112731

BY THE COMPTROLLER GENERAL

Report To The Congress

OF THE UNITED STATES

Many Water Quality Standard Violations May Not Be Significant Enough To Justify Costly Preventive Actions

Advanced waste treatment for municipal sewage may not be worth the tremendous costs--estimated by the Environmental Protection Agency at $10 billion--unless it will make a substantial difference to water quality. In setting or revising water quality standards, States generally do not consider costs, and many standards are based on questionable data. A number of costly advanced waste treatment plants may have little effect on water quality.

This report presents a number of options to the Congress concerning the funding of advanced waste treatment projects. It also makes recommendations to the Administrator of the Environmental Protection Agency to help improve the way water quality standards are set and implemented and the procedures used in assessing the need for advanced waste treatment.

UNITED STATES GENERAL ACCOUNTING OFFICE

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COMPTROLLER GENERAL OF THE UNITED STATES
WASHINGTON, D.C. 20548

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To the President of the Senate and the
Speaker of the House of Representatives

This report discusses the Environmental Protection Agency's Construction Grants Program and the significance of advanced waste treatment to prevent violations of water quality standards.

We made our review because of congressional concern about how water quality standards affect the degree of wastewater treatment needed by municipalities. The Congress was especially concerned about the large costs generally associated with advanced wastewater treatment.

Copies of this report are being sent to the Director, Office of Management and Budget; the Chairman of the Council on Environmental Quality; and the Administrator, Environmental Protection Agency.

Milton J. Socolar

Acting Comptroller General
of the United States

COMPTROLLER GENERAL'S
REPORT TO THE CONGRESS

MANY WATER QUALITY STANDARD VIOLATIONS MAY NOT BE SIGNIFICANT ENOUGH TO JUSTIFY COSTLY PREVENTIVE ACTIONS

D I G E S T

The Environmental Protection Agency administers a Construction Grants Program under the Federal Water Pollution Control Act, as amended, commonly referred to as the Clean Water Act, to restore and maintain the quality of the Nation's waters. The Agency estimates that $10 billion will be needed through the year 2000 to construct advanced waste treatment facilities for municipal sewage for this program.

GAO discussed advanced waste treatment with Federal and State water quality officials and consultants knowledgeable of water quality matters and reviewed various scientific studies on water quality. Based on these discussions and reviews, GAO found that advanced waste treatment--which removes some pollutants left after secondary treatment--with few exceptions, may not be justified. GAO found that:

--Mathematical models used to predict water quality are often imprecise and inexact.

--Federal funding is insufficient to achieve water quality standards for all waterways within a reasonable time.

--The Environmental Protection Agency makes it difficult for States to relax or downgrade water quality standards.

--Relating the impact of various treatment levels to water use is difficult. (See pp. 18, 23, 24, 45, and 69.)

Each State has developed water quality standards to protect its waterways and the uses it plans to make of them. The standards help determine the type of wastewater treatment needed to protect waters for those uses.

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Advanced treatment, which may be required in municipalities, is very expensive. Costs rise in relation to pollutants removed--the more pollutants removed, the higher the costs. States generally do not consider costs, however, in setting or revising water quality standards. (See pp. 42 to 44.)

VIOLATIONS MAY NOT BE SIGNIFICANT

Violation of a water quality standard may not always mean that significant environmental, social, or public health damage has occurred. The seriousness of a violation depends on a number of factors. For example:

--The scientific basis for the standard may be questionable. GAO's review showed that water quality levels needed to protect water for a designated use are sometimes based on limited experimental investigation and that competent scientists disagree about the effects of water quality on aquatic life.

--The water may not be important to society. Some streams are virtually inaccessible--guarded by canyons, steep slopes, or other physical barriers. Others offer no public access or access only to a few hikers. In low-population areas some streams may receive very little use. In these situations water quality standard violations are not as harmful as violations in heavily used waters.

GAO noted that a number of advanced waste treatment plants, either planned, under construction, or in operation, offered questionable benefits. The Appropriations Conference Committee in 1979 directed that environmental and public health benefits must be considered significant before such plants can be approved for construction. However, the Clean Water Act does not impose such a requirement. (See pp. 5 to 17 and 53 to 67.)

PREDICTING WATER QUALITY STANDARD VIOLATIONS IS UNCERTAIN

In many instances municipalities are constructing treatment facilities more sophisticated than secondary to prevent predicted water quality standard violations.

These predictions are generally based on mathematical models. GAO's review showed that the models being used produce highly uncertain results. When poorly developed or improperly applied, the models frequently cannot simulate complex natural processes, and adequate water quality data is either not used or not available. Many natural processes are too complicated for modeling to determine whether advanced treatment is needed.

Modelers could improve their techniques. For example, nonpoint source pollution (runoff from agricultural and forest lands and storm runoff from urban areas) should be considered, water quality data should be reliable and adequate, and the model's predictive reliability should be specified. (See pp. 18 to 41.)

COSTS HAVE NOT BEEN CONSIDERED ADEQUATELY

The law does not require communities to consider adequately the costs of achieving water quality standards. Although EPA generally assumes that the economic feasibility of achieving a standard will be determined before standards are set, most standards have not received such analysis. Almost all of the State officials in the 12 States GAO visited said they did not perform rigorous economic analyses before setting standards. As a result, States tended to classify most of their waterways as fishable/swimmable--which often necessitates advanced treatment.

It is difficult for States to reclassify streams downward and may become even more difficult in the future because the Agency discourages downgradings. Agency officials said a State is expected to ensure the economic reasonableness of attaining the water uses it designates in a standard. They said that when a body of water is given a fishable/swimmable designation, the Agency presumes that the State had determined the economic reasonableness of attaining the necessary water quality for that use. (See pp. 42 to 52.)

THE CONGRESS IS CONCERNED ABOUT PROJECTS HAVING INSIGNIFICANT ENVIRONMENTAL AND PUBLIC HEALTH IMPROVEMENTS

The Clean Water Act allows advanced waste treatment plants to be built regardless of environmental impact or cost. However, in 1979 the Appropriations Conference Committee stipulated that Construction Grant Program funds could be used for advanced waste treatment only if (1) the incremental cost of the treatment is $1 million or less or (2) the Agency Administrator personally determines that advanced treatment is required and that it will definitely result in significant water quality and public health improvements.

During July 1978 hearings before the Subcommittee on Oversight and Review, House Committee on Public Works and Transportation, GAO and others pointed out a number of questionable advanced waste treatment projects. During fiscal year 1979, the first year of the Appropriations Conference Committee restriction, the Agency acted on 26 projects where advanced waste treatment cost more than $1 million and the Agency's regional administrators acted on 178 projects involving $1 million or less. These actions included approval of the entire project as proposed, approval of a portion of the project, or deferral of all or a portion of the project.

GAO's review of nine of these projects showed that, for most, the Agency's review process did not indicate that advanced waste treatment would definitely result in significant water quality and public health improvements. For example, the Agency's analysis of the projects did not show the:

--Significance of the projects' advanced treatment portion to the environment. Rather, the analysis discussed the project as a whole and failed to distinguish between secondary treatment and advanced treatment.

--Effect on public health. There was little indication that the projects would produce significant health improvements or that they were intended to do so.

--Significance of the advanced waste treatment portion on established waterway uses. Little analysis had been done to determine how the advanced treatment portion would improve water uses.

--Social significance or benefits of the projects. Little, if any, documentation existed showing how many more persons would be able to fish, swim, or boat on the waterway. (See pp. 55 to 58.)

RECOMMENDATIONS TO THE ADMINISTRATOR, ENVIRONMENTAL PROTECTION AGENCY

GAO recommends a number of corrective measures to improve the process for setting and implementing water quality standards and to better assess the need for advanced waste treatment. (See pp. 69 to 70.)

AGENCY COMMENTS AND GAO EVALUATION

In commenting on a draft of this report, the Agency agreed with GAO that the Nation's water pollution control program is costly and complex. But it generally did not agree with GAO's conclusions, stating they reflect a misunderstanding of the legislative objectives and fail to recognize that States may legally set their own water quality standards.

GAO recognizes that the Congress wanted to make "all" waters fishable and swimmable, but only "wherever attainable." Although the Congress did not require the Agency to weigh benefits against the costs of building advanced waste treatment, it did recognize that the fishable/swimmable goal was not attainable in all cases. In fact, the Agency itself directs States to consider "environmental, technological, social, economic, and institutional factors" in determining attainability. Therefore, GAO continues to believe that costs should be considered in setting water quality standards and in determining the need for advanced waste treatment. (See pp. 70 to 73.)

MATTERS FOR CONSIDERATION
BY THE CONGRESS

GAO is presenting for congressional consideration several options that would give the Agency the flexibility to more closely consider costs in explaining the need for advanced waste treatment projects. (See pp. 73 to 74.)

Contents

ABBREVIATIONS

AWT	advanced waste treatment
BOD	biochemical oxygen demand
DO	dissolved oxygen
EPA	Environmental Protection Agency
GAO	General Accounting Office
mg/l	milligrams per liter
O&M	operation and maintenance
ug/l	micrograms per liter
USGS	U.S. Geological Survey
WQS	water quality standards

GLOSSARY

Advanced waste treatment — Treatment processes which remove additional pollutants from wastewater beyond those eliminated by primary and secondary treatment. There are different degrees of advanced treatment with substantially different costs. Advanced waste treatment processes may remove nutrients such as phosphorus and nitrogen, a high percentage of suspended solids, and oxygen-demanding substances.

Algal blooms — Prolific growths of algae that may be stimulated by phosphorus and nitrogen in water. Algae can severely decrease the oxygen dissolved in the water; certain species can cause taste and odor problems. The advanced waste treatment processes of denitrification and phosphorus removal are designed to prevent algal blooms in waste-receiving waters.

Biochemical oxygen demand — The oxygen consumed in waste decomposition.

Dissolved oxygen — The oxygen freely available in water. Dissolved oxygen is vital to fish and other aquatic organisms and for the prevention of offensive odors. Traditionally, dissolved oxygen has been accepted as the single most important indicator of a water body's ability to support desirable aquatic life. Secondary treatment and advanced waste treatment are generally designed to protect dissolved oxygen in waste-receiving waters.

Effluent — A wastewater discharge.

Effluent limitations	Restrictions established by a State or EPA on quantities, rates, and concentrations in wastewater discharges.
Kinetic rate coefficient	A number that describes the rate at which a water constituent (such as biochemical oxygen demand or dissoved oxygen) increases or decreases.
Modeling	Mathematical techniques for predicting the effect of waste treatment on water quality.
Nonpoint sources	Sources of pollution that are difficult to pinpoint and measure. Common examples are runoff from farms, forests, mines, construction sites, and city streets.
Nutrients	Elements or compounds essential for growth and development of organisms; for example, nitrogen and phosphorus.
Point sources	Sources of pollution that can be readily identified, such as factories and sewage treatment plants.
Pollution (of water)	Contamination or other alteration of the physical, chemical, or biological properties of water--including changes in temperature, taste, color, or odor--or the discharge into the water of any liquid, gaseous, radioactive, solid, or other substance that may create a nuisance or render such water detrimental or injurious to public health, safety, or welfare.
Primary waste treatment	Treatment usually involving screening and sedimentation for removing the larger solids in wastewater. The process removes about 30 percent of carbonaceous biochemical oxygen demand from domestic sewage.

Secondary waste treatment	Treatment following primary treatment that uses biological digestion and additional settling to reduce biochemical oxygen demand by 80 to 90 percent.
Suspended solids	Small particles suspended (not dissolved) in water. Very small particles are difficult to remove by conventional means.
Wasteload allocation	The maximum load of pollutants each discharger of waste is allowed to release into a particular waterway. Discharge limits are usually required for each specific water quality criterion being violated or expected to be violated.
Water quality criteria	Specific levels of water quality which, if not violated, are expected to render a body of water suitable for its designated use.
Water quality standard	A legal designation of the desired use for a given water body and of the water quality criteria appropriate for that use.

CHAPTER 1

INTRODUCTION

THE NATURE AND FUNCTION OF WATER QUALITY STANDARDS

One goal of the Federal Water Pollution Control Act, as amended, commonly referred to as the Clean Water Act, is to achieve by mid-1983, wherever attainable, water quality that provides for

--the protection and propagation of fish, shellfish, and wildlife and

--recreation in and on the water.

These are commonly called the fishable/swimmable goal. The act requires States or, if necessary, the Environmental Protection Agency (EPA) to set and/or maintain appropriate water quality standards (WQS) for both interstate and intrastate waters. WQS must include (1) a designation of a use or uses for a given body of water (for example, swimming, fish habitat, or public drinking water supply) and (2) water quality criteria specifying the type of water quality needed to protect the designated use(s).

EPA has recommended water quality criteria for various water uses and requires States to justify less stringent criteria. States may require higher water quality than EPA recommends. According to EPA officials, EPA is precluded by the act from reviewing State criteria for excessive stringency, and it does not do so.

WQS serve several functions. In particular, standards may form the basis for:

--Requiring treatment beyond secondary for municipalities.

--Controlling nonpoint sources (such as agricultural runoff).

WATER QUALITY STANDARDS AND ADVANCED WASTE TREATMENT

Theoretically, WQS are to be developed as follows:

--First, the desired use(s) are designated for a body of water (for example, domestic or agricultural water supply, swimming, fishing, or boating) after considering the costs of attaining the use(s).

--Second, water quality characteristics (temperature, dissolved oxygen (DO), heavy metals, toxic substances and others) related to the designated use(s) are identified and concentration limits (water quality criteria) are set for those that cannot be violated without interfering with the designated use(s).

--Third, the quality of the existing water is analyzed and accurate, scientific models are developed to predict water quality after all point source dischargers have secondary treatment (or its industrial equivalents). If water quality will not meet the standards, the models must accurately determine the additional treatment needed. This additional treatment is called advanced waste treatment (AWT).

In practice, however, it does not always work that way. Many difficulties prevent this approach from producing reliable results. Estimating the value of the environmental and social benefits of a designated water use is often not easy. The process of identifying the (1) water quality needed at any given time to support the designated use and (2) costs of attaining this water quality is complicated. This complexity is due in part to the limits of present scientific understanding and the intricacy of ecological relationships. Consequently, it is very difficult to set optimal WQS.

The following chapters discuss in more detail the relationship between WQS and AWT. Chapter 2 explains why AWT may not always be necessary to prevent WQS violations. In that chapter we discuss the scientific basis for some water quality criteria. We point out that unless strong scientific evidence is available, the criteria may not be significant to water quality. Thus, funds may be spent to prevent insignificant violations with no appreciable improvements to water quality or public health. Chapter 3 discusses how modeling predicts what happens to water quality when pollution loads change and how modeling may be used to predict the need for AWT. Chapter 4 discusses the high costs of AWT and the extent to which EPA allows cost considerations to enter into the use designation process. In chapter 5 we evaluate the significance of a number of AWT projects being approved by EPA. For some AWT projects, the Appropriations Conference Committee restricted funding to those that will significantly improve the environment and public health.

SCOPE OF REVIEW

We made our review at EPA headquarters, Washington, D.C.; EPA regional offices in Seattle, Washington; Kansas City, Missouri; Chicago, Illinois; Dallas, Texas; Boston, Massachusetts; Atlanta, Georgia; and at State agencies responsible for water quality in Washington, Oregon, Iowa, Kansas, Ohio, Oklahoma, Michigan, Alabama, Wisconsin, Illinois, Massachusetts, and Minnesota. The locations were selected to obtain broad geographical coverage of States for which AWT projects had been approved by EPA. We reviewed pertinent documents, interviewed various officials and consulted experts in the areas of WQS and AWT.

As of September 30, 1979, about $28 billion has been appropriated and $24 billion obligated to construct publicly owned waste treatment works. EPA estimates that $1.5 billion applies to AWT. EPA and the States have placed a high priority on constructing such facilities if needed to meet WQS. In many cases these facilities will provide AWT that is much more expensive than secondary treatment.

We visited nine AWT projects awarded in fiscal year 1979; reviewed documents; and discussed these projects with local officials, design engineers, and other interested parties. The nine projects visited were selected because they represented the first projects awarded in fiscal year 1979.

The Appropriations Conference Committee has required the EPA Administrator to personally ensure that Federal funds for fiscal year 1979 be used for projects providing treatment beyond secondary only if the projects would significantly benefit the public health and improve water quality. Four of the projects we visited were reviewed by EPA regional offices.

We looked at 11 projects to evaluate the use of models the Administrator reviewed before approving treatment beyond secondary. These 11 projects were the first projects considered in EPA's revised review process. Five of the projects were approved as proposed, but six had portions disapproved. We evaluated these projects solely to determine if the modeling was reliable. We did not review the Administrator's decisionmaking process.

We concentrated our review on AWT for municipal sewage treatment plants and did not consider AWT for industrial dischargers. However, we believe that the analysis used to justify effluent limits for industrial dischargers may have the same problems we identified for municipal dischargers, as shown in the following chapters.

We discussed our work with the EPA's internal audit group, reviewed relevant internal audit reports, and reached agreement on any followup action required in connection with our findings. According to an EPA internal audit official, only a very small portion of the group's work is related to program results-type reviews and no work has been done on the significance of WQS violations.

We reviewed the steps leading to AWT because AWT is so costly. According to EPA, about $10 billion will be needed by the year 2000 for additional treatment at some facilities. WQS may determine the need for treatment beyond secondary.

During the review we were assisted by Dr. Donald T. Lauria, Professor of Water Resources Engineering at the University of North Carolina, and by Mr. Jerome Horowitz, private consultant on water quality and pollution control. We reviewed water quality studies by groups such as the National Academy of Sciences and the National Academy of Engineers, EPA's Environmental Research Laboratory in Duluth, Minnesota, the American Fisheries Society and other similar research oriented organizations. We also discussed water quality matters with individuals recognized as being experts in such fields as water quality and mathematical modeling.

To demonstrate that WQS may not be applicable in all instances, we drew from studies used by EPA and the National Academy of Sciences in establishing the basis for such standards. We also provide comments from various officials and experts that support this position.

CHAPTER 2

MANY WATER QUALITY STANDARD

VIOLATIONS MAY NOT BE SIGNIFICANT

Violation of a WQS does not necessarily mean that significant environmental damage has been done. WQS violations vary widely in their ecological 1/ effects; some violations may have virtually no ecological impact. Violations also vary greatly in their social significance, depending on the value of the water body and its aquatic life to society.

The following discussion is not intended to show that WQS are erroneous, but that much uncertainty exists in the WQS-setting process.

VIOLATIONS MAY BE ECOLOGICALLY INSIGNIFICANT

The ecological significance of violating WQS is neither precise nor certain. Scientific information on how all species respond to different levels of pollution is simply not available. WQS violations which may be dangerous to some types of aquatic life may cause little damage to others. In fact, standards are generally designed to protect the more sensitive (and presumably more valuable) species, which may be a small fraction of the total aquatic life in a body of water. The significance of a violation also varies with its frequency, duration, intensity, and extent.

The scientific basis for some standards is questionable 2/

The biological significance of a WQS violation depends, in part, on whether scientific evidence shows that a certain

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1/The interrelationship of aquatic organisms and their environments.

2/A large portion of the scientific information cited throughout this chapter was obtained from EPA's "Quality Criteria for Water - 1976" and "Water Quality Criteria - 1972," prepared by the National Academy of Sciences for EPA.

level of water quality is needed to protect aquatic life. Unfortunately, not enough scientific knowledge is available to eliminate uncertainty in setting standards. EPA describes its criteria as "scientific judgments" based on limited experimental investigation and has warned that they should be used with considerable judgment.

The data to quantify the fishable/swimmable goal in a scientifically sound manner is still rather limited. The ideal data base for criteria development would include information on a large percentage of aquatic species and would show the response to a range of concentrations for various factors (DO, ammonia, pH, phosphorus) over a long period. But this data is not available. Investigators are only now beginning to derive such data for a few water constituents. The effects of any substance on more than a few of the vast number of aquatic organisms have not been investigated.

The opinions of competent scientists conflict on the degree to which various characteristics--even common ones--affect aquatic life. Test results vary widely for the same fish species, similar conditions, and the same toxic material. The Director of the Illinois Environmental Protection Agency has pointed out that the fishable/swimmable goal is a biological objective, but the criteria are physical and chemical substitutes. He stated: "To allege that we have sufficient knowledge to make this chemical to biological relationship with great specificity is, in my judgment, wrong."

We reviewed a number of characteristics affecting the water quality EPA says is needed for fishing/swimming. In particular, we looked at DO and ammonia because these characteristics are very important to fish.

DO criterion lacks firm scientific basis

DO concentrations are important in gaging water quality. In fact, DO has been called "probably the single most important water quality parameter in fisheries management." Therefore, a complete and thorough scientific basis for the recommended DO criterion would be expected, but cannot be found. Scientists disagree considerably on how much DO fish need. Most species of adult fish (including brook trout) can survive at very low DO concentrations. Minimum tolerable levels reported by some investigators are several times greater than those reported by others for the same fish species, tested at about the same temperatures. Many apparent contradictions also exist about the effects of DO levels on hatching of fish eggs and growth of many young fish.

We believe EPA lacked sufficient data to base the DO criterion on the needs of specific fish species. EPA, however, based its recommended DO criterion on concentrations known to permit "the maintenance and well-being of the population as a whole." The DO levels for maintaining a good, naturally occurring fish population also lack clear-cut scientific support. For example, a DO concentration of 4 milligrams per liter (mg/l), 1/ and perhaps much lower, will support a varied fish population, including valuable food and game species; but one researcher found the greatest variety of species at 9 mg/l. Lowering the DO to even 5 or 6 mg/l can kill some fish or stunt their growth. In fact, researchers have pointed out that the rates of growth and embryonic development and the activity of fish can be limited by the supply of oxygen even when DO concentrations are near or above saturation levels.

According to "Water Quality Criteria - 1972" (prepared by the National Academy of Sciences and the National Academy of Engineering):

> "Any reduction of dissolved oxygen can reduce the efficiency of oxygen uptake by aquatic animals and hence reduce their ability to meet demands of their environment. There is evidently no concentration level or percentage of saturation to which the oxygen content of natural waters can be reduced without causing or risking some adverse effects on the reproduction, growth, and consequently the production of fishes inhabiting those waters * * *" Any reduction in oxygen may be harmful by affecting fish production and the potential yield of a fishery."

EPA headquarters has recommended a minimum DO level of 5 mg/l (not a daily average). Because DO levels may fluctuate during a 24-hour period, achieving a minimum of 5 mg/l requires a higher level of DO (for example, 6 mg/l) as a daily average. However, at least two EPA regions have recommended minimums of 4 mg/l and daily averages of 5 mg/l.

The choice of a DO criterion has a significant economic impact. For example, Ohio officials told us that raising the average DO from 5 to 6 mg/l will cost about $76 million per year in Ohio alone. Ohio officials believe an average of 5 mg/l DO at the 7-day, 10-year low flow (occurring only

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1/Equivalent to parts per million (assuming unit density).

0.2 percent of the time) is more than adequate to protect Ohio's aquatic life.

<u>Ammonia criteria also have inadequate scientific basis</u>

Ammonia is another water quality factor for which the EPA-recommended criterion lacks a clear-cut scientific basis. For example:

--Extensive research on ammonia toxicity has shown many different results for different species under different test conditions, and some research results are contradictory. A committee of the American Fisheries Society concluded that EPA has not shown that its recommended criterion is appropriate for most freshwater fish. The State of Ohio has determined that a higher level could be used for warmwater species, and the State of Iowa has set different criteria for warmwater and coldwater species and for winter and summer conditions.

--Various researchers reported toxic levels ranging from 0.2 to 2 mg/l of un-ionized ammonia. On the other hand, EPA recommended a criterion of 0.02 mg/l to protect life forms for which no research was available. EPA's "Quality Criteria for Water-1976" provided no scientific basis for this safety factor, and the Director of EPA's Environmental Research Laboratory (Duluth, Minn.) recently conceded that EPA's recommended criterion appears to be too conservative for many streams.

The ammonia criterion selected by a State can have quite an impact on sewage treatment costs. AWT may reduce the ammonia in sewage to meet the WQS for ammonia. However, much of this treatment may not be useful because violating the standards may have no biological significance.

<u>Other important factors have little scientific foundation</u>

Another important water quality characteristic is pH (a measure of acidity), which affects the toxicity of many compounds. Again, we found no clear-cut scientific support for the EPA-recommended criteria for freshwater fish. According to the European Inland Fisheries Advisory Commission, there is no definite pH range within which a fishery is unharmed and outside which it is damaged; rather, it deteriorates gradually as pH values move further away from the normal range. At some levels of pH, various species of aquatic life thrive but others do poorly.

Bacteria levels are considered important for swimmable waters, and EPA has recommended levels of fecal coliform bacteria that should not be exceeded for swimmable waters. However, epidemiological studies have not determined that the bacterial levels in bathing waters relate to illness in swimmers. In fact, a cause-and-effect relationship is questionable at the bacterial levels typically found in U.S. waters today.

EPA has recommended other specific criteria to protect waters used for domestic water supply from pollutant levels that could cause public health problems. Like other criteria recommended by EPA, these have limited scientific support and are very conservative. For example:

--EPA set a criterion of 50 ug/l (micrograms per liter) for total chromium, although symptoms of excessive dietary intake are unknown, and a family is known to have drunk water for 3 years at a level of 450 ug/l (9 times EPA's recommended criterion) without known ill effects.

--EPA recommended a mercury criterion of 2 ug/l. "Water Quality Criteria-1972" also recommended this criterion, in the belief that mercury intake from all sources should be limited to 30 ug/day. The lowest continuous exposure associated with toxic symptoms, however, is approximately 300 ug/day of the most toxic form of mercury for a person of average weight (154 pounds).

The quality criteria for domestic water supplies are made even more conservative by assuming that the drinking water treatment process will remove none of the toxics for which the criteria are set. The degree to which toxic substances are removed by the drinking water treatment process (sedimentation, filtration, and chlorination) is generally not known. Some toxic substances, however, are known to be associated with suspended solids in raw surface waters and may be removed, at least to some extent, by treatment.

EPA officials informed us that EPA is making some of its criteria less conservative. For example, EPA has published drafts of criteria for 65 toxic pollutants. The methodology used to derive aquatic life criteria departs from the traditional practice of protecting the most sensitive species tested and instead introduces statistical techniques designed to be 95 percent protective. EPA officials also informed us that EPA intends to update all its criteria periodically to keep them scientifically current.

General standards do not fit all waters at all times of year

The biological significance of a WQS violation depends on how the general criteria fit the specific water body and the time of year when the violation occurs. Five basic factors may make a violation relatively unimportant in a specific body of water at a specific time of year.

Local aquatic species

The general standard may not fit the local aquatic community. Aquatic species vary greatly in sensitivity, and EPA-recommended criteria are set to protect the more sensitive species (for example, trout). If these species are not present in a body of water, a WQS violation may be without biological significance. In waters across the United States, some 500 native freshwater fish dwell. Each tends to live in a certain environment. For example, sturgeon are not found in a trout stream. Habitat is affected by more than just water quality. These environments are named according to the species that inhabit them:

--The trout stream is usually in forested mountains near the source. The water is swift and clear; it cascades and tumbles; and the bottom is stoney. The stream is almost completely shaded by trees, which keeps its waters cold enough for trout to survive.

--The bass stream lies downhill from the trout fishery. Its water is somewhat slower and warmer; more than three-quarters of the water is in sunlight. Some 30 percent of the surface is made up of calm eddies and pools. Less oxygen is dissolved in this water, but a greater variety of fish have adapted to it.

--The minnow stream is too small and warm to support trout and too small to support significant numbers of smallmouth bass or other warmwater game fish. The stream supports primarily forage fish (such as darters, minnows, and shiners).

--The sturgeon river has waters which are deep, warm, and slower than the trout and bass streams. Most of the river is in sunlight, and the warmth supports much more life than the bass stream. Sturgeon, catfish, carp, and rock bass live in these rivers.

--The lake trout lake is dominated by lake trout and whitefish. Older lakes and those farther south, however, may feature rough fish such as perch, bullheads, and carp.

Natural levels of local pollutants

Local violations of general WQS may result from natural sources. Levels of pollutants from these sources vary substantially from one water body to the next, which makes it difficult to achieve standards consistently. Although natural levels of pollutants may have significant adverse effects, including fishkills, they may be part of the normal ecology and not significant enough to warrant corrective action.

Some States hedge their standards to ignore violations from natural causes. According to Washington and Kansas officials, WQS violations are, in effect, ignored when the cause is believed to be natural. In many States, WQS are widely violated by natural conditions without much regard. Extreme natural conditions affect the more common water quality characteristics. For example:

--Some waters have naturally low oxygen content--some so low that fish cannot live in them during a large part of the year. However, tidal marshes in Louisiana have low DO throughout the summer but support a thriving fishery.

--Natural stream erosion and snow melt during periods of high flow cause violations of criteria for suspended solids and turbidity (muddiness).

--Many temperature standards are violated by common natural conditions (e.g., summer heat).

Toxicity-reducing characteristics of local water

The toxicity of a pollutant may be so greatly reduced by the characteristics of local waters that a WQS violation has no significant biological effect. For example:

--Heavy metals such as cadmium, lead, copper, or zinc may be considerably less toxic in hard water. Cyanide and hydrogen sulfide are less toxic in waters with high pH.

--Various instream conditions may reduce ammonia's toxicity.

Form of the pollutant

The form in which a pollutant occurs may have a significant biological impact. For example:

--According to an EPA official, criteria for heavy metals are based on laboratory tests using the pure form of the metal. He said that in actual streams these metals generally are present in less potent forms. According to a sanitary engineer, because only soluble metals are toxic, many streams have good fish stocks in spite of violating standards for total forms of various metals.

--Certain forms of cyanide are much less toxic than others. EPA recommended a criterion of 5 ug/l total cyanide to protect aquatic life and wildlife. But, according to an environmental consultant, only free cyanide has been shown to be toxic to fish at concentrations less than 1,000 ug/l. The National Academy of Sciences' "Water Quality Criteria-1972" recommended 5 ug/l free (not total) cyanide. On July 25, 1979, EPA proposed to replace its recommended total cyanide criterion with one stated in terms of free cyanide. According to EPA officials, however, relatively small amounts of complexed cyanide can quickly generate enough free cyanide to violate this criterion if the water in question is moderately clear and is exposed to sunlight.

--Phenols are a large class of compounds. Many phenols are toxic, and many of them give fish an unpleasant taste. Except in the case of chlorophenols, a committee of the American Fisheries Society found no justification for the EPA recommendation of 1 ug/l. Phenol concentrations 10 to 25 times greater than EPA's criterion commonly occur in Iowa's waters and have caused no problems. On July 25, 1979, EPA proposed changing the phenol criterion for protection of freshwater aquatic life to 600 ug/l as a 24-hour average and 3,400 ug/l as a maximum never to be exceeded.

--Turbidity criteria are often violated. Although turbidity reflects the amount of sediment being carried in the water, EPA officials told us that only a rough relationship exists between turbidity and the damage to fish habitat and spawning done by sedimentation. They said that the damage depends on the size of the sediment particles in a particular stream at a particular time.

--Fecal coliform (bacteria) standards set to protect swimming waters are also frequently violated. However, the violation is significant only if bacteria that cause disease in humans are present. An EPA official told us that many violations--perhaps most--are caused by nonpoint source pollution, much of which is from nonhuman sources (for example, drainage from pasture lands). He told us there is little danger of disease transmission from such a nonhuman source.

According to EPA officials, many water quality characteristics influence a constituent's toxicity, but sufficient data was available to include only the effects of hardness on metals toxicity. While other characteristics (for example, pH) also affect toxicity, not enough quantitative data was available to include them in developing water quality criteria.

EPA officials further added that the form of a metal does affect toxicity; insoluble forms usually, but not always, are less toxic than soluble forms. The practical difficulty is that metals can shuttle back and forth between soluble and insoluble forms as the water chemistry changes. EPA argues that it may be practically impossible to predict changes in water chemistry and shifts in metal solubility. Therefore, EPA has chosen to express water quality criteria in terms of total metal.

Time of year

The time of year when a WQS violation occurs may affect the violation's significance. According to numerous experts, violations of bacterial standards set for swimming waters usually have no significance during the cold winter months.

Water quality criteria are generally set to protect the most sensitive life stages of aquatic organisms, such as spawning and migration. When such activities are not occurring, or in streams stocked with fish propagated elsewhere, violations of such standards may not be biologically significant.

Some violations may not cause problems

The biological significance of a WQS violation depends on the nature of the violation itself--its intensity, duration, frequency, and extent. In other words, a brief, occasional, and slight violation in a small portion of a water body is generally not as serious as a sudden, intense violation over a major part of the water body. A particular violation, therefore, may have no significant biological effect.

The longer a potentially lethal concentration lasts, the more fish may die as a result. Even when the concentration is not potentially lethal, duration and frequency are important in determining biological significance.

EPA-recommended water quality criteria are set at levels to protect aquatic populations from long-term effects on reproduction, growth, and level of activity. These criteria presume continuous exposure. Higher concentrations may be reached occasionally, but briefly, for many pollutants without causing damage. For example, changes in instream ammonia levels, as well as movement of fish into and out of ammonia-enriched waters, affect the exposure time and consequently the effects on aquatic life. According to an environmental consultant, large numbers of small, sensitive fish have been known to concentrate just downstream from a fish hatchery where the ammonia level was more than 11 times higher than the EPA-recommended criterion (based on continuous exposure); further downstream, where ammonia levels were much lower, fewer fish were found.

EPA is now recognizing the importance of duration in assessing the significance of a violation. Although water quality criteria are generally regarded as limits never to be violated, no matter how briefly or slightly, EPA in May 1978 proposed the concept of a twofold criterion--an instantaneous maximum and a 24-hour average. In estimating the costs of controlling combined sewer overflows for its 1978 Needs Survey, EPA recognized that duration was important and used the following criteria for DO:

> "The minimum receiving water dissolved oxygen concentration shall not average less than 2.0 mg/l for more than 4 consecutive hours; nor shall the minimum receiving water dissolved oxygen concentration average less than 3.0 mg/l for more than 72 consecutive hours (3 days). In addition, the annual average receiving water

dissolved oxygen concentration shall be greater than 5.0 mg/l for all waters which will support warm water species and shall be greater than 6.0 mg/l for all waters which will support coLd water species."

The extent of a violation may also be an important factor in determining its biological significance. Violations in only a portion of a water body may not be highly significant. EPA's mixing zone 1/ guidance recognizes that limited areas of degradation are less significant. This guidance permits a State to allow poorer water quality (within certain concentration limits) in a limited zone near a source of pollution, as long as a zone of passage for migrating fish and other organisms is protected and certain other conditions are met.

VIOLATIONS MAY BE SOCIALLY INSIGNIFICANT

The environmental significance of WQS violations may also depend on the social significance of the water body. The social significance is determined by

--the extent to which a water body is valuable to someone for commercial or recreational purposes and

--the availability of other water bodies providing a similar use.

Some natural waters are of little value to society

The significance of violations varies with the water body's commercial or recreational usefulness to society. This usefulness depends on the degree to which a water body supports desired activities (such as fishing and swimming) and on its accessibility to those who want to use it.

Waters vary naturally in the amounts and kinds of fish they support. The population of aquatic life naturally found in one water body may be of a higher or lower value than another water body. In particular, waters differ in their ability to support game and pan fish, which are more desirable for human use.

1/A zone of initial dilution in the immediate area of a point or nonpoint source of pollution.

Many natural factors affect the kind of quality of fish supported. Some waters naturally support substantial populations of trout or bass; others support primarily forage fish such as minnows or rough fish such as carp. Some water bodies (such as salt lakes) do not support any significant fish life. Some streams are essentially dry ditches (except when it rains) and are often useless as far as aquatic life is concerned. Other intermittent streams, however, may have deep holes that can sustain fish during long droughts. Some streams are at times fully diverted for irrigation; others, according to a Washington State official, are no more than artificial channels for returning irrigation waters. Even high-quality streams may be of limited value for fishing; Washington State officials told us that many high mountain streams are virtually without resident fisheries and that many naturally go dry during part of the summer.

Waters also vary in attractiveness to swimmers. Some streams are simply too dangerous for swimming because of waterfalls, rapids, and dangerous currents. Others discourage swimming because they are shallow, muddy, or cold. Many streams dry up or nearly dry up in summer. New York alone has over 3,000 intermittent streams that generally cannot support swimming in the summer. Streams composed of treated sewage (no matter how well treated) may discourage swimming for esthetic reasons despite their pleasant appearance and acceptably low bacterial concentrations.

The usefulness of a water body for swimming or fishing also depends on its accessibility. Social usefulness and the significance of WQS violations are reduced by inaccessibility. Some streams are almost inaccessible because of canyons, steep slopes, or other physical barriers. Others have no public access and some can be reached only by a few hikers. Many are in low-population areas and receive little use. Kansas WQS recognize the significance of accessibility. Kansas has strict limits on coliform bacteria only where public swimming facilities are maintained.

Significance of violations is reduced if other high-quality waters are available

The significance of a violation also varies with the degree to which the water use in question is readily available in other nearby bodies of water. A violation that limits the use of a specific water body for swimming or fishing has less significance when it is located near other swimming and fishing waters. In the State of Washington, for example, State officials told us of a lake maintained by wastewater flows. They said that nutrients in the sewage promoted algae and weeds, which interfered with swimming. However, the lake is an excellent fishery. According to these officials, to make the water swimmable would require AWT (or land disposal, which would be more cost effective but would dry up the lake). They said that because a nearby lake is available for swimming, this lake is maintained solely for fishing.

CHAPTER 3

PREDICTING WATER QUALITY VIOLATIONS BY USING MATHEMATICAL MODELS IS VERY UNCERTAIN

AWT is usually justified on the basis of predictions that without it WQS will be violated, at least during summer droughts. These predictions, which are based on mathematical modeling, may be made in the absence of existing violations or before secondary treatment is installed. We found, however, that current water quality modeling is often unreliable--too unreliable to be used as the only justification for constructing treatment facilities beyond secondary.

Mathematical modeling is very important for properly predicting or estimating the level of treatment needed. Modeling may be the only way to estimate the level of treatment needed when there are no discharges from sewage plants in the area or when determining the specific treatment level needed beyond secondary. We believe modeling has a place in making cost-effective environmental decisions. However, our review indicates that substantial improvement is needed.

Many of nature's processes are still not known well enough to justify AWT through modeling. Mathematical models that simulate DO levels in water are often difficult to prepare. Often extensive information is needed and a great deal of analysis is necessary to simulate a stream's complex natural processes.

Many streams cannot be modeled; some, because essential information is not available. However, EPA believes that:

> "While models currently in use do not attempt to represent each and every process within an aquatic system, those major processes that are significant and relevant to the [AWT] decision are adequately represented by those models."

We observed that modeling is poorly done in many instances. Principal problems include

--neglecting or not fully understanding the impact of nonpoint sources on water quality,

--using unreliable or inadequate water quality data, and

--failing to determine the model's predictive reliability.

Some decisionmakers responsible for funding projects for treatment beyond secondary seem to know that modeling results are often imprecise. In some situations where modeling results are suspected of being imprecise, decisions are made to (1) construct less sophisticated facilities than a model may specify, (2) phase in construction for the AWT portions of new sewage treatment plants, and (3) require stream surveys to assure reliable water quality information.

MODELING IS A COMPLICATED PROCESS

The Clean Water Act requires that sewage treatment plants must provide at least secondary treatment. In many instances modeling is used to predict how much additional treatment is needed beyond secondary. Modeling predicts the amount of pollution that can be allowed without violating WQS. Modeling involves the calculation of total maximum daily loads of pollutants. The act explicitly requires a margin of safety in the calculation of total maximum daily loads to account for any lack of knowledge about effects on water quality. These calculated loads are then distributed among the point and nonpoint sources of pollution through a process known as wasteload allocation. The allocations are translated into pollution control requirements through discharge permits, which set forth the effluent limits that govern the design and operation of treatment plants.

Mathematical models aid decisionmakers in ensuring that pollutant discharges will not violate WQS. EPA estimated that $10 million is spent annually on developing mathematical models and special intensive stream surveys to obtain the data required for modeling.

We discussed modeling problems with water quality experts at the local, State, and Federal levels and reviewed literature on mathematical modeling. We asked a member of EPA's AWT Task Force 1/ to provide additional modeling

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1/This task force is responsible for reviewing all projects with incremental costs for treatment beyond secondary in excess of $1 million. (See ch. 5.)

information on 11 projects costing $202.1 million which have incremental costs for treatment above secondary of $46.1 million. (See app. I.) EPA shares our belief that these projects reflect the quality of modeling work currently used to justify AWT. EPA agrees that models have been misused in the development of wasteload allocations and effluent limitations. However, it says that most of the shortcomings have been identified and remedial actions are being taken.

DO models for streams are among the simplest mathematical models for estimating maximum daily pollution loads. The most common models deal with only the DO component of water quality. These models evaluate a stream's DO levels and the impact of various levels of pollutant discharges on future DO levels. According to EPA officials, DO models have been researched since the 1920s and are the most reliable type of model. We concentrated our review on stream models of DO rather than on models dealing with DO in lakes, reservoirs, and estuaries, which are much more complex. Although it is recognized that DO is just one component of water quality, other components (such as toxic substances and nutrients) are usually ignored in the most common models.

Models currently in use vary from simple "desk-top" types to highly complex ones requiring a large computer to perform the calculations. Simple or complex, all the models for DO serve one common purpose--to predict whether supplies of DO will be adequate during drought conditions once the treatment plants are built.

An adequate supply of DO is important for two reasons:

--Aquatic organisms must utilize oxygen that has been dissolved in the water. Wherever it is important to protect a stream's fishery, it is also important to protect the fishery's oxygen supply.

--When waters lose all oxygen they often smell foul and become septic. To protect the public, AWT must ensure that streams never lose all DO.

Modelers must consider major factors that are hard to determine

DO models keep track of a stream's oxygen supplies like an accountant; they add the DO "income" and subtract the DO "expenditures." Streams obtain oxygen from three major sources:

--From oxygen already present in the water from other sources.

--From the atmosphere by a process called atmospheric reaeration. Water tumbling over rocks picks up much more oxygen from the atmosphere than water lying in deep, still pools. When ice covers the water in a solid sheet, air is blocked off and generally the water does not get oxygen from the atmosphere.

--From algae and other aquatic plants by a process called biological reaeration. In sunlight plants produce oxygen and add it to the water. At night the plants breathe oxygen, thereby removing it from the water.

Streams lose oxygen in three major ways:

--By oxidation of materials carried in the water. As these materials decompose, they withdraw oxygen from the water. Most models distinguish between two kinds of oxidative decomposition: carbonaceous 1/ oxygen demand and nitrogenous 2/ oxygen demand.

--By decomposing muck in the streambed, a process called benthic or sediment oxygen demand.

--By nighttime loss of oxygen to plants living in the water.

These six broad classes of oxygen income and expenditure are not fixed constants; they are highly variable rates. Like some kinds of rates, they are a function of time. When the oxygen income rate is fast and the oxygen expenditure rate is slow, the stream will soon have a high net oxygen balance, even if its starting balance was zero. Conversely, when a stream expends oxygen more rapidly than its oxygen income allows, it will eventually have a small net oxygen balance. The net balance depends on how high the rates are and how long they last. A short burst of high expenditure may do little harm to the net oxygen balance, but a long spell of low

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1/Readily oxidizable organic matter that is effectively removed by secondary treatment.

2/Organic matter that is difficult to oxidize and is removed by the AWT process of nitrification.

expenditure may use up all the oxygen if the income is low. Because the factors affecting DO levels in water are hard to determine, the precision of a model depends to a large extent on how well these factors are determined.

Biochemical oxygen demand and ammonia measurements require painstaking analysis

DO models require projections or data about biochemical oxygen demand (BOD) and ammonia discharges, two very important factors in oxygen consumption. BOD and ammonia measurements allow the computation of the ultimate oxygen demand. These are not easy measurements to make and require painstaking effort.

One common measure of the amount of oxygen-demanding substances in a river is biochemical oxygen demand. When BOD is carefully measured, analysts keep track of how much DO is lost from the water day by day, usually for 5 days; if necessary, they keep track for longer periods, such as 30 days.

Careful workers take pains to specify the kind of BOD: the 1-day BOD (the amount of DO consumed during 1 day), the 5-day BOD, the 20-day BOD, and so forth. BOD also depends on temperature; at higher temperatures BOD is generally higher, and at lower temperatures it is generally lower.

Temperature and time are two of the most important factors affecting BOD, but others may also be important. For example, many kinds of metals dramatically lower BOD; tiny traces of copper may cut the BOD in half. Whenever something is done to reduce metal concentrations in a stream, BOD is likely to increase sharply. Most laboratories measure BOD at 20° C for 5 days, often diluting the samples with distilled water (rather than with river water, which may contain trace metals and other oxidation inhibitors). Some laboratories add bacteria to BOD samples; others do not. Each of these procedures may give a different value for BOD, which may cause considerable error or uncertainty when the values are used in developing mathematical models.

Ammonia may also reduce oxygen in a stream. When water contains oxygen, ammonia, and certain kinds of bacteria, the ammonia is oxidized. As ammonia is oxidized, it removes oxygen from the water, thereby lowering the DO. Shallow streams tumbling over a rocky streambed generally lose ammonia quickly, but deep, sluggish streams generally lose it very slowly.

Modelers must decide how to deal with ammonia oxidation throughout a stream. Wherever the stream is shallow and rocky, the modeler may be justified in selecting a high oxidation rate. Where the stream is deep and sluggish, the modeler may select a rate near zero. Because the physical characteristics of a stream vary, the oxidation rate should also vary to predict DO consumption accurately. Without detailed analyses of ammonia and its impact on DO throughout the stream, the modeler cannot vary the rate and therefore has to guess what is going on. For example, a U.S. Geological Survey (USGS) representative said that ammonia oxidation rates for the Willamette River study changed from place to place, depending on whether the water was shallow or deep. In shallow waters the ammonia oxidation rates were higher than in deeper waters.

Even when a shallow, rocky stream contains ammonia, oxygen, and the right kind of bacteria, it does not follow that all the ammonia will be oxidized. Some of the ammonia may be bound onto metal ions or clay particles, a process which removes ammonia from solution without decreasing the DO. Ammonia is also an excellent plant food. If the water is full of algae and other aquatic plants, they may remove the ammonia without decreasing DO. All these factors must be accurately accounted for and carefully measured or estimated before DO levels can be realistically modeled.

MANY WATER QUALITY PROCESSES CANNOT BE ACCURATELY MODELED

It is very difficult to model the complex natural processes found in many water bodies because so little is known about them. The legislative history of the Clean Water Act pointed out how many States were struggling to identify the complex relationships between pollutants and water use. The task is arduous. The state of the art for simulating the effects of nutrient loads does not allow precise prediction. Predicting the effect of future pollutant loads on future water quality adds to the complexity and uncertainty of model results. One EPA modeler stressed that modeling aquatic relationships is far less certain than trying to simulate physical relationships such as the trajectory of a rocket. This modeler said biological relationships such as those in a stream are not precisely known now and may never be, regardless of the amount of effort put into modeling.

The modeler tries to estimate what will happen to water quality if some variables are changed, but some problems can prevent the estimates from being accurate. These problems are that:

--Little is known about the complex natural processes of water bodies.

--In many cases existing methods for estimating stream reaeration are not applied properly.

--Water quality data is frequently subject to measurement errors or is not available.

EPA agrees that nutrient modeling is still highly uncertain and that it is extremely difficult to develop a sound basis for selecting AWT processes for removing nitrogen and phosphorus. However, EPA officials believe that despite the uncertainties identified in this report, the state-of-the-art of DO modeling is sufficiently developed for decisionmakers to use in determining needed levels of treatment.

Methods for estimating stream reaeration and oxygen production are subject to substantial variation

The rate of transfer of oxygen into water from the atmosphere (reaeration) and from algae and other aquatic plants (photosynthesis) is very difficult to measure. The reaeration rate is one of the most important factors in DO models because it determines the oxygen income of the stream. However, many methods of estimating reaeration give substantially different results.

Many kinds of equations for estimating reaeration are in widespread use. USGS is now preparing an analysis of these equations because several studies comparing the various methods showed big differences. USGS applied six of the most respected predictive equations to a stream that had been carefully measured and found the following:

--Results from the six equations for any given set of hydrologic conditions differed substantially. Differences of 1,000 percent or more were not uncommon.

--For any given data set, the relationships between streamflow and estimated rates of reaeration may be quite different. Some estimates showed that reaeration increased with the rate of flow, but others showed that it decreased.

--No one method consistently gave results above (or below) those of another method.

Wisconsin Department of Natural Resources staff performed a similar analysis to help select the best reaeration equations. The staff measured reaeration rates using gas tracers, then compared the measurements with estimated reaeration rates for selected streams using 20 different equations. These comparisons emphasized the problems inherent in estimating reaeration. The average error rate for the five best estimating equations ranged from 23.8 percent to 40.1 percent of measured reaeration rates. The remaining 15 equations varied in error rate from 41.6 percent to over 200 percent.

Estimating a stream's oxygen production is especially complicated when algae or other aquatic plants grow in the water. The modeler must accurately estimate how much oxygen is produced during daylight hours and how much is removed from the water at night. If the modeler assumes that the stream will be in drought, (which may occur at any season of the year), the oxygen production estimates must be recomputed for drought conditions. Further, the modeler must accurately estimate how the stream will respond to pollution control measures. These complications make it difficult for many water quality processes to be modeled accurately.

Changes in the reaeration formula may greatly affect BOD effluent limits. For example, Iowa's reaeration formula includes a gas escape coefficient, 1/ among other values. Our analysis showed that the Harlan, Iowa, effluent limits for BOD would change from 10 mg/l to 30 mg/l when the gas escape coefficient is changed from 0.048 to 0.115.

Iowa recently revised Harlan's BOD effluent limit from 10 to 30 mg/l. Treatment beyond secondary for BOD is no longer required. An Iowa representative said that a major reason for the change was an increase in the gas escape coefficient from 0.048 to 0.115. Thus, changes in the gas escape coefficient can significantly change waste treatment requirements.

1/An estimate of reareation from the atmosphere.

EPA recognizes the need for caution and judgment in the selection and use of methods for estimating reaeration rates in any given situation. According to EPA officials, steps are being taken to provide further guidance on this selection process.

In summary, it is important to accurately estimate the assimilation of oxygen into a stream. Although there are methods for accurately estimating physical reaeration, they are rarely used. Predictions of biological reareation are extremely complicated and subject to many sources of error. Poor estimates for reaeration can result in justification of excessively stringent treatment facilities.

Water quality data can be subject to measurement errors

The wide range of water sampling techniques and laboratory procedures often lead to erroneous data as a result of collection errors, faulty lab procedures, and the failure to accurately measure characteristics such as BOD. Measurement errors, especially in effluents, can invalidate even the best models.

Collection errors

Obtaining accurate water quality data requires diligence and skill. Well-trained teams must be deployed in the field to make careful measurements, collect samples for analysis in the laboratory, and develop detailed understanding of the stream. Lack of attention to detail can be disastrous. For example, wherever algae and other aquatic plants are common, the field team must make detailed DO measurements around the clock because DO during the afternoon may be well above the saturation value (called supersaturation) while DO between midnight and dawn may approach zero.

Where plant life is important in the stream being surveyed, DO values may vary from quite high in the afternoon to nearly zero after midnight. The Ohio Environmental Protection Agency reported instances where DO fluctuated within a day from over 5 mg/l to 1 or 2 mg/l. These large variations were caused by plants producing oxygen during the daytime (photosynthesis) then consuming oxygen at night (respiration). Depending on when and where the stream is surveyed, DO levels could be nearly anything. In modeling, it matters greatly whether DO levels are very high or very low.

Faulty laboratory procedures

Errors can result in a stream survey from improper laboratory procedures. Samples must be properly collected, carefully handled, and rushed to a competent analytical laboratory. Time is critical because some important tests must be made on very fresh samples. For example, BOD tests must begin quickly--any delay will cause the laboratory to miss the short-term oxygen demand. If samples for BOD analysis sit on the shelf for some time before they are analyzed, the oxygen demand may be seriously underestimated.

Wisconsin's Department of Natural Resources recently discovered errors in its wasteload allocations because nonstandard testing techniques were used for measuring long-term BOD. Papermill companies on the Fox and Wisconsin Rivers hired consultants to evaluate the State's modeling. The consultants observed that the State used rubber stoppers in the bottles used for BOD tests. The rubber allegedly absorbed some DO from the sample, thereby distorting the BOD values. Representatives from the State and the papermills could not specify the significance of the errors, but both agreed that the analysis had to be redone. Although the State redid the long-term BOD tests for the Fox and Wisconsin Rivers, we note that it did not redo the long-term BOD tests for several other rivers where treatment beyond secondary was required. EPA recently approved funding for one such facility in Walworth County, Wisconsin.

Although it is standard procedure for BOD tests to be run in bottles with glass stoppers, Wisconsin's laboratory used rubber stoppers for years without anyone noticing. Yet this seemingly insignificant detail may have had serious consequences for pollution control programs on two of Wisconsin's most important rivers. One paper industry representative said the rubber stopper controversy substantially delayed the final effluent limits for dischargers on these two rivers. EPA believes that while some may use this type of deviation from standard procedures to discredit or raise doubts about the validity of the modeling results, the magnitude of error caused by this particular mistake was probably insignificant in the overall analysis.

Inability to measure small amounts of BOD

Uncertainties in measuring small amounts of BOD can reduce the reliability of the best models. When treatment beyond secondary is at issue, effluent BOD can be very low. Paradoxically, very low BOD values are especially subject to large measurement error. For example, the Illinois Pollution Control Board noted:

> "Measurement of BOD at the 4 mg/L level may be expected to have an analytical error of 100 percent.* * *These errors are over and above those caused by improper sample collection and laboratory methods not consistent with standard procedure. It should be noted that much of the sampling and analytical work done in Illinois is by small treatment-plant operators with limited laboratory experience and frequently with outdated or poor-quality equipment."

Other water quality experts have also stated that BOD measurements are often very imprecise.

MANY MODELS ARE NOT PROPERLY APPLIED

Modelers must evaluate nonpoint source pollution, use actual data rather than assumptions, and have some type of verification study to determine the model's predictive accuracy. In many cases, the models we evaluated did not do these things. As a result, it is difficult for decision-makers to know how much to rely on the modeling results.

The impact of nonpoint source pollution is often overlooked

Nonpoint source pollution can contribute so much waste that water quality cannot be improved significantly, even with high levels of sewage treatment. Many of the models we evaluated did not separately consider pollution from non-point sources, which makes it impossible to determine if proposed sewage treatment plants are more sophisticated than necessary. In addition, reducing nonpoint source pollution may allow water quality goals to be achieved without AWT.

EPA and the Council on Environmental Quality agree that nonpoint source pollution is too serious to be neglected. In fact, EPA's May 1976 report to the Congress pointed out that 37 of 45 States concluded that some State waters will not meet 1983 water quality goals because of nonpoint source pollution. The Council on Environmental Quality noted in its 1976 report:

> "In many cases, the substantial cost involved in going from the 1977 to the 1983 standards may not noticeably improve water quality because of the small amount of pollution removed from regulated

point sources compared with pollutant loadings from natural sources, unregulated agricultural activities, urban stormwater runoff, and other nonpoint sources."

The Southeastern Wisconsin Regional Planning Commission estimated that by the year 2000 only 240 miles of streams and 18 lakes in its area could meet the fishable/swimmable goal by controlling point sources. Nonpoint source controls, on the other hand, would enable 720 stream-miles and 90 lakes to meet the goal. With both point and nonpoint controls in place, 1,054 stream-miles and 94 lakes could meet the goal. Situations like this point out the need for comprehensive information to decide which mix of solutions is most cost effective.

Many of the models we reviewed did not separately consider nonpoint sources. Modelers we spoke with generally justified this failure by saying they model only low flows (summer droughts) when nonpoint source waste is not expected to contribute to the stream's problems. Concentrating on low flows can mean that modelers do not consider all conditions under which water uses may be adversely affected. Further, nonpoint source pollution can still occur during low flows. For example, the USGS study of the Willamette River in Oregon estimated that nonpoint sources during summer stream surveys represented about 45 percent of the long-term BOD contributed to the river. This Willamette study is considered one of the best intensive stream surveys ever done.

An EPA task force representative informed us that only 1 of the 11 models the task force reviewed, which we requested information on, separately considered nonpoint source pollution.

EPA officials contend that in most cases nonpoint sources are not a factor in determining the need for advanced treatment. However, EPA recognizes that nonpoint sources of pollution are a factor in some situations and is considering regulations that will require modelers to evaluate the impacts of nonpoint sources on water quality. EPA now has guidance stating that non-weather-related, nonpoint source wastes (such as from leachates; benthic oxygen demands; and background DO, BOD, and ammonia) should be considered even in low-flow situations.

Inadequate data is used

Many modelers use inadequate data in constructing their models. Inadequate data results when estimates or assumptions vary from actual stream conditions, when stream surveys are not conducted during the most stressful period, when sewage flows are not matched to low flows, and when actual streamflow data is not used.

Estimates or assumptions sometimes vary from actual stream data

Modelers may use guesses or assumptions taken from water quality research studies in the absence of actual water quality data. Using guesses or assumptions rather than actual data weakens the model's predictive accuracy. We believe that assumptions should be used sparingly for high-cost projects and only when they are clearly identified so that policymakers may understand and evaluate the risks of substituting assumptions for measured values.

Stream surveys reduce the modeler's need for estimates or assumptions. Measurements or calculations may be made for such facts as (1) daily variations in DO, (2) BOD rate curves showing DO consumption over time, (3) trace minerals, (4) toxics, (5) ammonia, (6) streamflows and velocities, (7) water temperatures, (8) point and nonpoint sources, and (9) consumption and production of oxygen by sludge deposits and plants.

We reviewed several modeling studies and observed that assumptions were used extensively. Modelers defended their use of assumptions by saying they lacked the resources for comprehensive studies necessary to develop actual data. The number of possible assumptions or combinations of assumptions is tremendous. For example:

--Reaeration rates were obtained from textbooks rather than actual instream data.

--Carbonaceous and nitrogenous BOD rates were assumed to be constant for the entire stream rather than measured throughout the stream's length.

--Ice cover, where applicable, was not considered, although it affects the reaeration rate.

--Low flows were assumed to occur only during summer, although winter flows may have been even lower.

--Oxygen demand from sediment deposits was ignored or assumed to be constant throughout the stream.

--Long-term BOD was not measured. Instead, it was derived by applying an arbitrary multiplier to the 5-day BOD.

Iowa's modelers used many assumptions in lieu of actual data from comprehensive stream surveys. An Iowa representative explained that these assumptions had to be used because comprehensive surveys were not conducted.

Accurate BOD values are important because they are used for predicting consumption of DO. Models require information on long-term (ultimate) BOD. However, such measurements are time consuming and require large incubators in the laboratory; as a result, they are usually predicted from the 5-day BOD. The relationship between long-term and 5-day BOD varies from one waste to another and one stream to another. In Wisconsin, it was shown in one case that the ratio of long-term to 5-day BOD varied from 1.2 to 6.3. It was also shown that there is no fixed time interval for reliably defining long-term BOD. Yet, many modelers assume that long-term BOD is always equal to 1.5 times the 5-day BOD. For example, the DO model for Rock Creek near Sulphur Springs, Texas, explicitly sets the ratio of long-term to 5-day BOD at 1.5. The accompanying report, however, shows that no one even attempted to measure the relationship between long- and short-term BOD. We found similar examples at Sac City, Iowa, and Meriden, Connecticut.

Using assumed values or guesses reduces the model's accuracy for predicting the effect of various treatment levels on water quality. Consequently, a solid basis for the model's recommending costly pollution control measures is reduced as more and more assumed values or guesses are introduced into the modeling process.

EPA agrees that models making extensive use of estimates and assumed values should not be the sole basis for recommending costly pollution control measures. However, EPA maintains that not every wasteload allocation has to be developed through a model that is calibrated and verified on field data. EPA believes that in an overwhelming majority of cases, simplified models based on limited hydrologic and water quality data can yield sufficiently reliable results on required levels of treatment.

Comprehensive stream surveys are not conducted or are taken at the wrong time

Comprehensive stream surveys are generally designed to measure all water quality characteristics which significantly influence water quality under stressful conditions. Modelers often do not use comprehensive stream surveys, and when they do, they often do not take measurements when water quality conditions are at their worst. When modelers do not have essential information on water quality, or obtain information when conditions are not at their worst, model reliability may be reduced. Water quality modelers we spoke with said they had to use assumptions and estimates because limited funds reduced the number and quality of stream surveys.

EPA believes that regulatory agencies do schedule comprehensive surveys during seasons when low flows generally occur; however, it is likely in most cases that sampling is done at flows higher than the 7-day, 10-year low flow. EPA believes that sampling at flows somewhat higher than the 7-day, 10-year low flow in no way detracts from the reliability of the data, as long as the sampling period is preceded by a period of no rainfall so that instream flows are steady. EPA officials also pointed out that it is impossible to predict exactly when the 7-day, 10-year low flow will occur and therefore it is impractical to attempt sampling only at the 7-day, 10-year low flow.

We observed a number of situations where stream surveys may not have been comprehensive enough to identify water quality conditions for all portions of the stream during the most critical periods. For example:

--Raw sewage discharges at Rochester, New Hampshire, made it difficult to project future water quality and justify treatment beyond secondary. Raw sewage masks what water quality would have been under secondary treatment. EPA disagrees that this factor precludes accurate determination of future water quality conditions with secondary treatment.

--Stream flows substantially above the low flows distort stream velocities and DO conditions expected during droughts. Stream surveys for Meriden, Connecticut, were taken when the river flow was over 70 cubic feet per second, or 3-1/2 times the low flow of 20 cubic feet per second. EPA believes that sampling at this time did not induce an error or inaccuracy of a magnitude that would invalidate the modeling results.

--Salmon spawning is proposed as a beneficial use for the Rochester, New Hampshire, receiving stream. However, stream surveys were not conducted during the fall and spring spawning seasons when the river is at a higher flow.

--Many surveys are conducted only during regular working hours even though nighttime DO fluctuations may be significant. As a result, the DO readings used for modeling may not be representative of nighttime conditions.

The Iowa Department of Environment Quality is currently considering requiring stream surveys for all treatment plants beyond secondary. An April 24, 1979, memorandum to the Iowa Water Quality Commission proposed:

"The justification for any advanced treatment levels for each facility would be supplemented by extensive stream surveys at low stream flow conditions and the detailed evaluation of stream aquatic resources."

We believe that comprehensive stream surveys should be made for summer and winter droughts and during high flows if WQS may be violated then; the surveys should include nighttime DO measurements and time-of-travel measurements in the stream. However, information supplied by an EPA task force member for our 11 sample projects indicates such measurements are not made consistently. For example, of the 11 projects:

--Only three had stream surveys for both summer and winter low-flow conditions; the other eight were only for summer conditions. No models considered high-flow conditions even though in four instances WQS were violated during high flows.

--Seven models did not have DO measurements between midnight and sunrise, which we believe is essential for accurate DO accounting.

--Five models were not based on actual, measured time of travel or stream velocity.

A task force representative said that lack of actual data forced the use of assumptions and estimates. We believe the use of assumptions and estimates increases the chance of error; either the treatment plant will be overly stringent or WQS will not be met. (See app. I for details on specific projects.)

We discussed the issue of intensive stream surveys with EPA officials. One official agreed that use of assumptions and estimates in models reduces their reliability. This official said EPA is considering requiring intensive stream surveys as justification for treatment beyond secondary. Some EPA officials informed us that our concept of stream surveys is idealistic and unnecessary. They contend that the surveys and models may cost more than an AWT project for a small community. EPA further maintains that regulatory agencies generally identify the critical period in a stream on the basis of monitoring and hydrologic information. EPA sees no need to require intensive surveys during winter and summer low flows, claiming that critical conditions usually occur in late summer or early fall and the ice-cover situations are more the exception than the rule. EPA also believes that intensive surveys are not necessary in all instances. It claims that many generalizations can be drawn from existing water quality analyses and that field surveys should only be undertaken to resolve uncertainties remaining after sensitivity analyses have been performed. According to EPA officials, a preliminary model can quite often be developed on the basis of limited field data.

Treatment plant discharges are sometimes overstated

Overstating the amounts of wastewater and pollutants discharged from sewage treatment plants during droughts can cause overly complex treatment plants to be built. We noted an example in Iowa in which the amount of wastewater discharged from a treatment plant into a stream during drought conditions was assumed to be an average of the 30 wettest days (or largest flows) of the year. Although we did not find this type of assumption in other models, we believe it illustrates the problems that can arise from poor model development.

The Iowa Department of Environmental Quality developed effluent limits for about 300 treatment plants, of which 120 were expected to require treatment beyond secondary. We chose one of the larger treatment plants, Cedar Rapids, to determine if it is reasonable to expect stormwater flows to occur while the Cedar River (the receiving stream) is in extreme drought. Further, we wanted to know if stormwater flows contribute the same amount of pollutants as normal sewage effluent.

We observed that many of the Cedar River's low flows occur during the winter, December through February, when the ground is frozen. The superintendent of Cedar Rapid's Department of Pollution Control informed us that no significant stormwater enters the sewer system during the winter since the ground is frozen and the precipitation stays on the ground as snow. The superintendent did say that it is possible for a 2-inch rain to cause some stormwater flows during the summer, perhaps 25 percent more flow, without the river rising. However, he said it would be very unlikely that stormwater flows could be sufficient to double the average flow, as the Iowa model assumes, without the river rising. He said he has never observed rain of 2 inches or more when the river is flowing near its critical low-flow level.

In any event the stormwater does not contribute significant amounts of ammonia, the most critical pollutant discharged into the stream.

We evaluated low-flow and rainfall data at Cedar Rapids for the water years 1/ 1911-77. The flow data showed that only 26 months, or 3.2 percent of the total, had 7-day low flows under 400 cubic feet per second. The State used a critical low flow of 346 cubic feet per second for its model. We found that of these 26 low-flow months, only 6 had total rainfall over 2 inches and in only 1--September 1934--did the rainfall exceed 2 inches for any two-day period. Consequently, it is highly unlikely that significant stormwater will enter the sewers during low flows, much less during a critical low-flow period.

We asked an Iowa engineer to recompute the Cedar Rapids effluent limit for ammonia assuming average dry weather flows. He determined that the winter ammonia limits would be increased from 7 mg/l to 15 mg/l. The Cedar Rapids superintendent said the consulting engineer estimated $1,600,000 in construction costs and $175,000 in annual operating costs could have been saved if the less restrictive winter effluent limit had been used.

1/Water years start Oct. first and end Sept. 30.

EPA representatives said the high and low stormwater flows should be evaluated separately. They said future Iowa projects requiring treatment beyond secondary should be evaluated on this basis since the current Iowa practice can permit unnecessarily sophisticated treatment plants to be built.

Streamflow data is estimated with substantial margins of error

Most models we reviewed attempt to predict water quality at critical low-flow conditions. When actual flow readings are not available, or are available for too short a period, low flows must be estimated. Such estimates can result in large errors.

Estimated flows are based on available data, usually from USGS records. The longer the record, the more accurate the estimate, provided there are not complications such as new dams. A USGS representative in Iowa said continuous-record stations with flow data for 30 years or more produce the most reliable estimates, generally within 10 to 20 percent of the true value. Partial-record stations with data for a shorter period, such as 10 years, may have an error rate of 20 percent or more. Estimates must also be prepared, however, for streams for which no flow data is available. In these cases the measured flow from a similar nearby stream is generally used and adjusted based on the relationship of a drainage area to stream flow. These estimates are subject to even greater error than partial-record stations.

We noted five EPA construction grant projects where modelers used drainage area to stream flow relationships rather than actual flow data: Walworth County, Wisconsin; Brockton and Leominster, Massachusetts; Valparaiso, Indiana; and Rochester, New Hampshire.

Many models are not properly verified

Many of the models we reviewed had not been formally verified to check their accuracy. Model verification is a way of checking whether the model's predictions are right; the predictions are compared with actual stream data taken after the model was calibrated. If the predictions agree with the actual data from the stream, the model has been verified; if the predictions do not agree, the model can not be trusted because its predictions could not be verified. Also, many models did not provide general information for decisionmakers on the expected reliability of the model results. When poorly constructed models are not identified as such, model users can make poor decisions about treatment plant design. Thus, WQS may not be met after a new, sophisticated treatment plant is built even though the model predicted that stream standards would be met.

We have previously criticized modelers, as have experienced analysts, for failing to properly specify model reliability. The following comments demonstrate the historical concern over the need for verification.

--"The current trend to attempt application of models without verification is shocking. It is no wonder that such models are increasingly distrusted. In other cases verification and calibration [1/] are based on the same set of data, usually poor data at that. In some instances where reasonably good calibration and independent verification have been made, seldom are limits specified within which application of the model is feasible. There is also a misconception that once a good applied model has been calibrated and verified, it can be used indefinitely, even though radical changes in river conditions have taken place over the years."2/

1/Calibration is the procedure in which the model parameters are adjusted such that the model output matches the observed water quality characteristics of interest.

2/Presentation by a water quality expert to the National Workshop on Verification of Water Quality Models, West Point, New York, Mar. 6-9, 1979.

--"There is no reason to believe that a model is capable of approximating reality so well that its result can be accepted without reservation. This is the case even for those aspects of reality pertinent to the purpose the model was designed to serve." 1/

Verification studies which use independent stream surveys provide a rough measure of model accuracy. A task force member gave us information indicating that independent model verification of stream surveys was not performed for 5 of 11 projects in our sample. Virtually all of the model documentation we reviewed failed to comment on the model's predictive accuracy. We found this to be true regardless of whether a formal verification study had been made on the model.

In October 1979 the National Council of the Paper Industry for Air and Stream Improvement, Inc., gave us a draft copy of its report reviewing use of mathematical models for evaluating water quality. This industry group sent out a questionnaire to all of the areawide planning agencies that engage in water quality modeling. Approximately 64 percent, or 118, of 185 agencies responded.

In reviewing the responses to the survey, we noted that many models were not calibrated or verified. An assessment of the calibration-verification process was possible in 49 of the 118 responses to the survey. Nineteen reported that models were both calibrated and verified; 22 reported an attempt at calibration only; and the remaining 10 neither calibrated nor verified models. These limitations were generally recognized by the areawide planning managers, who cited the expenses involved with data collection as the justification for not verifying models.

EPA representatives responsible for model review said modelers generally do not even provide comparisons of predicted and actual DO readings, on which verification studies are based. They explained that formal verification studies are not conducted usually because of lack of intensive stream survey information and lack of skill to make such studies. We noted that the verification studies apply only to current conditions. The impact that changes in

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1/Exposure draft of "Guidelines for Model Evaluation," U.S. General Accounting Office, PAD-79-17, Jan. 1979.

future pollutant loads have on water quality cannot be assessed until the changes actually happen.

EPA believes that for some types of DO modeling, calibration and verification never resolve all uncertainties. According to EPA officials, future BOD decay rates with higher levels of treatment cannot be measured through calibration and verification; the water quality analyst still has to estimate future rates, although many empirical formulations are available for predicting rates. The hydrologic characteristics of a stream can be accurately measured through field studies; for example, measuring times of travel at different flow conditions. However, ultimately some of the key modeling terms, such as rate constants, have to be estimated. Therefore, EPA believes that the physical characteristics of a stream should be taken from site-specific field data but chemical calibration and verification are not always necessary.

SOME DECISIONMAKERS ARE BEGINNING TO QUESTION MODELING RESULTS

Some decisonmakers are beginning to recognize that modeling results are not always reliable. Thus, some decisions to construct sewage treatment beyond secondary may be based only partially on the modeling results. If decisionmakers know that the justification for treatment beyond secondary is questionable, they can avoid constructing overly sophisticated facilities. For example, increments of more stringent treatment might be phased in over a period of time if stream surveys demonstrate that lower treatment levels are inadequate; uniform effluent limits can be established for various types of water bodies; or treatment facilities can be designed to produce a "reasonable cost" effluent, no matter what the modeling indicates is required. EPA is currently requiring phased construction for the larger facilities with treatment beyond secondary when modeling does not justify more sophisticated treatment.

According to EPA, a disadvantage of a phased approach for small communities is that they have to go through the construction grants process twice. Communities are reluctant to do this because of the administrative complexity of the program and difficulties in obtaining public support for another large bond issue. EPA also believes that in a great majority of cases involving proposed AWT, the need for treatment beyond secondary can be demonstrated.

Some advanced treatment facilities are built in phases and only after stream surveys show that further water quality improvements are needed

Treatment facilities beyond secondary may be phased in after new stream surveys demonstrate the need for improved water quality. Thus, treatment beyond secondary is gradually increased until water quality standards are reached. The Oklahoma Department of Health, for example, has recognized that modeling imprecision makes it difficult to establish effluent limits without first partially cleaning up the water and then remodeling with the new stream data. The department's position statement of May 3, 1979, said that construction of facilities for treatment beyond secondary should be phased in to allow time for comparing modeling results with actual instream data. The position statement concluded:

> "When it has been clearly demonstrated through verification of models and instream studies that treatment beyond secondary is necessary, such treatment will be required."

Blanket effluent limits are sometimes used in lieu of modeling for certain types of water bodies

Some States use blanket effluent limits that require no analysis but instead are based on the type of water body into which the plant discharges. This method eliminates the need for modeling. Wisconsin, for example, requires all discharges into marshes to have an effluent limit of 20 mg/l for 5-day BOD and total suspended solids. A Wisconsin Department of Natural Resources official said this requirement was instituted because the impact of sewage discharges on marshlands cannot be accurately modeled.

Effluent limits more stringent than secondary are limited based on cost or operational constraints

Several States limited the level of stringent treatment no matter what modeling demonstrates is needed. Representatives from several States said high construction and operation costs plus operational problems necessitated limitations for the most stringent treatment facilities. Iowa and Wisconsin, for example, generally require no more stringent effluent limits than 10 mg/l for 5-day BOD and total suspended solids, and Illinois generally requires effluent limits no more stringent than 10 mg/l for 5-day BOD and 12 mg/l for total suspended solids.

CHAPTER 4

THE HIGH COSTS OF GOING BEYOND SECONDARY TREATMENT ARE NOT ADEQUATELY CONSIDERED IN SETTING STANDARDS

AWT IS EXPENSIVE

The costs of constructing advanced waste treatment facilities are high. Related costs, such as those to reduce nonpoint pollution and combined sewer overflows, are also high. Other related costs involve plant operation and maintenance (O&M), other environmental improvements needed before AWT can improve water uses, and negative environmental impacts associated with AWT. Generally, the act does not authorize EPA to require States to compare costs in setting or revising standards. Even when costs may be considered, EPA limits the extent they can be compared to the significance of the violations they are intended to correct.

Capital costs

The capital cost of constructing AWT facilities is substantial. The 1978 Needs Survey for constructing waste treatment facilities identified $10.3 billion as needed for treatment beyond secondary to bring the Nation's waters up to the goals stated in the Clean Water Act.

Operation and maintenance costs

Nearly every wastewater treatment plant is more expensive to operate, maintain, and repair over its lifetime than to construct. The average O&M costs for AWT per million gallons of sewage treated are much greater than for secondary treatment. An EPA contractor studying O&M costs for various size treatment plants found that the average cost per pound of oxygen-consuming material removed was nearly 9 times higher for AWT than for conventional secondary treatment plants; for suspended solids, the AWT cost was nearly 10 times more per pound removed. The cost differential is not nearly as great for larger plants, especially those treating 5 million gallons per day and over. Thus, small plants are relatively more costly to operate.

Water quality experts in several States we visited also stressed that facilities providing treatment beyond secondary are far more difficult to operate than traditional secondary treatment facilities. Operating problems are especially prevalent in rural areas where it is difficult to obtain highly skilled treatment plant operators.

Illinois EPA officials said their experience with the most sophisticated treatment plants showed that few facilities can produce a very high quality effluent. For example, an EPA study entitled "A Critical Evaluation of Current Performance of Some Activated Sludge and Lagoon Systems in Illinois" summarized the effluent quality of a variety of treatment processes over a wide range of operating conditions. One hundred and twenty-five plants that may be considered to have AWT were studied intensively. The study concluded that only two of the facilities could consistently produce an effluent of 4 mg/l 5-day BOD and 5 mg/l total suspended solids.

Costs of other needed environmental improvements

In some cases large expenditures will be needed for other environmental improvements before AWT facilities can significantly improve water quality. According to an EPA consultant, "One may spend a fortune on [building waste treatment plants] only to find that the water is still far below standard." Nonpoint source pollution may negate pollutant reductions obtained from point source control and prevent desired beneficial water uses even after AWT facilities are operating. But reducing nonpoint source pollution usually involves considerable expense. For example, EPA estimated that $10 billion would be needed to solve problems caused by agricultural runoff. In addition, EPA's 1978 Needs Survey estimated that $26 billion would be required to solve the nationwide combined sewer overflow problem.

Although EPA estimates that nonpoint sources account for more than half of the pollutants entering the Nation's waterways, the effects of nonpoint sources are often neglected in determining the need for AWT plants.

Counterbalancing environmental effects

Correcting WQS violations may have counterbalancing environmental effects which, in our opinion, should be considered as part of the treatment costs. Some AWT is designed to reduce nutrients (especially phosphorus and/or nitrogen) and thus prevent nuisance algal blooms which make lakes less attractive and swimming less enjoyable; these algal blooms may also reduce oxygen levels in the water. However, removing nutrients is not necessarily beneficial because it may also reduce the fish food supply and thus impair the quality of the fishery. According to a professor of water quality engineering, poor fishing is associated with the total absence of pollution. In fact, fertilizer sometimes is used in commercial and sport fisheries to add nutrients, to produce algae for the fish to eat. Nutrient removal also may reduce large aquatic weeds, which may interfere with swimming and boating but which seem to make a good environment for fish. In addition, clean, sandy beaches ideal for swimming are preferred by the snail which is associated with outbreaks of "swimmers' itch."

COSTS HAVE NOT BEEN ADEQUATELY CONSIDERED IN SETTING STANDARDS

EPA assumes that a State will determine the economic feasibility of achieving WQS before setting them, but that kind of analysis is seldom done. States tend to classify waters as fishable and swimmable in the absence of clear information to the contrary, and obtaining EPA approval to reclassify downward is very difficult. The law does not provide for costs to be adequately considered in the standard-setting process.

The standard-setting process assumes costs will be analyzed, but they seldom are

EPA regulations provides for States to consider economic and social factors in determining attainability of standards. According to EPA officials, a State is expected to ensure the economic reasonableness of attaining the water uses it designates in a standard. These officials said that when a water body is given a fishable/swimmable designation, EPA presumes that the State has determined that these uses can be attained economically.

However, State and EPA regional officials stated that States generally do not perform economic studies to determine whether the fishable/swimmable standards can be attained at a reasonable cost. For example, a large number of small streams in Washington are designated as a group for one classification due to sheer numbers and lack of data. We were told that it would be virtually impossible to classify individually the thousands of small streams in the State with any accuracy. A similar situation exists in Alaska. According to an EPA official, determining the appropriate use designation for all the streams in Alaska would require a large-scale study lasting many years. Alaska has an estimated 3 million lakes over 10 acres in size, and the total number of Alaskan river-miles is so vast that realistic estimates have not yet been produced.

According to this EPA official, most States classify many streams in some general way, expecting to make exceptions to the general classification as they obtain more information. Other EPA regional officials said the cost of bringing certain bodies of water up to a standard was not considered in setting the standard.

Overclassification may be common, but reclassifying a water body downward is no easy matter

EPA regional officials stated that in the absence of firm data, States tend to overclassify water bodies. For example, an EPA regional official said that all freshwater streams in Alaska are classified for virtually all uses, yet many have been destroyed--perhaps almost irretrievably--by small-scale gold mining. He said that eventually Alaska will have to request downgrading or prohibit mining. He told us that the tendency of States to overclassify was caused by the fear that errors in underclassifying water might destroy fish and wildlife habitats, perhaps irretrievably.

Sewage treatment officials in Seattle said that small streams in their area had also been overclassified because of a general classification. The director of the Illinois Environmental Protection Agency told us that his agency believes that many of its classifications are inappropriate and represent the idealistic enthusiasm that prevailed in the early 1970s when the standards were set. Many Illinois streams cannot support a viable fishery or swimming and boating activities because of their physical limitations, surrounding land use, or both.

To obtain EPA approval to reclassify a water body downward, a State must demonstrate that a standard cannot be attained. Downward reclassification is possible only where a particular water body is not attaining its designated use or is attaining the use but not the water quality level supposedly necessary to support that use. For example, the water body may actually be used for fishing, but the DO levels supposedly necessary to support fishing may regularly fail to meet recommended DO criteria.

EPA will approve downgrading only if a State demonstrates that the designated use, or at least the criteria set for that use, are unattainable because of (1) natural background, (2) irretrievable person-induced conditions, or (3) existing point sources that would have to go to treatment beyond secondary would result in substantial and widespread adverse economic and social impact.

EPA has defined "widespread" as at least as large as a county or a standard metropolitan statistical area.

In March 1979 EPA reported that 36 States had reviewed their WQS since 1975, and 9 had downgraded the designated uses for one or more streams. EPA has approved few of these requests for downgrading.

An EPA headquarters official reported that the number of downgradings has depended on State and EPA regional office attitudes toward the program. He stated that EPA regions that take a hard line on standards' revisions often force States to make extensive justification for any changes. In general, EPA discourages downgradings.

According to another EPA official, it is extremely difficult for States to obtain approval to downgrade designated water uses. He told us that EPA requires very detailed justification and formal public hearings. An Oregon official told us that Oregon has not requested any downward reclassifications of uses because of the expensive, time-consuming process involved.

Our review of several downgrading actions revealed that extensive negotiations are usually necessary and can take from 4-1/2 months for a single stream to 21 months or more if numerous streams are involved. Adequately documenting and justifying downgradings can be costly to a State. For example, according to an EPA official, a downgrade was approved for a creek in Virginia after a consulting firm prepared an extensive study of the economic impact on one plant. According to this official, the study cost $25,000. Another EPA official told us that an economic analysis similar to the one done for Virginia would cost more for larger plants.

EPA does not have explicit guidance on the type and extent of economic analyses needed to justify a downward reclassification. According to an EPA official, EPA regions are not consistent in defining "substantial and widespread adverse economic and social impact" and in deciding how economic analyses should be done. EPA is now developing more explicit guidance on the kinds and extent of information that States should submit. EPA estimates that it will issue a program guidance memorandum around October 1980.

Generally States have tried to reduce classifications for one of two reasons. Either (1) the States consider the cost to make a stream fishable/swimmable an excessive burden to municipalities, which would have to build and operate expensive AWT projects, or (2) the physical condition of the waters is such that it prevents or restricts attainment of a fishable/swimmable status. For example, the streams may be contaminated by acid mine drainages; may have been channelized, which reduces fish habitat; or may have low or shallow flows not suitable for swimming or full-time fish habitat.

Two of the following downgrading attempts were based on costs (Alabama and Ohio) and one was based on physical conditions of the waterways (Nebraska).

Alabama

Alabama forwarded proposed downgradings to EPA region IV in June 1977. The region approved 7 downgradings but disapproved 50 other stream-use classifications. Twenty were disapproved because the State had not justified why the reduced-use classifications had been made, and 30 were disapproved because EPA believed the higher use could be or was already being attained.

Alabama resubmitted 29 of the stream-use classifications, but 23 were again disapproved by EPA region IV in February 1978. EPA disapproved the reclassifications because it believed the State could not adequately justify that the streams either could not support fish life or could do so only at excessive cost. In February 1979 the State provided EPA additional information for these streams; however, EPA had still not completed action on the proposals by March 1979, 21 months after negotiations began.

Piney Creek is an example of the negotiations and controversy involved in the Alabama downgradings. In September 1977 EPA disapproved changing the use from fish and wildlife to agriculture and industrial water supply because the need for the downgrade was not demonstrated. In January 1978 Alabama showed that the town of Ardmore has a very small wastewater treatment plant discharging into Piney Creek but would need an AWT plant to maintain fish and wildlife standards in the stream. The stream at times goes dry, and the State Department of Conservation and Natural Resources does not believe Piney Creek is suitable for a fish and wildlife use classification. The State concluded that the town of Ardmore would suffer "adverse economic impact" if required to build and operate an AWT plant.

In February 1978 EPA disapproved the downgrading proposed for Piney Creek because

--the State did not demonstrate that the fish and wildlife use was unattainable and

--the increased sewer charge per family would be only 1.11 percent of the 1977 estimated median family income and thus insufficient to demonstrate substantial adverse economic impact.

In November 1978, after public hearings were held on the proposed downgradings, Alabama again requested approval of the Piney Creek downgrading. The State said that new cost data showed sewer charges for the Ardmore AWT plant would equal about 1.76 percent of the 1977 median family income (about $190 a year) if an AWT plant had to be built. The State also said that the creek had very low DO upstream from the Ardmore plant, which indicated that the natural stream could not meet DO criteria for fish.

In January 1979 EPA region IV referred the Alabama classification problem to EPA headquarters for further action. EPA region IV stated that, for Piney Creek, the 1.76-percent median family income figure for sewer costs was still insufficient to demonstrate adverse economic impact. In addition, the information on natural stream conditions was questionable since it was not clear whether it was based on more than a single measurement. Thus, the region stated that Piney Creek should remain designated for fish and wildlife use.

Ohio

Ohio submitted revised WQS to EPA region V in February 1978. Ohio had proposed a "limited warmwater habitat" use classification because of the

--severe hardship faced by a municipality required to upgrade its sewage facility at its own expense when scheduled Federal funding would not be available soon enough,

--existence of low streamflows, and

--limitation of wastewater treatment technology or the presence of irreversible conditions caused by acid mine drainage.

The State also proposed a "seasonal warmwater habitat" use classification, which would require higher water quality only at fish reproduction and habitation seasons in low-flow streams. The State believed that a higher use classification at all times would require AWT and cause economic hardship.

However, EPA believed that two of the use classifications, which applied to about 40 streams, constituted downgradings and had to be justified by documentation. EPA believed the lack of available grant funds did not justify downgradings because the problem could be alleviated by case-by-case time extentions. After extensive negotiation between the State and EPA, the question on uses was still not resolved as of March 1979.

Nebraska

Nebraska, which is in EPA's region VII, proposed to reduce the use classification for some of its waters from fishable/swimmable to either fishable with partial body contact or to eliminate all uses. The State believed that some waters were physically not acceptable for fishing and swimming because they had only intermittent flows, were too shallow, or were too swift.

When EPA initially disapproved the proposals, Nebraska reestablished 12 streams as fishable/swimmable and downgraded 7 others to fishable with partial body contact, such as for boating and wading but not swimming. EPA approved these 7 downgradings but disapproved 11 others the State had proposed and issued an official ruling designating the higher use classifications. EPA considered the waters to be suitable for full body contact and therefore believed they should be protected.

Variances require similar justification

Rather than reclassifying a stream segment, some States grant variances to individual dischargers for a limited time for a particular water quality constituent or constituents because of "unattainability." The downward reclassification has the effect of lowering many criteria, while the variance applies to only one or a limited number of criteria. When one or several criteria for a use designation cannot be met, the use--although possibly somewhat impaired--is generally not lost. Issuing variances for criteria which cannot reasonably be attained continues to protect the designated use to some degree. Such variances are acceptable to EPA only if the State can provide the same type of justification required for downward reclassifications.

Downward reclassifications may become even more difficult

On July 10, 1978, EPA announced it was considering a proposal to make the socioeconomic justification of downward reclassification even more stringent. The proposal would require the State to show that

--all nonpoint sources have been controlled to the maximum extent feasible and

--the economic and social costs of the additional point source and nonpoint source controls necessary to attain the currently designated use would not be reasonable compared to the resulting benefit.

EPA is also considering proposing that the States designate all water as fishable/swimmable (and thus generally subject to EPA-recommended criteria) except where the State can--on a case-by-case basis--justify a downward reclassification. EPA estimates that it will prepare revisions to its existing WQS regulation in September 1980.

EPA allows only limited cost considerations in the use designation process

EPA does not permit downward reclassification of a fishable/swimmable standard because of cost--even if no reasonable relationship exists between costs and benefits--unless substantial and widespread adverse economic and social conditions will result. Under the present proposal, even if these adverse conditions exist, the downward reclassification will not be permitted unless the State can prove that nonpoint sources have already been controlled to the maximum extent feasible and that no reasonable relationship between costs and benefits exists. Thus, even if a State shows that the costs of attaining WQS will seriously damage local economies, EPA apparently will not permit the State to lower the use designation as long as--in EPA's judgment--the benefits associated with attaining the standards have some reasonable relationship to the costs.

In addition, by never permitting a downward reclassification from a use currently attained--except when a use is being attained but the EPA-recommended water quality criteria for that use are not being attained--EPA ignores the possibility that local economic pressures or changes in industrial or agricultural patterns may justify reclassifying a stream use downward. For example, as an area becomes more industrialized, the industrial discharges may reduce water quality; the benefits associated with the increased industrialization, however, may justify accepting this reduction in quality.

EPA also recognizes the probability of severe adverse economic impact when project service costs (debt retirement charges and operational charges) represent more than a certain percentage of median household income. This percentage increases as median household income increases, ranging from 1-1/2 percent for under $6,000 to 2-1/2 percent for over $10,000. These guidelines are not rigid but are merely rules of thumb. An EPA official told us that projects exceeding the guideline percentages may be funded. The costs permitted by the guidelines are substantially higher than current costs actually paid for sewer services. Using a Bureau of Labor Statistics study, EPA estimated the cost of sewer services is approximately 0.2 percent of median family income. The EPA guidelines thus allow project costs to cause sewer charges to rise to 7.5 to 12.5 times the present level of charges.

EPA recognizes, somewhat, the costs of preventing violations of water quality criteria in several other ways. For example, EPA allows water quality criteria violations within mixing zones (limited areas around discharge points). Concentrations of pollutants in these zones may approach levels which kill half a test group of fish within 96 hours. According to EPA's "Quality Criteria for Water," the permissible size of a mixing zone depends on the "acceptable amount of damage" and the "relative social and ecological values of the aquatic life that may inhabit a particular waterway area." In addition, EPA allows violations of WQS during extremely low-flow conditions, apparently recognizing that resulting damage is not worth the cost of prevention. Finally, EPA's recommended criteria for such aspects of water quality as DO and pH may be considered a socioeconomic decision, not a biological one. In fact, the Director of EPA's Environmental Research Laboratory in Duluth wrote in March 1979:

> "In regard to the DO question, there is no question that a minimum of 5 and an average of 6 is better than an average of 5 and a minimum of 4. The question is the significance of that difference and whether it is worth the cost. Certainly no one can argue that the fish fare as well at minimums of 4. The real issue boils down to how much benefit we would gain * * * ."

EPA has effectively minimized the States' ability to tailor WQS to local conditions

EPA admits that its recommended criteria do not take into account the variability of waters from State to State. Even so, EPA presumes the criteria apply to all streams, subject to change only upon States' presentation of what EPA describes as "adequate technical justification" and what the Association of State and Interstate Water Pollution Control Administrators describes as "overwhelming contradictory information." According to a May 1979 report of the Association of State and Interstate Water Pollution Control Administrators, EPA stiffly opposes any relaxation of certain water quality characteristics (DO, ammonia, phosphorus, iron, or lead) to levels that can be reasonably achieved. The report declared that although EPA rarely promulgates WQS, it has considerable control over State-adopted WQS through its approval/disapproval authority.

CHAPTER 5

QUESTIONABLE AWT PROJECTS ARE BEING FUNDED

Many AWT projects have been judged to have been constructed without adequate justification. As a result, the Appropriations Conference Committee, in appropriating EPA's fiscal year 1979 construction funds, required EPA to ensure that large AWT projects would definitely have signficant environmental and public health improvements. This requirement seems to conflict with the Clean Water Act, as discussed in this chapter. Although EPA believes it is following the Appropriations Conference Committee's mandate for definite and significant improvements, the environmental and public health benefits expected from recently approved AWT projects continue to be questionable.

EPA has weakened the Appropriations Conference Committee restriction on large AWT projects considerably by

--exempting various types of advanced treatment from the review process,

--not requiring public health improvements in most cases, and

--not emphasizing enough the requirement that the impact of AWT on water quality must be highly certain.

The weakening of the Appropriations Conference Committee restriction may be due to an apparent conflict between it and the Clean Water Act. Whereas the act requires whatever level of treatment is needed to attain WQS regardless of the significance of improvements in water quality, the restriction limits Federal funding to those treatment projects that will definitely and significantly improve water quality.

INADEQUATE JUSTIFICATION IN PRIOR YEARS FOR AWT

In recent years we and others have been critical of the justification for wastewater treatment beyond secondary.

--A 1976 GAO report "Better Data Collection and Planning is Needed to Justify Advanced Waste Treatment Construction" (CED-77-12, Dec. 12, 1976) questioned the environmental impact of various AWT facilities. The report pointed out that some AWT facilities were developed on the basis of special studies but without adequate knowledge of site-specific causes of the water quality problems and without knowing how the AWT facility would improve water quality.

--A report was prepared for EPA by a consultant to evaluate a number of AWT projects, carefully chosen from lists of outstanding candidates prepared by EPA and State agencies, to try to find the country's best projects. The report concluded that all the projects were based on bungled justifications and that "it is probably safe to assume that nearly every other example of AWT planning in the U.S. is at least as poor as these six."

--EPA's 1978 review of 330 AWT projects that had been proposed to meet very stringent effluent limitations indicated that about half the projects lacked adequate site-specific receiving water data. EPA officials further indicated that, in reviewing grant applications for AWT in the past, little consideration had been given to the impact of AWT on water quality as long as AWT was needed to meet WQS.

--A March 1979 report by the Surveys and Investigations Staff of the House Appropriations Committee discussed AWT facilities that had been built in the late 1960s and early 1970s. The report found shortcomings in virtually every facility visited.

--In September 1978 EPA regions were asked to submit to EPA headquarters two of the best examples of water quality planning that resulted in treatment beyond secondary. In a December 18, 1978, memorandum for the record, an EPA environmental specialist reported that the good examples, on the whole, were discouraging. Of the 18 projects submitted, he identified 12 as suspect:

--Four projects were on intermittent or very small streams.

--Three projects were justified by a State-imposed blanket effluent limit or a dilution policy.

--Three projects were based on limited data.

--Two projects involving ammonia removal were based on current and projected instream ammonia levels in excess of EPA criteria, even though the streams supported an excellent fish population with no apparent ammonia toxicity problems.

The memorandum stated that, in many cases, State WQS and effluent policies are forcing AWT on water quality managers without adequate technical analysis.

THE SIGNIFICANCE AND/OR CERTAINTY OF ENVIRONMENTAL BENEFITS EXPECTED FROM LARGE-SCALE AWT PROJECTS CONTINUE TO BE QUESTIONABLE

In approving the fiscal year 1979 appropriation for EPA's Construction Grants Program, the Appropriations Conference Committee stipulated that construction grant funds may be used for treatment beyond secondary only if (1) the incremental cost of AWT is $1 million or less or (2) the Administrator personally determines that AWT is required and will definitely result in significant water quality and public health improvements.

EPA agreed that rigorous case-by-case analyses should be encouraged, and it implemented the Appropriations Conference Committee restriction through a program requirements memorandum in March 1979. Earlier guidance had been provided in a June 8, 1978, memorandum. The program requirements memorandum requires most projects with an AWT increment over $1 million to be reviewed by EPA headquarters and authorized by the Administrator before approval.

According to an EPA official, as of December 31, 1979, EPA headquarters has had 74 projects submitted for review; final decisions have been made on 50 projects costing $1,878 million in total; and capital cost savings from these decisions have totaled $90.2 million. Decisions on more projects are pending, with a potential additional capital cost savings of over $9 million. EPA officials claimed that the inflationary loss of purchasing power due to delays of the original projects caused by these reviews is estimated at $93 million for capital costs. According to EPA officials, this loss cannot be directly compared to the cost savings achieved by these reviews since the costs are losses in purchasing power and the savings are real resource savings.

Despite EPA's review and authorization, four of five projects we reviewed had questionable aspects--ranging from high uncertainty to minimal environmental impact and low social significance--concerning their appropriateness. These projects are discussed below.

Rochester, Minnesota

EPA approved a project for Rochester, Minnesota (with a $10 million AWT increment), designed to limit (1) ammonia and BOD to protect aquatic life in a river and (2) phosphorus to reduce algal growth in a nearby lake. State fisheries officials, however, told us that proposed flood control projects are expected to devastate the fishery downstream from the treatment plant. One fisheries official was uncertain whether enough fisheries resources would remain to warrant AWT.

In addition, it appears that the flood control projects would change the low-flow ammonia and DO levels. The levels would increase or--if flow augmentation were practiced--would make the degree of AWT unnecessarily stringent.

Experts are divided on the value of removing phosphorus. Some say it will reduce algae noticeably and improve uses of the lake, whereas others say algae will not be reduced, or not enough to affect water uses. One expert suggested that undesirable forms of algae may become more dominant. Several experts thought that it might not be possible to reduce nonpoint sources of phosphorus enough to change the algae discernibly.

St. Petersburg, Florida

EPA headquarters authorized regional approval of a project at St. Petersburg, Florida (with an $8.03 million AWT increment), exempting it from review because it featured land application of the effluent. The project will use effluent to spray-irrigate various green areas, thereby reducing the use of drinking water for the same purpose. As a public health measure, the AWT effluent will be made clearer than drinking water and chlorinated to remove viruses, before it is sprayed.

City officials said they anticipated no water use improvements as a result of the project because there are no uses reasonably desired for the receiving water (Boca Ciega Bay) that are not now being attained. The Director of the Center for Mathematical Modeling at the University of South Florida told us that most of the bay's waters are of acceptable quality with problem areas (low DO, algae, odors, and fishkills) in bayous and inlets which have limited flushing. He said that even if sewage is removed totally, these areas will still have severe nonpoint source pollution problems but the extent and severity of the problems will be lessened.

The project's principal benefit appears to be that it will reduce peak demand for drinking water in St. Petersburg sufficiently to postpone--perhaps indefinitely--expensive expansion of the municipal water supply system. Expansion of a municipal water supply system for a city like St. Petersburg would not be eligible for Federal funding.

Walworth County, Wisconsin

A project in Walworth County, Wisconsin (with a $4 million AWT increment), will remove three secondary discharges into or above a shallow, eutrophic 1/ natural lake and one secondary discharge into a creek downstream of the lake. Instead of discharging into the lake, the project will discharge AWT effluent into the creek.

EPA's internal review concluded that the project's impact on lake eutrophication could not be predicted. Although EPA's summary claims that existing water quality and uses of the creek would be somewhat enhanced by the project, the State's modeling study shows that when the plant reaches full capacity sometime in the future, DO levels of 3 mg/l will often occur in the creek. EPA recommends a minimum of 5 mg/l for protection of aquatic life--a level which would not be met even with zero discharge at the planned facility. In addition, in spite of the advanced treatment, ammonia levels in the 6 miles immediately downstream of the discharge are projected to be four times greater than the criterion recommended by EPA to protect aquatic life. The effects of the AWT increment were not shown separately from other aspects of the project. Finally, although one of the project's purposes is to restore the creek as an excellent smallmouth bass stream, the creek has become shallow and wide; it supports mostly carp and trash fish and lacks habitat suitable for gamefish. These physical changes severely limit the extent to which the project can improve the use of the creek.

Leominster, Massachusetts

A project at Leominster, Massachusetts (with a $1.26 million AWT increment), is expected by EPA and State officials to upgrade the fisheries and recreation potential of the generally scenic and undeveloped area of the Nashua River. However, the social impacts of the improvements appear negligible because other nearby water bodies provide similar recreational resources.

1/Rich in dissolved nutrients, such as phosphates.

According to State environmental and fisheries officials, the Nashua River provides the area's only potential for good warm-water stream fishing. Other lakes and ponds, however, also provide good warm-water fishing. The fisheries officials said the Wachusett Reservoir near Leominster also provides excellent bank fishing for bass and lake trout. They told us one impounded area of the river was much like a lake because it was wide and sluggish. According to State environmental officials, tributaries to the river provide cold-water fishing.

The Director of Public Works for the City of Leominster told us that the local area has many alternative water bodies (for fishing, boating, and swimming) and to spend money on the Nashua would be wasteful. He believed that it would not be a great loss if the Nashua remains as it is. He said that the Squannacook River (a tributary of the Nashua) provides good fishing and that it and other fishing streams are not overcrowded now that year-round fishing is permitted.

MANY INAPPROPRIATE SMALL-SCALE AWT PROJECTS ARE STILL BEING APPROVED

The Appropriations Conference Committee report did not restrict expenditures for projects with AWT increments under $1 million. However, EPA has required that such projects be reviewed intensively at the regional level to ensure they will provide significant water quality and public health benefits. In spite of this requirement, regional offices are still approving AWT projects that are not likely to provide significant benefits.

As of September 30, 1979, 178 projects with AWT incremental costs under $1 million had been reviewed by EPA regional offices since the Appropriations Conference Committee imposed the restriction on large AWT projects. The total incremental AWT cost for these projects is $64.6 million. We reviewed four of the projects approved by EPA regional offices and believe that all were questionable, either in whole or part.

Sac City, Iowa

Ammonia is to be removed by a project approved for Sac City, Iowa (with a $400,000 AWT increment), although since 1971 no ammonia levels attributable to Sac City's effluent have violated present WQS. The requirement for ammonia removal was based on a State wasteload allocation accepted by EPA region VII. However, new (1979) wasteload allocations show little difference in instream ammonia with or without ammonia removal at Sac City. According to a State game warden, the receiving water already has the best small-mouth bass and walleye fishing in the State.

New Concord, Ohio

The $350,000 AWT increment in the project approved for New Concord, Ohio, will produce benefits which appear to be of marginal ecological and no social significance. The receiving water is too small to support much desirable fish habitat and is not used for fishing or swimming. According to the design engineer, even changing the sewage discharge to distilled water would not change existing water uses.

A New Concord official told us that fishkills do occur when the present secondary plant discharges into a nearly dry stream. But the district chief of the State's Fish and Wildlife Division said the fishkills were of limited ecological significance because they were limited to a short distance below the plant and the area was repopulated within a short time by fish from a much larger creek downstream. He also said there has been no evidence of species change associated with the plant's present effluent.

The project includes filtration to reduce BOD and suspended solids from roughly 10 mg/l (without filtration) to 7 mg/l (with filtration). The design engineer said the additional features were silly and involved a large additional cost to buy something of no use to anybody.

Sulphur Springs, Texas

In a project approved for Sulphur Springs, Texas, a sand filter (costing $600,000 in AWT funds) is planned to reduce BOD from 20 mg/l to 10 mg/l and suspended solids from 20 mg/l to 10 mg/l; these changes were justified to keep DO in the stream at 2 mg/l under low-flow conditions. The 1974 wasteload evaluation on which the effluent limits were based was a primitive effort based on sketchy data. A better evaluation was completed in 1979, and although it too had deficiencies which cast doubt on its accuracy, it showed that the filter would protect only about a 1-mile stretch of the receiving stream (Rock Creek) as it passes through open country to prevent the DO from falling below 2 mg/l. The DO level of 2 mg/l represents a margin of safety over anaerobic (zero oxygen) conditions; it is designed to protect the water from stinking, which might occur at zero DO, but 2 mg/l is arbitrary. The plant discharges into Rock Creek, which in turn flows into White Oak Creek about

10 miles further downstream. Both creeks are very small; neither has a specific use classification.

Sandusky, Michigan

A project approved for Sandusky, Michigan (with a $619,000 AWT increment), is designed to meet very stringent effluent limitations (for example, summer monthly averages of BOD = 4 mg/l, ammonia = 0.5 mg/l). The effluent limitations were set to achieve WQS for Dwight Drain. The plant discharges into Berry Drain which joins Dwight Drain several miles downstream. The State classifies virtually all waters for at least a warm-water fishery and has so classified Dwight Drain. State fisheries officials, however, said the drains had no potential as fisheries.

According to State environmental officials, the effluent limitations were also set to ensure that no nuisance problems (odor) occur even at very low flows when the stream is entirely composed of sewage effluent. However, State officials were uncertain whether odor problems would result if these standards were relaxed. We believe the impact of the polishing pond, which will reduce the average summer BOD from 10 to 4 mg/l, will be insignificant since the odor problems occur infrequently and appear to be related to combined sewer overflows. Other aspects of the project will eliminate the overflows.

THE CONGRESSIONAL RESTRICTION ON AWT PROJECTS HAS BEEN WEAKENED

EPA has weakened the congressional restriction by

--exempting various types of advanced treatment from the review process,

--revising the requirement for significant public health benefits, and

--not emphasizing the requirement for a high level of certainty that AWT will significantly improve water quality.

Various types of AWT exempted

Although EPA agreed that rigorous case-by-case analyses should be encouraged, it has exempted various types of AWT from review. According to EPA officials, these exemptions were made because EPA believed they were consistent with priorities set forth in the Clean Water Act or were not relevant to the concerns that led the Congress to require AWT reviews.

Projects involving land treatment or other reuse/recycling technology are generally exempted from special review for significant water quality and public health improvements as long as the cost is not excessive. According to EPA officials, EPA's policy is to encourage projects involving land treatment or other technologies promoting recycling and reuse of pollutants or reduction of energy requirements. AWT cost is not considered excessive as long as it does not exceed the cost of a secondary treatment facility by more than roughly 25 percent (or by more than roughly 50 percent in the case of a very stringent AWT project) and as long as the total average annual cost to a domestic user does not exceed a certain percent (1.5 to 2.5 percent) of the area's median household income. Nationwide, average sewage treatment costs represent 0.2 percent of median household income. EPA exempted the $8 million AWT project at St. Petersburg, Florida (see p. 56), from the AWT review process because it met these requirements and because it involved land-application of AWT effluent.

Projects for achieving effluent levels of BOD and suspended solids below the levels EPA requires for secondary treatment do not have to be reviewed if the State has defined secondary treatment more stringently than EPA and if the extra costs would be a small percentage of the costs of the treatment facility. For example, Texas has set 20/20 BOD/suspended solids as its definition of secondary treatment, whereas EPA's definition is 30/30. According to an EPA project engineer, however, any large plant built today to achieve 30/30 effluent will have sufficient sophistication to reach 10/10 effluent in the summer and somewhat better than 30/30 in the winter. He said the additional sophistication is needed to handle unusually high waste loads or waste flows at the treatment plant so that 30/30 effluent can be achieved consistently. According to EPA officials, EPA approved this exemption after it determined that the State criteria defining secondary treatment more stringently than EPA's could be met using conventional secondary treatment technologies.

Revised public health requirement

EPA modified the Appropriations Conference Committee's mandate that all large AWT plants must produce significant public health improvements to require only "mitigation of public health problems where they exist."

In only one of the AWT projects we reviewed was there any indication that the AWT portion of the plant was intended to improve or safeguard public health. Present forms of AWT are not directed at removing substances strongly associated with public health problems. Additional removal of toxic substances or disease-organisms by AWT is merely a byproduct rather than a principal goal of AWT. EPA officials informed us that public health improvements are basically accomplished through disinfection, not AWT. Some concern for special organics which may lead to cancer has been voiced, but the significance of such organics and the impact of AWT on them are unknown.

High level of certainty not adequately considered

The Appropriations Conference Committee required the EPA Administrator, before funding projects with an AWT increment over $1-million, to determine personally that the AWT will definitely result in significant water quality improvements. We recognize that absolute certainty is difficult to attain considering the present understanding of water quality matters. The relationship between effluent improvements and water quality improvements is not clear cut (see ch. 3), nor is the relationship between water quality characteristics and biological impact on uses (see ch. 2.) Nevertheless, we believe the Appropriations Conference Committee was seeking a high level of assurance of significant results before spending Federal funds for AWT. EPA has not always given this assurance before approving recent AWT projects. Each of the projects we looked at had some uncertainty about significant results. For some, it was questionable whether WQS could be met even after AWT was installed. For instance:

--EPA approved phosphorus-removal at Rochester, Minnesota, although some experts said it would have no noticeable impact on water quality and uses. One expert, who has written extensively on phosphorus and algae in lakes and who generally believes in phosphate control, testified that he was uncertain whether even shutting down the Rochester plant entirely would make a difference. EPA reviewed the project and could not determine whether nonpoint sources would interfere with attaining desired beneficial uses even after AWT. Although it was believed that AWT would improve aquatic life, a fisheries official was uncertain whether new flood control projects will leave enough of a fishery to be worth protecting.

--Federal, State, and local officials thought the AWT project in Walworth County, Wisconsin, would significantly improve water quality, but it was uncertain how many more fishermen, canoeists, and swimmers would use the waters as a result of the incremental treatment. Nonpoint source pollution and the water body's physical characteristics make it extremely doubtful, in our opinion, that AWT alone would significantly increase water use.

EPA appears to be trying to reduce the uncertainty associated with AWT projects. For example, in reviewing the project at Leominster, Massachusetts, EPA concluded that modeling inadequacies left the need for sand filters uncertain and has refused to fund them until further studies can be done. The State has postponed doing the studies until the project is concluded and operating. For some other projects, EPA has deferred funding of filters. (See app. I.)

THE REQUIREMENT FOR SIGNIFICANT WATER QUALITY IMPROVEMENT IS SUBJECT TO VARIOUS INTERPRETATIONS

The phrase "significant water quality improvements" as used by the Appropriations Conference Committee and in EPA's implementing documents is ambiguous. It is not clear whether the term requires

--significant (large) improvements in one or more water quality characteristics, with or without significant biological or social impact (for example, a 30-percent reduction in ammonia levels to meet the EPA-recommended criterion regardless of whether the number or size of fish is improved);

--significant (large) improvements in one or more water quality characteristics with significant improvement in the designated use of the water, regardless of whether significant social benefits are attained (for example, a 30-percent reduction in ammonia levels that improves the number of fish in a minnow stream); or

--significant (large) improvements in one or more water quality characteristics with significant positive impact on the designated use of the water and significant social benefits (for example, a 30-percent reduction in ammonia levels which improves the number and size of fish in a reasonably accessible trout stream and leads to a significant increase in the use of the stream for fishing).

Because it was not clear to us which level of significance EPA required, we asked EPA whether achievement of EPA-recommended criteria alone constitutes a significant water quality improvement, regardless of the amount of incremental improvement attributable to AWT. EPA replied that meeting EPA-recommended criteria set to protect a particular designated use should allow attainment of that use and thus would generally improve water quality significantly. However, EPA also stated that for a project to be approved, the beneficial uses attained by the project must be significantly better than the uses attainable with lesser treatment.

Our review identified a conflict between two EPA documents. EPA's implementing document (program requirements memorandum 79-7) showed that improvements in the designated use are specifically required only for a small percentage of AWT projects--those with especially stringent requirements. However, EPA's final draft (June 1979) of the "National Municipal Policy and Strategy" suggests that simply permitting attainment of EPA-recommended water quality criteria is grounds for approving AWT.

This conflict is supported by comments we received from EPA regional officials and State officials. For example, EPA regional officials said the filters would have been approved at Leominster if the model had been better, even though the filters only reduced BOD from 10 or 15 to 7 mg/l. The filters would have been approved because the model showed they were needed to meet WQS during summer droughts. One of the design engineers said the engineers had questioned the need for filters on the grounds that the small additional BOD reduction did not appear commensurate with the costs. He said the State insisted that the WQS had to be attained. We noted a similar situation in Wisconsin. State officials there informed us that any degree of water quality improvement would be considered significant if it would bring the water quality up to required standards.

We believe it is still unclear how EPA determines the requirement for significant water quality improvement. Although the Appropriations Conference Committee does not address the social significance of water, we are concerned that EPA has stated formally that, in determining significance, it does not consider other nearby waters providing a similar use.

CONFLICT BETWEEN THE CLEAN WATER ACT AND THE APPROPRIATIONS CONFERENCE COMMITTEE RESTRICTION

The Clean Water Act establishes a national goal of making <u>all</u> waters fishable and swimmable <u>wherever attainable</u> (emphasis supplied). It requires dischargers to achieve whatever quality is required by the States or EPA to meet

WQS. Furthermore, the act permits the States to set overly stringent discharge requirements. In other words, a municipality may be required to build an AWT plant to prevent slight WQS violations predicted to occur once every 10 years for a brief duration in a minnow stream even though the standard was based on more sensitive and useful fish. In determining whether and how much AWT is needed, States are encouraged by the act to err on the side of the environment, to provide a margin of safety to cover any lack of knowledge concerning the relationship between effluent limitations and water quality.

The act provides 75 percent Federal funding for construction of publicly owned AWT facilities required to meet discharge requirements imposed by States or EPA. It is particularly important that the act allows treatment beyond secondary regardless of the small degree of resulting water quality improvements. There is no requirement in the act to withhold funds for AWT if the expenditures will not result in a significant environmental impact. The act does not even require that such expenditures be directed to those AWT facilities that will have significant impact. Furthermore, there is no requirement in the act that the significance of WQS violations be weighed against the costs of preventing them. In fact, the act does not appear to allow for such evaluations.

EPA regional officials summed up the situation for us as follows:

--EPA has no legal basis to challenge an overly stringent State requirement; theoretically, a State could set any "crazy" number more stringent than EPA's criteria and EPA could not force the State to change it.

--A single, minor standard violation once every 10 years would be sufficient to justify a requirement for treatment beyond secondary.

--EPA has no legal grounds to refuse funding for projects needed to attain State effluent limitations.

In contrast, in approving the fiscal year 1979 appropriation for EPA's Construction Grants Program, the Appropriations Conference Committee stipulated that:

"Construction grant funds may be used for treatment greater than secondary only if (1) the incremental cost of the advanced treatment is $1 million or less, or (2) if the Administrator personally determines that advanced treatment is required and will definitely result in significant water quality and public health improvements* * *." (Emphasis supplied.)

Essentially, it requires EPA to err, if necessary, on the side of avoiding unnecessary expenditures.

State and EPA officials told us they believe a fundamental conflict exists in the congressional guidance on water quality. On the one hand, the Clean Water Act requires effluent limits that will permit achievement of WQS, whether or not meeting standards will definitely result in a significant water quality improvement. On the other hand, the Congress--through its appropriations process--has limited Federal funding assistance to those AWT projects which the EPA Administrator believes will definitely produce significant water quality and public health improvements. As a result, EPA has been placed in a position where it must refuse a community funding support for an AWT project that will not produce significant water quality improvement but still require AWT construction as necessary to achieve WQS at virtually all times.

A similar conflict appears to exist within EPA. A May 1979 report of the Association of State and Interstate Water Pollution Control Administrators assessed the problem as follows:

> "On the one hand, there is strong concern for stringent, relatively uniform and inflexible water quality standards * * *. On the other hand, there is growing concern within USEPA * * * regarding cost/benefit and cost/effectiveness considerations of the water quality program * * * without adequate funding AWT projects will not be constructed and many stream segments will not meet standards. Also without more realistic, selective and attainable standards, many stream segments will continue to attract funding for projects of questionable value in terms of water quality improvement."

The report suggested that WQS be evaluated for cost/benefit relationships in specific stream segments. It argued that such an approach can be interpreted as addressing the "wherever attainable" aspect of the national goal of fishable/ swimmable water.

CHAPTER 6

CONCLUSIONS, RECOMMENDATIONS, AGENCY

COMMENTS, AND OUR EVALUATION

CONCLUSIONS

Because of the difficulties associated with (1) designating water uses and establishing water quality criteria needed to protect those uses and (2) predicting WQS violations on the basis of mathematical modeling, AWT may be having little effect on water quality. Rigid adherence to WQS and to modeling results has been the basis for many questionable AWT plants. These two factors affect billions of dollars that have been (or will be) spent under EPA's Construction Grants Program.

We noted that WQS are generally regarded as rigid guidelines never to be violated, and the Clean Water Act does not allow WQS violations--even insignificant ones--to occur. However, many WQS violations may not be significant enough to justify AWT.

Violations may not be significant for a number of reasons. First, the scientific basis for the standard might be questionable. Our review showed that the scientific basis for water quality characteristics needed to protect aquatic life is sometimes based on limited experimental investigation. Conflicting opinions also exist on the effects of various levels of water quality on aquatic life. The American Fisheries Society has objected strongly to EPA's guidance on the water quality requirements of aquatic life. The data available to quantify the fishable/swimmable goal in a scientifically sound manner is still rather limited. Second, WQS violations may not be significant unless there is some social significance attached to them. A violation that impedes the use of a specific water body for swimming or fishing has less significance in an area of many fine swimming and fishing waters than it does in an area where such resources are limited. Third, WQS violations predicted by modeling are frequently highly uncertain. Many water quality processes cannot yet be modeled in a practical sense, and others can only be modeled inexactly. Many of nature's processes are unknown and thus too complicated for AWT to be justified through modeling.

When the Clean Water Act was amended in October 1972, apparently an assumption was made that the Federal Government would have sufficient funds to construct all the treatment projects needed to meet WQS. However, Federal funding levels are not sufficient for constructing treatment projects to meet the fishable/swimmable goal in the foreseeable future. According to EPA, the cost to treat wastewater at levels beyond secondary in order to achieve WQS is estimated to be about $10 billion.

The costs associated with wastewater treatment are frequently higher than the initial construction costs. When WQS were first established, little consideration was given to the costs of reaching or maintaining a given quality of water for a designated use. Local communities are becoming more concerned about the limited benefits that may be provided by AWT and are starting to question the high costs involved. In several instances, municipalities have gone to Federal court to seek relief from AWT requirements. Additional expenditures will be needed for correcting nonpoint pollution and other types of water pollution reduction programs.

The Appropriations Conference Committee required EPA to ensure, before obligating its Construction Grants Program funds, that large AWT projects would <u>definitely</u> result in significant environmental and public health improvements. Our review of nine projects approved for funding by EPA after the requirement was imposed showed that the significance and/or certainty of expected improvements was questionable for a large number of the projects. In particular, it is extremely difficult to know how AWT will improve water quality and water uses. Relating impacts of various treatment levels to water quality and water uses is extremely complex and subjective.

Obtaining EPA approval to reclassify WQS downward is very difficult and can only be done if the State can justify the reclassification to EPA's satisfaction. EPA resists attempts by States to relax (or downgrade) WQS.

We believe the standard-setting process places too much emphasis on preventing <u>all</u> types of WQS violations rather than just significant violations. Until this emphasis in the law is changed, AWT plants may continue to be built to prevent occasional and insignificant violations. Therefore, because

--the WQS-setting process is questionable,

--modeling to determine violations is often imprecise and inexact,

--Federal funding is insufficient to achieve WQS for all waterways within a reasonable period of time,

--obtaining downward reclassification from EPA is very difficult, and

--relating the impact of various treatment levels on water uses is very difficult,

we believe that AWT, with few exceptions, may not be justified at this time. We recognize there may be times when AWT is justified, such as phosphorus removal from the Great Lakes to comply with our Canadian treaty obligations. However, we conclude that funding of AWT projects should be curtailed. We do not believe Federal funds should be spent to provide a level of treatment that produces such uncertain results.

RECOMMENDATIONS TO THE EPA ADMINISTRATOR

We recommend that the Administrator, Environmental Protection Agency, take the following steps to improve the process of setting, revising, and implementing WQS and help ensure that AWT plants provide meaningful improvements to the Nation and the environment:

--Become more realistic and cost conscious about the attainability of WQS when a State has made a reasonable showing that the standards are unattainable or too costly to attain. The Administrator should not impede the downgrading process with burdensome evidentiary requirements.

--Reduce the cost criteria for what constitutes an "expensive" sewage plant. To a greater degree, the Administrator should accept State and local views that project costs are not commensurate with benefits.

--Permit variances in reclassification criteria in cases where stream improvement requires treatment beyond secondary to meet WQS but where ecological and social or public health improvements are not significant enough to justify the costs of the improvements.

--Require EPA regions to be more consistent in approving variances of WQS and downgrading of WQS.

--Require, when AWT is an issue, that at least two thorough surveys of the waterway be done: one for calibrating the mathematical model and another for verifying the calibrated model.

--Develop material to help decisionmakers know the predictive accuracy of models used to justify AWT; establish minimum requirements for the predictive accuracy of these models,

--Establish criteria to determine the degree of modeling reliability that will be acceptable.

--Develop specific criteria governing what constitutes an adequate and cost-effective water quality survey for justifying AWT projects.

--Revise the AWT review guidelines or, if necessary, suggest legislative changes to allow revisions, to:

1. Delete the provisions that allow projects not having significant water quality improvements to be funded because the projects will cost more if they have to be revised or redesigned to delete insignificant treatment processes.

2. Delete the provisions that allow projects to be exempted from the review process if they involve land treatment.

3. Delete the provisions that allow projects to be exempted from the review process just because the State's definition of "secondary treatment" is more stringent than EPA's.

AGENCY COMMENTS AND OUR EVALUATION

We sent a draft of this report to EPA for comment and received written comments (see app. II).

Our draft report proposed that the Congress declare a moratorium and withhold funding for treatment beyond secondary because we believed EPA was not fully complying with the Appropriations Conference Committee's requirement to fund only those projects that will definitely result in significant environmental and public health improvements. After reviewing the Agency's draft and final comments, we concluded that the best way to help the Congress resolve this extremely complex issue was to present a number of options for the Congress' consideration. Accordingly, we have listed several options rather than one, as we had originally proposed.

EPA agreed that the Nation's water pollution program is costly and complex but stated that our conclusions appeared to reflect a misunderstanding of the legislative objectives established by the Congress in the Clean Water Act. EPA also commented that we failed to recognize States' legal prerogative to define their own standards, which may exceed Federal limitations.

We do not believe we have misunderstood the legislative objectives established by the Congress nor that we have failed to recognize the States' legal prerogatives. We recognize that the Congress wanted to make "all" waters fishable and swimmable, but only "wherever attainable." Although the Congress did not require EPA to weigh the benefits of AWT against the costs, it did recognize that the fishable/swimmable goal was not attainable in all cases. Furthermore, EPA's regulations provide for States to consider "environmental, technological, social, economic, and institutional factors" in determining attainability.

EPA said that we are inaccurate in stating that the costs for meeting the Congress' water quality objectives are not considered in the water planning process. We disagree, based on our discussions with State and EPA regional officials. According to these officials, in most cases States did not adequately consider costs in initial use designation decisions. EPA says that States are required to consult with their citizens when proposing stream use designations, WQS, and treatment systems designed to have discharges compatible with WQS. However, our review showed that while some States wanted to reduce classifications because they considered the cost to make a stream fishable/swimmable an excessive burden to their municipalities, EPA did not agree.

EPA believes the States, in many instances, are adequately demonstrating that treatment beyond secondary (1) is needed and (2) represents a cost-effective solution for reducing pollutant loadings to our waterways. We do not agree. In its review process, EPA itself is finding that in many instances States are not adequately demonstrating that treatment beyond secondary is needed. We do not contest that EPA's AWT project reviews have saved over $90 million. However, we believe that substantial additional savings could be realized by more careful reviews, and in this report we identify some important areas for improvement. We believe fewer AWT projects will be proposed now because of concern over their costs and benefits. Consequently, the AWT reviews have probably saved much more than $90 million.

EPA stated that our report was based largely on an incomplete analysis of how it reviews AWT proposals. As a general practice, we cannot analyze all projects an agency might review. Therefore, we selected all the projects EPA had made final decisions on as of June 30, 1979. We had planned to look at more projects involving EPA's review of the modeling process, but EPA told us that it would take too much time away from its own review to respond to our requests for information. EPA assured us that the limited projects we reviewed would be typical of the other projects in its review process.

EPA stated that it is prudently managing construction grants expenditures and is following the Appropriation Conference Committee's directives to require sufficient documentation and fund only cost-effective AWT processes. The committee's directive does not address cost-effectiveness; it addresses definite and significant improvements. As we point out in our report, many of the AWT projects being approved by the EPA's Administrator or EPA's regional offices are unlikely to result in definite, significant water quality and public health improvements.

EPA believed that our opinion that some streams should not be protected from degradation because they are not "socially significant" concerns an area over which EPA cannot exercise control. We agree. We also recognize that the Clean Water Act states that all waters, regardless of location or accessibility, should be protected from pollution and restored, if possible, to natural conditions. We included a section in the report relating to the social insignificance of some WQS violations to identify another factor the Congress may want the Administrator to consider before approving AWT grants. The costs associated with water pollution cleanup are enormous, and "social significance" is just one factor the Congress may want to consider if at some future date it has to cut back the amount of funds devoted to water pollution control and cleanup.

We do not suggest, as EPA stated, that States should downgrade use designations in WQS. Nor did we conclude that imprecise models are being used as the basis for WQS. We reported that EPA makes it very difficult for States to downgrade use designations, and we conclude that mathematical models of water quality are often based on guesswork and assumptions. Questionably stringent WQS and dubious mathematical models have been used to justify expensive treatment plants that may have little effect on public health or environmental quality. We believe these matters are of interest to the Congress.

EPA states that we appear to be advocating scant documentation for supporting WQS downgrading and absolute documentation to support efforts aimed at achieving high water quality. We believe that before EPA spends large sums of money on AWT, the evidence should be very strong that significant benefits will result from such treatment. States told us they did not know the type and extent of information needed to downgrade their WQS. The guidance EPA is preparing for the States, specifying what factors to include in justifying downgrading requests may help resolve this problem.

In our draft report, we proposed that the Congress declare a moratorium and withhold funding for treatment beyond secondary because we found that EPA was not fully complying with the requirement set out by the Appropriations Conference Committee. In response, EPA pointed out that the Clean Water Act does not require cost/benefits analysis for AWT decisions and that a moratorium on AWT was incompatible with the explicit congressional intent to restore and maintain high standards of water quality nationwide. To help resolve these issues, we are providing several matters for the consideration of the Congress.

MATTERS FOR CONSIDERATION BY THE CONGRESS

We believe a cost/benefits approach to funding AWT projects should be seriously considered. Therefore, we are presenting for the Congress' consideration several alternatives which would give EPA the flexibility to consider costs more closely in justifying AWT projects.

--Amend the Clean Water Act to require explicitly a cost/benefits review to show whether AWT will result in significant water quality, social, or public health benefits before such projects can be funded. The amendment should leave the WQS review process intact but should ensure that AWT projects are reviewed rigorously before being funded. Thus, the act would allow Federal funding of projects only where benefits exceed costs.

- --Amend the act to require the States to do a cost/benefits analysis of effluent limitations more stringent than those required by the act. If costs exceed benefits, the Federal Government should not fund AWT for those projects. States could still establish mandatory effluent limitations, but EPA would fund projects only where a cost/benefits analysis justified the need for such stringent limitations.

- --Amend the act to declare a moratorium on AWT projects by withholding funding for wastewater treatment beyond secondary until EPA can clearly show what ecological, social, and public health benefits are being realized by the various levels of treatment beyond secondary. A number of AWT plants have been built and are operating. The Congress may want to have EPA explicity show what ecological, social, and public health benefits are being realized now that such plants are on line and operating.

- --Amend the act to eliminate the requirement for a margin of safety which compensates for the lack of knowledge concerning the relationship between effluent limitations and water quality and include language in the act to require that all treatment beyond secondary and costing $1 million or more must produce significant ecological and social or public health improvements. This change of emphasis should promote wiser investments in AWT facilities.

RECAP OF IMPORTANT MODELING CONSIDERATIONS FOR SELECTED AWT PROJECTS PROPOSED FOR THE ADMINISTRATOR'S APPROVAL [1/]

	Construction Cost		Modeling Considerations						Task Force Actions	
	Total	Incremental above secondary	Did the model separately consider nonpoint sources pollution?	Were there water quality standard violations at high flow?	Period modeled	Were nighttime DO readings taken?	Was the time of travel measured?	Was a second survey taken for verification purposes?	Type of action	Savings
	******(millions)******									
Walworth County, Wisc.	$ 20.0	$ 4.0	No	No	Summer only	Yes	Yes	Yes	Approved	
Leominster, Mass.	19.3	2.8	No	Yes	Summer/Winter	Yes	Yes	Yes	Delete filters	$ 1.5
Brockton, Mass.	16.9	9.7	No	No	Summer only	Yes	Yes	Yes	Approved	
Waupun, Wisc.	5.5	1.9	No	No	Summer only	Yes	Yes	Yes	Defer filters, nitrification, & chlorination	2.0
Meriden, Conn.	28.8	5.3	No	No	Summer only	No	Yes	Yes	Approved	
Manasquan, N.J.	16.4	1.2	No	Unknown	Summer only	No	No	No	Capacity reduced	3.5
Portage, Ind.	6.6	2.6	No	No	Summer only	No	No	No	Defer filters & interceptors	3.3
Valparaiso, Ind.	11.9	2.9	No	No	Summer only	No	No	No	Defer filters	0.6
Souix Falls, S. Dak.	49.1	9.4	No	Yes	Summer/Winter	No	No	No	Approved	
Albert Lea, Minn.	20.0	4.0	Yes	Yes	Summer/Winter	No	No	No	Approved	
Rochester, N.H.	7.6	2.3	No	No	Summer only	No	Yes	Yes	Defer filters	1.3
			Yes 1	Yes 3	Summer only 8	Yes 4	Yes 6	Yes 6		
			No 10	No 7	Summer/Winter 3	No 7	No 5	No 5		
				Unknown 1						
TOTAL	$202.1	$46.1	11	11	11	11	11	11		$12.2

[1/] This schedule demonstrates that many proposed AWT projects did not separately consider nonpoint source pollution, only considered summer low flows but not winter low or any high flows, did not measure nighttime DO readings or actual stream time-of-travel, and did not have a second stream survey for model verification purposes.

APPENDIX I

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

FEB 5, 1980

OFFICE OF
PLANNING AND MANAGEMENT

Mr. Henry Eschwege
Director
Community and Economic Development Division
United States General Accounting Office
Washington, D.C. 20548

Dear Mr. Eschwege:

We have reviewed the General Accounting Office's draft report, "Many Water Quality Standard Violations May Not Be Significant Enough to Justify Costly Preventive Actions." The opinion, expressed in the report, that the nation's water pollution control program is costly and complex is unassailable. The report's conclusions, however, appear to reflect a misunderstanding of the legislative objectives established by Congress in the Clean Water Act, and the primary recommendation fails to recognize the legal prerogative of states to define standards for protection of their waters which may exceed federal limitations. Congress clearly said federal water quality objectives are the minimum required, and that States may adopt more stringent standards of protection. We support the need for State discretionary authority in this area.

Recommendations calling for a moratorium on funding all variations of wastewater treatment beyond secondary are incompatible with the explicit Congressional intent to restore and maintain high standards of water quality nationwide. The report states the costs for meeting Congress' water quality objectives are not considered in the water planning process. This is inaccurate and moreover ignores the process by which States are required to consult with their citizens when proposing stream use designations, water quality standards, and treatment systems designed to have discharges compatible with water quality standards.

In many instances the States are adequately demonstrating that treatment beyond secondary is needed and represents a cost effective solution for reducing pollutant loadings to our waterways. EPA is screening State proposals seeking funding for advanced wastewater treatment processes. Our screening initiatives follow the directives established by the Appropriations Committees, and the review has resulted in considerable savings to the Federal Government and to local taxpayers that would have paid higher treatment plant operating costs had unneeded AWT proposals been funded.

The GAO report, based largely on an incomplete analysis of how AWT proposals are being reviewed by EPA, fails to note that we deleted or deferred funding for 23 out of 50 AWT proposals submitted by the States for review through December 31, 1979. After thorough analysis of these 23 projects we determined that sufficient documentation was not presented showing AWT processes were needed to meet water use designations. These AWT systems were not funded as proposed, saving $90.2 million in unneeded expenditures. We are now reviewing twenty-four additional AWT proposals. We believe that a complete analysis of our funding determinations shows EPA is prudently managing construction grant expenditures and is following the Appropriations Committees' directives to require sufficient documentation and fund only cost effective AWT processes.

We agree with the report's conclusion that the water quality planning process is complex, and that the maximum benefit should be sought for each water pollution control dollar spent. The opinion advanced, however, that some streams should not be protected from degradation because they are not "socially significant" is not a discretionary area for administrative determination. Congress clearly states in the Clean Water Act that all waters, regardless of location or accessability, should be protected from pollution and restored, if possible, to natural conditions. We agree with this Congressional determination to restore and maintain the quality of all of the nation's waters and have designed the national water quality regulatory strategy to achieve these national objectives as defined by Congress. Further, we must take serious exception with a GAO report which seems to be aimed primarily at excoriating the Agency for a faithful interpretation and implementation of federal law.

The draft report suggests EPA should ignore the Congressional objectives as defined in the Clean Water Act and encourage States to downgrade use designations and water quality standards. This position is supported by GAO's conclusion that imprecise models are being used as the basis for water quality standards, and that models are not a valid basis for determining effluent limitation requirements. Few models, even very expensive and refined models, can absolutely duplicate a complex natural system and conclusively predict how man's activities affect that system over time. Ample analytical techniques exist, however, and sufficient information is available to make informed judgments. All scientific opinions include a degree of uncertainty, and scientists will interpret the same data differently. In our water program we question the reliability of both modeling and scientific opinion, and the agency makes every effort to assure both are reasonably accurate.

The draft report's conclusion, however, that the agency's process for approving water quality downgradings is too rigorous seems incompatible with the point advanced on modeling. EPA has a policy on downgradings, and additional guidance is being prepared for use by the States which will amplify what factors must be considered so downgrading requests are adequately and successfully justified. Generally, our policy requires that States demonstrate designated water uses and established water quality standards cannot be achieved because of economic hardships, natural conditions, or irreversible man-induced activities. Models are useful to States trying to meet these requirements, but they must be documented.

GAO appears to be advocating that we require scant documentation for supporting water quality downgradings and absolute documentation to support efforts aimed at achieving high water quality. Our position is to require adequate documentation to support both water quality downgradings and efforts to improve water quality. Eight States have sought water quality standard or stream use designation downgradings within the past two years. EPA found in one case that adequate justification was presented to approve the downgrading request, and we are reviewing the seven other downgrading requests. EPA will continue to review water quality standards and stream use designations, but the Clean Water Act requires we strive for high water quality within limits of natural conditions.

We appreciate the opportunity to comment on the draft report.

Sincerely yours,

William Drayton, Jr.
Assistant Administrator
for Planning and Management

(089010)

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