WATER TREATMENT REGULATION IN THE UNITED STATES AND EFFECTS ON THE GLOBAL INNOVATION PROCESS

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Table of Contents

I. Water Treatment Regulation

A. Origins of the Clean Water Act

The principal law governing pollution of the United States' surface waters is the Federal Water Pollution Control Act or Clean Water Act. It is one of the further reaching legislative frameworks in the OECD countries providing broad authority to the central or national government and makes the government a full-fledge partner in environmentally related corporate decisions. Originally enacted in 1948, it was totally revised by amendments in 1972 that gave the Act its current shape. The 1972 legislation spelled out ambitious programs for water quality improvement that have since been expanded and are still being implemented by industries and municipalities. Congress made certain fine-tuning amendments in 1977, revised portions of the law in 1981, and enacted further amendments in 1987. Table 1 lists the original law and major amendments to it.

Table 1. Clean Water Act and Major Amendments

(codified generally as 33 U.S.C. 1251-1387)

Year	Act	Public Law
1948	Federal Water Pollution Control Act	P.L. 80-845 (Act of June 30, 1948)
1956	Water Pollution Control Act of 1956	P.L. 84-660 (Act of July 9, 1956)
1961	Federal Water Pollution Control Act Amendments	P.L. 87-88
1965	Water Quality Act of 1965	P.L. 89-234
1966	Clean Water Restoration Act	P.L. 89-753
1970	Water Quality Improvement Act of 1970	P.L. 91-224, Part I
1972	Federal Water Pollution Control Act Amendments	P.L. 92-500

1977	Clean Water Act of 1977	P.L.95-217
1981	Municipal Wastewater Treatment Construction Grants Amendments	P.L. 97-117
1987	Water Quality Act of 1987	P.L. 100-4

(Copeland)

The Federal Water Pollution Control Act of 1948 was the first comprehensive statement of federal interest in clean water programs, and it specifically provided state and local governments with technical assistance funds to address water pollution problems, including research. Water pollution was viewed as primarily a state and local problem, hence, there were no federally required goals, objectives, limits, or even guidelines. When it came to enforcement, federal involvement was strictly limited to matters involving interstate waters and only with the consent of the state in which the pollution originated.

During the latter half of the 1950s and well into the 1960s, four laws that amended the 1948 statute shaped water pollution control programs. They dealt largely with federal assistance to municipal dischargers and with federal enforcement programs for all dischargers. During this period, the federal role and federal jurisdiction were gradually extended to include navigable intrastate, as well as interstate, waters. Water quality standards became a feature of the law in 1965, requiring states to set standards for interstate waters that would be used to determine actual pollution levels. By the late 1960s, there was a widespread perception that existing enforcement procedures were too time-consuming and that the water quality standards approach was flawed because of difficulties in linking a particular discharger to violations of stream quality standards. Additionally, there was mounting frustration over the slow pace of pollution cleanup efforts and a suspicion that control technologies were being developed but not applied to the problems. These perceptions and frustrations, along with increased public interest in environmental protection, set the stage for the 1972 amendments.

B. Safe Drinking Water Act

In 1976 Congress passed the "Safe Drinking Water Act, which requires the EPA to regulate contaminants which may be health risks and which may be present in public drinking water supplies. Passed in 1974, and revised in 1986 and 1996, SDWA extends public health protection to America's drinking water consumers. Under SDWA, EPA sets legal limits on the levels of certain contaminants in drinking water. The legal limits reflect both the level that protects human health and the level that water systems can achieve using the best available technology. Besides prescribing these legal limits, EPA rules set water-testing schedules and methods that water systems must follow.

The rules also list acceptable techniques for treating contaminated water. SDWA gives individual states the opportunity to set and enforce their own drinking water standards if the standards are at least as strong as EPA's national standards. Most states and territories directly oversee the water systems within their borders. Between 1974 and 1986, EPA regulated approximately 20 contaminants. Congress's 1986 SDWA revisions named 83 contaminants and required EPA to regulate all of them by 1989.

C. Health Risks Stimulate Regulation

Just as their uses range widely, the health risks that led Congress to require the regulation of these contaminants range widely. Six are probable cancer-causing agents. Others can cause liver and kidney damage, or problems of the nervous system and brain. EPA set different monitoring schedules for different contaminants, depending on the routes by which each contaminant enters the water supply. In general, surface water systems must take samples more frequently than ground water systems because their water is subject to more external influences.

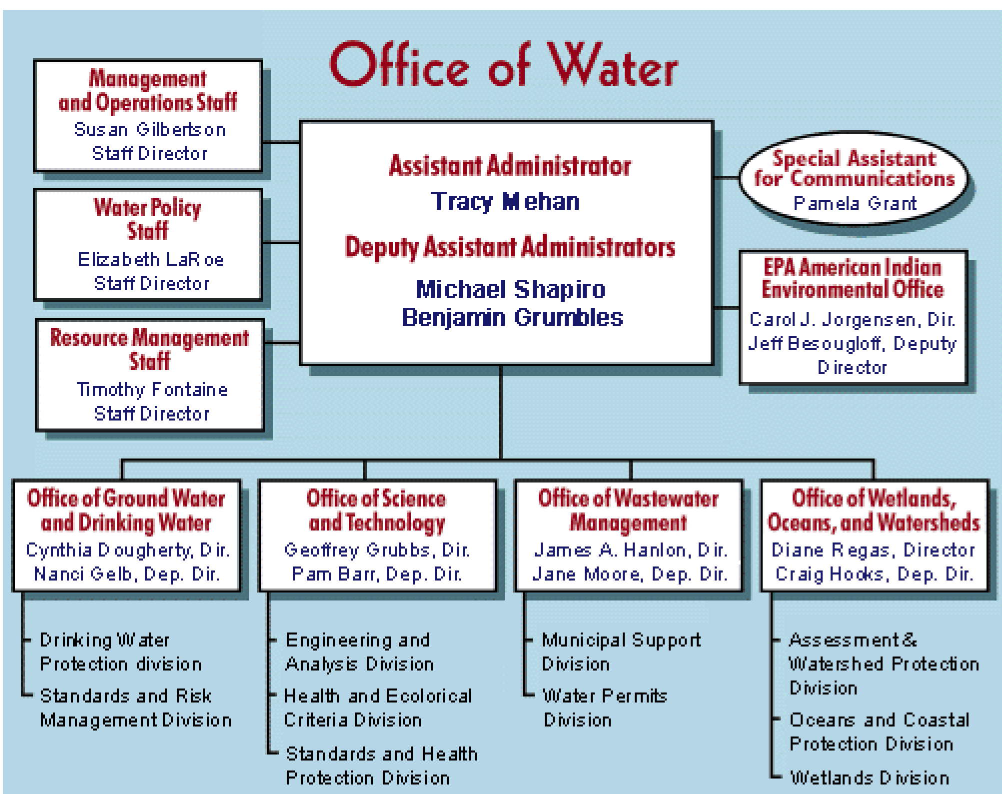
Systems, which prove over several years that they are not susceptible to contamination, can usually get state permission to reduce the frequency of monitoring. Asbestos, for example, is unlikely to appear suddenly in a system's water. If a system has asbestos-concrete water mains and water of certain corrosiveness, or if asbestos is present naturally in an area, the system might detect asbestos in its water. Otherwise, a system, which has never detected asbestos, must test for asbestos only once every nine years. If the system were ever to detect asbestos, it would have to begin more frequent monitoring. Nitrate and pesticide levels, on the other hand, vary depending on rainfall and farmers' schedules. Systems in areas prone to nitrate problems test quarterly to track the seasonal variations. If a system does not detect contaminants in initial samples, then repeat sampling frequencies will be lower than initial frequencies.

D. National Drinking Water Advisory Council

The EPA is committed to working with its stakeholders--the people for whom safe drinking water is an important aspect of daily and/or professional life. One of the formal means by which EPA works with its stakeholders is the National Drinking Water Advisory Council (NDWAC). The Council, comprising members of the general public, state and local agencies, and private groups concerned with safe drinking water, advises the EPA Administrator on everything that the Agency does relating to drinking water.

The NDWAC has working groups that make recommendations to the full Council, which in turn advise EPA on individual regulations, guidances, and policy matters. These NDWAC working groups consist of approximately 20 members with a variety of viewpoints. All NDWAC working group meetings and full NDWAC meetings are open to the public.

Organizational Chart of the Office of Water



(www.epa.gov/water/programs/orgchart.html)

E. Small Systems Technology, Variances, and Exemptions

Affordable Technologies: When promulgating new national primary drinking water regulations, EPA is to identify technologies that are affordable and which achieve compliance for categories of systems serving fewer than 10,000. Technologies may include packaged or modular systems and point-of-use (POU)/ point-of-entry (POE) units under the control of the water system (no POU for microbial contaminants).

Surface Water Treatment Rule (SWTR): EPA must within 1-year list small system technologies that meet the SWTR. Within 2 years, EPA (in consultation with the States) must list technologies that achieve compliance with all existing regulations.

Variance Technology: Whenever an affordable technology cannot be identified that meets an MCL, EPA is required to identify "variance technologies" that are affordable, but do not necessarily meet the MCL. Such technologies shall "achieve the maximum reduction or inactivation efficiency that is affordable considering the size of the system and the quality of the source water." EPA is to issue guidance on variance technologies for existing regulations within 2 years.

Small System Variances: States are authorized to grant variances from standards for systems serving up to 3,300 people if the system cannot afford to comply (through treatment, an alternative source, or restructuring) and the system installs the variance technology. The terms of the variance must ensure adequate protection of human health. States can grant variances to systems serving 3,300-10,000 people with EPA approval.

Regulations for Variances: Within 2 years, EPA, in consultation with the States, must promulgate regulations for variances. Regulations must specify procedures to be used to grant or deny variances, requirements for the installa- tion and proper operation of variance technologies, eligibility criteria for a variance, and information requirements for variance applications.

Block on Certain Variances: Variances are not available for microbial contaminants or for contaminants regulated prior to 1986.

Variance Time Frames: A variance must require compliance with its conditions within 3 years of the date it is issued. States may allow an additional 2 years when needed.

States must review variances every 5 years following the compliance date established in the variance.

Affordability Criteria: Within 18 months of enactment, EPA, in consultation with the States and the Rural Utilities Service of the Department of Agriculture, must publish information to assist States in developing affordability criteria to use in making variance determinations.

Change to Existing Variance Process: The process for variances (retained from the old law) is streamlined by allowing a system to receive a variance "on the condition" that the system install the BAT, rather than after the installation of the technology, as previously required under SDWA. (NOTE: This change applies to ALL system sizes, not just small systems.)

Review of Variances: EPA must review/approve variances for systems serving 3,300-10,000 people. EPA may review and object to any proposed variance. Consumers of water systems for which a State proposes a variance may petition EPA to object to a variance. States must respond to EPA objections before granting a variance.

Technology Information: EPA may request information from manufacturers, States, and other interested persons on the effectiveness of commercially available treatment systems and technologies for the purpose of developing guidance or regulations related to small system technologies and variances.

II. Federal and State Responsibilities

It is difficult for the federal government to directly enforce the Clean Water Act, as the Environmental Protection Agency does not have the field personnel to act locally. Therefore the EPA coordinates efforts with state and local authorities in both development of new regulations and enforcement efforts. The EPA also provides both financial and technical support for all parties involved, whether state, local or industry.

A. Jurisdiction of the Clean Water Act

Federal jurisdiction is broad concerning the Clean Water Act, particularly regarding establishment of national standards or effluent limitations. The Environmental Protection Agency (EPA) issues regulations containing the BPT and BAT effluent standards applicable to categories of industrial sources (such as iron and steel manufacturing, organic chemical manufacturing, petroleum refining, and others). Certain responsibilities are delegated to the states, and this Act, like other environmental laws, embodies a philosophy of federal-state partnership in which the federal government sets the agenda and standards for pollution abatement, while states carry out day-to-day activities of implementation and enforcement. Delegated responsibilities under the Act include authority for qualified states to issue discharge permits to industries and municipalities and to enforce permits. (As of December 1998, 43 states had been delegated the permit program; EPA issues discharge permits in the remaining states.)

In addition, states are responsible for establishing water quality standards, which consist of a designated use (recreation, water supply, industrial, or other), plus a numerical or narrative statement identifying maximum concentrations of various pollutants which would not interfere with the designated use. These standards serve as the backup to federally set technology-based requirements by indicating where additional pollutant controls are needed to achieve the overall goals of the Act.

B. Jurisdiction of Enforcement

While the CWA addresses federal enforcement, the majority of actions taken to enforce the law are undertaken by states, both because states issue the majority of permits to dischargers and because the federal government lacks the resources for day-to-day monitoring and enforcement. Like most other federal environmental laws, CWA enforcement is shared by EPA and states, with states having primary responsibility. However, EPA has oversight of state enforcement and retains the right to bring a direct action where it believes that a state has failed to take timely and appropriate action or where a state or local agency requests EPA involvement. Finally, the federal government acts to enforce against criminal violations of the federal law.

In addition, individuals may bring a citizen suit in U.S. district court against persons who violate a prescribed effluent standard or limitation. Individuals also may bring citizen suits against the Administrator of EPA or equivalent state official (where program responsibility has been delegated to the state) for failure to carry out a nondiscretionary duty under the Act.

III. Enforcement and its Effect on Innovation

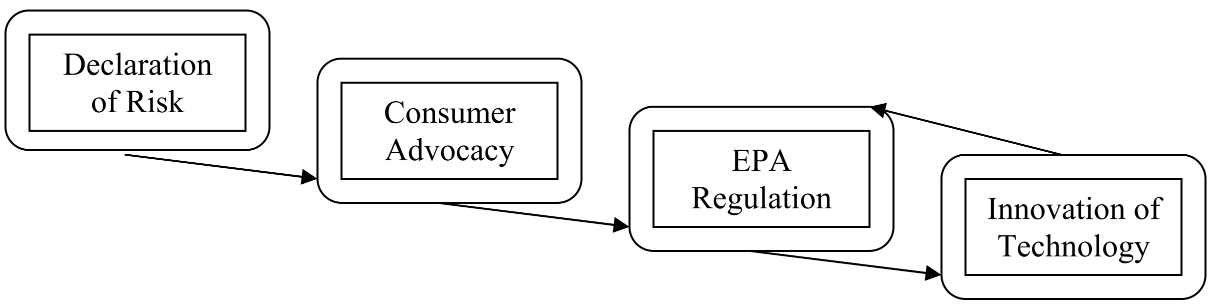
The Safe Water Drinking Act has been termed a technology-forcing statute because of the rigorous demands placed on those who are regulated by it to achieve higher and higher levels of pollution abatement. Industries were given until July 1, 1977, to install "best practicable control technology" (BPT) to clean up waste discharges. Municipal wastewater treatment plants were required to meet an equivalent goal, termed "secondary treatment," by that date. (Municipalities unable to achieve secondary treatment by that date were allowed to apply for case-by-case extensions up to July 1, 1988. According to EPA, 86% of all cities met the 1988 deadline; the remainder was put under judicial or administrative schedules requiring compliance as soon as possible. However, many cities, especially smaller ones, continue to make investments in building or upgrading facilities needed to achieve secondary treatment.)

The Act required greater pollutant cleanup than BPT by no later than Mar. 31, 1989, generally demanding that industry use the "best available technology" (BAT) that is economically achievable. EPA provides guidance on technologies that will achieve BPT, BAT, and other effluent limitations. Compliance extensions of as long as 2 years are available for industrial sources utilizing innovative or alternative technology. Failure to meet statutory deadlines could lead to enforcement action.

In addition, the federal government and the EPA encourage innovation in the water treatment industry by providing financial support and incentives. State and local authorities that use innovative technology receive more funding than those not using innovative methods. Grants are generally available for as much as 55% of total project costs. For projects using innovative or alternative technology (such as reuse or recycling of water), as much as 75% federal funding was allowed.

The innovation process for environmental technology consists of a series of feedback loops. There are a number of existing government programs that focus on directly fomenting innovation through grants, but the great majority of innovation comes from the need of municipalities and industries to comply with updated EPA policies. In regards to water treatment, every year the EPA issues new limits and substances that are considered contaminants. This creates a constant need for innovation in the industry. For the most part, whenever a new ruling is issued, all parties must use the "best available technology" (BAT) on the market which often is available on international markets or is the result of innovation or manufacturing in advanced industrialized countries. As technology advances, it also enables the EPA to issue more standards. Often the impetus for change comes from consumer advocacy. When a substance or situation is found to be harmful in some way, advocacy groups lobby for further regulation, which must then be taken up by the EPA and results in the need for more advanced technology. A simple flow chart is located below.

Process of Technological Innovation



We review below four environmental regulation cases in which the regulatory process has been largely led by the innovatory process.

A. Innovative Technology: Bubble Aggregate Managed Mixing

At 1/10th the size of traditional gravity separation technology, the BAMM fits easily into facilities with limited real estate. Few moving parts, efficient use of chemistry and low power requirements keep the BAMM's operating and maintenance costs to a minimum. Through more effective and redundant flotation, the BAMM system removes BOD/COD, TSS, FOG and Bio-Growth from a variety of process streams up to undetectable levels. During the mixing process, fine micro bubbles come into immediate contact with stream contaminants to produce more durable flocks with high solids content. The BAMM has manual and PLC automation to allow for system customization and real-time stream management. Flotation redundancy at the water's surface allows the clean water to "drain" from the floating particles to the bottom of the tank and eliminate carry over.

1. How BAMM Works

Multiple polymer/chemistry capabilities allow the user to 'tune' the system to the specific needs of his stream and produce ideal "charge satisfaction" for flotation. A fourth polymer may be added to collect opposite charges into one flocculent. The Water Air Mixer (WAM) injects pressurized air or gas directly into the stream creating bubbles, which come into immediate contact with the particles to form aggregates of great strength and durability, ideal for flotation. In addition, the WAM's high-energy mixing environment ensures thorough polymer mixing without polymer. The "Servo Sensor" allows the system to respond to changing stream conditions in real-time via PLC automation or manual control. The "Bloom Chamber" allows the bubbles, particles and chemistry to further mix. This reduces flotation retention by increasing bubble-particle contact before the aggregates enter the flotation tank. Unlike any other gravity separation equipment on the market today, the BAMM delivers the bubble-particle solution to the top of the flotation tank which reduces the distance the aggregate has to float, and allows the clean water to 'drain' to the bottom of the tank for discharge. The flotation tank's unprecedented design creates flotation redundancy by recirculating the aggregate solution at the top of the water's surface. The aggregates created through this process are stronger and more durable, which produce "dryer" solids than traditional gravity separation equipment.

B. Innovative Technology: TiO_2 Photo Catalytic Water Treatment

Titanium dioxide (TiO_2) photocatalytic water treatment technology is used to destroy dissolved organic contaminants from aqueous waste streams. The method focuses on the development of an ambient solid-state process in which contaminated water flows through a fine TiO_2 catalyst bed activated by ultraviolet-A light. The TiO_2 semiconductor catalyst, when excited by light, generates hydroxyl radicals. These radicals react with the waste material to form compounds such as water, carbon monoxide, and oxygen, although more complex by-products can also be formed. It is expected that efficient destructions of dissolved organics occurs between 30 seconds and 2 minutes, depending upon the molecular weight of the organic compound and the presence of other organic molecules.

1. Technology Needs

Organic chemicals are the most ubiquitous form of contamination in the United States. The Department of Energy alone owns over 200 problem sites contaminated with organics. Organic contaminants in the subsurface can exist in soluble form or as an insoluble separate phase, floating on the water table or sinking to the base of the aquifer. Technologies currently exist to treat groundwater contaminated with organics. The state of the art is to pump- and-treat the groundwater using either adsorption on activated carbon or air stripping to treat the organics. TiO_2 photo catalytic water treatment may provide an effective alternative to currently available technology without generating a secondary waste.

The TiO_2 photo catalytic waste technology was accepted into SITE Emerging Technologies Program in 1991. The project was co-funded by DOE as part of an interagency agreement between EPA and DOE to co-fund research and development activities of mutual interest.

2. Accomplishments

- Several extended field trials have been conducted on raw effluent contaminated with a variety of organics, mainly BTEX, trichloroethene, and methyl tertiary butyl ether.
- Average treatment time was 60 seconds at a direct operating cost of $1 to $2 per 1,000 gallons.

- The technology has treated effluent with contaminants as high as 1,000 parts per million (ppm), and has achieved effluent qualities as low as 5 parts per trillion.

C. Innovative Technology: Ion-exchange Resin

The R-Reactor of the Savannah River Nuclear Power Plant was shutdown in 1964, and is currently maintained in a Surveillance and Maintenance (S&M) mode. The disassembly basin still contains the majority of the water left at shutdown, currently about 5,000,000 gallons. The ASTD deployment was designed to remove the majority of the Cs-137 and Sr-90, using highly nuclide specific ion-exchange resins. The use of highly specific resins would generate the least amount of secondary waste, by removing only the constituents of concern. The treatment was conducted in-situ, with the treated effluent discharged back into the basin. The goal was to treat one to two basin volumes of water, and to remove 67% to 73% of each of the radionuclides. At that point, the water could be treated one final time, which would meet the DOE release limits (and perhaps the EPA drinking water limits) and be released directly to a surface stream. Even if the water were not released, treatment of the basin water would reduce the impact to the surrounding groundwater, if the basin were to leak in the near future.

The deployments utilized two technologies for Cs-137 removal. One was a system from the 3M Co., St. Paul, MN (the Selective Separation Cartridge- SSC™) and a commercial water softening resin from Graver Technologies, Glasgow, DE. The 3M SSC™ system for Cs-137 removal treated over 6.8 million gallons of the basin water, or approximately 1.3 basin "turnovers" at 98 to 99% removal efficiency. The Selion CsTreat® system treated an additional 1.2 million gallons for Cs-137, at 97 to 99% removal efficiency. The Sr-90 deployment system treated over 5.6 million gallons at greater than 99.9% removal efficiency. Over 75% of both radionuclides were removed from the R-Disassembly basin water by the completion of the deployments.

In FY '99, the DOE Office of Science and Technology (OST, EM-50) approved a Deployment Plan for the water cleanup at the 105-R Disassembly Basin and provided funding amounting to $550,000 through FY 2001. FDD provided matching funding through EM-60 of $950,000 for these three years. The Deployment Plan, SR-09-DD-61, called for the use of a highly selective NUclide REmoval System (NURES) commercialized by Selion, OY, Finland. Graver Technologies Inc., of Glasgow DE, licensed the NURES technology from Selion, and provided the NURES selective resins and equipment to the SRS.

In FY 2000, FDD also partnered with 3M, St. Paul, MN to deploy a similar highly selective material for Cs-137 at the R-Disassembly Basin. This technology is called the Selective Separation Cartridge (SSC™) technology. The 3M system was developed under a DOE Technical Task Plan FT-06-C-261, overseen by DOE's National Energy Technology Laboratory, Morgantown, WV, who provided the funding for the construction of the 3M system. FDD funded the 3M system deployment costs at the disassembly basin. Neither the Selion, nor the 3M, ion-exchange technologies had been previously deployed at a Department of Energy site. The 3M Cs removal system had been tested at the R-Disassembly Basin in 1998 at 5 gpm for a short period of time (2 weeks).

1. Selion CsTreat® for Cs-137

The Selion CsTreat® technology is based on a deep bed ion-exchange technique, using very finely divided hexacyannoferrate, with a very high surface area. The bed is operated in a down–flow mode, with preferred flow rates in the range of 10 to 20 bed volumes per hour (BV/hr). At that flow rate, the CsTreat®'s anticipated removal efficiency is greater than 99.9% (a DF; Decontamination Factor of >1,000). The system for the R- Disassembly basin was initially designed to treat 50 gallons/min (3000 gallons/hr, or 400 cu. ft/hr). At 20 bed volumes per hour, his would have required 20 cubic feet of resin. This proved to be too expensive for the available ASTD deployment funding, since the CsTreat® costs ~$16,000 per cu. ft. In order to meet the deployment goals, the target flow rate was reduced to 15 to 20 gpm (~160 cu. ft/hr), and the flow rate was increased to 50 BV/hour. This allowed the use of only ~3 cu. ft of CsTreat®, at a cost of ~$48,000.

2. 3M Selective Separation Cartridge® (SSC™) for Cs-137

Since the original deployment goal of 50 gpm could not be accomplished with the downsized Selion system, FDD partnered with the 3M Co., St. Paul, MN to deploy 3M's highly selective Cs-removal system. The 3M system could be also operated at 15-20 gpm. The 3M cartridge membrane is trademarked Selective Separation Cartridge® (SSC™). The high surface area sorbent particles are loaded or enmeshed onto a web or membrane, which is then fabricated into a spiral-wound, cartridge-filter. The R-basin deployment used 22 cylindrical cartridges, 2.3" in diameter by 21" in length, at a total cost of $60,000. The 3M-cartridge technology can provide higher flow rates than a standard packed bed system, and channeling is not a concern for the cartridge technology.

The colbalti-hexacyanoferrate forms an insoluble precipitate with cesium, therefore it was not intended to be regenerated; rather both the 3M and Selion materials will be disposed as low level radioactive waste (LLRW).

3. Selion Sr-90 Removal System

The Selion ion-exchange system for Sr-90 is based on a sodium titanium oxide, again with a very small particle size and high surface area. Prior to the system deployment, Selion determined in tests (with simulated R-basin water), that two of the major cations present in the basin water, Ca (at 13 mg/L), and Mg (at 0.5 mg/L) would interfere strongly with strontium-90 removal. Therefore, it was decided to "pre-treat" the basin water with a conventional water softening resin, "GRAVEX® GX–080." This resin is a sulfonated styrene and divinylbenzene strong acid exchange resin, produced by Graver Technologies, DE. The plan was to use the Gravex® water softening resin to remove the majority of the Ca and Mg in the water, prior to a final treatment with the SrTreat®. However, there was insufficient time to utilize the SrTreat® at the end the Ca/Mg pretreatment, so the SrTreat® was not deployed. Twelve 100-gallon tanks containing the water softening GRAVEX® GX–080 resin were not regenerated; they were disposed as LLRW.

4. 3M Strontium Removal (SSC®) Cartridge System

The 3M-strontium selective removal system was based on a sulfonated divinylbenzene compound, similar to Graver's water softening resin. As with the SrTreat®, calcium and magnesium also compete strongly with Sr-90 removal for the 3M material. Two sets (22 cartridges per set) of the 3M Sr-90 removal cartridges were tested in the R-Basin in June 2000, at 20 gallons per minute. Initial Sr-90 removal during the first 5,000 gallons treated was greater than 99% (DF >100). After this point, Ca and Mg started to saturate the available exchange sites, and 50% breakthrough for Sr-90 occurred at ~12,000 gallons on both sets of filters. The concentration of Ca was ~13 mg/L, while the concentration of natural strontium was 0.15 mg/L in the basin water, a factor of about 100. The 3M cartridges did not demonstrate a high enough selectivity for strontium vs. Ca/Mg for the R-Basin deployment, so no further testing was conducted with the 3M SSC® Sr-90 cartridge removal system.

5. Results

Both the 3M and Graver/Selion systems were highly effective at removing Cs-137. The Selion CsTreat® is more sensitive to particulate plugging than the 3M SSC cartridge technology. The 3M SSC® filter cartridges can be used at higher flow rates than the Selion CsTreat®, which is limited by the bed volumes/hr it can treat. The Selion system would work very well at high Cs-137 concentrations and low flows, while the 3M-system will work more effectively at low Cs-137 concentrations and high flow rates.

The "Gravex 080®" resin was shown to be moderately selective for Sr-90 in the presence of Ca and Mg. This allowed the resin tanks to continue to be utilized even after they were saturated with respect to Ca and Mg.

The in-situ approach demonstrated a new and innovative water treatment technology for these radionuclides. The selective and highly efficient ion exchange media removed Cs-137 from the R-Reactor Disassembly Basin water with drastically reduced radiological waste volumes. The innovative in-site technologies saved the DOE an estimated $4 to $5 million at the R-Disassembly Basin compared to conventional baseline technology (transport to and treatment at a centralized wastewater treatment facility).

D. Innovative Technology: Mobile Monitoring Lab

Modern wastewater treatment plants are an impressive ensemble of concrete, pipes, pumps, tanks, gauges and laboratories. At the receiving end of all the sewage, chemicals and toxic waste a city can produce, these plants have to deal with whatever comes down the pike -- and that's plenty. Most municipal plants in Georgia are doing a good job, according to state officials who oversee them. But water quality is an increasingly tense issue. The state already monitors for a long list of organic substances. In the past decade, the Environmental Protection Agency has established a list of more than 150 toxics for regulation in public water supplies, and they add 25 or so new contaminants every three years.

When there's a problem, plant managers must make the necessary changes or face stiff fines from the state Environmental Protection Division. Often finding the cause is half the battle. That's where a new mobile water quality lab, developed by British company Capital Controls and researchers at the University of Georgia, can help. Called the Environmental Process Control Laboratory, the lab's detailed, real-time data can diagnose problems in the wastewater system. Probes, sensors and respirometers record levels of dissolved oxygen, suspended solids, ammonium, nitrites, nitrates, phosphates and other organic compounds that are indicators of plant performance.

"The lab is a quantum leap in terms of what you can see and learn, a bit like what I imagine the Hubble telescope is to astronomy," said Bruce Beck, a Georgia Research Alliance eminent scholar and professor in UGA's Warnell School of Forest Resources. "Beyond that, it is also a research platform we can re-engineer to collect data from pulp and paper mills, streams, rivers, and even aquaculture ponds, in addition to water treatment plants."Rather than measuring bacteria directly, the lab's sensors instead record the level of biochemical activity in the wastewater effluent. Managers can use this information in much the same way doctors use a blood profile to understand what's happening in the body as a result of a bacterial infection.

"Computer models are used so much in this field," said Beck. "But the equations have got to have real applications at some point, and up until now, nobody has been able to collect the data to check out how good the equations really are." The lab has been field tested for the past year at an Athens/Clarke County wastewater treatment facility, where managers say it has helped them to understand how storm events and seasonal changes in water volume effect the plant's operation and efficiency.

"The data helped us determine that instead of running two aeration basins, we could use just one, and that saves on electricity costs," said David Bloyer, operations coordinator at the water pollution control plant off Will Hunter Road. "We had considered trying this, but we weren't confident about it before. The lab also told us how to go about planning for future permits -- like those for phosphorus levels, for example, which are probably on the horizon." Beck, who came to UGA in 1993 as part of the state's push to study and improve water quality, is pleased with the field trials and anxious to make the lab available to other Georgia cities. "Ultimately, I believe the lab could help foster public understanding of the very complex problems of running one of these plants," he said. "These plant managers are really under the gun in many instances. The public is very concerned about water quality, yet few people know much about what's involved in providing clean, safe water to millions of Georgians."

IV. Federal Funding of the Clean Water Act

A. Direct Funding of the Clean Water Act

Federal law has authorized grants for planning, design, and construction of municipal sewage treatment facilities since 1956 (Act of July 9, 1956, or P.L. 84-660). Congress greatly expanded this grant is program in 1972. Since that time Congress has authorized $65 billion and appropriated $69 billion in funds to aid wastewater treatment plant construction. Grants are allocated among the states according to a complex statutory formula that combines two factors: state population and an estimate of municipal sewage treatment funding needs derived from a biennial survey conducted by EPA and the states. The most recent estimate, completed in 1996, indicates that $140 billion is needed to build and upgrade needed municipal wastewater treatment plants in the United States and for other types of water quality improvement projects that are eligible for funding under the Act.

Under the title II construction grants program established in 1972, federal grants were made for several types of projects (such as secondary or more stringent treatment and associated sewers) based on a priority list established by the states. Grants were generally available for as much as 55% of total project costs. For projects using innovative or alternative technology (such as reuse or recycling of water), as much as 75% federal funding was allowed. Recipients are responsible for non-federal costs but were not required to repay federal grants.

B. Training Funded by the EPA

The EPA offers technical advice and training for industrial participants and government authorities. One training program specifically from the Clean Water Act is called the Drinking Water Academy (DWA). Established by the U.S. EPA Office of Ground Water and Drinking Water, the DWA is a long-term training initiative whose primary goal is to expand EPA, State, and Tribal capabilities to implement the 1996 Amendments to the Safe Drinking Water Act (SDWA). In addition to providing classroom and Web-based training, the DWA will act as a resource for training materials pertaining to SDWA implementation. The EPA formed the DWA to help the EPA, States, and Indian Tribes enhance program capability to meet the public health protection objectives of the SDWA requirements. The 1996 SDWA Amendments created a number of new programmatic challenges for the States, Tribes, and the water systems they regulate. The Amendments also provided new funding opportunities to meet these growing needs. DWA training will support EPA, State, and Tribal efforts to implement these new regulations.

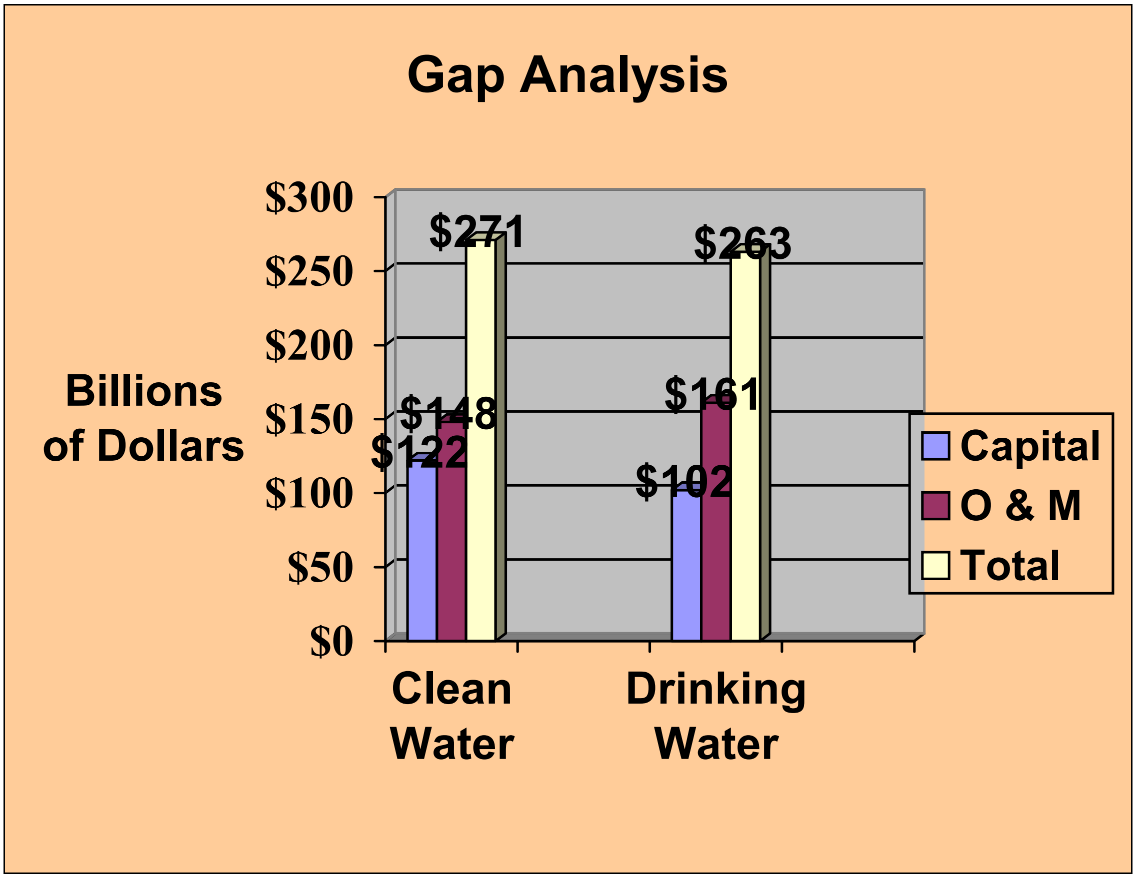
C. Clean Water and Drinking Water Infrastructure Gap Analysis

(See also Appendix VII for full report)

With the aging of the nation's infrastructure, the clean water and drinking water industries face a significant challenge to sustain and advance their achievements in protecting public health and the environment. To gain a better understanding of the future challenges facing these industries, the U.S. Environmental Protection Agency (EPA) has conducted "The Clean Water and Drinking Water Infrastructure Gap Analysis", in order to identify whether a funding gap will develop between projected investment needs and projected spending. The study provides an important empirical basis for discussions addressing the critical needs of our water infrastructure. EPA conducts surveys of the nation's clean water and drinking water infrastructure needs every four years. These surveys formed the starting point for calculating the capital and O&M investment needs.

The Gap Analysis covers a 20–year period from 2000 to 2019 and includes estimates of the funding gap for both capital and operations and maintenance (O&M). The report discusses the methods for calculating the capital and O&M gaps, but does not address the policy implications of the results. For clean water, the estimates of investment needs and spending used to calculate the gaps cover all of the approximately 16,000 publicly owned treatment works (POTWs). The drinking water analysis covers the approximately 54,000 community water systems and the 21,400 not-for-profit non-community water systems in the 50 states, U.S. Territories, and Tribal areas.

This analysis estimates a total capital payments gap of $122 billion, or about $6 billion per year, for clean water and $102 billion, or about $5 billion per year, for drinking water. The O&M gap is estimated at $148 billion, or $7 billion per year, for clean water and $161 billion, or $8 billion per year, for drinking water. Under the "revenue growth" scenario, the capital gap is $21 billion, or about $1 billion per year for clean water and $45 billion, or about $2 billion per year, for drinking water. The O&M gap is estimated at $10 billion, or $0.5 billion per year, for clean water, while no O&M funding gap would occur for drinking water. This information is represented in the tables below.



(EPA Gap Analysis – Appendix VII)

V. Criticism of the Clean Water Act

Most criticism of the EPA in general and the Clean Water Act specifically comes from the industry, and is voiced through the state and local authorities. Much of the focus is on the stringency of the EPA regulations. Due to regional and local variations in geology and environment, regulations have different effects in different areas. Some states and local municipalities have a more difficult time meeting the requirements and do so at a higher cost. In some areas, polluting entities exist at natural concentrations close to or higher than the EPA regulations maximum limits. In these areas, treated water is discharged cleaner than the areas natural waters.

A. Funding Criticism

Policymakers have debated the tension between assisting municipal funding needs, which remain large, and the impact of grant programs such as the Clean Water Act's on federal spending and budget deficits. Due to the level of technology required and fines placed in enforcement, many municipalities suffer economic hardship in meeting the EPA regulations. However, the federal support conflicts with congressional desire to cut spending deemed unnecessary by some lawmakers who believe funding should come at state and local levels. In the 1987 amendments to the Act, Congress attempted to deal with that apparent conflict by extending federal aid for wastewater treatment construction through fiscal year 1994, yet providing a transition towards full state and local government responsibility for financing after that date. Grants under the traditional title II program were authorized through fiscal year 1990. Under title VI of the Act, grants to capitalize State Water Pollution Control Revolving Funds, or loan programs, were authorized beginning in fiscal year 1989 to replace the Title II grants.

States contribute matching funds, and under the revolving loan fund concept, monies used for wastewater treatment construction will be repaid to a state, to be available for future construction in other communities. All states now have functioning loan programs, but the shift from federal grants to loans, since fiscal year 1991, has been easier for some than others. The new financing requirements have been a problem for cities (especially small towns) that have difficulty repaying project loans. Statutory authorization for grants to capitalize state loan programs expired in 1994; however, Congress has continued to provide annual appropriations.

B. Policy Criticism

Numerous programs under the Clean Water Act are subject to criticism, primarily by special interest groups of some form. Environmentalists often claim regulations are not stringent enough and industrialists that are required to treat discharge water claim they are too stringent. Even individuals and industries that do not actually treat water often find themselves at odds with the EPA. Most of the feedback to the EPA comes from lawmakers, as they are the victims of lobbying efforts of these special interest groups. There is evidence that international firms consider the differential impact and cost of regulatory implementation as part of their investment and locational strategies.

Also, there are many aspects of water pollution and treatment that are not yet addressed by the Clean Water Act. It takes lobbying efforts and scientific research to identify areas in need and to specify appropriate regulation. For example, prior to the 1987 amendments, programs in the Clean Water Act were primarily directed at point source pollution, wastes discharged from discrete and identifiable sources, such as pipes and other outfalls. In contrast, except for general planning activities, little attention had been given to non-point source pollution (storm water runoff from agricultural lands, forests, construction sites, and urban areas), despite estimates that it represents more than 50% of the nation's remaining water pollution problems. As it travels across land surface towards rivers and streams, rainfall and snowmelt runoff picks up pollutants, including sediments, toxic materials, and conventional wastes (e.g., nutrients) that can degrade water quality.

The 1987 amendments authorized measures to address such pollution by directing states to develop and implement non-point pollution management programs (section 319 of the Act). States were encouraged to pursue groundwater protection activities as part of their overall non-point pollution control efforts. In 1999, the EPA updated its regulations covering non-point pollution, making it more stringent by lowering the "total maximum daily load" allowed. Federal financial assistance was authorized to support demonstration projects and actual control activities. These grants cover up to 60% of program implementation costs.

Recently, the Act's wetlands permit program has become one of the most controversial parts of the law. Some who wish to develop wetlands maintain that federal regulation intrudes on and impedes private land-use decisions, while environmentalists seek more protection for remaining wetlands and limits on activities that take place in wetlands.

1. Financial Effects of the TMDL Plan

Both states and the entities they regulate appear likely to face heightened costs and compliance burdens under the proposed regulations. Administrator Browner indicated that developing and implementing the TMDL plans would cost from $1 to $2 million per state, and the EPA cost estimate for developing a single TMDL under the plan is $25,000. California authorities, however, predict investments of $350,000 for each "medium complexity" TMDL and $1.1 million for more intricate TMDLs. As usually happens with EPA cost estimates, the reality will likely be much worse. For example, when a TMDL was prepared to mitigate nitrogen pollution in the Long Island Sound, costs over a four-year period exceeded $20 million! State groups have long argued that states do not have the resources to administer their current TMDL obligations, a gap that will only widen under the plan. “The costs for water quality monitoring, assessment, TMDL development and implementation will experience a tremendous increase at every stage of the process,” according to comments filed by state regulatory agencies in response to the August 1999 Proposal.

The largest cost questions arise, however, with respect to the rulemaking’s impact on individual farmers and the livestock industry in the U.S. and ultimately in other similarly positioned countries. U.S. Secretary of Agriculture Dan Glickman recently testified before the Senate Agriculture Committee that the EPA needs to analyze how much the extended TMDL program would cost landowners. Concerns are centered on the idea that a regulatory scheme based on non-point sources of pollution will require farmers to expend resources to improve the quality of a nearby water body, regardless of whether the farmer contributed to the pollution of that water body.