, R&D institutions, and regional experts should form an ad hoc group to address and promote this issue.

2 **Develop policy and collaborative action.**

Developing and maintaining a sustainable water supply in Wisconsin begins with collaboration and public policy. Stakeholders should express their concerns in a unified voice. Reliable information and education for leaders, industry spokespeople, and system managers and operators should form the basis of this unified voice. Water and wastewater associations in Wisconsin and other key supporters such as the Fox-Wolf BAPW group, the Water Environment Federation, the Great Lakes Foundation, watershed quality groups, and water resource experts across the state can help create the message.

3 **Develop a support infrastructure to help select the most appropriate strategies (see *Action Path 2*) to meet water and wastewater system needs.**

Based on the policy developed, leaders should identify the necessary resources (technical expertise, training, financial assistance, and environmental and safety compliance) that help system managers and public program designers choose the best strategies and initiatives. This includes getting public support.

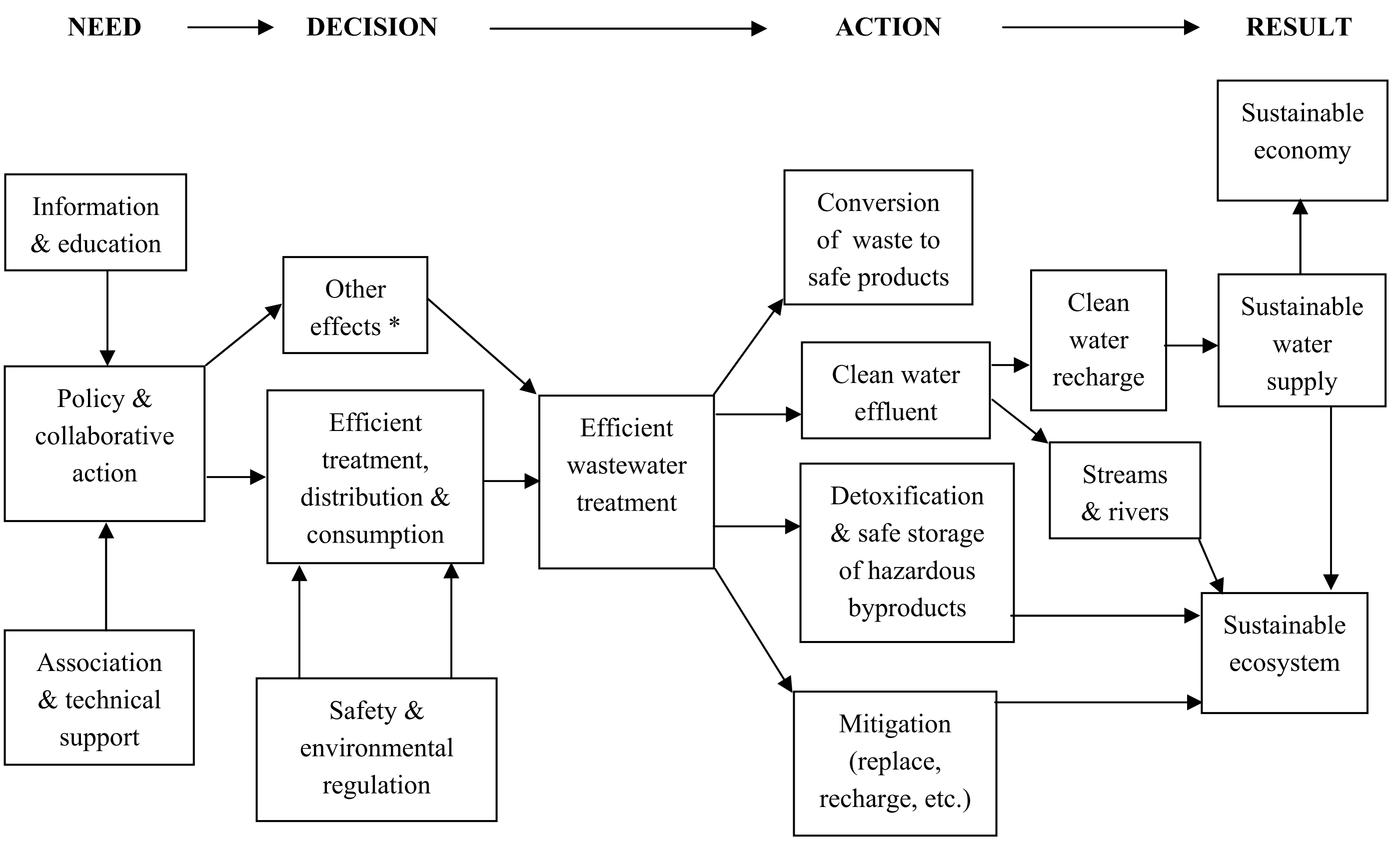
4 **Individual utility systems implement customized strategies to address sustainability.**

Depending on their individual situations, utilities should apply different strategies. Surface water systems should choose different solutions from groundwater systems. Depth of water table and characteristics will cause differences in approach. Wastewater systems each deal with different types of waste streams and should change their systems accordingly. Some may have larger industrial loads; others, more residential. Eventually all municipal utilities must manage detoxification of solid waste, safe storage, safe discharge, supply water recharge, and environmental mitigation.

This action path results in a sustainable water supply that supports a sustainable economy and ecosystem. When system flows (particularly water and materials) are in balance the end-state will be sustainable. On the energy side, the best way to serve sustainability is to minimize waste through energy efficiency, heat recovery, and renewable energy that replaces the use of fossil fuels in electric generation.

Attaining this vision will require a concerted effort among all the actors in the state who desire a high-quality, abundant water supply. Figure 4 lays out a general strategy intended to produce a sustainable water supply.

Figure 4: Action Path 3—Developing & maintaining sustainable water supplies



* Agricultural nonpoint, storm water, industrial, and other sources

Action Path 4: Beneficial Reuse of Waste Products

Vision

Every byproduct of water and wastewater treatment has an economic use or can be returned to the environment with no negative impact.

Discussion

In support of a sustainable water supply, ecosystem, and economy, the water and wastewater industry seeks to identify and develop new consumer products that reduce byproduct volume and minimize the negative impacts of effluent. New products, such as reusable graywater, Class A biosolids, inert plastics, solids useful for building or road construction, and recycling purified yellow grease are among the many possible examples of reuse.

Utilities may have to modify some treatment processes, at least at the back end, to allow for new raw materials and products. Reusing graywater may necessitate major transformation of the physical infrastructure with parallel delivery systems and controls, both on the customer and utility sides. In one example, scarcity and high cost of water have forced some power plant operators to consider using graywater for cooling towers.

An effective reuse program will address byproduct analysis, discover byproducts, match byproducts to productive uses, and determine economic feasibility and market acceptance of new consumer products. In addition to landfill avoidance, reuse may produce sales revenue.

Action Path

1 **Identify waste byproducts and recycle opportunities.**

Waste byproducts can yield new consumer products including biosolids, food waste, lime, water plant residuals, wastewater from rendering plants, chlorides/brine, radium/brine, biogas, waste heat, metals, and yellow grease. Utilities need a new assessment that matches market needs to new products. This assessment may be initiated by collaborative policy support and industry association support. The assessment should include an identification of research needs and technical resources.

2 **Perform market analysis of reuse/recycle products.**

An industry leadership group should seek businesses to create new products from the waste stream. A market analysis can identify potential collaborators interested in using waste byproducts. Ideal collaborators will have technical expertise and, if possible, financial resources to invest in new product development. They will identify possible products and determine stage of development, barriers to development, and product positioning. The analysis should contain a benefit-cost analysis, including the avoided costs of landfilling or distributing the displaced waste, along with any energy benefits. An analysis should also include discovery of what has already been developed or attempted by R&D institutions, universities, consultants, the Water Environmental

Federation (WEF), the American Water Works Association (AWWA), the Electric Power Research Institute (EPRI), and other organizations that develop products. The effort should recruit those state and federal agencies that assist in business and product development.

3 Develop recovery operations.

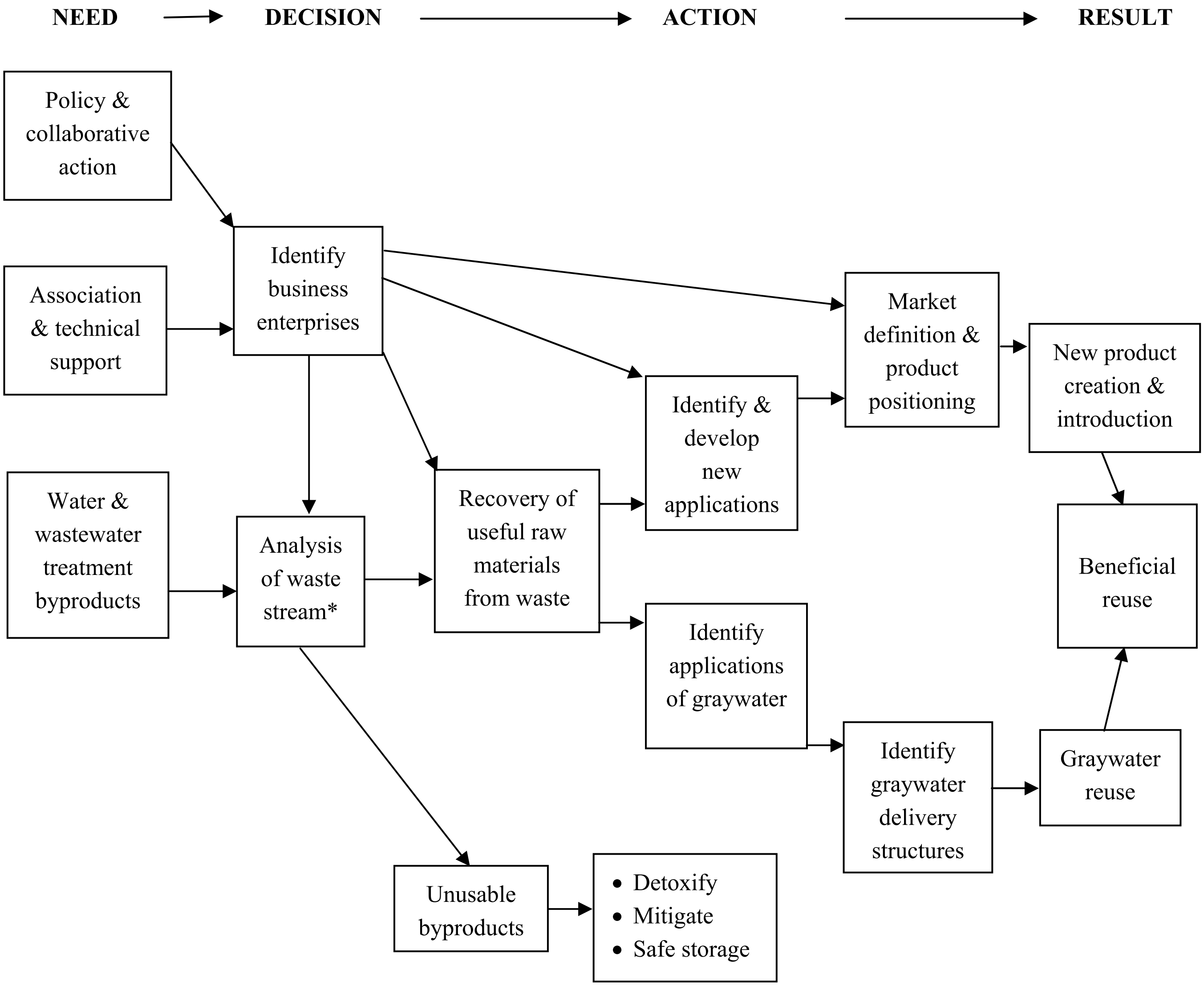
Recovering waste byproducts to reuse in other products will require new processing equipment. The means of production as well as the support infrastructure for the new equipment must be identified. Special delivery systems may be necessary for graywater applications, such as for cooling towers, irrigation, or for nondrinking residential use.

4 Identify and develop markets for new products

Collaborators should work with the Great Lakes ByProducts Management Association, Fox River Valley Organic Recycling, universities, consultants, AWWA, EPRI, and other agencies to develop market research plans, technology research strategies, and marketing plans to gain customer and public acceptance.

Through new product creation and identification of new uses, we can discover beneficial uses for most components of the water and wastewater waste stream. The result will also support the goals of *Action Path 3*. Figure 5 plots an approach to the waste byproduct reuse market.

Figure 5: Action Path 4—Beneficial reuse



* Includes municipal storm water

Crosscutting Functions

Cross-cutting functions—generating a positive public image, cooperative environmental compliance, and a consensus-based research and development agenda—are essential features that must be integrated into all four Action Paths.

Generating a Positive Public Image

Vision

The public understands:

1) Its responsibility to conserve water and preserve water quality

2) Why it should support decisions made by water and wastewater system officials

Overview

The industry needs the public to understand that water is a limited resource, a valuable commodity, and an important public issue. The public should know there are serious and immediate environmental, public safety, and cost implications. One way to provide good information is through a campaign to promote public awareness of water issues. The industry should develop a unified vision with collaborative solutions, based on representation from the public, operators, regulators, industry experts, and industry associations. The vision should include a unified message from utilities to the public.

Special messages that target elementary schools, technical colleges, universities, system operators, policy-makers, and the general public might include:

> "Water is a valuable resource. Even though it is renewable, demand may exceed its ability to be replenished. Furthermore, water quality is just as important as water quantity. Therefore we mustn't take water for granted anymore, as we've been doing."
>
> "Treating water and wastewater yields byproducts that may be difficult for the environment to handle. Therefore disposal solutions must be supported and funded.
>
> "It all starts at home—the first step to a sustainable water supply is home water conservation."

A strong public image is necessary for water and sewer customers to understand the link between their use and industry's *energy use and energy supply*. About two kilowatt-hours are saved for every thousand gallons of water that does not have to be pumped to customers. The lifetime operating costs of alternative systems, of which energy can be a large part, need to be understood when selecting major new treatment technologies. Informed public support can ensure that the best technologies are chosen.

As above, selecting the best system strategies to replace *aging plants/infrastructure* will occur where a positive public image of the utility decision-making process exists. Similarly, public support and understanding of the need is necessary for financial support for major capital projects. One critical component of any resource development program for water and wastewater utilities will be demand-side management programs to shave or shift use to off-peak periods.

The public generally assumes that governmental regulation and responsible market actors will ensure that utilities are *developing and maintaining a sustainable water supply*. As water and sewer customers, we have been accustomed to running the tap, watering our lawns, cooling our power plants, and sending the used water back to the utility, with little consequence beyond having to pay a nominal water and sewer bill. Both water supply and quality are changing, even in Wisconsin where water appears to be relatively abundant and clean. The industry faces many public image challenges as the new costs of drawn-down aquifers, clean water standards, competition for supply, increasing demand, and effluent standards take their toll. The public expects pristine environmental conditions, economic development, and clean water. The price that consumers will be willing to pay in the future will be a reflection of the effectiveness of future public information and education campaigns. Demand-side management programs where water and sewer utilities promote customer water conservation and demand shifting/reductions to reduce the need for new facilities will become necessary.

Beneficial reuse of waste products, an important element of developing a sustainable water supply, will depend upon public support in the form of public policy and collaborative action. Some byproducts, such as graywater and Class A biosolids, will require special attention.

Common Sense in Environmental Compliance

Vision

Environmental regulations for supply water quality and wastewater effluent are based on scientific research, economic feasibility, and governmental financial support.

Overview

The municipal water and wastewater industry desires a sensible, research-based, collaborative approach to regulations. Water and wastewater regulation should be based on clearly presented scientific facts and should provide reasonable choices for compliance and for financing the required changes so that systems are not put at financial risk. Government mandates should include funding assistance. Collaboration, initiated by water and wastewater utility managers, should include high-level meetings among regulators, researchers, industry consultants, association representatives, and public interest groups.

Energy costs are already a significant share of operating expenses for water and sewer utilities. They need to reduce these costs. Pending regulation on *Cryptosporidium*, *Giardia*, other biologicals, nitrates and nitrites, radionuclides, chemical disinfection byproducts (DPBs), and security concerns will exert additional upward pressures on energy operating costs. New regulations promulgated over the next few years will force utilities to choose technological solutions that may be more energy intensive, such as UV, ozonation, and ultrafiltration. Some utilities will not have the complete range of choices due to limitations on water source, current contamination levels, and other factors. Utilities will have to consider which technology is feasible, given that energy cost is a key variable in the decision.

Table 5 lists some of the technologies available to support environmental compliance in water treatment.

Table 5: Technologies that support environmental compliance in water treatment

Compliance requirement	Technology options
Disinfection	UV radiation (also effective against *Giardia* cysts and *Cryptosporidium* oocysts)
Pretreatment Oxidation of various inorganic and organic chemicals Minimize chlorine-generated trihalomethane (THM) Disinfection	Replace chlorination with ozonation (very effective against viruses, bacteria, and *Giardia*.)
Reduce turbulence Disinfection Reduce production of disinfectant byproducts (DBPs)	Ultrafiltration (UF), Nanofiltration (NF), Microfiltration (MF), and Reverse Osmosis (RO)
Disinfection	Chemical alternatives to chlorine—hypochlorite, chloramines, chlorine dioxide (volatile and health effects of byproducts unknown)
Reduce radionuclide presence in drinking water	In-situ radionuclide treatment, surface treatment of radionuclides

The industry's challenge is to:

1 Develop consensus on environmental compliance needs, including where standards should be set given resource limitations, the public's risk tolerance, and public willingness to pay for compliance.

2 Identify what current information on compliance standards needs to be challenged and reevaluated.

3 Identify what additional information needs to be gathered about available technologies to achieve compliance.

4 Sort out which technologies are compliant and characterize them according to which ones are appropriate for given applications. In some cases utilities will be forced into major system upgrades to replace *aging plants/infrastructure*.

5 Identify the respective energy impacts and compliance trade-offs of available technologies. Working hand-in-hand with technology R&D, the industry will need the best information on the energy impacts of various treatment technologies as they relate to *energy use and energy supply*.

6 Provide decision tools and guidance on technology selection.

7 Develop support for services and financing that can assist utilities in compliance efforts.

8 Provide utilities with technical and financial support to meet regulations. Funding to support new infrastructure required by new standards will be needed especially for smaller utilities that may not have the tax and customer base to support major improvements.

Sensible, research-based, collaborative regulation and Beneficial Reuse of water and wastewater treatment byproducts will also support *developing and maintaining a sustainable water supply*.

R&D in New Technology

Vision

New technology R&D supports:

1 Policy-maker decisions on regulatory standards and program needs—public need and cost drive regulatory standards

2 Utility selection of new systems and equipment upgrades—regulation, risk, and economic promise drive new technology choices

3 New enterprise to identify and develop new useful byproducts

Overview

Tighter regulatory standards and higher costs drive the decision-making process for new design and technology in water and wastewater systems. System managers look at technical feasibility (Will the technology work in this situation? Is it compliant?), capital cost (How do the first costs of the alternatives compare?), and operating cost (How do the operating costs of the alternatives compare?). Energy cost constitutes a significant part of operating cost and deserves special attention.

Independent research organizations, working with regulatory and industry groups, must test new technologies for environmental and safety compliance and for operation cost. Managers require clear, balanced, objective, and reliable information to make confident choices. Industry leaders seek to work with organizations with trusted reputations to provide this information, secure funding for selected R&D, and to collaborate with government regulators and programs.

Three areas of technology R&D are important to the water and wastewater industry:

- Technologies that meet compliance requirements
- Technologies that improve water production and wastewater treatment efficiencies
- Technologies that support new product development from recycle and reuse efforts

Challenges to new R&D include:

- Prioritizing the R&D needs for limited R&D budget
- Getting regulator assistance, acceptance, and support for research design
- Recruiting and showing benefit to utility participants that provide testing sites
- Developing the means to consolidate, catalogue, and disseminate current and new information

New R&D Opportunities

Water treatment technologies

Both policymakers and utility managers expect reliable, accurate, field-tested results when considering new equipment. They also want choices, especially because not all technologies fit all applications. Information important to their decisions include (1) the technical feasibility and match of the application which may include the ability to comply with regulatory standards, (2) the capital costs of alternatives in dollars per MGD, and (3) operating costs (including energy), in dollars per MGD. Emerging water treatment technologies require field-testing, benchmarking, and comparative analysis to provide this information.

Table 6 lists new technologies along with key decision variables, which provide a basis for collecting standard information. Some of the missing information is available through literature review. Other information will need to be generated through field tests. A completed Table 6 will cross reference to many issues related to energy use and supply, aging infrastructure, sustainable supply, and environmental compliance. Results will help identify the best water treatment practices.

Wastewater treatment technologies

New wastewater treatment technologies will also require field testing, benchmarking, and comparative analysis to help decision-makers select the best upgrades. Table 7 lists available technologies along with key decision variables. A completed Table 7 will cross reference to many issues related to energy use and supply, aging infrastructure, sustainable supply, and environmental compliance.

Customer Conservation and Alternative Use

Modern utilities will also include customer programs in their system design plans. Programs to promote conservation and alternative use not only reduce operating costs, they support capital improvement plans by buying time for system capacity upgrades. Table 8 lists some customer-side technologies that many utilities take into account.

Table 6: New water treatment and development options—decision variables

Technology option	Facility application*	Compliance standards to meet	Barriers to implemen-tation	Capital $/MGD	O&M $/MGD	Energy intensity (kWh/MGD) (preliminary)	Energy $/MGD	Capital improvement funding sources
UV disinfection						LPHO (low power): **50** MP (med power): **150**		
Ozonation (O_3)*						@6 kWh/lb O_3: Dose=3mg/L: **150** Dose=12mg/L: **600**		
Ultrafiltration						Low-head membrane (9 PSI): **150** Standard membrane (30 PSI): **500**		
Microfiltration						Low-head membrane (9 PSI): **150** Standard membrane (30 PSI): **500**		
Nanofiltration								
In situ radionuclide treatment *								
Water supply well rehabilitation								
Flow reduction								

*Pending Wisconsin Department of Natural Resources approval

Table 7: New wastewater treatment and development options—decision variables

Technology option	Facility application*	Compliance standards to meet	Barriers to implementation	Capital $/MGD	O&M $/MGD	Energy intensity (kWh/MGD) (preliminary)	Energy $/MGD	Capital improvement funding sources
Vortex mixing system								
Plasma-assisted sludge oxidation kiln								
Load reduction**								
Flow reduction***								
Electro-ionic treatment of wastewater****								
Class A biosolids production improvements								
Microwave treatment of sludge for Class A biosolids								
Others								

* Where and when is this technology applicable? Which are the best candidates?

** Load reduction is reducing the amount of organic and inorganic materials coming through the customer waste stream that increases treatment requirements.

*** Flow reduction is reducing the amount of water coming through the waste stream from customers, from storm water runoff, and from influent.

**** This technology has not been tested in wastewater applications, but may be a low energy approach for some applications.

Table 8: New customer water conservation technology and program options—key variables

Technology option	Market sector	Implementation barriers	Customer cost	Water savings	Energy savings	Energy $ per MGD
Clothes washers	Residential, Commercial					
Dishwashers	Residential, Commercial					
Showers	Residential, Commercial					
Outdoor residential water conservation	Residential					
Time-of-use customer rates	All sectors					
Dry-cooling for coal-fired boilers	Industrial, Power utility					
Graywater vs. treated water to cool boilers	Industrial, Power utility					
Water and energy efficient irrigation	Agricultural					
Others						

Other Industry-Identified R&D Needs

Water and wastewater industry representatives propose other R&D projects that do not provide immediate, direct, energy-saving benefits.

Water Treatment Projects

Energy-Saving Guidelines—Advanced Technologies that Remove or Inactivate Waterborne Pathogens

Need: Wisconsin water utilities must choose among several competing technologies, including membranes, ozone, or UV irradiation to remove or inactivate *Cryptosporidium* and other pathogens. They need information on the energy effects of each to aid in their decisions.

Energy: An energy-saving potential exists in avoiding future energy consumption by selecting the most energy efficient options. Although energy differences need to be verified, membranes and ozone require significantly more energy than ultraviolet irradiation.

Approach: Produce a research report reviewing the three advanced treatment processes, demonstrating the performance of each process in terms of pathogen control, control of other water quality problems, and energy cost.

Energy Savings From Rehabilitation of Water Supply Wells—A Database Analysis

Need: Water-supply well screens and aquifer formations become plugged over time from mineral scale and bacterial deposits. These deposits increase resistance to water entering the well, thereby increasing the amount of draw down and energy required to draw water. Well efficiency can be restored somewhat through chemical and physical rehabilitation processes that remove the deposits. However, well operators will not initiate expensive rehabilitation unless they need new capacity. An effective education program will be needed to change the standard practices of well operators.

Energy: Over time the drop in well efficiency often exceeds 50 percent, which more than doubles the energy cost. Energy consumption is not generally a factor when scheduling rehabilitation projects, but more frequent well rehabilitation reduces energy consumption and may extend the productive life of a well—most rehabilitation projects are much more effective if they are conducted before efficiency has dropped significantly. The amount of energy savings depends on the pumping rate and pumping head of a particular well. Generally the savings are not large enough to justify well rehabilitation treatments in domestic water supply wells. However, for high-capacity wells the savings can be significant, particularly for municipal wells in the sandstone aquifer. Many of these wells can lift more than one million gallons of water per day from wells 600 feet deep. There are hundreds of municipal water supply wells and thousands of high-capacity wells for other purposes in Wisconsin. Assuming that most of these wells could be maintained near original efficiency as opposed to operating at 50% efficiency over time, energy consumption for lifting water could be cut in half.

Approach: Several existing databases describe rehabilitation technologies for high-capacity wells in a variety of aquifers. Most prominent is a national database completed recently by the American Water Works Association Research Foundation. Other databases are maintained by well rehabilitation contractors working in Wisconsin. These databases document improvements in well capacity but do not contain energy savings estimates. This research will review these databases and interview clients of representative projects to verify the reported results. Additional case histories from projects in other existing databases will be added when possible. After a reliable database of verified results has been compiled, the annual and lifetime energy savings from these projects will be calculated. A key element of the analysis will be to determine the lifetime of the efficiency improvement to estimate the payback period for the investment. The results will also be used to develop a set of recommendations for rehabilitation schedules that reduce energy costs and increase well life.

In-Situ Leaching for Radionuclide Treatment in Water Supply Wells

Need: In 2002 the US Environmental Protection Agency promulgated new standards for radionuclides in drinking water. About 50 to 100 municipal wells in Wisconsin are expected to exceed the standards for radium and gross alpha. Most of these wells will require some type of treatment within three to five years to comply with the standard. A project to demonstrate in-situ leaching is pending approval by the Wisconsin Department of Natural Resources.

Energy: Energy savings will primarily be through avoiding future energy use to operate traditional radionuclide treatment equipment and through reduced pumping costs from not having to use alternative, more distant water sources.

Approach: This project will test an innovative in-situ leaching technology that may provide long-term reduction in radionuclide levels without surface treatment. Beginning with a geochemical modeling phase to prepare for application on a municipal well in Wisconsin, a field test will use a simple food-grade inorganic salt as a leach solution to displace radionuclides from iron hydroxides prevalent in the producing intervals. The iron hydroxides will be left with exchangeable ions on the sorption sites that should serve as an exchange media to remove radionuclides from the water. If successful, the process will reduce radionuclides to acceptable level for a period of several years to a few decades before the treatment would need to be repeated. Once field parameters are set, a full scale field test will tried on a municipal well in eastern Wisconsin.

Ultraviolet Disinfection Validation Center

Need: Scientific understanding and regulatory directives have combined to create the impetus for taking advantage of the public health and fiscal benefits offered by UV disinfection. The US Environmental Protection Agency is developing guidelines and an associated UV reactor validation protocol. However, no facility yet exists to provide validation in accordance with this protocol. The goal of this project is to develop and evaluate alternatives for creating a validation facility in Wisconsin.

Energy: UV disinfection is generally the most energy efficient way to inactivate *Cryptosporidium*. A proper and thorough validation of UV reactors will yield the most cost-effective approach to design and operate UV disinfection systems, and to avoid over design. A validation facility will allow water utilities to capitalize on the operating cost and public health savings that come from UV disinfection. The significant power savings associated with UV disinfection relative to alternatives will benefit both water and power utilities.

Approach:

1 Identify critical attributes of a UV validation facility.

2 Evaluate potential UV validation sites in Wisconsin (including adequate space, quantity and quality of water, available head, and spiked-water disposal options).

3 Develop a conceptual implementation plan for a UV validation facility at the selected site; this includes equipment lists, mechanical layouts, hydraulic profile, and site plan.

4 Develop construction and O&M cost estimates for the facility.

5 Investigate funding and project delivery alternatives, including national and regional stakeholders and funding sources.

6 Work with Wisconsin Department of Natural Resources to establish an acceptable validation protocol for Wisconsin.

Public Perceptions of Water and Water Pricing Structure

Need: Public perception of water is distorted due to its traditional abundance, historic low cost, reliability of supply, and high quality. Factors not fully articulated in the current pricing structure are the increasing processing costs for current systems and the projected $231 billion infrastructure upgrades required to meet new national water quality standards. The impact of escalating costs in terms of energy use, processing changes, and national quality standards is a message the public must comprehend.

Energy: As higher regulatory standards are promulgated, energy costs will be driven higher. A fair comparison of the energy costs of the various compliance alternatives will help consumers support system upgrades and adjust their own consumption. Furthermore, water consumers affect water prices by their consumption, both in quantity and in time of use.

Approach: This project will consolidate up-to-date information on water and wastewater issues and establish a repertoire of consumer information. General themes include:

- "Clean Water for Health"
- "Clean Water for the Economy"
- "Improved Waste stream processes for competitive advantage and conservation"

Each theme will address the energy content, end-product quality, and the value of water conservation. The amount of information needed will be judged by its effectiveness in moving the consumer to change traditional habits or improve systems.

Wastewater Treatment

Several new technologies have undergone limited field testing and make good candidates for future studies and demonstrations.

Vortex Mixing System

Need: For large wastewater systems, proper mixing and aeration is a challenge. Vortex mixing provides complete mixing to help meet pH standards for wastewater discharge. The technology reduces mixing time, chemical use, and maintenance costs.

Energy: This new system reduces energy costs through higher mixing efficiencies.

Approach: Vortex mixing was featured in an industrial application in *Industrial Waterworld* (Jan/Feb 2002). The technology can be field tested in a municipal wastewater facility to measure, verify, and demonstrate energy and other benefits.

Plasma-assisted Sludge Oxidation Kiln

Need: Wastewater utilities are searching for ways to avoid landfill, land-spread, and incineration of sludge. Plasma-assisted sludge oxidation kiln (patent pending by Hydro-Quebec) applies a low-power plasma torch to catalyze sludge oxidation by using the heat value of the organic material in untreated sludge as a heat source for treating large quantities of sludge. The process reduces sludge volume by 95 percent (*Industrial Waterworld*, Jan/Feb 2002).

Energy: This process consumes less than 125 kWh per ton of treated wet sludge.

Approach: This technology should be field tested for measurement, verification, and demonstration in Wisconsin.

Avoiding Increases in Energy Costs at Wastewater Plants that Switch to Class A Biosolids Production

Need: Wastewater Treatment Plants that land-apply biosolids for beneficial reuse (primarily on crop land) must meet Federal Class A or Class B criteria. Most plants in the U.S. meet Class B criteria. However, public perception and regulation are inducing many operators to make capital improvements that will produce Class A biosolids. Many processes for producing Class A solids are still under development.

Energy: Two of the most promising technologies—temperature-phased anaerobic digestion (TPAD) and sludge pasteurization—appear to require significantly greater energy inputs than traditional Class B processes. Modifications in production configuration, as well as biogas cogeneration, may improve energy efficiency in these processes. Another approach—microwave treatment of sludge—may also achieve the fecal coliform reduction required for Class A biosolids at a lower energy cost.

Approach: This research will estimate:

- The increased heat energy needed to reach and maintain the required elevated temperatures without heat recovery measures
- The increased energy available from biogas production
- The net external energy requirement based on the difference between the two items above

The research will also review the energy reduction alternatives being implemented at European and U.S. installations that have TPAD, pasteurization, and other energy-intensive solids stabilization processes. The results, to be shared with wastewater managers, will highlight the potential energy impacts of producing Class A biosolids and recommended energy conservation measures.

Saving Energy through Flow and Load Reductions

Need: The flows and loads to a treatment plant determine facility sizing, capital costs, and energy consumption. Reduced flows (water) and loads (organic) to a plant translate to energy savings and avoided capital expansion. Plant operators need information that shows them the energy and operating cost impacts of flow and load reduction measures.

Energy: Minimizing inflow and infiltration into the sewers that serve a plant reduces flow in wet weather. In dry weather, customer water conservation reduces flow. Reducing organic load to a plant—such as garbage disposal effluent, a significant source—can have an even bigger impact on energy consumption than reducing flow. All three approaches cut down on pumping energy costs. Lowering organic load also reduces treatment energy costs.

Approach: This research will evaluate:

1 Estimated energy cost to treat organic load from residential and commercial garbage disposals

2 Estimated annual energy cost to treat inflow and infiltration

3 Estimated annual energy savings from water conservation, based on an assumed flow reduction derived from a separate study

Energy savings translate to wastewater utility fee reductions and tax reductions for citizens. If the study shows significant energy saving potential, a second phase will provide utility and public education.

Peak Electric Shaving and Distributed Energy Opportunities—Capacity and Feasibility for Emergency Generators at Municipal Wastewater Plants

Need: Wastewater plants often have emergency generators to ensure uninterrupted power. Using these generators to supplement available power can reduce costs associated with expanding generating capacity at power utilities. This could, in turn, stabilize rates for power utility customers.

Energy: Emergency generators will not likely reduce energy consumption. However, they may defer future capacity costs of new generation.

Approach: This research will:

1 Quantify the capacity of emergency generators at wastewater plants in Wisconsin

2 Determine the potential for using these emergency generators to supply distributed power during peak electric demand.

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Appendix A: Water and Wastewater Industry Roundtable

The November 9, 2001 Water and Wastewater Roundtable was designed to meet four objectives:

1 Bring together a sample of key experts from the Wisconsin industry, research organizations (public and private), and government to discuss the mid-term needs facing the Wisconsin industry.

2 Create a list of industry needs and identify their relationships to energy.

3 Translate needs into potential research, development, demonstration, and education projects.

4 Describe the technical and financial resources available to encourage formation of collaborative teams that will implement projects.

A steering team facilitated by Wisconsin Focus on Energy and supported by industry volunteers from the WATER Alliance designed the roundtable. Local industry leaders and associations promoted the event to their members and colleagues. The event drew plant managers, R&D consultants, government officials, and Focus on Energy advisors. The roundtable drew 62 participants.

Participants received context on industry issues and trends from state and national experts. Afterward, they broke into smaller groups for facilitated discussion of key issues faced by the industry. Individuals listed their needs, discussed them, reached agreement on key action areas, and reported back to the larger group. The full group also heard about the technical and financial resources available from Focus on Energy to implement these projects.

Table A-1: Participation breakout for the November 9, 2001 roundtable

Type of participant	Number attending*
Water or Wastewater utility manager/operator	30
Private Industry	13
Industry consultant/contractor	8
University	1
State government	3
Wisconsin Focus on Energy - Energy Advisors/Facilitators	7
TOTAL	**62**

*Includes 12 members of the WATER Alliance

Appendix B: Resources

Key water and wastewater industry markets and groups include:

1 Municipal water treatment facilities

2 Municipal wastewater treatment facilities

3 Water and wastewater system design contractors, service companies, and industry consultants

4 University and research institutions

5 Local and state governments and regional compacts

6 Industry associations

American Council for an Energy-Efficient Economy
A nonprofit organization dedicated to advancing energy efficiency as a means of promoting both economic prosperity and environmental protection. ACEEE collaborates on projects and initiatives with dozens of organizations including federal and state agencies, utilities, research institutions, businesses, and public interest groups. Support for ACEEE's work comes from a broad range of foundations, governmental organizations, research institutes, utilities, and corporations.
www.aceee.org

American Water Works Association
An international nonprofit scientific and educational society dedicated to the improvement of drinking water quality and supply. Founded in 1881, AWWA is the largest organization of water supply professionals in the world. Its more than 50,000 members represent the full spectrum of the drinking water community: treatment plant operators and managers, scientists, environmentalists, manufacturers, academicians, regulators, and others who hold genuine interest in water supply and public health. Membership includes more than 4000 utilities that supply water to roughly 180 million people in North America.
www.awwa.org
303.794.7711

Central States Water Environment Federation
A regional affiliate of the Water Environment Foundation. Founded in 1928, WEF is a nonprofit technical and educational organization with members from varied disciplines who work toward the WEF vision of preservation and enhancement of the global water environment. The WEF network includes more than 100,000 water quality professionals from 79 Member Associations in 32 countries. WEF and its members research and publish the latest information on wastewater treatment and water quality protection; provide technical expertise and training on issues, including nonpoint source pollution, hazardous waste, residuals management, and groundwater; sponsor conferences and other special events around the world; and review, testify, and comment on environmental regulations and legislation. WEF is a federation of 79 Member Associations (MA) and six Corresponding Associations located throughout the world. When members join WEF, they also join an MA and enjoy benefits from both organizations. Every MA is represented on the Federation's Board of Directors, which is WEF's policy-making group. This diverse international leadership is one reason WEF is the leading technical organization on water quality issues.
www.cswea.org

Central Wisconsin Groundwater Center
Part of the University of Wisconsin-Extension Cooperative Extension Service and housed in the College of Natural Resources at UW-Stevens Point, the Center works with citizens and local governments throughout Wisconsin, particularly those in the central part of the state, that need help in using information and developing skills to decide the future of their drinking water and groundwater resources.
www.uwsp.edu/cnr/gndwater

Consortium for Energy Efficiency
A national, nonprofit public benefits corporation promoting the manufacture and purchase of energy-efficient products and services. Its goal is to induce lasting structural and behavioral changes in the marketplace, resulting in the increased adoption of energy-efficient technologies. CEE members include utilities, statewide and regional market transformation administrators, environmental groups, research organizations and state energy offices. Also contributing to the collaborative process are CEE partners—manufacturers, retailers, and government agencies. The U.S. Department of Energy and Environmental Protection Agency provide major support through active participation and funding.
www.cee1.org

Consortium for Industrial Efficiency
A group of private and public organizations that offer free and fee-based services that help Wisconsin industries improve their efficiency and competitiveness. Under the guidance of the Energy Center of Wisconsin, they created *A Resource Guide for Wisconsin Industries*. This resource guide is intended for businesspeople who are looking for help with a specific industrial problem, or those who are interested in new ways to improve their company's bottom line. The booklet also helps streamline customer referrals among Consortium members. A easy-to-use Internet guide helps locate people working in utility, government, and nonprofit organizations who specialize in industrial issues.
www.ecw.org/ecw/cieguide/index.html

Electric Power Research Institute
Founded in 1973 as a nonprofit energy research consortium for the benefit of utility members, their customers, and society. EPRI's mission is to provide science and technology-based solutions of indispensable value to EPRI's global energy customers by managing a far-reaching program of scientific research, technology development, and product implementation. EPRI is the only science and technology consortium serving the entire energy industry—from energy conversion to end use—in every region of the world. With expertise in a wide spectrum of scientific research, technology development, and product application, EPRI offers solutions that cut across traditional boundaries, taking advantage of the latest advances in many fields. EPRI has published several publications on the energy aspects of water and wastewater systems.
www.epri.com

Energy Center of Wisconsin
ECW is a private, nonprofit organization dedicated to improving energy efficiency in Wisconsin. It provides energy-efficiency programs, research, and education to residents, businesses, industry and government.
www.ecw.org

Federation of Environmental Technologists
A nonprofit educational organization headquartered in Milwaukee, Wisconsin. The organization's motto is, "Dedicated to Pollution Prevention and Economic Growth."
www.fetinc.org

Focus on Energy
Over a three-year period beginning in 2001, the majority of utilities in Wisconsin are transitioning their energy efficiency and renewables programs to a state-administered, statewide public benefits program called Focus on Energy. This program targets homes, commercial and industrial businesses, schools, production agriculture, renewables, and water and wastewater. Included in Focus on Energy is the Wisconsin Industries of the Future program, the General Industries program that targets energy management and best practices projects, the Water and Wastewater program, and the Renewables Program. All four programs offer a wide range of technical and financial assistance.
www.focusonenergy.com
800.762.7077

Groundwater Coordinating Council
In 1984 the Legislature enacted Wisconsin Act 410 to improve the management of the state's groundwater. This act established a Groundwater Coordinating Council to be made up of representatives of state agencies with groundwater protection responsibilities. The GCC consists of the heads of all state agencies with some responsibility for groundwater management plus a Governor's representative. The agency heads have appointed high-level administrators who have groundwater responsibilities to sit on the Council. The GCC has created five subcommittees to assist in its work. The subcommittees are composed of about 50 people including some members of the GCC, employees of state agencies, representatives of counties and municipalities, and public members. Additionally, the Wisconsin DNR has one permanent position with half-time responsibilities related to coordination of the GCC.
www.dnr.state.wi.us/org/water/dwg/gcc
608.266.2621

International Ultraviolet Association
Collects and disseminates information on, and encourages research in all aspects ultraviolet technologies. It serves as a liaison among industry, educational and research institutions, governmental agencies, conversation groups, and the general public in information collection and dissemination, problem solving, and research in ultraviolet technology and applications. It encourages the establishment of standardized terms, units, and nomenclature and guidelines for using ultraviolet technology. IUVA attempts to provide a common voice and forum for the interests of companies using ultraviolet technologies and to encourage adopting environmental regulations that would encourage using ultraviolet technologies.
www.iuva.org
519.632.8190

Public Service Commission of Wisconsin
The PSC is an independent regulatory agency responsible for the regulation of Wisconsin public utilities, including those that are municipally-owned. The utilities regulated include electric, natural gas, telephone, water, and combined water and sewer.
psc.wi.gov
608.266.5481

U.S. Department of Energy
DOE is organized along four principle business lines: National Security, Energy Resources, Science & Technology, & Environmental Quality. Formed in 1977 in response to the energy crisis at the time, in recent years the Department has been tasked with other key national initiatives, including environmental activities and technology innovation. DOE's Office of Industrial Technologies (www.oit.doe.gov/bestpractices) offers information for

industry that may have particular application to water and wastewater utilities, such as the Pumping System Assessment Tool (PSAT) and Fact Sheets through the DOE Best Practices Program, developed by Oak Ridge National Laboratory.
www.energy.gov

U.S. Environmental Protection Agency
EPA provides leadership in the nation's environmental science, research, education, and assessment efforts. EPA works closely with other federal agencies, state and local governments, and Indian tribes to develop and enforce regulations under existing environmental laws. EPA is responsible for researching and setting national standards for a variety of environmental programs. EPA delegates to states and tribes the responsibility for issuing permits and monitoring and enforcing compliance. Where national standards are not met, EPA can issue sanctions and take other steps to assist the states and tribes in reaching the desired levels of environmental quality. The Agency also works with industries and all levels of government in a wide variety of voluntary pollution prevention programs and energy conservation efforts.
www.epa.gov

University of Wisconsin Water Resources Institute
Coordinates research programs applicable to solving present and emerging water resource problems. In carrying out this mission, the Institute has developed a broadly based research, training, information transfer, and public service program involving personnel from many academic disciplines in the University of Wisconsin System. The Institute is one of 54 Water Resources Research Institutes nationwide authorized by the federal Water Resources Research Act. The state-based Water Resources Research Institutes are located at land grant universities and promote research, training, and information dissemination on the nation's water resources problems.
www.wri.wisc.edu

University of Wisconsin-Madison Department of Civil and Environmental Engineering
Involved with research and instruction in construction engineering and management; environmental engineering; structural engineering; geotechnical and geoenvironmental engineering; geological engineering; geospatial information engineering; transportation engineering and city planning; water resources engineering; and water chemistry.
www.engr.wisc.edu/cee

WATER Alliance
Made up of small and large water utilities in Wisconsin, water and wastewater associations, Wisconsin's electric utilities, University of Wisconsin-Madison, the Water Consortium at UW-Madison, the Department of Natural Resources, private engineering firms, and industry. The WATER Alliance is committed to technology and market research, demonstration, and education that recognizes the importance of energy efficiency and renewable energy use in the water and wastewater industry. Contact information pending.

Wisconsin Department of Agriculture, Trade, and Consumer Protection
Serves the citizens of Wisconsin by assuring the safety and quality of food, fair business practices for the buyer and seller, efficient use of agricultural resources in a quality environment, consumer protection, healthy animals and plants, and the vitality of Wisconsin agriculture and commerce. The DATCP inspects and licenses more than 100,000 businesses and individuals, analyzes millions of laboratory samples, conducts hundreds of hearings and investigations, educates businesses and consumers about best practices, adopts rules that have the force of law, and promotes Wisconsin agriculture at home and abroad.

datcp.state.wi.us/arm/agriculture/land-water/water-quality
608.224.4505

Wisconsin Department of Commerce
The state's primary agency for delivery of integrated services to businesses. The department's purpose is to foster the retention and creation of new jobs and investment opportunities in Wisconsin; foster and promote economic business, export, and community development; and promote the public health, safety and welfare through effective and efficient regulations, education and enforcement.
www.commerce.state.wi.us

Wisconsin Department of Natural Resources
DNR offers loans to public water systems through the Safe Drinking Water Loan Program to build, upgrade, or replace water supply infrastructure to protect public health and address federal and state safe drinking water requirements. The Clean Water Fund Program, also through the Wisconsin DNR, provides loans to municipalities for wastewater treatment and urban storm water projects. Regulations often pose difficult obstacles to smaller systems, but there are funds available to aid compliance. The DNR also offers training and certification for water and wastewater system operators. The DNR website contains a calendar listing opportunities for operator training and certification from several providers (www.dnr.state.wi.us/org/es/science/opcert/training.htm). Recent topics have included activated sludge, anaerobic digestion, advanced ponds, biosolids and sludge disposal, confined space safety, cross connections, emergency preparedness, excavations, industrial waste treatment, iron removal, lab analysis, land application of sludge, leak detection, lime softening, meter repair, phosphorous removal, preventive maintenance, bloodborne pathogen safety, septic hauler information, VOC removal, wastewater collection and disinfection, and zeolite softening.
www.dnr.state.wi.us
608.266.2621

Wisconsin Ground Water Association
A nonprofit volunteer organization whose purpose is to advance the understanding of groundwater in Wisconsin. WGWA's stated objectives are to promote an understanding of scientific, technical, legal, and public policy aspects of ground water; to provide a forum for exchange of information among groundwater professionals and other interested parties on all aspects of groundwater resources; to disseminate information to governments, schools, and civic professional organizations, and educate the general public regarding groundwater resources; and to promote professional awareness and technical skills among groundwater professionals.
www.wgwa.org

Wisconsin Rural Water Association
Assists water/wastewater systems to improve and preserve the quality and quantity of water resources in Wisconsin. The association offers programs and training in water, wastewater, groundwater, and small systems. Recent classes offered by WRWA have included biosolids/sludge treatment and disposal, confined space safety, emergency preparedness, excavation, hazard communication, leak detection, management techniques, blood borne pathogen safety, and wellhead protection.
www.wrwa.org
715.344.7778

Wisconsin Wastewater Operators Association
Comprised of wastewater treatment professionals who serve municipalities and industries throughout the state. Membership includes treatment plant operators, engineers, consultants, plant managers, equipment manufacturers,

regulatory agencies, educators, and students involved in the wastewater treatment industry. WWOA's programs and seminars target wastewater treatment facilities in every region of the state. Membership in WWOA is open to anyone interested in the wastewater treatment profession. One of the primary goals of WWOA protecting Wisconsin's water quality through effective and efficient operation of wastewater treatment facilities by trained professionals.
www.wwoa.org

Wisconsin Water Association
The Wisconsin chapter of the American Water Works Association.
www.wiawwa.org
608.831.6554

Wisconsin Water Resources Association
The Wisconsin Section of the American Water Resources Association provides an interdisciplinary forum for people involved in all aspects of water resources research and management.
www.awra.org/state/wisconsin

Wisconsin Water Well Association
Represents more than 300 registered well drillers and pump installers. Its purpose is to increase the industry's knowledge and understanding of proper drilling, pump installation, and well abandonment techniques; work with the appropriate state agencies in the protection of Wisconsin's ground water; and increase the public's awareness of the importance of and involvement in ground water efforts.
wisconsinwaterwell.com
608.251.2714

Appendix C: Water and Wastewater Industry Overview

This appendix is an excerpt from "Wisconsin Focus on Energy Water Supply and Wastewater Industries—Market Research Baseline" (Xenergy, 2001)

In Wisconsin, the state's larger water utilities and sanitation districts (Class AB) consumed on average 1609 kWh per million gallons pumped in 1999, while Classes C and D consumed 1961 kWh and 1899 kWh, respectively. In addition to municipally owned and operated facilities, there are a number of privately owned wastewater treatment facilities that are operated by larger industrial operations. The water and wastewater communities are a relatively close market. There are only about 1800 entities across the state, with many in the government sector.

Wisconsin Summary Statistics

The water supply and wastewater treatment industry employs over 1700 people and accounts for over $120 million in annual sales. The majority of water supply and wastewater treatment facilities in Wisconsin are small, single-location establishments (approximately 60 percent of the total).

Table C-1: Size and employment distribution for the Wisconsin water supply and wastewater treatment industries

Water and wastewater industry characteristics	Small single	Small multiple	Medium 25–249 employees	Large >249 employees	State total
	1–24 employees				
% of WI water and wastewater establishments	60%	23%	17%	0%	105
% of WI water and wastewater employees	21%	14%	65%	0%	1745

Sources: iMarket (2001) and 1997 Economic Census Data (U.S. Department of Commerce 1999)

Trends

Increasing water use per capita—According to the World Watch Institute, worldwide population has tripled since 1990, but water usage has increased by a factor of seven. In Wisconsin, water usage between 1985 and 1995 rose from 570 million gallons per day (Mgal/d) to 754 Mgal/d, an increase of nearly 33 percent.

Increasing pressure from development—Approximately 70 percent of Wisconsin's residents rely on groundwater for drinking water. In southeastern Wisconsin especially, development has dramatically increased pressure on groundwater supplies. Because of consumption, the water table is dropping between 5 and 10 feet per year, forcing municipalities to drill deeper and deeper into the aquifer to find potable water and dramatically increasing pumping and maintenance costs.

Increasing energy use—Energy usage in the water supply and wastewater treatment industries has been on the rise as a result of population increases in many areas as well as changes in drinking water regulations. The Safe Drinking Water Act (SDWA) and Interim Enhanced Surface Water Treatment Rule (effective December 2001) requires use of energy-intensive processes, such as ozonation and membrane filtration to bring water up to regulated standards (EPRI 1993; U.S. EPA 1999).

Industry observers indicated that key concerns within the water supply and wastewater treatment industries center on providing water to end-users at the lowest possible cost. While privately owned facilities may seek to increase profits, municipal and publicly owned facilities are more concerned with increasing their visibility in the market. Both observers mentioned that changing regulations create difficulties for their member organizations, especially for smaller plants in rural areas with fewer end-users. Revenue for these types of facilities is likely to be low, making regulatory compliance difficult. Rising energy costs also pose a significant challenge to these types of facilities. Regardless of facility size, the industry observers interviewed suggest that energy-efficiency investments should be undertaken at every affordable opportunity to reduce overall costs.

Comparison of the Water and Wastewater Industry to Other Industries

The information summarized in Table C-2 suggests that firms in the water and wastewater industries have pursued energy-efficiency opportunities more actively than other energy-intensive industries. For example:

- Nearly one-half of the sample water and wastewater facilities have assigned a person or group with responsibility for energy management, versus one-third for energy-intensive industries as a group and one-quarter of sample industrial facilities.
- Nearly one-half of water/wastewater facilities have a designated budget for energy management versus 13 percent for energy-intensive industries as a whole.
- Nearly two-thirds of water/wastewater facilities set annual energy-reduction goals versus 38 percent for energy-intensive industries as a whole.
- Water/wastewater facilities undertake capital improvement projects more frequently than other industries: 47 percent implemented a project valued at $10,000 in the past 2 years versus 17 percent for industries in general and 28 percent for energy-intensive industries. On average, the sample water/wastewater facilities reported that roughly one-half of their capital improvements have improved energy efficiency as a primary objective.

Table C-2: Indicators of energy efficiency interest and activity for the Wisconsin water supply and wastewater treatment industries*

Indicator of energy-efficiency interest/activity	WI Industries of the Future **	General Industrial	Water & wastewater
Have person or group with assigned responsibility for energy management	35%	25%	49%
Average number of persons assigned to energy management (when at least 1)	2	1	3
Have a budget for energy-management activities	13%	8%	47%
Have energy cost-reduction goals	38%	39%	63%
Undertook capital projects >$10,000 in past two years	28%	17%	47%
Used energy-efficient equipment in capital projects:			
in all cases	28%	81%	39%
in most cases	51%	9%	61%
Use energy costs as a criterion in selecting equipment	51%	62%	61%
Equipment purchase policies require consideration of energy efficiency	15%	10%	30%
Equipment purchase policies give preference for energy efficiency	28%	19%	0%

* The table shows the results of a number of items from the nonresidential omnibus survey that serve as indicators of interest and activity in energy efficiency.

** Wisconsin Industries of the Future represents a collaboration between the Focus on Energy program and the U.S. Department of Energy to identify and pursue technological research, development, demonstration, and outreach projects to help the state's seven most energy-intensive industries improve their energy efficiency and reduce negative environmental impacts. These industries include forest products, metal casting, food processing, biotechnology, printing, chemicals, and plastics. General Industrial refers to all other industries not included in Industries of the Future.