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April, 1976

Staff Report to the National Commission on Water Quality

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Staff Report to the National Commission on

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April 30, 1976

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MEMORANDUM TO: Chairman

SUBJECT: Staff Report

I am pleased to transmit the Report of the Staff to the National Commission on Water Quality.

F. J. CLARKE
Executive Director

National Commission on Water Quality
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CHAPTER I.

INTRODUCTION

and

SUMMARY OF FINDINGS

I. INTRODUCTION AND SUMMARY OF FINDINGS

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INTRODUCTION

The Federal Water Pollution Control Act Amendments of 1972, Public Law 92-500, expanded the Federal role in water pollution control. It raised the level of Federal funding for construction of publicly owned waste treatment works, elevated planning to a new level of significance, emphasized public participation, and created a regulatory mechanism requiring uniform technology-based effluent limitations or more stringent limitations if required to meet water quality standards. As a means of enforcement, it instituted a national permit system for all point source dischargers.

OBJECTIVES, GOALS AND POLICIES

Congress specified requirements, goals and objectives to be achieved within stated time frames. The objective of the Act is to "restore and maintain the chemical, physical, and biological integrity of the Nation's waters." In addition, there are two goals and eight policies.

The goals are:

- To reach, "wherever attainable," a water quality that "provides for the protection and propagation of fish, shellfish, and wildlife" and "for recreation in and on the water" by July 1, 1983.
- To eliminate the discharge of pollutants into navigable waters by 1985.

The policies are:

- To prohibit the discharge of toxic pollutants in toxic amounts.
- To provide Federal financial assistance for construction of publicly owned treatment works.
- To develop and implement areawide waste treatment management planning.
- To mount a major research and demonstration effort in wastewater control and treatment technology.
- To recognize, preserve and protect the primary responsibilities and roles of the states to prevent, reduce and eliminate pollution.

- To insure, where possible, that foreign nations act to prevent, reduce and eliminate pollution in international waters.

- To provide for, encourage and assist public participation in executing the Act.

- To pursue procedures that drastically diminish paperwork and interagency decision procedures and prevent needless duplication and unnecessary delays at all levels of government.

REQUIREMENTS AND DEADLINES

The Act calls for reaching these ends in phases, with accompanying requirements and deadlines.

Industry is required to install "best practicable control technology currently available," and publicly owned treatment works to achieve secondary treatment by July 1, 1977. Both must also install "more stringent limitations, . . . to meet (state or Federal) water quality standards. . ."

The 1983 requirements are intended to be more rigorous and innovative. Industries are to install "best available technology economically achievable . . . which will result in reasonable further progress toward the national goal of eliminating the discharge of all pollutants." Publicly owned treatment works are to achieve "best practicable waste treatment technology . . . including reclaiming and recycling of water, and confined disposal of pollutants." Each must meet those requirements, as well as any water quality related effluent limitation, by July 1, 1983.

Ultimately, all point source controls are directed toward achieving the national goal of elimination of discharge of pollutants by 1985.

The Act embodied a new approach to the use of water resources. Some mechanisms are found in Title I, the broad policy title. Others are woven throughout the Act in the grants and planning sections, in standards and enforcement and in permits.

The Act requires comprehensive programs to prevent, reduce and eliminate pollution. It further calls for research and development to reduce unnecessary water use. The statute directs the designation of areawide institutions to plan and to identify institutions within the area to control and maintain water quality and reduce pollution from all sources by land use or other methods.

Construction grants for publicly owned treatment works are made available to encourage full waste treatment management, including:

"(1) the recycling of potential sewage pollutants through the production of agriculture, silviculture, and aquaculture products, or any combination thereof;

"(2) the confined and contained disposal of pollutants not recycled;

"(3) the reclamation of wastewater; and

"(4) the ultimate disposal of sludge in a manner that will not result in environmental hazards."

Grantees are urged to join with other facilities, to encourage industrial use of publicly owned facilities, and to raise revenues through its operation.

These provisions outline a long-term program to reduce water use, curb the generation of wastes, and establish financially self-sustaining publicly owned treatment and pollution control facilities.

Congress recognized it was placing demands on people, technology, the economy and public and private institutions which, ultimately, would determine the success of the program. It was uncertain whether the required technologies existed; how the new law's implementation might affect society, the economy and the environment; and how well the institutional system would or could respond to this demanding new law. To provide guidance in these areas of uncertainty in time for the next Congressional examination of the Nation's water pollution control program, the Congress established a National Commission on Water Quality.

COMMISSION CHARGE

The Commission was established by Section 315 of the Law. Its mandate is to determine if a mid-course correction is needed, and to report its findings, conclusions and recommendations to the Congress within three years.

The Commission's charge is to:

> . . . make a full and complete investigation and study of all of the technological aspects of achieving, and all aspects of the total economic, social, and environmental effects of achieving or not achieving, the effluent limitations and goals set forth for 1983 in section 301(b)(2) of this Act.

The Commission agreed "that a comprehensive study of the goals and requirements for 1983 cannot be properly undertaken without attention to the progress made toward clean water by industries and municipalities under the 1977 requirements." It stated that it would "examine progress toward the 'elimination of the discharge of pollutants' as an indicator of what will remain to be done after 1983."

The Commission focussed primarily on the goal and effluent limitations for 1983, and the effects of applying those limitations. No study could assess all the far-reaching implication of each of the Act's provisions. Limitations of data, time and resources, and evolving knowledge and issues restrict what could be accomplished.

Among issues or questions which the Commission did not study, or did not study in sufficient detail for definitive conclusions, are:

- Alternatives to the strategy of Public Law 92-500 to control discharges through regulation based on permits;
- Additional Federal financial incentives;
- Control of nonpoint sources and impacts of applying controls;
- Relationship of pollutants to public health; and
- Impacts on ground water.

Nevertheless, the results of the Commission's analysis constitute a major undertaking and provide new and useful information on a broad range of important issues to be found in the following components of this report:

Chapter II -- An analysis of the capabilities and costs of technology for achieving the effluent limitations required by 1977 and 1983, as well as a look at what remains to be done after 1983;

Chapter II -- An assessment of the capability of the public and private sectors to apply the defined effluent limitations for 1977 and 1983, as well as those more stringent to protect water quality;

Chapter III -- An analysis of the economic effect of the cost of applying the necessary technologies on both a macro-economic and microeconomic scale -- as well as the social effects of these changes;

Chapter IV -- A description of present water quality and environmental (water-based and related terrestrial) conditions, and projections of anticipated change which may result from implementation of the Act.

Chapter V -- An assessment of the public and private response as the institutional segments finance, implement, manage and enforce the nation's water pollution control program.

Chapter VI -- Identification of the effects in several selected regions of the nation.

C A V E A T

The Commission staff particularly wishes to emphasize that:

1. Commission studies performed by contractors often provide a range of costs and benefits for differing technologies, conditions or assumptions. Complete and reliable data were not always available covering all questions the Commission and contractors have analyzed; every effort is made to explain methodologies and to qualify estimates in the full text of the Commission staff report. In the following summary, reflecting this variability has been sacrificed for the sake of brevity. Therefore, all cost and expenditure estimates and quantified statements of effects should be regarded as staff best professional judgment, rather than as exact measures of these items. The staff recognizes that others might have chosen other figures for different reasons.

2. Many of the source documents -- EPA prescribed effluent limitations, standards, regulations, guidance documents and supporting reports -- have been, and many still are, undergoing repeated revision by EPA during the course of the Commission's studies. Since analyses had to begin on fixed dates and proceed to completion on short time schedules, documentation available at the time of initiating contractor studies is the basis for the results. Where later EPA publications are likely significantly to affect the results, the staff has attempted to note that fact.

3. Numerical data contained in the report represent the best estimates of the Commission staff or the Commission's contractors.

4. Estimates are often presented using excessively significant figures, even though the staff recognizes that a particular value may, at best, reflect an approximate point falling within a range. Such a range may be large or small, depending upon the quality of the data base from which the value is derived. The fact that a range exists is implicit in all data.

5. Any projection or estimate of future consequences cited in numerical terms constitutes the best judgment by the staff, assuming an implicit set of conditions. Any interpretation to the contrary is unwarranted.

6. The summary which follows represents the condensation of six chapters. Those who wish to pursue some subject discussed in the summary in more detail should examine the full report.

CHAPTER I.

SUMMARY OF FINDINGS*

Public Law 92-500 requires the application of progressively stringent uniform pollution control and treatment requirements to both publicly owned systems, industrial and agricultural dischargers by July 1, 1977 and July 1, 1983. The questions of technological availability, the adaptability and uniformity of its application to both the public and privately owned systems, the costs and associated projected economic impacts, and the predicted environmental improvements are the primary focus of this chapter.

The most salient questions that must be addressed by those who wish to examine the Act, its progress, its problems and its potentials, are here: Does the technology exist for BPT and BAT, can it be applied, at what costs and economic impacts, with what expectation for environmental improvement and, perhaps most important, with what alacrity of purpose are the various governmental institutions pursuing the Act's implementation?

What follows attempts to examine these questions in the light of the findings of the Commission's studies. The framework applied is essentially the incremental one of the Act, itself, dealing -- first -- with the application of the 1977 requirements; next, with the 1983 requirements; and, beyond that, the prospects for achieving the goal of elimination of the discharge of pollutants and the objectives of restoring and maintaining the "chemical, physical, and biological integrity of the Nation's waters."

I. PROGRESS UNDER THE 1977 REQUIREMENTS

Analysis of the prospects of achievement of the goals and objectives of the Act must necessarily begin with the implementation of the first phase. Looking at the progress under the 1977 requirements has proven an essential prerequisite to the Commission's primary charge to examine effects of achieving or not achieving the 1983 effluent limitations and goals. Thus, recognizing now, over three years after enactment, that achievement of the 1977 requirements is severely delayed -- at least in the public sector -- it is legitimate to ask:

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*All dollar figures stated herein are in June, 1975, dollars.

QUESTION: *What will be the effects of the delay in achievement of the 1977 requirements on the timetable for "achieving or not achieving the effluent limitations and goals set forth for 1983?"*

ANSWER: *Slow progress toward achieving secondary treatment by publicly owned treatment works by July 1, 1977, will delay achievement of "best practicable waste treatment technology over the life of the works" by 1983. Similarly, but to a lesser degree, industries and agriculture not achieving "best practicable control technology currently available" by July 1, 1977, will delay achievement of "best available technology economically achievable" by July 1, 1983.*

Not achieving the 1977 requirements by the statutory deadlines will, as Commission studies indicate, delay achievement of the 1983 interim water quality goal "wherever attainable" and may, in some geographic areas, result in further water quality degradation before restoration begins. The longer the delay, the more uncertain the prediction of future change.

Extended delay in achieving both 1977 and 1983 requirements will preclude water quality improvement in some areas, and may even allow degradation to occur in certain instances. For other areas, contributions from nonpoint sources may negate the positive effects of achieving both the 1977 and 1983 requirements, regardless of the pace of progress toward their achievement.

A. Technological Aspects -- 1977

Publicly Owned Treatment Works -- 1977

QUESTION: *Is secondary treatment for publicly owned treatment works, as defined by the Administrator of the Environmental Protection Agency, technologically achievable?*

ANSWER: *Yes.*

As interpreted by EPA, the 1977 requirement for secondary treatment and the 1983 requirement for "best practicable waste treatment technology over the life of the works (BPWTT)" are virtually synonymous. EPA has interpreted BPWTT as requiring secondary treatment. Only where water quality

standards necessitate it is a level of treatment beyond secondary required, and this is applicable to the 1977 requirement, as well as the 1983.

Thus, the real issue as to technological achievability in relation to publicly owned treatment works involves consideration of regulatory interpretation and administrative flexibility, rather than technological feasibility.

Rigid interpretation by EPA of the statutory directive in P.L.92-500 to define secondary treatment has raised significant issues. Among them are: (1) Should there be separate "effluent limitations based upon secondary treatment" for different technologies such as activated sludge, trickling filters, waste stabilization lagoons and physical-chemical treatment? (2) Is disinfection (chlorination) a legitimate part of a secondary treatment definition? and (3) Should the same secondary treatment definition be required for all ocean discharges?

Moreover, there is evidence of a rigidity on the part of both Federal and state officials toward affecting the application of the statutory directive to "encourage the recycling of potential sewage pollutants through the production of agriculture, silviculture, or aquaculture products." Many of the states rigidly adhere to the requirement for secondary treatment as a prerequisite to land application of wastewater from publicly owned treatment works. Land application may not be the universal panacea that its proponents contend, but it has unquestionable adaptability to many smaller publicly owned systems where it can provide both efficient and least-cost options. Far broader application, however, can be made of land for the disposal of municipal sludges for either crop production or landfilling. Major deterrents to the use of treated sewage or sludge are health concerns over the effects on humans from the consumption of the food crop, and institutional problems.

The latter can be severe. Large metropolitan areas must invariably seek disposal sites in neighboring, less settled or rural areas since suitable quantities of land are not available within most municipal boundaries. Such disposal is often unacceptable to the receiving jurisdiction, and the costs of transport and energy expenditure can push costs beyond the level of practicality.

In any event, sludge production and the problem of its eventual disposition present major by-products of the technological treatment process, especially as treatment becomes more advanced. The estimated 1972 raw sludge production from publicly owned treatment works was 4.7 million tons (dry weight), with an expected increase to about 16 million tons (dry weight) by 1990, exclusive of separate stormwater sewer control (category VI). Processes which convert sludge to gases (portions of which are usable as fuel) can reduce the 1990 amount to about 12 million tons (dry weight). Control of separate stormwater systems could add 4 million tons of raw

sludge (dry weight) in 1990, but this type sludge is not easily converted to gases. Dewatering sludge is difficult, and will be even more difficult as higher levels of treatment become operable; large quantities of water will accompany the sludge to disposal sites or will require evaporation.

The Commission's assessment of the technologies of publicly owned treatment works placed operation and maintenance costs for categories I through V (all except control and treatment of stormwaters in separate sewers) at more than $2.0 billion per year by 1990 in excess of that required for 1973. In the same analysis, annual operating manpower is projected to increase from an estimated 107,000 people to adequately operate existing facilities in 1973, to 185,000 people by 1990, when the facilities reach their design capacity, exclusive of separate stormwater sewer control (category VI). Control of separate stormwater systems could require an additional 24,000 people in 1990.

Electric energy demands are estimated to increase from 7.6 to 21.0 billion kilowatt-hours per year; fossil fuels from 72,000 to 87,000 billion BTUs per year, both exclusive of separate storm sewer control (category VI). Converting the two types of energy to a common base, an increase of 106 percent over 1973 energy demand for publicly owned treatment works is projected, equivalent to 27.0 million barrels of oil per year (74,000 barrels per day). The increase amounts to 0.20 percent of the 1973 national energy use, while the total energy requirement equals 0.41 percent. Control of separate stormwater systems could add 16,000 barrels per day to the 1990 requirement.

QUESTION: *What are the estimated capital costs for installing the needed treatment technologies and improvements to comply with the requirements of the Act?*

ANSWER: *The Commission's best estimate of the capital costs by categories for plants reporting a need for secondary treatment only (category I), $10.8 billion; for plants reporting a need for treatment more stringent than secondary (category II), $24.8 billion; infiltration/inflow correction (category III-A), $6.9 billion; major sewer system rehabilitation (category III-B), $9.5 billion; new collectors (category IV-A), $13.0 billion; and new interceptors (category IV-B), $13.5 billion; is $78.5 billion.*

Estimated costs to meet the 1977 requirements include capacity to accommodate the projected 1990 United States sewered population (210 million, or 82 percent of 256 million). Costs also include the collection and treatment of industrial wastes discharged into publicly owned treatment works.

The cost estimates for categories I and II include both secondary treatment and more advanced treatment where necessary to achieve water quality standards. Of the $35.6 billion total in these two categories, $27.3 billion is for secondary and $8.3 billion is for advanced treatment to meet water quality standards. These cost estimates for treatment works are predicated upon their providing an effluent adequate to meet the 1983 interim water quality goal stated in P.L. 92-500.

EPA has not thus far included combined sewer overflows and separate stormwater sewers within "publicly owned treatment works" that must comply with their definition of secondary treatment. Therefore, Commission cost estimates for correction of combined sewer overflows (category V) depend upon the treatment or control technology selected, ranging from $17.0 billion for disinfection only, to $89.0 billion for secondary treatment. The estimated cost of primary treatment for all systems discharging to effluent limited waters and secondary treatment for discharges to water quality limited waters is $79.6 billion of which $63.7 billion is for storage facilities. While $79.6 billion has been included in all Commission cost estimates to maintain the technology based effluent limitations, technologies designed on a site-by-site basis might prove adequate to meet water quality standards even though they would not achieve the same degree of effluent reduction as those priced here. Some of these site specific options are discussed in Chapter II.

Commission cost estimates for control or treatment of stormwaters in urbanized areas of the nation's 243 Standard Metropolitan Statistical Areas (category VI) depend upon treatment or control technology chosen, ranging from $160 billion for removal of debris, to $430 billion for physical-chemical treatment. The estimated cost for removal of suspended solids and disinfection to destroy bacteria is $199 billion, of which $92.3 billion is for collection and storage. Adding these last two costs (category V, $79.6 billion; and category VI, $199 billion) to those for categories I through IV produces a total publicly owned treatment works cost of $357.1 billion. EPA believes that capital construction is not the most cost effective solution to storm sewer pollution and is concentrating on non-capital intensive management practices. The estimated costs of only those categories (categories I, II and IV-B) for which the vast majority of Federal funds is currently being spent, are $49.1 billion.

QUESTION: *Will all publicly owned treatment works achieve required treatment by July 1, 1977?*

ANSWER: *No. Achievement is dependent primarily on Federal funding. Universal secondary treatment by publicly owned treatment works cannot be achieved by July 1, 1977. Achievement requires sufficient money, manpower and material assured at an annual rate to meet whatever deadline date is chosen. When this requirement can be achieved depends on Congressional authorization and appropriation, and Presidential approval of adequate sums to fund the Federal share, as well as on the rate at which local, state and Federal agencies can formulate, finance and approve projects within the funded categories. Engineering design and construction manpower must be available to complete the approved and funded projects. There must be no shortage of construction materials, supplies and treatment equipment.*

The rate of construction of publicly owned treatment works is determined principally by the level of Federal funding. A schedule of estimated expenditures, including funding of all publicly owned treatment works categories under P.L.92-500 by 1985 (except control and treatment of separate storm sewer flows), could be structured as follows:

		Amount (Billions, 1975 $)			Calendar Year Achieved
I	Secondary treatment		$ 10.8		1980
II	Treatment more stringent than secondary		24.8		1980
III-A	Correction (infiltration/inflow)		6.9		1985
III-B	Sewer rehabilitation		9.5		1985
IV-A	Collector sewers		13.0		1985
IV-B	Interceptor sewers		13.5		1980
		Minimum		Maximum	
V	Combined sewers	$ 17.0	79.6	$ 89.0	1985
	Subtotal	$ 95.5	$158.1	$167.5	
VI	Control of stormwaters	158.0	199.0	427.0	
	Total	$253.5	$357.1	$594.5	

A condition for achieving this schedule is that secondary treatment, treatment more stringent than secondary and interceptor sewer expenditures would be given priority over other categories, and would be met by 1980, while all other categories, except control and treatment of separate storm sewer flows, would be met by 1985. The 1973 expenditures for all categories eligible for Federal funding were shared 75 percent Federal, and an average of 7 percent state and 18 percent local. Funding of selected categories would vary these percentage shares of total expenditures; changing the target year for achievement of the various categories would alter the distribution and the impact. Full or partial funding of the Federal share of estimated expenditures for controlling or treating separate storm sewer flows could add as much as $199.0 billion and considerably alter the impact. Without increments for inflation, to achieve the above pattern for categories I through V in eleven years would require Federal appropriations and commitment ranging from $2.6 billion in the first year to $15.6 billion in the last two years. Future inflation could require increasing any pattern of Federal expenditures selected now; the total for the eleven-year example here could be increased to $184.4 billion.

Costs to individual communities will vary both with the magnitude of the need and by the size of the community, with highest costs to the small communities that gain no economies of scale. Thus, while some communities will have no costs because they have no needs, a small community with population less than 5,000 could incur per capita costs of more than $200 if it had to provide treatment beyond secondary. The crucial determinant of the local share of total expenditures is the degree to which Federal and state governments subsidize local costs to install sewers, correct combined sewer overflows and control or treat separate stormwater sewer flows.

More than two-thirds of publicly owned treatment works capital expenditures are usually financed with bonded debt. Property taxes are used by a significant number of communities especially to repay capital borrowing. Sewer service charge use has grown from 20 percent of all municipalities in 1945 to 61 percent in 1960 and 85 percent in 1969.

While future financial prospects are not encouraging for many state and local governments, bearing their proportionate share of expenditures for construction of publicly owned treatment works required by P.L. 92-500 will not generally constitute a major demand on expected revenues. Rather, the financial condition of state and local governments might affect their capacities to respond to projected required operation and maintenance expenditures for these plants. If state and local revenues and expenditures were to continue to increase according to historical trends, 21 states and 21 "local aggregates"

could face fiscal problems in the period 1975-1980 and 44 states and 40 "local aggregates" would have difficulty in the 1980-1985 period, assuming the 11-year program outlined here.

Optimum operating performance of publicly owned treatment plants is essential to achievement of the intended water quality improvement. A 1974 survey revealed that only some 67-70 percent of treatment plants for which adequate data were available were meeting operating design criteria, while 56 percent of the plants surveyed did not have adequate data available to evaluate performance. Monitoring requirements to comply with current grant and permit procedures will enable a much more accurate evaluation of future performance. Operator training is inadequate to supply current needs, and accelerated completion of publicly owned treatment works will require more trained operators and higher technical levels of training to assure optimum operation of more sophisticated plants.

Industries -- 1977

QUESTION: *Is "best practicable control technology currently available," as defined for industrial dischargers, technologically achievable?*

ANSWER: *Generally, yes. Exceptions are some short-term limits and water constituents or mixed wastewater streams.*

"Best practicable control technology currently available" for controlling, reducing or treating industrial wastewaters adequately to conform with the 1977 requirements is available. Generally, these technologies are "end-of-pipe," as opposed to process change. In defining BPT for industrial discharges, the Environmental Protection Agency apparently expects a higher reliability from the technology than is likely to be realisitc in actual performance. Thus, some technologies intended to meet 1977 requirements, even if they exactly duplicate the technology suggested by EPA, are likely to operate so as to cause an industrial discharger to violate his permit, or a more sophisticated technology or "fail safe" system must be installed at added expense to assure constant compliance. Subcategories used by EPA are generally suitable for application of uniform effluent limitations, but difficulty is expected in some industries with multiple waste streams where the limitations and suggested technologies for specific products or processes do not take into account the actual mix of wastes treated in a common facility.

There is disagreement whether EPA has given adequate attention in the formulation of effluent limitations to such factors (enumerated in Section 304(1)(B) as cost and benefits, age of equipment and facilities, the process employed, etc. There is some evidence that actual permit conditions may vary from the effluent limitations, depending upon when the permits were issued. Variances probably extend both in the direction of being more stringent and less stringent. Since the Commission's analysis is based on the limitations rather than the permits, actual achievement of the requirements may differ somewhat from what is indicated in the results of this analysis. Overall, however, it is the judgment of the staff that this variation between actual permits and limitations is not so substantial as to place the results of the analysis in question.

Pretreatment standards require industries discharging to municipal systems to reduce or eliminate "pollutants which are . . . not . . . susceptible to treatment by [publicly owned] treatment works" or any "pollutant [which] interferes with, passes through, or otherwise is incompatible with such works." [Sec. 307(b)(1)] Standards are not yet promulgated for all industries, and EPA has stated in the latest proposal (July 9, 1975, and subsequent internal redraft dated September 10, 1975) that its objective is to approach as nearly as possible to "best practicable control technology currently available" as the pretreatment standard for 1977 for major contributing industries with incompatible pollutants. Several of the pollutants designated as "incompatible" are actually substantially removed in a publicly owned treatment works (approximately the same as the pollutants BOD and suspended solids which are included in the EPA definition of secondary treatment). Raising or lowering the minimum discharge volume subject to pretreatment standards, or changing the pollutants to which they apply, can change radically the cost of meeting such standards. Thus variations in both the quantity limits and the numerical parameters can alter the effects on industries discharging to public systems and could determine whether individual plants close or continue in operation.

QUESTION: *For industry to achieve the 1977 requirements, what will be the capital costs?*

ANSWER: *The Commission did two estimates of the capital costs of meeting the 1977 requirements: one, a product of the technology studies, represented the cost of the necessary hardware and its installation; the other, an economic assessment reflecting certain considerations of the economic dynamics of the several categories of industry studied and their likely response to the treatment requirements. The two separate cost estimates are as follows:*

Capital Costs for 1977
(in billions of 1975 dollars)

Industry	Technology	Economics
Iron and steel	$ 2.91	$ 2.08
Organic and Miscellaneous Chemicals	4.29	4.29*
Inorganic Chemicals	0.52	0.81
Petroleum Refining	1.05	0.83
Pulp and Paper	2.64	2.19
Metal Finishing	14.14	9.13
Fruits and Vegetables	0.44	0.17
Plastics and Synthetics	0.16	0.21
Textiles	0.54	0.46
Steam Electric Power	3.74*	3.74
Feedlots	0.71**	0.43
All Other Industry***	10.94	11.66
TOTALS	$ 42.08	$ 36.00

*Includes growth to 1977.
**Includes growth to 1977 and assumes coverage of all feedlots whose runoff would reach watercourses.
***See Table II-30, page II-82, for listing of other industries.

Assuming the installation of technologies for all industrial production facilities in place as of June, 1973, i.e., no closures and no growth (except for steam electric power and feedlots), the total capital cost to achieve BPT and pretreatment to the BPT level and residuals disposal is estimated to be $42.1 billion.

For discharges to water quality limited waters, costs for individual industrial plants are difficult to derive and are not included in Commission industrial cost estimates; in those cases where data were available, an assessment of required technology indicates installation of technologies more stringent than BPT, but generally less stringent than BAT, is now required [Sec. 301(b)(1)(C)]. No cost estimates for control of toxic pollutants are included except where control may be a part of the BPT limitation. Also, neither the cost to industry for capital cost recovery for repayment of their share of the construction costs of publicly owned treatment works which can be attributable to treatment of industrial wastes, nor the costs to the industry for the use of the public system are included here.

Steam electric power includes costs to comply with chemical requirements for both existing plants and those which will come on line prior to July 1, 1977, but thermal compliance costs include only those for new plants. Thermal requirements for existing plants take effect July 1, 1981, and costs are included in the 1983 BAT totals.

Converting all energy requirements to achieve BPT to one type fuel oil, 169,000 barrels daily would be required for all industrial plants in place in June, 1973, which equals 0.48 percent of the 1973 national energy use.

Operation and maintenance costs, excluding depreciation and interest on capital, for wastewater control or treatment facilities for industrial plants in place in June 1973 to achieve BPT for industry over and above June 1973 expenditures is $7.7 billion yearly ($7.3 billion assuming control of fewer feedlots as proposed by EPA in November 1975). Costs for plants that may close have not been deducted nor have costs for new plants been added, except for growth in feedlots and steam electric power.

QUESTION: *When might all industrial dischargers achieve best practicable control technology currently available?*

ANSWER: *Perhaps by 1980; industries appear to be moving to achieve the 1977 requirement at a rate that will assure achievement earlier than publicly owned treatment works will achieve their 1977 requirement.*

According to published historical data, about one-fifth of total estimated required industrial investment to reach BPT was made by January 1, 1975. If these data accurately reflect the yearly rate of industrial expenditures, four-fifths of the amount to reach BPT remains to be spent after January 1, 1975, if industry is to install BPT by July 1, 1977. Expenditures should rise rapidly as the deadline approaches and costs of construction are reflected in reported data. Whether all industrial dischargers will achieve this requirement on schedule is currently being debated, but complete achievement by the deadline now appears unlikely. EPA is still issuing effluent limitations for some industries; others are not yet issued. Some industries will be delayed because of pending administrative hearings on permit conditions or litigation involving challenges to the effluent limitations or permit conditions. These procedures cannot be completed, in some cases, before the deadline. A large number of agricultural and small dischargers do not yet have permits.

Estimated capital requirements for industries -- metal finishing, chemicals (organic, inorganic and miscellaneous), pulp and paper, and steam electric power -- to meet the 1977 water pollution control requirements, account for some 55 percent of the total for BPT. For industries to achieve BPT by July 1, 1977, using published historical trends to January 1, 1975, pollution abatement expenditures as a percent of total capital spending for iron and steel would have to increase from 4 percent in 1974, to 27 percent in 1976; chemicals from 4 percent in 1974, to 26 percent in 1976; chemicals from 4 percent in 1974, to 33 percent in 1976; and textiles from 2 percent in 1974, to 12 percent in 1976. (All based on assumed BPT compliance in 1977.)

Small segments of existing capacity in several major water using industries will experience disproportionately high capital requirements -- 5-10 percent for textiles, pulp and paper and metal finishing, and 1-2 percent for petroleum refining and iron and steel (Figures III.D.4 and III.D.5). These are primarily small, older, less efficient facilities with higher production costs that may close because of competitive disadvantages resulting from pollution control expenditures.

Supply constraints can affect achieving 1977 requirements. Capital expenditures to meet BPT will probably reduce capital investment for productive capacity in some industry segments, particularly if the apparent required acceleration of expenditures from 1975 to 1977 occurs. Skilled manpower could also be in short supply. These capital, materials or manpower shortages will not, of course, materialize if industry has actually been spending at a higher aggregated rate than is reflected in historical data or if the ultimate achievement of BPT extends beyond July 1, 1977. Supply and productive capacity shortages in supplying industries do not seem probable.

Projected plant closures are significant in six industries: pulp and paper, metal finishing, textiles, fruits and vegetables, feedlots*(including dairies) and meat packing. Concentrated in a small, high-cost segment of each of these industries (usually 5-10 percent of capacity), closures are generally the old, small, single-plant firms that, in many cases, might not remain economically viable over the next decade in the absence of required expenditures for water pollution control. The majority of plant closures are plants that discharge to municipal systems and have been described by EPA as having incompatible pollutants subject to pretreatment standards. (Analysis was based on proposed pretreatment standards as of June 30, 1975; very different proposed standards that might substantially alter this result are now being considered by EPA.) Because of estimated plant closures, productive capacity of these industries will

* The predicted closures are based upon a limited number of covered feedlots in each category; the prediction may still remain valid under the latest EPA proposal (November 1975).

become more concentrated. Except for metal finishing, however, in no other case is this result attributable solely to water pollution control expenditures; it is rather a reflection of existing trends in the industry which P.L. 92-500 tends to accelerate. Except for those segments of industries that would probably close because of depressed profits, the profit level for remaining industry is not substantially impacted.

Regional negative impacts are concentrated in the Northeast, and to a lesser extent in the Middle Atlantic and North Central regions, principally because of concentrations of metal finishing facilities, small pulp and paper mills, old textiles mills, small feedlots (particularly dairies) and old fruit and vegetable canning plants. The Northeast seems the least able to reemploy the resources dislocated as a result of the Act.

By 1985, the average price increase due to implementing BPT (including interest and O&M) is predicted to be 6.2 percent. This is equivalent to a .60 percent annual rate of inflation. The greatest price increase is a 40 percent price increase for metal finishing services which leads to price increases of over 7 percent for fabricated metal products and instruments which extensively use metal finishing services. Mining is the only other major industry with price increases in excess of 7 percent due to BPT.

B. Social Effects and Benefits - 1977

The Commission's "Study Plan," February, 1974, stated "Achieving or not achieving the Act's requirements and goals can have social costs and benefits" and ". . . cost and benefit figures associated with the achievement of the 1983 requirements for industry and municipalities will be used to evaluate the effects on the economy . . . ." Consistent with this commitment, the Commission also examined ". . . available leisure and recreational opportunities . . . and the general quality of life resulting from achieving or not achieving the goals of the Act." Increases in individual satisfaction associated with improved water quality are not always reflected in the use of marketable water-related goods or services. These unquantifiable, intangible benefits are acknowledged but their magnitude would largely be an accumulation of individual perceptions or subjective responses.

Thus the studies of social effects and benefits were structured to reflect the results of achieving the requirements and goals within statutory timeframes. Generally, measurable benefits from the Act were assumed to be zero in 1972 and to increase yearly thereafter as the several requirements of the Act are achieved, culminating with realization of BPWTT and BAT in 1983, with maximum annual benefits

occurring two years later. Increased annual benefits thereafter reflect only population and economic growth. Delays in implementing the Act's requirements would shift this 1985 maximum annual benefit level to a later year by whatever number of years the implementation was delayed.

Because of the structure of Commission studies, attempts now to separate the 1977 and 1983 social effects and benefits would be largely arbitrary. Therefore, the full discussion is presented under the 1983 date. Some of the separate effects for 1977 are presented there where the data are separable.

C. Environmental Effects -- 1977

QUESTION: *How far will the uniform application of BPT to industrial dischargers and secondary treatment to publicly owned treatment works go toward achievement of the interim goal, a water quality "wherever attainable" "which provides for the protection and propagation of fish, shellfish, and wildlife and provides for recreation in and on the water . . . by July 1, 1983"?*

ANSWER: *Based on the analysis of the Commission's 41 environmental sites, application of the 1977 requirements will restore a large portion of the Nation's presently polluted waters to a level of physical and chemical quality sufficient to provide for achievement of the interim goal. The chief exceptions are caused by toxics, pulse loads discharged from point and nonpoint sources during and following storms and delays in actual achievement of the 1977 requirements. Maintaining that level of quality with continued growth will depend upon timely and effective compliance with outstanding permits and the effective application of more stringent limitations that may become necessary following adoption of water quality standards where the volume of pollutant discharges begins to produce lower water quality.*

The interim goal provides a pragmatic measure of progress toward achievement of the stated objective of the Act -- the restoration and maintenance of the chemical, physical and biological integrity of the Nation's waters. The most quantifiable indicators of biological health in an aquatic system are the physical and chemical parameters assessed at each of the study sites. Individually and together, they provide a broad picture of existing

water quality and projected progress toward a quality that will support the purposes listed in the interim goal. As minimum criteria to determine whether a body of water meets the interim water quality goal, the Commission selected the following: (1) a dissolved oxygen level of at least four mg/l during seasonal low-flow conditions; (2) toxic materials limited to those levels proposed and recommended in Water Quality Criteria;* and (3) total coliform of not more than 1,000 per 100 milliliters, or fecal coliform bacterial densities not exceeding 200 per 100 milliliters.*

Applying these criteria to the 41 sites and extrapolating from the results, a generalized statement can be made about the projected conditions of the waters of the entire nation. Obviously, because of natural conditions or as a result of water pollution control efforts prior to implementation of P.L. 92-500, much of the nation's waters are already of sufficient quality to meet the interim goal. In many of these areas, the application of 1977 requirements will serve to maintain that quality into the future. In other areas with large concentrations of industry or population, more stringent limitations are already being specifically required under the water quality standards provisions of P.L. 92-500. A few of these portions are of such deteriorated quality that it is highly improbable the interim goal will ever be "attainable." Progress toward the interim goal in these waters can only be adequately evaluated after 1977 requirements are met and recovery has begun. Even so, the application of BPT to industrial discharges and secondary treatment to publicly owned wastewater treatment works will substantially improve the quality of much more of the nation's waters during most flow conditions.

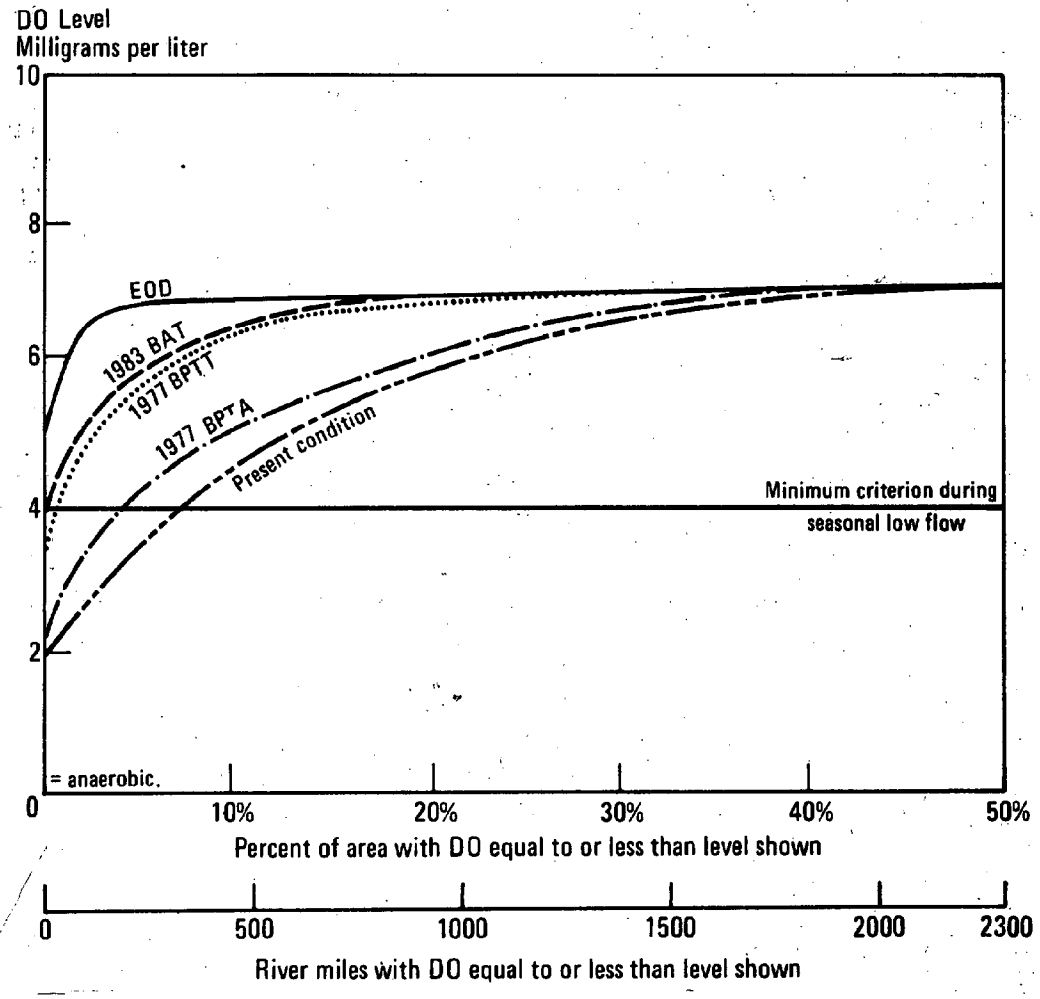
Controlling pollution from publicly owned treatment works by installation of secondary treatment as defined by EPA or higher levels of treatment to meet water quality standards, including chlorination, will result in a marked reduction in coliform bacterial contamination. Approximately three-fourths of the nation's waters will attain acceptable total and fecal coliform bacterial levels during seasonal low-flow conditions. Similarly, dissolved oxygen will improve to the point where nearly half of the waters now showing levels of dissolved oxygen below four mg/l will meet that minimum dissolved oxygen standard. (See Figure I-1) Turbidity and suspended solids will also show improvement, especially in regions of the country such as New England, where there is naturally clear water. EPA has estimated that its present permit program for industries alone will reduce BOD approximately 12 million pounds per day and suspended solids an estimated 28 million pounds per day.

Improvements as a result of the application of the 1977 requirements will vary, however, depending upon site specific characteristics of the receiving waters and the pollutant loads from point and nonpoint

* Water Quality Criteria, 1972; NAS-NAE, 1972.

Figure I-1

DISSOLVED OXYGEN IMPROVEMENT UNDER 4 LEVELS OF POLLUTION CONTROL ABATEMENT



*Based on projected improvements at 21 sites covering a total of 4600 river miles during seasonal low flow conditions.
Source: Natl. Commission on Water Quality compiled from environmental contractor reports.
February 1976

KEY ABATEMENT LEVELS

- EOD
- 1983
- 1977 T
- 1977 A
- Present

See Table IV-3 for explanation of abatement levels

sources. Uncontrolled nonpoint sources, especially as a result of storm-related pulse loadings in urban areas, will periodically deplete dissolved oxygen and raise total and fecal coliform counts, as well as increase turbidity and suspended solids. The frequency and relative impact of this phenomenon, however, will depend as much on the hydrology and meteorological conditions of the area as the quantity of pollutants contained in the stormwater.

As of October 1, 1975, separate effluent limits for any toxic pollutant have yet to be promulgated by EPA other than those that are part of BPT limits. Control of some toxic substances will result from the application of the 1977 requirements and water quality standards, but, in many areas, the effective reduction or elimination of toxics may be a critical factor, delaying achievement of the 1983 goal. The failure to adequately control toxics also bears serious implications for public health and the long-term impacts of toxics and heavy metals on the aquatic system, which should not be lightly dismissed.

Another deterrent to achievement will be delays in implementation, particularly control of discharges from publicly owned treatment works. As illustrated in Figure I-1, the predicted water quality improvement most nearly corresponding with full achievement of the 1977 requirements (BPTT) shows a significant improvement in DO levels at 21 of the Commission's assessment sites over what is likely to be achieved by 1977 (BPTA).

Probable population growth in an area, new commerce and industry, associated land-use changes, increased runoff from expanding urban areas and other nonpoint sources may significantly lower the DO concentration unless checked by adoption of increasingly stringent water quality standards and control of nonpoint sources. Projected long-term water quality deterioration is demonstrated in the examination of growth impacts on water quality in several regions studied. In some of these areas, if effluent limitations or the stringency of abatement measures were to remain unchanged, increases in industrial production and total population will increase total pollutant concentrations in receiving waters, even with application of the 1977 requirements. For such areas, to restore -- and especially, to maintain -- the physical, chemical and biological integrity of the water, further pollutant reductions probably will be required. More stringent effluent limitations may be necessary for point sources; control of combined storm and sanitary sewers, separate storm sewers and nonpoint sources may be required. In still other areas, especially those with heavy agricultural activities, sediment, pesticides, nutrients and salinity will have to be controlled if water quality goals are to be reached and sustained.

Thus, there are indications of significant progress toward achievement of the interim goal in much of the nation's water through the application of the 1977 requirements. How quickly recovery of heavily polluted areas will occur, however, is difficult to predict. Adequate control will provide the potential for restoration of a desirable sport fishery to 20-25 percent of the areas where it is now non-existent. For shellfish, secondary treatment of municipal wastewater and, in some cases, combined sewer overflows, would provide improvement in most areas where beds are now closed as a result of bacterial contamination. Depending on the degree and frequency of coliform contamination from storm runoff, many of these beds can be opened to harvesting once point source control takes effect. The same will be true of many beaches now closed to public use as a result of untreated or inadequately treated discharges from publicly owned treatment works.

More critical to the question of achievability will be how well the first phase (1977) point source controls will serve to preserve the quality of the water from future deterioration or from seasonal or climatic episodes that produce large loads of uncontrolled and untreated stormwater. The effect of achieving cannot be accurately evaluated, however, without reference to the date of achievement since growth occurs during delay and further adds to the total load even with constant levels of abatement. The extent to which application of the 1983 requirements serve to alleviate this circumstance is treated in Section II.D.

II. EFFECTS OF ACHIEVING OR NOT ACHIEVING THE EFFLUENT LIMITATIONS AND GOALS SET FORTH FOR 1983.

A. Technological Aspects -- 1983

Publicly Owned Treatment Works -- 1983

QUESTION: *Does technology adequate to achieve "best practicable waste treatment technology over the life of the works" for publicly owned treatment works exist?*

ANSWER: *Yes, since -- as defined by EPA -- this technology is virtually the same as that described by EPA for 1977.*

For publicly owned treatment works for which a construction grant is made "from funds authorized for any fiscal year beginning after June 30, 1974," [Sec.201(g)(2)], the requirement is "the application of the best practicable waste treatment technology over the life of the works" [Sec.201(g)(2)(A)]. Additionally, however, effluent limitations for individual treatment plants must be set at a level that would not interfere ". . . with attainment or maintenance of water quality" to "assure protection of public water supplies, agricultural and industrial uses, and the protection and propagation of a balanced population of shellfish, fish and wildlife, and allow recreation activities in and on the water" [Sec.320(a)].

In short, each publicly owned treatment works must be designed to meet the 1983 "interim" water quality goal of the Act.

QUESTION: *Will all publicly owned treatment works achieve the "best practicable waste treatment technology over the life of the works" by July, 1983?*

ANSWER: *No. The primary reasons for not achieving this requirement by the scheduled date is an inadequate rate of Federal funding, slow obligations of existing funds and the time it takes for construction of treatment works.*

Rather than attempt to separate the costs for various categories of treatment between 1977 and 1983 requirements, the Commission has examined all of them within the section on progress under the 1977 requirements.

One of the indeterminants, however, is how much of the costs of connection of combined storm and sanitary sewer overflow must be accounted for in order to realistically achieve the 1983 water quality goal.

EPA's position on this is ambivalent. The 1975 Water Quality Strategy Paper suggests that the secondary treatment requirement for 1977 does not apply to combined storm and sanitary sewer overflows and storm sewer discharges which are characterized as "wet weather overflows."* After concluding P.L.92-500 does not "specify a technological level of control or a date for control," the statement is made that, "States, therefore, are at liberty to handle acute overflow problems on a case-by-case basis after thorough study but will not be expected to provide correction of most problems by 1977."

Subsequent discussion mentions swimming, "drinking water supply and support of fish and other aquatic life," as beneficial uses for the protection of which construction grant funds might be used "only where marginal benefits in terms of pollution control are relatively large compared to the marginal costs." This rationale suggests that correction of "wet weather flows" would be part of 1983 requirements. Dividing the requirements in this manner may provide a means for segregating the 1977 and 1983 costs. If this interpretation of P.L.92-500 were accepted, the costs of BPWTT could include the $79.6 billion for control and treatment of combined sewer overflows and the $199.2 billion for separate storm sewer flows already discussed in connection with the 1977 requirements for publicly owned treatment works.

QUESTION: *When might all publicly owned treatment works achieve best practicable waste treatment technology over the life of the works?*

ANSWER: *Depends, primarily, on level of Federal funding. Could be achieved in 11 years with adequate funding.*

Because the level of treatment beyond secondary that may be required is to be determined on a case-by-case basis as necessary to meet water quality standards, actual technologies cannot be described now for standards that may be in effect on July 1, 1983. Further, since the achievement of both 1977 and 1983 requirements for publicly owned treatment works is largely determined by Federal appropriations, the effects can be controlled to some degree by Federal decisions. The Federal share of the

*This discussion is based on the "Water Quality Strategy Paper," draft third edition, June 30, 1975, pp.C-1 to C-11.

cost of whatever remains to be done to provide secondary treatment after 1977, or more stringent limitations for discharges to water quality limited waters will probably exceed actual Federal dollar amounts spent prior to that date; total expenditures will be determined by funding levels chosen for categories eligible for Federal support. Full Federal funding adequate to support the $158 billion total estimated expenditures for all eligible categories, except separate storm sewer flows, seems highly unlikely. Achieving full funding of secondary and a higher level of treatment to meet more stringent effluent limitations, as well as some interceptor sewer costs, seems more probable. Therefore, the effects of achieving whatever level of treatment (and expenditure) that is selected can be influenced by the Congress and the President as Federal funds are authorized and appropriated. If progress is to be made toward a definite, chosen goal, the level of expenditure must exceed that necessary to overcome annual inflation rates, plus whatever additional capacity is necessary to treat wastes from growth in total sewered population. A low level of Federal support could preclude ever fulfilling existing needs for secondary treatment; an unrealistically high level of support could require radical adjustments, both at its initiation and at its termination. If reasonable progress is to be made toward achieving treatment requirements in an orderly manner, choices and priorities are essential. The sooner made, the less confusion and dissipation of resources. Some certainty as a basis for short-range, five- to ten-year planning is needed; a fixed term, with a pre-announced termination date and gradual elimination for the publicly owned treatment works Federal construction grant program, could encourage fixing of priorities and concentrating funds on more significant water pollution problems. Possible adverse economic effects could also more easily be minimized with advance planning.

Industries -- 1983

QUESTION: *Is defined "best available technology economically achievable" for industrial dischargers technologically attainable?*

ANSWER: *Generally, yes, with the exception of short-term (24-hour) limitations in some cases, and those instances where application of technologies must be transferred from one industry to another or have not been adequately demonstrated.*

The 1983 technologies incorporate suggested process changes to reduce or eliminate pollutants, but, in most cases, also include end-of-pipe treatment. As with BPT, however, while the long-term average (monthly or yearly) BAT effluent limitations can be achieved, inherent technological limitations will sometimes preclude achieving the short-term (24-hour) limits. Either technologies more advanced or complex than those contemplated by EPA will have to be installed or the effluent limitations reconsidered for short-term variations. Examples are abatement technologies for petroleum refining and pulp and paper. In addition, the statistical method employed by EPA for determining short-term, contrasted with long-term, effluent limitations was not consistent for all industries. Considering the lack of background data, it might have been appropriate to prescribe only long-term effluent limitations for BAT until an adequate data base is developed. Some of the suggested technologies are not now being used for the specific, designated application within a given industry. In other cases, the indicated technology must be transferred from some other industry. While, strictly speaking, the technology is "available," it has not heretofore been used for the purpose intended in the limitation. Some examples are metal finishing, organic chemicals and iron and steel. As with some BPT limitations, problems can arise where suggested technologies for a given production process waste stream must be applied to combined waste streams from several production lines, for some of which there may be individual limitations, and for some of which there are not yet -- and may never be -- promulgated effluent limitations.

Several technological solutions for both 1977 and 1983 limitations are founded upon reduction in water use or by-product recovery. These options are likely to have wider application for BAT than for BPT. The full potential of such approaches is undeveloped, but will probably become more prevalent as limitations become more stringent and technologies for treating large wastewater volumes become more expensive.

New source performance standards are required for "any source, the construction of which is commenced after the publication of proposed regulations prescribing a standard of performance, ... if such standard is thereafter promulgated." [Sec. 306(a)(2)] The "standard of performance" is to be that for "control of the discharge of pollutants which reflects the greatest degree of effluent reduction which the Administrator determines to be achievable through application of the best available demonstrated control technology, processes, operating methods, or other alternatives, including, where practicable, a standard permitting no discharge of pollutants." [Sec. 306(a)(1)] Those point sources which comply with these standards "shall not be subject to any more stringent standard . . . . during a ten-year period" from the date construction is completed or during the depreciation or amortization period whichever ends first. [Sec. 306(d)] Technologies considered necessary to meet these standards are often similar to BAT.

Some difficulty may be encountered where technology transfer is required. However, more pollutant reduction options are available to the designer of new facilities than in retrofitting existing facilities, and this capability should mitigate transfer difficulties.

The process of identifying "any toxic pollutant or combination of such pollutants" and establishing effluent standards, which can include "a prohibition of the discharge," has not been completed by EPA. [Sec. 307(a)(1)]. Based upon preliminary proposed regulations naming benzidine, cyanide, cadmium, mercury, polychlorinated biphenyls and the pesticides aldrin, dieldrin, DDT, DDD, DDE, endrin and toxaphene, several industries will be impacted by toxic pollutant controls. Among them are iron and steel (cadmium, cyanide and mercury), petroleum refining (cadmium and cyanide), metal finishing (cadmium and cyanide), inorganic chemicals (cadmium and mercury), textiles (benzidine) and pulp and paper (mercury). Adequate evaluation of available technologies and costs were not possible, although techniques to reduce toxics were explored and technologies for some industries are available.

B. Economic Effects -- 1983

QUESTION: *What are the relative industrial costs and economic impacts of achieving the 1983 requirements?*

ANSWER: *Relative to the capital cost requirements for the installation of BPT, the 1983 requirements for BAT are estimated to be somewhat reduced. Demands on three industries -- chemicals, metal finishing and machinery and mechanical products -- will account for 75 percent of the total capital outlay.*

Industrial Impacts

Expenditures for those plants in place as of June, 1973, that will incur costs to achieve BAT are estimated at $23.2 billion. Predicting national industrial growth from 1973 through 1983, and applyine new source performance standards (NSPS) to new or expanded plants, the Commission estimated an additional expenditure of $19.9 billion. Together, the cost to industry for meeting BAT and NSPS between now and 1983 could reach over $43 billion.

Added Expenditures for 1983 Requirements

Economic Impact Expenditures	Existing Plants Amount (Billions 1975 $)	New Sources 1973 to 1983 Amount (Billions 1975 $)
Iron and steel	$ .56	$ .65
Organic and miscellaneous chemicals	3.64	2.25
Inorganic chemicals	.26	.35
Petroleum refining	1.18	.29
Pulp and paper	.44	.73
Metal finishing	8.21	3.97*
Fruits and vegetables	.10	.05
Plastics and synthetics	.29	.09
Textiles	.20	.28
Steam electric power	2.03	.90
Feedlots	.14	.23
All other industry	6.18	10.11
Total	$23.23	$19.90

*Excludes captive shops included in machinery and mechanical products ($8.30 billion, under all other industry).

No costs are included for any technology more sophisticated than BAT for discharges into water quality limited waters, nor is there inclusion of cost estimates for control of toxic pollutants except where control may be a result of the application of BAT limitations. While the exactness of these estimates is subject to question, they do indicate an order of magnitude of needed expenditure. Greater opportunities to reduce the generation of pollutants exist in the design of new production processes and facilities than can be identified in the retrofitting of existing plants. Also, as the price of water and costs of wastewater treatment and residuals increase, there will be definite economic incentives for industrial producers to reduce the quantities of water used and the wastes generated.

Costs of operation and maintenance of the treatment technologies installed as a result of the BAT requirements will be high -- $5.8 billion annually. Operation and maintenance costs for new sources will be spread throughout the period from now to 1983, and will be relatively small in any one year.

Based on estimated energy requirements from the Commission's technology studies, a conversion of all energy required to meet BAT to one type of fuel -- oil -- 211,000 barrels would be required daily in excess of the amount to achieve BPT for just those industries in place in June, 1973. This is equal to a 0.6 percent of the 1973 national energy use. The energy penalty resulting from installation of cooling towers at steam electric power plants projected to be in place in 1983 included in the above requirement could add from 0.06 percent to 0.4 percent, depending on the assumed number of 316(a) exemptions.

Industrial users of publicly owned systems ordinarily enjoy a subsidy of about 45 percent of capital costs, even with industrial capital cost recovery, since the industrial user avoids interest payments on his proportion of the Federal share of capital investment. Industries with compatible waste thus gain the advantage of both economies of scale (which may account for a saving of up to 80 percent for small users) and a substantial subsidy. This advantage will exist only so long as pretreatment standards are applied to actually incompatible wastes; if these standards are so applied as to equalize costs between direct dischargers and those using public systems, the advantage is eliminated. A direct discharger able to take full advantage of accelerated depreciation for pollution abatement expenditures, state and local tax relief and the interest differential of industrial revenue bonds for financing, may realize a total subsidy almost as large as that available to industries connected to public systems.

At the time Commission analyses were being completed, pretreatment standards were generally the same for 1983 as for 1977, i.e., BPT for industries discharging incompatible wastes to publicly owned treatment works. The latest EPA proposal (July 9, 1975, and subsequent internal redraft dated September 10, 1975) indicates that these standards may be changed to require BAT as a prerequisite for industries discharging incompatible wastes to publicly owned systems after July 1, 1983. As the capital costs of pretreatment plus recovery of the industries' proportionate share of the capital cost of treatment works approach or exceed the capital cost of installing BAT, the remaining incentive for industries to discharge into these systems is any savings on the capital expenditure represented by the interest differential between municipal and private borrowing -- which can be very attractive. Some industries within urban areas where land or space is limited are precluded from the option of constructing separate BAT facilities. Neither capital cost recovery nor costs for use of publicly owned treatment works are included in the industrial costs stated here.

The majority of plant closures are predicted for plants discharging to municipal systems defined by EPA as having incompatible pollutants. Since pretreatment standards remain in a state of flux, the exact number of plant closings of this type must remain an estimate based upon pretreatment guidelines suggested at the time Commission studies were

I N D U S T R Y

Economic Impact Expenditure Estimate

(Millions of 1975 Dollars)

Indepth[a]	BPT (1977) Capital	BPT (1977) Annual O&M	BAT (1983) Capital	BAT (1983) Annual O&M	1975-83 NSPS K
Fruits & Vegetables	167	15	96	10	47
Inorganic	805	178	261	104	351
Organic	3325	487	2990	2242	1873
Misc. Chemicals	965	163	650	228	380
Iron and Steel	2080	322	556	202	647
Metal Finishing-Job[b]	1715	328	780	168	3967
Captive[b]	7418	2275	7428	1365	f
Petroleum Refining	829	142	1184	429	294
Plastics & Synthetics	209	33	286	29	91
Pulp and Paper[b]	2194	111	437	20	734
Steam Electric[c]	4089	989	1275	16	900
Textiles	458	58	203	61	275
	24254	5101	16146	4874	9559
Other					
Ore Mining and Dressing[d]	610	25	0	0	146
Coal Mining[d]	1700	95	0	0	0
Petroleum & Gas Ext.[d]	234	18	1070	61	266
Mineral Mining & Proc.	730	72	0	0	496
Meat Products & Rendering	148	20	181	10	64
Dairy Products	188	13	73	5	0
Grain Mills	33	2	8	1	0
Cane Sugar Processing	153	17	170	13	8
Beet Sugar	90	17	69	5	2
Canned & Preserved Seafood	41	12	120	12	38
Misc. Food & Beverages	5	1	5	1	4
Timber Products	14	1	25	8	33
Furniture and Fixtures	8	3	0	0	2
Bldg. Paper & Board	120	12	0	0	13
Paint and Ink	23	22	0	2	2
Soap and Detergent	10	1	2	0	2
Phosphate Mfg.	73	9	14	1	46
Fertilizer Mfg.	77	50	64	23	50
Paving and Roofing	6	6	4	1	1
Rubber Processing	220	18	48	12	299
Leather Tanning	77	20	47	7	13

	BPT		BAT		
	Capital	Annual O&M	Capital	Annual O&M	1975-83 NSPS
					K
Glass Mfg.	42	5	16	3	26
Cement Mfg.	34	4	9	1	12
Concrete, Gypsum, Plaster	100	26	0	0	36
Asbestos	4	1	9	4	3
Insult. Fiber	14	6	0	0	3
Ferroalloy Mfg.	48	16	13	3	11
Nonferrous Metals [b,e]	40	21	31	7	39
Machinery & Mechanical Prod. [f]	3900	390	3900	390	8295
Transportation Industry	1200	130	140	39	137
Water Supply	1200	160	100	3	28
Auto & Other Laundries	25	4	21	1	8
Foundries	180	26	0	0	0
Fish Hatcheries	50	10	47	31	--
Structural Clay	5	1	0	0	2
Pottery	3	1	4	3	1
Steam Supply	0	0	0	0	--
Nonferrous Mills	260	25	0	0	33
Feedlots					
Beef	100	8	30	0	225[g]
Hog	178	9	59	0	--
Dairy	152	10	46	0	--
All Other Industries	12095	1287	6325	647	10344
In-depth Industries	24254	5101	16146	4874	9559
Total	36349	6388	22471	5521	19903

(a) Cost estimates for all Indepth industries (except Iron and Steel) and seven of the Other Industries (Meat Products and Rendering, Dairy Products, Grain Mills, Leather Tanning, Nonferrous Metals, Fertilizer and Feedlots) represent costs only for those plants which are projected to remain open.
(b) Municipal user charges included.
(c) Some growth included in BPT and BAT estimates.
(d) These cost estimates were based upon a preliminary contractor report. The Commission believes the cost estimates presented in Table II-30 are more accurate; the cost estimates presented here are included because they were used in the impact analysis.
(e) These cost estimates were based upon a preliminary contractor report. The differences in these estimates and those presented in Table II-30 are principally due to two factors: (1) the estimates in Table II-30 include $83 million for two bauxite refineries on the Mississippi River to meet BAT requirements not included in the cost estimates above; and (2) the Nonferrous Metals estimates in Table II-30 do not attempt to take account of treatment facilities in place as of January, 1973, for primary aluminum smelting and refining, a subsector of Nonferrous Metals.
(f) Metal Finishing BPT and BAT costs are excluded from Machinery and Mechanical Products BPT and BAT costs, but Metal Finishing Captive NSPS costs are included in Machinery and Mechanical Products NSPS costs.
(g) Includes all Feedlots.

SOURCE: National Commission on Water Quality.

CAPITAL COSTS TO INDUSTRY
(Billions 1975 dollars)

Industry	1977 Technology[1]	1977 Economic[4]	1983 Technology[1]	1983 Economic[4]
Iron and steel	$ 2.91	$ 2.08	$ 0.95	$ 0.56
Organic & Misc. Chemicals	4.29	4.29	3.64	3.64
Inorganic Chemicals	0.52	0.81	0.25	0.26
Petroleum Refining	1.05	0.83	1.18	1.18[5]
Pulp and Paper	2.64	2.19	0.80	0.44
Metal Finishing	14.14	9.13	14.09	8.21
Fruits & Vegetables	0.44	0.17	0.16	0.10
Plastics & Synthetics	0.16	0.21	0.29	0.29
Textiles	0.54	0.46	0.30	0.20
Steam Electric Power	3.74[2]	3.74	2.03[6]	2.03[6]
Feedlots	0.71[3]	0.43	0.17[3]	0.14[7]
All Other Industry	10.94	11.66	7.64	6.18
TOTALS	$ 42.08	$ 36.00	$ 31.50	$ 23.23

(1) Does not include growth or plant closures (except as noted otherwise).
(2) Includes growth to 1977.
(3) Includes growth and assumes coverage of all feedlots; assuming EPA proposed regulations of November 1975, 1977 + $0.11 billion; 1983 + $0104 billion.
(4) Includes closures, but not growth (except as noted otherwise).
(5) Closures are negligible.
(6) Includes growth to 1983. Costs range from $2.03 billion to $7.96 billion, depending on assumed exceptions.
(7) Includes all categories of feedlots with a limited number covered in each category; 1983 figure includes growth to that year.

RECAP OF ABOVE

	Technology	Economic Impact
1977 --	$ 44.31	$ 36.00
1983 --	30.56	23.23
TOTAL	$ 74.87	$ 59.23

OPERATION AND MAINTENANCE -- Annual Costs

Technology: $ 7.7 billion -- 1977 requirements
6.2 billion -- 1983 requirements*
$ 13.9 billion annually

Economic: $ 6.8 billion -- 1977 requirements
5.8 billion -- 1983 requirements**
$ 12.6 billion annually

*Range from $6.2 to $6.9 billion depending on assumed exemptions for steam electric power.
**Range from $5.8 to $6.5 billion depending on assumed exemptions for steam electric power.

completed (June 1975). Changes in the level of stringency do not change which plants in an industry are most adversely affected. The segment of industry with disproportionately higher costs for BPT requirements is the same segment with disproportionately higher costs for the BAT requirements. Few plants could justify the expenditures required to reach BPT requirements if they were going to close rather than meet the BAT requirements.

Plant closures are significant in six industries: pulp and paper, metal finishing, textiles, fruits and vegetables, feedlots* (including dairies) and meat packing. They are concentrated in a small high-cost segment of the industry (usually 5-10 percent of capacity). They are generally the old, small, single-plant firms, that in many cases could not remain economically viable over the next decade in the absence of water pollution controls.

Beyond those plants that would close due to depressed profits, the profit level for remaining industry is not substantially impacted. The steam electric power industry is an exception, with a .3-.7 percent absolute decline in the present rates of return on a rate base in an industry where profits are already depressed.

BAT results in smaller price increases than do the BPT effluent limitations. By 1985, the average price increase for all industries due to BAT (including interest and O&M) is 2.8 percent. This is equivalent to a .27 percent annual rate of inflation. The highest price increases are from 3.0-4.6 percent for industries which make extensive use of metal finishing services such as fabricated metal products, instruments, non-auto transportation equipment, non-electrical machinery and chemicals. The price of metal finishing services increases 20 percent. By 1985, the total price increases due to BPT and BAT effluent limitations are predicted to be 9.0 percent.

General Effects on the Economy, 1975-1985 -- In an attempt to evaluate economic effects of P.L.92-500 upon general economic activity, 13 alternative sets of variables (scenarios) were analyzed to estimate a range of possible results. In all cases, impacts on GNP (Gross National Product), prices, employment and investment were predicted to be smaller than normal fluctuations in these variables.

Inflation is 9 percent above baseline projections in 1985, indicating an inflation rate that is .9 percentage points higher, due to the imposition of pollution abatement standards. It should be noted, however, that in these calculations, no value is assigned to such "free goods" as water and air. As a result, improved water quality is not given an increasing value in assessing the average price of goods and services.

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* The predicted closures are based upon a limited number of covered feedlots in each category; the prediction may still remain valid under the latest EPA proposal (November 1975).

GNP and employment are stimulated in the remainder of the 1970s and depressed in the 1980s. The maximum addition to unemployment is .9 percent of the work force; unemployment has ranged from 3.5 percent to more than 9 percent in the last decade.

Impacts on plant and equipment investment and housing are negative. The stimulative effects of the abatement expenditures tend to offset the depressive effects via increased costs and prices. The most negative effects are projected to be in the latter years when both residential and non-residential investments are projected to be as much as 7.3 percent below baseline projections.

Productivity is positively affected by the requirements of the Act in years of high unemployment and unused capacity since an increase in output is often possible without proportional increases in overhead costs. The increased costs of production because of water pollution abatement tend to offset the positive effects so that, in most years, productivity declines slightly -- that is, total employment increases more (or decreases less) than total output.

Results of analyses of the several sets of assumptions or variables (scenarios) reflect that:

A smooth pattern of total industrial expenditures through 1983 yields smaller impacts in the 1976-1978 prices.

High levels of public expenditures would add to stimulative impacts and less to inflationary impacts.

The additional economic impacts associated with BAT (over BPT and NSPS) represent about one-third of the total impact after 1980, and less than one-fifth of the negative impacts on GNP and employment.

If actual industrial expenditures are one-half of Commission estimates, general economic impacts will also be approximately one-half of those forecast.

If high unemployment rates continue into the 1980s, the economic impacts will be little different from those forecast. Stimulative effects would last slightly longer and inflationary impacts would be somewhat smaller.

If 25-50 percent of the abatement investments are in productive equipment (product and process changes), inflationary and stimulative effects are significantly less than otherwise. Stimulative impacts would also last two-three years longer and the depressive effects in the later years would be much smaller.

The addition of air pollution abatement expenditures (approximately one-third the size of the water pollution abatement expenditures) tends to increase all impacts proprotionately. The depressive effects outweigh the stimulative a year earlier (1981 vs. 1982) than in the comparable case without air expenditures.

Supply Constraints -- Strict industrial and municipal compliance with the 1977 and 1983 deadlines for P.L.92-500 would cause severe shortages of sanitary engineers needed to design and construct water pollution abatement facilities. Enrollment of both undergraduate and graduate college students in the requisite engineer fields is declining. Current unemployment levels in the construction industry indicate that construction labor will not be an impediment to achieving the requirements of P.L.92-500.

Chances of shortages of materials, especially pipes, valves and fittings; structural clay products; service industry machinery; industrial controls; and cement and gypsum, increase if the 1977 and 1983 deadlines are strictly enforced. Current over-capacity in the water pollution control equipment industry should provide adequate supply of specialty equipment.

Spreading expenditures for water pollution control over a longer period can substantially eliminate shortages. A reasonably "smooth" pattern of pollution abatement expenditures should cause relatively low price increases.

Tight supplies of chlorine, caustic soda, lime and soda ash can occur in the future, but primarily from demands for other uses. Even major changes in wastewater treatment demand will not add significantly to the total demand. Municipalities' recent experiences with chemical shortages may stimulate better methods of insuring adequate supplies in the future.

C. Social Effects and Benefits -- 1977 and 1983

QUESTION: *Who is likely to bear the adverse social impacts from the achievement of the water quality requirements and goals?*

ANSWER: *Adverse impacts will fall most heavily on the employees and owners (either individual or corporate) of those industrial plants closed as a result of the implementation of the 1977 and 1983 effluent limitations. Generally, small older businesses will be adversely affected. Employment losses from plant closures, both direct and indirect,*

could amount to over one-quarter million jobs with full implementation of BPT and BAT limitations. Other categories adversely impacted will be the moderate-income family seeking to enter the housing market for the first time, and the low-income resident who will bear a higher relative cost of the local share of financing pollution control facilities relative to his income as a result of the shift from property taxes to user fees.

Heaviest job losses are indicated for the industrial categories of textile manufacturing, electroplating, pulp and paper, and meat and dairy processing. The majority of lost employment is expected to occur in the Northeast and North Central states, and a consequence may be a shift in jobs favoring the South. Women and white males will be most affected. Women are 50 percent of the labor force in the textile industry, while white males dominate the labor force in those portions of the electroplating and pulp and paper industries that would be most likely to close. Minorities do not appear to bear a disproportionate share of job losses. Thus, while benefits may be fairly evenly distributed geographically and demographically, the unfavorable impacts of the Act's implementation are not.

The average cost per family for treatment plant and interceptor sewer needs and for BPT will be $306 yearly, while the costs per family for both BPT and BAT and all municipal categories except urban runoff, assuming achievement in 1985, will be $522 yearly. Each case is based upon the families actually to be serviced by these projects. Excluding industrial cost recovery and cost of secondary or indirect price increases, the Federal income tax and user charges are the two most important revenue sources for the financing of the publicly owned treatment works program. User charges weigh particularly heavily on low-income groups, while the Federal income tax is more progressive. One important consequence of Federal funding is to shift burdens from lower income groups and from regions like the South with low incomes relative to the rest of the nation. The price increases caused by the Act weigh most heavily on the lowest income families, and next upon the middle income families.

QUESTION: *How many jobs will be created by the implementation of P.L.92-500? What kind of jobs will they be and how well distributed geographically and demographically?*

ANSWER: *New jobs, due to construction activities, reach a peak in 1977 of 472,000, and remain over 100,000 per year through 1983.* Overall, between 1975 and 1985, implementation of the Act will create a total of 11.5 million new jobs, a majority of which will be associated with publicly owned treatment facilities.*

One characteristic of treatment plant construction is its higher requirement for non-professional and unskilled labor, unlike requirements for other types of pollution control which tend to require relatively more professional and technical skill. The increased demand for construction labor could be significant at a time when construction trades are experiencing 20 percent unemployment. Also, because the treatment facility requirement is geographically distributed throughout the nation, the impacts would be widespread, providing new opportunities for employment in construction work in towns and cities all over the nation.

Other categories of employment directly benefit from the Act's implementation such as the professional fields of sanitary engineering, civil engineering and planning and environmental consultants.

QUESTION: *Who benefits? Are there identifiable publics that receive the benefits derived from improved water quality?*

ANSWER: *Sports fishermen, commercial fishermen, seafood canners and processors and those commercially associated with water-based recreational pursuits -- especially recreational boating -- will be major beneficiaries of the Act. Property owners, too, of riverside and shoreline properties will enjoy not only the benefits of improved water quality adjacent to their property, but also the increased value of the property, as well.*

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*Assumes BPT met by 1977 with expenditures over three years, and BAT met by 1983 with expenditures spread over six years; and $60.9 billion for publicly owned treatment works spread over 11 years.

Water-based recreational pursuits are so popular and prevalent in the United States that, with the exception of portions of the arid Southwest, most Americans are within reasonable distance of water bodies, many of which could provide increased recreation with improvements in water quality. The public, in general, will also benefit from a larger abundance of marketable fish and shellfish which should reduce prices to the consumer.

One major positive social impact of achieving the Act's interim goal will be to open recreational opportunities to low and middle income urban residents where they have been, heretofore, limited or nonexistent. For reasons of historic, commercial and cultural significance, most of the major cities in the U.S. are located next to the water -- on major lakes, rivers or coastal sites. Cleaning up adjacent heavily polluted waters would provide recreational opportunities near urban dwellers. Increased water-oriented recreation would be possible, however, only if the public had access to the water. The Commission study of beach closings and openings identified this possible result as an especially significant factor -- opening beaches in the heavily settled regions of the Northeast, the Great Lakes and the Central-Atlantic regions.

Conversely, increased benefits to property owners may not be widely distributed, possibly indicating the need to secure or provide access to the waters of improved quality so that the citizens who have borne the cost of the clean-up can also enjoy the benefits of the endeavor.

QUESTION: *Are the benefits from the achievement of the 1983 interim water quality goal quantifiable, and what will they amount to?*

ANSWER: *Improved water quality will provide the American public with greatly expanded opportunities for water-based recreation, sports fishing and the commercial harvesting of fish and shellfish. Each of these activities will result in directly measurable benefits to individuals, segments of society and to the economy in general. Translated into dollar gains, the quantifiable benefits for these activities, measured by the Commission studies, could range from an annualized $3.2 to $4.2 billion by 1980, to between $4.8 and $6.2 billion by 1985. There will be additional unquantifiable benefits resulting from aesthetic changes in water bodies and water-related activities, as well as indeterminate dimensions of benefits to the public health and welfare that will undoubtedly result from the removal of toxics, heavy metals and other pollutants from the nation's waters.*

Marine fishing resources may be affected in two ways: (1) The reopening of many shellfish areas now closed to harvesting mainly as a result of the discharge of raw or insufficiently treated sewage; and (2) the increase in productivity of existing fisheries through improved water quality. Assuming the timely implementation of the Act to achieve the interim goal by 1983, estimates of the aggregate measure of benefits associated with commercial marine fisheries rises to more the $575 million per year by 1985.

Projections of sport fishing in marine waters suggest an increase of around 76 percent over 1974 participation, or almost 237 million additional days of sport fishing that may be available yearly beginning in 1985. Again, assuming the Act's implementation proceeds on schedule, the economic value of these additional fishing days may approach $3.2 billion per year by 1985. Freshwater fishing is expected to increase by 1985 with resulting benefits approximating $220-$559 million per year. Projected increases in boating activities appear to be even more substantial as a result of the water quality improvements, since boating activities do not depend on the resource availability in the way that satisfactory fishing experiences depend on availability of fish. As a result, boating is estimated to produce benefits reaching $498 million to $1.15 billion per year by 1985, excluding water-skiing, canoeing, sailing and other water-based and water-related activities dependent, at least in part, on the quality of the water for a satisfactory experience. No attempt was made to quantify benefits related to these latter activities because of inadequate historic data to establish clearly the relationship between water quality and the particular activity. These activities are likely to increase in proportion to perceived improvements in water quality and, together, represent a large sector of unquantified benefits.

Swimming activities are correlated with the availability of beaches meeting public health criteria. Nationally, if all public beaches now closed to swimming as a result of water pollution were to be opened, an estimated 1,128 miles of shoreline and 7,165 acres of public beach area would be affected during the swimming season. Opening these beaches could provide up to $129 million in annual benefits from new activities and an additional $392 million annually in diverted activities by 1985. Benefits from beach openings are projected to be concentrated in the New England, Mid-Atlantic and Great Lakes regions, where the combination of population concentrations and large beach areas now closed to use offer a potential for expanded public recreation.

QUESTION: *Are these short-term benefits?*

ANSWER: *No. Assuming the maintenance of the water quality, these gains will continue to accrue far into the future. By the year 2000, an estimate for the recreational benefits from marine fishing could climb as high as $4.4 billion per year, and annual quantifiable benefits for all activities could range from $6.3 to $8.5 billion by 2000.*

Land values of shore and riverfront property are expected to increase as the water quality improves. The generally higher price of shorefront property places a premium on these areas adjoining water of satisfactory quality for recreation. As the public recognizes quality improvements in deteriorated reaches along rivers and beaches, the value of nearby property will rise as a measure of the buyer's willingness to pay more for the perceived quality improvement available at the shorefront location. Commission studies estimated these increased property values reaching a level of almost $93 million per year after assumed achievement of the water quality goals by 1985. Since property values have shifted upward in a permanent trend, the estimated benefit level can be assumed to continue indefinitely into the future.

QUESTION: *Are there unquantifiable benefits associated with the achievement of the 1983 interim water quality goal?*

ANSWER: *Yes, two important kinds: (1) Those not fully identified yet, such as health effects, where quantification now is impossible; and (2) Those associated with non-contact related experiences.*

Empirical information for the nation establishing the exact association between long-term exposure to low concentrations of carcinogenic chemicals in drinking water and human health is woefully lacking. Recent studies purporting to connect high incidence of cancer with persistent chemical concentrations in drinking water suggest profound implications for the health of the American public and the need to launch a full-scale detailed analysis to identify possible direct association with trace chemical concentrations in drinking waters and human health. The implementation of the Act, with its emphasis on removal of toxic or potentially toxic materials, could provide immeasurable benefit to present and future populations of Americans. While the reduction in upstream discharges of pollutants will have some effect on the quality of water withdrawn downstream,

any reduction in municipal or industrial water supply treatment costs is expected to be minimal and may be offset by the costs of sludge disposal of substances removed in water supply treatment which can no longer be returned to the source of supply.

Many people perceive a real benefit to clean water, even though they do not participate in water-related recreational activities. Although not subject to exact measurement, individuals -- and the public generally -- take satisfaction in the knowledge that the quality of the water of a particular stream or lake -- or of the waters of the nation, in general -- are improving. Measurement of public attitudes toward water pollution control programs give ample support for this contention.

D. Environmental Effects -- 1983

QUESTION: *Do incremental improvements in water quality characteristics associated with achievement of the 1983 effluent limitations contribute significantly to the realization of the 1983 goal?*

ANSWER: *In most cases, the gains are projected to be less than those indicated for achievement of the 1977 requirements.*

Measuring the incremental environmental effect beyond achievement of Phase I (1977) to the next level of effluent limitations (1983) -- that of BAT for industrial and agricultural dischargers and BPWTT for municipal sources -- becomes highly conjectural. The capacity to predict within reasonable accuracy the future disposition of a dynamic ecosystem under constantly changing stresses is limited, at best. Recognizing these very real limitations, the environmental effects of the application of the next more stringent level of treatment to point source discharges (1983 requirements) would appear to provide less improvement in the physical and chemical indicators than achieving the 1977 requirements. Additional portions of rivers and other water bodies do reach the minimum quality standards reflecting the interim goal of a quality that "wherever attainable" "provides for the protection and propagation of fish, shellfish, and wildlife and provides for recreation in and on the water." Potentially, the resulting improvements from the 1983 requirements could provide an estimated additional 10 to 15 percent increase in suitable areas for game fish habitat resulting, primarily, from improvements in the DO level, control or elimination of toxic substances and nutrient removal. More shellfish areas and beaches could be opened if flows from combined

storm and sanitary sewers were brought effectively under control in some places. Depending upon the level and effectiveness of control of toxic substances, wildlife and waterfowl would be less endangered. These are significant advances, but improvements will not be so widespread nor so large as from the application of 1977 requirements.

Many areas, including some large urban industrial centers located on fresh waters, are already requiring control or treatment measures more stringent than the technology-based effluent limitations for 1977, based generally on the allocation of pollutant discharge loads so as to assure the maintenance of desired water quality. Major municipal dischargers in these areas are generally required to reduce effluent BOD and suspended solids concentrations by one-third to one-half the levels achievable with secondary treatment. Major industrial dischargers are generally required to meet limitations more stringent than BPT, but less than BAT requirements. Where these measures are being implemented, the achievement of standards or the attainment of improved water quality is deemed to require and justify a degree of pollution control beyond that of the 1977 technology-based limitations.

Even after achievement of the 1983 requirements, a number of potential residual dissolved oxygen problems may persist, resulting from urban runoff and combined sewer overflows. For portions of 15 of 38 sites (36 percent), projections indicate that more stringent treatment than that for 1983 will be required to achieve adequate DO levels. Little improvement in fecal and total coliform bacterial levels can be expected since the major remaining sources of coliform bacterial loading is attributable to uncontrolled nonpoint sources which may be unaffected by implementation of the 1983 point source requirements.

Progress toward identification and elimination of toxic substances will be a more critical indicator of achievement of the 1983 interim goal, since toxic substances are present now at all sites for which data are available. In the absence of effluent limitations for toxics control, the extent to which concentrations of heavy metals from industrial discharges will be controlled by the application of BAT to industrial dischargers is unknown. Also, by 1983, it is conceivable that additional materials will be identified as toxic in certain concentrations and subject to effluent limitations and control. Which substances or in what concentrations, however, is impossible to predict. Aside from municipal and industrial wastes, toxics from other sources, such as heavy metals contained in urban storm runoff and mine drainage and pesticides concentrated in runoff from agricultural lands or forested areas, are recognized as having potential for catastrophic effects on plants, fish, wildlife or humans.

Unfortunately, limited knowledge of what concentrations of a potentially toxic material constitute a danger in the environmental system precludes complete identification of all toxics. A sophisticated knowledge of long-range biological effects of small concentrations is lacking. Although tolerance ranges have been established in the laboratory for a number of substances under rigidly controlled, simulated environmental conditions, adequately defining a toxic substance under natural environmental conditions is difficult. Information is also lacking on the pathways and movements of toxic materials in the environment, including recycling from sediments and chronic and sublethal effects and impacts.

Accumulated residues of historical pollutant discharges may continue to pose a threat even after their sources have been controlled or eliminated. For example, pollutants attached to sediment particles concentrate where sediments are deposited and remain there until disturbed or dissipated. Sludge blankets or benthic deposits from uncontrolled discharges in the past continue to affect ambient water qualities.

Delay in achieving control or treatment measures allows these depositions of materials to continue and may eliminate some of those already depleted aquatic food chain species before corrective measures provide an opportunity for their restoration. Additional growth during the period of delay, either industrial or population, even with application of wastewater control or treatment, contributes to the total pollutant load and may produce further water quality degradation. Ultimate installation of the required technologies may not always be able to overcome the consequences of the delay.

Even achievement of the 1977 requirements, secondary treatment for publicly owned treatment works, may pose environmental problems. Required chlorination of municipal effluents to reduce fecal and coliform bacteria counts can adversely affect aquatic organisms. While this disinfection is usually justified as a measure for protection of public health, other methods of disinfection that do not have this adverse environmental effect, such as ozonation, are practiced elsewhere.

For 70 percent of the environmental sites, the high coliform counts result either from urban runoff or agricultural and other nonpoint sources. These sources are not affected by the 1977 and 1983 point source control or treatment requirements.

III. TECHNOLOGICAL ASPECTS AND ECONOMIC EFFECTS OF 1977 AND 1983 REQUIREMENTS APPLIED TO AGRICULTURE

QUESTION: *Are agricultural point sources of pollutants amenable to the technological concepts of BPT and BAT?*

ANSWER: *Some are, such as feedlots. Others, such as irrigation return flows, present unique and widely variable problems when attempting to apply universal uniform effluent limitations requirements of P.L.92-500.*

QUESTION: *What is being done to implement BPT for irrigation return flows?*

ANSWER: *Since EPA has defined the 1977 requirement as monitoring the quantity and quality of intake water supply and irrigation return flows, BPT -- as so far defined -- is technologically achievable. Complex and widely varying systems by which excess water applied for irrigation reaches surface and ground waters in the vicinity of its application, do present even monitoring problems, however. Known control technologies currently available are not so well developed as to assure their universal practicable application with predictable results.*

* * * * *

QUESTION: *Is "best available technology economically achievable" to control pollutants in irrigation return flows technologically attainable by July 1, 1983?*

ANSWER: *No, simply because no universally applicable or effective technology has been developed which can be applied with reasonable predictable results for all geographic areas.*

* * * * *

QUESTION: *Should statutory provisions, intended to control pollution from irrigation return flows, remain a part of P.L.92-500?*

ANSWER: *Yes, if they should be so formulated and designed as to recognize the variety of pollutant effects, the unique institutional structure of irrigated agriculture, the wide geographic differences in irrigation objectives and practices, and the state-of-the-art for control practices and measures for reducing pollutants from irrigated agriculture.*

A. Feedlots

Technology costs and economic effects of applying BPT and BAT to beef cattle, dairy, hog and turkey feedlots have been included in analyses already discussed; those for layers, broilers and horses were not examined because there is generally little liquid discharge; and those for catfish* and ducks** were given cursory examination but not reported because of their localized importance. The cost of controlling point source discharges from feedlots to the BPT level is very high for small operations of all types in wet and cold regions of the country. Investment costs range up to $160 per head of capacity for small dairies in the upper tier of midwestern and eastern states and in the southeast. Costs are much lower for large operations of all animal types in milder, drier climates, ranging down to $48 per head of capacity for an 800-head dairy, $14 per head of capacity for a 20,000-head beef feedlot, and $5 per head capacity for a 1,500-head hog feedlot. Comparable ranges for costs for installing BAT and $231 for small dairies to $57 for 800-head; $35 for 20,000-head beef feedlots and $10 per head for a 1,500-head hog feedlot. Price increases, decreased profits and feedlot closures because of pollution control expenditures, other than dairies for which the distribution is general nationally, reflect the same geographic pattern of higher costs that occur for small operations in wet, cold regions. One of the major problems with feedlots has been limiting application of P.L. 92-500 to the significant discharges. After a judicial ruling that EPA's classification was inappropriate, the Agency has now issued new, proposed regulations (November 20, 1975).

B. Irrigation Return Flows

Difficulty with applying the "best practicable control technology currently available" (the 1977 requirement) and "best available technology economically achievable" (the 1983 requirement) to irrigation return flows results from the wide variation in irrigation practices, selective underdraining of irrigated lands and historical appropriative surface water rights dependent upon available quantity flowing in watercourses. There is little doubt that Congress intended to include irrigation return flows as a point source subject to effluent limitations and NPDES permits, but the BPT and BAT limitations concepts, even with all the problems their application has encountered, are more simply and easily applied to industrial than to irrigation discharges. Some irrigated land is underdrained; some not.

*Reliable, comprehensive, national data were not available.

**Available data show 63 duck farms with about one-third on Long Island, New York and most of the others in Indiana.

Drainage systems have been installed on about 55 million acres of non-irrigated land and on about 5 million acres of irrigated land. The underdrains and runoff collected in them are point sources, while excess irrigation water that may enter surface watercourses by sheet runoff or by percolation through the soil is not. The concentrations of all pollutants except dissolved mineral salts can be expected to be similar in drainage from irrigated and non-irrigated land. Some underdrained irrigated land accumulates percolating irrigation water applied to its upslope neighbors; the discharge is a point source accumulated from several irrigators. Even where there is a "discernible, confined and discrete conveyance" such as a "pipe, ditch, channel, tunnel, conduit, well, [or] discrete fissure," irrigation return flows from many farms may be indiscriminately commingled before they can be adequately monitored or treated, if treatment becomes necessary. Sometimes efficient application of irrigation water may decrease pollutants, but it can also reduce the quantity of water stored in the soil that later percolates into surface watercourse or groundwater aquifers to provide a sustained supply to downstream or downslope users. Reducing water withdrawals during high flow periods may result in lower and more polluted flows during dry seasons.

As with feedlots, EPA attempts to fix a size or numerical limit for irrigation return flow point sources below which BPT or BAT limitations would not apply have been unsuccessful. Thus far, EPA has accepted monitoring the intake supply and discharge quantity and quality as compliance with the 1977 requirement; parameters to be measured include flow, suspended solids, total dissolved solids or specific conductance, turbidity and sometimes nitrates and other variables as conditions at the site may dictate.

More than 90 percent of all irrigated acres (39 million) and all irrigated farms (257 thousand) are in twenty states; two states, California (with 18.5 percent of irrigated acres, 7.2 million, and 19.9 percent of irrigated farms, 51 thousand) and Texas (with 17.6 percent, 7.0 million acres, and 11.9 percent of irrigated farms, 29 thousand) account for 35 percent to 40 percent of the national total. About 41 percent of all irrigation water is supplied from groundwater, 15 percent by direct diversion of surface water, and 44 percent by irrigation organizations, including around 20 percent from Bureau of Reclamation projects. The pollutant of most concern, dissolved salts, is perhaps more critical in California and those states entitled to use water from the Colorado River. Sediments contained in return flows represent a generalized contribution while nutrients (nitrates) and toxic pesticides are of more localized concern.

Four primary methods are used for applying water to land; about 54 percent is irrigated by furrows or ditches, 30 percent by flooding,

15 percent by sprinklers and 1 percent by subirrigation, which is important in a very few regions. Well-managed sprinkler systems are generally among the most efficient methods of applying irrigation water. Since all water applied in excess of that which can be stored in the root zone either evaporates or becomes return flow in the form of either tailwater, drainage or deep percolation, increasing the efficiency of irrigation will reduce the quantity of return flow. Irrigated land with installed subsurface drains is concentrated in the South Pacific (1.55 million acres), Great Basin (.23 million acres), Pacific Northwest (.63 million acres), Colorado (.21 million acres) and Rio Grande and Western Gulf (.24 million acres) drainage basins, with the exception of Florida (.91 million acres).

The cost and effectiveness of three levels of control of irrigation return flow were investigated: "low", "medium", and "high".

The low level of control would reduce the mass emission of pollutants in return flow by increasing the efficiency of water use through "irrigation management service" (IMS), but it would increase the concentration in the volume of water retained. In many cases, increasing efficiency reduces mass discharge of dissolved salts simply by reducing the mass of salt applied to the land in the water. In areas with highly saline soils, increased efficiency will decrease the rate of salt leaching and the total salt load carried in the water body. The cost of a typical IMS averages about $5.00 per acre per year and, since this system does not eliminate return flow, the cost of monitoring return flows, estimated at $2.00 per acre per year, must also be considered. However, IMS has been estimated to save about $2.00 per acre per year in fertilizer costs, and this is estimated to balance the cost of monitoring. Therefore, IMS is estimated to result in a net cost of about $5.00 per acre per year.

The medium level of control as defined in this study would improve irrigation efficiency to the maximum extent feasible by initiating IMS, lining unlined laterals and canals, and installing sprinkler systems on all land that is now surface irrigated. Sprinkler irrigation may not always be economical because of the length of the growing season, crop adaptability or other factors. These controls would be applied only to surface irrigated land with installed drains. The medium level of control for land that is not artificially drained and that is surface irrigated would be IMS, plus sedimentation basins to treat all tailwater. In both cases, monitoring of return flows would still be required.

The high level of control investigated would add desalting of return flows from lands with installed drains to the medium level of control, and would prohibit the discharge of tailwater by requiring

installation of tailwater recovery systems for capturing and pumping back to the irrigation system any water that collects at the lower end of the field.

Where conditions are favorable, irrigation management service can improve irrigation efficiency by approximately 20 percent, while increasing crop yields by about 15 percent. The use of the service can reduce the discharge of pesticides, phosphorus, sediments, and organic matter by 20 or 40 percent. The degree of control of nitrogen discharges which can be achieved is highly variable and is dependent on local conditions. The cost, where major structural improvements in the delivery system are not required, averages about $5 per acre per year.

Increasing irrigation efficiency by 20 percent could reduce irrigation water diversion by about 20 percent and reduce return flow volume from 40 to 50 percent but would increase the dissolved salts concentration in the return flow by 30 to 60 percent. It would generally have no effect on consumptive use of water by plants. It would decrease the mass emission of salt in the return flow by about 20 percent, and would alter the temporal distribution of downstream flow. The water quality impacts of these alterations may be beneficial or detrimental, depending on local conditions.

Major structural changes in water conveyance, distribution and application systems (canal lining, installing sprinklers, etc.) to improve efficiency are much more expensive, and have about the same average degree of effectiveness in reducing water use and return flow as IMS. The effectiveness of such structural changes in improving efficiency is highly dependent on local soil types, being very effective in coarse grained soils and only marginally effective in soils with high clay content. Costs range upward to $78 per acre per year, depending upon local circumstances.

Desalting all the drainage water from one acre of irrigated land costs up to $130 per year, assuming a plant for return flows from each 10,000 acres of land and evaporation ponds for the resultant brines. Cost of collection and transport of return flows is not included, nor is the cost of disposal of residue from the ponds. The effectiveness of desalting is limited by the fact that most irrigation return flows reach receiving waters as nonpoint sources. Only 12 percent of irrigated land is drained, although 25 to 50 percent probably contributes some return flow to the drains. However, installed on-farm and master drains are normally provided only to supplement the natural drainage system provided by subsurface porosity, and they intercept only a portion of the percolating water under drained land. Drains may be installed to advantage only where there are certain subsoil conditions.

C. The Colorado River - A Special Case

The overriding water quality problem in the Colorado River is salinity. The salt loads in the river stem mainly from the weathering of the basin's saline soils. Man's affect on the salt concentrations arises from activities which both change the total amount of salt and decrease the river's flow. Under present conditions the net increment to the salt load from irrigated agriculture or other uses is probably less than half that from natural sources. However, consumptive use or out-of-basin transfers decrease dilution and further increase salt concentrations. The increment in salinity concentration attributable to reduced flow is at least as large as that from the increased salt load. Future water depletions have a greater potential for degrading water quality than new sources of salt.

Increased salt concentrations in the Colorado River tend to be more harmful to man than they are to the natural environment. The biological communities of the lower Colorado are tolerant of salt concentrations historically associated with low flow conditions. In contrast, man's use of the river, including irrigated agriculture and municipal and industrial use, are affected by the present salt concentrations. Some varieties of crops cannot be grown. Salt tolerant crops require increased quantities of irrigation water if salinity concentrations are high. Municipal or industrial users of water from the lower Colorado must meet costs for water softening or for controlling salt deposits.

The apportionment of the water resources of the Colorado River is governed by a complex set of treaties, compacts, Federal and state laws and court decisions. The present upper basin use amounts to about 3.7 million acre-feet each year. Consumptive use will increase in the future as the upstream states commit to use the quantities to which they are entitled. The Bureau of Reclamation has estimated that this demand could grow to be 5.9 million acre feet per year by the year 2000. When development occurs remedial actions to control downstream salinity concentrations will be required. Without such actions salinity at Imperial Dam could increase from the present 850 mg/l to as much as 1,250 mg/l.

The program to control salinity in the Colorado may include a variety of measures. Title II of P.L. 93-320, the Colorado River Basin Salinity Control Act, authorizes the Secretary of the Interior, acting through the Bureau of Reclamation, to construct three projects to isolate and remove highly saline inflows and undertake improvements to decrease the seepage of irrigation water from the delivery and drainage canals in the Grand Valley area of Colorado. P.L. 93-320 also directs the Secretary of the Interior to complete planning reports on 12 additional salinity control projects. Of these projects, four

would control salt loads from irrigation sources, three from natural springs, and five from natural diffuse sources.

The initial four projects are to be funded on a cost-sharing basis. 75 percent of the cost is Federal and 25 percent is derived from the Upper and Lower Colorado River Basin Development Funds. Over $125 million was authorized, but there have been no appropriations to date.

The seven basin states have developed and are in the process of adopting salinity standards, including both numerical criteria for salt concentrations and measures to assure their achievement and maintenance. The core of the program is the 16 Federal projects of P.L. 93-320. In addition, the implementation plan includes a "no salt return" policy for industrial uses and a reformulation of certain future agriculture development projects to minimize their salt discharges. The industrial policy requires that wherever possible, new water uses for energy or other industrial development not return the salts removed by water diversions. At the present time this policy means that "blowdown water" from cooling towers at steam electric generating plants is contained in evaporation ponds. The third feature of the states' implementation plan is an on-going research program mainly focused on lessening the salt load contributed by irrigated agriculture.

The Commission's findings confirm the potential for reducing the salt load in the river by increasing the efficiency of irrigation practices. Based upon general assumptions, a program to increase irrigation efficiency throughout the basin could potentially reduce the salt load in the river by 2.0 million tons per year from the current 9.0 million tons per year. Projects designed to decrease salinity through increased irrigation efficiency, however, should never be initiated without careful evaluation on a site-by-site basis.

D. Agricultural Nonpoint Sources

Certain nonpoint sources may contribute large quantities of pollutants to the nation's waters on a temporary or intermittent basis. Runoff from agricultural cropland may deliver sediment, fertilizer, pesticides and organic materials to surface water. Non-irrigated cropland in the United States was estimated to total about 380 million acres in 1967, roughly 90 percent of the total cropland. The only measures evaluated for reducing pollutant contributions such as sediment, fertilizer, pesticides and organic material to streams were those recommended by the Soil Conservation Service in its 1967 Conservation Needs Inventory. This Inventory indicates that about 158 million acres -- 40 percent -- of non-irrigated cropland needs better soil conservation practices applied. Implementation of these practices is estimated to require a capital investment of $2.6 billion. No mechanism now exists that could dictate implementation of all the land needing these measures, even if all investment costs were borne by the Government.

IV. INSTITUTIONAL FACTORS INFLUENCING "ACHIEVING OR NOT ACHIEVING, THE EFFLUENT LIMITATIONS AND GOALS SET FORTH FOR 1983 . . ."

Institutional Factors -- 1977 and 1983

QUESTION: *How has the response of persons in the institutional structure for water pollution control -- Federal, state, interstate, regional and local governments, industrial and agricultural dischargers, and all interested groups -- affected achieving or not achieving, by the stated deadlines, all that is required to meet the requirements and goals of P.L.92-500?*

Individually and collectively, their response has contributed to the time required to achieve results under P.L.92-500. Unfortunately, the interrelationships have too often been adversary, rather than cooperative in nature.

The task has been larger than any of the initial participants recognized. Probably none of those involved in the formulation of P.L.92-500 fully appreciated the magnitude of the task assigned to, and the response expected from, persons in the various government levels and among industrial and agricultural point source dischargers and the many "publics" in implementing the Act. Congress seriously underestimated the EPA manpower requirements, the time required and the complexity of establishing effluent limitations and issuing permits to every discharger while, at the same time, rapidly accelerating a publicly owned treatment works construction grants program with several major new requirements. To the extent that EPA acquiesced in the several statutory deadlines and encouraged the various program expansions, it, too, overestimated its own capacity to respond to the Act.

The breadth and detail of the delegations to the EPA Administrator for definitive explanatory or implementing regulations are enormous. States initially had serious reservations about the new direction of the national program and the joint capability to implement it. Local governments were ill prepared to reformulate pending and developing construction grant applications under the new requirements. State pollution control agencies were inadequately manned to perform the review, permit and enforcement functions expected of them. States and local governments were thrust into much sharper conflicting roles as both regulator and regulated. The traditional and normal tension between levels of government became more strained than ever. Private dischargers who generally favored an approach utilizing uniform national requirements were unhappy with the initial effluent

limitations issued by EPA. Agricultural dischargers were hardly aware of the full import of the Act until long after its passage. All affected and interested groups differed widely and strongly as to the best course toward implementation. EPA became the focus of the contending viewpoints, with individual Members of Congress who had been intimately involved in shaping the legislation often expressing different interpretations of the intent of the Act. EPA's anxiety to do a good job with the new statute often cause it to regard all its critics as its adversaries. Only in the last year or so have the relationships become more relaxed.

QUESTION: *What are the implications of the resultant delays in meeting deadlines or implementing various statutory directives?*

ANSWER: *The obvious implication is that the time schedule for accomplishment of some requirements and goals of the Act is out-of-phase. The first major deadline -- installation by dischargers of Phase I wastewater treatment technologies by July 1, 1977 -- will not be met by all dischargers, and the series of delays which have occurred within the institutional structure and the slow flow of grant funds share major responsibility. This fact requires consideration of alteration in the present time schedule for accomplishment to coincide more closely with the realities of current circumstances and available funding, as well as the limitations inherent in the intergovernmental process and the interactions between these governments and the various affected and participating "publics."*

* * * * *

QUESTION: *Where, in the program structure, are the delays most seriously manifested, and what do they reveal about the fundamental implementation strategy of the Act?*

ANSWER: *The strategy of the Act is predicated on the proposition that 75 percent Federal construction grant assistance for publicly owned treatment works, coupled with strong centralized national initiatives for regulation and enforcement structured within a framework of comprehensive state and local planning, will produce the most expeditious, effective and sensitive application of resources and manpower to the accomplishment of national water quality objectives. In the first three years, a disparity has developed between the proposition and its realization.*

Delays in issuance of guidelines, effluent limitations and regulations; delays in the obligation and outlay of Federal funds for construction grants; delays and variances in the issuance of the NPDES permits for municipal, industrial and agricultural dischargers; and the fact that mandated planning requirements are seriously out-of-synchronization with the construction grants and permit phases, all contribute to uncertainty as to the validity of the essential proposition. Experience with implementation to date can neither effectively discredit nor irrefutably sustain the proposition. Experience can, however, identify the points in the implementation process where the delays have been most pronounced and made some observations, based on performance thus far, about the basic structure of institutional cooperation vital to the Act's fair and effective implementation.

A. Regulation

QUESTION: *Has implementation progressed sufficiently to identify any basic problems with the regulatory strategy contemplated in P.L.92-500?*

ANSWER: *While there are still a number of uncertainties about the implementation of the regulatory scheme, the conduct of two activities in the regulatory strategy can jeopardize the effective implementation of the Act. One is the development and promulgation of effluent limitations which are being aggressively contested by industry in over 250 legal challenges. The other is the capability of the Federal, state and local regulatory and administrative agencies to develop useful information systems for monitoring and reporting compliance with the Act's various program components.*

Development of effluent limitations presented EPA with one of the most complex, perplexing and controversial activities essential to the Act's implementation. The basis for the entire regulatory strategy, the setting of effluent limitations, presumes an understanding by EPA personnel of every segment and subcategory of industry, their various production processes, the waterborne wastes they generate and the technologies for treating those wastes. Such detailed expertise may be more than the Agency can reasonably be expected to possess about complex, ever-changing industrial operations.

Problems with the development and perfection of effluent limitations have slowed the entire regulatory process. Due one year after enactment (October 18, 1973), the first EPA effluent limitations were

not issued until January 31, 1974, and the process of identification of industrial subcategories and the issuance of limitations still continues. In particular, promulgation of pretreatment and toxic substances standards pose major uncertainties for the regulated dischargers.

The methodology EPA selected to define the effluent limitations (based on model plant performance), as well as the statutory interpretation of Sections 301 and 304, have been criticized by industry and independent advisory groups and challenged in court. The methodology, it is charged, results in indiscriminate and inflexible application of fixed numerical limitations to industrial categories and subcategories without adequate recognition of products and production technologies of a particular plant or sensitivity to such considerations as size, age of plant, location, etc. In practice, however, Commission studies found evidence of a degree of variability in the permits which are the end product of the actual application of effluent limitations.

Many of the EPA effluent limitations are being legally contested. More than 250 lawsuits have been initiated by industries challenging the promulgated "effluent limitation guidelines," on (1) the fundamental nature of the regulatory scheme, and (2) the substance of the regulations. These challenges have been consolidated in U.S. Courts of Appeals to 21 proceedings. Issues in these legal controversies are detailed in the "P.L.92-500 Litigation" section of Chapter V of this report.

To date, only one case has been decided on its merits; all others are still pending. Thus the final outcome cannot be predicted. What has been demonstrated, however, is the perhaps inherent difficulty experienced in attempting the detailed specification and universal application of regulations to industrial categories and subcategories and numerous, complex and changing production processes.

The Commission's studies of the application of treatment or control technologies by industries indicate that the EPA effluent limitation strategy, based on allowable pollutants per unit of production for an entire subcategory, in effect sometimes causes a "force fit" of a simplistic set of numbers to wastes from industrial production processes. The more complex the industry and the more variable its production processes, the more difficulty EPA has encountered in applying this regulatory strategy. As the trend in most industries is toward more sophistication, variation, change and complexity in production, problems for the regulator are not likely to decrease, but rather increase. As new source performance standards and Phase II (1983) requirements for application of BAT become effective and are incorporated into individual permit conditions under the NPDES, the process will require of the regulator even more knowledge and technical sophistication.

It is within the permit system that the controversy over effluent limitations is most significant. Permits issued under the National Pollutant Discharge Elimination System provide the legally enforceable application of the Act's requirements. In some instances, constituents from a particular discharge will precisely match the constituent parameters of the applicable effluent limitations. But, in many cases, they do not.

In more representative situations involving complex industrial processes, the discharge will not precisely correspond to the effluent limitation on a constituent-by-constituent basis because of the variety of products produced. Thus, permits that follow effluent limitations exactly may not include all pollutants. Conversely, when permits do include pollutants not enumerated in effluent limitations, they must be negotiated on a plant-by-plant basis rather than in strict conformity with the promulgated limitations. While the overall impact on water pollution control may be insignificant, it does pinpoint a divergence in application of the Act's strategy of transforming universal uniform effluent limitations into permits.

The permitting process has been subject to other divergence from strict compliance with the Act -- chiefly as a consequence of delay. Initiating the issuance of industrial and municipal permits was postponed pending development of effluent limitations, review and upgrading of state water quality standards and completion of waste load allocations pursuant to the Sec. 303(e) state basin planning process. Consideration of agricultural permits awaited a determination of how best to proceed. By the December 1974 deadline, EPA and the NPDES states had issued only a little more than half of the estimated 47,000 required permits. Included were permits for 94 percent of the major industrial dischargers, and 91 percent of the major municipal dischargers.*

There are differences, too, between the application of the NPDES to the industrial and municipal dischargers. EPA placed major emphasis on issuing industrial permits. Industrial permittees are now operating under prescribed construction schedules, although, as Commission studies show, many may not actually have the required facilities in place in time to meet the July 1, 1977, deadline. Some share doubts, however, that the installed technologies will, under all circumstances, strictly meet permit conditions.

*Major dischargers represent approximately 12 percent of total permittees and account for 60 to 80 percent of total point source pollutant discharges. EPA regions identified them on a subjective basis -- taking into account discharge volume, receiving water quality, discharge, severity and discharger compliance history.

Progress with the NPDES in the public sector has not been so promising. Recognizing the inextricable relationship between Federal construction grants and permit compliance as well as the legal and political difficulties of enforcing permits issued to publicly owned treatment works, EPA made what was probably the only realistic decision and is writing permits to reflect the availability of funds and the eligibility of the permit applicant. Consequently, only about 50 percent of the publicly owned treatment works permits prescribe compliance with required effluent limitations (secondary treatment or a higher level of treatment to meet water quality standards by July 1, 1977).

Where public facilities are to be funded, use of permit conditions to assure the application of strict compliance schedules for construction and optimum performance of the facility when completed, varies from EPA region to EPA region and from state to state. Smaller cities and communities (with population under 25,000), which make up over 25 percent of all municipal dischargers, apparently have had difficulty understanding and applying the complex requirements of the law and regulations or do not always possess the technical and legal staff capabilities to decipher the Act's requirements and the detailed requlations. Such communities must rely upon consulting engineers and engineering firms who may not always examine the cost-effective control options. For example, most communities elect traditional treatment works without investigating potential cost savings and efficiencies in such alternatives as land treatment. Currently, EPA and the states rarely provide field technical advisory services to assist small communities in the development of water pollution control strategies. Wider use of such a service might be both helpful and efficient. Limited in-house capabilities and reliance upon consulting engineers are probably equally applicable to many industries, and certain small plants might be well served by a similar type of service.

Application of the NPDES beyond the 1977 requirements is uncertain. Industry appears generally reluctant to accept the 1983 requirements (BAT), claiming that they are being treated inequitably when compared with municipal dischargers; that the environmental improvements associated with the application of BAT to point source dischargers are, in most cases, marginally beneficial when compared with effects of nonpoint sources; that capital costs, energy expenditures and residual disposal problems associated with BAT are excessive contrasted with benefits realized; and that current economic conditions intensify competition for investment capital. Also, delay in the issuance of toxic and pretreatment standards extends the uncertainty about the future application of these provisions of the Act and their economic and environmental impacts. An indeterminate number of discharges

(EPA estimates between 50,000 to 100,000) remain to be permitted, such as small feedlots, stormwater sewers, irrigation return flows, etc., presenting an enormous policy and management problem for the Agency.

As for designation of the NPDES authority to the states, EPA initially emphasized the states' assuming the program, perhaps at the expense of developing consistent, unequivocal guidelines for NPDES implementation. As of October 29, 1975, EPA had designated 26 states for NPDES authority, with indication that eventually as many as 39 states, Puerto Rico and the Virgin Islands would be certified. Remaining states and territories may never apply to undertake the program. The Federal framework established by P.L.92-500 can be sustained even after designation through the prescribed mechanisms -- effluent guidelines, permit reviews, Sec. 106 grants and Sec. 303(e) planning. According to Commission survey results from several state and EPA regions, neither the EPA personnel nor those from the states believe that, once designated, EPA will ever reassume NPDES authority from a state.

There presently appears to be no direct correlation between delegation and degree of Federal involvement at the state level. In Texas, for example, which is not certified for permit authority, the state, in effect, is performing most of the permit functions. In some other states designated for permitting authority, EPA continues to maintain a dominant role.

Evaluation of progress under the Act's regulatory strategy must include recognition that the law specifies a cyclical pattern for its critical components. Effluent limitations issued under Sec.301(b)(2) for 1983 "shall be reviewed at least every five years and, if appropriate, revised . . ." [Sec.301(d)]; water quality standards are subject to periodic revision under Sec.303; the Administrator's definition of secondary treatment and other actions are subject to change "from time to time" under Sec.304; new source performance standards are also subject to change "from time to time" under Sec.306(b)(1)(B), as are toxic standards under Sec.307; and the Administrator "shall . . . review at least annually" pretreatment standards under Sec.304(f)(1). Regular NPDES permits are issued for terms up to five years, and new source permits are not to exceed ten-year periods. Thus, most significant administrative actions relating to the principal instrument for enforcement -- each point source discharge permit -- are automatically reviewable in prescribed cycles. Opportunities for change and refinement are not just suggested; in some instances, they are mandated by the Act. Thus, whatever the delays, confusion and errors to date, early opportunities are available for improvement. Experience to date provides guidance to the Congress and to EPA for actions to be taken in the next cycle of effluent limitations and permits.

Compliance monitoring is the mechanism intended to alert EPA and NPDES states to permit violations, thus triggering compliance or enforcement action. As such, coverage and performance of the system will be critically dependent upon the collection, review and assessment of information from permittees. Moreover, situated at the sensitive juncture between Federal and state enforcement programs, its utility as a management tool requires effective cooperation between EPA and the states for regular, systematic, selective, on-site inspection of permittees, premises and monitoring records and instruments. Without an effective information collection and retrieval system and clear delineation of Federal-state responsibility for report review and spot-checking, much of the intended improvement through installation of control facilities could be lost, in effect, to poor operation or deliberate by-passing of wastes by the discharger. Unfortunately, perfecting a strategy for using compliance monitoring as an enforcement tool has had a low priority; the responsibilities among the Federal government, the states and the dischargers remain ambiguous; and an organized, systematic, uniform information management system is only now being devised.

Status of present compliance monitoring efforts has most relevance to the Act's strategy for enforcement. One of the recognized shortcomings of the water pollution control program prior to enactment of P.L.92-500, was the difficulty regulators had identifying the discharger or dischargers responsible for violating water quality standards, and then prosecuting the violator through extended and intricate enforcement proceedings. Although one of the Act's major objectives was to clarify and expedite the process toward enforcement against violators, the prospect of detecting permit violations under existing circumstances is quite tenuous. Without uncontestable data showing violation of permit conditions, the entire strategy fails.

An adequate compliance monitoring, reporting and detection system is essential now as issuance of major permits is concluded. Perhaps, as the states move increasingly toward acceptance of the NPDES program, an appropriate and potentially effective role for EPA would be to allocate manpower and resources to monitoring permittees and assuring compliance with construction schedules. EPA is committed to giving more attention to this function but the actual scheme for monitoring permits, the requisite manpower allocations, and the appropriate assignment of Federal and state roles remain to be perfected. Recognizing the enormity of the task of maintaining up-to-date information in a central location on all permittees, an effective monitoring information system based upon a carefully selected sample of dischargers might be designed.

Citizens also need such a system. Effective public participation depends on availability of and accessibility to comprehensible information about progress toward achievement of water quality goals. Clearly, a part of the strategy envisioned within the regulatory process of

P.L.92-500 was the presence of an interested and informed public that would press pollution control officials at every level of responsibility to administer the program with vigilance. Public contribution to the regulatory scheme, however, will be severely hampered without a system to provide the informed, but not technically trained, citizen with information on permit issuance, compliance and overall progress in the reduction of pollutant discharges.

B. Financing

QUESTION: *Has the flow of Federal construction grant funds to the states for publicly owned treatment works impacted the timely achievement of the 1983 requirements and the interim goals?*

ANSWER: *Yes.*

The obligation of Federal construction grant funds has not progressed with either the facility or the efficiency the Congress intended. Now, three years after enactment of P.L.92-500, only about 40 percent of the authorized $18 billion of Federal funds has been obligated for construction of publicly owned wastewater treatment works, and only about $1.4 billion of the appropriated amount has been actually expended. This means that the accelerated pace envisioned by the Congress for public treatment works construction has not occurred. Only now are obligations beginning to reach a level (approximately $6.8 billion in FY 1976, based on a 15-month fiscal year) commensurate with the scope and pace indicated in the Act. Indeed, even at present obligation levels, the bulk of the $18 billion will not be spent until five or more years after July 1, 1977. Thus, a major portion of the nation's publicly owned wastewater treatment systems will not meet secondary treatment or higher treatment levels where required for water quality standards by the statutory deadline.

There are some legitimate reasons for the lag in the obligation of funds. The formulation and application of implementing regulations and procedures were difficult. Delay at the local and state level in preparing and submitting acceptable Step 1 facility plans is another major reason. Finally, Presidential refusal to allot one-half of the $18 billion in authorized Federal funds had at least a psychological effect in slowing construction grant processing.

Undeniably, the approval process is layered with a debilitating maze of regulations for satisfying planning, management and operating requirements. Some are prescribed by the Act (i.e., reduction of excessive infiltration and inflow and determining the proportionate share of volume and strength of wastes from various classes of users). Some are required to comply with Federal legislation and Executive Orders to achieve programs other than control of pollution. Some are designed to minimize adverse environmental effects. Some result from EPA's legitimate concern for review and audit procedures to prevent fraudulent or illegal use of public funds. Together, these requirements total 27 discrete decision points fulfilling numerous EPA regulations interpreting P.L. 92-500 and coordinating its implementation with the 27 other Federal laws and Executive Orders that must be satisfied for each grant. Many of these requirements would still remain, even if the Act were amended to provide for state assumption of some construction grant review and certification functions.*

Nevertheless, the Commission study of construction grants concludes that:

- o There is an excessive burden of red tape in the approval procedure.
- o Much time-consuming duplication exists between Federal, regional and state review processes.
- o Lack of uniform procedures and evaluation criteria interferes with efficient administration.
- o Staffing is inadequate at both the EPA and state levels to adequately cope with post-award project review.
- o Heavy dependence on consulting engineering firms for the development of local plans and design of facilities has placed a heavy load on the capacity of these firms, adding to the time necessary to complete each project.

Most significant, perhaps, is the finding that the net impact of these various impediments is to discourage innovation of design of public treatment systems. Those who observe the construction grants process believe that "standard specifications get through the approval system faster," and thus most designs are of traditional or conventional treatment methods.

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*H.R.9560 proposed amendment of P.L.92-500 to provide for increased state responsibility for the construction grant process.

Whatever the explanation, delay has occurred and its implications are manifold. Not only is achievement of the 1977 requirement for uniform application of secondary treatment to all publicly owned wastewater treatment systems affected but also achievement of the 1983 "interim" water quality goal of the Act may be delayed as well. Delay has made the program vulnerable to inflationary impacts on the cost of labor and materials for construction.

As estimated costs to provide required publicly owned wastewater treatment facilities increase, the needs survey must be evaluated to ascertain its validity for measuring progress and allocating Federal grants and its utility for fixing priorities among needed treatment categories and facilities. The Commission's own assessment of the EPA 1974 needs survey concluded that, in many cases, the survey was not an accurate assessment of actual needs. Some states and municipalities manipulated their population estimates or water quality designations to inflate their needs, hoping to maintain or improve their relative share of annual Federal grant allocations.

Commission studies also determined that the needs survey and the priority lists -- because they are treated as separate functions -- are not being used as a management device to make decisions that will contribute to achievement of water quality goals or for making effective resource allocations. Continued use of the present allocation formula based solely on state or local estimated needs can be fair and effective if the reported needs are independently verified. Most states, in fact, have little confidence in using the results of the survey as the basis for allocation. Change, however, to some other formula, such as a combination of needs and population, must be approached cautiously to avoid creating other disparities such as funding deficiencies in some states and regions of the nation, while virtually over-funding facilities in other states. Congress is faced with choosing between allocating construction funds where real needs exist to achieve environmental goals or treating the program as one of traditional public works.

Efficient utilization of manpower and resources remains a critical management problem. The present inability of a state or local agency to develop long-range projections of needed facilities based on a reliable continuing level of Federal funds, creates management problems, leads to an imbalance between large and small projects, and limits optimum distribution of projects among Steps 1, 2 and 3 so as to maintain a fairly constant flow of funds and projects. Although the Commission finds evidence of improvement, a coherent manpower strategy supported with an even and dependable flow of funds, with full local, state and Federal commitment to stabilize the construction grants process could be a major contribution to achievement of the Act's municipal treatment objectives.

Research and development into water pollution control, for example innovative technologies for the treatment and utilization of wastewaters, has actually declined. A comparison of the FY 1975 appropriation for purpose shows a 14.5 percent decrease over what was being spent in 1969. Impacts of inflation have reduced the purchasing power of the research dollar. As a percentage of construction grants for water pollution control, research and development for municipal technology has decreased from 17.5 percent in FY 1967, to 0.3 percent in FY 1973. One very clear implication of this decline is that Federal construction grant expenditures are almost exclusively for the installation of tried and tested traditional technologies. The framers of P.L. 92-500 hoped for something more imaginative.

C. Planning

QUESTION: *Has implementation of the planning provisions of the Act progressed commensurate with the planning policy objectives articulated in Sec.101(a)(5) -- "that area-wide waste treatment management planning processes be developed and implemented to assure adequate control of sources of pollutants in each state"?*

ANSWER: *No. The planning process is already out of sequence with the implementation strategy.*

The strategy of P.L. 92-500 relies on planning as the essential device for integrating NPDES permits, construction grants, control of nonpoint sources, projected growth and predicted land use changes into a reasonable formula for local pollution control, attuned to both state and local needs, solutions and priorities. That planning has not functioned that way so far can be attributed to two factors: (1) the diffuse and uncoordinated planning requirements of the Act and (2) the delay, by EPA, in implementing Sec. 208, the areawide planning provision.

As a consequence, the discernible planning patterns emerging from state and Federal interpretations of the Act are characterized by disjointed and often unrelated activities. The key elements of the planning process -- facility planning and areawide waste treatment planning -- are seriously out of synchronization. The 1974 Water Quality Strategy Paper indicated that construction grants, permits and nonpoint source controls should be consistent with, and serve the purposes of, the relevant plans. Instead, relevant plans are dictated by grants and permits. This process may be reversed in time for the next series of five-year permits, but that is by no means assured.

Under the Act's timetable, initial state basin plans were to have been completed, and initial areawide plans near completion, by mid-1975. To date, only one-third of the 635 state river basin plans [Sec. 303(e)] have been completed and no areawide (Sec. 208) plans will be completed for at least another year. As a result, for five to six years following enactment of P.L. 92-500, construction grant and NPDES activities will have proceeded without having to comply with prescribed state, regional and local plans. Instead of constructed and permitted treatment facilities located and controlled according to local plans for future growth, the facilities will, to a considerable extent, dictate the pattern of the area's long-range development. Clearly, this was not the intent of the Congress. While it may be too late to restore the planning process to its appropriate sequence in phase with the on-going construction grants and permitting processes, it is not too late to critically examine planning's role within the context of the Act's present implementation, and determine what legislative or administrative changes might improve the effectiveness and utility of the planning program.

Even though slow in getting started, a great deal of energy, manpower and resources are now being expended in the implementation of the planning provisions. EPA has allocated $163.5 million in total support grants to 149 designated areawide planning agencies. Most of the recipients are Councils of Government, representing the multi-governmental structure of the major metropolitan areas of the nation. Moreover, elaborate processes are underway in most of these areas to develop the cooperative participation of local governmental entities, interested groups and appropriate organizations in the plan's development.

Efforts should be intensified to fund more planning agencies. Future success for adequate pollution control may depend upon the utility and viability of these plans. Guidance and assistance is needed if the plans that evolve are to be physically and politically realistic and environmentally sound and capable of engendering the necessary public support to be followed. Any effective strategy for control of nonpoint sources within the framework of the Act can only be a product of the areawide planning process.

Other critical elements that must be produced by areawide waste management planning are future priorities for construction of publicly owned treatment works; the next series of NPDES permits for point source dischargers; the necessary actions to restore and maintain water quality in areas experiencing rapid growth and heavy industrial development; questions of public access to, and utilization of, improved waters for recreation; and the integration of the water pollution control plan with air and solid waste control strategies.

Because these elements are critical to the future success of water pollution control efforts in localities and within the states, a strengthened role for public participation should be incorporated into the areawide waste treatment planning process and its eventual implementation. Without participation and support of the affected publics, the chances are slim for design and execution of a plan acceptable to a wide, diverse constituency with varied private, public and political interests.

D. Public Participation

QUESTION: *Has the experience with public participation in water pollution control programs differed significantly under P.L.92-500 from prior experience?*

ANSWER: *No. Even though the Act mandated an unprecedented public role, there is no empirical evidence to suggest that the actual influence of the citizen on the decision-making process has effectively increased.*

The Act contains the most comprehensive provisions for public participation ever written into Federal law. Sec. 101(e) requires public participation in the development, revision and enforcement of any standard, effluent limitation, plan or program pertaining to the implementation of the statute. Not only is public participation to be provided for, but also it is to be encouraged and assisted by the EPA Administrator and by the states. Prior to enactment of P.L. 92-500, there was only one mandated requirement for participation of the public in the administrative processes of water pollution control. The 1965 Federal Water Pollution Control Act required hearings prior to the adoption of state water quality standards, and provided for public hearings (if deemed necessary) following water pollution enforcement conferences.

Ironically, despite expanded opportunities provided in the 1972 Act for public involvement, actual citizen participation may have declined. Some reasons can be identified. For one thing, rather than causing citizen influence to focus at strategic points for maximum impact on decisionmaking, the statute and EPA's regulatory interpretation have proliferated opportunities for citizen exposure throughout the entire administration and regulatory process, dissipating the limited energies and resources of the relatively small community of actively involved individuals. For example, many persons with long experience in the water pollution control program, feel that procedures of the prior Federal law, even with its recognized limitations, did, in the standard-setting hearings and periodic enforcement conferences, provide the citizen with a more effective forum in which to express his views.

Such "benchmark" episodes are absent from the present implementation process. Instead, interested citizens complain they are deluged with an indiscriminate flow of notices of trivial public hearings, tedious regulations, complex permit applications, etc., with little or no effort by the Agency or the states to identify for the recipient what has critical importance for future water quality and what is merely procedural or pro-forma. In other words, while EPA and the states have accepted and perhaps fulfilled their statutory responsibilities to provide for an opportunity for the public to participate through notices of hearings, rule-making and permit application, they have done little to fulfill the other directive in the Act: To encourage and assist those who wish to participate so their participation is meaningful. Also, there is some indication that the intensity of active citizen interest in water pollution control as a public issue is subsiding, and that many organized groups have turned their efforts to other objectives.

On the other hand, EPA and state emphasis on the public hearing as the principal device for public expression and influence, tends to discourage many citizens. These hearings -- occurring, as they frequently do, late in the decisionmaking process -- frequently appear to be pro-forma exercises. Matters discussed are often highly technical, not easily understood without some non-technical explanation, and that is rarely offered. Generally, Agency and state personnel and public interest groups agree that hearings are of limited utility and often wasteful of everyone's time and resources.

There has also been a tendency to create and maintain a discrete separation between program development and opportunities for public involvement. Most EPA personnel in Washington and the regions appear to expect their public affairs offices to be the proper unit for citizen assistance and support programs. Although this arrangement may have some administrative logic, there is also an undeniable tendency -- not unique to EPA -- to isolate public affairs activities from substantive program activities. Also, placing the function here may give it a public relations flavor of image making for the Agency. Indeed, nationwide interviews with Federal and state pollution control officials revealed strong inclination to treat the participatory process as chiefly affording citizens an opportunity to vent their emotions. The opinion survey also indicated there is strong sentiment among the majority of state and local officials that the achievement of water pollution control is essentially a technical activity best left to the professionals.

As a result, efforts seeming to promote public participation can project a patronizing superficiality which veteran participants are quick to discern. EPA has no specific budget for developing and assisting public participation opportunities although considerable

amounts of both money and manpower have been spent on publication and distribution of regulations, permit applications and notices as well as public hearings, all with minimal effect.

The largest potential for public impact is probably in the design and eventual implementation of Sec. 208 areawide plans. There are requirements for creation of citizen advisory groups associated with each of the designated 208 autorities. There is some question as to how effectively this is working in actual application, but it is safe to hazard that chances for implementation of eventual areawide plans will be slim indeed, if they are developed in a vacuum without the contribution and involvement of a broad range of interested groups.

E. Participants and Practitioners -- Adversaries or Partners

Contention among all interested parties about how the Act is to be interpreted and applied has probably been the activity which has consumed the most energy during the three years P.L. 92-500 has been in effect. Beginning with the admonition, "It is the national policy that to the maximum extent possible the procedures utilized for implementing this Act shall encourage the drastic minimization of paperwork and interagency decision procedures, and the best use of available manpower and funds, so as to prevent needless duplication and unnecessary delays at all levels of government" [Sec. 101(f)], the statute continues for some 90 pages with detailed specifications and directions. Many of these provisions delegate additional explanatory and rule-making duties to the Administrator. A positive, ringing declaration that, "It is the policy of the Congress to recognize, preserve, and protect the primary responsibilities and rights of States to prevent, reduce, and eliminate pollution, to plan the development and use (including restoration, preservation, and enhancement) and land and water resources, and to consult with the Administrator in the exercise of his authority under this Act . . . ." [Sec. 101(b)] is followed by section after section retaining final administrative discretion with the Federal Administrator in most instances. Delegations to the Administrator are often qualified by directing action only "after consultation with appropriate Federal and state agencies and other interested persons." There is considerable evidence that only lip service is given to these pronouncements.

In fact, progress and achievement of results have been slowed by the time and energy consumed in disagreements -- among the levels of government, between the dischargers and the Federal and state regulatory personnel, between all affected persons and groups and the regulation writers as to how the regulations should be written, between the environmental and public interest groups and state, Federal and

local officials, and even between Congress and EPA personnel as to the proper meaning of the Act. Time spent in administrative hearings or preparing and defending court cases may not be the most effective use of manpower.

Consultation requires not only listening but also hearing. Ultimate personnel needs to make the Act fully operative, though not precisely known, are probably immense. Man-hours spent in bickering between Federal and state officials may be unproductive man-hours in terms of water quality. Dischargers probably know more about their production processes and their wastewater constituents than anyone else; while they should not be allowed to subvert the statute's implementation, they contribute little if their stance is that of antagonistic adversaries; and not all knowledge is concentrated in the bureaucratic regulatory agencies. The resources of all interested or affected groups are needed -- cooperating at least in an atmosphere of "constructive tension" -- to make the Act work for its intended benefits to all the people.

V. "WHAT WILL REMAIN TO BE DONE AFTER 1983"

A. Elimination of the Discharge of Pollutants -- The 1985 Goal

QUESTION: *Assuming achievement of the 1977 and 1983 requirements for publicly owned treatment works and agricultural and industrial dischargers at some date later than 1983, as well as the control of toxics, what major pollutant sources will continue to prevent realization of the interim and ultimate goals?*

ANSWER: *Any point source (such as urban runoff in separate storm sewers) not adequately controlled with the 1977 and 1983 requirements or any nonpoint source (such as urban runoff from other than combined sanitary and storm and separate storm sewers and agricultural or general land runoff) contributing pollutants to the nation's waters can prevent achievement of the water quality goals of the Act. The effect of these source contributions in some site specific areas of the country will prevent achievement of the water quality goals of the Act and may, in some cases, overwhelm improvements from point source control. To the extent that publicly owned treatment works, industrial and agricultural dischargers have not achieved elimination of the discharge of pollutants, they, too, would be major contributors.*

* * * * *

QUESTION: *Are there technologies available now, or that might reasonably be expected to become available within the next ten years, that could achieve the elimination of "the discharge of pollutants into the navigable waters"?*

ANSWER: *Yes. However, in most cases, the costs of these technologies are such that applied to point source discharges, their installation would be prohibitively expensive, and the economic and social effect would be too severe to be absorbed within the foreseeable future; further, predictable environmental effects, using present analytical techniques and methodologies, would appear to be minimal, particularly in the absence of adequate control of nonpoint sources of pollutants in some places.*

* * * * *

QUESTION: *Does the goal of the elimination of "the discharge of pollutants into the navigable waters" have value as a guide to policymakers?*

ANSWER: *Yes. Wastes generated by projected population increases and continued economic growth, if discharged to the nation's waters, can soon minimize the effect of improvements in receiving water quality realized through achievement of the 1977 and 1983 requirements of the Act applied to point source discharges. If new sources of pollutants -- new industrial plants, agricultural activities and increased discharges from publicly owned treatment works -- install "the best available demonstrated control technology, processes, operating methods or other alternatives, including, where practicable, a standard permitting no discharge of pollutants"* [Sec.306(a)(1)], *and if existing water quality standards are regularly reviewed and appropriate waste load allocations timely made, this action may assure that growth does not negate the improvements achieved by point source effluent limitations as the program envisioned by P.L.92-500 is implemented.*

Considering the time it will take municipal, industrial and agricultural point source dischargers to achieve the 1977 and 1983 requirements, the 1985 goal of the elimination of the discharge of pollutants (EOD) into navigable waters cannot possibly be achieved by all point source discharges by 1985. For approximately 20 industries, however, the 1985 goal will be achieved by some subcategories if they comply with the effluent limitations for 1977 (BPT) and 1983 (BAT). Only one industry, metal finishing, is required to achieve EOD for all subcategories, the proposed 1983 BAT effluent limitation.

Since the Act does not define EOD, various interpretations have been proposed. The chosen interpretation is important in assessing possible technologies and costs. The Commission has defined EOD as follows:

> "The elimination of the discharge of pollutants shall apply to removal of those constituents which are added during use of the water. The resultant discharge must be of equal or lower concentration than that of the original supply."

The EOD goal is stated in the Act only in relation to point source discharges; it does not apply to nonpoint sources.

Most industrial dischargers will not be required to achieve EOD as part of the BPT and BAT effluent limitations, nor will publicly owned treatment works achieve EOD as part of the treatment required to meet

secondary treatment in 1977, "best practicable waste treatment technology over the life of the works" in 1983 or even more stringent effluent limitations to meet water quality standards. Where an industry or a publicly owned treatment works does achieve EOD, it will usually be achieved by eliminating the discharge of water, not by treatment and discharge of treated wastewater to navigable waters. This method of EOD requires complete reuse of plant effluent. Complete reuse appears to be viable for only a very limited number of plants.

While technologies are available, or will become available in the foreseeable future, to achieve or closely approach EOD, they are generally considerably more costly and more energy intensive per unit of flow treated than those required to satisfy the 1977 and 1983 requirements. The dominant technological consideration for achieving EOD relates to the capability to remove soluble salts normally not covered by 1977 or 1983 effluent limitations. Removal of these salts creates large quantities of brines, which must then be disposed of in an environmentally and otherwise acceptable manner, generally at very high costs.

If EOD were a requirement rather than a goal, it is probable that more wastewater reuse or less water consumption (or both) would result, particularly by industry.

Land application is often regarded as a technological solution for achieving EOD. While some land application systems can usually accomplish slightly more effective removal of BOD, suspended solids and nutrients from untreated wastewater than more conventional secondary treatment processes, these systems along will not achieve EOD. Additional technologies to remove dissolved salts and other contaminants would be required, just as would be required following other treatment processes. In effect, land application is similar to secondary treatment, but can serve as a more efficient "pretreatment" system for the add-on innovative technologies which must also be employed for achieving EOD. While land application shows promise, it cannot be considered a panacea, not only because of technological limitations but also because of institutional problems of acquiring or leasing large land areas.

To accelerate the achievement of the EOD goal, research and development efforts over the next decade should be directed to dissolved salt reduction by membrane separation processes (reverse osmosis, electrodialysis, ultrafiltration, and related technologies); dissolved organic reduction by adsorption processes (ion exchange, activated carbon, synthetic polymers) and land treatment technologies. With adequate financial support for research and development, several of the innovative EOD technologies could become available as viable full-scale treatment systems within five to ten years.

Only minor incremental improvements in water quality characteristics are predicted to occur (at the Commission's study sites) in moving from achieving the 1983 requirements to EOD of point source effluents. For example, on the basis of these studies, the differences in projected DO for 21 of the Commission's study sites may not be significant -- when comparing anticipated changes under 1983 requirements and those expected for the EOD level. The existing coliform bacterial contamination would not be significantly reduced, since the major source nationwide is from nonpoint sources. On a regional and local basis, much of the problem will be eliminated by achieving the 1977 point source requirements. Potential or existing eutrophication problems will continue at EOD for point sources, since nonpoint sources contribute approximately 80 percent of the total nitrogen and 50 percent of the total phosphorus to our rivers, streams and standing waters. Suspended solids are also contributed primarily from nonpoint sources. Achievement of EOD for point sources will leave approxiamtely 90 percent of the load (after achieving the 1977 requirements) entering the nation's navigable waters.

Removal of the BOD load which represents the difference between that remaining after achievement of the 1983 requirements and achievement of EOD from point source discharges may be of minor significance when compared with that being contributed presently from urban storm runoff, agricultural runoff, etc.

Nonpoint sources are a major contributor to toxic substances, based on the Commission's environmental studies. EOD from point sources will not eliminate toxic substances, even if they are uniformly restricted in all municipal and industrial permits. Furthermore, EOD of toxic substances in view of probable nationwide costs, would require additional study.

In terms of biological impacts, approximately 5-10 percent of the nation's waters presently unsuitable for game fish habitat will become suitable upon achieving EOD from point source discharges, based only on the Commission's study sites. In reality, conditions are better nationwide, and the actual aggregate improvement might be less than this.

B. Selected Nonpoint Sources Other Than Agriculture

Construction and timber harvesting may cause large temporary increases in the transport of sediments and other pollutants to receiving waters. Inactive mines, subsurface waste disposal and salt water intrusion may contribute pollutants either continuously or intermittently, depending on local circumstances. These nonpoint pollutant sources are significant to the Commission's study because they may in some instances overwhelm and negate the reductions achieved through point source effluent limitations. Point sources are of primary concern during low-flow conditions

of streams when nonpoint sources (except for sources such as acid mine drainage from inactive mines) make little or no contribution and nonpoint pollutants are contributed principally during periods when point sources may have little or no impact on water quality.

Silviculture and Timber Harvesting--About 500 million of the 2.3 billion acres of land in the 50 states are in commercial forests. About 1.7 and 1.5 million acres were harvested in 1965 and 1970, respectively. Logging operations are the major cause of increased sediment yield in the Northeast and Pacific Northwest, while site preparation for reforestation of upland forests predominates in the Southeast. A change in logging practice -- from skidding felled logs to a loading point by use of tractors to non-tractor yarding (high lead, skyline, balloon) -- is estimated to decrease sediment yield on the order of one-half ton per acre, and to increase logging costs by $39 to $130 per acre. A change in site preparation method for upland forests from bulldozing and burning to chopping with a drum chopper for the Southeast is estimated to reduce sediment yield by as much as 70 percent (14 tons/acre, average) and to reduce the cost of site preparation by $26 to $39 per acre. A disadvantage of the method is that it requires more frequent burning of the growing forest to control scrub hardwood size, thereby increasing air pollution to some degree.

Construction--About 1.6 million acres of land are disturbed annually by construction activities, 90 percent for highways and roads, and 5 percent each for urban residential and urban non-residential construction. The annual sediment yield from uncontrolled construction sites is estimated to average 200 million tons, an average of 124 tons per acre of disturbed land and 11 percent of the yield from the 380 million acres of non-irrigated cropland. Controls such as sedimentation basins, diversion ditches, sodded ditches, grade stabilization, and other effective practices can be used to control sediment production. In addition to reducing the sediment contribution to surface waters, such controls may yield benefits in the form of reduced quantities of fill dirt that must be hauled to the construction site. Costs are estimated to range from about $910 to about $1,482 per acre (average $1,170 per acre) for a reasonable mix of the above measures. This would total $1.8 billion per year. The proposed sediment controls are predicted to reduce sediment yield by about 70 percent, or 140 million tons per year.

Inactive Mines--The primary water quality problems associated with inactive mines are sediment production from denuded areas and acid production from exposed reactive areas. Sediment production problems may occur in all areas where mining has been practiced, but acid mine drainage is confined primarily to the Appalachian coal fields. Vegetative buffer strips along affected streams have been demonstrated as effective in abating sediment delivery. The width required is a function of land

slope, with 145 feet estimated to be required for a 30 percent slope. The cost of establishing such vegetative buffers is estimated to average $520 per acre, or about $9,000 per mile of affected stream ($18,000 per mile if sediments are delivered from both sides). About 5,000 miles of stream are reported to be affected by sediment in Appalachia. Acid production from surface mined lands can be controlled most economically by reclaiming the affected land at a cost ranging from $130 to $5,200 per acre, and averaging $2,100 per acre. About one-third of all acres of inactive surface coal mines in Appalachia are estimated to need such reclamation. More than half of all acid mine drainage is discharged from inactive underground mines. The cost of neutralization with limestone was reported in 1969 to range from $0.20 to $0.50 per thousand gallons, depending upon the strength and quantity of the acid. About 5,700 stream miles in Appalachia are affected by acid mine drainage.

Subsurface Disposal--The deliberate use of subsurface excavations for waste disposal is a growing practice that poses a continuing threat to the nation's groundwater quality. Presently, the wastewater derived from about 32 million tons of municipal and industrial solid waste are buried in landfills each year, and around 300 industrial wastewater injection wells are in operation in the country. The subsurface is also used inadvertently for disposal of liquids spilled on the surface and leaked from pipelines, pits, lagoons and storage tanks. The threat to groundwater quality -- and ultimately to surface water quality -- by subsurface disposal can never be entirely eliminated. In most cases, it can be minimized by judicious site selection, utilization of sound and proved design procedures, and careful management and operation of the facility. In rare cases, it must simply be recognized that groundwater quality deterioration will be an inevitable consequence of development, and appropriate plans must be made to deal with the resulting problem.

Salt Water Intrusion--Forty-two of the fifty states report salt water intrusion problems. Seawater intrusion into coastal aquifers as a result of overpumping fresh groundwater is a ubiquitous problem in most coastal states. Upstream encroachment of seawater as a result of deepening of channels for navigation and of reduction of streamflow because of increasing consumptive uses upstream presents problems to municipalities, industries and agriculture.

More than two-thirds of the nation is estimated to be underlain by saline water. Frequently, saline water and fresh water are in direct contact in an aquifer. In other cases, fresh and saline water aquifers that were originally separated by impermeable strata have been connected inadvertantly by improperly completed or sealed, water, oil and gas wells or by other disruptions of the earth's surface. Salt water intrusion into bays and estuaries can be controlled (conceptually at least) by increasing freshwater inflows, construction of navigation locks, or allowing navigation channels to silt up. Seawater intrusion into coastal aquifers

can be controlled by decreasing withdrawal, increasing freshwater recharge, or construction of hydraulic or mechanical barriers between the fresh and saline parts of the aquifer. Intrusion of underlying brine into freshwater aquifers through improperly completed or abandoned wells can be controlled by finding and sealing the offending wells. One or more of the above solutions is likely to be effective in solving the problem in any particular area, but the cost of implementation cannot be generalized because of the extreme dependency of the optimum solution on site specific conditions.

C. The "Objective" of the Act

QUESTION: *Is progress being made toward the "objective of this act . . . to restore and maintain the chemical, physical, and biological integrity of the Nation's waters"?*

ANSWER: *Yes, although progress to date attributable to P.L.92-500 is minimal, since results from its implementation are only now beginning to be realized.*

* * * * *

QUESTION: *Can this "objective" serve as a guide to policy-makers for their actions?*

ANSWER: *Not with much certainty or specificity. Even the experts cannot agree upon a full statement of the objective's meaning. "Restore" obviously means returning to some prior condition; restoring "physical" integrity could mean eliminating man-made changes in the nation's waterways so that sediment loads and temperatures would be as they were before man's perturbations of the land; restoring "chemical" and "biological" integrity would require knowing these conditions of the nation's waters at some historical point in time with a degree of accuracy not possible from existing historical data. Man has consistently adjusted, or attempted to alter, the "biology" of the nation's waters to suit his perceived needs. These adjustments or alterations would have to be eliminated in any literal application of the objective -- often to man's discomfort, if not to the detriment of his general well-being or health.*

A major objective of P.L. 92-500, as stated in Section 101(a), is "to restore and maintain the chemical, physical, and biological integrity of the nation's waters." Hence, the new concept of "chemical, physical, and biological integrity" of water requires understanding by the Commission in its various studies.

Of key importance to understanding this objective, however, is a precise interpretation of the word "integrity." While the House Committee on Public Works did not explicitly define the word in its report, it stated that "the word integrity as used is intended to convey a concept that refers to a condition to which the natural structure and function of ecosystems is maintained." The report further said that "natural is generally defined as that condition in existence before the activities of man invoked perturbations which prevented the system from returning to its original state of equilibrium." The Senate Committee made reference to sources which could be used to come to a definition of integrity for specific waters. They said, "The 'natural . . . integrity' of the waters may be determined partially by consultation of historical records on species composition; partially from ecological studies of the area or comparable habitats; partially from modelling studies which make estimations of the balanced natural ecosystems based on the information available."

Even with this guidance, the integrity concept is still difficult to define, primarily because few professional ecologists or environmentalists agree to a precise definition. The Commission, with assistance from The Institute of Ecology's Advisory Committee on Water Ecosystems, has examined differing opinions and philosophical approaches to defining the phrase, but is uncertain which viewpoint or philosophical approach most closely reflects the intent of Congress, as stated in the Act.

Although it has physical, biological and chemical components, ecosystem integrity as a single concept is preferable to dissection into "component integrities" for purposes of definition. The concept of ecosystem integrity relates to regulation of the structure and function of all components. To understand this concept requires understanding of several basic characteristics of ecosystems:

1. Interrelationships among species and their physical-chemical environments are results of long-term continuing evolutionary processes.

2. Due to interactions among species and with the environment, ecosystems tend toward short-term stability of biomass, and maintain characteristic rates of energy flow.

3. Ecosystems evolve toward a steady-state condition through species succession following short-term environmental disturbance.

4. Occasional natural disturbances (e.g., floods) are essential to maintenance of diversity of ecosystems.

5. Maintenance of life on earth is dependent upon the continued functioning of evolutionary ecosystem processes.

If natural ecosystem integrity is viewed as a phenomenon that should be "restored and maintained," difficulties arise when attempting to apply this concept as a measure of success for a water pollution control program. Is ecosystem integrity achieved when an aquatic environment provides optimum services required by man, or does the achievement of ecosystem integrity require restoration of conditions existing prior to human impact?

Those who interpret ecosystems integrity to mean "conditions prior to technological perturbations of man" feel the definition to be philosophically correct for several reasons. They say our knowledge of ecosystems is very incomplete, and that we may be changing and modifying ecosystems in ways we do not fully understand. Ecosystems are important, these proponents say, because we may someday need them for very different purposes than we do today. Persons arguing for restoration and maintenance of ecosystems as they were "prior to man's technological perturbations" believe that condition provides a maximum range of possible future human uses.

However, others believe using the environment and maintaining environmental quality at a level no higher than is required for current use is philosophically acceptable. They feel that it is impossible, and in fact undesirable, to achieve an environmental quality that existed prior to human technological impact and that man has been, and should continue to be, an integral component of the ecosystem in which he lives. Upgrading general environmental quality above a level necessary for survival is an unnecessary expense which society can ill afford.

Contractors performing 41 site-specific water quality and environmental studies, the primary focus of the Commission's national environmental impact assessment, were instructed to compare existing conditions and projected changes within the site to physical, chemical, biological and ecological characteristics of an "undisturbed setting" within or adjacent to each of the study sites. However, in a number of site-specific studies, environmental contractors found it impossible to document these characteristics for the "undisturbed setting." Often, there was insufficient data, historical or present, and, in some

instances, contractors were only able to use a "hypothesized" set of environmental conditions representing some "undisturbed" level for comparison. For nearly all study sites, except in extreme headwater regions, there have been important changes in physical, chemical and biological characteristics over time. Even where an "undisturbed setting" is described, then there are pollutant discharges from upstream that prevent accurate characterization of such a setting.

Thus, the Commission cannot claim that its studies, even in a limited sense, have identified a "chemical, physical, and biological integrity" at these locations to which the water there should be restored. They do, however, utilize information for the respective sites to analyze progress toward a water quality better than today and one that will provide "for the protection and propagation of fish, shellfish and wildlife."

II. TECHNOLOGY ASSESSMENT

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II. TECHNOLOGY ASSESSMENT

A. INTRODUCTION

The Act requires achievement of technology-based effluent limitations by specified dates to control point-source discharges. Application of the technologies capable of achieving these minimum limitations must be augmented where required to achieve water quality requirements and goals.

Technology assessments have been conducted for point-source discharges from publicly owned treatment works, industry and agriculture. The current and potential technological capabilities and the corresponding costs have been identified and evaluated for each type of discharge to meet the various effluent limitations.

Generally, technologies are available to achieve the 1977 and 1983 effluent limitations for publicly owned treatment works and industry. For certain industrial categories, technologies which serve as the basis of EPA regulations actually may not achieve the promulgated effluent limitations, particularly the short-term (24 hour) limits. In these cases, strict compliance will necessitate more elaborate and expensive technologies. On occasion, the technology has not been employed in the particular applications that are suggested. Instead, the technology must be "transferred" from another industry, or segment of the same industry.

Agricultural assessments are constrained by lack of regulations. While technologies are available to control runoff from feedlots, the regulations with respect to the size of feedlots to be covered are unsettled. Control of runoff from feedlots is achieved by merely storing and spreading, a technology readily available.

For irrigation return flows, nothing more than monitoring is presently required in permits and no regulations have been promulgated. Technological measures to reduce pollutants from irrigation return flows are available but which pollutants will be controlled and to what degree must be established before costs can be assessed realistically.

Although not subject to specific effluent limitations, nonpoint sources undoubtedly will play a key role in achieving the goals of the Act in some locations. Technologies capable of minimizing or reducing pollutants from nonpoint sources have been explored, although an analysis as detailed as that for the 1977 and 1983 point source requirements could not be undertaken. The more promising control strategies are usually accomplished by modifying operating procedures, rather than by treatment. For example, agricultural nonpoint sources are best controlled by applying soil conservation measures.

While not a requirement of the Act, elimination of the discharge of pollutants into the navigable waters by 1985 is a national goal [Sec. 101(a)(1)]. The Administrator may require elimination of the discharge of pollutants for BPT or BAT where there is a technology that can achieve it. An overview of what remains to be done toward the elimination of the discharge of pollutants into navigable waters after the 1983 requirements are achieved and what technologies are applicable is included in a section on "Innovative Technology."

Innovative technologies to achieve elimination of discharge of pollutants are coming into use on a limited basis. In some cases, usually low water-use industries, the goal will be achieved by compliance with BPT or BAT effluent limitations. Eliminating the discharge of pollutants from other point sources is technologically feasible, but far more costly than achieving 1983 requirements, if technologies available now or within the foreseeable future are to be employed.

The technology analysis was sometimes constrained by the absence of promulgated regulations. As mentioned above, this was the case with agriculture. In several cases, with toxics and pretreatment too, the regulations are in a state of uncertainty, and the Commission's technology assessment is highly speculative. Where effluent limitations had not been promulgated (or even drafted, in some cases) at the time the Commission contracts were under way, Commission contractors postulated effluent limitations. To the extent that the bases for Commission analyses differ from those eventually promulgated by EPA, the assessments will be different from the effects that are likely to occur.

Some other analytical limitations are worth noting too. All technology assessments undoubtedly lack specificity when considering exactly what approach may be available on a plant-by-plant basis to meet effluent limitations. Analysis of "end-of-pipe" alternatives is much easier than identifying internal "process changes", since plant-specific opportunities eventually must be determined case-by-case. This generalization is not as significant for publicly owned treatment works as it is for industries, where plant-by-plant options may be virtually unbounded. Overall, the need to generalize probably results in a conservative assessment of applicable technologies since optimized technological solutions could not be assessed. Nevertheless, many in-plant changes are an integral part of the technological solutions Commission contractors have utilized to meet the effluent limitations.

While optimized technologies may result in lower costs, a countervailing consideration is the omission of technologies (and corresponding costs) to achieve effluent limitations for toxic pollutants and water quality-limited waters by industrial point sources. On balance, aggregates for publicly owned treatment works, industry and agriculture are thought

to be within expected limits of engineering estimates. Costs for specific cases, and even for some individual categories of point-source discharges, undoubtedly are subject to considerable variability because of the necessary simplifying assumptions and lack of definitive regulations.

In spite of the numerous limitations, the Commission was able to obtain a comprehensive insight into the more technologically viable techniques for achieving the requirements of the Act. The details of this examination follow.

B. PUBLICLY OWNED TREATMENT WORKS

1. Introduction

The Commission's studies of Publicly Owned Treatment Works (POTW) were designed to provide 1) a determination of what technologies capable of meeting the requirements of the Act are available or likely to become available in the foreseeable future; 2) estimate the capital, operating and maintenance costs of applying these technologies; 3) estimate the associated requirements for non-financial resources such as manpower, materials, energy, land and chemicals; and 4) analyze the quantities, characteristics and methods for disposal of residual wastes remaining after treatment.

The definition of "treatment works" contained in Section 212 of the Act is extremely broad:

> The term "treatment works" means any devices and systems used in the storage, treatment, recycling, and reclamation of municipal sewage or industrial wastes of a liquid nature to implement Section 201 of this Act, or necessary to recycle or reuse water at the most economical cost over the estimated life of the works, including intercepting sewers, outfall sewers, sewage collection systems, pumping, power, and other equipment, and their appurtenances; extensions, improvements, remodeling, additions, and alterations thereof; elements essential to provide a reliable recycled supply such as standby treatment units and clear well facilities; and any works, including site acquisition of the land that will be an integral part of the treatment process or is used for ultimate disposal of residues resulting from such treatment. [Sec. 212(2)(A)]

> In addition to the definition contained in subparagraph (A) of this paragraph, "treatment works" means any other method or system for preventing, abating, reducing, storing, treating, separating, or disposing of municipal waste, including storm water runoff, or industrial waste, including waste in combined storm water and sanitary sewer systems. [Sec. 212(2)(B)]

These types of facilities generally serve one of four functions: wastewater collection, wastewater treatment, control of combined sewer overflows, and urban runoff control.

2. Regulations

Publicly owned treatment works are subject to Federal, state and local laws and regulations which establish limits on effluent quality and on air emissions, and place restrictions on methods of sludge disposal.

a. Wastewater

By July 1, 1977, publicly owned treatment works must achieve secondary treatment [Sec. 301(b)(1)(B)] as defined by EPA and compliance with applicable state laws or regulations which demand higher levels of treatment [Sec. 301(b)(1)(C)]. A second set of effluent limitations to be met by July 1, 1983 is to be achieved through the application of best practicable waste treatment technology over the life of the works (BPWTT) [Sec. 301(b)(2)(B)], or more stringent effluent limitations where necessary to contribute to the attainment or maintenance of required water quality [Sec. 302(a)]. The more stringent effluent limitations may be adjusted where there is no reasonable relationship between the economic and social costs and the benefits to be obtained [Sec. 302(b)].

Table II-1 shows the limitations on biochemical oxygen demand (BOD), suspended solids, pH and fecal coliform bacteria that constitute EPA's definition of the effluent quality attainable through secondary treatment. Somewhat higher concentrations of BOD and suspended solids are permissable in those cases where a publicly owned treatment works receives more than 10 percent of its design flow from industrial waste discharged by categories for which less stringent effluent limitations have been promulgated. Case-by-case exceptions may be granted for treatment works served by combined storm and sanitary sewer systems where increased flows during wet weather may prevent the attainment of the level of secondary treatment defined by EPA(1).

TABLE II-1: Definition of Secondary Treatment

Characteristic of discharge	Unit of measurement	Maximum Average Concentration 30 Consecutive Days	7 Consecutive Days
Biochemical oxygen demand (5-day)	mg/l	30[a,b]	45[b]
Suspended solids	mg/l	30[a,b]	45[b]
Fecal Coliform	No. per 100 ml	200[c]	400[c]
pH	pH units	between 6.0 and 9.0 at all times	

[a] Or, in no case more than 15 percent of influent value.
[b] Arithmetic mean.
[c] Geometric mean.

Source: 40 CFR 133. "Secondary Treatment Information," Federal Register Vol. 38, No. 159, pp. 2298-2299, August 17, 1973.

The limitation on fecal coliform bacteria normally cannot be met without chlorination or some other form of disinfection. Although EPA is now reconsidering the need for such a provision, the analysis that follows is based on the present definition of secondary treatment.

EPA has not promulgated regulations defining the effluent quality associated with BPWTT; however, proposed "Alternative Waste Management Techniques for Best Practicable Waste Treatment" has been published for public comment(2). This document essentially sets the 1983 requirements for POTW's equal to the 1977 requirements, and lists three options for achieving BPWTT: treatment and discharge, land application and reuse. Although the choice is left to the municipality, applicants for grants must demonstrate that the option selected is cost-effective.

Facilities using treatment and discharge must provide secondary treatment as a minimum, or a higher level of treatment consistent with maintaining receiving-water quality. (In this regard, EPA's proposed definition of BPWTT is somewhat redundant with respect to the requirements of Section 302.) Land application systems are governed by criteria designed to protect groundwater for use as a public water supply. Reuse is an acceptable alternative provided that it does not result in greater pollution of ground and surface waters than would result from treatment and discharge, or land application.

A few states have established secondary treatment standards similar to EPA's, but somewhat more stringent. For example, one state places an upper limit of 25 mg/l on BOD and suspended solids in contrast to EPA's 30 mg/l. Other state secondary treatment standards include specifications for constituents, such as dissolved oxygen and chlorine residual, not included in EPA's definition.

Effluent limitations more stringent than secondary treatment also may be imposed. The states have designated their surface waters as either effluent limited or water quality limited. An effluent limited receiving water is one in which water quality standards can be achieved through permits based on the uniform, technology-based effluent limitations promulgated by EPA. Water quality limited receiving waters require effluent limitations more stringent than these. A facility discharging to an effluent limited receiving water would not need to go beyond secondary treatment. Effluent limitations for municipalities discharging to water quality limited receiving waters are determined by waste load allocations which consider all discharges to a particular receiving water and which are part of the continuing planning process under Section 303 of the Act(3).

A few states have designated all of their waters water quality limited, while a few others have designated all waters effluent limited. In general, a large portion of the more stringent effluent limitations are aimed at maintaining dissolved oxygen in receiving waters and limit

effluent BOD to between 10 and 20 mg/l. A few also control nitrogenous oxygen demand by limiting ammonia nitrogen to between 2 and 5 mg/l(3).

Limits on nutrients are generally applicable to plants discharging to lakes or to streams tributary to lakes. The permissible concentration of phosphorus in the effluent is usually between 0.5 and 2.0 mg/l. Restrictions on total nitrogen are uncommon(3).

The use of land application as a method of wastewater treatment is subject to various state regulations and policies. Few states specifically allow irrigation of any land with wastewater unless it has been subjected to some form of treatment, usually a level proximate to secondary. Table II-2 presents the results of a recent survey of state restrictions on land application.

TABLE II-2. Summary of State Restrictions on Land Application by Irrigation[a]

Treatment Required Prior to Land Application	Number of States[a] Reporting		
	Non-Food Crops	Food Crops	Parks and Golf Courses
Land Application Prohibited	2	5	3
Primary	1	0	0
Secondary[b]	9	2	3
Secondary[b] and Disinfection	12	10	16
Not Specified	13	20	15
No Response	19	19	19
Total	56	56	56

[a] Includes District of Columbia, American Samoa, Guam, Puerto Rico, Trust Territories and Virgin Islands.

[b] Includes Lagoons.

Source: National Commission on Water Quality. From Metcalf and Eddy, Inc., Water Pollution Abatement Technology: Capabilities and Costs. Publicly Owned Treatment Works. 1976.

b. Combined Sewer Overflows and Storm Sewer Discharges*

Combined sewer overflows and storm sewer discharges are not now included in regulations defining the level of effluent quality attainable through secondary treatment(1) or in proposed regulations on best practicable waste treatment technology over the life of the works(2).

Effluent limitations for overflows from combined sewer systems will be established on a case-by-case basis where control of overflows is necessary to meet water quality standards. The EPA Water Quality Strategy Paper indicates that permits from the National Pollutant Discharge Elimination System will "require municipalities to operate existing treatment facilities to minimize discharges of pollutants from combined sewer overflows and bypasses to the extent possible with available funding and planning"(4). Municipal permits also will contain provisions for monitoring overflows and for planning corrective action.

A survey of state pollution control agencies conducted by a Commission contractor(5) revealed that the states are just beginning to approach combined sewer overflow problems. Only five states have established criteria for the quality of combined sewer overflows, and only a handful of enforcement actions have been taken.

Under P.L. 92-500, storm sewer discharges are subject to regulation as point sources but not the minor amount of runoff which is not carried in any pipe, ditch or other "discernible, confined and discrete conveyance" [Sec. 504(14)]. A recent court decision (7 ERC 1881) obligates EPA to issue permits for storm sewer discharges. This decision also states that EPA has the latitude to rank categories and subcategories of point sources of different importance and to treat them differently within its permit program. No effluent limitations for storm sewer discharges have been promulgated to date.

The EPA Water Quality Strategy Paper states that facility plans and areawide waste treatment management plans should include consideration of methods to control pollution from storm sewer discharges. Presumably, these plans will identify locations where these discharges are a problem, and indicate the level of control needed to meet water quality standards.

*As used in this report, "runoff" pertains to water flowing over the land surface. Except in sparsely populated areas, runoff is normally collected in storm sewers (pipes or ditches) that convey it to some point of discharge. If the collection system also handles wastewater, it is termed a "combined sewer" system. Such systems contain often numerous points where combined sewage is allowed to overflow to surface waters during storms, since sewage treatment plants generally have not been designed to treat the volume of combined sewage that results from all but very minor storms. "Storm sewer discharges" is also taken to include runoff from areas in need of storm sewers.

c. Residuals Disposal

Treatment of municipal wastewater generates considerable quantities of sludge, and lesser amounts of grit, screenings and scum. Disposal of these materials normally is accomplished through ocean dumping, landfilling, land application or incineration.

Ocean dumping of sewage sludge is regulated under both P.L. 92-500 and the Marine Protection, Research, and Sanctuaries Act of 1972 (P.L. 92-532). Public Law 92-532 requires permits from EPA for all dumping of materials other than dredge spoil in U.S. waters, the contiguous zone and the territorial sea, and for dumping of materials transported from the U.S. anywhere in the oceans. Criteria for the evaluation of permit applications define EPA's policy "to regulate the dumping of all types of materials into ocean waters and to prevent or to regulate strictly the dumping or other discharge into ocean waters of any material in quantities which would adversely affect human health, welfare, or amenities, or the marine environment, ecological systems, or economic potentialities, or plankton, fish, shellfish, wildlife, shorelines, or beaches"(6). EPA considers ocean dumping of sludge to be only an interim measure since sludges tested to date fail to meet the criteria for special permits. Interim permits require the permittee to "seek means of meeting the criteria or to find alternative means of disposal"(4).

Land application of sewage sludge is addressed in an EPA draft technical bulletin entitled Municipal Sludge Management: Environmental Factors(7). This document states that land application of treated sludges for agriculture, enhancement of parks and forests, and reclamation of poor or damaged terrain is an acceptable method for the utilization of sludges. A key point is that sludge must be stabilized prior to land application; i.e., treated to reduce public health hazards and to prevent nuisance odors. Proper site selection, design, operation and monitoring are essential elements of a satisfactory land utilization system.

Disposal of sludge in sanitary landfills is discussed in EPA's Guidelines for the Land Disposal of Solid Wastes(8). These guidelines list digested and heat-treated sludges and incinerator ash as materials compatible with normal sanitary landfill methods, provided these materials contain no free moisture. Raw sewage sludge and septic tank pumpings are considered special wastes for which precaut ons are needed to prevent ground and surface water contamination, nuisance odors, and possible spread of pathogens. The guidelines do not mention grit, screenings and scum, all of which are commonly disposed of in landfills. These guidelines are mandatory for Federal agencies and are recommended for use by state and local agencies.

Air emissions from sludge incinerators must meet Federal, state and local air pollution requirements. The Air Quality Act of 1967 resulted in the establishment of ambient air standards as well as standards of performance for various classes of sources including sewage treatment plants. The Federal standards of performance for sewage treatment plants limit opacity to 20 percent and particulates to 1.3 pounds per ton of dry sludge input. Some local air quality requirements are so strict as to preclude the use of sludge incinerators(3).

3. Characteristics of Wastewater, Combined Sewer Overflows and Storm Sewer Discharges

Wastewater received by publicly owned treatment works (municipal wastewater) consists of sewage flows generated in households, commercial and industrial establishments, and public buildings and varying amounts of groundwater and stormwater. Its volume and composition depend upon the pattern of domestic water use, the quality of the water supply used in a given area, industrial wastes, and infiltration of groundwater into the collection system through cracks and defective joints in sewer systems. Separate sanitary sewer systems also may receive considerable amounts of stormwater inflow from submerged manhole covers and from normally illegal connections of roof leaders, foundation drains and area drains.

The principal contaminants in municipal wastewater include oxygen demanding materials, suspended solids, dissolved solids, nutrients, toxic substances and pathogenic organisms. Typical concentrations of biochemical oxygen demand, suspended solids, dissolved solids, phosphorus and nitrogen characteristic of strong, medium and weak municipal wastewater are shown in Table II-3.

TABLE II-3: Municipal Wastewater Characteristics

Constituent	Concentration (mg/l)		
	Strong	Medium	Weak
Biochemical Oxygen Demand (5-day)	335	200	100
Suspended Solids	360	200	100
Total Dissolved Solids	860	515	270
Phosphorus (as P)	20	10	6
Nitrogen (as N)	80	40	18

Source: National Commission on Water Quality. From Metcalf and Eddy, Inc., Water Pollution Abatement Technology: Capabilities and Costs. Publicly Owned Treatment Works. 1976.

Metals such as chromium, copper and zinc are of concern because they may interfere with biological treatment processes (see Table II-4), they are normally not as amenable to removal by conventional treatment as are organic substances, they may render sludge unsuitable for land

TABLE II-4. Concentrations of Metals which Interfere with Biological Treatment Processes

Metal	Concentration (mg/l)		
	Aerobic processes	Anaerobic digestion	Nitrification
Copper	1.0	1.0	0.5
Zinc	5.0	5.0	0.5
Chromium (Hexavalent)	2.0	5.0	2.0
Nickel	1.0	2.0	0.5
Lead	0.1	-	0.5

Source: National Commission on Water Quality. From Metcalf and Eddy, Inc., Water Pollution Abatement Technology: Capabilities and Costs. Publicly Owned Treatment Works. 1976.

application, and they may adversely affect water quality. Some of the metals come from industrial discharges into municipal systems, but studies of New York City sewage treatment facilities indicate that appreciable quantities also come from residential and other nonindustrial sources, as shown in Table II-5.

TABLE II- 5. Sources of Heavy Metals in New York City Wastewater

Source	Percentage of Total Load				
	Copper	Chromium	Nickel	Zinc	Cadmium
Water Supply	20	0	0	7	0
Industrial	19	52	65	20	39
Residential	47	28	25	42	49
Runoff	14	9	10	31	12
Unknown	0	11	0	0	0

Source: L.A. Klein, M. Lang, N. Nash and S. L. Kirschner, "Sources of metals in New York City wastewater," Journal Water Pollution Control Federation, Vol. 46, No. 12, December 1974, pp. 2653-2662.

Combined sewer systems exhibit wide variations in flow between wet and dry weather. Wet weather flow associated with a rainfall intensity of 0.1 inch per hour may exceed the dry weather flow by a factor of five to 10, while a one-inch-per-hour rainfall may produce flows 50 to 100 times the dry weather flow (9).

Overflows from combined sewer systems include a portion or all of the domestic and industrial wastewater discharged during the storm, together with the pollutants washed from streets and other surfaces. In addition, solids, oil and grease accumulate within combined sewers during periods of dry weather and are flushed out during the early stages of a storm. During this "first flush" the concentrations of pollutants in the overflow often exceed those characteristic of untreated wastewater in dry weather. This condition may last for only a few minutes or it may continue for several hours, particularly in large sewer systems(9). After the first flush passes, the overflow normally becomes diluted to the point where its BOD concentration, averaged over the entire storm, is less than that of the untreated dry weather flow.

Storm sewer discharges can be considered significant sources of pollution with regard to the total quantities of pollutants released. As shown in Table II-6, the 1973 suspended solids load attributable to storm sewer discharges was almost four times that of wastewater treatment plant effluents and combined sewer overflows. This suspended solids load will become relatively more important as other sources achieve compliance with the requirements of the Act.

TABLE II-6. 1973 Average Daily Pollutant Load of Storm Sewer Discharges Compared with those of other Municipal Discharges.

	Storm Sewer Discharges[a,b]	Effluent of Wastewater Treatment Plants	Combined Sewer Overflows[c]
5-day Biochemical Oxygen Demand (tons/day)	2,600	7,900	1,800
Suspended Solids (tons/day)	47,000	7,100	6,200
Nitrogen (tons/day)	190	3,000	150
Phosphorus (tons/day)	94	880	60
Flow (million gallons/day)	22,500	24,000	3,600

[a] For the Urbanized Area portion of Standard Metropolitan Statistical Areas.

[b] Source: National Commission on Water Quality. From Black, Crow and Eidsness, Inc. and Jordan, Jones and Goulding, Inc., Water Pollution Abatement Technology: Capabilities and Costs. Urban Runoff. December 1975.

[c] Source: National Commission on Water Quality. From Metcalf and Eddy, Inc., Water Pollution Abatement Technology: Capabilities and Costs. Publicly Owned Treatment Works. 1976.

In terms of gross quantities of pollutants contained in storm sewer discharges, BOD, nitrogen and phosphorus appear to be lesser problems than suspended solids when other municipal discharges are used as a point of reference; however, they can have pronounced short-term effects on water quality since storm sewers like combined sewer overflows, release pollutants in a number of separate, and often intense, discharges.

Storm sewer discharges constitute a highly significant source of bacterial contamination as indicated by the coliform content. Observed fecal coliform densities vary from a few hundred to millions of organisms per 100 milliliters, while sewage treatment plants are not allowed to discharge more than an average of 200 per 100 milliliters under EPA's current regulations on secondary treatment. Appreciable quantities of heavy metals and other toxic substances have been found in urban runoff. Most of these materials are associated with very fine particles (smaller than 250 microns). The principal sources of pollutants in urban runoff are listed in Table II-7.

TABLE II-7: Sources of Pollutants in Urban Runoff

Source	Pollutants
Dustfall and rainfall	Suspended solids (particulates), nitrogen, sulfur, acid, pesticides
Vegetation	Oxygen-demanding substances, nutrients
Animal droppings	Bacteria, oxygen-demanding substances
Fertilizer usage	Nutrients
Pesticide usage	Pesticides
Erosion at construction sites and other pervious areas, and in drainage channels	Suspended solids
Motor Vehicles	Suspended solids, lead, oil and grease
Snow and ice removal	Dissolved solids, chloride, suspended solids, toxic compounds (e.g., sodium ferrocyanide)
Weathering of paving materials	Suspended solids

Source: National Commission on Water Quality. From Black, Crow and Eidsness, Inc. and Jordan, Jones and Goulding, Inc., Water Pollution Abatement Technology: Capabilities and Costs. Urban Runoff. December 1975.

Wide variations in the quality of storm sewer discharges have been reported for different locations, and for different storms at the same location. Some investigators have reported a "first flush" effect while others have not found such a phenomenon. It appears that the existence and intensity of any "first flush" depends upon such factors as the extent of paved surfaces, rainfall intensity, size of watershed, the frequency with which catch basins and sewers are cleaned, and the elapsed time since the last rainstorm. Table II-8 shows the ranges in the concentration of several pollutants in urban runoff at 10 sites across the country.

4. 1973 Baseline Conditions

At the time of the 1970 census, 144 million persons, or 71 percent of the U.S. population of 204 million, were connected to municipal sewer systems. About 93 percent of the population served resided in regions designated by the Census Bureau as urbanized areas.*

Data collected in the 1974 EPA Needs Survey** indicates that approximately 25 percent of the nation's sewered population is served by combined sewer systems. These systems are most numerous in the northeastern quarter of the continental United states. Some overflow occurrences result from bypassing of dry weather flows because of overloaded sewers and treatment plants, and cannot be considered combined sewer overflows in the strict sense. The number of overflows associated solely with storm events cannot be estimated from the available data.

The extent of wastewater treatment provided by publicly owned treatment works in 1973 is difficult to assess because of the lack of adequate data. The trend since 1940 is shown in Figure II-1. Since the data upon which this figure is based include some privately owned treatment plants, less importance should be placed on the absolute numbers of facilities shown than on the relative level of treatment provided. In 1940, only about half of the nation's municipal treatment plants provided more than primary treatment. By 1974, however, 81 percent of the facilities were providing some form of treatment beyond primary (but not necessarily that level of secondary treatment required for 1977), and five percent had tertiary treatment. Figure II-1 does not show the number of plants

* Generally, urbanized areas include central cities of at least 50,000 population, the surrounding closely settled territory, incorporated places of 2,500 or more inhabitants, incorporated places of fewer than 2,500 inhabitants provided each has a closely settled territory of 100 housing units or more. (For a complete definition see p. xiii 1970 Census of Population(10)).

**See p. II-24 for explanation of 1974 Needs Survey.

TABLE II - 8 RUNOFF QUALITY

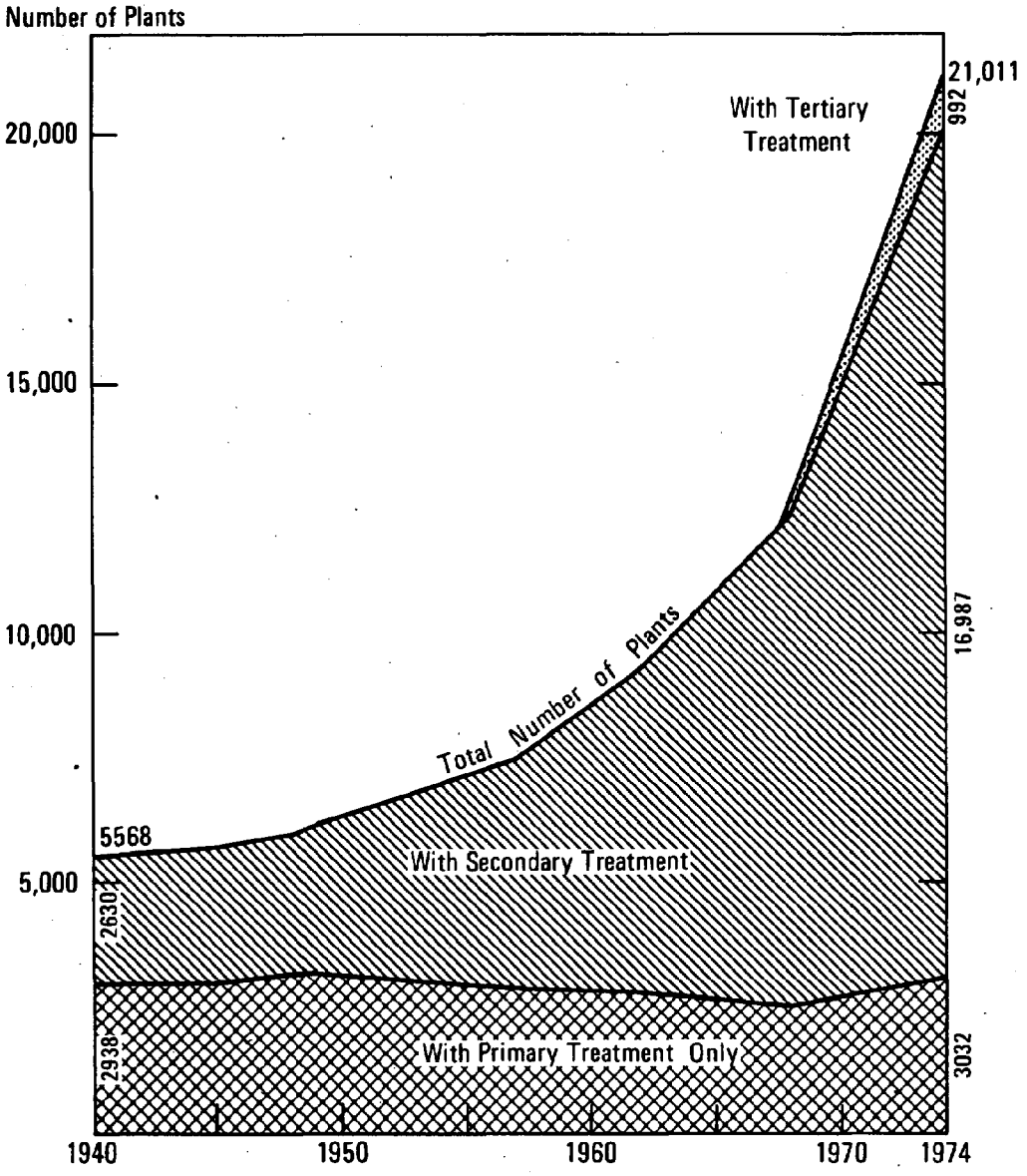
Site	Suspended Solids (mg/l)	BOD (mg/l)	COD (mg/l)	Total Nitrogen (mg/l)	Total Phosphorus (mg/l)	Fecal Coliform (Organisms/100 ml)	Lead (mg/l)	Chloride (mg/l)	Total Dissolved Solids (mg/)	Oil and Grease (mg/l)
Cincinnati, OH	4-1200	1-173	20-610	0.3-7.5	0.02-7.3	-	-	3-428	-	-
(mean)	(227)	(17)	(111)	(3.1)	(1.1)	-	-	(12)	-	-
Atlanta, GA	6-800	1-10	5-64	-	0.01-1.28	90-104,000	0.05-0.15	-	-	6.2-26.3
(mean)	(215)	(6)	(26)	(0.94)	(0.33)	(11,000)[1]	(0.08)	-	-	(11.7)
Durham, NC	27-7340	-	20-1042	0.1-11.6[b]	0.2-16	100-200,000	0.1-2.86			
(mean)	(1223)	-	(170)	(0.96)[b]	(0.82)	(23,000)[1]	(0.46)			
Tulsa, OK	112-864	2-26	64-215	0.13-2.24[c]	0.6-2.1[d]	0-290,000	-	-	56-396	-
(mean)	(401)	(14)	(121)	(0.82)[c]	(1.16)[d]	(720)[1]	-	-	(174)	-
Lubbock,TX[j]	144-670	-	110-461	0-5.28[e]	0.36-3.53[f]	-	-	-	166-1150	-
(mean)	(296)	-	(215)	(1.94)[e]	(0.64)[f]	-	-	-	(307)	-
Des Moines, IA	14-3170	14-166	-	0-4.69[e]	0-1.76	-	-	18-2724[h]	-	-
(mean)	(578)	(63)	-	(1.47)[e]	(0.93)	-	-	(681)[h]	-	-
New York, NY[k]	20-1653	5-143	0-131	0.65-19.3	0.05-1.46[d]	<3,000-4,600,000	-	3.7-2370	-	0.4-76[i]
(mean)	(184)	(30)	(46)	(3.64)	(0.48)[d]	(283,000)[1]	-	(452)	-	(17)[i]
Washington, D.C.	130-11,280	3-90	29-1514	0.5-6.5	0.2-4.5[g]	40,000-1,300,000	-	-	-	-
(mean)	(1697)	(19)	(335)	(2.1)	(1.3)[g]	(310,000)[1]	-	-	-	-
Castro Valley, CA	-	2-90	13-340	0.3-12.0	0.3-2.1	100-47,000	0.01-1.0	5-110	-	0-91
(mean)	-	-	-	-	-	-	-	-	-	-
West Lafayette, IN	9-95[a]	4-232[a]	-	-	-	900,000-2,900,000[a]	-	-	-	-
(mean)	(38)	(37)	-	-	-	(1,800,000)[1]	-	-	-	-

a Average values for separate storms.
b Kjeldahl nitrogen.
c Organic nitrogen.
d Soluble orthophosphate.
e Nitrate as N.
f Orthophosphate.
g Total phosphate.
h Snowmelt only.
i Hexane extractable materials.
j Runoff quality affected by discharge of industrial wastewater to storm sewer.
k Runoff quality may be affected by illicit connections.
l Geometric mean

Source: National Commission on Water Quality. From Black, Crow and Eidsness, Inc. and Jordan, Jones and Goulding, Inc., Water Pollution Abatement Technology: Capabilities and Costs. Urban Runoff. December 1975.

Figure II.1

TRENDS IN MUNICIPAL WASTEWATER TREATMENT 1940-1974



Source: U.S. Dept. of Interior, Fed. Water Quality Admin., "Municipal Waste Facilities in the U.S.; Statistical Summary, 1968 Inventory", Publication No. CWT-6, 1970.
1974 data from EPA STORET Municipal Waste Facilities Inventory. Some privately owned treatment works included in 1974 data.

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that discharge without treatment. This number is estimated to be about 3,500 on the basis of the data generated in the 1974 EPA Needs Survey.

Although the distribution of treatment plants by size, shown in Table II-9, is for facilities reported in the Needs Survey, it is considered representative of all existing plants. Although 78 percent of the plants are smaller than one million gallons per day (MGD), they treat only 7 percent of the nation's wastewater flow. Plants larger than 20 MGD constitute only 2 percent of the number of plants, but they treat 61 percent of the flow.

TABLE II-9: Size Distribution of Treatment Plants

Treatment Capacity (MGD) [a]	Percent of Number of Plants [b]	Percent of Flow [b]
Less than 1	78	7
1-5	15	14
5-20	5	18
More than 20	2	61
Total	100	100

[a] One Million gallons per day (MGD) is approximately equivalent to the flow of a population of 10,000 in the absence of industrial flow.

[b] For facilities reporting needs in 1974 EPA Needs Survey.

Source: National Commission on Water Quality. From Metcalf and Eddy, Inc., Water Pollution Abatement Technology: Capabilities and Costs. Publicly Owned Treatment Works. 1976.

The present method of effluent disposal reported in the 1974 Needs Survey is shown in Table II-10. Surface water outfalls are used in 84 percent of the plants. Some form of disposal on land is used by 13 percent of the facilities and 2 percent use ocean outfalls. In terms of total flow, 89 percent goes to surface waters; 8 percent to the oceans; and 3 percent to land. It can be concluded from these data that plants discharging to the oceans are typically larger than those discharging to surface waters.

TABLE II-10. Present Method of Disposal of Treatment Plant Effluents.

Disposal Method	Percent of Plants	Percent of Total Flow
Surface Water Outfalls	84	89.4
Ocean Outfalls	2	7.8
Holding Ponds	5	1.3
Deep Wells	< 1	negligible
Groundwater Recharge	1	0.9
Other Land Disposal	3	0.6
Water Supply Recycling	< 1	negligible
Septic Tank Fields	4	negligible
	100	100.0

Source: National Commission on Water Quality. From Metcalf and Eddy, Inc., Water Pollution Abatement Technology: Capabilities and Costs. Publicly Owned Treatment Works. 1976.

5. State of the Art of Technology

In general, adequate technology exists to meet municipal needs for wastewater collection and treatment systems.

Storage and treatment techniques for controlling combined sewer overflows have been demonstrated, and can be considered currently available but costly.

Although techniques which appear capable of preventing the contamination of urban runoff are becoming available, these techniques have not been proved to date. Technology for treating storm sewer discharges is now at a relatively early stage of development; however, there has been discussion of adapting technology for wastewater treatment and combined sewer overflow control for possible application to this source of pollution.

a. Wastewater Collection

Existing wastewater collection systems normally have been reliable in the performance of their primary function, the protection of public health through the timely conveyance of wastewater from its source to the point of disposal; nevertheless, the efficiency of many of these systems suffers because of their age and the limitations of technology available at the time they were installed.

Public Law 92-500 requires an applicant for a construction grant to demonstrate that the collection system serving a proposed treatment works is not subject to excessive amounts of infiltration and inflow. Techniques are available for sealing leaky sewers and for eliminating inflow from such sources as roof and area drains.

It is anticipated that the conventional practice of collecting and tranporting wastewater predominantly by gravity will continue during the foreseeable future. Alternatives to conventional collection systems are available in the form of vacuum and pressure sewer systems, but the cost of these systems limits their applicability to a relatively small number of cases where gravity collection or individual septic tank systems are not feasible because of adverse terrain or unsuitable soil conditions.

b. Wastewater Treatment

Several opportunities exist for reducing the cost of wastewater treatment by controlling the volume and strength of wastewater generated in the home. Water-saving plumbing fixtures become more economical with increases in the costs of water and wastewater services, particularly for new installations and for the replacement of worn-out fixtures. Widespread use of dual cycle toilets and flow-limiting shower heads would reduce domestic wastewater flow by about 40 percent(3) but the potential savings in treatment costs would be significantly less than 40 percent since wastewater strength would increase in proportion to the reduction in flow.

Garbage disposals increase household water consumption by about 4 percent. City-wide use of these appliances can increase wastewater total suspended solids by 55 percent, BOD by 30 percent and grit by 40 percent(11). Automatic dishwashing uses about twice the water needed for manual dishwashing and can increase per capita flow by about 3 percent(3).

Banning the use of phosphate detergents can reduce the phosphorus content of domestic wastewater by about 50 percent; however, greater reductions in phosphorus normally are necessary where eutrophication is a problem. Thus, the only savings in treatment costs that would result from such a ban would be about $0.90 per capita per year associated with reduced consumption of chemicals at treatment plants designed to remove phosphorus(3).

Since the above measures for flow and load reduction are not likely to be implemented soon on a wide scale without the imposition of legal restrictions, and since the historical trend toward increased domestic water usage appears to have leveled off, the analysis that follows assumes that there will not be major changes in household wastewater generation in the immediate future.

The principal constituents of concern in the design of wastewater treatment facilities are BOD, suspended solids, ammonia nitrogen, total nitrogen, phosphorus and pathogens. A large number of different treatment systems can be assembled from available unit processes; they can be grouped under five basic options:

1) suspended growth (e.g., activated sludge)
2) fixed film (e.g., trickling filter)
3) lagoon and pond
4) physical-chemical, and
5) land application.

There are variations of suspended growth and fixed film processes that can control nitrogen and all flow ranges can be accommodated.

Some lagoon processes also are capable of removing nitrogen when facilities for algae removal are provided. Without algae removal, most lagoon systems are not capable of achieving the level of suspended solids removal required by EPA for secondary treatment. Some techniques for upgrading lagoon performance are available while others are under development. Because of their substantial land requirements, lagoons generally are not applicable to plants over 1 MGD, although there are more than 200 lagoons now in use that are larger than this.

Physical-chemical systems are capable of producing high quality effluents. Although they can be designed to handle any flow range, their complexity and cost often preclude their application in small plants.

Many treatment facilities that have been termed "secondary" in the past do not comply with EPA's definition of secondary treatment, but their performance normally can be upgraded through modifications of existing processes or through the addition of processes for effluent polishing.

Effluent limitations more stringent than secondary treatment frequently are required to meet water quality standards. Extensive research over last decade has produced a number of applicable advanced waste treatment techniques that have been proven in pilot plant studies, and often in full-scale demonstration projects. Advanced technology is expensive, but it can be considered available.

Achieving the effluent limitations required by the Act will require closer attention to operation and maintenance than has been provided in the past. Without it, there may be a considerable difference between the level of treatment for which a facility is designed and the level actually achieved.

Secondary treatment and best practicable waste treatment technology can be achieved through land application and wastewater reuse also. Irrigation of crops and other vegetation is the predominant land application technique in present use. Infiltration-percolation is a high-rate process suitable for well drained, sandy soils. For impervious soils, land application may be accomplished by allowing wastewater to flow across a vegetated surface into runoff collection ditches. The principal use of this overland flow technique has been for treating food processing wastes, rather than municipal wastewaters.

Opportunities exist for reusing treated effluent for a number of municipal, industrial, agricultural and recreational purposes. Although there are many public health questions that need to be answered before direct recycling for public water supply can be practiced on an extensive scale, groundwater recharge through land application or recharge wells is an example of indirect reuse which has been practiced successfully. Municipal water supplies can be augmented by substituting reclaimed water for potable water in such applications as watering of golf courses, if separate transmission facilities are provided. Treated effluents have been used in industrial applications, primarily for cooling. Irrigation of cropland is an example of agricultural reuse. Reclaimed wastewater also has been used for aesthetic enhancement through ornamental lakes, and for the creation of reservoirs suitable for boating, fishing and swimming.

Numerous options for sludge treatment and disposal are available. The objectives of sludge treatment are to reduce the sludge volume and to eliminate its noxious properties so that it may be disposed of economically and in an environmentally acceptable manner. The principal difference among sludge handling systems lies in the methods of stabilization and ultimate disposal. Lime stabilization and aerobic digestion are normally employed in small trickling filter and activated sludge plants while anaerobic digestion is common in larger plants. No stabilization is necessary or desirable prior to sludge incineration. Methods of ultimate sludge disposal include: landfill, land application, ocean disposal, reclamation (e.g., marketing of processed sludge as a fertilizer), conversion to innocuous gases (e.g., incineration), and reuse (e.g., recovery of lime and chemical sludges).

Since sludge handling and ultimate disposal are often the most costly elements of wastewater treatment systems, constraints on sludge disposal may influence the choice among sludge-producing wastewater treatment options.

c. Combined Sewer Overflow Control

Methods available for reducing pollution from combined sewer overflows include source control, collection system control, storage and

treatment. Source control, which includes measures taken in the urban drainage basin to improve the quality of runoff and to reduce peak and total flow entering the sewer system, is discussed in the next section dealing with storm sewer discharges.

Collection system controls include sewer separation, catchbasin cleaning, control of infiltration and inflow, line flushing, improvement of overflow regulators, and remote monitoring and control for flow routing and in-line storage. Separation of combined sewer systems has come to be viewed not as a panacea but as a poor alternative because of the cost and disruption associated with large-scale replacement of sewer lines, and because of the pollution potential of storm sewer discharges. Periodic removal of solids that accumulate in the collection system during dry weather would prevent these materials from being flushed out during a storm, and restore sewer capacity needed during wet weather. Improved overflow regulators capable of reducing the suspended solids concentration of the overflow are becoming available.

Some form of storage normally is essential in a scheme of combined sewer overflow control since it is not feasible to treat combined sewage at the rate it is generated during a storm, especially if substantial reduction of pollutants is necessary. Most collection systems can be altered to provide a limited amount of storage through the use of inflatable dams or other regulators within trunk and interceptor sewers, but substantial off-line storage in holding basins or tunnels would be required for all but the smallest of storms. After a storm, impounded combined sewage can be released gradually for treatment at dry weather facilities, or treated separately.

Technology for treating combined sewage is basically similar to that used for wastewater. Special consideration is needed in process selection and design to accommodate the wide variations in flow and strength characteristic of combined sewerage systems, however.

The design of combined sewer overflow control facilities would differ significantly from that of wastewater treatment plants since facility size would be determined primarily by rainfall characteristics rather than the quantities of domestic and industrial wastewater received.

d. Storm Sewer Discharges

A number of techniques are emerging for preventing the contamination of urban runoff by controlling pollutants at their source. Street sweeping, as it is now practiced, is relatively ineffective in removing

the fine particles (under 250 microns) which contain most of the oxygen-demanding materials, nutrients and toxic substances found of the street surface. Vacuum street sweepers that are now available may be capable of removing substantial portions of these fine particles. Improved street cleaning alone would achieve only a partial reduction in pollution because of other sources of contaminants, such as soil erosion(12).

Temporary storage of rainwater on rooftops and parking lots by means of throttled drain inlets can reduce peak flows and thereby eliminate part of the suspended solids load attributable to erosion of drainage ditches and streambanks, and may reduce the need for separate storage facilities if treatment is to be provided(12).

Pollution associated with snow and ice removal can be reduced by moderation in the use of salt, by avoiding the use of toxic anti-caking ingredients in road salt, and by substituting abrasives for salt, where possible. Although it is doubtful that the use of salt can be eliminated, better management of this source of pollution can improve the quality of surface waters, as well as groundwater(12).

Control of erosion at construction sites is another method of improving runoff quality and is considered in Section II-F, Selected Nonpoint Sources.

Treatment processes proposed for controlling storm sewer discharges may be grouped under the headings of solids separation, biological treatment, disinfection and physical-chemical treatment. Reported performance and capital costs vary significantly, even for similar systems. Data for operation and maintenance requirements are almost nonexistent. Nevertheless, some generalizations can be made using basic studies reported in the literature.

Some form of storage normally is included in proposed treatment systems. The benefits of storage are that it can be designed to incorporate sedimentation for achieving substantial reductions in suspended solids and associated pollutants (toxic substances, oxygen demand, nutrients), especially if chemicals are added, and that it eliminates the need to design downstream processes large enough to handle peak flows.

Biological treatment is not particularly well-suited to controlling urban runoff pollution. Treatment at sewage treatment plants would be difficult because biological processes do not respond well to sudden changes in flow and load, especially if toxic substances are present. Treatment in separate facilities would require some means of maintaining the necessary population of microorganisms during periods of dry weather.

Physical-chemical treatment offers distinct advantages over biological treatment in that it can accommodate "shock" loadings and is not affected by toxic substances. It is more expensive, however, and produces large quantities of sludge. Disinfection would be required to reduce bacterial counts to acceptable levels.

6. Sources of Data

The approach taken in estimating the cost to the nation of achieving the requirements of P.L. 92-500 for publicly owned treatment works involved four basic steps: 1) an identification of needed facilities, together with enough information to define the types of technologies that might be applicable; 2) a determination of available technologies most likely to be used to meet the needs identified, and for each technology, the costs; and 3) an assignment of available technologies to individual needs, followed by 4) addition of costs. A similar approach was taken in estimating quantities of residual wastes generated and requirements for manpower, energy, materials and land.

a. Inventory of Needed Facilities

For wastewater treatment plants and combined sewer overflow control facilities, the 1974 U.S. EPA Needs Survey was used as the primary inventory of facilities needed to meet the requirements of the Act. This survey was conducted in response to P.L. 92-243, an amendment to Sec. 516 of P.L. 92-500. P.L. 93-243 directed EPA, in cooperation with the states, to conduct a state-by-state survey of costs of new facilities required by publicly owned treatment works as of June 1974, to be used as a basis for allocating construction grant funds among the states. Costs were reported in the following categories:

I.	Secondary treatment and BPWTT
II.	Treatment to meet more stringent effluent limitations
III.A.	Infiltration/inflow correction
III.B.	Major sewer system rehabilitation
IV.A.	New collector sewers
IV.B.	New interceptor sewers
V.	Control of combined sewer overflows
VI.	Treatment and/or control of storm sewer discharges.

The Needs Survey was used as a data base in the Commission's investigation because it represented the most recent inventory of existing facilities and because it presumably identified, either directly or through representative sampling, all publicly owned treatment works that needed additional facilities to meet the requirements of the Act. In addition, the survey requested from the states a wealth of technical information that would permit the Commission to estimate costs independently.

A considerable amount of care had to be exercised in interpreting the Needs Survey data. Since the results were to be used as a basis for allocating federal funds, the states had an incentive to overstate their needs. It is difficult to determine how extensively costs may have been inflated, but the opportunity existed for reporting unnecessarily high population estimates, high estimates of population connected to the sewers, and high per capita flow and industrial flow, and for reporting effluent limitations more stringent than those actually required to meet water quality standards. The cost of facilities is quite sensitive to all of these factors. Furthermore, at the time the survey was conducted, the states had only limited information to guide them in forecasting the extent of industrial use of municipal facilities, and in predicting the level of pollution abatement required for facilities discharging to water quality-limited receiving waters(5).

The Needs Survey data also suffers from lack of completeness. Although each needed facility seems to be reasonably accounted for in the data base, records for individual facilities often were missing part of the technical information needed by the Commission. Usually it was possible to overcome this deficiency through the judicious use of assumptions and other sources of information compiled by the Commission contractors.

The need for new collection systems was determined on the basis of the population expected to be served by municipal treatment facilities by 1990. Although the Needs Survey did obtain detailed information on the length and diameter of needed collector sewers, interceptor sewers and appurtenances, these data were not available in a form for convenient analysis.

The Needs Survey does not contain a uniform data base which could be used for estimating the cost of controlling pollution from storm sewer discharges. The varying depth of study by individual states is reflected in their needs reports which range from single-page cost statements to voluminous documents supplemented by computer analysis. In the absence of a more suitable data base, Commission contractors made varying assumptions about the extent of land area in the country for which storm sewer discharges might need to be controlled and estimated the cost of treating the runoff from these areas.

b. Population Projections

Because of the dominant influence of population on the cost of needed collection and treatment facilities, it was deemed necessary to make an independent projection of the population that would be served by publicly owned treatment works in the year 1990. This date was selected so that the Commission's cost estimates could be compared with those of the 1974 EPA Needs Survey.

The starting point in this analysis was information developed by the 1970 Census which contains data on the urban, rural-nonfarm and rural-farm populations served by sewers in 1970. The estimate of the 1990 total population was taken from the Department of Commerce Series 1-E projection with some slight modifications.

It was assumed that the entire population growth between 1970 and 1990 would occur in urbanized areas, and that the rural-nonfarm and rural-farm populations would remain unchanged. Assumptions were made that the percentage of the urban population not now connected to sewers would decrease by a factor of 50 percent between 1970 and 1990, and that there also would be corresponding decreases of 30 percent and 10 percent in the unsewered rural-nonfarm and rural-farm population segments respectively. These assumptions result in the projection, shown in Table II-11, of the 1990 population served by sewers.

TABLE II-11. Projection of U.S. Population Served by Publicly Owned Treatment Works

Year	Total Population (millions)	Population Served by Sewers (millions)	Percent Served by Sewers (%)
1970[a]	203.9	143.7	70.5
1990[b]	256.0	210.2	82.1

[a] Includes the 50 states and the District of Columbia.
[b] Includes the 50 states, the District of Columbia, American Samoa, Guam, the Trust Territories of the Pacific Islands, Puerto Rico and the Virgin Islands.

Source: National Commission on Water Quality. From Metcalf and Eddy, Inc., Water Pollution Abatement Technology: Capabilities and Costs. Publicly Owned Treatment Works. 1976.

c. Technologies and Costs

Information on the costs and capabilities of available and emerging water pollution control technologies was drawn from numerous sources, including searches of the technical literature, mail surveys, and personal contact with researchers, government officials and wastewater treatment personnel.

For the category of new collector and interceptor sewers, 97 recent sewer construction projects were reveiwed to determine the typical

per capita requirements for sewers and pumping stations of various sizes. Total costs were estimated from these per capita requirements, the projected increase in population connected to municipal sewer systems, and published data on the cost of collection system components.

An effort to develop an independent estimate of the cost of correcting infiltration and inflow conditions, and of major sewer system rehabilitation did not prove productive. The 1974 Needs Survey estimates were used for these projects.

All available information on wastewater treatment and sludge disposal processes was reviewed to determine applicability, reliability and capabilities of different technologies.

Information on available technology for controlling combined sewer overflows and urban runoff was drawn from the technical literature. Master plans prepared for several large cities and the results of demonstation projects were reviewed and proved to be valuable sources of additional information on methods of controlling combined sewer overflows. Adequate meteorological data, essential to the design of facilities for controlling wet weather pollution, were available from publications of the National Weather Service.

7. National Assessment

a. Costs

The Commission's estimates of the capital and operation and maintenance costs for meeting the 1983 requirements of the Act for publicly owned treatment works with facilities designed to meet the needs of the 1990 population are shown in Table II-12. The costs are presented using the same categories as the 1974 Needs Survey.

To estimate the cost of wastewater treatment plants, the 15,089 plants smaller than 20 MGD reported in the 1974 EPA Needs Survey were divided into 54 classes. The facilities in a given class were similar with respect to their 1990 design flow, extent of existing facilities, and effluent limitations on BOD, suspended solids and nitrogen. Technologies and costs were assigned to each class after a consideration of influent strength, existing capacity, required capacity, in-place processes, climate and required effluent quality. The results of this assignment of technologies are summarized in Table II-13. It was assumed that expansions of plants that now provide secondary treatment would be accomplished through the use of technology similar to that already installed.

TABLE II-12: Capital and Operation and Maintenance Costs for Publicly Owned Treatment Works[a]

Category		Capital Costs[b] ($ Billions)		Incremental Annual O&M Costs[b] ($ Billions/yr)	
I	Secondary Treatment and BPWTT	10.8		0.36	
II	Treatment to Meet More Stringent Effluent Limitations	24.8		0.83	
IIIA	Infiltration/Inflow Control	6.9		0	
IIIB	Major Sewer Rehabilitation	9.5		0	
IVA	New Collectors	13.0[c]		0.16	
IVB	New Interceptors	13.5[d]		0.16	
V	Correction of Combined Sewer Overflows[e]	79.6	[17-89][f]	0.50	[0.12-0.52][g]
	SUBTOTAL	158	[95.5-168]	2.0	[1.6-2.0]
VI	Treatment and/or Control of Storm Sewer Discharges[h]	199	[158-427][i]	1.3	[0.31-3.2][j]
	TOTAL	357	[254-595]	3.3	[1.9-5.2]

[a] For meeting 1983 requirements for 1990 population for projects not funded as of June 1974.

[b] Not including interest, amortization or depreciation. Capital costs include interest during construction. Incremental O&M cost is the difference between 1990 and 1973 O&M cost.

[c] Revised capital cost estimate is $14 billion.

[d] Revised capital cost estimate is $14 billion.

[e] Based on primary treatment plus disinfection on effluent limited receiving waters and secondary treatment plus disinfection on water quality limited receiving waters.

[f] Ranges from 17 to 89 depending upon level of control.

[g] Ranges from 0.12 to 0.52 depending upon level of control.

[h] Based on primary treatment plus disinfection for the Urbanized Area portion of Standard Metropolitan Statistical Areas.

[i] Ranges from 158 to 427 depending upon level of control.

[j] Ranges from 0.31 to 3.2 depending upon level of control.

[Indicates range]

Source: National Commission on Water Quality, February 1976, compiled from technology contractor reports to the Commission.

TABLE II-13: Distribution of Wastewater Treatment Technologies by Effluent Limitation

Effluent Limitation[a] (mg/l)		Secondary Treatment in Place	Number of Plants[b]	Percent of Plants Using				
				Activated Sludge	Fixed Film	Aerated Lagoon	Oxidation Pond	Land Application
BOD:	15-30	Yes	4156	28	31	9	28	4
SS:	15-30	No	4052	30	32	5	25	8
BOD:	15-30	Yes	393	37	43	6	11	3
SS:	15-30	No	238	48	23	5	16	8
NH_3-N:	0-6							
BOD:	15-30	Yes	39	15	41	5	34	5
SS:	15-30	No	71	40	24	6	20	10
Total-N:	0-6							
BOD:	0-15	Yes	1724	41	36	6	14	3
SS:	0-15	No	1634	55	14	5	17	9
BOD:	0-15	Yes	843	42	38	4	13	3
SS:	0-15	No	496	55	20	4	14	7
NH_3-N:	0-6							
BOD:	0-15	Yes	1288	46	22	8	21	3
SS:	0-15	No	517	45	24	6	17	8
Total-N:	0-6							

[a] Range in effluent limitations on biochemical oxygen demand (BOD), suspended solids (SS), ammonia nitrogen (NH_3-N) and total nitrogen (Total-N).

[b] With needs for new or improved facilities.

Source: National Commission on Water Quality. From Metcalf and Eddy, Inc., Water Pollution Abatement Technology: Capabilities and Costs. Publicly Owned Treatment Works. 1976.

Large plants often are faced with unusual design constraints (e.g., shortage of land for treatment plant expansion) that are peculiar to large cities. Consequently, costs for the 365 plants larger than 20 MGD reported in the Needs Survey were considered separately. Reported capital costs were compared with data collected by Commission contractors.* The only major adjustments were deletions where costs for the same facility appeared more than once in the 1974 Needs Survey, and population adjustments.

The capital cost estimates for each of the 54 classes of facilities under 20 MGD and for facilities over 20 MGD was apportioned to Categories I and II of Table II-12 on the basis of the amount of flow that appears in the Needs Survey record for these categories. This method was selected because there are some advanced waste treatment plants in Category I, Secondary Treatment, and some secondary treatment plants in Category II, Treatment to Meet More Stringent Effluent Limitations. The total capital cost estimate was refined by making adjustments to compensate for facilities which could not be classified because of insufficient Needs Survey data, and to correct for overstated population estimates.

This procedure resulted in an estimate of $35.6 billion for wastewater treatment plant capital costs -- $10.8 billion in Category I (secondary treatment and BPWTT) and $24.8 billion in Category II (more stringent treatment). The need for disinfection accounts for about 4 percent of the capital cost.

About 40 percent of the existing lagoon systems are expected to need more than secondary treatment to meet water quality standards. The remaining 60 percent will have to install filtration, or similar processes for algae removal, at an estimated cost of $0.26 billion, to achieve the suspended solids removal required under EPA's definition of secondary treatment.

A separate estimate was made of the capital cost of providing only secondary treatment for <u>all</u> facilities. This estimate was $27.8 billion. Thus, $7.8 billion, or 22 percent of the total cost for wastewater treatment, is associated with the need for advanced waste treatment(3).

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*American Public Works Association(5), and written responses to questionnaires from member agencies of the Association of Metropolitan Sewerage Agencies.

At one time, EPA was considering, as part of the definition of BPWTT(13), a requirement for a more stringent minimum level of treatment which would have included a specification for an average ultimate oxygen demand* of less than 50 mg/l in warm weather** and an average ultimate biochemical oxygen demand*** of less than 30 mg/l at all other times. Facilities serving a population of fewer than 10,000 and located outside SMSA's or those discharging to ocean waters were not included. Meeting this requirement generally would entail biological nitrification or some other method of ammonia removal, and would add about $1.4 billion to the capital cost estimate(3).

Costs for infiltration/inflow correction and major sewer system rehabilitation (Categories IIIA and IIIB), shown in Table II-12, were taken directly from the Needs Survey since a lack of data prevented independent estimates for these categories of need. The 1974 Needs Survey estimates that $6.9 billion is needed for controlling infiltration and inflow. This amount is equal to one-fifth of the $36.8 billion Needs Survey estimate**** for construction of wastewater treatment facilities. This estimate may be premature because the Needs Survey was conducted before most municipalities had completed the evaluation of their sewer systems. Commission contractors conclude that the estimate is probably low because of the number of authorities that reported only the cost of conducting the sewer system evaluation without the projected cost of correction.(5)

The total cost of new collection systems ($26.5 billion), shown in Table II-12, was apportioned to Categories IVA (new collectors) and IVB (new interceptors) in the same ratio as they were reported in the Needs Survey. It is not known precisely how much reserve capacity is provided for in the cost estimate, but since the per capita requirements are based upon a review of recent projects, it is presumed that they correspond to current engineering practice.

To be accurate, a national assessment of the cost of abating pollution from combined sewer overflows would involve, detailed information on the characteristics of rainfall and receiving waters for each facility served by combined sewers. Because of the dearth of such information, Commission studies were structured to develop a range of costs by altering assumptions about the level of abatement required.

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* Ultimate oxygen demand = $1.5(BOD) + 4.6(NH_3\text{-}N) - (D.O.)$

** Warm Weather was defined as influent temperature greater than 20^{o} C.

*** Ultimate biochemical oxygen demand = $1.5(BOD_5) - (D.O.)$

**** Costs shown are in 1975 dollars.

A common design storm, defined in terms of its frequency and duration as a 2-year, 1-hour storm, was used for all analyses; that is, facilities were designed to collect, store and treat the runoff from the storm of one hour duration whose rainfall is equalled or exceeded, on the average, once in two years. Designs for this storm will reduce the average annual number of overflows per site from the present 60 to about one to five.

To simplify the analysis, rainfall was assumed uniform within each of the five regions shown in Figure II-2. The size of the 2-year, 1-hour storm in each of these regions is also shown.

While it appears that the Act intends that combined sewer overflows be subject to effluent limitations for publicly owned treatment works and presumably would be included in the secondary treatment and BPWTT effluent limitations, alternative less stringent levels were also explored. Initially the Commission contractor derived costs for treatment options 1 through 5 as shown in Table II-14. Commission technology and economic contractors have used Option 5 (primary treatment and disinfection for effluent limited receiving waters and secondary treatment plus disinfection for water quality limited receiving waters) as the basis upon which impact analyses have been conducted. About 80 percent of the $80 billion capital cost of this option is attributable to storage facilities. The selection of this option reflects an assumption that this level of control is the most probable that would be needed to meet receiving water quality requirements.

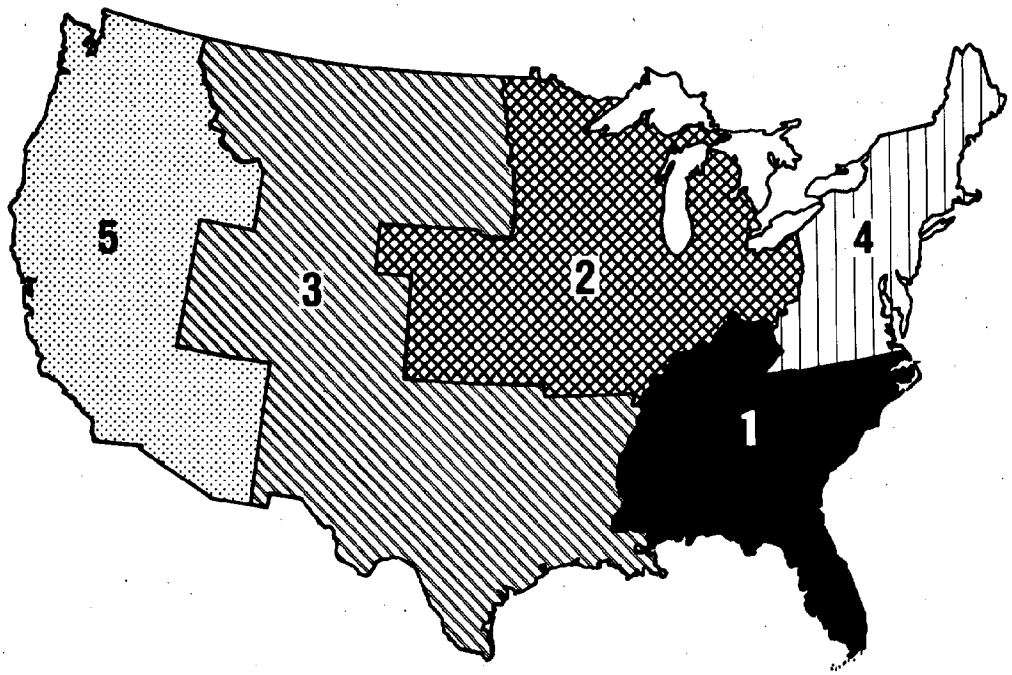
In recognition of the high costs for controlling combined sewer overflows and in anticipation that site-specific alternatives may eventually be adopted, the Commission contractor was directed to investigate other technological alternatives which might provide substantial reduction in discharge of pollutants at markedly lower costs. Options 6, 7 and 8 shown on Table II-14 are the principal possibilities that might be employed.

The eight levels of abatement were considered for the rainfall in each region. Storage volume and treatment rate were varied to determine the least-cost system capable of containing and treating the design storm within 24 hours. No storage was necessary for the option of disinfection only. Estimates of sludge handling costs were based upon the assumption that sludge generated at wet-weather facilities would be treated at large dry-weather plants.

In Table II-14, the eight treatment options are compared in terms of their costs, the degree of pollutant removal attainable, and cost per pound of pollutant removed. Secondary treatment of all overflows, Option 3, is the most effective in that it controls 70 percent of the BOD and 80 percent of the suspended solids, but it is also the most expensive. The least expensive solution, in-line storage and treatment

Figure II -2

RAINFALL REGIONS USED FOR ANALYSIS OF COMBINED SEWER OVERFLOW CONTROL



RAINFALL CHARACTERISTICS

	2 yr., 1-hr. Rainfall (inches)		Average Annual Rainfall (inches)	
Region [a]	Range	Average [b]	Range	Average [b]
1	1.30 - 2.55	1.64	39.1 - 57.6	46.2
2	1.00 - 1.70	1.36	24.8 - 50.0	34.6
3	0.40 - 2.45	1.23	7.7 - 59.2	25.4
4	0.80 - 1.80	1.20	30.7 - 55.5	41.9
5	0.35 - 0.80	0.49	6.3 - 86.4	36.7

(a) As shown on map above

(b) Weighted average based upon the distribution of facilities needed for control of combined sewer overflows.

Source: Natl. Commission on Water Quality, from Metcalf and Eddy, Inc., "Water Pollution Abatement Technology: Capabilities and Costs, Publicly Owned Treatment Works", 1976
February 1976

TABLE II-14: Comparison of Abatement Levels for Combined Sewer Overflow Control

Treatment option	Treatment: Effluent limited receiving water[a]	Treatment: Water quality limited receiving water[a]	Storage	Capital Cost ($ Billions)	Annual Operation and Maintenance Cost ($ Billions)	Annual Cost[b] ($ Billions)	System Efficiency (percent removal): BOD	System Efficiency (percent removal): Suspended Solids	Cost per Pound of Pollutant Removed[c]: BOD	Cost per Pound of Pollutant Removed[c]: Suspended Solids
1	Disinfection only		None	17	0.06	1.6	0	0	n.d.[d]	n.d.[d]
2	Primary and disinfection		In-line and off-line	70	0.47	7.1	30	55	18	2.9
3	Secondary[e] and disinfection		In-line and off-line	89	0.52	8.9	70	80	9.6	2.5
4	Disinfection only	Primary and disinfection	In-line and off-line	45	0.26	4.5	14	27	24	3.7
5	Primary and disinfection	Secondary[e] and disinfection	In-line and off-line	80	0.50	8.0	49	67	12	2.6
6	Swirl concentration with disinfection of overflow and treatment of underflow at existing dry-weather plant(s)		Off-line storage of underflow	33	0.09	3.2	13	45	18	1.6
7	Treatment of stored runoff at existing dry-weather plant(s)		In-line only	1.5	0.15	0.30	45	45	0.50	0.15
8	Treatment of stored runoff at existing dry-weather plant(s)		Off-line storage of "first flush"[f]	6.7	0.12	0.75	54	54	1.0	0.31

[a] Cities reporting needs only in Category I of the 1974 Needs Survey are considered to be located on effluent limited receiving waters; those reporting Category II needs are assumed to be located on water quality limited receiving waters.
[b] Capital Cost, annualized at 7 percent for 20 years, plus annual Operation and Maintenance Cost.
[c] Annual Cost divided by pounds of pollutant removed annually.
[d] Not defined.
[e] In the traditional sense, not as defined by EPA.

Source: National Commission on Water Quality. Data from Metcalf and Eddy, Inc., Water Pollution Abatement Technology: Capabilities and Costs. Publicly Owned Treatment Works. 1976.

at dry-weather plants (Option 7), removes 45 percent of the BOD and suspended solids.

Comparison of the options in terms of cost per pound of pollutant removed is difficult because all the options are not designed to remove the same pollutant. Option 1, disinfection of all overflows, is not designed to remove either BOD or suspended solids. Primary treatment is oriented toward suspended solids removal, but it would remove that portion of the BOD load associated with settleable suspended solids. Consequently, it is not surprising that it costs more to remove a pound of BOD using primary treatment than using secondary treatment, which is designed to remove BOD. In spite of the limitations of this kind of comparison, two options emerge as extremely attractive: Option 7, which uses in-line storage followed by treatment at dry-weather plants, and Option 8, which uses off-line storage of the "first flush" followed by treatment at dry-weather plants. Despite the somewhat limited effectiveness of these options, they constitute a relatively inexpensive first step toward controlling overflows from combined sewers. (For the sake of comparison, large secondary treatment plants provide 85 percent removal of BOD from sewage at a cost of about $0.25 per pound of BOD removed.)

The costs for Options 6, 7 and 8 do not include disinfection of those overflows which will not reach dry-weather plants for treatment. Therefore, total costs for options 6, 7 and 8 should be increased to account for the probable necessity of chlorinating untreated overflows. An allowance almost as great as required for Option 1 should be included. Nevertheless, the total costs for site-specific solutions employing these options plus chlorination could be substantially less than uniform application of Option 5. It is difficult to assess national costs when all solutions for controlling combined sewer overflows are so dependent upon yet to be finalized regulations, site by site specifics regarding rainfall and receiving water characteristics and the vagaries of each system.

In estimating the cost of controlling pollution from storm sewer discharges, critical assumptions were necessary with regard to extent of land area in need of runoff control, level of abatement required, and design storm. Three land areas were considered:

- All 243 Standard Metropolitan Statistical Areas (SMSA's), which generally include all cities of 50,000 inhabitants or more and the entire area of each contiguous county. These areas account for 11 percent of the land area of the U.S. and 69 percent of the population.

- The urbanized areas within these SMSA's. These include 1 percent of the nation's land area and 58 percent of its population.

o The central cities of all urbanized areas. These account for 0.4 percent of the nation's land area and 32 percent of the population.

The five abatement levels for which costs were estimated and the associated design storms are shown in Table II-15.

The methodology for estimating costs is as follows:

1) Conceptual designs for treatment systems were prepared for each abatement level for each of the 10 sites listed earlier in Table II-8. The estimated costs for these facilities formed the basis of cost curves (cost per unit of treatment capacity vs. population density) used in estimating national costs.

2) Information from the technical literature was used to establish the cost of stormwater collection as a function of population density.

3) The cost of collection and treatment for each SMSA, urbanized area and central city was calculated by means of a computer program which used these cost relationships and the following information specific to each geographical unit: land area, population, design storm, annual rainfall, area served by combined sewers, area without storm sewers, and a factor to incorporate regional differences in construction costs.

This methodology produced the capital and operation and maintenance costs shown in Table II-16.

As indicated previously, the most significant contaminants in urban runoff appear to be pathogens and suspended solids. Abatement level 3 would control these constituents, together with those toxic substances, nutrients and oxygen-demanding materials associated with the suspended solids. Areas within SMSA's but outside the urbanized areas are so sparsely settled that storm sewer discharges are less likely to be significant sources of pollution in these regions than in the urbanized areas. Consequently, the cost of achieving abatement level 3 in the urbanized areas, $199 billion, was selected by the Commission as being indicative of the national total capital cost of abating pollution from storm sewer discharges. A large portion of this cost, $84 billion, is attributable to stormwater collection.

TABLE II-15. Hypothetical Abatement Levels Considered in Analysis of Storm Sewer Discharges

Level	Description	Technology	Design Storm	Avg. No. of Storms Exceeding Storage and Treatment Capacity Per Year	Estimated Percent Pollutant Reduction				
					Suspended Solids	BOD	Nitrogen	Phosphorus	Bacteria
1	Removal of unaesthetic debris	Bar screen	1-year, 1-hour	more than 3	3	1	0	0	0
2	Removal of sediment and associated pollutants	Sedimentation	2-year, 1-hour	2	60	35	15	35	0
3	Removal of sediment, bacteria and associated pollutants	Sedimentation plus chlorination	2-year, 1-hour	2	60	35	15	35	99
4	Removal of sediment, oxygen demand, and associated pollutants	Aerated lagoon plus sedimentation	1-year, 6-hour	1	90	60	15	40	99
5	Treatment higher than secondary	Physical-chemical treatment plus chlorination	1-year, 24-hour	less than 1	97	90	70	70	99

Source: National Commission on Water Quality. From Black, Crow and Eidsness, Inc. and Jordan, Jones and Goulding, Inc., Water Pollution Abatement Technology: Capabilities and Costs. Urban Runoff. December 1975.

TABLE II-16. National Capital and Operation and Maintenance Costs for Controlling Stormwaters

Abatement Level[a]	1	2	3	4	5
Capital Cost ($ billions)					
Central City	60	81	85	100	190
Urbanized Area	158	189	199	225	427
SMSA	174	200	212	235	454
Operation & Maintenance Cost ($ billions/year)					
Central City	0.12	0.32	0.53	0.50	1.2
Urbanized Area	0.31	0.84	1.4	1.3	3.2
SMSA	0.36	0.96	1.6	1.5	3.7

[a] See Table II-15 for definition.

Source: National Commission on Water Quality. From Black, Crow and Eidsness, Inc. and Jordan, Jones and Goulding, Inc., Water Pollution Abatement Technology: Capabilities and Costs. Urban Runoff. December 1975.

The methodology used for estimating operation and maintenance costs for each category of need shown in Table II-12 was basically similar to that used in estimating capital costs. Costs associated with wastewater collection were based upon surveys conducted by the Commission's contractors(3). Costs for operation and maintenance of wastewater treatment plants were estimated from information on the requirements of various unit processes for manpower, energy, chemicals and materials. Costs for controlling combined sewer overflows were based upon the results of demonstration and pilot plant projects. Information on the operation and maintenance of urban runoff control facilities is almost nonexistent; however, it was possible to make some generalizations from studies reported in the literature.

It was recognized that the present design and operation of wastewater treatment plants often do not provide the level of reliability required by EPA. The need for standby units was not addressed specifically, but where differences in the reported cost for a given process were attributable to differences in reliability, the cost for the more reliable design was used in the Commission's analysis. Estimated operation and maintenance costs provide for a higher than customary level of manpower that is consistent with dependable operation.

The 1974 Needs Survey was assumed to be a complete inventory of needs for wastewater treatment and combined sewer overflow control. Any

publicly owned treatment works not reporting needs for these kinds of facilities was not specifically included in the analysis. The methodology used by the Commission contractor for estimating needs for new collector and interceptor sewers resulted in the inclusion of some costs (minor) for new collectors to serve communities not in existence on October 18, 1972, which are not eligible for construction grants. The Needs Survey theoretically included eligible projects only. Needs for infiltration and inflow correction for major sewer system rehabilitiation were taken directly from Category III reported in 1974 Needs Survey.

The Needs Survey data on effluent limitations, industrial flow, and per capita domestic flow used in this analysis are imperfect. The Needs Survey provided little information upon which an estimate of the cost of controlling combined sewer overflows and urban runoff could be based; therefore, it was necessary to make major assumptions for many factors to which the cost estimates were quite sensitive.

The cost functions used in estimating costs are representative of national average conditions (e.g., influent composition, climate and chemical costs). Consideration was given to abnormal circumstances, such as unusual site probelms, only to the extent that these circumstances are reflected in the Needs Survey for the larger facilities.

Many of the cost functions used were based upon numerous installations reported in the literature and can be considered reliable; however, cost functions for many unique wastewater treatment processes and for technology to control combined sewer overflows and urban runoff are based on very little data and must be considered approximate.

Table II-17 compares the 1974 Needs Survey cost estimates with those developed by the Commission. The two compare favorably for wastewater treatment facilities even though the Commission's estimate is based upon lower population estimates and stricter effluent limitations than the Needs Survey. The Needs Survey estimates for new collector and interceptor sewers are substantially higher than those estimated by the Commission. The Commission's estimated cost of combined sewer overflow control is almost double that reported in the Needs Survey, but its estimate of the cost of controlling urban runoff is substantially less. Nevertheless, the Needs Survey estimates for these kinds of facilities do fall within the extremely wide range of the Commission's estimates.

Differences in the estimates of wastewater collection (Category IV) are attributable partially to the Needs Survey's higher estimate of the 1990 population served by publicly owned treatment works. The differences in Categories V and VI are due largely to uncertainty because of the newness of technology for controlling wet-weather pollution, and uncertainty as to the level of control needed to meet water quality standards.

TABLE II-17: Comparison of NCWQ Cost Estimates with EPA 1974 Needs Survey

	Category	Capital Costs ($ Billions) NCWQ[a]		EPA Needs Survey
I.	Secondary Treatment	10.8		16.4
II.	Treatment to Meet More Stringent Effluent Limitations	24.8		20.4
IIIA.	Infiltration/Inflow Correction	6.9[b]		6.9
IIIB.	Major Sewer System Rehabilitation	9.5[b]		9.5
IVA.	New Collectors	13.0		22.8
IVB.	New Interceptors	13.5		23.1
V.	Correction of Combined Sewer Overflows	79.6	[17-89][c]	40.4
	Subtotal	158	[95.5-168]	139
VI.	Treatment and/or Control of Stormwaters	199	[158-427][d]	305
	Total	357	[254-595]	444

[a] Projects not funded as of June 1974. Costs do not include interest, amortization, depreciation or land for expansion.
[b] Needs Survey estimates.
[c] Ranges from 17 to 89, depending on level of control.
[d] Ranges from 158 to 427 depending on level of control.
[Indicates range]

Source: National Commission on Water Quality, February 1976, compiled from technology contractor reports to the Commission.

Of all the estimates developed by the Commission for publicly owned treatment works, those for wastewater treatment facilities (Categories I and II) are considered the most reliable; however, it must be remembered that these are for the 1990 population served by sewers. The use of 1990 as a basis for facility design in the present analysis produces an underestimate of costs because new facilities normally would be designed with adequate capacity to accommodate growth farther into the future than 1990.

b. Resources

Estimates of the manpower and land required for the construction of publicly owned treatment works are shown in Table II-18.

TABLE II-18: Manpower and Land Requirements for Construction of Publicly Owned Treatment Works

Category	Manpower (thousand man-years)	Land (thousand acres)
Wastewater Treatment	280	32
New Collection Systems	300	3.4
Combined Sewer Overflow Control[a]	660	39
SUBTOTAL	1,200	74
Storm Sewer Discharge Control[b]	2,100	140
TOTAL	3,300	214

[a] Based on primary treatment plus disinfection on effluent limited receiving waters and secondary treatment plus disinfection on water quality limited receiving waters.

[b] Based on primary treatment plus disinfection for the Urbanized Area portion of Standard Metropolitan Statistical Areas.

Source: National Commission on Water Quality, February 1976, compiled from technology contractor reports to the Commission.

Table II-19 shows the manpower, energy and chlorine required for operation and maintenance. The energy requirements shown are those in excess of those likely to be supplied by methane produced by sludge digestion.

TABLE II-19. Manpower, Energy and Chlorine Requirements for Operation and Maintenance of Publicly Owned Treatment Works

Category	(1) Wastewater Treatment[a]	(2) Wastewater Collection	(3) Combined Sewer Overflow Control[b]	(4) Subtotal (1)+(2)+(3)	(5) Storm Sewer Discharge Control[c]	(6) Total (4)+(5)
Manpower (thousand man-years/yr.)						
1973	47	60	Negligible	107	0	107
1990	85	82	18	185	24	209
change	38	22	18	78	24	102
Oil Equivalent[h] of Energy (thousand bl./day)[d]						
1973	65	5	Negligible	70[e]	0	70
1990	127	7	12	146[f]	16	162
change	62	2	12	76[g]	16	92
Chlorine (thousand tons/yr.)						
1973	250	Negligible	Negligible	250	0	250
1990	440	Negligible	110	550	860	1,410
change	190	Negligible	110	300	860	1,160

[a] Includes facilities with and without needs.
[b] Based on primary treatment plus disinfection on effluent limited receiving waters and secondary treatment (in the traditional sense not as defined by EPA) plus disinfection on water quality limited receiving waters.
[c] Based on primary treatment plus disinfection for the urbanized area portion of Standard Metropolitan Statistical Areas
[d] Based on 33 percent efficiency in generation and transmission of electrical energy
[e] Equals 0.20 percent of 1973 U.S. total energy consumption
[f] Equals 0.41 percent of 1973 U.S. total energy consumption
[g] An increase of 106 percent above 1973 value.
[h] Includes electrical and fuel oil requirements.

Source: National Commission on Water Quality, February, 1976, compiled from technology contractor reports to the Commission.

c. Residuals

The total annual sludge production will increase significantly when all needed publicly owned treatment works are constructed. The 1972 raw sludge production has been estimated at 4.7 million tons per year (dry solids basis)(14). By 1990, this figure is expected to increase to 24 million tons per year. Seven percent of this is attributable to controlling combined sewer overflows* and 43 percent to controlling storm sewer discharges.** Sludge processing reduces the total to about 20 million tons per year on a dry solids basis through processes, such as digestion and incineration, which convert some of the sludge to gaseous products. The actual quantity of material going to ultimate disposal will be more than double this 20 million tons because of the high water content of treated sludge.

The quantities of pollutants that would be discharged from publicly owned treatment works in 1990 if all needs are met are compared with 1973 quantities in Table II-20. The BOD load would be about half the 1973 load, and suspended solids and total phosphorus would be reduced by 60 percent and 17 percent respectively. Total nitrogen would remain virtually unchanged because the total volume of wastewater treated annually will increase, but not all treatment plants will be required to remove nitrogen. No conclusions about environmental impacts can be drawn from this information because such an evaluation would require an assessment of effects at specific disposal sites.

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* Based on primary treatment plus disinfection on effluent limited receiving waters, and secondary treatment (in the traditional sense, not as defined by EPA) plus disinfection on water quality limited receiving waters.

** Based on primary treatment plus disinfection for the urbanized area portion of Standard Metropolitan Statistical Areas.

TABLE II-20. Projected Flow and Pollutant Load Discharged from Publicly Owned Treatment Works

	Wastewater Treatment Plants[a]		Combined Sewer Overflow Control		Storm Sewer Discharges	
	1973	1990	1973	1990[b]	1973	1990[c]
Flow (MGD)	24,000	36,000	3,600	3,600	22,000	22,000
Biochemical Oxygen Demand (tons/day)	7,900	3,200	1,800	920	2,600	1,800
Suspended Solids (tons/day)	7,100	3,200	6,200	2,000	47,000	19,000
Total Nitrogen (tons/day)	3,000	3,200	150	100	190	160
Total Phosphorus (tons/day)	880	780	60	26	94	61

[a] Includes facilities with and without needs

[b] Based on primary treatment plus disinfection on effluent limited receiving waters and secondary treatment plus disinfection on water quality limited receiving waters.

[c] Based on primary treatment plus disinfection for the Urbanized Area portion of Standard Metropolitan Statistical Areas.

Source: National Commission on Water Quality, February, 1976, compiled from technology contractor reports to the Commission.

C. INDUSTRY

1. Study Definition

Primary emphasis was placed upon technologies required to achieve the effluent limitations promulgated, proposed, or under consideration by the EPA for 1977 and 1983, corresponding to "best practicable control technology currently available" (BPT) and "best available technology economically achievable" (BAT). Alternatives to EPA's BPT and BAT limitations were considered, and special attention was given to technologies now available or likely to become available in the foreseeable future to approach or achieve the 1985 goal of the elimination of the discharge of pollutants into navigable waters.*

Abatement costs were estimated for both construction and operation and maintenance, and associated non-financial resources including energy, chemicals, labor and land. Costs for pretreating wastes before discharging to municipal sewer systems were also estimated, assuming the approach to pretreatment promulgated by EPA in November 1973(15). (Specific pretreatment limitations are yet to be finalized for most industrial categories - see Section 3.c.) Finally, the technological problems associated with the ultimate disposal of materials removed from wastewaters, commonly referred to as "sludges," were explored, and the quantities of sludges and the costs of their disposal were calculated.

The broad spectrum of activities existing among water-using industries makes this study complex, and dictates use of a standard methodology and set of simplifying assumptions. Industries discharging significant quantitites of waterborne pollutants were divided into two groups. Separate studies of 10 industries were conducted "in depth." (An eleventh industry, animal feedlots, was also studied in-depth: see Section E.) These are either very large water users or illustrate important technological, economic or environmental issues. An additional 38 industrial categories were investigated in a "general industry" study. They were chosen because they were identified explicitly in the Act, or had been identified by EPA as categories for which effluent limitations would eventually be promulgated. Of the 38 general industry categories, four were subdivided into two sectors, giving a total of 42 categories studied as separate entities. Of these, it was determined that 20 should receive the most attention because of the relative significance of their water pollution abatement problems. One study covered all the industries within the "general" group.

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*These are discussed in Section D. - Innovative Technology

Table II-21 ranks the major manufacturing categories by total water intake in 1973, and shows those sectors studied in depth. (A tenth, non-manufacturing category, steam electric power, was also studied in depth.)

Table II-22 lists the industrial categories included in the general industry study. Those designated as group "A" received the least amount of study. The 20 deemed most significant were divided among groups "B" and "C". The "C" categories were given the most attention because they are major dischargers or because little prior information existed.

The standard approach and assumptions used throughout all the industry studies were:

o Each industrial category was divided into subcategories and - with a few exceptions - uniform effluent limitations were postulated for each subcategory. The utility of using subcategories in addition to those used by EPA was examined in the in-depth studies.

o A series of increasingly stringent effluent limitations was postulated, and in many cases more than one technological option for achieving each was assessed. For the categories studied in depth, limitations in addition to those promulgated or under consideration by EPA were studied to provide possible alternatives should it be concluded that the published limitations either were not technically feasible or economically achievable, or because the final limitations were not yet known in many cases, and because all are subject to possible revision.

o Where possible, in-plant changes aimed at reducing the amount and strength of wastewaters received as much attention as external ("end-of-pipe") treatment that removes the wastes after generation. This approach was followed because a combination of in-plant and external control strategies will often be the least-cost abatement strategy, and many in-plant changes are expected to be used by industry to meet the 1983 and "new source" requirements.

o Abatement needs were based upon one or more representative plant "models" for each subcategory. This approach facilitates analysis of plant-level economics, and variations in plant costs due to different production processes, size, etc., can be taken into account by using more than one representative plant per subcategory. Deriving plant-level expenditures also facilitates aggregating to total expenditures for each industry.

o Costs were calculated incrementally, starting from the abatement measures that were in place in each industry as of January 1973. A "baseline" is necessary in any calculation of expenditures, and the industrial studies used January 1973 to represent in-place abatement "before the Act."

Table II-21: Ranking of Major Industrial (Manufacturing) Categories by Total Water Intake in 1973[1]

Category	SIC. No.	Total Intake (billions of gallons)	Sectors Covered by In-Depth Studies (SIC Nos.)	No. of Plants in Sectors Covered In Depth	Total Intake by Sectors Covered In Depth (billions of gallons)
Primary Metals	33	4,941	Iron & Steel (SIC 331)	416	4,250
Chemicals and Allied Products	28	4,176	Inorganic Chemicals, Organic Chemicals, Plastics and Synthetics (SIC 281;2865,2869;282 less 2822)	3,700	4,048
Paper and Allied Products	26	2,415	Pulp, Paper, and Paperboard Mills (SIC 2611, 2621,2631)	598	2,305
Petroleum and Coal Products	29	1,283	Petroleum Refining (SIC 2911)	250	1,278
Food and Kindred Products	20	804	Canned and Preserved Fruits & Vegetables (SIC 2032-2035,2037)	2,123	123
Transportation Equipment	37	242	none	none	none
Stone, Clay, and Glass Products	32	219	none	none	none
Textile Mill Products	22	178	All	1,926[2]	178
Machinery, Except Electrical	35	171	none	none	none
Lumber and Wood Products	24	160	none	none	none

Table II-21: (Continued)

Rubber and Misc. Plastic Products	30	154	none	none	none
Fabricated Metal Products	34	107	Metal Finishing (SIC 3471)	70,000[3]	12
Electrical and Electronic Equipment	36	104	none	none	none
Instruments and Related Products	38	37	none	none	none
Miscellaneous Manufacturing	39	12	none	none	none

Total water intake for all manufacturing industries in 1973 = 15,024 billion gallons.[4]

(1) Includes brackish and saline, as well as fresh waters.

(2) There are approximately 3,440 additional mills which use insignificant amounts of water.

(3) Only a rough estimate. The number of "job shops", business establishments doing metal finishing only, is approximately 4,000. The remainder ("captive shops") are parts of larger manufacturing operations (including many in categories other than SIC 34).

(4) This figure excludes the steam electric power category, which was also studied in depth.

Source: 1973 Census of Manufacturers: Water Use in Manufacturing, Bureau of the Census, 1975. Table 3A

Table II-22: Categories within General Industry Study

Group "A"	SIC Nos.	Group "B"	SIC Nos.	Group "C"	SIC Nos.
Glass Manufacturing	321, 322, 323	Fertilizer Manufacturing	2873, 2874	Ore mining and Dressing Iron, Copper, Lead, Zinc, Uranium, Radium, Vanadium	10
Cement Manufacturing	3241	Ferroalloy Manufacturing	3313, 2819	Canned and Preserved Seafood Processing	2091, 2092
Structural Clay Products	325	Nonferrous Metals Manufacturing Copper, Lead, Zinc, and Aluminum	3331, 3332, 3333, 3334, 3341	Miscellaneous Food and Beverages -- Brewing	2082
Pottery and Related Products	326	Builder's Paper and Board Mills	2661	Water Supply	4941
Concrete, Gypsum and Plaster Products	327	Meat Products Processing and Rendering	2011, 2013, 2016, 2017, 2077	Machinery and Mechanical Products Manufacturing	3079, 34, 35, 36, 37, 38, 39
Asbestos	3292, 3293, 2661	Dairy Products Processing	2021, 2022, 2023, 2024, 2025	Leather Tanning and Finishing	31
Insulation Fiberglass Manufacturing	3296	Grain Mills Wet Milling, Wheat Starch and Gluten, and Cereal	2041, 2043, 2046	Coal Mining	11, 12
Auto and Other Laundries	721, 7542	Cane Sugar Processing	2061, 2062	Petroleum and Gas Extraction	13
Foundries	3321, 3322, 3325, 3361, 3362, 3369	Beet Sugar Processing	2063	Mineral Mining and Processing	14

Table II-22: (Continued)

Group "A"	SIC Nos.	Group "B"	SIC Nos.	Group "C"	SIC Nos.
Nonferrous Mill Products	335	Transportation Industries	40, 41, 42, 43, 44, 45, 46, 47		
Timber Products Processing	24	Rubber Processing	3011 3021, 3031, 3041, 3069, 3293, 2822		
Furniture and Fixtures	25				
Miscellaneous Food & Beverages	205, 206, 207, 208, 209, 514, 541				
Grain Mills -- Dry Milling, Wheat and Rice Feeds	2041, 2044, 2048				
Paving and Roofing Materials (Tar, Asphalt)	2951, 1611, 2952, 3996				
Paint and Ink Formulation and Printing	27, 2851, 2893				
Soap and Detergent Manufacturing	2841				
Phosphate Manufacturing	2819, 2874				
Steam Supply	4961				
Ore Mining and Dressing Gold, Silver, Bauxite, Ferro-ally Ores, Tungsten Molybdenum, Mercury, Other	10				
Nonferrous Metals Manufacturing Bauxite Refining	2819				
Fish Hatcheries and Farms	0921, 0279				

Source: National Commission on Water Quality, October 1975.

o Costs were expressed in mid-year 1973 dollars in the contractors' reports and reflect relative price levels at that time. These figures have been converted to approximate 1975 dollars by the Commission staff, using a uniform multiplier of 1.3. All costs in this report reflect 1975 dollars unless otherwise noted. Only capital and direct operation and maintenance expenditures were caluclated. Adjustments for such factors as inflation rates, depreciation and financing costs were considered in the economic impact studies.

o Costs of abatement technologies aggregated to subcategory and industry level do not incorporate plant closures or industrial growth after January, 1973. These factors were also addressed in the economic impact studies.

o Where available, EPA's promulgated effluent limitations, and supporting data given in the Agency's "Development Document for Effluent Limitations Guidelines and New Source Performance Standards" were used to define the effluent limitations associated with BPT and BAT. When limitations had been proposed but not promulgated, Development Documents supporting the proposed limitations were used. In cases where the limitations had not yet reached the proposal stage, the limitations suggested by EPA's contractors and under consideration by EPA were used. In a few cases, particularly within the general industry study, none of these sources were available and Commission contractors were forced to hypothesize what the limitations would be. Of the 10 industries studied in depth, promulgated limitations were available for all subcategories of the petroleum refining, steam electric power, and textile categories. Promulgated limitations were available only for portions of the other seven: limitations suggested by EPA contractors and under consideration at the time of the Commission's studies were used for the remaining subcategories.

Alternatives to the abatement levels promulgated, proposed or under consideration by EPA were not analyzed for most of the 42 categories in the general industry study. For about 12 of these, no limitations had been proposed by EPA by the inception of the studies. Approximately the same number of categories within the general industry study had limitations that were only proposed or under consideration. In the latter situation, Commission contractors used EPA's contractor reports, and assumed that the suggested limitations would be promulgated.

There were other differences between the general and the in-depth studies. EPA studies served as the primary data base for most of the general industry studies, and the contractor assumed the viability of EPA's suggested BPT and BAT technologies for all but the nine group C industries. However, costs were developed independently in all cases. Areas such as toxic materials limitations and state water quality standards

were considered to some degree in the in-depth studies, but were given little or no attention in the general industry study.

None of the aggregate cost data include costs of meeting water quality standards or toxic pollutant standards which might require more sophisticated technologies than required to meet the BPT and BAT effluent limitations.

2. The Industrial Setting

a. Water Use

Across the spectrum of individual activities, the following uses of water are most prevalent:

1) Cooling and heating
2) Steam generation
3) As a chemical solvent or reactant
4) Washing
5) Materials transport
6) Air pollution abatement.

Cooling is the largest volume usage, and the steam electric power category is, by far, the major user of cooling water. Cooling water is often physically separated from water required in the manufacturing process ("process water"), often does not come into contact with the product and, except for the addition of heat, may remain relatively uncontaminated. This is particularly true for electric power generation where, although some chemicals may be added to the "once-through" condenser cooling water before it is discharged, the main addition is simply heat. Steam electric power is the industry most impacted by thermal effluent limitations.

Water used for steam may become contaminated after contact with chemicals or intermediate products, and the pollutants absorbed must be "stripped" from the condensed steam before it is reused or discharged. The petroleum refining industry provides a major example -- "sour water strippers" are used to remove sulfur and other polluting compounds from condensed steam that has been used to heat crude oil during the distillation process.

Water is known as the "universal solvent," meaning that it dissolves a large number of chemical compounds. Thousands of industrial processes depend on this property, and some of the dissolved materials usually end up in wastewaters. Water is also used in many chemical reactions, and a fraction may be combined into other chemical compounds. When this occurs, that fraction is truly consumed, and does not appear in the plant's discharge. (The quantities of water lost in this way are minor: more water is lost through evaporation.)

The canned and preserved fruits and vegetables industry offers examples of water used for materials transport. Commodities such as potatoes are often transported between processing stages by flumes filled with rapidly moving water. Water fluming can also serve the purpose of washing and cooling, as well as the primary purpose of minimizing product damage during transport. Fluming water leaches soluble materials from the product, and may contribute significantly to the plant's wastewater discharge.

The greatest source of wastewater in producing steel ingots is from the "scrubbing" (washing) of pollutants from gases. All of the major production processes produce large volumes of these gases, laden with suspended solids and a variety of chemicals. Controlling these potential air pollutants results in a complex water pollution problem. Some of the effluent from the scrubbing process can be recovered, treated and recycled. The balance must be treated before it can be safely discharged to land or surface waters.

The volume of intake water used per unit of product has been decreasing in recent years in many industries. This trend results from several factors, including increases in the cost of the water, water pollution control costs, and the adoption of economic process changes which are less water intensive. (An example of the last case is the shift from "sulfite" to "kraft" chemical pulping in the pulp and paper industry: the kraft process discharges only half the water per ton as the older calcium sulfite process.)

A low flow, concentrated wastewater stream normally is easier and less costly to control and treat than a high volume, more dilute stream and hence water conservation can play an important role in water pollution abatement. "Conservation" refers to reductions in the net intake water requirements per unit of product. This is different from "gross water applied," a quantity determined by the details of the manufacturing process. The difference between these is the amount of water recycled and reused within the process: increased recycle and reuse decreases the intake water requirement and the discharge flow. Table II-23 summarizes information published by the Department of Commerce on historical water use by the manufacturing sector. The trend toward increased recycling and reuse is most dramatic between 1968 and 1973, when gross use increased by 32 percent, while net intake actually dropped slightly.

Table II-23: Historical Gross and Intake Water Usage by all Manufacturing Industries

Year	Gross Water Used (billions of gallons)	Net Water Intake (billions of gallons)
1959	26,257	12,131
1964	29,857	14,007
1968	35,701	15,467
1973	46,965	15,024

Source: Census of Manufacturers: Water Use in Manufacturing, Bureau of the Census, 1961, 1966, 1971, 1975.

b. Waterborne Pollutants

The wide variety of uses for water is reflected in the number of industrial wastewater constituents which are considered pollutants. The most common pollutants controlled are:

- o Biochemical Oxygen Demand, Five-day (BOD)
- o Chemical Oxygen Demand (COD)
- o Suspended Solids (SS), or Total Suspended Solids (TSS)
- o pH (a measure of acidity or alkalinity)
- o Oil and Grease (O&G)

Examples of other pollutants controlled in several industries are ammonia, sulfides, phenols and color. Table II-24 shows the complete list of pollutants controlled by EPA's effluent limitations for the 10 industries studied in depth.

In addition to the pollutants listed in Table II-24, EPA's proposed Toxic Pollutant Effluent Standards would limit the discharge of the pesticides aldrin, dieldrin, DDT (and DDD, DDE), endrin and toxaphene, the compounds PCB, benzidine and cyanide, and the heavy metals cadmium and mercury(16). Promulgation of these proposed toxic standards would impose additional limitations on the pulp and paper, iron and steel, metal finishing, ore mining, ferroalloys, nonferrous metals, transportation, petroleum, and sectors of the chemicals industries, among others.

TABLE II-24: Industrial Pollutants Controlled by Effluent Limitations Either Promulgated or Under Consideration by EPA

Category	Pollutants Controlled by BPT (1977)	Additional Pollutants Controlled by BAT (1983)
Canned and Preserved Fruits and Vegetables	BOD, SS, fecal coliform, pH, O&G	None
Inorganic Chemicals	SS and pH for all subcategories; plus for specified products: ammonia, COD, BOD, fluoride, sulfite, sulfide, O&G, total organic carbon, cyanide, free bromine (molecular), arsenic, barium, cadmium chromium, copper, iron, lead, manganese, mercury, nickel, selenium, silver, zinc	EOD[1] (for some product/processes)
Iron and Steel	SS, O&G, pH, cyanide, phenol, ammonia, iron, zinc[2], lead[2], chromium, tin	Sulfide, fluoride, nitrate, manganese
Metal Finishing	SS, pH, cyanide, fluoride, phosphorus, copper, nickel, chromium, zinc, cadmium, lead, iron, tin, silver, gold, iridium, osmium, palladium, platinum, rhodium, ruthenium	EOD[1]
Organic Chemicals	BOD, SS, pH, for all subcategories; plus for specified products: phenol, cyanide, chromium, copper	COD
Petroleum Refining	BOD, COD, SS, O&G, pH, phenol, ammonia, sulfide, chromium	None
Plastics and Synthetics	BOD, COD, SS, pH for all subcategories; plus for specified products: O&G, fluoride, phenol, chromium, copper, zinc	None
Pulp and Paper	BOD, SS, pH	color
Steam Electric Power	SS, O&G, pH, polychlorinated biphenyls, chlorine, copper, iron	Heat, zinc, chromate, phosphorus
Textiles	BOD, COD, SS, fecal coliform, pH, phenol, sulfide, chromium	color

[1] The 1983 limitations correspond to elimination of the discharge of process wastewater pollutants.
[2] For Primary Steelmaking, only controlled by BAT.

Source: National Commission on Water Quality, February 1976.

(EPA's proposed toxic standards are discussed further in Section 4.b.)

Another parameter defined as a pollutant in the Act is heat. Many industrial processes generate wastewaters with a higher temperature than that of the intake water and, in some cases, the wastewater must be cooled, even before biological treatment. The steam electric power industry is unique in this regard because the discharge of large quantities of heat energy from the plant is fundamental to the electric generating process. Control of heat discharged to surface waters is commonly accomplished with evaporative cooling devices. The requirement that some classes of electric generating plants install these devices has been one of the more controversial regulations issued under the Act. (Thermal pollution controls for this industry are discussed in Section 4.c.)

Generally, this Act and previous laws require a higher degree of treatment if the discharge is to surface waters than to municipal sewers. In the latter case, treatment may consist only of screening large solids (rags, woodchips, leaves, etc.), but sometimes involves more sophisticated treatment before discharge, called "pretreatment," anticipating that the municipal system will treat the wastewater again before final discharge.

Treatment of wastewaters to remove pollutants is commonly referred to as end-of-pipe abatement -- the strategy usually being to combine all waste flows into a few streams which converge upon a central facility where they are treated before being discharged. In addition, pollutants can often be reduced at the source by various in-plant changes, ranging from simple better "housekeeping" procedures to reduce spills and leaks, to fundamental changes in the manufacturing processes themselves. Other measures are aimed primarily at flow reduction (water conservation). The least-cost abatement strategy will often be some combination of these in-plant changes and end-of-pipe treatment. The optimal combination depends upon the degree of abatement required, costs of candidate in-plant changes, treatment costs, and other site-specific factors which are difficult to generalize.

c. Abatement Measures in Place

Considerable effort in the in-depth industry studies, and to a lesser extent in the general industry study, was devoted to assessing water pollution abatement technology in place in the 1973 base year. Although industry wide, plant-by-plant surveys covering abatement measures in place were not available for most categories,* Commission contractors

*An exception is petroleum refining, where there are only 250 plants, and where a very detailed industry survey carried out in 1972 was utilized. Surveys complete in most other respects were available for non-ferrous metals, iron and steel, and pulp and paper.

were able to make reasonably accurate estimates of end-of-pipe treatment in place for most of the in-depth categories, and rough estimates for some of those covered by the general study. Information on in-plant measures undertaken partially or wholly for purposes of water pollution abatement was much more difficult to obtain and, in most cases, only rough estimates of the presence of such measures were possible. In fact, many of the representative plant "models" assumed none of the in-plant measures considered for 1983 in the studies were in place in the base year -- a realistic assumption for the majority of cases.

Conventional wastewater treatment systems can be separated into two different types: biological and physical-chemical. The basic principle of biological treatment is simply to accelerate the natural processes that would occur if the wastes were to be introduced into the natural water environment. Dissolved organic materials are converted into carbon dioxide and "biomass" by cultivating bacteria that feed on the waste constituents. The sludge from these processes is composed primarily of bacterial cellular matter. The most common biological systems have as their essential component either activated sludge basins, or aerobic or anaerobic lagoons.*

Physical-chemical treatment is normally used on either inorganic wastes or organic wastes which are slow to degrade biologically.** (The latter are sometimes referred to as "refractory organics.") Physical-chemical treatment normally requires less space than biological treatment, and may be preferred for treating biodegradable wastes for facilities with space constraints, a particular problem for plants located within cities. Examples of water-using industrial plants often found within cities are textile mills, metal finishing shops, some types of paper mills, and fruit and vegetable canneries. Many of those plants discharge to municipal sewers, and some form of physical-chemical and/or biological pretreatment may be required.

Table II-25 summarizes the information from the Commission's in-depth industry studies on the end-of-pipe wastewater treatment in place as of January 1973. No attempt was made in the technology assessment studies to quantify the financial investment this represents.

d. Subcategorization

The subcategorization of each industrial category has been used by EPA to expedite the development of effluent limitations and to help

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* Aerobic bacteria require dissolved oxygen; anaerobic do not.

**Materials classed as "organic" always contain carbon, and normally originate from naturally occurring raw materials of plant or animal origin, including fossil fuels, especially petroleum and its derivatives.

TABLE II-25: Summary of Wastewater Treatment Practices as of January 1973[1]

Industrial Categories	No. of Plants	Fraction of Industry Discharging to Publicly Owned Treatment Works: By Number of Plants	Fraction of Industry Discharging to Publicly Owned Treatment Works: By Production Capacity	Fraction of Industry Discharging to Land: By Number of Plants	Fraction of Industry Discharging to Land: By Production Capacity	Fraction of Industry Discharging to Surface Waters: By Number of Plants	Fraction of Industry Discharging to Surface Waters: By Production Capacity	Fraction of Surface Water Dischargers with "Secondary" Treatment[2]: By Number of Plants	Fraction of Surface Water Dischargers with "Secondary" Treatment[2]: By Production Capacity	Fraction of Surface Water Dischargers with Technology in Place Basically Equivalent to BPT[3]: By Number of Plants	Fraction of Surface Water Dischargers with Technology in Place Basically Equivalent to BPT[3]: By Production Capacity
Canned and Preserved Fruits and Vegetables	2,123	40%	(50%)	40%	(35%)	20%	(15%)	(63%)	(78%)	unknown, but very small	unknown
Inorganic Chemicals	See footnote 4.	Small	negligible	negligible	negligible	(100%)	(100%)	(45%)	45%	(less than 45%)	(less than 45%)
Iron and Steel	416	unknown	negligible	negligible	negligible	unknown	(100%)	unknown	(30%)	unknown, but small[5]	unknown, but small[5]
Metal Finishing	70,000	70% (85% job, 65% captive)	unknown	negligible	negligible	30% (15% job, 35% captive)	unknown	81%	unknown	29%	unknown
Organic Chemicals	See footnote 4.	unknown	(10%)	negligible	negligible	(90%)	(90%)	(20%)	25%	negligible	negligible
Petroleum Refining	250	14%	12%	15%	4%	71%	84%	42%	65%	1%[9]	2%[9]
Plastics and Synthetics	See footnote 4.	(40%)	(20%)	negligible	negligible	(60%)	(80%)	(30%)	(30%)	unknown	unknown
Pulp and Paper[6]	598	30%	10%	negligible	negligible	70%	90%	37%	60%	(29%)	(51%)
Steam Electric Power	1,037	negligible	negligible	negligible	negligible	100%	100%	Chemical: unknown, but small Thermal: not relevant		Chemical: unknown, but very small Thermal: 42%	18%[7]
Textiles	1,926[8]	76%	unknown	very small	negligible	24%	unknown	(28%)	(53%)	(28%)	(53%)

(1) All figures shown are estimates, the degree of accuracy varying with the industry. Numbers in parentheses are little more than educated guesses. (Only industries covered in the in-depth study are listed here. Little or no information is available for most of the industries covered by the "general" study.)

(2) For the purpose of this table, "secondary" treatment is considered to be anything beyond gravity separation.

(3) Plants with the same basic type of technology as recommended by the EPA for 1977: many of these are not currently meeting the 1977 limitations.

(4) The Organic and Inorganic Chemicals and Plastics and Synthetics categories are normally found together in various combinations, so a discrete number of plants cannot be assigned to each. The total number of plants producing any products of these three types is approximately 3,700

(5) For complete facilities. Technology equivalent to BPT may be in place for certain processes within the facility.

(6) For mills producing both pulp and paper, production is measured in terms of pulp.

(7) Cooling towers and/or cooling lakes or ponds.

(8) An additional 3,400 mills use insignificant amounts of water.

(9) Includes only those with sand filtration. If long detention time polishing ponds are assumed to be equivalent technology, these numbers would increase to approximately 10%.

Source: National Commission on Water Quality. Compiled from technology contractor reports to the Commission. February 1976

achieve economic equity among different types of plants. This procedure is also useful in an overview assessment of abatement technologies. There are inherent shortcomings in any practical subcategorization scheme, however. No two manufacturing facilities, no matter how outwardly similar in terms of products, raw materials and processes used, will have identical pollution abatement problems. Imposing a uniform effluent limitation (per unit of raw material processed or product produced) on all plants within even the most carefully defined subcategories involves potential inequities, some of which might be eliminated if the limitations were applied on a plant-by-plant basis. The proper degree of generalization requires tradeoffs between minimizing potential inequities and keeping the regulatory program manageable.

As a compromise, Commission contractors were instructed to assess the degree to which EPA's subcategories reflect genuine and reasonable differences in production processes, abatement problems and costs. The basic factors EPA attempted to take into account in the subcategorization process were types of raw materials and production processes, products, size and age, wastewater characteristics (including treatability), and geographic location. With very few exceptions, the resulting subcategories are defined primarily in terms of products produced and/or processes used. Size and age are used as criteria for delineating subcategories only in the case of meat products, where small renderers are to be exempted; and steam electric power, where all units operating before 1970 and those under 500 megawatts capacity operating before 1974 are to be exempt from thermal controls. Size is considered in assigning effluent limitations within subcategories to petroleum refineries, dairies, leather tanneries, and metal finishers, but is not used explicitly in defining the subcategories. Age is implicit in other cases. For example, effluent limiations promulgated for the iron and steel industry differentiate between the basic oxygen and open hearth steel making processes, and nearly all newer plants are of the basic oxygen type. Of the 52 industries studied, only two -- canned and preserved seafood and cane sugar processing -- have effluent limitations which subcategorize explicitly on the basis of geography. Location can relate to climate, a factor which affects biotreatment effectiveness. As with age, however, some geographic differentiation is implicit in other cases where certain types of plants are concentrated in one area.*

*Most of the effluent limitations promulgated by EPA contain a clause which allows for variation from the promulgated values if the discharger can show that factors relating to his plant are "fundamentally different from the factors considered in the establishment of the guidelines." This clause is intended to be used in unusual situations, and in effect, allows the permitting authority to declare an individual plant to be in a subcategory by itself, subject to approval by the Administrator. The legality of this clause is currently being challenged in the courts.

Alternative subcategorizations which appear to be manageable and which might materially improve the subcategorization schemes used by EPA were not discovered in most of the industry studies. While non-product/process factors can substantially affect abatement costs, the Commission was not able, in the time available, to incorporate them to any greater degree than was done by EPA in establishing its effluent limitations.

For some industries, EPA's effluent limitations are related to specific internal waste streams, or to particular products or processes, rather than to the discharge from the entire facility. This approach expedites writing discharge permits for those industries which combine different products and processes in a wide variety of combinations. (The number of "representative plants" needed to characterize the industry from a technological point of view may be unmanageable from a regulatory point of view.) Of the industries studied in depth, the organic and inorganic chemicals, plastics and synthetics, iron and steel, and canned and preserved fruits and vegetables categories have effluent limitations defined in terms of individual products or processes. Regulated discharges for plants in these categories are derived by summing the discharges allowed by the promulgated effluent limitations for each product or process occurring within the plant. This is sometimes referred to as a "building block" approach and is one practical way to expedite the permitting process for these industries.

Difficulties may occur in applying this procedure to actual facilities. Two common problem areas are:

- For reasons of economy of scale, similarity or compatibility of wastes, limited space or difficulty of separating sewer lines, effluents from two or more unit processes are often treated together in a combined treatment facility. Physical and chemical interactions occur among the pollutants in the combined stream which affect the treatability of the waste.

- There are instances where particular pollutants are emitted by several processes, but regulated for a lesser number. If waste streams for these processes are combined, questions arise as to whether and how "credit" should be given for the pollutant from the unregulated process in the combined stream.

Commission studies have uncovered problems of this nature in the iron and steel, chemicals, and steam electric power categories. For iron and steel and chemicals, modified limitations for related unit processes whose wastes are normally combined would be beneficial.

Chemical constituents in six different, specific waste streams are controlled by EPA's effluent limitations for the steam electric power industry. Potential problems of the second type mentioned above have

surfaced during the Commission's assessment of these limitations. For example, copper in waste streams from the boiler (boiler "blowdown") is limited in the BPT (and BAT) limitations. Some plants treat the condensed boiler steam before reuse (condensate polishing). For these plants; the copper limitations for boiler blowdown can be met without further treatment. However, the polishing process itself generates wastes which must be discharged periodically. This type of discharge, which may contain copper in amounts exceeding the concentrations allowed in the boiler blowdown stream, is classified as a "low volume waste" and not subject to limitations on copper.

The canned and preserved fruits and vegetables industry consists of a large number of diverse plants distributed throughout the nation, processing many different combinations of commodities and product styles. EPA's subcategorization is strictly on a commodity basis. The "building block" approach is to be used to define limitations for the typical situation in which a plant processes more than one of the 56 commodities specified in the limitations. To facilitate analysis of the impact of the Act on this industry, Commission contractors were successful in defining natural groupings of plants with similar water pollution abatement problems. The groupings were then used to define 24 subcategories of processors. Subcategorizing the industry in this manner, rather than strictly by single commodities, was necessary to provide realistic plant-level estimates of abatement costs, and represented a significant advancement in the methodology for analyzing the economics of an industry of this nature. From the standpoint of defining effluent limitations, however, the single commodity approach appears to be the only practical alternative.

An identical strategy was adopted for study of the iron and steel, organic chemicals and inorganic chemicals industries.

A difficulty of the "building block" approach is the full coverage of all products or processes in a specific plant. EPA has yet to develop effluent limitations for all products and processes. Commission contractors who developed generalized combinations of products or processes for study mitigated this problem from an analytical standpoint, but difficulties associated with issuing actual permits are likely to persist.

3. Capabilities and Costs of Industrial Technology

a. Industrial Effluent Limitations

Both the Act and the legislative history must be examined to analyze which technologies are appropriate when considering BPT and BAT. The determinations of regulations for "best practicable control technology currently available" are to be made by the EPA Administrator based on factors specified in the Act [Sec. 304(b)(1)(B)]. These factors are

"the total cost of the application of technology in relation to the effluent reduction benefits to be achieved," as well as, "the age of equipment and facilities involved, the process employed, the engineering aspects of the application of various types of control techniques, process changes, non-water quality environmental impact (including energy requirements), and other such factors as the Administrator deems appropriate."

An elaboration of the procedure to be used for identifying "best practicable technology" comes from the Report of the Senate Public Works Committee on S.2770 which says "the Administrator should establish the range of best practicable levels based on the average of the best existing performance by plants of various sizes, ages, and unit processes within each industrial category"(17).

For BAT, determinations of regulations are also to be made by the Administrator, and are to take into account "the age of equipment and facilities involved, the process employed, the engineering aspects of the application of various types of control techniques, process changes, the cost of achieving such effluent reductions, non-water quality environmental impact (including energy requirements) and such other factors as the Administrator deems appropriate". [Sec. 304(b)(2)(B)].

The Senate debate of the Conference Report addresses the determination of BAT. "Rather than establishing the range of levels in reference to the average of best performers in an industrial category (the procedure required for best practicable), the range should at a minimum be established with reference to the best performers in any industrial category"(18).

In either case, the Administrator is not to require specific types of control technologies or processes; rather, effluent limitations are to be established for categories and classes of point sources.

The vast majority of EPA effluent limitations have taken the form of a maximum allowable discharge quantity of a specific pollutant per unit of production. For example, an effluent limitation may be expressed as an allowed maximum discharge of two pounds of suspended solids per 1,000 pounds of product. Implicit in this limitation is the volume of wastewater discharged per pound of product and the concentration of suspended solids in that volume. Both volume and concentration may vary from discharge to discharge, but in no case can they combine to produce more than the maximum allowable pounds of suspended solids per unit of production.*

*In some cases (for example, petroleum refining), the limitations are expressed in terms of allowable pounds of pollutant per unit of raw material (e.g., pounds per barrel of crude oil refined).

Effluent limitations are usually stated both as averages over 30 consecutive days (long-term) and as a 24-hour maximum (short-term). Commission technology contractors were instructed to address technologies capable of meeting both the 30-day and the 24-hour limits.

The effluent limitations contain restrictions on different pollutants for different industries, although the most common pollutants (BOD or COD and SS) are covered in virtually all cases. The pollutants covered by effluent limitations for a specific industry are generally those that are present in significant quantities in that industry's discharge, are potentially harmful, or are removed by the technology which will be employed (see Table II-24).

Effluent limitations, once promulgated, form the basis of individual permits issued under the National Pollutant Discharge Elimination System (NPDES). The Commission's analyses only considered meeting EPA effluent limitations promulgated, proposed or contained in EPA contractor reports or, in the case of several categories within the "general" study, the Commission contractors' estimates of what they might eventually be. Consistency between the effluent limitations and permits actually issued was not examined in the technology assessment studies.

b. Best Practicable Control Technology Currently Available (BPT)

As a general rule, the 1977 limitations corresponding to the application of BPT can be achieved through the use of currently available, proven technologies. However, Commission studies identify several subcategories for which the required technology will be more elaborate than that envisioned by EPA, and some of these cases will require technologies which have yet to be tested in that particular industrial subcategory ("technology transfer").

The types of technologies envisioned by EPA for 1977 are generally consistent with those suggested by Commission studies. The suggested additional measures in some cases result from the way the effluent limitations have been formulated, rather than from disagreements about long-term average performance capability. Treatment systems are normally designed on the basis of long-term (annual or perhaps seasonal) average effluent quality criteria. Effluent limitations are currently being stated in terms of pollutant discharges (per unit of product produced or, in some cases, of raw material consumed) that are "maximum for any one day" and "average of daily values for 30 consecutive days." In some cases, these numbers were derived from a statistical analysis of data averaged over longer time spans and, in others, by engineering judgment or "rules of thumb" applied to long-term design values. In many industries, very little operating data are available on short-term (daily and monthly) fluctuations in effluent qualities and quantities from actual plants, and the capability of the technologies suggested by EPA to dampen those inherent variations to the degree required by the limitations is questionable

This "variability problem" applies to both the BPT and BAT limitations, and there is considerable controversy about the attainability of the daily -- and, to a lesser extent, the 30-day -- limitations even in those industries for which the long-term capability of the stipulated technology is not disputed. In some cases, it is claimed that the promulgated values are not consistent with the longer-term data from which they were supposedly derived. In other cases, technology sufficient to meet the 30-day average requirement may not be sufficient to meet the daily maximum requirement. This may not be revealed until the system has been designed, installed and operated. Pulp and paper and petroleum refining are two industries for which Commission contractors had sufficient data to make quantitative judgments about the degree of variability control needed to meet the effluent limitations.* In both cases, the conclusion was that measures beyond those envisioned by EPA will be required. The following communication from the petroleum refining study contractor summarizes this problem:

> "Based on our analysis of the technological capabilities available to the petroleum refining industry, the effluent limitations promulgated by EPA for 1977 can be met on an industry-wide basis. However, it is our belief, based on our evaluation of available treatment systems and methods of in-plant control, that the technological model suggested by EPA for Best Practicable Control Technology Currently Available will not be sufficient to assure that these limitations are met industry-wide by the petroleum refining industry. The problem basically revolves around the capabilities to meet the short-term (daily and monthly average) limitations for certain controlled constituents, particularly total suspended solids, chemical oxygen demand, and oil and grease. We believe that the long-term attainable effluent concentrations used by EPA in developing (its) numbers are reasonable for most of the controlled constituents, with the possible exception of chemical oxygen demand. However, the variability limitations are such that a refinery operating at the process wastewater flow rate used in estimating the mass discharge limitations would have difficulty meeting the short-term requirements. We believe this problem can be circumvented if all refineries resort to the in-plant controls which EPA has associated with 1983 technology, including a limited amount of wastewater reuse. This essentially means that long-term average mass discharge rates will be lower than those used by EPA for the 1977 limitations to assure that refineries can actually meet the daily and monthly maxima allowed by (them)."**

*Because of a superior data base, the petroleum refining study addressed the variability problem in the greatest depth.

**Citation from letter to Commission staff from Engineering Science, Inc., summarizing results found in Chapter V of their report to the Commission, Water Pollution Abatement Technology: Capabilities and Costs, Petroleum Refining Industry, 1975.

Despite the fact that detailed data on daily variabilities from existing plants were not available for use in Commission studies, enough information was obtained to suggest the following conclusions:

- Methods used by EPA to derive the daily and 30-day numbers from available data are not consistent among the industrial categories.

- The achievability of the daily values 100 percent of the time by even "exemplary" plants, during normal operation, with the technology suggested by EPA is highly questionable in several cases.

- In many cases, abatement systems are being designed to meet the 30-day values. A "wait and see" and "hope for the best" attitude is being taken toward the maximum daily limits.

- Considerable uncertainty about EPA's enforcement posture with respect to violations of the daily values exists among industrial dischargers.

A peripheral issue to the variability problem is the applicability of the promulgated limitations to unusual situations, such as plant start-ups and shut-downs or cases involving accidents or unusual equipment malfunctions.* Effluent qualities from even a properly designed and operated treatment system will fluctuate widely during these periods, and the applicability of EPA's limitations to them needs to be clarified. There seems to be an unwritten assumption among EPA's technical personnel that the limitations apply only during periods of "normal operation," but this is neither stated nor defined an any of the promulgated limitations or ~~in~~ any of the discharge permits reviewed by the Commission. A clear policy statement on this question should be made to clarify the issue for both EPA and the permittees.

Additional short-term data are now being collected under the monitoring requirements of the NPDES permits. The Commission studies suggest that a uniform statistical procedure should be developed for inferring proper 24-hour and 30-day limits from these data, and that it be applied to each industry as its data base becomes adequate in order to verify the limitations currently in effect for 1977.

Required end-of-pipe treatment systems vary only in design details among subcategories for some industries, whereas in others, different types of measures are required. In-plant measures tend to be much more

*Production stops and starts are not really "unusual situations" in general. Many industries have regular production cycles which involve routine "down times" for clean up and maintenance.

subcategory specific. For the petroleum refining, pulp and paper, canned and preserved fruits and vegetables, textiles, organic chemicals, and plastics and synthetics categories, end-of-pipe technology for 1977 is basically biological treatment similar to that used for treating domestic sewage, with additional effluent "polishing" and increased water conservation in some cases. Physical-chemical treatment is required for the inorganic chemicals, iron and steel, metal finishing, and steam electric power industries. Most physical-chemical systems require the precipitation of dissolved compounds by adding chemicals, plus the settling of suspended solids. In the inorganic chemicals category, substantial opportunities exist for achieving the elimination of discharge of all process wastewaters by means of recycling. EPA's BPT limitations dictate that the processes associated with 28 of the 59 product categories examined by the Commission contractor achieve this "closed system" configuration. The contractor found that 19 of the 28 product categories could achieve this requirement by inprocess or recycle strategies alone. Eliminating all wastewater discharges to surface water is one way of achieving the national goal of the elimination of discharge of pollutants. This is addressed in detail in Section D of this chapter.

Metal finishing operations produce both concentrated and dilute waste streams containing the metals being finished or plated, plus other potentially toxic materials, including cyanide. The abatement needed to meet the BPT limitations involves precipitating the metals, using lime or caustic soda additives, neutralization of the acidic wastes, and conversion of the cyanide to harmless compounds by chemical reactions with chlorine. The 1983 limitations require the elimination of discharge of all process water pollutants, including the variety of salts that result from wastewater neutralization. One way to achieve this is to increase the degree of recovery of plating metals and acids, concentrate the salts by means of advanced treatment technologies, such as reverse osmosis, and evaporate the remaining water, leaving a concentrated brine or solid salt residue. The cost of this procedure would be very high, and the Commission economic impact studies indicate that its imposition upon the smaller facilities would accelerate the existing trend toward fewer, but larger, metal finishers.

Both chemical and thermal limitations apply to the steam electric power industry. The chemical limitations can be met with standard physical-chemical treatment, although the costs of achieving them are a matter of controversy and there is some uncertainty about the interpretation of the limitations. (See Section 2.d.) The technology employed for the abatement of heat discharged to the environment -- normally evaporative cooling towers -- is considerably different from what is usually thought of as "wastewater treatment technology." Thermal pollution abatement in this industry is discussed in Section 4.c.

The following list outlines the differences between EPA's abatement models and those that the Commission's in-depth industry studies indicate will be needed by significant numbers of dischargers to meet the 1977 effluent limitations promulgated or under consideration by EPA. The increments shown rely exclusively upon end-of-pipe treatment. In-plant changes not applied generally for 1977 may serve as alternatives in some situations.

Best Practicable Control Technology Currently Available

Industry Category	Probable Increment Needed
Pulp and Paper*	Additional solids removal, using multi-media filtration for approximately one-third of the pulping mills.
Metal Finishing*	Additional solids removal, using filtration for most shops, plus steps to reduce water use for some shops.
Iron and Steel*	Additional solids removal via filtration, plus partial recycling for some subcategories.
Organic Chemicals*	Additional BOD and SS removal, using additional stages of biotreatment and filtration, plus activated carbon adsorption for some segments of subcategories.
Textiles	Additional solids and COD removal, using chemical coagulation, either before or after biotreatment, for some subcategories.
Petroleum Refining	Additional in-plant flow reduction measures needed for all subcategories because of potential effluent variability problems.

*Conclusions based in part upon limitations under consideration, but not proposed, by the EPA at the inception of the Commission's technology studies.

In most of these cases, deficiencies in the BPT systems envisioned by EPA can be remedied without using unproven technologies, but the cost will be higher than EPA has estimated. However, two of the remedies do

rely upon unproven technology: for pulp and paper, filtration of pulping wastes is still at the experimental stage; and for organic chemicals and plastics and synthetics, Commission studies indicate that carbon adsorption will be required for some classes of plants for which there is little or no experience to date with this form of treatment.

Industries within the Commission's general study for which EPA acknowledges reliance upon technology undemonstrated within the industry to meet the 1977 limitations are: off-shore oil and gas extraction, transportation, nonferrous metals smelting and refining, canned and preserved seafood, and sugar processing. No cases in which the necessary technology was clearly impractical have been uncovered, although the Commission was not able to carry out a detailed assessment. Because of the uncertainties inherent in the design of these systems, cost data for them should be considered speculative.

A significant issue is raised by possible inconsistencies between EPA's technology models and the corresponding effluent limitations. Commission studies indicate that, in many cases, the abatement which is actually being installed is equivalent to the suggested technologies, rather than being designed to meet the limitations per se. This is most readily apparent in those industries where the additional measures needed to guarantee that the limitations are met consistently may involve unproven technology. However, a potential problem also exists in the cases where the additional measures do not involve unproven technologies. The number of engineering consulting firms capable of perceiving the necessary design variations from the systems suggested by EPA are limited, and many industries have little "in-house" expertise in the control and treatment of wastewaters. It appears that there may be a significant number of abatement systems installed in these industries that will be equivalent to EPA's BPT models, but will not meet the BPT limitations. This failure may not be appreciated until after the systems have been installed and operated. The necessary corrections will not be simple "add ons" in all cases. EPA may then be faced with the dilemma of enforcing violations against dischargers who installed the suggested abatement technology in good faith and in accord with the compliance schedules stipulated in their NPDES permits. The design parameters of any system must be adjusted to fit the needs of the particular discharger, and this requires considerable expertize when stringent effluent limitations must be met.

c. Discharges to Publicly Owned Treatment Works

The degree to which the various industrial categories use publicly owned treatment works (POTWs) for the disposal of wastewaters extends from negligible to virtually complete dependence. The dischargers most likely to be connected to POTWs are generally small water users, located

in or near cities and towns. Some companies, and even entire industrial categories, prefer this practice wherever possible.

The industries in which a substantial number of plants or wide production capacity discharge to POTWs are listed in Table II-26. Also tabulated are the industries which utilize POTWs to a small extent (less than 10 percent), if at all. Smaller plants of several other industries -- petroleum refining, chemicals, pulp and paper, builders paper and board, and rubber processing -- make moderate use of POTWs (on the order of 10-20 percent of the production capacity).

Wastewaters generated by plants which use POTWs usually contain suspended solids and oxygen-demanding materials at levels amenable to conventional municipal wastewater treatment. However, it is often necessary to use some form of pretreatment before the municipality will accept the waste. Potential detrimental effects of industrial contributions generally fall into three categories: damage to structures, impairment of treatment performance, or reduced effluent quality from the POTW because of wastes not susceptible to conventional municipal treatment. Table II-27 shows examples of wastewater characteristics which can be detrimental and the industries which are most likely to discharge the pollutants. The frequency and degree of impairment depend on the size of the industry's flow relative to that of the POTW, as well as the technology used by the POTW.

TABLE II-26: Relative Use of POTWs
by Major Industrial Categories

Industries with Substantial Use of POTWs(1)	Industries with Minimal Use of POTWs(2)
Meat Processing	Mining (all types)
Dairy Processing	Petroleum & Gas Extraction
Canned and Preserved Fruits and Vegetables(3)	Sugar (except refining)
	Seafood Processing
Grain Milling	Iron and Steel
Brewing	Ferroalloys
Textiles	Nonferrous Metals
Leather Tanning	Water Supply
Metal Finishing	Steam Electric Power

(1) Generally more than 70 percent of plants or production capacity to POTWs.
(2) Generally less than 10 percent of plants or production capacity to POTWs.
(3) An estimated 40 percent of plants discharge to POTWs.

Source: National Commission on Water Quality, February 1976.

Pretreatment technology may be as rudimentary as screening to remove large solids or as complex as that required for plants discharging directly to navigable waters. In general, the technologies used to date have focused on reduction of constituents which disrupt or impair POTW performance. Corrosive and explosive materials are usually prohibited, but additional pretreatment requirements to reduce constituents that impact POTW operation vary considerably among municipalities.

TABLE II-27: Effects of Industrial Wastes on POTWs

Type of Effect	Waste Characteristic	Potential Industrial Discharger
Damage to Structures	Acids Solvents Strong Alkalies	Chemicals* Petroleum Refining Textiles
	Large solids	Virtually all
	Excessive flow	Virtually all
Reduce Performance of POTW	Excessive variability	Food Processing (seasonal)
	Toxics	Textiles Chemicals* Petroleum Refining Leather Tanning Metal Finishing
Pollutant Not Amenable to Treatment by POTWs	Non-degradable organics	Pulp and Paper Chemicals* Textiles Petroleum Refining
	Inorganic salts (including metals)	Metal Finishing Chemicals* Iron and Steel Textiles Petroleum Refining

*Includes Inorganic and Organic Chemicals and Plastics and Synthetics.

Source: National Commission on Water Quality, February 1976.

The Act identifies four basic objectives related to industrial use of POTWs:

- Encouragement of areawide waste treatment management, often interpreted as encouraging industrial use of POTWs. [Sec. 208.]
- Recovery of the Federal share of construction costs in proportion to industry's use of the POTW. [Sec. 204(b)(1).]
- Payment of industry's proportionate share of the POTW's operation and maintenance expenses. [Sec. 204(b)(1).]
- Establishment of pretreatment standards for industrial wastes entering POTWs. [Sec. 307(b).]

Realization of the first objective will be influenced by the others, all of which are controversial and/or in a state of flux. Many municipalities have or are developing systems to recover proportionate shares of construction and operation and maintenance costs from industry. Where an option exists, some industrial plants may decide to discontinue using POTWS. In special cases, usually related to high residential growth compared to industrial growth, recovery of construction costs proportionate to industrial use may discourage continued use of POTWs. Where they continue to discharge to POTWs, industry will undoubtedly reduce the discharge of wastes into POTWs to the extent possible to minimize proportionate share surcharges.

Establishment of Federal pretreatment standards for industry may have a more dramatic effect than the cost recovery and proportionate charge provisions. The Administrator must establish pretreatment standards to prevent the discharge of any pollutant which interferes with, passes through or otherwise is incompatible with POTWs. EPA has promulgated a general approach to pretreatment as the basis for industry specific standards.(15) Two categories of pollutants were defined: "compatible," i.e., those which have historically been associated with the design of POTWs (BOD, suspended solids, pH, fecal coliform bacteria); and "incompatible," i.e., anything else. The compatible pollutants are limited to those four which appear in the EPA definition of secondary treatment for POTWs. Only incompatible pollutants were to be limited, with the limits being identical to those promulgated by EPA for BPT (1977) for discharges to navigable waters.

Industry-specific pretreatment standards for a small number of industrial categories were promulgated in February 1975(19). With two exceptions, these standards only verify that pretreatment will not be required for "compatible" pollutants. The exceptions were COD and surfactants for the soap and detergent industry, and oil and grease for the canned and preserved seafood and meat products industries. As of

October 1975, EPA has not issued any pretreatment regulations which would not require all other users of POTWs to pretreat pollutants other than BOD, TSS, pH and fecal coliform to the BPT limitation level.

Recently, EPA has been reconsidering the general provisions. While various possible changes are being considered, the basic thrust remains essentially the same. A key new aspect, however, is EPA's indication that it may later revise the pretreatment standards so that they are comparable to the BAT effluent limitations by 1983(20).

Commission contractors assumed that all pollutants other than those listed above as "compatible" would have to be reduced to the levels dictated by EPA's BPT limitations before they could be discharged to POTWs. Costs incurred by current users of municipal systems for this pretreatment were included in the costs incurred by 1977. No pretreatment beyond the BPT level was assumed for 1983. No charges levied by the municipality for use of its system were included in this phase of the Commission studies. These can be substantial in many cases, and will be an important factor in determining future use of POTWs by the industrial sector. (See Chapter III, Section E, for further discussion of these issues.)

In addition to including BPT-level pretreatment for the incompatible pollutants, some pretreatment technology was also assumed for those industries whose wastes are "compatible," but which, in the opinion of the Commission's contractors, have historically or can now be expected to practice some degree of pretreatment in order to reduce proportionate charges or to comply with local municipal standards. Except in the canned and preserved fruits and vegetables category, where discharges to POTWs greatly exceed those to navigable waters, these costs are small when compared to the industry total for 1977.

Of the industries studied in-depth, the pretreatment assumptions outlined above have a major impact on the expenditures required of the textiles and metal finishing categories because both rely heavily upon POTWs and because most of the pollutants they discharge are deemed "incompatible." The portions of the total 1977 estimated capital costs due to pretreatment are summarized in Table II-28 for those industries for which they are significant.*

*The EPA is currently reviewing the entire pretreatment issue and has proposed, or intends to propose, regulations it says may substantially effect the impacts on certain industries. However, because of the uncertainty as to how this will be resolved, the Commission has followed the original EPA pretreatment regulations. Data in Table II-28 are based on achieving BPT abatement levels for "incompatible" pollutants as derived by Commission contractors per discussion in the text above.

Table II-28: Pretreatment Technologies and Costs[1]

Industry Category	Motivation for Pretreatment	Type of Technology Required	Percent of 1977 Capital Costs Due to Pretreatment
Canned and Preserved Fruits and Vegetables	Reduce proportionate share charges, assure compatibility with local requirements.	Screening, equalization or clarification, sludge handling, neutralization in some cases.	42
Metal Finishing	Removal of "incompatibles."	pH control, cyanide and metal removal.	80
Textiles	Removal of "incompatibles."	Screening, equalization and chemical treatment.	80

(1) Capital and O&M costs for 1977, including those for pretreatment as well as for meeting EPA's BPT limitations, are shown on Table II-30.

Source: National Commission on Water Quality, February 1976. Compiled from data contained in in-depth industry contractor reports.

Commission contractors for the technology studies were unanimous in suggesting that many pollutants presently classified as being incompatible are, in fact, effectively treated by POTWs. The Commission contractor for the textile industry study concluded:

> "When regulations recognize COD, phenol and sulfides as compatible pollutants (parameters which can be effectively treated at activated sludge plants) economics will normally favor the use of POTWs . . . When compared on an individual plant basis, total capital cost of a system meeting pretreatment regulations can be higher than surface water dischargers for many subcategories. The higher costs of pretreatment systems are due to the removal of the 'incompatibles' utilizing chemical treatment, as opposed to biological treatment. Chemical treatment is usually selected because it takes less area and is better suited to mills discharging to municipal systems located in populated areas. Pretreatment standards as presently stated offer the mill little economic incentive to discharge into municipal systems . . . We believe these regulations need careful review and revision to encourage joint municipal-industrial water treatment, not discourage it."(21)

Commission studies lend no support to an approach which forces extensive pretreatment of all pollutants other than BOD, TSS, pH and fecal coliform bacteria. The better approach is to develop pretreatment limitations on a subcategory-by-subcategory basis, taking into account the treatability of the wastes by the POTW.*

d. Best Available Technology Economically Achievable (BAT)

As in the case of the 1977 limitations, the Commission finds that the necessary technologies will be available in most cases to meet the more stringent effluent limitations prescribed for 1983. Debate focuses more upon costs in relation to benefits than upon technological capabilities. However, wastewater treatment remains basically an empirical science, and little or no full-scale operating data are available for many of the advanced techniques envisioned for 1983. As a result, judgments about technical capabilities are much less secure than in the case of BPT. There are a substantial number of cases in which the feasibility or reliability of the technology suggested by EPA for 1983 is questionable. Examples are metal finishing (elimination of discharge of process water pollutants by advanced treatment and evaporation); organic chemicals (required removal efficiencies for activated carbon

*The promulgated regulations(15) do allow for the POTW to grant credit to the industrial user for any fraction of any "incompatible" pollutant that the POTW is committed to remove in its NPDES permit. Many factors, currently uncertain, are involved in determining the effect of this provision. Presently, there appear to be few instances in which such credit is being granted. No credits were allowed for in the pretreatment costs presented herein.

adsorption questionable on an industry-wide basis); and iron and steel (by-product coke treatment involves technology that is unproven; elimination of discharge of pollutants required for other processes is also unproven technology). Even those technologies which appear to be technically feasible may not be adequate to achieve the 1983 limitations in several cases. In other cases, less elaborate measures than those envisioned by EPA may be adequate. Differences between technologies postulated by Commission contractors and those envisioned by EPA for 1983 are summarized in the following table.

Best Available Technology Economically Achievable

Category	Differences between NCWQ Contractors and EPA's Suggested BAT
Organic Chemicals	Use of in-plant changes and/or highly efficient biotreatment may preclude need for activated carbon suggested by EPA for a substantial number of plants.* Carbon in excess of that envisioned by EPA may be needed in a few cases.
Inorganic Chemicals	Evaporation units required because complete recycle stipulated by limitation does not appear feasible in several subcategories.
Textiles	Additional solids and COD removal as for BPT: carbon adsorption also required in some subcategories.
Fruits and Vegetables	Limitations can probably be met using activated sludge treatment plus in-plant changes; multi-media filters envisioned by EPA may not be necessary in most subcategories.*
Petroleum Refining	Attainability of COD, TSS and O&G limitation even on long-term basis questionable: effluent desalting and partial recycling may be necessary.

*In these cases, postulated technologies are less elaborate than those envisioned by EPA.

The effectiveness of the prescribed BAT systems cannot be verified unequivocably without more operating data. The variability problem discussed in the context of BPT applies also to BAT and may be even more acute. The following discussion of the petroleum refining category is a continuation of that quoted in Section 3.b.

> "We believe that by 1983 technology will be available to permit the industry to meet the promulgated limitations. However, on the basis of our analyses, we find it unlikely that the treatment technology model defined by EPA as Best Available Technology Economically Achievable for the petroleum refining industry will be sufficient to meet these limitations. Based on what is admittedly a small amount of pilot-plant data and operating data from two full-scale carbon plants which are not identical to EPA's technological model, we find it probable that even the long-term achievable concentrations for several constituents which were used in developing the 1983 limitations will not be attainable. Specifically, these problem constituents are: chemical oxygen demand, oil and grease, and total suspended solids. We also found that the allowed variability between long-term average discharges and the maximum monthly and daily discharges, which are the basis of the published effluent limitations, are considerably more stringent than those allowed by EPA for BPT technology and appear to be unsubstantiated with regard to the capabilities of the technology to produce these levels of control. Thus, we believe it is likely that there would be a widescale noncompliance with both the long-term average mass discharge rates used by EPA to calculate the (limitations) and with the shorter-term numbers that are actually published as the 1983 effluent limitations. For this reason, we added another level of technology which involves desalting as much as 50 percent of the total wastewater flow so that it can be completely reused within the refinery. However, it should be remembered that the desalting methods which we have included as potentially available in 1983 cannot be considered at this time to be proven technology for this application and thus the question of compliance with the 1983 effluent limitations on an industry-wide basis is still conjectural."

Verifying the anticipated effluent variability for suggested BAT systems is not possible at this time because there are very few systems equivalent to BAT in place. Until more operating data become available, it would appear advisable to express the 1983 limitations solely in terms of long-term average performance criteria.

Color removal is currently required of a few industries for 1983 and by some New Source Performance Standards (NSPS). Two industries affected are textiles and pulp and paper. Using conventional methods, color removal at the treatment end is expensive, and may consume large quantities of chemicals. Little operating data are available, but it

appears that better internal controls, coupled with process modifications, may be the best strategy for color reduction in many cases. Changes in product specifications also may play a role. Development and application of these changes will take time, and the potential rate of adoption is uncertain. In the pulp and paper industry, EPA's NSPS for some subcategories require color removal to the same degree as the BAT limitations. These should be reviewed to verify that reliable and economically achievable abatement options exist.

In-plant changes play an important role in the abatement strategies postulated for 1983 for many of the industries studied in-depth. Flow reduction measures, by means of increased water recycling and reuse, are common to all of these strategies, as are better housekeeping procedures. Other measures can reduce the quantities of wastes generated, and most of these impact water usage as well. Uncertainties inherent in Commission studies in this area preclude definitive discussions of these changes. Not only are the cost data very approximate, but the technological feasibility of some of the techniques has yet to be proven on a scale adequate to confirm industry acceptance. The particular measures discussed should be considered only as illustrative of what might be done.*

Table II-29 summarizes some of the most significant in-plant pollution abatement measures which Commission studies indicated may be feasible to retrofit or design into a significant number of plants by 1983. Also described are the expected effects in terms of water discharged and/or changes in pollutant loadings, and the direction of change in overall industry production costs (including the cost of end-of-pipe wastewater treatment). A net <u>decrease</u> in annual O&M expenditures is indicated for some categories, primarily due to savings in energy and chemicals, both within the manufacturing process itself and for end-of-pipe wastewater treatment. Quantitative estimates of installation costs and changes in plant O&M costs have been incorporated into Commission estimates of capital and O&M costs, the latter being net of any estimated savings.** The fact that some savings opportunities appear to exist is one reason to expect internal controls to become an increasingly important part of water pollution abatement planning in the future.

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* The Commission did, however, restrict consideration to only those measures which have been tried at least at the "pilot plant" stage: no purely theoretical measures were included.

**The savings figures are tenuous. They depend critically upon the assumed cost of energy and chemicals, as well as site specific factors which cannot be considered in the aggregate. The assumptions used in their derivation are detailed in the Commission's industry contractor reports.

TABLE II-29: Examples of In-Plant Abatement Measures

Industry Category	Abatement Measures	Estimated Effect on Waste Load Needing Treatment	Assumed Implemented by:	Expenditure for Installation as % of Total Capital Expenditure for Abatement	Effect on Overall Plant O&M Expenditures
Petroleum Refining	Separation of storm water sewers. Two-stage sour water stripping. Conversion of barometric to surface condensers. Spent caustic neutralization. Segregation of cooling and process water. Various water reuse and conservation measures.	Flow regulation. Reduce ammonia & sulfides by 95% Reduce oil & grease emulsions. Reduce sulfides, COD; adjust pH. Reduce flow being treated by 24-48%	1977	50 - 83%	Increase
Pulp and Paper	Internal spill containment.	Eliminate shock loading	1977	17-26% for mills with pulping, 6-7% for mills without	Increase
	Clean cooling and service water segregation and reuse, other measures for water reuse. More efficient ("countercurrent") pulp washing techniques. Fiber recovery techniques.	Reduce flow being treated by 10-50%. Reduce BOD load by 5-30%, TSS by 10-45%.	1983	12-24% (including spill containment)	Decrease (substantial savings in some cases)
Canned & Preserved Fruits & Vegetables	Water conservation through use of "dry cleaning, washing, and peeling techniques. Steam blanching. Dry collection and transport of solid wastes. Reuse of process waters. Dry product transport. Miscellaneous water conservation and waste management measures. (increased product yield results in some cases.)	Reduce flow being treated by 5-7%. Reduce BOD loading by 0-80%, TSS by 0-71%.	1983	Not reported separately.	Increase in O&M partially offset by savings in most cases; net decrease in O&M realized in 6 of 24 subcategories.
Metal Finishing	Counter-current rinsing	Substantial flow reduction	1977 Some 1983 Most	Varies widely depending upon many plant-specific factors	Decrease
	Segregation of Process Flows	Varies - permits optimum effluent control	1977 Some 1983 Most		Increase
	Segregation of Batch Dumps and Floor Spills	Varies - permits optimum effluent control	1977 Many 1983 Most		Increase
	Chemical Recovery Systems	Substantial flow and pollutant reductions	1977 Few 1983 Many		Decrease.

Source: National Commission on Water Quality, February 1976. Compiled from contractor technology studies.

e. Costs and Resources

(1) Technologies to Comply with EPA's BPT and BPT Effluent Limitations

Abatement costs cannot be estimated definitively without making simplifying assumptions. Actual expenditures will depend upon the mix of abatement measures eventually employed by each discharger, and changes in the numbers, products and production rates of the plants within each industry over time. A least-cost strategy today may not be a few years hence, when relative price levels of abatement components have shifted. (For example, the recent substantial increase in energy prices favors low energy systems.)

Cost estimates reflect June 1973 relative price levels, are expressed in 1975 dollars,* and involve Commission contractor judgments about which abatement strategies will be used.

Additional land required for in-plant changes and end-of-pipe treatment facilities are included in the capital costs. Since actual purchase prices of industrial land vary from a few hundred to several hundred thousand dollars per acre, gross averages were used for each industry category and represent the Commission contractor's judgment as to the appropriate value for that industry. In most cases, this item is not critical since land costs are a small part of total capital. Operation and maintenance (O&M) costs are defined as the change in the total direct cost of operating a facility after installation of the water pollution abatement technology. Depreciation and financing costs are not included in this discussion. Definition of a "baseline" level of expenditure from which costs due to the Act are to be measured, as well as incorporation of future changes in industry --growth and plant closures -- all fall within the purview of the economic impact analyses. The data presented here were the starting points for those analyses.

The major qualifications that characterize the aggregate cost figures derived in the technology assessment studies may be summarized as follows:

- While Commission studies endeavored to cover all industry, a few segments which represent an extremely minor portion of industry costs were not studied.

*Energy prices as of November 1973 were used. All costs were adjusted to 1975 dollars using a uniform multiplier of 1.3.

- Costs apply to industry as its plants were configured in 1973, including 1973 production rates, product mixes and product specifications.

- No costs are included for technologies to control toxic materials beyond those required by EPA's BPT and BAT effluent limitations.

- Other costs for wastewater control not directly related to the effluent limitations are not considered. Examples are stormwater monitoring and control (required by the effluent limitations in only a few categories), sanitary sewage treatment and control of hazardous wastes.

- No costs are included for meeting water quality standards where such standards imply abatement more stringent than that associated with EPA's BPT and BAT effluent limitations.

- No charges for proportionate share of O&M or capital recovery assessments are included in costs for dischargers to publicly owned treatment works.

- Effluent limitations under consideration, but not yet finalized by EPA, were used in a large number of cases. This occurred to varying degrees in approximately 40 of the 49 industry categories studied. Further, 12 categories were examined without the benefit of any form of effluent limitations or EPA studies upon which limitations would eventually be based. The twelve industries are ore mining and dressing, coal mining, mineral mining and processing, miscellaneous food and beverages, machinery and mechanical products, water supply, structural clay products, pottery and related products, concrete gypsum and plaster products, steam supply, foundries and non-ferrous mill products. In view of the scarcity of data available in studying these industries, the costs provided here reflect, at best, order of magnitude estimates.

- Costs are <u>incremental</u> in the sense that credit has been given for pollution abatement measures in place as of January 1973. Aggregates therefore measure the additional outlays required for plants, as they existed in 1973, to comply with the 1977 and 1983 requirements.

- The figures are only estimates, not "exact" calculations. Costs for in-plant changes vary greatly with plant configuration. Other uncertainties about engineering feasibility and design details of the technologies postulated for 1983 make the BAT figures more speculative than those for BPT and pretreatment.

Aggregate capital and O&M costs for achieving the pretreatment, BPT and BAT requirements for all industrial categories are shown in Table II-30. The total capital cost for 1977 is about $44 billion, with about $31 billion additional required to achieve the 1983 limitations. Pretreatment requirements account for 37 percent of the total capital cost for 1977, with the metal finishing category alone accounting for 70 percent of the pretreatment total. These figures incorporate judgments by Commission contractors and Commission staff about which technologies will be required to achieve the effluent limitations. As explained previously, these technologies differ from those suggested by EPA in several cases.

The least-cost abatement strategy for a particular discharger will often be some combination of in-plant changes and end-of-pipe treatment, the optimal combination depending upon the degree of abatement required, costs of candidate in-plant changes, treatment costs, and other site-specific factors which are difficult to generalize. Time constraints and the breadth of the Commission's studies precluded detailed optimizations, and their absence tends to make the Commission's cost estimates higher than the theoretical "least cost" solutions in many cases. Other site-specific factors excluded from consideration -- the possibility of having to excavate through bedrock, for example -- tend to cause the estimates to be understated.

The volume and strength of wastewater and the required percent pollutant reduction are the primary determinants of the capital costs of end-of-pipe treatment systems. Operation and maintenance costs are composed primarily of labor and treatment-related energy and chemicals, including the costs of handling and disposing of sludges. Table II-31 gives cost data for some representative plants. These data apply to plants with no abatement measures in place, and illustrate the range of costs for individual plants, both for different industries and within a given industry.

Results for the petroleum refining category illustrate the effect of plant configuration, or "complexity" upon abatement costs. All petroleum refineries are designed from a conceptual base of nine basic chemical processing steps which are utilized in a variety of combinations and sizes and, in general, the more processes, the greater the raw waste load per unit of crude oil refined. A type "D" refinery is more complex than a type "B" and this accounts for the fact that the treatment expenditures per barrel of crude oil are greater for the D than the B refinery, where the "economy of scale" effect would tend to make unit costs less for the D refinery, all else being equal. Process complexity is therefore an important variable in determining abatement expenditures for this industry, as well as for many sectors of the iron and steel, chemicals, metal finishing, and plastics and synthetics industries. EPA's limitations

TABLE II -30: Aggregate Capital and Direct Operation and Maintenance Costs to Achieve EPA's BPT, Pretreatment, and BAT Effluent Limitations[1]

INDUSTRY	1977 BPT EFFLUENT AND PRETREATMENT LIMITATIONS[4] CAPITAL (Million $)	O&M[6] (Million $/yr)	1983 BAT EFFLUENT LIMITATIONS[5] CAPITAL (Million $)	O&M[6] (Million $/yr)
IN-DEPTH STUDIES:				
Fruits & Vegetables[2]	443	39	161	16
Inorganic Chemicals[2]	520	156	247	104
Iron & Steel[2]	2,910	229	949	64
Metal Finishing[2]	14,140	3,170	14,100	2,210
Organic Chemicals[2]	4,290	650	3,640	2,470
Petroleum Refining	1,050	179	1,180	395
Plastics & Synthetics[2]	160	32	286	29
Pulp & Paper[2]	2,640	135	798	21
Steam Electric Power[1]	3,740	1,420	2,030[9]	260[9]
Textiles	537	88	300	29
Feedlots[1][7]	705	43	169	1
Subtotals (In-Depth Industries)	31,140	6,140	23,860	5,600
GENERAL INDUSTRY STUDY, GROUP C:				
Ore Mining & Dressing[3]	610	25	400	18
Coal Mining[3]	1,000	50	400	26
Petroleum & Gas Extraction[2]	234	18	1,070	61
Minerals Mining & Processing[3]	730	72	500	50
Canned & Preserved Seafoods[2]	41	12	120	12
Misc. Food & Beverages[3]	5	1	5	1
Leather Tanning & Finishing	120	27	73	13
Machinery & Mechanical Products[3][8]	3,900	390	3,900	390
Water Supply[3]	1,200	160	100	3
GROUP B:				
Meat Products & Rendering[2]	130	13	240	14
Dairy Products	79	6	51	3
Grain Mills	56	4	13	1
Cane Sugar	153	17	170	13
Beet Sugar	90	17	69	5
Builders Paper & Board[2]	120	12	0	0
Fertilizer[2]	64	36	60	16
Rubber Processing[2]	220	18	48	12
Ferroalloy	48	16	13	3
Nonferrous Metals[2]	91	30	112	30
Transportation[2]	1,200	130	140	39
GROUP A:				
Fish Hatcheries & Farms[2]	50	10	47	31
Timber Products Processing[2]	14	1	25	8
Furniture & Fixtures[2]	8	3	0	0
Paint & Ink Formulation[2]	23	22	0	2
Soap & Detergent[2]	10	1	2	0
Phosphate[2]	73	9	14	1
Paving & Roofing Materials[2]	6	6	4	1
Glass[2]	42	5	16	3
Cement[2]	34	4	9	1
Structural Clay Products[3]	5	1	0	0
Pottery & Related Products[3]	3	1	4	3
Concrete, Gypsum & Plaster[3]	100	26	0	0
Asbestos[2]	4	1	9	4
Insulation Fiberglass[2]	14	6	0	0
Steam Supply[3]	0	0	0	0
Auto & other Laundries[2]	25	4	21	1
Foundries[3]	180	26	0	0
Non-ferrous Mill Products[3]	260	25	0	0
Subtotals (General Industries)	10,940	1,200	7,640	760
TOTALS	42,080	7,340	31,500	6,360

(1) For industries as structured in January 1973; except steam electric power and feedlots which include growth.
(2) Final effluent limitations unavailable for part or all of industry at time of study.
(3) Neither effluent limitations nor development documents were available for industry at time of study.
(4) Does not include capital recovery or user charges for use of municipal treatment works.
(5) Costs in addition to those for BPT.
(6) Depreciation and interest on capital not included.
(7) For feedlots which discharge to streams. If only for feedlots greater than 1,000 animal units: BPT capital = $113 million, BPT O&M = $11 million/year; BAT capital = $35 million, BAT O&M = $<1 million/year. (See. Sec. II.E.2.)
(8) Excluding metal finishing operation.
(9) Costs range up to $7.96 billion capital and $0.95 million O&M depending upon assumed number of Sec. 316(a) exemptions and state enforcement of thermal controls on plants exempt from federal regulations. (See Sec. II.C.4.)

Source: National Commission on Water Quality, February 1976. Compiled from data in contractor reports to the Commission.

TABLE II-31: Illustrating Plant-Level Costs

PETROLEUM REFINING

1. Type: Subcategory "B" - "Cracking" - emphasis on the production of gasoline and other motor fuels

Capacity: 42,500 barrels of crude oil per day - 347 day/yr

Abatement Option: Installation of in-plant measures to reduce the strength and flow rate of the waste load, secondary biological wastewater treatment (aerated lagoon), and effluent filtration (multi-media) for 1977. Further treatment by activated carbon plus 50 percent recycling of treated effluent for 1983. (Data assume no abatement technology already in place and includes in-plant, end-of-pipe and solids handling requirements.)

Abatement Level	Capital Cost[1] (mill. $)	O & M[2] Cost (mill. $/yr)	Energy[3] (mill. KWH/yr)	Construction Labor (man days)	O&M Labor (man days/yr)	Land Required (Acres)	Installation Time (Years)	O & M Chemical Requirements (tons/yr.)			Sludge[6] Generation (tons/yr)	Sulfur (tons/yr)
								Alum	Polyelectrolyte	Other		
BPT	3.82	1.16	56.778	6,120	3,246	5,075	2.5	310	6	50[4]	1,995	17,375
BPT to BAT	3.16	1.09	46.4	4,690	3,585	Neg.	2.0			90[5]	1,352	0

Total capital expenditure to meet BAT limitations = $6,974,500

Total (annualized)[7] cost per barrel of crude to meet: BPT limitations = 12¢/bl. BAT limitations = 22¢/bl. Purchase price of crude oil = $11.00/bl (1975).

(1) Includes cost of land at $52,000 per acre.
(2) Annual values assume production at or near capacity.
(3) Includes energy for steam generation for sour water strippers as well as electrical energy for end-of-pipe treatment.
(4) Precoating chemicals for "vacuum" filters (for sludge).
(5) Activated carbon makeup.
(6) Dry weight basis.
(7) Calculated as: (Capital cost x 16.3% + Land Cost x 10% + O&M Cost)/Annual Production.

Source: Engineering Science, Inc., Water Pollution Abatement Technology: Costs and Capabilities, Petroleum Refining Industry, 1975.

TABLE II-31: Illustrating Plant-Level Costs (contd.)

2. Type: Subcategory "D" - "Lube" - produces significant quantities of lubricating oils as well as gasoline, the lighter heating oils, and asphalt:

Capacity: 45,200 barrels of crude oil per day - 347 day/yr

Abatement Option: Same as in the previous case. (Data assume no abatement technology already in place and includes in-plant, end-of-pipe and solids handling requirements.)

Abatement Level	Capital[1] Cost (mill. $)	O & M[2] Cost (mill. $/yr)	Energy[3] (mill. KWH/yr)	Construction Labor (man days)	O&M Labor (man days/yr)	Land Required (Acres)	Installation	O & M Chemical Requirements (tons/yr.)			Sludge[6] Generation (tons/yr)	Sulfur (tons/yr)
								Alum	Polyelectrolyte	Other		
BPT	4.54	1.34	60.952	7,010	3,764	8.05	2.5	590	11.6	55[4]	2,160	16,125
BPT to BAT	4.15	1.57	78.15	5,900	4,815	Neg.	2.0			165[5]	2,382	0

Total capital expenditure to meet BAT limitations = $8,684,000

Total (annualized) [7] cost per barrel of crude to meet: BPT limitations = 13¢/bl. Purchase price of crude oil = $11.00/bl (1975).
BAT limitations = 27¢/bl.

(1) Includes cost of land at $52,000 per acre.
(2) Annual values assume production at or near capacity.
(3) Includes energy for steam generation for sour water strippers as well as electrical energy for end-or-pipe treatment.
(4) Precoating of chemicals for "vacuum" filters (for sludge).
(5) Activated carbon makeup.
(6) Dry weight basis.
(7) Calculated as: (Capital cost x 16.3% + Land Cost x 10% + O&M Cost)/Annual Production.

Source: Engineering Science, Inc., Water Pollution Abatement Technology: Costs and Capabilities, Petroleum Refining Industry, 1975.

TABLE II-31: Illustrating Plant-Level Costs (contd.)

METAL FINISHING

1. Type: Small Job Shop - application of decorative copper-nickel-chrome finish to brass plumbing hardware.

Capacity: 17 square meters/hr - 8 hr/day - 250 day/yr

Abatement Option: Cyanide oxidation, pH adjustment and equalization of waste discharge flows for 1977. For 1983, add chrome reduction, clarification filtration, reverse osmosis and evaporation equipment to eliminate pollutant discharge. (Data assume no abatement technology already in place and includes in-plant, end-of-pipe and solids handling requirements.)

Abatement Level	Capital[1] Cost (Thou. $)	O & M[2] Cost (Thou. $/yr)	Energy	O & M Labor (man days)	O & M Chemical Requirements (lbs./yr.)				Sludge[3] Generation (tons/yr.)	Salt[3] Concentrate (tons/yr.)
					Sodium Bisulfite	Caustic	Sulfuric Acid	Sodium Hypochlorite		
BPT	61	26	4[a]	200	0	25,000	2,600	1,250	0	0
BPT to BAT	683	72	99[a] 1.1[b]	200	800	1,900	1,000	-600 (savings)	2.5	53

Total (annulized) [4] cost per 100 square meters processed: BPT limitations = $106
BAT limitations = $645

(a) Thousand kwh/yr.
(b) Billion Btu/yr.

(1) Includes costs of building and land at $39/sq. foot.
(2) Annual values assume production at or near capacity.
(3) Dry weight basis.
(4) Calculated as: (Capital costs x 16.3% + O&M Cost)/Annual Production.

Source: National Commission on Water Quality, February 1976. Compiled from Lancy Laboratories, Water Pollution Abatement Technology: Capabilities and Costs, Metal Finishing Industry, 1975.

TABLE II-31: Illustrating Plant-Level Costs (Contd.)

2. Type: Large Captive Shop - Steel stock for automobile bumpers is pickled for scale removal, phosphated for lubrication, stamped to shape, and finally chrome-nickel plated.

Capacity: 1,167 square meters/hr - 24 hrs/day - 300 day/yr

Abatement Option: Segregated treatment for nickel and chrome waste streams, then combined for neutralized general rinses, clarified and filtered for 1977. For 1983, substitution of caustic soda for lime in neutralizing waste flows (to avoid scaling problems in concentrating equipment) and addition of reverse osmosis and evaporation equipment to eliminate pollutant discharge. (Data assume no abatement technology already in place and includes in-plant, end-of-pipe and solids handling requirements.)

Abatement	Capital(1) Cost (mill. $)	O & M(2) Cost (mill. $/yr)	Energy	O&M Labor (man days/yr)	O & M Chemical Requirements (tons/yr.)					Sludge(3) Generation (tons/yr.)	Salt(3) Concentrate (tons/yr.)
					Caustic	Lime	Sodium Bisulfite	Polyelectrolyte	Sulfuric Acid		
BPT	1.91	0.57	0.90(a)	2,200	183	1,300	176	1.6	91	2,100	0
BPT to BAT	3.64	2.7	2.37(a) 186 (b)	650	702	-482 (savings)	0	0	0	0	2,850

Total (annualized) (4) cost per 100 per square meters processed: BPT limitations = $10
BAT limitations = $50

(a) Million kwh/yr.
(b) Billion Btu/yr.

(1) Includes cost of building and land at $39/sq. foot.
(2) Annual values assume production at or near capacity.
(3) Dry weight basis.
(4) Calculated as: (Capital cost x 16.3% + O&M Cost)/Annual Production.

Source: National Commission on Water Quality, February 1976. Compiled from Lancy Laboratories, Water Pollution Abatement Technology: Capabilities and Costs, Metal Finishing Industry, 1976.

recognize this explicitly for the petroleum refining industry by the basic subcategorization scheme, and by taking complexity into account in the allowable pollutant discharge. The difference in expenditures (per unit of crude refined) for the two refineries shown in the table are reduced by this flexibility. This approach seems appropriate, and should be applicable to other industrial categories of this type, including those listed above.

The second part of the table illustrates two extremes which characterize the metal finishing industry, a small "job shop" and a large "captive shop". The small shop is not required to achieve the same BPT effluent limitations as the large facility, but EPA's BAT effluent limitations require both to achieve complete elimination of the discharge of process water pollutants by 1983. To afford perspective to the annualized costs, the approximate selling prices for services are $600 per 100 square meters plated for the small shop and $420 per 100 square meters plated for the large shop. A major increase in energy is required for BAT as compared to BPT, as well as a large change in the quantity of residuals to be disposed of, since salts must be removed to achieve BAT.

Table II-32 details the O&M costs shown in Table II-31. The treatment and disposal of both biological and chemical sludges is a significant portion of total O&M expenditures.

Economy of scale has been mentioned in the context of Table II-31. For a fixed level of abatement -- i.e., fraction of raw waste load that must be removed -- the cost per gallon of wastewater treated in an end-of-pipe system decreases with increasing flow rate. The expenditures per unit of production for small facilities are usually greater than for comparable larger facilities, assuming the same type of treatment. Figure II-1 illustrates this "economy of scale" effect for a plant in the textiles category. Similar curves apply to virtually all conventional end-of-pipe systems.

The costs of achieving a specific level of abatement for existing plants, as opposed to plants still in the design stage, are potentially quite different. As a general rule, any form of industrial pollution control costs less when designed into the plant from conception, compared to being added on, or "retrofitted" to an existing facility. This is particularly true for major process changes aimed at waste load reduction. Many changes that are desirable from a pollution control point of view are technically infeasible, or at least prohibitively costly, to retrofit. As a result, the traditional response to more stringent abatement requirements by existing dischargers in most industries has been primarily the addition of more extensive end-of-pipe treatment. This trend may be changing, however, since the increasingly stringent limitations engendered by the Act have focused more attention on in-plant waste controls.

TABLE II-32: Components of O&M Expenditures for Representative Wastewater Treatment Systems

Petroleum Refining

Type of refinery: "Cracking" subcategory, 42,500 barrels of crude oil per day capacity. (See first entry in Table II-31.)

Type of treatment: Advanced oily-solids removal, followed by an aerated lagoon with settling pond followed by multi-media effluent filtration, sludge dewatering and landfilling. (The end-of-pipe part of BPT.)

O&M Expenditure = $445,900 per year[1] (of which $200,000 relates to solids handling)

O&M Component	Percent of BPT O&M Costs
Labor[2]	62%
Energy[3]	6%
Chemicals[4]	12%
Miscellaneous	20%
	100%

[1] Assuming production at or near capacity. Covers end-of-pipe and solids handling costs only.
[2] Labor rate (including benefits) of $19.50 per hour.
[3] 1.94¢/KWH.
[4] Polyelectrolytes at $1.76/lb.; alum at $81/ton; filter precoat at $137/ton.

Source: National Commission on Water Quality, February 1976. Compiled from Engineering Science, Inc., Water Pollution Abatement Technology: Costs and Capabilities, Petroleum Refining Industry, 1975.

TABLE II-32: Components of O&M Expenditures for Representative Wastewater Treatment Systems
(continued)

Metal Finishing

Type: Small Job Shop - application of decorative copper-nickel-chrome finish to brass plumbing hardware.

Type of treatment: Cyanide oxidation, pH adjustment and equalization of waste discharges for BPT. For BAT, addition of chrome reduction, clarification, filtration, reverse osmosis and evaporation equipment to eliminate discharge of pollutants.

Total Annual O&M Expenditure* = BPT - $26,000
BAT - $98,000

O&M Component	Percent of O&M Expenditures	
	BPT	BAT
Labor	82%	46%
Energy	1%	6%
Chemicals	13%	4%
Maintenance	3%	7%
Transportation and Disposal of Sludge and Salt Concentrates	0%	35%
Miscellaneous	1%	2%
	100%	100%

*Assuming production at or near capacity. Covers in-plant, end-of-pipe and solids handling costs.

Source: National Commission on Water Quality, February 1976. Compiled from Lancy Laboratories, Water Pollution Abatement Technology: Capabilities and Costs, Metal Finishing Industry, 1975.

TABLE II-32: Components of O&M Expenditures for Representative Wastewater Treatment Systems
(continued)

Type: Large Captive Shop - steel stock for automobile bumpers pickled for scale removal, phosphated for lubrication, stamped to shape, and finally chrome-nickel plated.

Type of treatment: segregated for nickel and chrome waste streams, then combined with neutralized general rinses, clarified and filtered for BPT. For BAT, substitution of caustic soda for lime in neutralizing waste flows (to avoid scaling problems in concentrating equipment to eliminate pollutant discharge).

Total Annual O&M Expenditure* = BPT - $ 570,000
BAT - $3,270,000

O&M Component	Percent of O&M Expenditures	
	BPT	BAT
Labor	44%	10%
Energy	5%	26%
Chemicals	33%	10%
Maintenance	2%	1%
Transportation and Disposal of Sludge	7%	1%
Transportation and Disposal of Salt Concentrates	0%	51%
Miscellaneous	9%	1%
	100%	100%

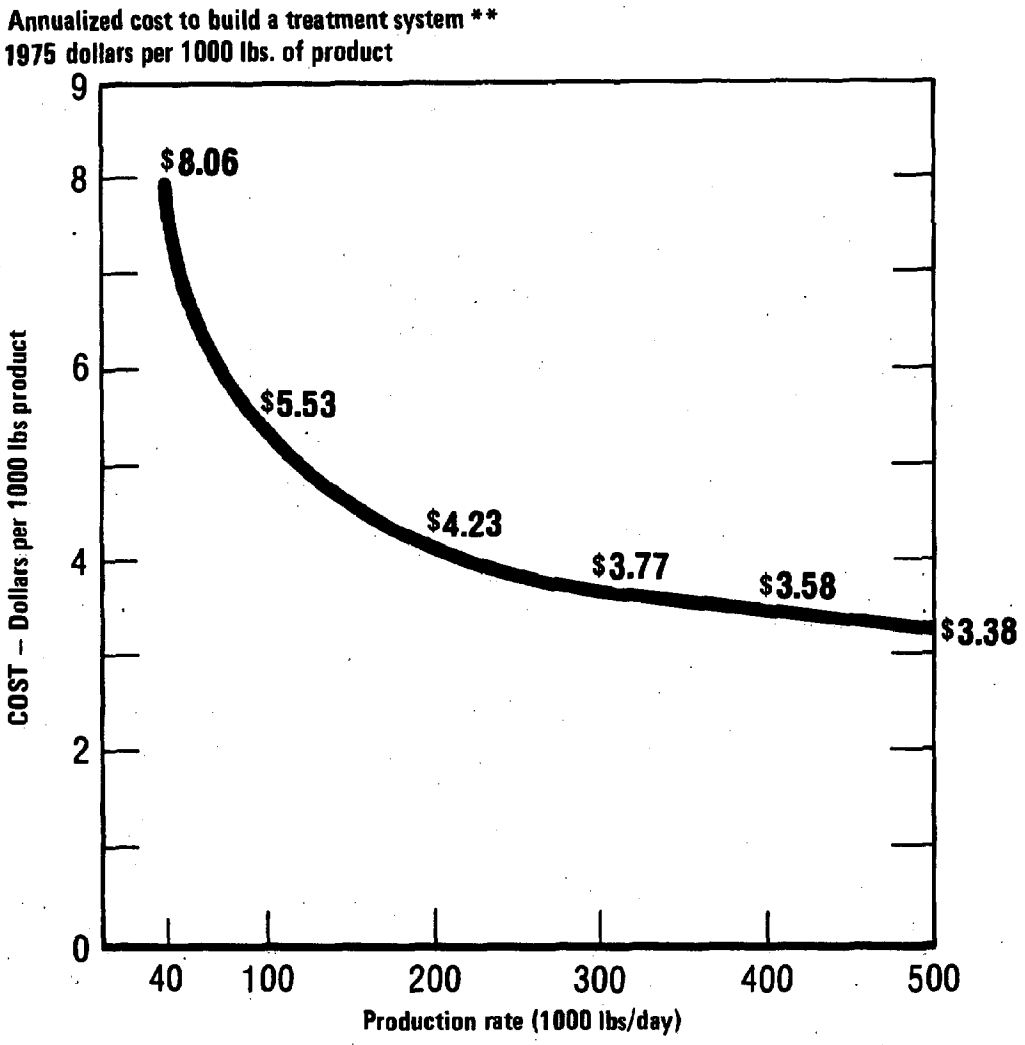
*Assuming production at or near capacity. Covers in-plant, end-of-pipe and solids handling costs.

Source: National Commission on Water Quality, February 1976. Compiled from Lancy Laboratories, Water Pollution Abatement Technology: Capabilities and Costs, Metal Finishing Industry, 1975.

Figure II-3

"ECONOMY OF SCALE" EFFECT FOR A TEXTILE PLANT*

(Effect of production volume on the cost of building a treatment system)



* Plant type: Textile finishing plant = chemical treatment, dyeing and printing of fabrics made of cotton and cotton-synthetics blends.

** Annualized cost calculated as: (Capital costs x 16.3% + O&M cost/Annual production). Wastewater treatment assumed: Screening, aerated lagoon, clarification, sludge digestion and disposal by spray irrigation.

Source: Natl. Commission on Water Quality, from Lockwood Greene Engineers, Inc., "Water Pollution Abatement Technology: Capabilities and Costs, Textile Industry", 1975.

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The advantages inherent in pre-planning to meet a known effluent limitation are recognized in the Act. New Source Performance Standards apply to all industrial point sources whose construction begins after publication of the proposed standards. In most cases, the NSPS are more stringent than the BPT effluent limitations. Several are identical to the BAT limitations and, in a few cases, are more stringent. These standards are discussed further in Section 3.f.

(2) Alternative Levels of Abatement

The Commission's technology studies were designed to identify abatement levels both more and less stringent than those required to meet EPA's effluent limitations. In each case, alternative levels were based upon the expected performance of technologies which are either presently available or which, in the contractor's judgment, can be expected to be available by 1977, or 1983.* In no cases were arbitrary "percent removal" targets stipulated. Where Commission contractors concluded that the technologies suggested by EPA were not consistent with the corresponding effluent limitations, the EPA technology model was used to define an alternative level of abatement performance. Other levels both more and less stringent than required to meet the BAT effluent limitations were included where they corresponded to logical increments in abatement technology. Figure II-4 shows aggregate industry costs for each abatement level. The number of levels varies depending upon the industry, and levels from industry to industry are not directly comparable. Level I in iron and steel bears no direct relation to Level I in textiles; they are similar only in that they both correspond to the abatement measures that EPA associated with BPT limitations.**

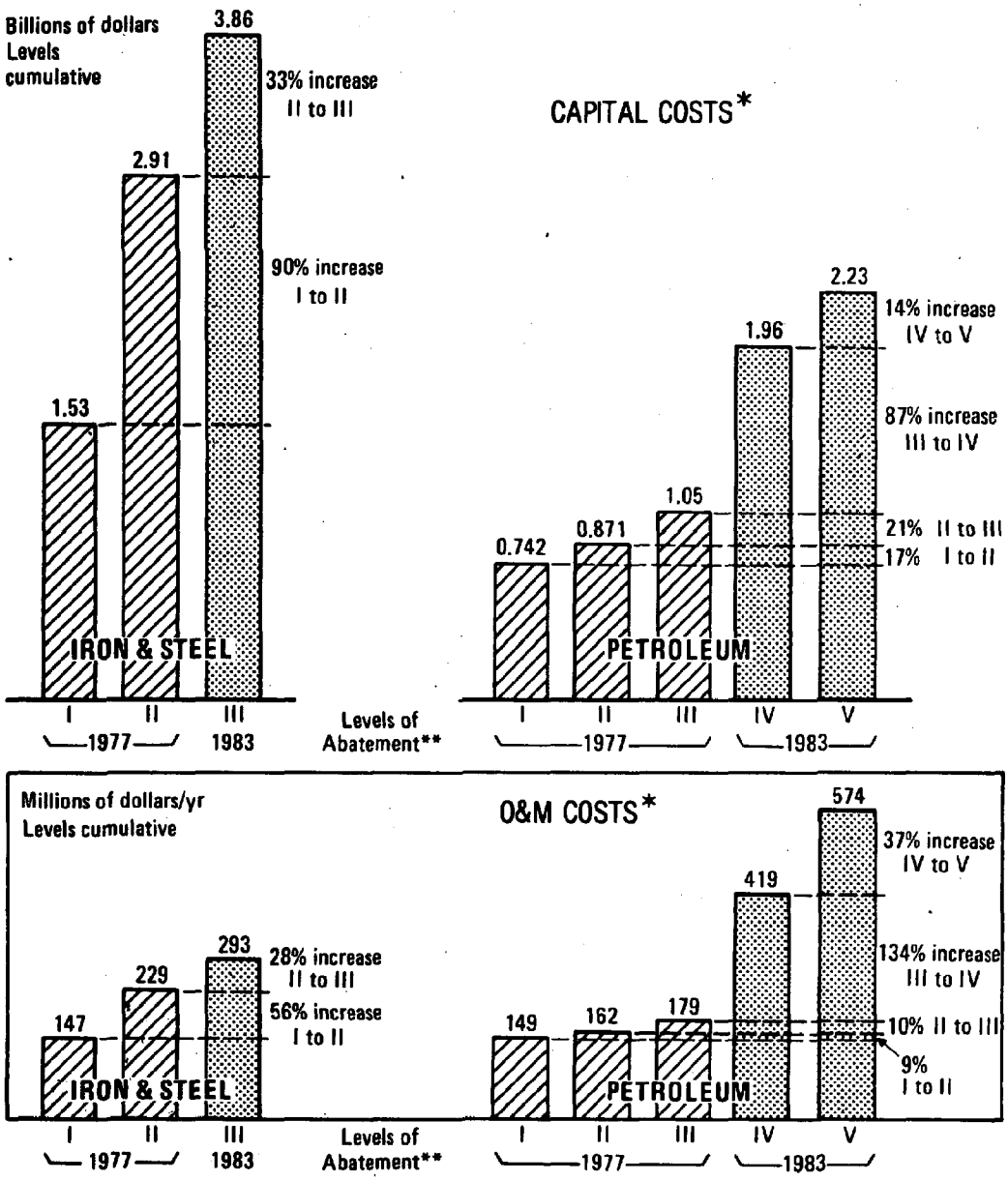
Because the levels were based upon discrete increments in technology, it is not always possible to precisely equate technology level and effluent quality. In the petroleum refining and iron and steel categories, for example, the technologies postulated by Commission contractors for meeting EPA's BPT limitations actually "overshoot the mark" in some subcategories, meaning that the resulting effluent qualities in many cases would actually exceed those required by the EPA. A similar result applies to the fruits and vegetables industry at the BAT level. This results from the Commission's consideration of abatement measures that correspond to realistic engineering designs.

*An additional level approaching or achieving the 1985 goal of the elimination of discharge of waterborne pollutants was assessed for some industries: See Section D of this chapter.

**See Figure II-4e for a description of each abatement level for the respective industry categories.

Figure II.4a

CAPITAL & DIRECT OPERATING COSTS FOR LEVELS OF WATER POLLUTION ABATEMENT — IN DEPTH INDUSTRY STUDIES



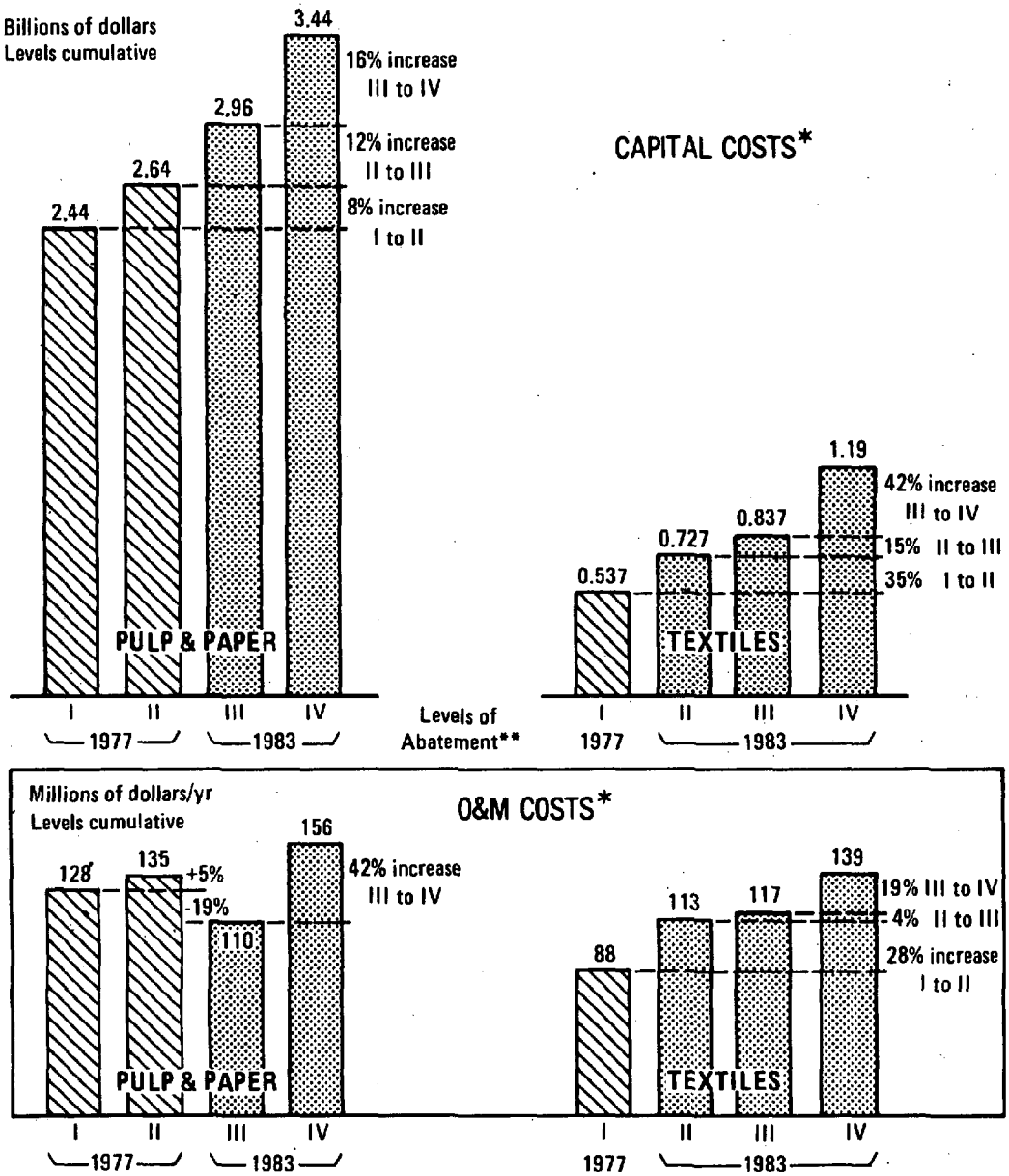
* Costs in 1975 dollars. For industries as structured in Jan. 1973. Include costs for direct discharges and pretreatment for discharges to publicly owned works (POTWs). Excludes depreciation, interest on capital and user charges for discharges to POTWs.

** Levels of abatement described in Figure II.4e.

Source: Natl. Commission on Water Quality from technology contractor reports
February 1976

Figure II.4b

CAPITAL & DIRECT OPERATING COSTS FOR LEVELS OF WATER POLLUTION ABATEMENT — IN DEPTH INDUSTRY STUDIES



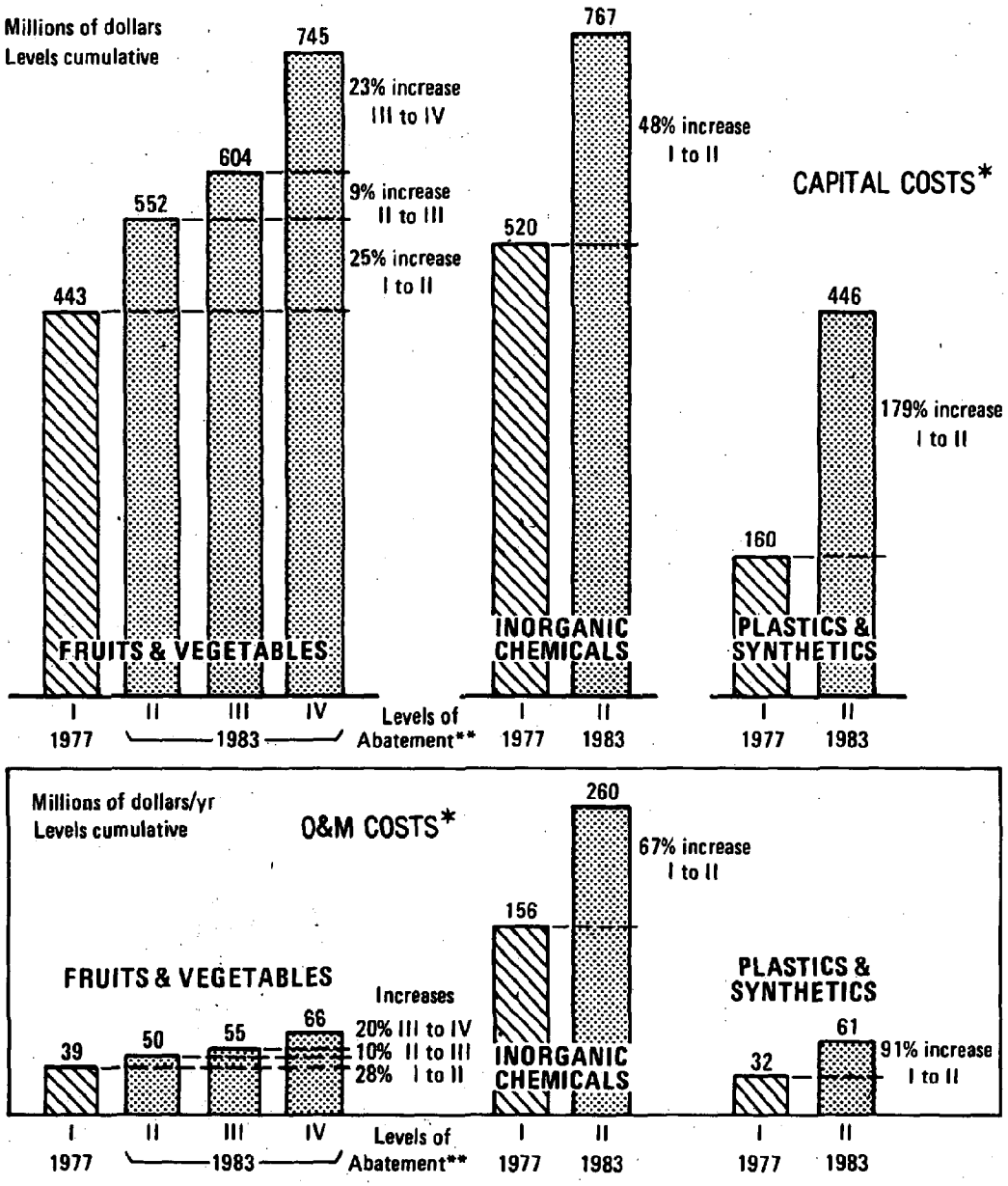
* Costs in 1975 dollars. For industries as structured in Jan. 1973. Include costs for direct discharges and pretreatment for discharges to publicly owned works (POTWs). Excludes depreciation, interest on capital and user charges for discharges to POTWs.

** Levels of abatement described in Figure II.4e.

Source: Natl. Commission on Water Quality from technology contractor reports
February 1976

Figure II.4c

CAPITAL & DIRECT OPERATING COSTS FOR LEVELS OF WATER POLLUTION ABATEMENT — IN DEPTH INDUSTRY STUDIES



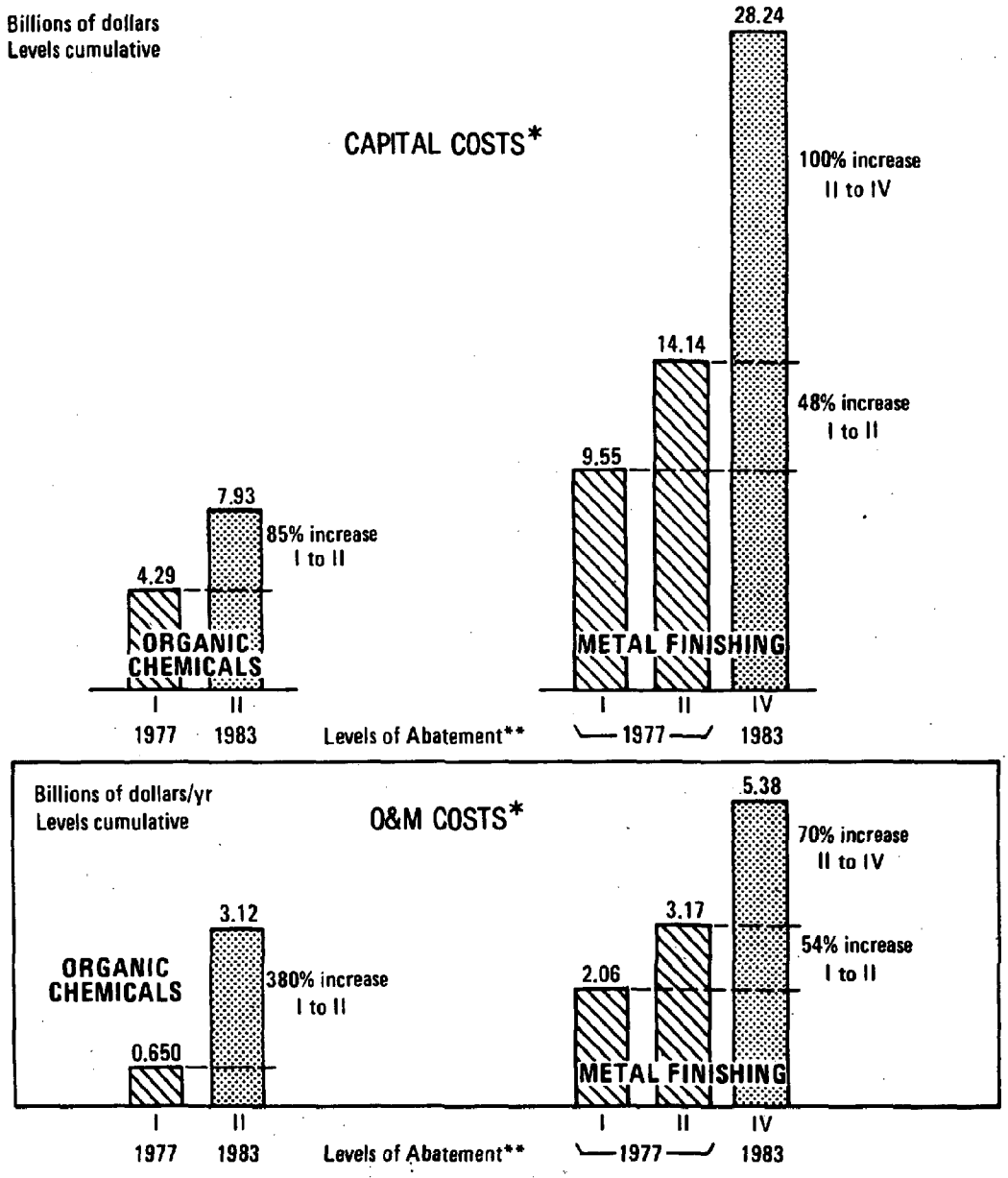
* Costs in 1975 dollars. For industries as structured in Jan. 1973. Include costs for direct discharges and pretreatment for discharges to publicly owned works (POTWs). Excludes depreciation, interest on capital and user charges for discharges to POTWs.

** Levels of abatement described in Figure II.4e.

Source: Natl. Commission on Water Quality from technology contractor reports
February 1976

Figure II.4d

CAPITAL & DIRECT OPERATING COSTS FOR LEVELS OF WATER POLLUTION ABATEMENT — IN DEPTH INDUSTRY STUDIES



* Costs in 1975 dollars. For industries as structured in Jan. 1973. Include costs for direct discharges and pretreatment for discharges to publicly owned works (POTW s). Excludes depreciation, interest on capital and user charges for discharges to POTW s.

** Levels of abatement described in Figure II.4e.

Source: Natl. Commission on Water Quality from technology contractor reports
February 1976

Figure II.4e

DESCRIPTION OF LEVELS OF ABATEMENT FOR IN-DEPTH INDUSTRIES SHOWN IN PRECEDING FIGURES II.4a - 4d

Industry	Level	Description
IRON & STEEL	I	Equivalent to EPA's suggested technology for 1977.
	II	Achieves EPA's BPT limitations
	III	Achieves EPA's BAT limitations; using more or less eleborate technology than suggested by EPA, depending upon subcategory
PETROLEUM	I	Less than EPA's suggested technology for 1977
	II	Equivalent to EPA's suggested technology for 1977
	III	Achieves EPA's BPT limitations
	IV	Equivalent to EPA's suggested technology for 1983
	V	Achieves EPA's BAT limitations
PULP & PAPER	I	Equivalent to EPA's suggested technology for 1977
	II	Achieves EPA's BPT limitations
	III	Intermediate technology between BPT and BAT
	IV	Achieves EPA's BAT limitations and is generally equivalent to EPA's suggested technology for 1983
TEXTILE	I	Achieves EPA's BPT limitations and is equivalent to EPA's suggested technology for 1977.
	II	Intermediate technology between BPT and BAT
	III	Achieves EPA's BAT limitations and is generally equivalent to EPA's suggested technology for 1983
	IV	A level more stringent that EPA's BAT.
CANNED & PRESERVED FRUITS & VEGETABLES	I	Achieves EPA's BPT limitations and is equivalent to EPS's suggested technology for 1977.
	II	Intermediate technology between BPT and BAT
	III	Achieves EPA's BAT limitations and is generally equivalent to EPA's suggested technology for 1983
	IV	A level more stringent that EPA's BAT
INORGANIC CHEMICALS	I	Achieves EPA's BPT limitations and is generally equivalent to EPA's suggested technology for 1977
	II	Achieves EPA's BAT limitations and is generally equivalent to EPA's suggested technology for 1983
PLASTICS & SYNTHETICS	I	Generally equivalent to EPA's suggested technologies for 1977
	II	Generally equivalent to EPA's suggested technologies for 1983
ORGANIC CHEMICALS	I	Achieves BPA's BPT limitations and is equivalent to technologies more or less elaborate than those suggested by EPA for 1977
	II	Achieves EPA's BAT limitations and is equivalent to technologies more or less elaborate than those suggested by EPA for 1983
METAL FINISHING	I	Equivalent to EPA's suggested technology for 1977
	II	Achieves EPA's BPT limitations
	III	(Not shown) Alternative technology for 1983 which only approaches EOD for entire industry. The alternative involves considerable in-process changes for chemical recovery. (Estimation of aggregated costs was not possible).
	IV	Achieves EPA's BAT limitations, which correspond to EOD.

Source: Natl. Commission on Water Quality. Compiled from technology contractor reports to the Commission.

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As discussed in Sections 3.b. and 3.d., Commission contractors determined that technologies more extensive than those suggested by EPA would be required to meet the assumed BPT limitations for the iron and steel, pulp and paper, petroleum refining, and metal finishing categories. Figure II-4 contrasts the costs of these higher levels with the costs of installing EPA's suggested technology. The resulting increases in capital costs are: iron and steel - 90 percent; pulp and paper - eight percent; petroleum refining - 21 percent; metal finishing -48 percent. In all cases but pulp and paper, these increases are major, and again serve to illustrate the problem that may result if the EPA suggested technologies are installed and the effluent limitations are not achieved.

Commission contractors' assessments of the capabilities of technology to achieve the BAT effluent limitations did not uncover many quantifiable differences between EPA effluent limitations and suggested technologies for 1983. Petroleum refining is the one case in which an alternative to EPA's technology was identified and the costs assessed; Figure II-4 shows a 14 percent capital increment in this case. Potential shortcomings have been detected in several categories (c.f. page II-75), but lack of data about the capabilities of BAT-level technologies precluded the Commission's contractors from making definitive estimates of differences in costs.

The average increase in capital costs in going from the technologies suggested by EPA for 1977 to those suggested for 1983 is 102 percent. This ranges from 36 percent for fruits and vegetables to 195 percent for metal finishing. If the alternative levels judged necessary by Commision contractors to actually achieve the assumed BPT and BAT limitations are considered, the average capital increase is 75 percent, ranging from 30 percent for pulp and paper to 179 percent for plastics and synthetics. In the two cases where 1983 effluent limitations more stringent than EPA's were considered, the capital costs increase is 23 percent for fruits and vegetables and 42 percent for textiles. In those cases where 1983 limitations less stringent than EPA's were considered, the range of capital cost reductions (from EPA's BAT) is 9 percent for fruits and vegetables to 14 percent for pulp and paper. With the exception of pulp and paper, the alternative technologies address the same pollutants as the EPA effluent limitations. In the case of pulp and paper, Level III achieves EPA's BAT limitations for all pollutants except color. The $480 million increase in cost to achieve Level IV (EPA's BAT effluent limitations) represents the incremental capital cost of controlling color for this industry.*

*This cost assumes conventional end-of-pipe treatment would be used. As discussed in Section 3.d., better strategies involving in-plant changes and/or product specification changes may be viable by 1983.

(3) Non-financial Resources

The non-financial resource emphasized in the Commission's technology assessment was energy. Others considered were land, labor (construction and operation and maintenance), and chemicals. Chemical and labor requirements from the technology studies are discussed in Chapter III, Section G. The remainder of this section focuses on the energy resources that will be required to operate and maintain the abatement systems that achieve EPA's BPT and BAT effluent limitations.

All of the strategies for meeting the BPT effluent limitations considered in the Commission's industrial studies require increased energy consumption. In plants using biotreatment, the biggest share of the increase is electrical energy for mechanical air-water mixing (aeration). Physical-chemical systems use energy primarily for pumping and sludge dewatering, and are usually less energy intensive than biological systems using mechanical aeration. Some in-plant measures postulated for 1977 also consume energy in the form of fuel oil or natural gas. Table II-33 shows the approximate fraction of on-site energy consumption for operating BPT-level water pollution abatement equipment supplied by electricity in several industries. With the exception of petroleum refining, with its significant fossil-fuel demands for sour water stripping (c.f. page II-101), electrical consumption predominates.

TABLE II-33: Fraction of Energy for BPT-Level Water Pollution Abatement Supplied by Electricity

Industrial Category	Fraction of Abatement Energy Supplied by Electricity
Canned & Preserved Fruits & Vegetables	100%
Inorganic Chemicals	82%
Iron & Steel	85%
Organic Chemicals	91%
Petroleum Refining	42%
Pulp & Paper	83%
Metal Finishing	77%

Source: National Commission on Water Quality, February 1976. Calculated from data contained in contractor technology studies.

Upgrading abatement performance to the levels associated with 1983 again increases the electrical and fuel energy requirements for end-of-pipe treatment, the fuel in most cases being used to evaporate concentrated wastewaters, or to "regenerate" activated carbon -- a heating process which drives off and oxidizes the organic matter once the carbon

has become saturated. Some in-plant changes, however, result in a savings in the plant's overall energy consumption. The resulting dollar savings have been credited against increases in abatement-related operation and maintenance costs. These savings result primarily from a reduction in the amount of aeration needed for end-of-pipe treatment (through reductions in raw waste loads), and from savings in the amount of steam needed in the manufacturing process itself. (See Table II-29 for a summary of these changes.) The approximate fractions of on-site energy consumption for operating BAT level abatement equipment supplied by electricity are given in Table II-34. In most cases, more fossil fuels will be required relative to electricity for BAT than at the BPT level.

TABLE II-34: Fraction of BAT-Level Water Pollution Abatement Supplied by Electricity

Industrial Category	Fraction of Abatement Energy Supplied by Electricity
Canned & preserved Fruits & Vegetables	100%
Inorganic Chemicals	33%
Iron & Steel	56%
Organic Chemicals	26%
Petroleum Refining	32%
Pulp & Paper	86% (1)
Metal Finishing	23%

(1) Oil savings due to in-plant changes not considered.

Source: National Commission on Water Quality, February 1976. Calculated from data contained in contractor technology studies.

Table II-35 lists aggregated fuel oil, electrical and total energy requirements for achieving the assumed pretreatment, BPT, and BAT effluent limitations.* Note the significant oil savings at level BAT for pulp and paper. As mentioned previously, the savings potential of the in-plant changes postulated by the Commission's contractor for this study are speculative, but major opportunities for abatement through in-plant change do exist for this industry, and some of these changes will reduce operating costs.

*Natural gas would be used in place of fuel oil in some situations. Energy and steam requirements were first calculated, then converted to barrels of fuel oil energy equivalents, assuming 5.8 million BTU or 5,000 pounds of steam per barrel.

Table II-35 Aggregate Energy Requirements to Meet Pretreatment, BPT and BAT Effluent Limitations Promulgated or Under Consideration by EPA.

(Industry as Configured in 1973)

Industry Category	Energy to Meet Pretreatment and BPT Limitations (4)			Additional Energy to Meet BAT Limitations		
	Electrical (million kwh/yr)	Fuel Oil (thousand bl/yr)	Total[1] (trillion Btu/yr)	Electrical (million kwh/yr)	Fuel Oil (thousand bl/yr)	Total (trillion Btu/yr)
Canned & Preserved Fruits & Vegetables	138	negligible	1.41	61	negligible	0.625
Inorganic Chemicals	492	123	5.75	289	2,040	14.8
Iron & Steel	400	61	4.45	680	1,060	13.1
Metal Finishing	3,200	1,700	42.6	2,400	14,310	108.0
Organic Chemicals	8,952	255	93.1	7,405	32,000	261.0
Petroleum Refining	8,406	7,439	129.0	0	5,944	34.5
Plastics & Synthetics	167	negligible	1.71	146	negligible	1.49
Pulp & Paper	1,072	249	12.4	470	-6,257[2]	-31.5[2]
Textiles	669	negligible	6.85	154	negligible	1.58
All Other[3]			79.0			41.5
Grand Total-All Manufacturing			376			445

(1) Electrical energy converted to primary energy Btus assuming 33% generating efficiency.
(2) A net savings - see text, page II-77.
(3) Based upon ratio of total O&M costs from "general" categories to those from the in-depth studies (cf. Table II-29: Steam electric and feedlots excluded from in-depth figure).
(4) Not including requirements of abatement systems in place as of the base year (1973).

Source: National Commission on Water Quality, February 1976. Based upon data contained in contractor technology reports.

All industries studied in depth are shown separately, with the exception of steam electric power. The rest are lumped together in the "All Other" category. The values shown for the "All Other" category are only rough estimates.* The energy "penalty" associated with thermal controls for the steam electric industry cannot be expressed in terms comparable with manufacturing industries as configured in 1973 for two reasons. First, the thermal limitations do not apply to the bulk of the generating capacity in existence in 1973, and second, the changes in fuel consumed per unit of electrical energy produced depend intimately upon the assumed mix of types of generation (fossil fuel, nuclear, combustion turbine, hydro-electric) in each utility system. The steam electric industry is discussed separately at the end of this section.

The total U.S. energy consumption in 1973 was 75 quadrillion BTU. The increase in total annual energy consumption by water pollution abatement activities in manufacturing, after upgrading to meet the 1977 effluent limitations, is 0.5 percent of the national rate of consumption in 1973. The total increase after upgrading to meet the 1983 effluent limitations is 1.1 percent of the 1973 national rate.

Table II-36 relates the increases in energy requirements to the total energy purchased by selected industries.** For several industries, increases are significantly higher than national values of 0.5 and 1.1 percent given above, while for iron and steel -- one of the major energy-consuming industries in the nation -- the relative increase is much smaller.

The organic chemicals category stands out as requiring the largest increase. The 21 percent shown for BAT is particularly startling. Substantial energy increases were projected for this industry due to the high levels of COD which must be removed by 1983, and the correspondingly large amounts of activated carbon requiring regeneration. The magnitude of the increase shown here is open to question, however, because little data on operating carbon systems of the required type are available. The contractor for this study based energy estimates on the only known full-scale system for which data were available. The results were substantially higher than the energy use suggested in an EPA technical bulletin.*** Whatever increase is predicted by hypothetical designs at this time, it is probable that in-plant changes not anticipated in the

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* Based upon multiplying the total energy requirement for the in-depth industries by the ratio of O&M costs for pollution abatement for the "general" categories to that for the in-depth categories.

** Selection was made on the basis of data availability.

***EPA Technology Transfer, Process Design Manual for Carbon Adsorption, October 1973.

Table II-36: Energy Requirements for Water Pollution Abatement as Fractions of Total Energy Purchased in 1973 (Industries as Configured in 1973)

Industry Category & Subcategory(1)	Energy to meet pretreatment and BPT Limitations(4) (trillion Btu/yr)	Total Energy to meet BAT Limitations(6) (trillion Btu/yr.)	Total Fuels & Electrical Energy Purchased in 1973 (trillion Btu)(2)	BPT divided by 1973 total	BAT divided by 1973 total
Canned & Preserved Fruits & Vegetables:					
SIC 2033 - Canned	0.75	0.95	61.0	1.2%	1.6%
SIC 2037 - Frozen	0.40	0.63	63.2	0.6%	1.0%
Inorganic Chemicals: (less SIC 2816 - Inorganic Pigments)	4.36	19.20	1,725	0.3%	1.1%
Iron & Steel	4.45	17.60	3,837(5)	0.1%	0.5%
Organic Chemicals	93.10	354.00	1,677	5.6%	21%
Petroleum Refining	129.00	163.50	3,104(5)	4.1%	5.3%
Plastics & Synthetics	1.71	3.20	295	0.6%	1.1%
Pulp & Paper	12.40	-19.1(3)	1,466	0.8%	-1.3%(3)

(1) Only those categories and subcategories for which total energy data are available are shown.
(2) Electrical consumption converted to Btus assuming 33% generating efficiency.
(3) A net savings - see text, page II-77.
(4) Not including requirements of abatement systems in place as of the base year (1973).
(5) Values for these categories include energy from raw materials, as well as purchased energy. This "captive consumption" is also important in the chemicals and pulp and paper categories, but relevent data were not available.
(6) Includes energy to meet pretreatment and BPT limitations.

Source: National Commission on Water Quality, February 1976, and Energy Consumption in Manufacturing, Conference Board, Ballinger, 1974.

Commission's studies will be used to reduce the amount of COD to be treated and, therefore, the carbon demands.

As indicated in the tables, the energy requirements shown for meeting the BPT limitations do not take into account the energy necessary to operate the abatement systems already in place in the base year, 1973. When this is included, the energy required for abatement can be a significant portion of a plant's total energy needs, as illustrated for a few industries in Table II-37, using data on electrical energy consumption.

It should be remembered that the technologies used for these calculations were developed during a period of relatively cheap energy. Recent dramatic increases in energy costs (relative to other factors of production) will encourage use of less energy intensive alternatives. For example, more emphasis may be placed in anaerobic biotreatment, which circumvents the large energy demands of mechanical aeration. As a result of this, the extreme cases shown in Table II-37, organic chemicals and petroleum refining, are probably unrealistic. However, there is little doubt that the effluent limitations will have a substantial impact on some industries' power bills.

There is an increase in fuel consumption associated with imposing evaporative cooling towers upon steam electric generating units which are either currently using, or had been designed to use, once-through cooling systems. Both the thermal efficiency and the generating capacity are reduced slightly (1.5 percent to 2.5 percent). The net increase in fuel consumption is difficult to calculate, however, because the generating efficiency of all other units feeding the same distribution system ("grid") must be taken into account. (These may be needed to compensate for the lost capacity and to supply the unit's share of the load should it have to be taken out of service during retrofitting.) Because the characteristics of the entire utility system, and not just those of the individual generating unit must be considered, the calculation of a net energy penalty for the industry as a whole is complicated and depends upon a large number of speculative assumptions.* A simplified approach which takes into account the change in thermal efficiency, but which assumes all units on the affected grids to have the same thermal efficiency, was used.

Two of several "scenarios" considered in the Commission's study of this industry were used to establish the limits on the energy requirements. The first assumes rather high exemption rates (about 80 percent of affected capacity) due to Sec. 316(a) of the Act, projected strictly

*This distinguished this industry from all others studied. Individual plants were not treated as isolated entities, but as components of multi-unit systems. This complicates the estimation of aggregate costs, whether they be financial or energy.

TABLE II-37: Total Electrical Energy For Water Pollution Abatement
(Industries as Configured in 1973)

Category	Total Electrical Energy to meet Pretreatment and BPT Limitations (million kwh/yr)[1]	Total Electrical Energy to meet BAT Limitations (million kwh/yr)[2]	Total Electrical Energy Consumed in 1973 (billion kwh)	BPT Divided by 1973 Total	BAT Divided by 1973 Total
Canned & Preserved Fruits & Vegetables:					
SIC 2033 - Canned	90	109	1.0	8.9%	10.8%
SIC 2037 - Frozen	48	71	2.7	1.8%	2.6%
Inorganic Chemicals: (less SIC 2816 - Inorganic Pigments)	929	1,215	98.6	0.9%	1.2%
Iron & Steel	2,100	2,780	43.0	4.9%	6.5%
Organic Chemicals	11,940	19,300	24.9	48%	78%
Petroleum Refining	14,270	14,270[3]	25.5	56%	56%[3]
Pulp and Paper	2,121	2,591	30.3	7.0%	8.6%

(1) Including that to power systems in place as of the base year (1973)
(2) Including BPT requirements.
(3) Electrical energy increment is negligible.

Source: National Commission on Water Quality, February 1976. Based upon data contained in contractor technology reports, plus Energy Consumption in Manufacturing, Ballinger, 1974.

on the basis of ecological criteria, and neglects any additional imposition of thermal controls to enforce state water quality standards.* The second, which provides the upper limit, assumes a reduced number of 316(a) exemptions (half those of the first scenario) and imposition of cooling towers for all other units with 25 megawatts or more capacity that would otherwise have been using once-through cooling. (Refer to Section 4.c. for more discussion of these scenarios.) Results from the Commission's analysis of these two cases are summarized in Table II-38, which compares the operating energy increase due to EPA's promulgated thermal limitations in 1983 with that estimated previously for the manufacturing sector. The latter value is taken to be 1074 trillion Btu, which projects the total given in Table II-35 for industry as configured in 1973 to 1983, according to the projected change in real GNP over that decade provided by the Economics and Social Impacts section of the Commission's studies.**

As in the case of the thermal control costs (Section 4.c.), the range is great. The actual value will certainly be greater than four percent and less than 27 percent, but the uncertainty will not be resolved until the procedures for obtaining exemptions from thermal limitations under Sec. 316(a) of the Act are clarified and until the pattern of state-level enforcement becomes established.

f. Best Available Demonstrated Control Technology (BADT)

The Act stipulates that effluent limitations, called New Source Performance Standards (NSPS), be issued for plants whose construction commences after the date of their publication, and which are consistent with application of "best available demonstrated control technology" (BADT). The NSPS are more stringent than the BPT limitations in most cases, and will have a major impact on abatement expenditures for new plants.

Because the NSPS are as stringent as EPA's BAT limitations for several industries, many of the questions about technological feasibility discussed in that context (Section 3.d.) also apply to these limitations. However, new plants generally have more options for abatement than old, and this will mitigate the difficulty of satisfying the NSPS in most cases: BPT-type treatment may even be sufficient if the waste load can be reduced substantially below that typical of older plants. Industries covered by the Commission's in-depth studies for which particular concern about the feasibility of the NSPS has surfaced are:

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* Refer to Section 4.c. for an explanation of the Sec. 306(a) exemption procedure, and page II-109 for a discussion of the importance of state standards to this industry.

**The date of enforcement for the thermal limitations is actually 1981, but the installation of towers will proceed throughout the decade. The late date (1983) is used here to be consistent with the 1983 deadline for achieving the BAT limitations applied to manufacturing.

Table II-38: Energy Consumption due to Thermal Effluent Limitations for the Steam Electric Power Industry

Scenario[1]	Estimated Electrical Capacity Affected by Thermal Limitations as of 1983 (MW)[2]		Approximate Energy Consumption for Meeting Thermal Limitations in 1983 (trillion Btu)[3]		Energy for Thermal Limitations as Fraction of Energy for Pretreatment and BAT Limitations in Manufacturing Sector in 1983[4]
1. Low Coverage	Fossil fueled:	24,487	Fossil fueled:	27.0	
	Nuclear fueled:	14,511	Nuclear fueled:	17.6	
	Total	38,998	Total	44.6	4.2%
2. High Coverage	Fossil fueled:	201,956	Fossil fueled:	223.0	
	Nuclear fueled:	58,095	Nuclear fueled:	70.6	
	Total	260,051	Total	293.6	27%

(1) See text, page II-104.
(2) Electric megawatts of generating capacity.
(3) Assumes 32% and 38% thermal efficiency and 0.65 and 0.70 annual capacity factors for nuclear and fossil units using one-through cooling, respectively, and a 2% increase in heat rate due to use of cooling towers.
(4) Value for manufacturing sector projected from 822 trillion Btu/yr (Table II-35) to 1074 trillion Btu/yr in 1983.

Source: National Commission on Water Quality, February 1976.

- o Iron and steel -- the NSPS are identical to the promulgated BAT limitations, and the required technology is yet to be proven in this industry. The ammonia limits appear to be particularly difficult to achieve.

- o Pulp and Paper -- The requirement for color removal in new (but not existing) pulping mills should be reviewed to verify that the required technology exists today, and is reliable and economically achievable. In addition, unproven filtration techniques may be necessary for some mills to achieve stipulated TSS levels.

Aggregate expenditures needed to install BADT cannot be quantified without predicting future industrial growth, an exercise beyond the scope of the technology assessment studies. Plant-level expenditures are also difficult to estimate because new plants are expected to incorporate a variety of innovations that affect waste loads as well as production costs, and assigning some portion of the costs of those innovations to pollution abatement is often difficult, if not arbitrary. The Commission's technology studies focused upon the technological feasibility of achieving the NSPS, with costs discussed only qualitatively.

4. Special Issues

a. Discharge to Water Quality Limited Waters

Where state water pollution control authorities judge that achieving the technology-based point source effluent limitations will not clean up the waters sufficiently to meet state water quality standards, those waters are designated "water quality limited" (WQL), and more stringent limitations may be imposed. The number of industrial dischargers that will be affected by these designations is unknown, but certainly significant in many regions where industry is concentrated. The Commission was unable to quantify the impact of WQL designations for the following reasons:

- o The limitations are derived by analyses that take into account the nature of the receiving waters and therefore are unique to each location.

- o Data on the number and location of plants issued WQL permits to date either have not been collected or are so fragmentary as to be unrepresentative.

- o Waters designated water quality limited are subject to periodic revision according to criteria that are not uniform among the states.

Limitations applied to a source discharging into WQL waters are typically more stringent than the technology-based limitations for 1977 in one or more of the following ways: 1) pollutants subject to the technology-based limitations may be restricted more severely; 2) additional pollutants may be controlled; 3) flow may be controlled -- the allowable rate may be adjusted seasonally, and discharge may even be prohibited during periods of low receiving water flow.

For those cases which fall mainly under category 1) above, the assumption that BAT level technology (as defined by EPA) will be required by 1977 gives a reasonable estimate of the increased expenditures associated with meeting WQL requirements. Unfortunately, this assumption alone does not imply the aggregate increase in expenditures because the number of plants affected is unknown in most categories.

Petroleum refining is the one exception. The Commission's contractor surveyed all available permits issued in this industry, and estimated that, as of 1974, there were 174 refineries discharging to surface waters in the 50 states, 68 of which -- representing 47 percent of the industry capacity -- were discharging into WQL waters. Assuming that application of EPA's BAT technology by 1977 will be required in those cases implies a 28 percent increase in aggregate capital expenditures above that considered in our study to be necessary to meet the BPT limitations. Whether this fractional increase is typical of other industries is not known.

State water quality standards can impact the steam electric power industry in a unique way. The national limitations for heat discharged by this industry do not become effective until 1981, and all generating units placed into service before 1970 and those of less than 500 megawatt capacity placed into service before 1974 ("old units") are exempted by EPA from any thermal limitations. Some of these exempt plants are being required to install evaporative cooling towers or other heat abatement devices by July 1, 1977, in order to comply with state water quality standards. Data supplied by the private electric utility industry indicates that there were 3,036 generating units with a combined capacity equal to approximately 75 percent of the total steam electric generating capacity in 1973 which fall within the "old unit" subcategory. A recent survey by the industry found that generating units representing 63 percent of the 28 percent of the "old unit" capacity covered by the survey were being subjected to some form of thermal regulation due to state water quality standards. Not all of these situations will involve the elimination of heat discharges called for in EPA's limitations, and the applicability of this particular sample to the industry as a whole has not been assessed. It does appear that a significant number of units that are exempt from EPA's thermal limitations will be forced to retrofit cooling towers, and the costs may be substantial for some

utility systems. In addition to cost, a more fundamental constraint is the time required to construct cooling towers. The Commission's study of this industry indicates that even under ideal conditions, a minimum of three years will be required to retrofit a large generating plant with such a system. (See Section 4.c. for further discussion of this industry.)

b. Toxic Effluent Standards

The Environmental Protection Agency's "Proposed Toxic Pollutant Effluent Standards" were published in the Federal Register December 27, 1973(16). The standards proposed limits on the discharge of the following materials considered by EPA to qualify for initial treatment under Sec. 307(a) of the Act: the pesticides aldrin, dieldrin, DDT, (and DDE, DDD), endrin and toxaphene, the compounds PCB, benzidine and cyanide, and the heavy metals cadmium and mercury. Final standards have not been promulgated, and the Agency apparently has vacillated widely in its approach to defining them. Because of this uncertainty, little quantitative analysis was completed by the Commission. However, some attention was directed to the capabilities of existing technology to control the relevant toxic materials. Table II-39 summarizes the Commission's tentative conclusions in this regard.

In the case of metal finishing, iron and steel, and inorganic chemicals, there is overlap among the proposed toxics standards and the BPT, BAT, and BADT (new source) limitations. However, the proposed toxics standards are given in concentrations, whereas the non-toxics limitations are usually expressed as pounds discharged per unit of product produced. These two approaches can conflict. An example is iron and steel, where cyanide is limited in both the promulgated BPT limitations and in the proposed toxics standards. This substance is discharged by a blast-furnace complex, using generally accepted controls, in concentrations of about two milligrams per liter with a flow of about 2,500 gallons per ton of "pig iron" produced -- giving a mass discharge rate of 0.04 pounds of cyanide per ton of product. The contractor for the iron and steel study estimates the level of technology that would be used to meet EPA's BPT limitations would reduce the discharge flow to 125 gallons per ton of product, with a cyanide concentration of 15 milligrams per liter -- 7.5 times the "baseline" level. However, the mass of cyanide discharged at this new level would be 0.015 pounds per ton, or about one-third the baseline level. Since the toxic limitations have yet to be promulgated, and many industries are well on their way to meeting the BPT limitations, potential conflicts in abatement strategies may exist if the final toxics standards are derived without considering the mass discharge rates implied by the corresponding BPT and BADT limitations.

TABLE II-39: Tentative Conclusions Regarding Capabilities of Technology to Meet the Proposed Toxic Pollutant Effluent Standards (16)

Industrial Category	Constituent to Be Limited	Comments
Inorganic Chemicals	Cadmium Mercury	Control with BPT-type of technology appears feasible in most cases.
Iron and Steel	Cadmium Cyanide Mercury	Technology capable of removal to specified concentrations only at pilot plant stage.
Metal Finishing	Cadmium Cyanide	Control part of BPT technology, but specified concentrations may be very difficult to achieve.
Organic Chemicals	Benzidine Cadmium Cyanide Mercury Pesticides PCB	Control of metals and cyanide with BPT-type technology appears feasible in most cases. Feasibility of pesticide manufacturers meeting the limitations was not studied.
Petroleum Refining	Cadmium Cyanide	Cadmium can probably be controlled to specified level, but entire wastewater flow would have to be treated. Waste streams containing cyanide can be segregated and treated using proven technology, but specified cyanide concentrations may be impossible to achieve in cases where wastewater flow is large compared to receiving water flow.
Pulp and Paper	Mercury	Reduction to required level not feasible with known technology in cases where wastewater flow is large compared to receiving water flow.
Textiles	Benzidine	Seldom used: Feasibility of meeting limitations was not studied.

Source: National Commission on Water Quality, February 1976. Based upon material contained in technology contractor reports.

A second major difference between the proposed toxics standards and the technology-based limitations is that the allowable discharge concentrations depend upon the dilution potential of the receiving waters. In the case of cyanide, for example, the allowable concentration for discharge to flowing waters is reduced by a factor of 10 when the receiving water's flow rate is less than 10 times the waste stream flow. As Table II-39 indicates, the extremely low concentrations that result will be impossible to achieve with proven technology in many cases, without in-plant dilution with clean water.

Neither of the toxic materials listed in Table II-39 for petroleum refining are controlled by the promulgated BPT, BAT or BADT limitations. Costs for controlling these materials to the levels specified in the proposed toxics standards have been estimated and illustrate the expected magnitude of the "add-on" effect of toxics control for one major industrial sector. Control of toxics to the levels defined for the "high receiving water flow" case would add approximately 16 percent to the capital cost of water pollution abatement needed by 1977, and about 23 percent to the annual operation and maintenance costs.*

c. Thermal Limitations

All industrial processes release heat to the surrounding air and water. Heat discharges to surface waters are primarily from the use of intake waters specifically for cooling, including condenser cooling for steam electric power generation. Table II-40 gives 1968 cooling water usage by selected industries. The steam electric power industry dominates: about 80 percent of the total water used for industrial cooling purposes in 1968 was used for generating electric power for resale, 6 percent was used for power generation at the plant site ("captive power"), and 14 percent for all other industrial purposes(22). EPA has indicated its intention to issue limitations for heat discharged from captive power generation, but has not done so to date. The potential impacts of such limitations were not studied by the Commission.

The thermal effluent limitations promulgated for the steam electric power industry are summarized in Table II-41. These differ from those promulgated for most other industries in three important ways:

- o There is no BPT-BAT differentiation. There is only one set of thermal limitations for existing units, to be achieved by July 1, 1981.

*These percentages apply to total investment, including that in place in the base year (1973).

TABLE II-40: Cooling Water Used by Selected Industries
(Billions of Gallons Used in 1968)*

SIC No.	Industry Category	Air Conditioning	Steam-Electric Power Generation	Other Cooling	Total Use (Including Process Waters)	Use for Cooling as % of Total
2621	Paper Mills, except Building Paper	8	248	97	1,194	30%
2631	Paperboard Mills	8	141	107	722	15%
281	Industrial Inorganic Chemicals	30	613	2,075	3,368	65%
282	Plastics and Synthetics	56	61	372	635	59%
2911	Petroleum Refining	3	167	1,056	1,427	74%
331	Blast Furnace, Basic Steel Products	25	1,147	2,046	4,392	47%
4911	Steam Electric Power	neg.	40,000	neg.	40,000	99%

*Water use as measured by intake. (Reuse or recirculation not included.)

Source: Data from 1967 Census of Manufacturers: Water Use in Manufacturing (Bureau of Census, 1971), as reproduced in The Economics of Clean Water -- 1973. U.S. Environmental Protection Agency, December 1973. (Data for 1973 not available.)

Table II-41: Summary of EPA's Promulgated Effluent Limitations on Heat Discharged by Steam Electric Generating Units*

All "no discharge" limitations allow for blowdown to be discharged at temperature not to exceed cold-side (after cooling) temperature, except where unit has existing closed-cycle cooling, blowdown may exceed the cold-side temperature. All limitations for existing units to be achieved by no later than July 1, 1981, except where system reliability would be seriously impacted, the compliance date can be extended to no later than July 1, 1983.

EXISTING GENERATING UNITS	
Capacity 500 Mw and greater	
Placed into service prior to January 1, 1970	NO LIMITATION
Placed into service January 1, 1970 or thereafter	NO DISCHARGE**
Capacity 25 Mw to 499 Mw	
Placed into service prior to January 1, 1974	NO LIMITATION
Placed into service January 1, 1974 or thereafter	NO DISCHARGE**
Capacity less than 25 Mw	NO LIMITATION
** Exceptions prescribed on a case-by-case basis for units in systems of less than 150 Mw capacity, units with cooling ponds or cooling lakes, units without sufficient land available, units with blowdown TDS 30,000 mg/l or greater and neighboring land within 500 ft of cooling tower(s), and units where FAA finds a hazard to commercial aviation would exist.	
NEW SOURCES	NO DISCHARGE

*No effluent limitations on heat from sources other than main condenser cooling water.

Source: Development Document for Effluent Limitations Guidelines and New Source Performance Standards for the Steam Electric Power Generating Point Source Category, EPA 440/1-74029-a, October 1974, page 5.

- The bulk of the industry's steam electric generating capacity as of January 1973 -- approximately 75 percent -- is exempt from the limitations by age and/or size criteria.*

- Sec. 316(a) of the Act allows for additional variance from the limitations for new and existing units not otherwise exempt if the discharger ". . . can demonstrate to the satisfaction of the Administrator (or, if appropriate, the state) that any effluent limitation . . . for control of the thermal component . . . will require effluent limitations more stringent than necessary to assure the protection and propagation of a balanced, indigenous population of shellfish, fish, and wildlife in and on that body of water" into which the discharge is to be made.**

Despite the large part of the industry exempt because of size and age criteria, the thermal limitations may require retrofitting heat abatement measures (normally evaporative cooling towers) onto a substantial number of plants. The final number of required retrofits will depend critically upon the number of variances granted under Sec. 316(a), another area of controversy. The rules for demonstrating "protection and propagation of a balanced, indigenous population" of aquatic life have yet to be standardized, and too few 316(a) appeals have been completed to date to make an unequivocal prediction of the impact of this clause on the industry's eventual thermal abatement costs.

The predominant technology in this industry for eliminating heat discharges to surface water is recirculating cooling systems employing natural or mechanical-draft cooling towers. These "closed-cycle" systems have been used primarily in water-scarce areas where the reduction in intake requirements by recirculating the cooling water has been an

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* Generating plants have from one to ten generating units, each with its own source of steam (boiler) and turbine generator. The limitations are applied to individual units. As of January 1973, there were approximately 1,000 steam electric plants with 3,000 generating units.

**"New" units are those whose construction began after March 4, 1974. Another relevant section is 316(b) which requires that "cooling water intake structures reflect the best technology available for minimizing adverse environmental impact." Potential intake effects were considered together with heating effects in projecting probable exemptions from the thermal limitations in the Commission's analysis.

advantage.* Projected additions to capacity imply increased use of closed-cycle systems, partially because of the requirements of the Act, and partially because of the increasing scarcity of suitable plant sites with water supplies sufficient to support once-through ("open cycle") cooling for modern, large capacity (800-1,200 megawatt) units.

Table II-42 summarizes the most common types of condenser cooling systems in place at commercial steam electric power generating plants as of January 1973. Cooling towers are prevalent only in water-scarce regions. "Impoundments" refer to man-made reservoirs or ponds. Once-through cooling is predominant in these cases, and the impoundments are often built by the electric utility for the specific purpose of sustaining an adequate cooling water supply. EPA's thermal limitations exempt plants using or in the process of constructing such cooling impoundments as of the date of promulgation of the limitations (October 8, 1974). New plants using "ponds", impoundments which do not impede navigable waters, are also exempt from the no discharge of heat requirement. (These exemptions are particularly important for the state of Texas, since 46 percent of the installed capacity in that state used once-through systems with cooling impoundments in 1972.)

Technologies other than evaporative cooling towers exist for thermal pollution abatement. Alternatives considered by the Commission include dry cooling towers, which release heat primarily by radiation to the air; hybrid wet-dry towers; spray systems, which cool by evaporation but do not require large towers; and "integrated" thermal systems in which the heated condenser water and/or a fraction of low pressure turbine exhaust steam would be delivered to near-by industrial facilities and residences for space heating and cooling. All of these systems have been applied successfully in pilot studies and other special situations.

Although alternatives to evaporative cooling towers can be expected to play an important role in the long-term future of the industry, the Commission concludes that they will have a minor impact on the industry's thermal abatement strategies in the 1975-1985 decade. This conclusion coincides with EPA's assessment. Commission studies have not revealed any major points of disagreement with EPA regarding the capability or cost of thermal abatement technology.** However, some aggregate thermal

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* The reduction in intake water requirements between open and closed cycle cooling depends upon meteorological conditions and the quality of the intake water. For a "typical" 1,000 megawatts nuclear plant using relatively clean river water, a closed-cycle design would require 2 to 5 percent of the intake rate of a once-through design.

**The same is not true for costs of chemical pollution abatement in this industry. The Commission contractor estimates chemical costs to be 80 percent greater than those estimated by EPA.

TABLE II-42: Steam Electric Cooling Systems In-Place as of January, 1975

Region	Percent of Generating Capacity Provided by Units Using the Following Types of Cooling Systems:			
	Once Through-Navigable Waters	Closed Cycle-Towers	Impoundment-Mainly Once Through	Mixed
New England (1)	87.3%	0%	0%	12.7%
Middle Atlantic(2)	89.3%	8.9%	0%	1.8%
EastNorth Central(3)	90.4%	0.8%	4.2%	4.6%
West North Central(4)	59.5%	16.1%	8.5%	15.9%
South Atlantic(5)	79.3%	5.3%	3.4%	12.0%
East South Central(6)	79.9%	6.7%	0%	13.4%
West South Central(7)	26.5%	27.8%	25.5%	20.2%
Mountain (8)	8.7%	54.2%	29.1%	8.0%
Pacific(9)	85.5%	14.5%	0%	0%
Non-Contiguous(10)	100%	0%	0%	0%
All	72.9%	11.2%	6.7%	9.2%

(1) Conn., Maine, Mass., New Hamp., R.I., Vermont
(2) New Jersey, N.Y., Penn.
(3) Ill, Indiana, Mich., Ohio, Wisc.
(4) Iowa, Kansas, Minn., Miss., Nebraska, N. Dakota, S. Dakota
(5) Del., D.C., Florida, Georgia, Md., N.C., SC., Va., W. VA.
(6) Ala., KY, Miss., Tenn.
(7) Ark., LA, Ok., Texas
(8) Arizona, Colo., Id., MO, Nevada, New Mex., Utah, Wyo.
(9) Calif., Oregon, Wash.
(10) Alaska, Hawaii, Puerto Rico, Virgin Islands

Source: National Commission on Water Quality, February 1976. Compiled from Teknekron, Inc., Water Pollution Control Act of 1972: Technologies and Economic Impacts, Steam Electric Power Industry. 1976.

abatement costs projected by the Commission contractor are considerably lower than those estimated by EPA. This difference results from alternative projections of the number of exemptions to be granted under Sec. 316(a), and of the number of plants that will be forced to closed-cycle cooling to meet state water quality standards. Estimates of aggregate thermal pollution abatement costs for this industry are critically dependent upon these tenuous projections, and the Commission contractor studied the effects of altering them by analyzing a range of possibilities.

A total of 21 alternative "scenarios" were analyzed in the Commission's study of the Act's impact on this industry. These included alternative assumptions about the number of Sec. 316(a) exemptions and the number of plants forced to closed-cycle cooling to meet state water quality standards, as well as consideration of alternative age and size criteria for subcategorizing the industry.* Two of these establish bounds on the probable impacts of the Act. Both use EPA's age and size criteria (cf. Table II-41) to define the units affected. In the "low coverage" scenario, a rather liberal number of exemptions is projected (about 80 percent of affected capacity), and no additional units are assumed to be affected by state-level thermal standards. The "high coverage" scenario reduces the generating capacity exempted by one-half, and further assumes state water quality standards require all unexempted plants in excess of 25 megawatts capacity to install closed-cycle cooling. In all cases, no thermal abatement costs were assigned to those units expected to require closed-cycle cooling because of a lack of adequate water for once-through operation. Table II-43 summarizes the aggregate thermal costs associated with these two scenarios.** These totals were produced by a simulation model which assumed an average growth in industry capacity -- the primary determinant of capital costs -- of 6 percent per year. The model predicted a growth in sales -- the primary determinant of operation and maintenance costs -- of 2.2 percent per year. The predicted growth in sales is about half that expected by the industry and the Federal Energy Administration. Increasing the sales growth rate to 4.4 percent per year would increase the operation and maintenance costs by approximately 20 percent. (See Chapter III, Section D for a discussion of the simulation model.) The wide range of possible costs dramatizes the uncertainties inherent in determining the impacts of the limitations at this time.

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* Alternative financial assumptions were also investigated. (All estimates of aggregate costs were derived in the economic impact phase of this industry study.)

**An "intermediate" scenario considers no state-level enforcement but the reduced number of Sec. 316(a) exemptions. Thermal abatement costs by 1983 in this case are $3,450 million capital, $630 million/year O&M.

TABLE II-43: Capital and Operation and Maintenance Costs for Thermal Pollution Abatement in the Steam Electric Power Industry (Industry Growth Included)

Scenario[1]	Estimated Electrical Capacity Affected by Thermal Limitations as of 1983 (MW)[2]	Capital Costs for Meeting Thermal Limitations, 1973-1983 (millions of 1975 dollars)	O&M Costs for Meeting Thermal Limitations in 1983 (millions of 1975 dollars/yr)[3]
1. Low Coverage	38,998	1,001[4]	277[5]
2. High Coverage	260,051	6,968[4]	897[5]

(1) See text, page II-118.

(2) Electrical megawatts of generating capacity.

(3) Includes costs due to energy penalties as well as direct operation and maintenance.

(4) Capital costs for achieving chemical limitations is estimated to be $4.78 billion in both cases.

(5) O&M costs for achieving chemical limitations is estimated to be $1.39 billion per year in both cases.

Source: National Commission on Water Quality, February 1976. Compiled from Teknekron, Inc., Water Pollution Control Act of 1972: Technologies and Economic Impacts, Steam Electric Power Industry. 1976.

The total generating capacity affected by the thermal limitations and not assumed to obtain exemption through Sec. 316(a) is also shown. The amount of this capacity provided by once-through plants presently operating or under construction is 19,306 megawatts (50 percent of the total affected) low coverage scenario, 191,088 (73 percent of the total affected) under the high coverage scenario. Much of the controversy regarding the application of EPA's thermal limitations revolves around the problems of retrofitting closed-cycle cooling systems to these plants. Some of the engineering problems involved are discussed below.

Because of the uncertainties associated with the Sec. 316(a) variance procedure, focusing on aggregate thermal abatement costs tends to obscure some important issues:

- Long lead-times imply a high incidence of retrofit. Under current conditions, it takes seven to ten years for nuclear, and three to five years for fossil fuel plant design, construction and testing before commercial operation can begin. This implies that some degree of retrofit -- either construction or design -- will be required of the majority of affected once-through plants scheduled to begin operation during the coming decade. Conversion from a planned once-through system may entail an engineering re-design, or a major construction change while construction is in progress. Conversion of a unit already in operation requires shut-down of the unit for two to five months beyond that normally allotted for maintenance, with attendent loss of capacity and reliability of the utility system.

- Cooling towers are not "add-on" technology in the usual sense. Plant design involves optimizing a complex, interactive system. Unlike many manufacturing processes, the operation of each major part of a steam electric unit is intimately connected to all others. Retrofitting requires major changes in the largest system in the plant, the circulating water system, and cannot be effected without reducing the operating efficiency and the capacity of the thermal power cycle.

- There are potential conflicts in siting criteria. Power plant sites should be carefully planned to optimize performance and minimize costs. A choice site for once-through cooling may be a poor or even unacceptable choice for a plant required to use cooling towers. For example, the requirement that a plant with a once-through cooling system be near a large water body often conflicts with the requirement that a site for closed-cycle cooling provide adequate foundation bedding for large

cooling tower structures. Other conflicting criteria for layout and arrangement tend to increase the costs of switching from once-through to closed-cycle cooling after a site has been selected. The incremented capital costs associated with using closed-cycle cooling for new sources are also highly site dependent. One factor is source water quality: once-through systems can generally use water with higher dissolved solids than can closed-cycle systems.

Table II-44 summarizes the difference in plant-level capital and operation and maintenance costs estimated for closed and open-cycle cooling designs at five candidate locations considered for a new nuclear plant.* The table shows the incremental costs for new source thermal abatement, as well as the effects of the potential siting criteria conflicts. The least capital cost site for the closed-cycle design (site D) is not the same as for the once-through design (site A). Differences in expenditures for transmission facilities and other factors would also have to be taken into account in actual practice -- these do not normally vary with type of cooling system, however.

Another aspect of the use of evaporative cooling towers raised in response to EPA's limitations is the increased consumption of water resulting from their use. In California, for example, a 1,000 megawatt nuclear generating unit using a once-through condenser cooling system will evaporate approximately 7,400 acre-feet of water per year, whereas the same unit, equipped with mechanical draft cooling towers, will evaporate approximately 12,000 acre-feet per year.** The aggregate impact of this increased demand upon fresh water supplies is not significant in most regions of the country, even projecting to the year 2000. However, the Commission has studied the potential impact in two water-scarce states -- Texas and California. Table II-45 estimates the increase in fresh water consumption in California and Texas due to imposition of cooling towers under the "high coverage" scenario, assuming that coastal plants using once-through systems with ocean or bay waters either will receive Sec. 316(a) exemptions or will employ salt water cooling towers. The first set of figures applies to actual electricity sales in 1972. The second set includes all additional units planned to begin operation by January 1980. (Data for the year 1983 were not readily available.)

The viability of cooling towers operating with ocean waters has been a controversial aspect of EPA's definition of "best available" technology for this industry. No closed-cycle cooling systems are

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* This is actual data, taken from the environmental impact statement for a proposed nuclear power plant (two units, total capacity of 2,300 megawatts) on Long Island, New York.

**1,000 acre-feet per year is approximately one million gallons per day (mgd).

Table II-44: Cost Comparison of Once-Through and Closed-Cycle Cooling for Different Sites

Closed-Cycle Cooling System

Site	Plant Capital(1)	Plant Operating and Maintenance(2)
A	286.3	3.78
B	337.6	3.73
C	293.6	3.70
D	277.4	3.70
E	283.3	3.78
	Once-Through Circulating Water System	
A	262.8	0.165
B	327.4	0.069
C	323.0	Base
D	268.6	0.127
E	290.7	0.029

(1) Expenditures are in millions of 1981 present worth dollars.

(2) Millions of 1981 dollars per year in excess to that required for once-through cooling at site C ("Base").

Source: National Commission on Water Quality, February 1976. Compiled from Teknekron, Inc., Water Pollution Control Act of 1974: Technologies and Economic Impacts, Steam Electric Power Industry, 1976. (Present-worth values shown in reference annualized, assuming 30-year life and nine percent interest rate.)

TABLE II-45: Consumption of Fresh Water by Evaporative Cooling Towers, Steam Electric Power Industry, Assuming No Conversions from Saline to Fresh Water Systems

State	1972 Steam Electric Capacity: Actual Consumption by Steam Electric Plants in 1972 (acre - feet)	1972 Steam Electric Capacity: Increase in Consumption in 1972 Assuming Conversions to Cooling Towers (acre - feet) [1]	1979 Steam Electric Capacity: Projected Consumption by Steam Electric Plants in 1979 in Absence of the Act (acre - feet) [2]	1979 Steam Electric Capacity: Increase in Consumption in 1979 Assuming Conversions to Cooling Towers (acre - feet)
California	20,900	1,470	52,000	1,470 [3]
Texas	144,000	11,200	243,000	29,800

[1] Mechanical draft systems. Assumes Sec. 316(a) exemptions for once-through plants consistent with high coverage scenario (42 percent of once-through capacity exempted in California; 36 percent in Texas Gulf region; 50 percent in remainder of Texas); exempts all once-through systems using man-made lakes or ponds and operating by 1974 or earlier.

[2] Assumes cooling mix planned by utilities before passage of the Act. Units on-line by 1973 assumed to continue to operate at historical capacity factors. Units coming on-line after January 1973 assumed to have a capacity factor of 0.7, 38 percent fossil thermal efficiency, 32 percent nuclear. Neither these nor the 1972 figures take account of the increase in natural evaporation from the building of ponds nor the rainfall captured by them.

[3] No new once-through systems using fresh water had been planned for the 1973-1979 period.

Source: National Commission on Water Quality, February 1976.

currently operating with ocean water, although they have been operated successfully with bay (brackish) water. Previous calculations of water consumption sponsored by the utility industry assume that all plants using ocean and bay waters would be forced to install cooling towers and convert to fresh water supplies.* Under the "high coverage" scenario, if all unexempted coastal plants operating in California by 1980 converted to fresh water, the steam electric industry's share of the fresh water consumed in the state would increase from 52,000 acre-feet to 132,000 acre-feet. The corresponding increase in Texas would be from 243,000 acre-feet to 294,000 acre-feet.

Although some coastal plants may convert to fresh water, the assumption that all once-through saline cooling systems will switch to fresh water supplies certainly would overstate the fresh water demand. Some installation of salt water towers, at least where brackish water is used, can be expected, and the number of Sec. 316(a) exemptions projected by the Commission's contractor for California coastal and Texas Gulf plants amounted to 80 and 70 percent of installed capacity, respectively. But even assuming the conversion to fresh water systems, and the reduced number of exemptions associated with the "high coverage" scenario, the increase in fresh water consumption does not appear to be significant in either California or Texas when the state as a whole is considered, at least not by 1980. The significance of increased water consumption in each particular locale depends upon present water rights held by the electric utilities and the appropriative water rights downstream that might be affected by increased consumption by an upstream user.

Large volumes of surface waters used for cooling can impact the water environment by raising the temperature of the receiving waters, by damaging aquatic organisms as they pass through the system ("entrainment"), and by trapping the larger aquatic species on the screens covering the intake structure ("impingement"). The environmental impact of these effects is highly site specific. No attempt was made to quantify these effects in the steam electric technology assessment beyond those involved in the projection of possible Sec. 316(a) exemptions. (See Chapter IV, Section 4.f. for a discussion of the projection technique.)

d. Residuals to Land and Air

Pollutants removed from wastewaters or converted to bacterial matter during biotreatment must go somewhere. The ultimate disposal of

*These calculations also did not take into account exemptions for existing plants using man-made lakes or ponds. (See "Comments on EPA's Proposed Sec. 304 Guidelines and Sec. 306 Standards of Performance for Steam Electric Power Plants," Edison Electric Institute et. al., Vol.3, Attachment IX, May 31, 1974.)

these "captured residuals," generally called "sludges," will be a growing problem as effluent qualities are upgraded. Sludges are thickened slurrys of concentrated pollutants, including any chemicals added during physical-chemical treatment, or thickened solutions of nonbiodegradable pollutants plus bacterial matter generated during biological treatment, or solid matter (dried sludges). Of the commonly used biological treatment schemes, activated sludge systems generally produce the most sludge per pound of BOD removed. Additional residuals include flotation skimmings, filter backwashes and incinerator ashes.

Different types of residuals produced by advanced treatment systems may pose particularly difficult disposal problems. Many of these residuals are soluble, inorganic salts, and their ultimate disposal may be the most critical intermedia issue associated with achieving very high levels of treatment. Because salts readily dissolve in water, their disposal on land may lead to serious problems of groundwater contamination and surface runoff to natural waterways unless proper precautions are taken. Ocean disposal would appear to be the minimum impact disposal strategy for some of these salts, but that option is not available to many industrial dischargers. The energy requirements for removing these salts will be high compared to conventional treatment. This will indirectly increase air pollution or nuclear waste generation, depending upon the source of the electrical energy.

By far the most common ultimate sludge disposal option is landfilling. The effort required to insure that the sludges do not have an adverse environmental impact depends upon their composition. Generally, the more constituents in the plant's wastewater, the greater the probability that the sludges will contain potentially toxic or otherwise undesirable materials -- including inorganic salts -- which must be kept from leaching into surface or ground waters. Sludges from chemical plants, for example, often require a landfill underlain by a layer of impervious clay, with leachate collection and even treatment. Sludges from food processors, on the other hand, often can be sprayed directly onto cropland if sufficiently dilute, or plowed directly into the soil if in cake (solid) form.

When suitable land is not available for land disposal, or transportation costs are high, sludges may have to be incinerated. This option has the advantages of eliminating odors (if properly controlled), independence from the weather, and great reduction in volume and weight. Supplemental fuel may be required if the sludge heat value is low, and measures must be taken to reduce potential air pollutants to levels required by air pollution regulations. In most cases, the remaining ash is chemically inert and, except when the soluble salt content is significant, relatively easy to dispose of.

The way in which sludge production increases with the level of water pollution abatement is illustrated in Figure II-5, which shows solid waste production as a function of abatement level for a petroleum refinery using activated sludge biotreatment.

A large quantity of "oily solids" sludge is generated at the first treatment step. The value shown at the "primary de-oiling" level is that which is normally removed from the wastewaters before discharge as part of a product recovery step. Additional biological sludges from the activated sludge process are added at Level I. Level III involves in-plant changes to reduce water use, and has no effect upon sludge production. Advanced treatment for partial effluent desalting and recycle is employed at Level V, and the great increase in sludge mass is due to extraction of the inorganic salts. Complete desalting and recycle is effected at the last level, with a doubling of the inorganic salts contribution.

At present, most sludges have little or no economic value. Oils are routinely recovered from refinery wastewaters prior to treatment, but none of the oily solids referred to in Figure II-5 presently have market value. Settled solids from fruit and vegetable processes have been used successfully in animal feeds, but use of "secondary" solids -- the biomass produced in biological treatment systems -- is only at the experimental stage. Options exist for using sludge for fuel (usually mixed with other combustibles), and even for making into products. Sludge from pulping wastewaters can be used in making some types of low-grade paper products, such as boxboard. Hopefully, additional uses for captured residuals will be found in the future.

e. Uniformity

The "uniformity" of the BPT and BAT effluent limitations is sometimes questioned. There are several definitions of uniformity that can be applied. Uniformity can refer to types of technologies, to concentrations of pollutants in the treated effluent, to required percentage removals of the pollutants, or to measures of economic burden.* Data have been collected in the technology studies which relate to all of these but the economic measures, which are addressed in Chapter III.

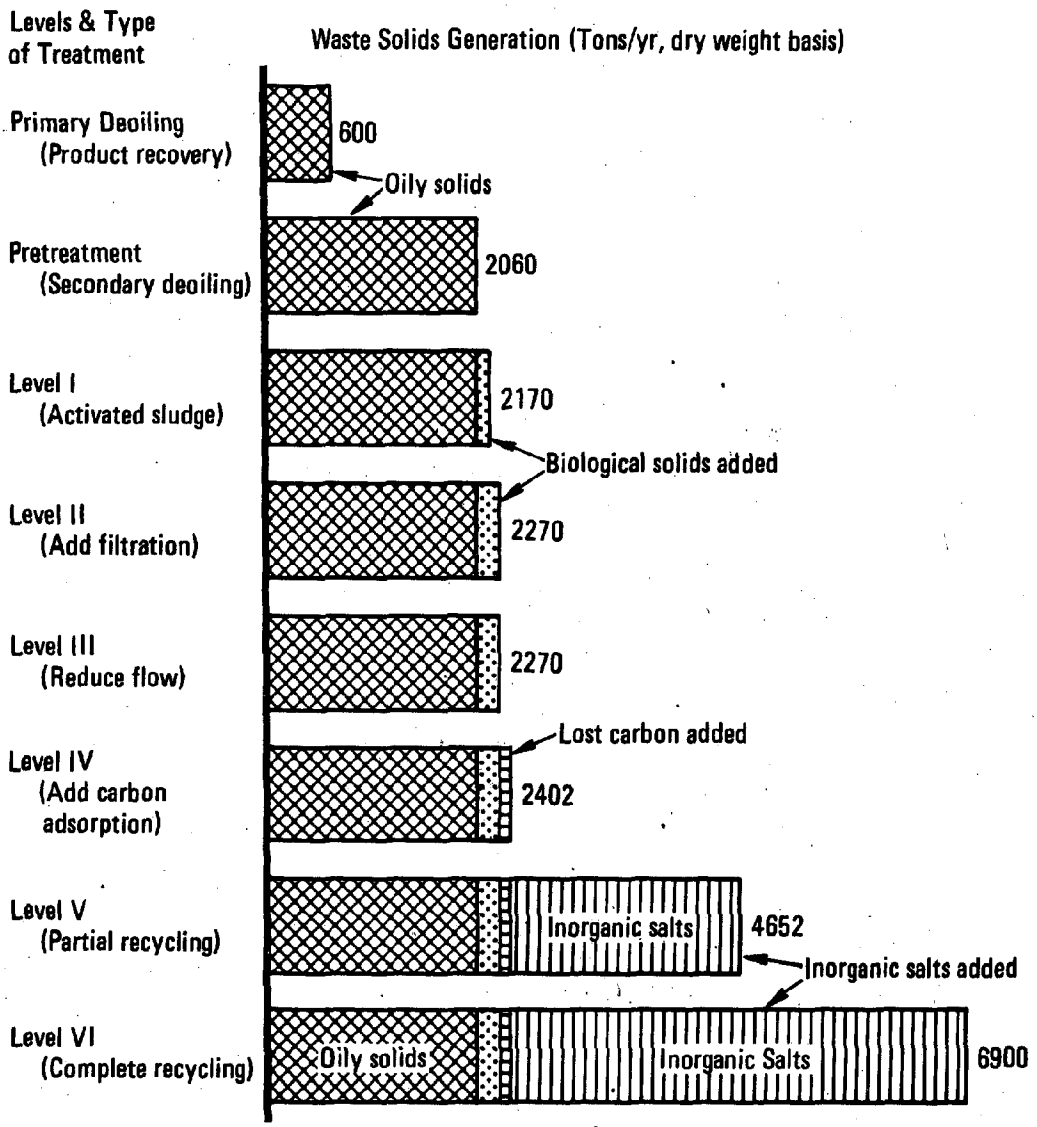
Table II-46 presents information on the fruits and vegetables, petroleum refining, textiles, and pulp and paper categories, showing

*There is no reason to expect uniformity among the limitations when expressed in terms of pounds of pollutant per unit of production -- inherent variations in the appropriate unit of production as well as in the quality of wastewaters generated by different types of manufacturing processes render such a comparison meaningless.

Figure II.5

SOLID SLUDGE INCREASE AS A RESULT OF WATER POLLUTION ABATEMENT

FOR A PETROLEUM REFINERY "Lube" subcategory 45,200 bl/day capacity



Source: Natl. Commission on Water Quality, from Engineering Science, Inc., "Water Pollution Abatement Technology: Capabilities and Costs, Petroleum Refining Industry", 1976.
February 1976

TABLE II-46: Comparison of EPA's Effluent Limitations in Terms of Implied Pollutant Concentrations and Percent Reductions in Pollutant Mass Discharge

Industry	Median Raw Waste Concentration			Effluent Concentration Limits (mg/l) & Percent (%) Pollutant Reduction Required[1]											
				BPT (1977)						BAT (1983)[4]					
	BOD	TSS	COD	BOD		TSS		COD		BOD		TSS		COD	
	mg/l	mg/l	mg/l	mg/l	%	mg/l	%	mg/l	%	mg/l	%	mg/l	%	mg/l	%
Fruits & Vegetables															
Max[2]	1820	1280		249	94.8	530	90.3			79	98.2	113	94.7		
Ave[3]	955	535		93	90.8	188	67.9			49	94.4	64	81.4		
Min[2]	489	128		39	77.6	62	0			28	92.9	34	56.2		
Petroleum Refining															
Max	1854	610	4634	15	99.2	10	98.4	115	97.7	4.8	99.7	4.8	99.2	29	99.5
Ave	1242	378	3176	15	97.7	10	96.6	109	95.8	4.8	99.3	4.8	98.4	27	98.9
Min	51.5	176	558	15	70.9	10	94.3	80	85.7	4.8	90.7	4.8	97.3	20	96.4
Textiles															
Max	5480	7500	30500	296	94.7	898	89.8	3850	94.1	134	97.6	112	98.5	1000	98.3
Ave	477	193	897	44	93	137	53.9	276	67.3	18.7	95.8	13	91.6	92	89.1
Min	140	50	524	17	60	53	0	112	45.2	11	88.6	7.5	74.6	32	81.
Pulp and Paper															
Max	849	1318		109	88.8	156	91.1			110	97.3	89	96.9		
Ave	321	361		47	85.2	75	76.7			19	93.6	24	92.5		
Min	95.9	200		27	66	36	56.1			11	86.8	16	75.1		

[1] Reduction efficiencies (%) are based upon reduction from median raw waste loads for both levels.
[2] Maximum and Minimum values represent extreme values for all subcategories. (Values in successive columns do not necessarily correspond.)
[3] Averages are weighted by subcategory flow.
[4] Flow reduction is projected for BAT level for all categories.

Source: National Commission on Water Quality, February 1976. Based upon data contained in technology contractor's reports.

effluent limitations in terms of concentrations (milligrams per liter, mg/l) and percentage reduction in pollutant mass discharge for biochemical oxygen demand, suspended solids and chemical oxygen demand. The data are based upon EPA's effluent limitations and the flows and raw waste loads associated with representative plants in the Commission contractors' reports.

It is instructive to examine the legislative history regarding the concept of uniformity. The Report of the House Public Works Committee on H.R.11896 states that the identification of "best practicable" is expected to be "in objective terms and (to) set out actual performance levels for . . . point sources rather than prescribing specific control techniques, processes, or equipment,"(23) that the standards should be based on treatment facilities at the end of the manufacturing process itself(24). The Senate Debate of the Conference Report stated that best practicable can be interpreted as the equivalent of secondary treatment for industry but that such an interpretation should not be construed as limiting the authority of the Administrator(18).

As a point of reference, EPA's definition of secondary treatment for publicly owned treatment works restricts BOD and suspended solids to 30 mg/l each (average of 30 consecutive days) with minimum removal of 85 percent regardless of effluent concentration, and also limits pH and fecal coliform bacteria.

Data in Table II-46 show that the flow-weighted average BOD percentage removal at BPT equals or exceeds 85 percent in each industry. At least one subcategory of each of the industries will not achieve 85 percent, with the minimum ranging from 60 to 78 percent. The variation in effluent concentration of BOD is quite pronounced, ranging from 15 mg/l to 93 mg/l for the average of each industry and from 15 mg/l to 296 mg/l considering the extreme subcategories across the industries. Effluent concentrations of suspended solids are higher and percentage removals lower than those for BOD, with wide variations from industry to industry and subcategory to subcategory. The average removal for three of the four industries is less than 85 percent, and the concentration exceeds 75 mg/l. The lowest percentage removals are not always indicative of poor performance, but may indicate low concentrations of suspended solids in the raw waste load. High removals (90 percent of more) are hard to achieve with dilute wastes.

A similar pattern emerges from the BAT effluent limitations, although the extremes are closer. BOD removal exceeds 85 percent for all subcategories of the four industries, but some subcategories are considerably below 85 percent removal for suspended solids. Concentrations of BOD range as high as 134 mg/l, with a low of 4.8 mg/l. Suspended solids range from 113 mg/l to 4.8 mg/l. The in-plant changes associated with BAT make these comparisons difficult to interpret. As wastewater flows

are reduced, pollutant concentrations in the raw waste load usually increase and comparison of percentage removals becomes less meaningful.

Concentrations and percentage removals of BOD and suspended solids are obviously not uniform from industry to industry and subcategory to subcategory: BPT for one industry is more stringent than BAT for the others. The results reflect differences in types and concentrations of raw wastes, treatability of wastes, and available technologies.

All four categories shown in the table produce wastes which are organic in nature. Two of the industries also discharge significant concentrations of COD and EPA effluent limitations include this pollutant. Petroleum refining must use carbon adsorption to achieve the BAT effluent limitations and textiles must use some chemical treatment. Both technologies are more sophisticated, costly and energy intensive than that required of the other industries.

The four industries illustrate the wide variations found in effluent limitations. The factors influencing technology-based standards are interrelated in such a complex web that "uniformity" in terms of applicable technologies, required effluent concentrations or percentage removals, can not be expected.

An often asked question pertaining to uniformity of costs relates to what effluent reduction benefits will be obtained for each additional abatement dollar. Unfortunately, there are few situations in which this can be answered in terms of a single quantitative measure, such as "dollars per pound of pollutant removed."

It is generally true that the costs required to remove a pollutant from a wastewater stream increase rapidly as the removal approaches 100 percent. With a waste stream containing a variety of pollutants, however, "percent removed" is ambiguous, because any abatement technology will remove different fractions of different pollutants. Furthermore, these fractions may change at different rates as more abatement technology is added.

In addition to these technology oriented complications, an analysis becomes even more complex when evaluating different effluent limitations since some pollutants are not specifically controlled at both the BPT and BAT levels for the same industry. Table II-24 shows that six of the 10 industries studied in depth have pollutants limited at the BAT level that are not limited at the BPT level. The achievement of the 1985 goal would bring even more pollutants under regulation than are controlled by the 1983 limitations. An additional complication which is important in an assessment of BAT is that in-plant changes aimed at pollution abatement

usually have little in common with the technologies employed for end-of-pipe treatment, and therefore relations between costs and effluent reductions for these strategies do not follow the traditional forms associated with end-of-pipe treatment, even for the simplest types of wastes.

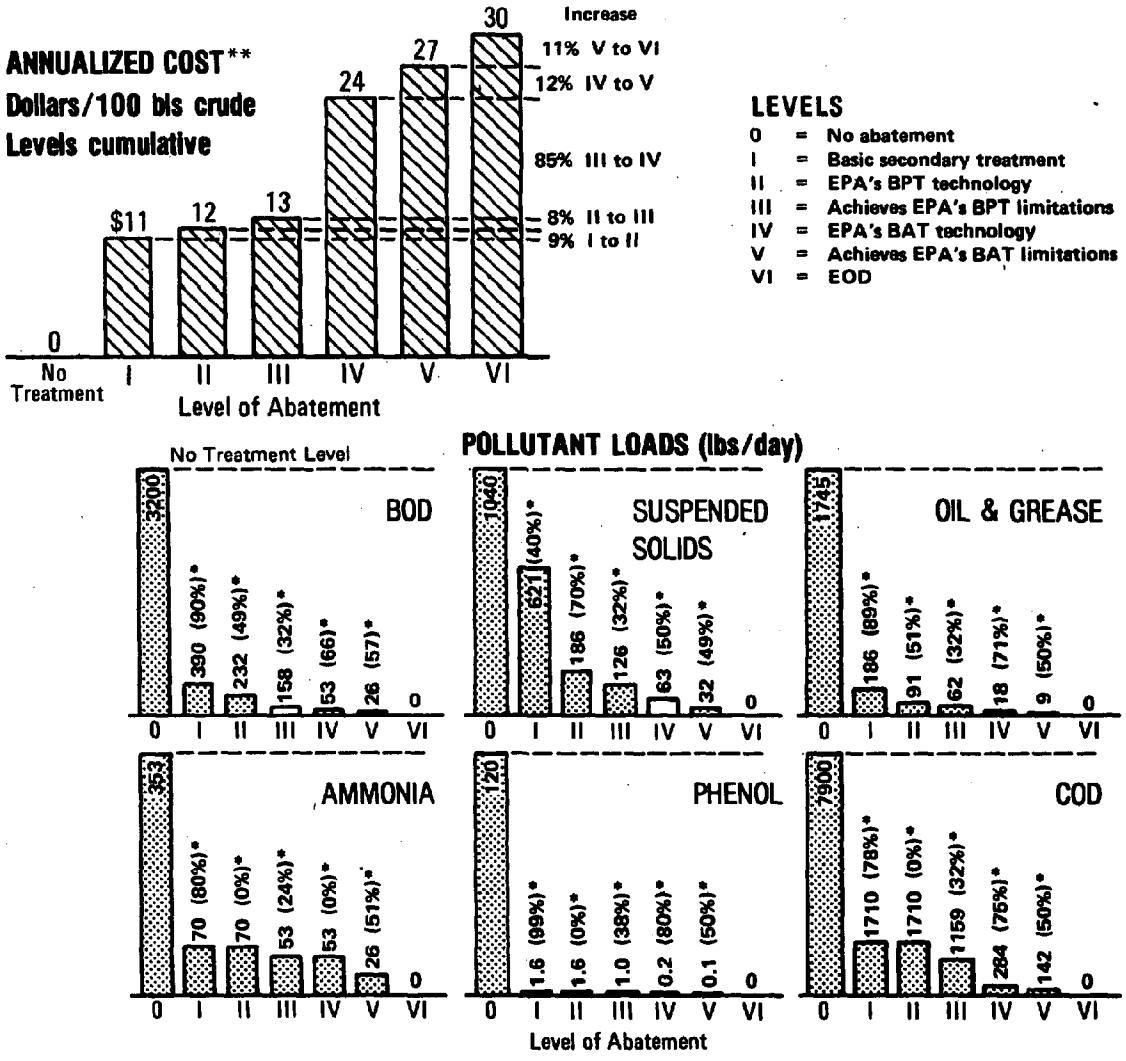
Figure II-6 shows the mass emission rates of pollutants from several representative plants as functions of increasingly stringent abatement levels. Annualized abatement expenditures per unit of production are given for comparison. Most of the removal of BOD for the organic wastes occurs at the first level of abatement, which corresponds to basic secondary treatment. However, suspended solids and COD do not reach comparable percent removals until higher levels are reached. The sulfur dioxide plant shows a substantial decrease in sulfite and COD emissions at Level I, with zero reduction in suspended solids. Dissolved solids, a parameter not controlled by the BPT or BAT effluent limitations for the chemical industry, is also shown for this case to illustrate the increase in dissolved materials which usually accompanies physical-chemical treatment. Presumably, these materials would have to be removed at an abatement level designed to achieve the 1985 goal.

These examples illustrate the difficulties involved in assessing uniformity in terms of cost per pound of pollutant removed. A variety of data of this type were examined by the Commission, but wide variation and discontinuities in the results dictate a much more exhaustive analysis before reaching any conclusions, if in fact any can be reached.

Figure II.6a

ANNUALIZED COSTS FOR ABATING POLLUTANT LOADS FOR EACH LEVEL OF ABATEMENT

Example: Petroleum Refining Model Plant
"Lube" type refinery. 45,200 bl/day capacity
Flow at 0 level = 1.9 MGD



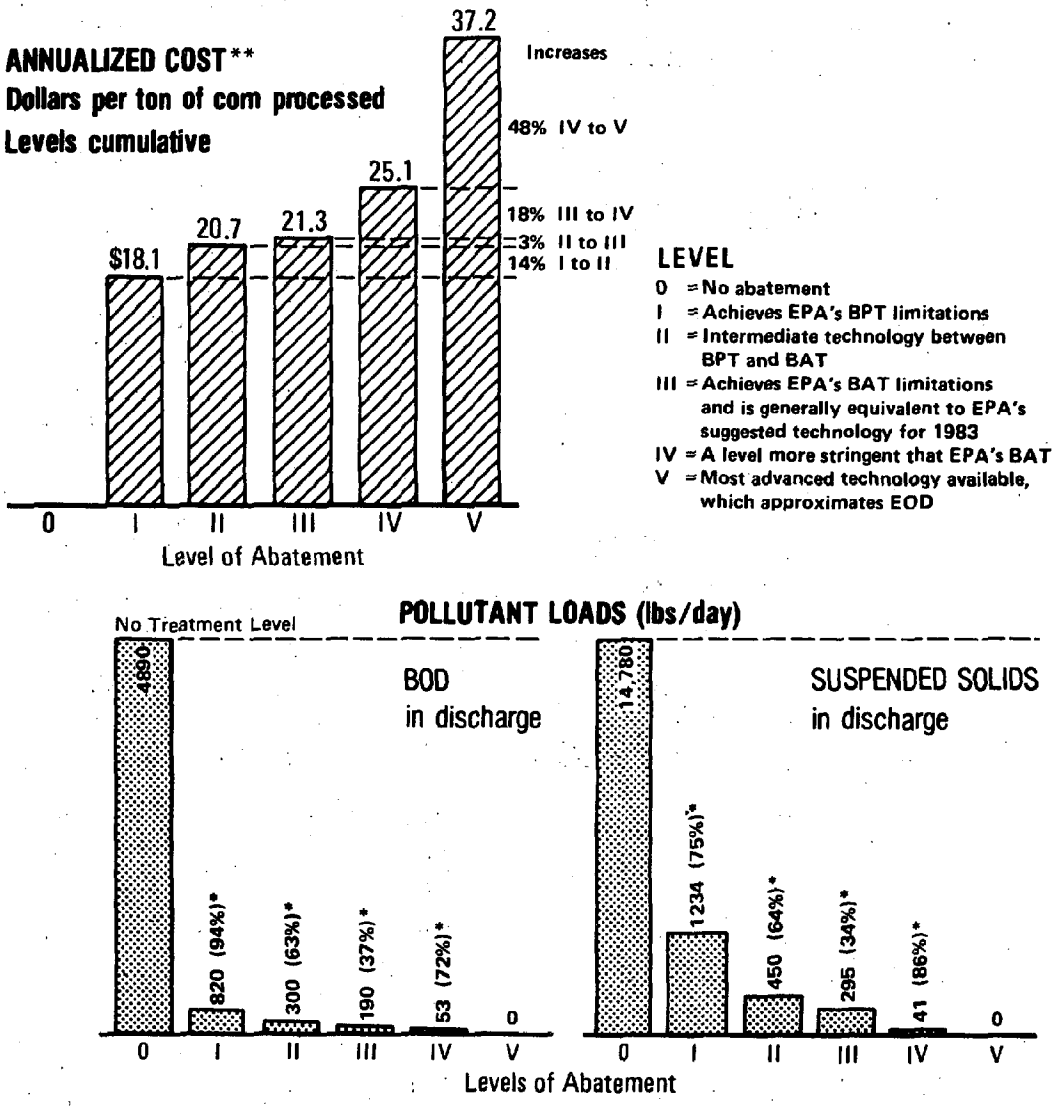
* Percent reduction from prior level.
** 15 percent; 20 year.

Source: Natl. Commission on Water Quality, from Engineering Science, Inc., "Water Pollution Abatement Technology: Capabilities and Costs, Petroleum Refining Industry", 1975.
February 1976

Figure II.6b

ANNUALIZED COST FOR ABATING POLLUTANT LOADS FOR EACH LEVEL OF ABATEMENT

Example: Canned Corn Plant
581 tons/day capacity
Flow at level 0 = 0.973 MGD



*Percent reduction from prior level.
**15 percent; 20 years.

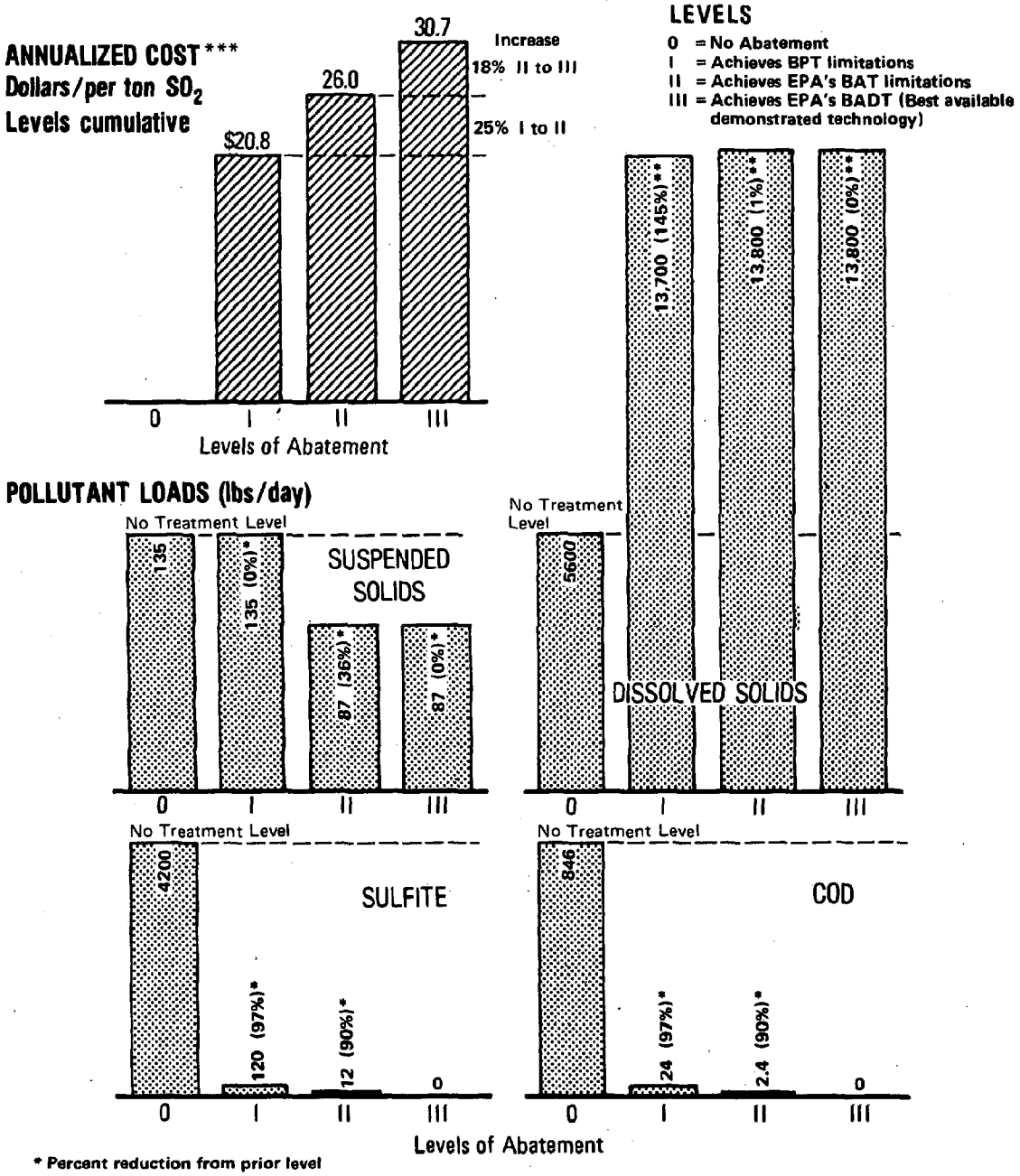
Source: Natl. Commission on Water Quality, from Environmental Associates, "Water Pollution Abatement Technology: Capabilities and Costs, Canned Fruits and Vegetables", 1975.

February 1976

Figure II.6c

ANNUALIZED COST FOR ABATING POLLUTANT LOADS FOR EACH LEVEL OF ABATEMENT

Example: Sulfur Dioxide (SO_2) Manufacturing
50 million lbs/year capacity
Flow at 0 level = 0.82 MGD



* Percent reduction from prior level
** Percent increase from prior level
*** 15 percent: 20 years.

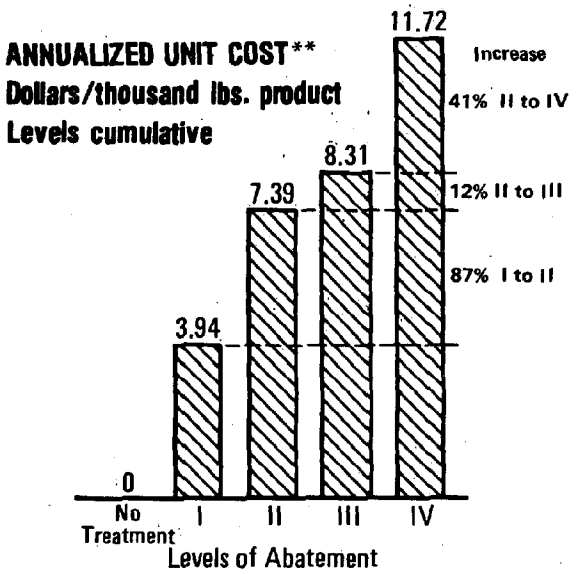
Source: Natl. Commission on Water Quality, from Catalytic, Inc., "Water Pollution Abatement Technology: Capabilities and Costs, Inorganic Chemical Industry", 1975.

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Figure II.6d

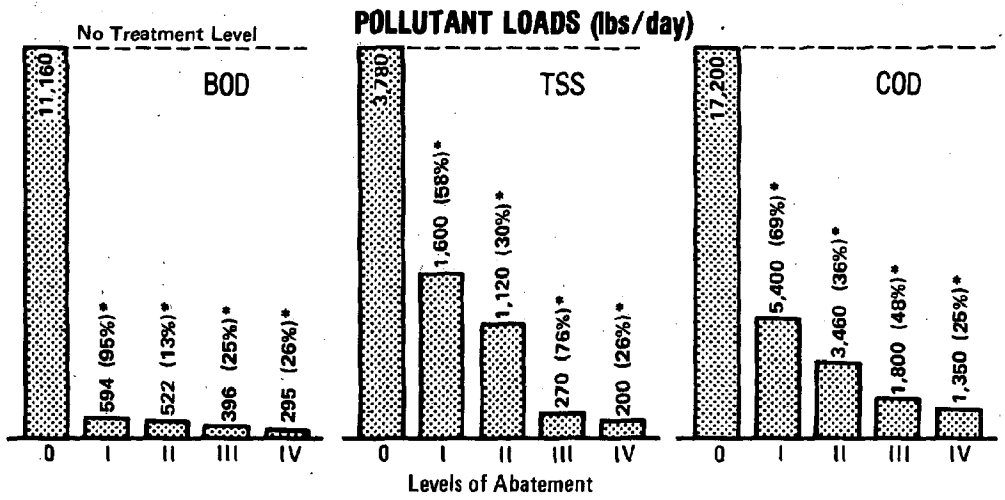
ANNUALIZED COST FOR ABATING POLLUTANT LOADS FOR EACH LEVEL OF ABATEMENT

Examples: Textiles — Woven Fabric
Finishing of cotton and cotton/synthetic blends
Subcategory 6 — Representative plant
180,000 lb/day production
Flow at level 0 2.43 MGD



LEVEL

- 0 = No abatement
- I = Equivalent to EPA's suggested technology and achieves EPA-BPT limitations
- II = Intermediate technology
- III = Achieves EPA.s BAT limitations and is generally equivalent to EPA's suggested technology
- IV = Further approaches EOD



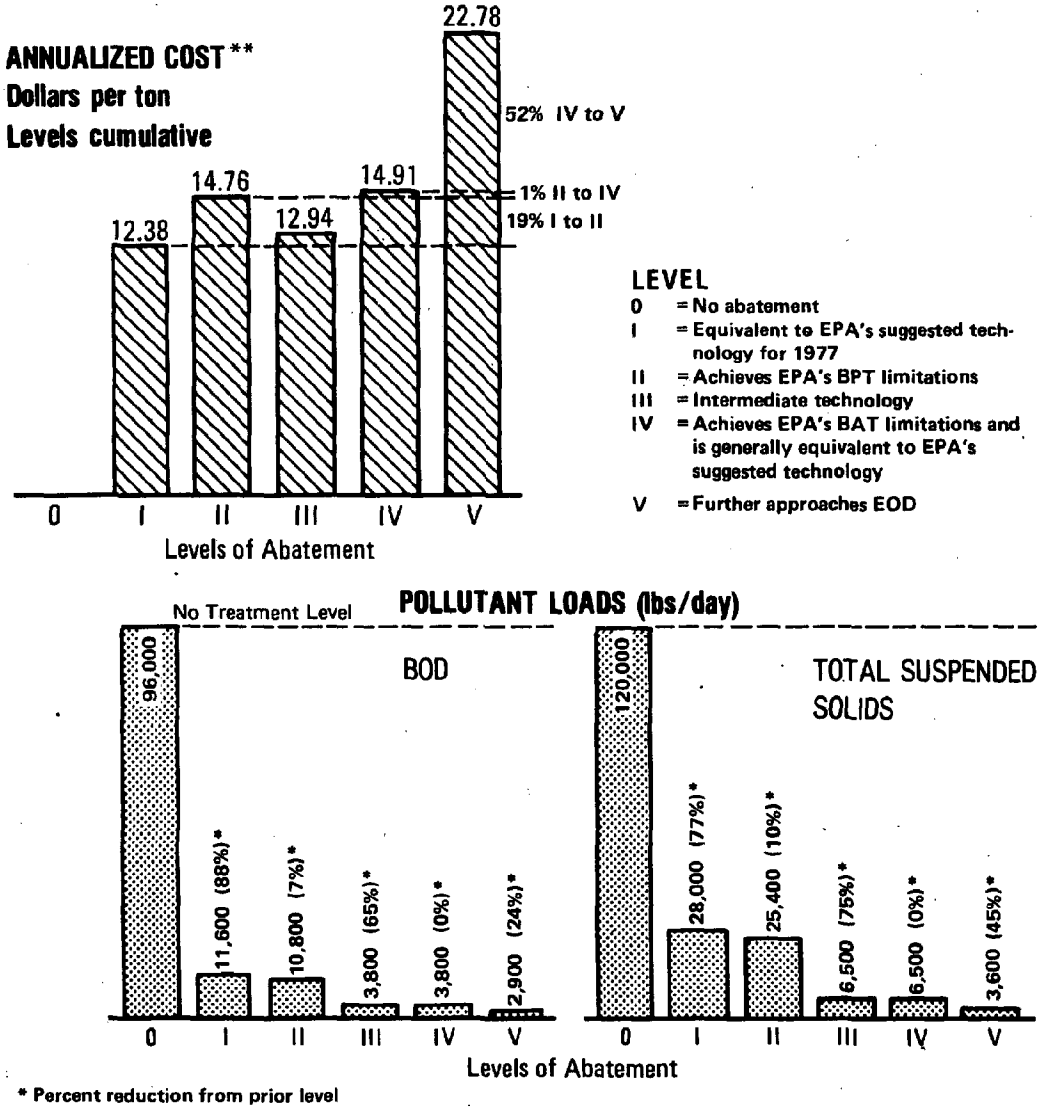
* Percent reduction from prior level.
** 15 percent; 20 year.

Source: Natl. Commission on Water Quality, from Lockwood Greene Engineers, "Water Pollution Abatement Technology: Capabilities and Costs, Textile Industry", 1975.
February 1976

Figure II.6e

ANNUALIZED COST FOR ABATING POLLUTANT LOADS FOR EACH LEVEL OF ABATEMENT

Example: Unbleached Kraft Plant
1200 tons/day capacity
Flow at level 0 48 MGD



* Percent reduction from prior level
** 15 percent; 20 years.

Source: Natl. Commission on Water Quality, from Hazen and Sawyer, "Water Pollution Abatement Technology: Capabilities and Costs, Pulp & Paper Industry", 1975.
February 1976

D. INNOVATIVE TECHNOLOGY

1. Introduction

The Act states that "it is the national goal that the discharge of pollutants into the navigable waters be eliminated by 1985." [Sec. 101(a)(1).] Considering solely technological knowledge, this goal could be achieved, or at least closely approached, by 1985 for all types of industrial and municipal (publicly owned treatment works) point discharges by application of existing or projected technologies. In many cases, the technologies required are now proved, at least on a pilot plant basis, but need to be transferred to other applications. The capacities required in many instances would be several orders of magnitude beyond present sizes.

Each Commission in-depth technology study contractor was asked to assess economically and environmentally feasible technologies which are available or likely to become available in the foreseeable future to approach or achieve elimination of discharge of pollutants (EOD).* Only in the case of the metal finishing(25) and petroleum refining(26) industry studies was EOD fully examined. For metal finishing, EOD is the proposed EPA abatement requirement for BAT. For three other in-depth industry studies (inorganic chemicals, canned and preserved fruits and vegetables and iron and steel), Commission contractors examined EOD to some extent for certain subcategories. Table II-47 lists those industry categories for which EPA has promulgated or proposed EOD for BPT (1977) or BAT (1983) effluent limitations.

A separate technology study was undertaken to address specifically the 1985 goal by characterizing the capabilities of innovative technologies to achieve or, where that is not yet possible, to closely approach elimination of the discharge of pollutants from municipal (including combined sewer systems) and industrial point source discharges(27). Effluent pollutant levels for constituents controlled by EPA limitations were assumed to be essentially the same as those defined by EPA for BAT (1983) for industrial sources, and BPWTT (1983) for municipal sources.

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*The Commission has defined EOD as follows: "The elimination of the discharge of pollutants shall apply to removal of those constituents which are added during use of the water. The resultant discharge must be of equal or lower concentration than that of the original supply."

TABLE II-47: Industries with Proposed or Promulgated EPA Limitations Requiring EOD

Industry	EOD for BPT (1977) Limitations	EOD for BAT (1983) Limitations
Metal Finishing	None	All Subcategories
Iron and Steel	Some Subcategories	Some Subcategories
Inorganic Chemicals	Some Subcategories	Some Subcategories
Petroleum & Gas Extraction	Some Subcategories	Some Subcategories
Fish Hatcheries & Farms	One Subcategory	One Subcategory
Cane Sugar	Some Subcategories	Some Subcategories
Beet Sugar	None	Some Segments
Timber Products	Some Subcategories	Some Subcategories
Furniture & Fixtures	Some Subcategories	Some Subcategories
Builders Paper & Board Mills	One Subcategory	One Subcategory
Non-Fertilizer Phosphates	Some Subcategories	Some Subcategories
Fertilizer	Some Subcategories	Some Subcategories
Paving & Roofing Materials	Some Subcategories	Some Subcategories
Glass	Some Subcategories	Some Subcategories
Cement	Some Subcategories	Some Subcategories
Asbestos	Some Subcategories	Some Subcategories
Insulation Fiberglass	Some Subcategories	Some Subcategories
Non-ferrous Metals	Some Subcategories	Some Subcategories
Auto & Other Laundries	Some Subcategories	Some Subcategories

Note:

1. These cover only process wastewater pollutants, and include only those industries for which proposed or promulgated limitations were available during the Commission's study.

2. Where evaporation ponds are used as part of EPA technology, EPA often allows an overflow during periods of excess rainfall.

Source: National Commission on Water Quality, February 1976.

Constituents not controlled by EPA effluent limitations for BAT and BPWTT (mostly salts) will vary widely. The innovative technology study did not cover elimination of pollutants from agricultural point sources or separate storm sewer discharges.

2. Discharges from Industry

a. Scope

The evaluation of innovative technologies to achieve EOD for industrial discharges focused on nine of the 10 industries studied in-depth (effluents from steam electric power were not included). These effluents constitute the vast majority of industrial process wastewaters to be discharged in 1983, both from the standpoint of volume and pounds of pollutants. The characteristics of these effluents and the innovative technologies applied to them are representative of virtually all industrial discharges.

Table II-48 presents the projected general quantity and quality characteristics of the discharges from the nine industries after meeting the 1983 BAT effluent limitations. Pollutants have been divided into seven groups with similar characteristics and for which common technologies would be appropriate. For example, soluble salts, regardless of source, will be removed or reduced by the same innovative technologies. These projections are of necessity generalizations and do not apply to every plant in every industry cited. Although the most common pollutant in 1983 is projected to be suspended material, it will not be the major problem in achieving EOD; on the contrary, it will be one of the simpler to control since suspended material will be removed incidentally by technologies necessary to remove more difficult constituents in the same waste streams. The greatest challenge from the standpoint of both technology and costs will be removal of soluble salts, particularly since these pollutants are prevalent in some of the largest volume waste discharges at concentrations exceeding 1,000 mg/l.

Because of the high costs per unit of volume to achieve EOD (see discussion in Section 2(b) below covering costs), most industries would probably go to great lengths to eliminate or reduce drastically wastewater volume if EOD were a requirement, rather than a goal. To achieve this, in-plant process changes would be made in many cases. In others, both innovative and conventional technologies would be used within the plant at the respective pollutant generating processes. These changes would be difficult and sometimes almost impossible to make for many older facilities, but they would be used in new plants.

Elimination of waterborne wastes through modification of a production process is highly industry and process specific. Many processes

TABLE 48: Wastewater Groupings Showing Contaminants after Application of 1983 Requirements

	Quantity (1)				Quality					
	VL	L	M	S	Soluble Salts (2)	Toxic Heavy Metals (3)	Undesirable Compounds (4)	High COD (5)	Nutrients (6)	Suspended Material (7)
Metal Finishing (9)										
Iron and Steel (Integrated Plants)	✓	↔ ✓			✓		✓ (phenol)		✓ (ammonia)	✓ (not biodegradable)
Inorganic Chemicals				✓ (8)	< 1000 mg/l					✓ (not biodegradable)
Organic Chemicals		✓	↔ ✓				✓	✓		✓
Petroleum Refining		✓			✓				✓ (ammonia)	✓
Plastics and Syuthetics			✓					✓ (mostly suspended)		✓
Pulp and Paper	✓						✓			✓
Textiles			✓				✓ (color)			✓
Canned Fruits and Vegetables			✓		✓ (pickling)					✓

NOTES: (1) VL, very large, > 10^7 gal/day
L, large, 10^6-10^7 gal/day
M, medium, 10^5-10^6 gal/day
S, small, < 10^5 gal/day
(effluents from typical plants)

(2) Soluble salts, > 1000 mg/l.

(3) Toxic heavy metals, about 1 mg/l.

(4) Carcinogenic, toxic, colored, etc., non-metallic compounds.

(5) COD about 1000 mg/l and COD/BOD > 2-4.

(6) Phosphorus and nitrogen, 1-20 mg/l.

(7) Suspended matter, oil and grease, 1-20 mg/l.

(8) Probably; information lacking.

(9) 1983 requirement is EOD.

Source: Water Purification Associates and Process Research, Inc., Water Pollution Abatement Technology: Capabilities and Costs, Innovative Technologies, 1976.

can be redesigned or operated to discharge less water, but few result in completely eliminating the discharge of water. Examples of process changes that would result in the elimination of process wastewaters include replacement of wet scrubbers with dry bag collectors for air pollution control; replacement of barometric condensers with non-contact heat exchangers; and improved housekeeping to prevent contamination. An example specific to the iron and steel industry would be replacement of blast furnaces with direct iron reduction facilities.

The innovative technologies studied can be classified into six main groups:

1) Membrane separation technologies
2) Adsorption technologies
3) Thermal separation processes
4) Suspended matter removal
5) Chemical oxidation processes
6) Land treatment

Table II-49 lists those innovative technologies now developed sufficiently to permit reasonably accurate estimates of cost, energy, residuals concentration and other pertinent information. Technologies examined in the study, but omitted from Table II-49, are freezing; adsorptive bubble separation; electorphoretic separation; and several adsorption techniques other than ion exchange. Some technologies have been included not because the technology itself is innovative, but because its suggested application is innovative. Ion exchange and evaporation are examples of commercially proved technologies which are applied in new circumstances.

Table II-50, an expansion of Table II-48, shows those technologies most applicable to achieve or closely approach EOD for each of the nine industries. To decide on applicable technologies, each of the selected seven pollutant classifications was considered individually. For two industries (organic chemicals and petroleum refining), no technologies are projected to achieve EOD because no presently known, absolutely reliable treatment will capture all traces of organics from these wastewaters. Although evaporation might at first seem applicable, the heat generated in the process will break down the organic molecules and generate a significant uncapturable volatile organic fraction which will carry over with the evaporated steam.

Table II-49: Innovative Technologies

	Technology	Technology Capability	Residuals	Cost*	Energy & Other Requirements	State of Development
Membrane Technologies	Reverse Osmosis	Removes dissolved materials of all sorts	Concentrated solutions about 2%	Medium to Low	~ 8 kwh/1000 gal	Demonstration, semi-commercial
	Ultrafiltration	Removes large dissolved molecules, colloidal and suspended solids	Concentrated suspension, or solution	Medium	~ 8 kwh/1000 gal	Demonstration, semi-commercial
	Electrodialysis (including other electromembrane processes)	Removes dissolved ionic species only	Concentrated solution, usually about 2%, can be up to 20%	Low	~ 10 kwh/1000 gal	Commercial for potable water, demonstration for wastewater
	Adsorption (mainly ion exchange)	Removes dissolved salts & other dissolved compounds	For ion exchange concentrated solution about 12%	Low	~ 1/3 of the cost is chemicals	Commercial for potable water & boiler feed; demonstration for wastewater
	Evaporation (including vapor compression)	Removes nonvolatile contaminants	Highly concentrated solution or slurry	Medium	400-1700 Btu/gal+ 62-87 kwh/1000 gal (for vapor compression)	Commercial
	High Gradient Magnetic Separation	Removes suspended material, preferably magnetic material	Concentrated slurry or sludge	Low	~ 0.7 kwh/1000 gal (depends on size)	Laboratory
	Filter-Coalescence	Removes oil	Concentrated oil	Low	~ 0.1 kwh/1000 gal	Demonstration
	Wet Oxidation	Destroys COD, phenols, cyanides, etc.	As vapor, as hot suspension	High	Depends on COD removal, ~ 0.34 kwh/lb COD	Commercial
	Ozonation	Destroys COD, disinfects	None	Low	~ 9 kwh/1000 gal	Commercial for potable water, demonstration for wastewater
	Land Treatment	Removes biodegradable solids, BOD and nutrients	None	Low	Large land areas 0.5-0.8 kwh/1000 gal#	Full scale, very site specific

* High > $7/1000 gal
Medium = $1-7/1000 gal
Low < $1/1000 gal
} Annualized (capital x 15%) plus O&M costs, excluding residuals disposal.

+ This amount of energy would, at 40% efficiency, be used to generate 47-200 kwh/1000 gal.

For spray irrigation; other methods have lower requirements.

Source: Water Purification Associates and Process Research, Inc., Water Pollution Abatement Technology: Capabilities and Costs, Innovative Technologies, 1976.

Table II-50: Matrix of innovative technologies to achieve or approach EOD

	Quantity (1)				Quality						Technology to Achieve EOD	Technology to Approach and Possibly Achieve EOD
	VL	L	M	S	Soluble Salts (2)	Toxic Heavy Metals (3)	Undesirable Compounds (4)	High COD (5)	Nutrients (6)	Suspended Material (7)		
Metal Finishing (9)				✓		✓	✓ (predominantly non-volatile)				Evaporation	Ion exchange, Electrodialysis, Reverse Osmosis, Adsorption, Freezing
Iron and Steel (Integrated Plants)	✓	✓			✓		✓ (phenol)		✓ (ammonia)	✓ (not biodegradable)	Evaporation + Ion exchange or Electrodialysis (for ammonia removal) + Oxidation of residual phenol	Ultrafiltration + Electrodialysis or Ion Exchange + Adsorption of residual phenol
Inorganic Chemicals				✓ (8)	< 1000 mg/l					✓ (not biodegradable)	Ultrafiltration, Evaporation	Coagulation & Filtration
Organic Chemicals		✓	✓				✓	✓		✓		Oxidation + Land treatment, Adsorption + Oxidation
Petroleum Refining		✓			✓				✓ (ammonia)	✓		Non-Salt Streams: Adsorption + Oxidation, Land Treatment. Salt Stream: Evaporation
Plastics and Synthetics			✓					✓ (mostly suspended)		✓	Ultrafiltration + Adsorption	Oxidation + Land treatment Adsorption, Coagulation
Pulp and Paper	✓						✓			✓	Ultrafiltration + Reverse Osmosis	Land Treatment
Textiles			✓				✓ (color)			✓	Reverse Osmosis + Land Treatment	Land Treatment, Reverse Osmosis
Canned Fruits and Vegetables			✓		✓ (pickling)					✓	Ion exchange or Reverse Osmosis or Electrodialysis + Land Treatment	Land Treatment

NOTES: (1) VL, very large, > 10^7 gal/day
L, large, 10^6-10^7 gal/day
M, medium, 10^5-10^6 gal/day
S, small, < 10^5 gal/day
(effluents from typical plants)

(2) Soluble salts, > 1000 mg/l.

(3) Toxic heavy metals, about 1 mg/l.

(4) Carcinogenic, toxic, colored, etc.,

(5) COD about 1000 mg/l and COD/BOD > 2-4

(6) Phosphorus and nitrogen, 1-20 mg/l.

(7) Suspended matter, oil and grease, 1-20 mg/l.

(8) Probably; information lacking.

(9) For this industry the procedures are for reaching BAT, which is EOD.

Source: Water Purification Associates and Process Research, Inc. Water Pollution Abatement Technology: Capabilities and Costs, Innovative Technologies, 1976.

b. Costs*

The annualized costs of the innovative technologies to achieve EOD for the various industries will generally range from $1 to $7 per 1,000 gallons treated, excluding residuals disposal. An evaluation of residuals disposal costs is included below in Section 2.d. Chemical oxidation is a technology which will approach EOD for the organic chemicals and petroleum refining industries, and the costs may be greater than $7 per 1,000 gallons. In those cases where land treatment alone is recommended to approach EOD for industrial wastewaters, the cost will generally be well below $1 per 1,000 gallons. The total cost for land treatment, however, will depend greatly upon conveyance distance and the cost of the land, including taxes. A more comprehensive discussion of land treatment is included below in Section 3, covering discharges from publicly owned treatment works.

Combinations of technologies will be necessary to achieve EOD for virtually all industrial waste flows. Although evaporation alone could achieve EOD for some, the energy demands would render it impractical and unrealistic. A concentration process would be used first to minimize the volume to be evaporated.

The costs noted above to achieve EOD are in addition to those required for BAT. For comparison, some examples of BAT costs are shown in Table II-51. These BAT costs range from a low of $0.35 per 1,000 gallons to a high of $65 per 1,000 gallons, and clearly illustrate the caution that must be used when discussing and comparing costs. Although it has been stated that EOD costs will generally range from $1 to $7 per 1,000 gallons, specific examples well outside this range can be found in any industry. For example, a plant operating eight hours per day will have unit abatement costs that are substantially higher than an identical plant operating 24 hours per day. This is because the capital costs for abatement systems will be essentially the same even though the facility operating eight hours per day will treat only one-third the volume of wastewater annually. Economy of scale is also important. All else being equal, small treatment facilities will almost always have a higher unit cost than large facilities.

When two or more innovative technologies are required to treat the same wastewater stream, the cost range for the system will increase accordingly. For example, if ultrafiltration and reverse osmosis are used in sequence, the incremental cost for EOD (over BAT) will generally be in the range of $2-$14 per 1,000 gallons.

*Costs are in 1975 dollars and include operating and maintenance costs plus annualized cost of 15 percent of capital.

TABLE II-51: Typical BAT (1983) Costs
for Selected Industry Subcategories

Industry/Subcategory	Cost--$/1,000 Gallons[1]
Pulp & Paper/Large Bleached Kraft Mill	$ 0.45
Pulp & Paper/Small Dissolving Sulfite Mill	0.50
Petroleum Refining/Small Topping Plant	13.00
Petroleum Refining/Large Integrated Plant	1.80
Iron & Steel/Large Integrated Mill	0.35
Iron & Steel/Large Scrap Mill with Hot Finishing	0.40
Metal Finishing/Small Job Shop	60.00[2]
Metal Finishing/Large Captive Shop	7.00[2]
Organic Chemicals	2.00 to 65.00[3]

(1) 1975 dollars. Sludge disposal not included. Actual costs for any specific facility can vary widely depending upon size, age and location of plant, the treatment option selected, and hours of operation per day.

(2) These costs are for EOD, the EPA requirement for BAT.

(3) Range of costs for 29 generalized plant configurations that represent most of the real plants in the industry.

Source: National Commission on Water Quality, compiled from technology contractor reports to the Commission. February, 1976.

c. Energy

Table II-49 shows that energy requirements for the recommended innovative technologies will generally be somewhat less than 10 KWH per 1,000 gallons. There are two exceptions -- one much higher (evaporation) and one usually lower (land treatment). For evaporation, energy demands are from 5 to 20 times greater (50 to 200 KWH per 1,000 gallons), depending upon the type of thermal separation system employed. A less energy intensive concentration step will almost always be required to reduce the waste volume fed to a thermal separation process. This will be the case even though, from a strictly technological point of view, many wastes could be treated by "brute force" evaporation, one of the few commercially available and relatively well-understood innovative technologies.

At the other end of the energy scale is land treatment, where spray irrigation generally consumes about 1 KWH per 1,000 gallons. Other land

treatment techniques, such as overland flow and infiltration/percolation, consume even less energy. However, total energy demands for land treatment are highly dependent upon conveyance distance and related pumping requirements. The significance of conveyance distance is discussed below in Section 3, covering discharges from publicly owned treatment works.

The energy demands to achieve EOD are in addition to those required for BAT. As was the case with costs, wide variations in unit energy requirements would exist within any industry, and caution must be used in making comparisons. For example, within the iron and steel industry, unit energy requirements over base level for BAT technology range from 0.4 to over 2,200 KWH per 1,000 gallons. In metal finishing, where EOD is the BAT requirement and for which evaporation is a key to achievement, energy demands range from 20 to 100 KWH per 1,000 gallons. On an overall basis, innovative technologies are generally more energy intensive than BAT technologies per unit of flow treated; the major exception is land treatment when conveyance distance is short.

d. Residuals and Their Disposal

Regardless of the degree of removal of pollutants, there is one inescapable fact -- everything has to go some place. Pollutants removed from the wastewater become sludges or concentrated brines which require careful handling and disposal elsewhere. If reuse, dispersion or ultimate disposal of these sludges and brines is slighted or ignored, they will, in turn, pollute the environment and the effort and expense of removing them from wastewater discharges will be nullified.

Several innovative technologies for treatment and ultimate disposal of residuals were studied. An effort was made to determine the increase in residuals volume from industrial wastewater treatment in going from the 1983 requirements to EOD; however, realistic data could not be derived because of the complexity of evaluating various combinations of innovative technologies applied to such a wide variety of separate wastewater streams. Adding to the complexity is the difficulty of determining which residuals, and what amounts, might be recovered and recycled for beneficial use. Nevertheless, the Commission contractor believes the added dry weight of residuals generated in achieving EOD by industry would not constitute a significant increase over BAT. However, the character of these added residuals would, in many cases, be radically different. Rather than the typical insoluble sludge, the residuals generated in going from BAT to EOD will include substantial volumes of concentrated brines. Disposing of these in an environmentally acceptable manner would be extremely difficult, particularly if they contain toxic or otherwise hazardous substances.

Since some of the traditional so-called "ultimate" disposal means, such as landfill, ocean dumping, deep well injection and incineration, are no longer acceptable for many hazardous wastes, the Commission contractor evaluated an innovative approach for handling at least some of this material. This approach is called "Storage for Reuse" (SFR), and involves carefully segregated storage of concentrated industrial waste residuals at strategically located nationwide storage sites. Eventually, some of the material would be recovered if and when markets for their use develop and technologies for their recovery are perfected. The belief is that the continued costs for storage will eventually create an economic incentive for recovery and reuse of these residuals. The SFR concept requires further development and is presented only as a possibility for further examination and evaluation.

Although unable to develop the added residuals generated by industry in achieving EOD, the contractor did determine total residuals generated by the nine major industries when BAT is achieved. This data is shown in Table II-52 and provides some perspective of the residuals disposal problem. (See Table IV-9 for a listing of residuals developed by an environmental studies contractor.) The BAT residuals total is 21.5 million tons (dry weight) per year based on 1973 production levels. An estimated 3.1 million tons (or about 14 percent of the total) is considered to contain materials that could be classified as hazardous. A hazardous waste is defined by EPA as "any waste or combination of wastes which pose a substantial present or potential hazard to human health or living organisms because such wastes are lethal, nondegradable, or persistent in nature; may be biologically magnified; or may otherwise cause or tend to cause detrimental cumulative effects(28)."

To visualize the potential impact, if the 21.5 million tons of waste residuals from these nine industries were disposed to the land at a concentration of 25 percent solids (75 percent water), an area of 100 square miles, one foot deep, would be required every year. Although land disposal will undoubtedly not be used for all these residuals, land requirements will nevertheless be significant, and efforts to minimize waste residuals must be aggressively sought. Brines generated in going from BAT to EOD will add to this land requirement where land disposal is used.

Although costs for sludge disposal were not included in the cost figures presented in Section 2(b) above, they certainly cannot be overlooked. An order of magnitude estimate can be developed using a range of $27 to $100 per ton (dry wt.) reported by EPA(29). This translates to a total cost ranging from $580 million per year to $2,150 million per year, for the 21.5 million tons projected for BAT abatement from the nine industries in Table II-52. Since brine volumes generated in going from BAT to EOD could not be determined, it is not possible to estimate added costs for their disposal.

TABLE II-52: Projected Industrial Waste Residuals Generated from Application of Best Available Technology*

Industry	Total Waste Residuals (Sludges & Concentrated Brines) (in million tons/yr. dry wt.)	Hazardous Portion (in million tons/ yr. dry wt.)
Iron & Steel	6.0	0.7
Textiles	0.4	0
Canned & Preserved Fruits & Vegetables	0.5	0
Inorganic Chemicals	7.2	0.6
Organic Chemicals	0.2	0.04
Pulp & Paper	4.6	0
Plastics & Synthetics	0.5	0.5
Petroleum Refining	1.0	0.2
Metal Finishing	1.1	1.1
TOTAL	21.5	3.1

* By applying 1983 BAT requirements to 1973 production levels.

Source: Water Purification Associates and Process Research, Inc., Water Pollution Abatement Technology: Capabilities and Costs, Innovative Technologies, 1976.

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3. Discharges from Publicly Owned Treatment Works

a. Scope

The evaluation of innovative technologies to achieve EOD for discharges from publicly owned treatment works applies to both dry weather flows and overflows from combined sewer systems. All combined sewer overflows are assumed to be stored for ultimate treatment with the dry weather flow at a common facility.

As with the industrial wastewater streams, the greatest challenge in achieving EOD for municipal wastewaters will be the removal of soluble salts, a particularly difficult problem with municipal effluents because of the volumes involved and their tendency to form slimes.

Land treatment is considered by many to be a viable and obvious means to achieve EOD for municipal effluents. However, in the context of the Commission definition of EOD (no net addition of polluting constituents to the water), land treatment only approaches EOD; it does not achieve it. Additional technologies (both conventional and innovative) would be required to fully control dissolved salts and nutrients, pathogenic organisms, viruses and heavy metals.

Land treatment has advantages and benefits, the primary being: 1) purification of wastewater along with its reuse as a valuable resource; 2) return or recycling of nutrients to terrestrial ecosystems with the generation of valuable agricultural, silvicultural or animal products; and 3) substantial reduction of surface water pollution by limiting the direct discharge of wastewaters.

The main disadvantages of land treatment are: 1) the significant land requirement; 2) the possible encroachment on the water rights of a downstream user by reducing the flow in the watercourse (a potential problem primarily in arid regions); 3) the effect on air quality and climate in the immediate area due to potential periodic odors and humidity; and 4) the potential for adverse public health effects relating to groundwater quality, insects and rodents, runoff, aerosols, and contamination of crops.

The physical, chemical and biological processes by which wastewaters are renovated within the soil matrix are shown in Table II-53. The primary factors limiting renovation efficiency are the characteristics of the applied wastewater, the hydraulic loading, the nature of the soil and the method of application.

The three major land treatment methods are: irrigation, overland flow, and infiltration/percolation. Figure II-7 illustrates each of these methods and the typical removal efficiencies anticipated from well-managed systems. Only irrigation approaches complete removal of nitrogen and phosphorus, and large land areas (150-500 acres per MGD) are required for high levels of removal. The land requirement is primarily related to the nature of the soil and the nitrogen uptake rate which, in turn, is dependent upon the nature of the crop (both its nitrogen requirement and its growing season.)

All three methods are generally operated on an intermittent basis and rely on the soil to retain a significant portion of the phosphorus load. Over an extended period of time (generally well over 10 years), the soil matrix will become saturated with phosphorus and lose its efficiency for removing this nutrient. When this happens, a new land treatment site will probably be required.

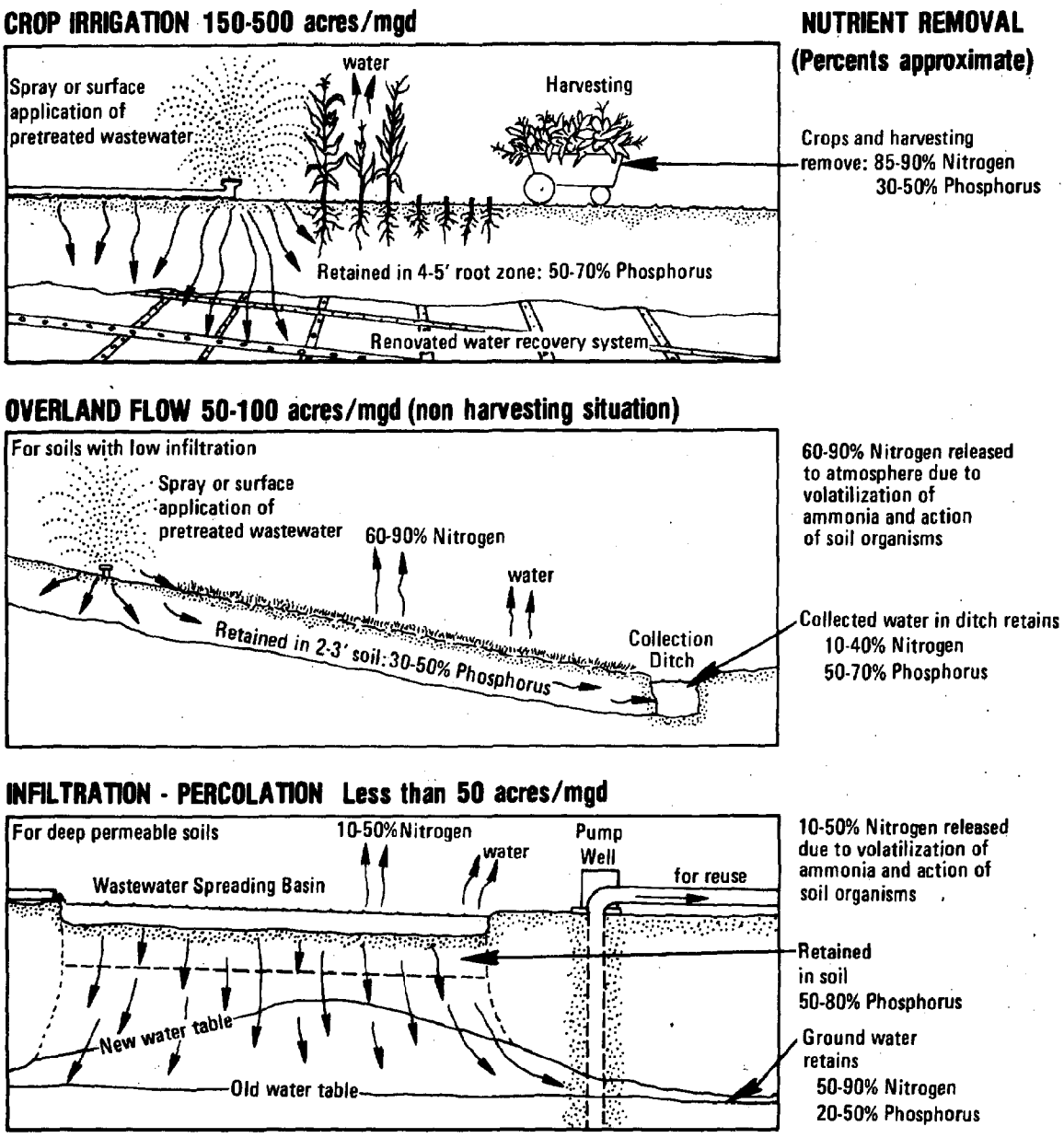
TABLE II-53:
Renovation Mechanisms of Land Treatment Systems

Constituents	Renovation Mechanisms
Suspended Solids	Filtration
Organic Matter	
Suspended Organics	Filtration
Particulate Organics	Bacterial Oxidation
Dissolved Organics	Adsorption, Oxidation
Nitrogen	
Organic Nitrogen	Filtration, Mineralization
Ammonium Nitrogen	Oxidation, Adsorption (clay soils), Plant Uptake
Nitrate Nitrogen	Plant Uptake, Denitrification
Phosphorus	Adsorption, Plant Uptake
Heavy Metals	Adsorption, Ion Exchange, Precipitation
Boron	Adsorption, Plant Uptake
Dissolved Solids (Potassium, Calcium, Magnesium, Sodium, Manganese and Chlorides)	Plant Uptake, Ion Exchange, Adsorption
Bacteria and Viruses	Die-off, Sedimentation, Entrapment, Adsorption, Predation (insects and worms)

Source: Water Purification Associates and Process Research, Inc., Water Pollution Abatement Technology: Capabilities and Costs, Innovative Technologies, 1976.

Figure II.7

COMPARISON OF LAND TREATMENT METHODS TO RENOVATE PRETREATED WASTEWATER



Source: Natl. Commission on Water Quality. Redrawn from Water Purification Associates, "Water Pollution Abatement Technology: Capabilities and Costs, Innovative Technologies", 1976.

February 1976

With a better understanding of hydraulic, heavy metals and nutrient loading limitations, particularly over long periods of time, land treatment can be expected to be an efficient and effective means of wastewater renovation. Added research is needed to understand better the relationships among threshold nutrient level for crop uptake, hydraulic load, ion exchange capacity, soil textural class and crop selection; and to quantify denitrification in storage lagoons, soils, flooded fields and various treatment processes.

Technologies required in conjunction with land treatment to achieve EOD for municipal wastewaters are disinfection, plus one or more of the following: reverse osmosis; ion exchange; and electrodialysis. In fact, these technologies, in conjunction with carbon adsorption and multi-media filtration applied to a secondary effluent, could achieve EOD without land treatment. Disinfection should be performed in a manner that does not add residuals to the wastewater. Two such approaches are ozonation and high energy electron irradiation. The value of chlorine is limited because it adds salts to the wastewater and may not be fully effective in destroying viruses.

b. Costs

The total cost for land treatment of discharges from publicly owned treatment works depends greatly upon conveyance distance, the cost of the land, and the loss of taxes due to removal of the land from the tax rolls. In the case of irrigation, the value of the crop also enters into the determination of true cost. Ignoring the cost of land, the loss of taxes or the value of crops, the cost for land treatment can be expected to range from $0.07 to $1.50 per 1,000 gallons, exclusive of conveyance system and related pumping costs. The low cost figure applies to large (50-100 MGD) infiltration/percolation systems. The high cost figure applies to small (0.1 MGD) irrigation land treatment systems.

Table II-54 provides comparative cost information for four irrigation land treatment systems ranging from 0.1 MGD to 100 MGD. The significance of conveyance distance (five miles for this comparison) to land site is apparent, particularly for smaller flow rates. This is more clearly illustrated by the following tabulation:

Flow Rate -- MGD	Conveyance Cost -- $/1,000 gal.	Percent of Total Cost
0.1	$1.65	53
1.0	0.28	31
10	0.09	17
100	0.04	10

TABLE II-54 : COMPARISON OF IRRIGATION LAND TREATMENT SYSTEM COSTS

COMPONENT	AVE. FLOW RATE	COSTS[1] - DOLLARS PER THOUSAND GALLONS			
		0.1 MGD	1.0 MGD	10 MGD	100 MGD
CAPITAL[2]					
Conveyance System (5 miles)[3]		$1.64	$0.27	$0.08	$0.03
Storage (50 day), Distribution System, Recovery System, Land Preparation, Administrative, Monitoring & Laboratory Facilities		1.02	0.43	0.33	0.30
O&M					
Labor		0.31	0.10	0.05	0.03
Material, Outside Services and Supplies		0.13	0.06	0.04	0.03
Energy[4]	(KWH/1000 gal)				
- Conveyance	0.5	0.01	0.01	0.01	0.01
- Other	1.0	0.02	0.02	0.02	0.02
TOTAL COST		$3.13	$0.89	$0.53	$0.42

(1) 1975 dollars. Land cost, tax loss and credit for sale of crop not included. Cost based on applying a pretreated wastewater (secondary quality) at a rate of 1.5 inches per week.
(2) Annualized using a capital recovery factor of 0.10.
(3) Costs based on force main and 150 ft. total pumping head.
(4) This is almost entirely pumping energy and is calculated at 2¢/KWH.

Source: National Commission on Water Quality, February 1976.
Compiled from information in EPA Technical Report, Costs of Wastewater Treatment by Land Application, June 1975.

Irrigation and overland flow land treatment systems generally require a wastewater pretreated to near secondary quality before land application (see Tables II-2 and V-25). To avoid soil clogging and resultant loss of flow capacity, infiltration/percolation systems generally require the quality of the applied wastewater to be superior to that from a secondary treatment plant. Tertiary treatment with multimedia filters will satisfy this requirement, as will the water recovered from an irrigation land treatment system. The costs given above and in Table II-54 for land treatment systems do not include preapplication treatment.

Supplemental technologies required in conjunction with land treatment for removal of salts can be expected to add from about $0.50 per 1,000 gallons to $2.25 per 1,000 gallons, depending upon plant size. The low cost figure applies to very large systems (50-100 MGD) and the high figure to systems near 0.1 MGD. These figures include operating and maintenance costs and annualized amortization costs using a capital recovery factor of 0.10. Costs for brine concentration and ultimate disposal, although significant, are not included since they would be very site specific and highly variable.

Table II-55 permits a comparison of representative costs for three systems to achieve EOD from publicly owned treatment works. Two irrigation land treatment approaches are shown, one following conventional secondary treatment, and the other following treatment in an aerated lagoon at the land site. A conveyance distance of five miles to the land site is assumed for this comparison. As previously noted, total costs for land treatment systems are significantly impacted by conveyance distance, particularly for small flow rates. The third approach shown in Table II-55 is an advanced wastewater treatment system consisting of physical/chemical processes (including nutrient removal) following conventional secondary treatment. Under the conditions chosen for analysis, all three approaches to EOD result in comparable costs.

c. Energy

The discussion of energy requirements in Section 2 above, covering discharges from industry, applies here as well. Note that land treatment generally consumes about 1 KWH per 1,000 gallons, exclusive of conveyance pumping, and that the other innovative technologies recommended to achieve EOD for municipal wastewaters consume somewhat less than 10 KWH per 1,000 gallons. Energy requirements for land treatment are highly influenced by conveyance distance and elevation differential between the wastewater source and the land site. Secondary activated sludge systems generally consume about 5 KWH per 1,000 gallons.

TABLE II-55 REPRESENTATIVE COSTS TO ACHIEVE ELIMINATION OF THE DISCHARGE OF POLLUTANTS FROM PUBLICLY OWNED TREATMENT WORKS

TREATMENT SYSTEMS		COSTS(1) - $/1,000 GALLONS			
A. Aerated Lagoon/Land Treatment/Salt Removal	Flow rate	0.1 MGD	1.0 MGD	10 MGD	100 MGD
1. Aerated lagoon system(2)		$0.52	$0.12	$0.05	$0.04
2. Land treatment system(3)		3.13	0.89	0.53	0.42
3. Salt removal system		2.25	1.10	0.65	0.50
TOTAL COST		$5.90	$2.11	$1.23	$0.96
B. Conventional Activated sludge/Land Treatment/Salt Removal					
1. Conventional activated sludge secondary treatment		$2.35	$0.70	$0.39	$0.23
2. Land treatment system(3)		3.13	0.89	0.53	0.42
3. Salt removal system		2.25	1.10	0.65	0.50
TOTAL COST		$7.73	$2.69	$1.57	$1.15
C. Advanced Waste Treatment/Salt Removal					
1. Conventional activated sludge secondary treatment		$2.35	$0.70	$0.39	$0.23
2. Advanced treatment including chemical treatment, multimedia filters and carbon adsorption		1.95	0.60	0.29	0.20
3. Salt removal system		2.25	1.10	0.65	0.50
TOTAL COST		$6.55	$2.40	$1.33	$0.93

(1) Annualized capital costs plus O&M costs. 1975 dollars. Brine disposal not included.

(2) Based on 7 day detention. Includes grit removal and chlorination. Assumes the lagoon is at the land disposal site and the storage basin is used for effluent clarification.

(3) Based on irrigation land treatment systems as outlined in Table II-54. Land cost, tax loss and credit for sale of crop not included.

Source: National Commission on Water Quality, February 1976. Compiled from technology contractor reports to the Commission and from EPA Technical Report, Costs of Wastewater Treatment by Land Application, June 1975.

d. Residuals and Their Disposal

In 1983, when municipal systems are required to achieve BPWTT, residuals (sludges) are estimated to be generated at a rate of 9.2 million tons per year (dry weight). Although this sludge amounts to less than one-half of the residuals projected from the nine industrial sources and is generally more amenable to beneficial use, it is still significant and must be handled very carefully.

In going from the 1983 BPWTT requirement for publicly owned treatment works to EOD -- as with industrial residuals -- substantial concentrated brine volumes will result. Except for treatment systems serving highly industrialized areas, these brines will contain relatively little toxic or hazardous materials since industrial dischargers to the municipal plant will have substantially eliminated them. Toxic and hazardous materials cannot be entirely overlooked, however, since recent evidence has shown significant metals contribution from non-industrial dischargers (see Appendix C of the metal finishing study(9)). These brines will have little or no potential value and must be disposed of in an environmentally acceptable manner. The "Storage for Reuse" concept would not apply.

An estimate of the magnitude of the brine load generated in going from BPWTT to EOD can be made by assuming that an average of 400 mg/l of dissolved solids (salts) will be removed from a projected 35 billion gallons per day of municipal effluent from separate and combined sewerage systems. This results in a residuals generation of 21.3 million tons per year (dry weight). At 2 percent brine concentration, typical for reverse osmosis systems, this residuals volume would amount to about 0.7 billion gallons per day (2.0 percent of the total volume of municipal effluent). Costs to dispose of these brines cannot be estimated easily. Ocean discharge would be the obvious and logical solution for communities adjacent to the coast. Solar evaporation could be utilized in the arid southwest, but inland communities in wetter climates would be faced with a difficult and expensive disposal problem.

The commonly accepted ultimate disposal options for municipal sludges include landfill, land spreading, subsurface disposal, ocean disposal, incineration and, for chemical sludges, recycling. The selection of a disposal option, or combination of options, will depend upon the nature of the residuals and the alternatives available. To economically and otherwise effectively handle these residuals requires certain concentration and disinfection processes. Several innovative sludge treatment technologies show potential, such as high energy electron irradiation for disinfection; solvent extraction and ultrasonic techniques for sludge dewatering; and a recirculating jet mill sludge drying/sterilizing system, but little meaningful cost information is available for any of these technologies.

Land spreading, incineration and recycling are the most effective and generally applicable sludge disposal options. Land spreading of sludges from publicly owned treatment works provides two beneficial soil effects: enhanced soil fertility; and reclamation or improvement of the soil structure (soil conditioning). Costs vary, depending upon a number of factors, primarily size of treatment plant (sludge production rate) and proximity to agricultural land. The Metropolitan Sanitary District of Greater Chicago estimates that disposal costs for its Fulton County land reclamation project range from $150 to $200 per dry ton(30). Costs for barging the digested sludge 200 miles and then piping it another 11 miles to the disposal site are included in these figures.

A study of various combinations of sludge transportation methods, hauling distances and application systems for a hypothetical large city shows an expected range for land spreading of $40 to $60 per dry ton(31). Transportation distances from 20 to 100 miles were considered. Credit for fertilizer and crop values were not deducted because of lack of data. Although sludge has historically generated costs rather than revenue, it does have a value. Based on the nitrogen-phosphorus-potassium content and the current value of fertilizers, Blue Plains, Washington, D.C., sludge should have a wholesale price of about $15 per ton (dry weight)(32). More experience and data are needed to provide a net cost for land spreading.

Land spreading of sludges from publicly owned treatment works causes concern because of potential problems from three constituents: nitrogen, micro-organisms and heavy metals. Nitrogen can adversely effect both ground and surface water but is controllable by intelligent sludge application and crop selection. Nevertheless, better understanding of biological denitrification processes in soils under a variety of situations is necessary.

Although not fully perfected, known technology probably can adequately control pathogenic organisms and viruses.

The area of most concern is heavy metals, which can accumulate through the food chain in concentrations toxic to humans and other animals. While the soil matrix has a certain ion exchange capacity, the important factor is the time frame within which the soil will remove and hold the heavy metals. Further understanding is needed in this area.

Thermal destruction or reduction by means of incineration or pyrolysis is another viable alternative for municipal sludge disposal. The most effective approach would be energy recovery systems involving incineration or pyrolysis of municipal sludges along with municipal solid refuse. Estimated net disposal costs per ton of sludge/refuse range from $5 to $20(27).

Recycling as a means of handling municipal residuals is limited to those materials which can be adequately separated and recovered for reuse. Presently, alum and lime are the only materials considered to be economically recoverable from wastewater sludges produced as a result of the addition of these chemicals in physical-chemical treatment processes.

4. Recommendations for Research, Development and Engineering

Research and development efforts over the next decade should be directed to membrane separation, adsorption and land treatment technologies, as stated by the Commission contractor:

> "Emerging from the analysis of these groupings are two technologies that appear to have implicit in them the possibility to treat any and all kinds of wastewater, cheaply, reliably and simply. These two groups are membrane/adsorption technologies and land treatment technologies. Of significance is that these technologies operate on the natural mechanisms by which water is purified for human and animal consumption on the one hand, and plant needs on the other"(33).

With respect to membrane separation technology, the contractor states:

> "Membrane technologies today appear to offer the possibility of becoming almost the 'universal' means of meeting EOD requirements cheaply, reliably, simply and at low energy. Moreover, membrane processes have a high degree of flexibility and when operated in conjunction with innovative evaporation technologies can produce a highly concentrated residual. Of the ten major sources of wastewater (nine industrial plus municipal), membrane technologies are basic to achieving EOD standards in six of the ten categories and are basic to approaching EOD standards in two of the remaining four categories.
>
> "The major obstacles limiting membrane technologies today are membrane fouling and low fluxes. Membrane fouling leads, on the one hand, to higher operating costs due to frequent replacement, maintenance and required pretreatment. On the other hand, it also leads to higher capital requirements because of the need to incorporate larger membrane areas to compensate for the reduced rejections and fluxes caused by fouling. Low fluxes also lead to increased operating costs associated with higher driving forces to push the water through at the highest possible rate.
>
> "It is recommended that research on the chemistry and physics of membranes should be accelerated to develop membranes which are:

"a. Anti-fouling,
"b. Higher flux,
"c. Longer lasting,
"d. Cheaper to construct"(27).

Simultaneous with membrane development, process engineering development for systems design is necessary to utilize membrane surface more efficiently, and reduce the effects of polarization.

In the area of adsorption, the contractor states:

"Among the major impediments to the more widespread use of adsorption technologies in general and ion exchange in particular, is the expense and energy intensiveness of the regeneration process coupled with the allied problem of the disposal of the regenerated wastes. Another problem of many ion exchangers and adsorbents is that they are non-specific, so that they will remove (at a cost) materials which it is not necessary to remove or should not be removed.

"It is therefore recommended that chemical and physical-chemical research be concentrated on the following:

"a. The development of inexpensive regenerants for ion exchange and adsorption.

"b. The elimination or minimization of chemical regeneration in ion exchange.

"c. The development of specific ion exchangers and adsorbents"(27).

The contractor further recommends that process engineering development be conducted to maximize process efficiency for a fixed quantity of adsorbent, and to minimize the quantity of adsorbent, resin or complexing agent required.

For land treatment by spray irrigation, the Commission contractor recommends that further studies of potential pathogen survival and proliferation in soils, and of heavy metal accumulation and contamination of crops, should be conducted in full-scale operating facilities rather than in laboratory or pilot programs.

Specific aspects of land treatment which would benefit from further research and development are: 1) quantification of denitrification rates in storage lagoons and soils; 2) optimization of nutrient uptake by specific crops, considering hydraulic loading rates and soil texture; and 3) development of automated monitoring units.

For overland flow, further pilot scale facilities are needed to develop the potential of this land treatment alternative.

Finally, in the area of ultimate disposal for toxic and hazardous industrial residuals, substantial R&D effort is recommended on the concept of "Storage for Reuse" (SFR). Areas requiring extensive examination are: economic projection of future material value; determination of government and private sector roles in the management and operation of SFR systems; classification of industrial residuals into recovery and storage categories; location of regional SFR sites; development of safe transportation methods for industrial residuals; development of storage strategies which allow easy retrieval of materials; development of inert or secure containment materials; and development of specific recovery technologies.

If the development of innovative technologies is fostered, not only would EOD become more readily achievable, but BAT effluent limitations could be reached more cheaply and effectively in many cases.

With proper support through applied research and demonstration projects, several of the innovative technologies could become available as viable full-scale treatment systems within about five years.

E. AGRICULTURE

1. Introduction

The Commission employed three contractors to assess the capabilities and costs of technologies available for reducing or eliminating discharge from three potential sources of agricultural pollution; 1) feedlots, 2) irrigation return flows, and 3) runoff from non-irrigated cropland. Results reported in this section were abstracted from these contractors' reports(34,35,36).

2. Feedlots

Beef cattle, hog, turkey, and sheep feedlots normally discharge liquid effluents only in the form of runoff from precipitation. Dairy feedlots discharge runoff as well as water used for washing cows and equipment. Feedlot runoff is not a problem for totally covered production units, but appropriate measures must be taken for collection, storage, and possible pretreatment of wastes derived from such operations prior to land application.

a. Numbers and Types of Feedlots

The one million feedlots of major concern in this report are distributed by animal type as shown in Table II-56. As indicated, meat production increased by almost one-fourth, while the number of feedlots declined by over one-half in the decade ending in 1973. These trends are projected to continue through 1983. Historical data are not available for sheep because of their relative unimportance to the national economy.

Layers, broilers, and horses were not studied in depth because they are predominantly completely housed operations without liquid discharges. Catfish and ducks were examined in a cursory manner, but the results are not reported here because of their highly localized economic importance.

TABLE II-56: Number of Feedlots and Marketings 1964 and 1973

Types of Feedlots	Number of Lots		Thousands of Head Marketed	
	1964	1973	1964	1973
Hogs	802,000	425,000	86,086	82,217
Beef Cattle	401,000	185,000	22,202	31,600
Turkeys	42,000	4,000	101,000	132,200
Dairies	1,134,000	338,000	126,967*	115,620*

* Million pounds of milk

Source: Development Planning and Research Associates, Technologies and Economic Impacts of Water Pollution Control Act of 1972, The Feedlot Industry, 1976.

b. Cost and Effectiveness of Pollution Control Measures

Effluent limitations promulgated by EPA emphasizing no discharge require that runoff and process water be retained in holding ponds, then spread on agricultural lands in keeping with sound agricultural practice. BPT and BAT limitations require, respectively, facilities to retain the runoff from 10 year-24 hour, and 25 year-24 hour rainfall events, plus any process-generated waste water. Unlimited overflow of the specified detention structures is allowed when precipitation in excess of the design storm occurs.

The original effluent limitations promulgated by EPA and published in the Federal Register, Vol. 39, No. 32, Part II, February 14, 1974, exempted feedlots smaller than the following sizes from requiring a permit: 1,000 slaughter steers and heifers, 700 mature dairy cattle, 2,500 swine weighing over 55 pounds, 10,000 sheep, and 55,000 turkeys. This exemption was successfully challenged in court, and proposed new effluent limitations were published in the Federal Register, Vol. 40, No. 225, Parts 124 and 125, November 20, 1975. The proposed limitations require feedlot owners and operators to apply for a permit if any one of the following conditions is met: 1) measurable quantities of wastes are discharged to a waterway through a man-made ditch, pipe, or flushing system; 2) wastes are discharged directly into a waterway on the feedlot property itself; or, 3) more than the following number of animals are involved: 1,000 slaughter or feeder cattle, 700 mature dairy cattle, 4,500 slaughter hogs, 35,000 feeder pigs, 12,000 sheep or lambs, 55,000 turkeys, 180,000 laying hens, or 290,000 broiler chickens.

The exact number of permits that will be required is unknown, but it is anticipated that the vast majority of small feedlot operators in the country will not be affected by the revised regulations.

The size of holding pond, pump, piping, etc., required to comply with any particular level of control, and the cost and effectiveness of the system are highly site-specific, as indicated by Table II-57.

As indicated, BPT or BAT sized control structures are about three times as large in high rainfall areas as in dry areas, but they are much less effective in preventing discharge. Differences in facilities sized* to eliminate the discharge of pollutants (EOD) are even more striking, with one in Birmingham, Alabama, requiring nine times the capacity required for a feedlot of the same size in Boise, Idaho.

*As defined in Table II-57.

TABLE II-57: Holding Pond Capacity Required and Percent of Runoff Not Captured Between 1941 and 1970 From Holding Pond Designed for Indicated Level of Control for 12 Acre Open Feedlot for Any Type Animal in Location Shown.

	LEVEL OF CONTROL					
	BPT		BAT		EOD*	
Location of Feedlot	Cap.** (Ac.Ft.)	Uncontrolled Runoff	Cap.** (Ac.Ft.)	Uncontrolled Runoff	Cap. (Ac.Ft.)	Uncontrolled Runoff
Birmingham, Ala.	5.5	51%	6.2	48%	33.5	0%
Sacramento, Calif.	3.0	39%	3.5	32%	12.0	0%
Dublin, Georgia	5.2	41%	6.1	33%	20.8	0%
Boise, Idaho	1.8	2%	2.0	0.5%	3.6	0%
Storm Lake, Iowa	4.0	26%	4.6	21%	16.0	0%
Garden City, Kan.	3.6	16%	4.2	10%	14.4	0%
Saginaw, Mich.	3.2	33%	3.4	31%	12.8	0%
Syracuse, N.Y.	3.4	48%	4.0	42%	20.4	0%
Ft. Stockton, Tx.	3.8	0.3%	4.4	0%	4.4	0%
Centralia, Wash.	4.0	53%	5.0	45%	24.0	0%

*An EOD-sized facility, as used here, is one of sufficient capacity to have prevented runoff from occurring at the site during the period in which complete weather records were available, 1941-1970.

**Figures shown under capacity in Ac.Ft. for BPT and BAT are also 90 percent of 24 hour-10 year and 24 hour-25 year precipitation events in inches respectively.

Source: Development Planning and Research Associates, Technologies and Economic Impacts of Water Pollution Control Act of 1972, The Feedlot Industry, 1976.

Many feedlots of all sizes are so located that runoff from them never reaches a watercourse. The number of feedlots that would be affected by "locational exemptions" based upon whether or not runoff reaches a watercourse was estimated, and the cost of providing controls for the remaining "potential problem lots" was determined. The costs associated with potential problem lots were used for the economic analysis and appear in Table II-30, page II-82 (except costs for sheep and catfish, which would increase costs by about 2 to 3 percent). If the EPA regulations of November 20, 1975 are followed, some portion of the costs for all lots larger than 1,000 animal units should also be added to the cost for potential problem lots. However, most of the feedlots over 1,000 animal units were included in the potential problem lots so the omission is minor. The costs of providing control systems for all feedlots larger than several specified sizes were also determined, with all such cost estimates shown in Table II-58.

TABLE II-58: TOTAL INVESTMENT COSTS AND ANNUALIZED COSTS FOR SIX LEVELS OF FEEDLOT POLLUTION CONTROL

Control Strategy	LEVEL OF CONTROL					
	BPT		BPT+BAT		EOD*	
	Investment Cost	Annualized Cost	Investment Cost**	Annualized Cost	Investment Cost**	Annualized Cost
	Millions of June 1975 Dollars					
All Lots	2205	391	2698	454	2519	428
All Potential Problem Lots	724	133	896	155	865	150
All Lots Larger than 1,000 Animal Units (1)	113	25	148	29	168	30
All Lots Larger than about 500 animal units(2)	260	60	334	69	371	72
All Lots Larger than about 100 Animal Units(3)	842	172	1286	237	1036	192
All Lots Larger than about 50 Animal Units(4)	1535	298	2083	368	1175	317

* As defined in Table II-57.

** BPT + BAT assumed two stage construction; EOD assumed one stage.

(1) 1,000 Animal Units = 1,000 beef cattle (61 percent), 2,500 hogs (10 percent), 700 dairy cattle (3 percent), 55,000 turkeys (29 percent), 10,000 sheep (50 percent).

(2) About 500 Animal Units = 500 beef cattle (77 percent), 1,000 hogs (22 percent), 200 dairy cattle (13 percent), 24,000 turkeys (81 percent), 5,000 sheep (64 percent).

(3) About 100 Animal Units = 100 beef cattle (92 percent), 200 hogs (82 percent), 100 dairy cattle (27 percent), 4,000 turkeys (98 percent), 1,000 sheep (74 percent).

(4) About 50 Animal Units = 50 beef cattle (97 percent), 100 hogs (94 percent), 30 dairy cattle (83 percent), 2,750 turkeys (99 percent), 500 sheep (82 percent).

Note: Numbers in parentheses are percentages of total production in facilities larger than indicated sizes.

Source: Development Planning and Research Associates, Technologies and Economic Impacts of Water Pollution Control Act of 1972, The Feedlot Industry, 1976.

Costs estimated for BPT plus BAT are greater than EOD* in several cases because it was assumed BPT would be built and later upgraded to BAT, while EOD* facilities were assumed to be built in one operation. Regardless, a significant saving is realized if "locational exemptions" are considered.

Pollution control costs for both manure management and runoff control fall most heavily on small feedlots in wetter and colder climatological regions. The ranges in investment costs required for pollution control facilities for beef, dairy, and hog feedlots as they are affected by feedlot size and climatic factors are shown in Figure II-8. The costs shown are for feedlots that provide no housing for the animals.

The upper curves in Figure II-8 are the costs of BPT plus BAT in wet regions. The cost of EOD sized facilities would not be substantially different from that for BPT plus BAT. These costs do not include expenditures required for totally housed facilities currently not in compliance with no discharge requirements because of the lack of available data on which to estimate such costs. Relatively small numbers of such operators will be impacted fairly severely, but the overall impact on the entire feeding industry will be slight.

c. Materials and Energy Requirements

As indicated by Table II-59, because of the large number of facilities involved, the requirements for materials, energy and manpower are large. Major investment elements are earthwork and piping associated with disposal. Under the assumption that all feedlots, regardless of size or location, must be equipped with controls, it is estimated that 3,000 engineering man years would be required to design all the facilities. (About 1,000 man years for potential problem lots.)

d. Residuals

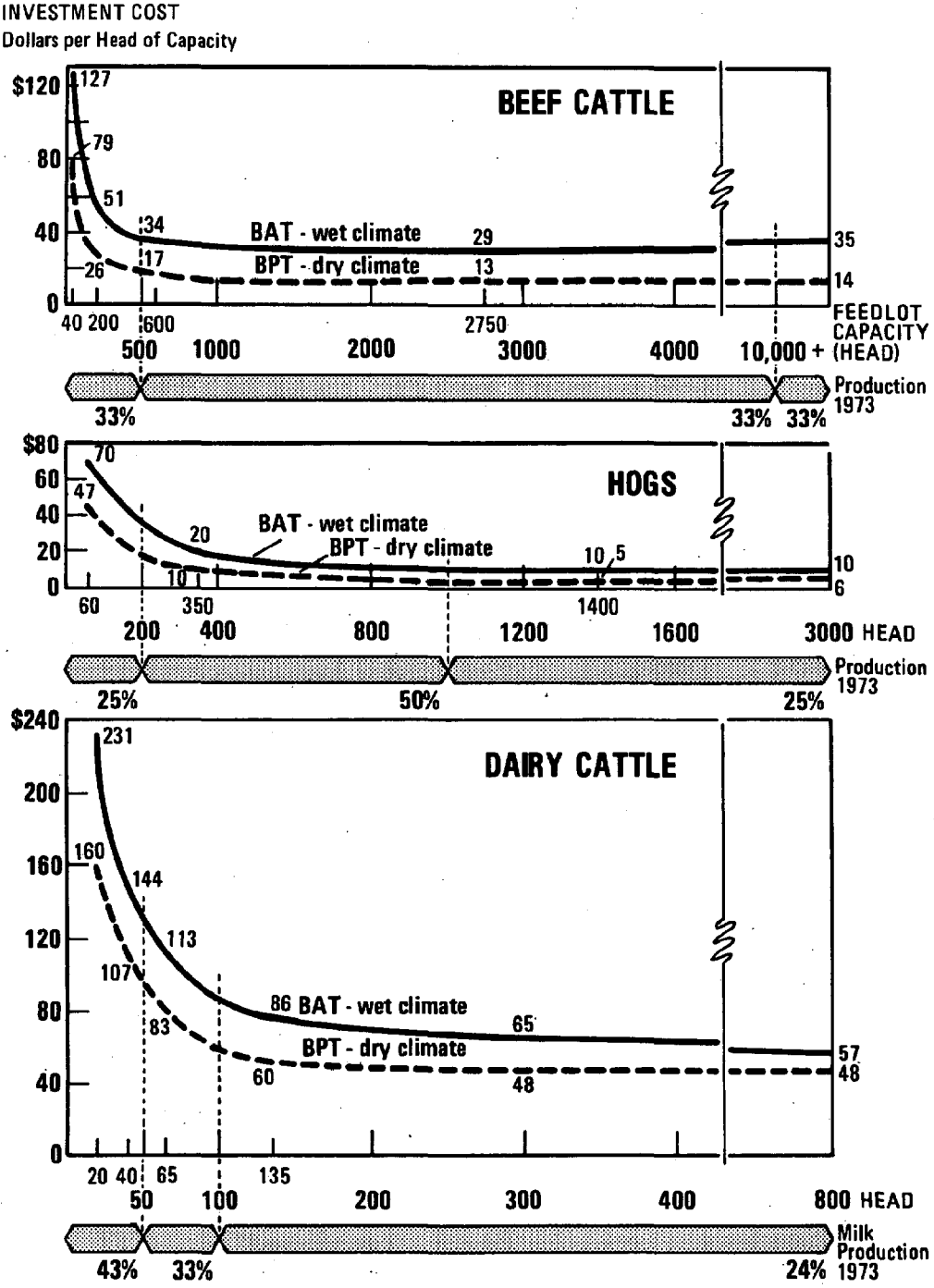
The total quantity of residuals in the form of sludges that would be generated by the construction of runoff control facilities was not estimated because in most cases, such sludge would constitute an insignificant addition to the manure that is already disposed of by land spreading, and it could generally be handled by the available manure handling equipment.

Residuals that would be discharged after construction of BPT and BPT+BAT sized facilities are shown in Table II-60. As indicated, little additional control is gained in upgrading from BPT to BAT.

*As defined in Table II-57.

Figure II.8

INVESTMENT COSTS FOR FEEDLOT POLLUTION CONTROL



Source: Natl. Commission on Water Quality, from Development Planning and Research Associates, " Technologies and Economic Impacts of Water Pollution Control Act of 1972, The Feedlot Industry", 1976.

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TABLE II-59 ESTIMATED MATERIALS AND ENERGY REQUIRED FOR EFFLUENT CONTROLS IN FEEDLOTS*

	BPT		BPT + BAT		EOD**	
	All Lots	Potential Problem Lots	All Lots	Potential Problem Lots	All Lots	Potential Problem Lots
INVESTMENT COSTS						
Land ($ Million)	237	81	239	82	280	100
Earthwork ($ Million)	629	212	781	267	857	316
Buildings and Structures ($ Million)	291	88	595	196	322	100
Mechanical Equipment ($ Million)	159	53	172	56	159	53
Piping ($ Million)	701	225	705	226	701	237
Electrical Service ($ Million)	75	22	75	22	75	22
Engineering (1000 hours)	5284	1760	6184	2005	5884	1943
OPERATING REQUIREMENTS (SELECTED)						
Labor ($ Million)	55	20	55	20	55	20
Labor (1000 hours)	16680	5855	16680	5855	16680	5855
Energy ($ Million)	9	4	9	4	9	4
Energy (MILLION KWH)	289	124	291	124	291	124

*Excludes duck and catfish categories.
**As defined previously

Source: Development Planning and Research Associates, Technologies and Economic Impacts of Water Pollution Control Act of 1972, The Feedlot Industry, 1976.

TABLE II-60: ESTIMATED ANNUAL UNCONTROLLED RUNOFF AND BOD_5 RESIDUAL FROM FEEDLOT INDUSTRY COMPLIANCE WITH SPECIFIED LEVELS OF CONTROL

Level of Compliance and Region	Beef		Hogs		Dairy		Turkey		All Species *	
	Runoff	BOD_5	Runoff	BOD_5	Runoff	BOD_5	Runoff	BOD_5	Runoff	BOD_5
	Ac.Ft.	Mill lb.	Ac.Ft.	Mill lb.	Ac.Ft.	Mill lb.	Ac.Ft.	Mill lb.	Ac.Ft.	Mill lb.
BPT										
Moisture Deficit [1]	2,617	7.5	567	0.4	217	0.6	567	6.9	3,967	15.4
Moisture Balance [2]	2,642	7.3	6,550	6.8	1,333	3.8	892	5.5	11,417	23.4
Moisture Excess [3]	2,825	8.1	4,550	3.6	1,675	4.8	6,975	40.6	16,025	57.1
Total	8,084	23.9	11,667	10.8	3,225	9.2	8,434	53.0	31,409	95.9
BAT										
Moisture Deficit [1]	2,092	6.0	458	0.4	133	0.4	433	5.4	3,117	12.2
Mositure Balance [2]	2,508	7.2	5,275	5.4	975	2.8	658	4.1	9,417	19.5
Moisture Excess [3]	1,708	4.9	3,491	2.4	1,067	3.0	6,383	36.9	12,650	47.2
Total	6,308	18.1	9,224	8.2	2,175	6.2	7,474	46.4	25,184	78.9

*Sheep feedlots not included, but not believed to be significant influence on totals

[1] The moisture deficit region is defined as that region where annual evaporation exceeds annual precipitation by 10 inches or more.

[2] The moisture balance region is defined as that region where annual precipitation and annual evaporation are within 10 inches of each other.

[3] The moisture excess region is defined as that region where annual precipitation exceeds annual evaporation by 10 inches or more.

Source: Development Planning and Research Associates, Technologies and Economic Impacts of Water Pollution Control Act of 1972, The Feedlot Industry, 1976.

3. Irrigation Return Flows

a. Introduction

About 25 percent of all farm sales in the United States are produced on the roughly 10 percent of cropland that is irrigated. Much of this land could not be farmed at all without irrigation. On the rest, irrigation is used to increase production, to produce different crops than could be grown without irrigation, or to assure the production of a crop each year.

Irrigated agriculture impacts water quality and quantity in at least six different ways: 1) it concentrates salts dissolved in water, primarily by the evapotranspiration of water; 2) it may weather naturally occurring minerals from irrigated soils; 3) it may add sediment to, or remove it from, receiving water; 4) it may add nitrogen and phosphorus to a receiving water; 5) it may add pesticides to a receiving water; and 6) it will alter the quantity and temporal distribution of downstream flows if it is derived from, or retruned to, surface waters.

The volume of irrigation return flow produced by a farm is the difference between the volume diverted from the water supply and the volume consumed by evapotranspiration. The proportion of the total water infiltrated into the soil that is in excess of the consumptive requrements of the crop (for both evaporation and transpiration) is called the "leaching fraction." The leaching fraction returns to surface or groundwaters as an irrigation return flow.

The leaching water percolates through the soil where a portion of it may be intercepted by artificial drains, collected and discharged to a receiving water as a point source. Percolating water not intercepted in drainage systems joins the local groundwater. It may return quickly to a surface stream, or it may remain in the ground for an extended period. Certain irrigation waters, once diverted, do not enter the soil but are returned directly to a receiving stream. Most operators of flood irrigation systems or ditch and furrow types do not completely control water application. Excess waters that are diverted and pass over the surface rather than through the soil are called "tailwater." They are also frequently discharged as point source irrigation return flows.

(1) Salinity

The concentrations of total dissolved solids in subsurface irrigation return flows are higher, typically, than those in the water delivered to the field. The applied water contains some concentration of salts. Growing plants consume pure water, leaving the salts behind in a smaller

remaining volume of water in the root zone. Leaching water serves to carry the salts away, maintaining the productivity of the soil. Increasing irrigation efficiency -- reducing the leaching fraction -- reduces the mass of salt diverted with the water. The volume of return flow in which the diverted salts are dissolved is reduced by a greater proportion, and the concentration of salts in the return flow is increased. The total mass of salt discharged is reduced, but the salts not diverted remain in the water supply.

In addition to the salts contained in the applied water, irrigation return flows may carry salts which are added to the leaching water as it passes through the subsoil. It may also leave some of the applied salts in the soil as precipitates, so that the relative concentrations of dissolved salts in applied water and return flows are different. The importance of this increment of salinity depends on the solubility and composition of the subsoil material, and on the size of the leaching fraction. In some regions it is of major importance, while elsewhere it is insignificant.

In most cases, regardless of the type of irrigation system used, and regardless of the efficiency of the irrigation system, most of the salt in irrigation return flow will be salt that was contained in the water applied to the land. Efficiency of irrigation has little effect on the quantity of water consumed by evapotranspiration. Any particular crop has a certain evapotranspiration requirement to produce a specified yield. Any water supplied in excess of this requirement will appear as return flow, and if a lesser quantity is applied, it will have an adverse effect on the yield and may cause a buildup of salts in the soil. Therefore, if the irrigation water is withdrawn from a stream, and the return flow is delivered back to the same stream, the efficiency of irrigation will not affect the total quantity of either water or salt transported by the stream in the long run, unless the soil being irrigated still contains native soluble salts.

(2) Suspended Sediment

Irrigation water which passes through the soil is essentially free of suspended sediment, but tailwater may contain sediments. Whether tailwater has a higher or lower concentration of suspended material than the initial supply depends upon local factors. The amount of sediment discharged with tailwater can be reduced by passing the return flow through a sedimentation basin or, under certain circumstances, the tailwater can be recovered and reapplied without any intervening discharge to a receiving water body.

In areas where the natural sediment burdens in streams are very large, the practice or irrigated agriculture can result in a net removal

of suspended material. Sediments originally carried by a stream may be deposited in diversion channels or on irrigated lands.

The concentration of suspended material in watercourses is determined by stream velocity. At points where the velocity is low, sediments will be deposited; where the velocity is high, erosion will occur. Excepting areas where a stream bed is incised in bedrock, the burden of suspended material carried by a stream cannot be controlled by changing the discharge of sediment to it.

(3) Fertilizer

Irrigation return flows may carry fertilizers with them depending on local conditions.

In general, because phosphorus is readily sorbed on soil particles, its concentration in drainage water can be expected to be very low. Some phosphorus will usually be associated with sediment contained in tailwater, but only small quantities are generally lost in this manner.

Nitrogen, particularly in the nitrate form, is a highly soluble and highly mobile ion. It can therefore be expected to be present in a highly unpredictable concentration in both tailwater and drainage water. Its concentration in tailwater is generally very low, and the concentration in drainage water is highly dependent on factors such as nitrate concentration in the soil, depth of drainage system, soil texture, concentration of organic matter in the soil, and depth to which the soil is aerobic.

(4) Pesticides

Pesticides may be added to receiving waters by irrigation return flows, but the quantity added is normally very low and is highly dependent on soil type, type of pesticide, time of application, method of application and other factors.

Most of the pesticides in current widespread use are only slightly soluble in water, and are strongly sorbed onto soil particles or onto particles or organic matter in the soil. Pesticides that exhibit this sorptive behavior will not usually be found in drainage water, but they may be present in very low concentrations in tailwater.

Pesticides that are degraded rapidly by either sunlight or soil microbes will seldom be found in either tailwater or drainage water. In most cases, recovery and reuse of tailwater or removal of sediments from tailwater will, for practical purposes, eliminate any threat of pesticide pollution of receiving water by irrigation return flow.

(5) Hydrology

Aside from increasing salinity by evapotranspiration of water, the greatest impact of irrigation on surface water is that it reduces total streamflow and alters its temporal distribution. Irrigation is the largest consumer of water, with forty to eighty percent of all water diverted for irrigation being consumed by evapotranspiration.

The dry weather flow of most uncontrolled streams is derived from groundwater, most commonly from groundwater recharged into alluvial deposits in the river basin during periods of high precipitation or high stream flow. The amount of water stored in this manner is largely dependent upon the magnitude and duration of flood flows. In regions characterized by extended dry seasons, streams may go completely dry toward the end of the dry season.

Diversion of water for irrigation can alleviate this problem by increasing the quantity of water stored in alluvial aquifers. The return flow from irrigation water applied to land at some distance -- a mile or more -- from the river may require many months to flow back to the river, and may increase the dry weather flow to the extent that a naturally ephemeral stream becomes perennial. Such an alteration in the natural regime of the stream may be highly beneficial not only to aquatic orgnisms but also to downstream municipal, industrial, agricultural users. If there is no upstream reservoir to control release during dry months, increasing upstream irrigation efficiency may be detrimental, rather than beneficial, to all downstream users.

Deeper aquifers that are recharged as a result of inefficient irrigation may also be utilized by municipalities, industries, and agriculture. In many such cases, increasing irrigation efficiency would result in impairment of the quality and decreasing the quantity of groundwater that is available for reuse.

In basins where supplemental water is imported for agricultural use, increased irrigation efficiency might have a detrimental impact on downstream users. If irrigators apply more water than is required to their fields, this water will be available later to downstream users. If more efficient water use were required, the upstream irrigators might well bring less water into the basin and deprive downstream users of a supply.

In summary, the use of water for irrigation may affect local and downstream hydrologic conditions in a variety of ways, some of which are beneficial and some of which are detrimental. Similarly, increasing irrigation efficiency may be either beneficial or detrimental to downstream users. It is therefore inappropriate to suggest that changes in irrigation practice should be made without thorough study of the specific location involved.

b. Location and Distribution of Point Source Irrigation Return Flows

About 39 million acres of farm land were irrigated in the United States in 1969. About 97 percent of this land is located in the 17 western states, Arkansas, Louisiana, and Florida. About 257,000 farms in the United States were reported to be irrigated in 1969, and about 223,000 of them were in these twenty states. These data are shown in Table II-61. About 57 percent of all irrigated land is in California, Texas, Nebraska, Colorado, and Idaho, and 36 percent is in California and Texas alone. No state other than these five has as much as five percent of the total irrigated acreage.

All irrigated farms are potential point source dischargers, at least of tailwater, but only those that are artificially drained are potential point source dischargers of drainage water. Artificial drainage systems have been installed on only about 4.6 million acres (12 percent) of irrigated land. Artificial drainage systems have also been installed on about 55 million acres of non-irrigated land, but the cost and effectiveness of controls for this land were not determined.

As indicated in Table II-62, about three-fourths of all irrigated land in the western states was in farms with more than 200 acres of irrigated land in 1969. About one-fourth was in the 2.5 percent of farms that irrigate more than 1,000 acres. It is likely that a greater percentage of the irrigated land is in the larger farms at this time.

About 41 percent of all irrigation water is self supplied from groundwater, 15 percent is supplied by direct diversion of surface water, and 44 percent is supplied by irrigation organizations, primarily (97 percent) from surface storage, including around 20 percent from Bureau of Reclamation projects.

TABLE II-61: LEADING STATES BY NUMBER OF IRRIGATED ACRES AND FARMS 1969

State or Region	Irrigated Acres	Percent of all Irrigated Acres	Number of all Irrigated Farms	Percent of all Irrigated Farms
United States	39,131,693	100.0	257,147	100.0
20 Leading States	37,957,018	97.0	233,396	90.8
California	7,240,131	18.5	51,050	19.9
Texas	6,888,075	17.6	28,552	11.9
Colorado	2,894,984	7.4	15,567	6.1
Nebraska	2,657,247	7.3	19,440	7.6
Idaho	2,760,852	7.1	17,840	6.9
Montana	1,841,421	4.7	9,197	3.6
Wyoming	1,523,422	3.9	5,034	2.0
Kansas	1,522,317	3.9	6,271	2.4
Oregon	1,519,421	3.9	12,014	4.7
Florida	1,365,206	3.5	7,373	2.9
Washington	1,224,238	3.1	14,074	5.5
Arizona	1,177,618	3.0	3,709	1.4
Utah	1,025,014	2.6	10,282	4.0
Arkansas	1,010,200	2.6	5,728	2.2
New Mexico	822,637	2.1	5,698	2.2
Nevada	752,696	1.9	NA	<1.4
Louisana	701,692	1.8	4,611	1.8
Oklahoma	524,065	1.3	3,809	1.5
Missouri	155,862	0.4	NA	<1.4
Mississippi	149,920	0.4	NA	<1.4

NA - Data Not Available

Source: Toups Corporation, Water Pollution Abatement Technology: Capabilities and Costs, Irrigated Agriculture, 1976.

TABLE II-62: FARM SIZE DISTRIBUTION IN THE WESTERN STATES

Farm Size (acres)	Farms Reporting	Percent of Farms	Irrigated Acres	Total Acres	Percent Irrigated	Cumulative
1-9	9,423	5.5	48,180	1,784,182	0.1	0.1
10-49	43,639	25.5	1,187,640	17,094,609	3.4	3.5
50-99	33,808	19.6	2,401,453	20,886,224	6.9	10.4
100-199	37,898	21.9	5,307,095	34,139,817	15.5	25.9
200-499	33,910	19.6	10,254.727	50,785,381	29.6	55.5
500-999	9,865	5.7	6,625,182	28,558,057	19.0	74.5
1,000+	4,299	2.5	8,817,870	37,174,801	25.5	100.0

Source: Toups Corporation, Water Pollution Abatement Technology: Capabilities and Costs, Irrigated Agriculture, 1976.

The fraction of irrigated land that is drained varies widely in different regions of the country, ranging from about two-thirds in Florida to less than one percent in the lower Mississippi. These data, along with figures on the amount of land irrigated by sprinklers and surface irrigation systems are shown in Table II-63.

Four primary methods are used for applying water to land. About 54 percent of the land is irrigated by furrows or ditches, 30 percent by flooding, 15 percent by sprinklers, and one percent by subirrigation, which is important in only a few regions of the country.

Sprinklers are generally the most efficient method of applying irrigation water because they allow excellent control of the amount applied and they provide uniform distribution of the applied water. There are many areas, however, where sprinklers cannot be used because of very low soil infiltration rates.

c. Cost and Effectiveness of Control Options

The cost and effectiveness of three levels of control of irrigation return flow were investigated: "Low", "Medium", and "High". The three levels are more descriptive of the cost of controls than, necessarily, of their relative effectiveness in the control of pollution.

TABLE II-63: DISTRIBUTION OF IRRIGATED LAND, METHOD OF APPLICATION OF WATER, AND DRAINED LAND BY MAJOR DRAINAGE BASINS

Region	Artificially Drained Land				Undrained Land*			
	Sprinkler Irrigation	Surface Irrigation	Subtotal	Percent	Sprinkler Irrigation	Surface Irrigation	Subtotal	Total
I. Pacific Northwest	180,067	445,198	625,265	11.7	1,665,395	3,069,787	4,735,182	5,360,447
II. South Pacific	85,608	1,462,491	1,548,099	21.2	1,218,700	4,143,903	5,362,603	6,910,702[a]
III. Great Basin	3,261	229,899	233,160	15.6	116,228	1,142,065	1,258,293	1,491,453
IV. Colorado	720	210,149	210,869	8.3	79,444	2,242,211	2,321,655	2,532,524
V. Missouri	20,973	617,084	635,057	8.9	858,994	5,635,754	6,494,748	7,132,805
VI. Arkansas-Red	18,785	158,830	177,615	4.3	603,995	3,308,322	3,912,317	4,089,932[a]
VII. Rio Grande & Western Gulf	14,188	223,832	238,020	3.9	1,074,342	4,246,943	5,321,285	5,559,305[a]
VIII. Lower Mississippi	15,406	0	15,406	0.8	37,458	658,851	696,309	711,715[a]
IX. Florida	105,771	800,052	905,823	67.2	373,175	68,862	442,037	1,347,860
	444,779	4,147,535	4,589,314		10,418,736	24,516,698	30,544,429	35,136,843

* Undrained land is defined as land that is not artificially drained.

a/ Acreage in rice production not included in total.

Source: Toups Corporation, Water Pollution Abatement Technology: Capabilities and Costs, Irrigated Agriculture, 1976.

The low level of control would reduce the mass emission of pollutants in return flow by increasing the efficiency of water use through irrigation management servicing (IMS), or by tailwater recovery, as applicable. In most cases, increasing efficiency reduces mass emission of dissolved salts simply by reducing the mass of salt applied to the land. This technique (IMS) has been developed in recent years and is presently applied to about 1 percent of irrigated land. Detailed accounts of soil moisture, soil moisture holding capacity, daily evapotranspiration requirements, and other pertinent data are kept on a field by field basis, usually on a computer. Proper manipulation of these data provides the farmer with accurate information regarding the optimum date and amount of his next irrigation.

This level of control was assumed to be applicable to all irrigated land with artificial subsurface drainage facilities. Its application to land that is irrigated by sprinklers and that is not artificially drained cannot be charged to abatement of pollution, because such lands do not normally have any point source return flows. Properly operated sprinkler systems do not produce tailwater, because they apply water at a rate equal to or less than the infiltration rate of the soil, and no surface runoff occurs.

EPA effluent limitations as promulgated provide for monitoring of return flows from irrigation systems encompassing 3,000 or more acres, although this size limitation has since been ruled illegal by the courts. The cost estimates presented herein assume all will be required to monitor their return flows, and the cost of monitoring has been estimated to be about $2.00 per acre per year.

The cost of a typical irrigation management service averages about $5.00 per acre per year and, since such a system does not eliminate return flow, the cost of monitoring return flows must also be considered. However, IMS has been estimated to save an average of about $2.00 per acre per year in fertilizer cost, and this is estimated to balance the cost of monitoring. Therefore, the low level of control is estimated to result in a net cost of about $5.00 per acre per year.

The medium level of control would improve irrigation efficiency to the maximum extent feasible by initiating IMS, lining unlined laterals and canals, and installing sprinkler systems on all land that is now surface irrigated. The above controls would apply only to surface irrigated land that has no installed drained. The medium level of control for land that is not artificially drained and that is surface irrigated would be either sedimentation basins to treat tailwater or recovery and reuse to eliminate the discharge of tailwater. Again, land that is without installed drains that is sprinkler irrigated would require no treatment.

The high level of control investigated would add desalting of return flows from artificially drained lands to the medium level of control, and would prohibit the discharge of tailwater by requiring the installation of tailwater recovery systems, which are systems for capturing and returning to the delivery system any water that runs off the lower end of the field.

The theoretical effectiveness of each of these three options, as demonstrated in laboratory soil columns, is shown in Table II-64. The effectiveness shown in Table II-64 could not be achieved in the field because the variables such as precipitation, soil type, soil texture, and soil uniformity cannot be controlled in the field as they are in the laboratory, and because, even when land is drained, much of the return flow is not picked up in the drains.

TABLE II-64: REDUCTION IN POLLUTANT LOADING ATTAINABLE UNDER LABORATORY CONDITIONS FOR ASSUMED CONTROL OPTIONS

	Reduction Below Existing Level (Percent)					
	Drained Land Control Option			Undrained Land Control Option		
Constituent	Low	Medium	High	Low	Medium	High
Salinity[a]	20	30-50	90**	*	*	*
Nitrates	*	*	40-80	*	*	*
Sediment	20-40	100	100	20-40	100	100
Phosphates	20-40	100	100	20-40	100	100
Pesticides[b]	20-40	100	100	20-40	100	100

[a] Percent reduction in tons.
[b] Pesticide pollution from surface flows
* Negligible
** Based on assumed 90 percent efficiency of R.O. desalting units

Source: Toups Corporation, Water Pollution Abatement Technology: Capabilities and Costs, Irrigated Agriculture, 1976.

Annualized per-acre costs for the three options in different regions of the country are shown in Table II-65. This table also provides cost figures for drained and undrained land and for sprinkler and surface irrigation systems.

TABLE II-65: SUMMARY OF ESTIMATED ANNUALIZED PER-ACRE COSTS OF THREE LEVELS OF CONTROL OF IRRIGATION RETURN FLOW

Region, Irrigation, and Drainage System	Irrigated Acres**	Cost of Control Option* - Dollars per acre per year - Low	Medium	High***
I. Pacific Northwest	5,360,447			
Sprinklers/Drained	180,067	5	42	85
Surface/Drained	445,198	5	81	124
Sprinklers/Undrained	1,665,395	0	0	0
Surface/Undrained	3,069,787	5	7	7
II. South Pacific	6,910,702			
Sprinklers/Drained	85,608	5	23	78
Surface/Drained	1,462,491	5	62	117
Sprinklers/Undrained	1,218,700	0	0	0
Surface/Undrained	4,143,903	5	7	7
III. Great Basin	1,491,453			
Sprinklers/Drained	3,261	5	37	78
Surface/Drained	229,899	5	76	117
Sprinklers/Undrained	116,228	0	0	0
Surface/Undrained	1,142,065	5	7	7
IV. Colorado	2,532,524			
Sprinklers/Drained	720	5	42	94
Surface/Drained	210,149	5	81	133
Sprinklers/Undrained	79,444	0	0	0
Surface/Undrained	2,242,211	5	6	6
V. Missouri	7,132,805			
Sprinklers/Drained	20,978	5	32	66
Surface/Drained	617,084	5	71	105
Sprinklers/Undrained	858,994	0	0	0
Surface/Undrained	5,635,754	5	7	7

TABLE II-65: Continued

Region, Irrigation, and Drainage System	Irrigated Acres**	Cost of Control Option* - Dollars per acre per year - Low	Medium	High***
VI. Arkansas-Red	4,089,932			
Sprinklers/Drained	18,785	5	12	47
Surface/Drained	158,830	5	51	86
Sprinklers/Undrained	603,830	0	0	0
Surface/Undrained	3,308,332	5	6	6
VII. Rio Grande-Western Gulf	5,559,305			
Sprinklers/Drained	14,188	5	18	60
Surface/Drained	223,832	5	57	99
Sprinklers/Undrained	1,074,342	0	0	0
Surface/Undrained	4,246,943	5	6	6
VIII. Lower Mississippi	711,715			
Sprinklers/Drained	15,406	5	15	61
Surface/Drained	0	-	-	-
Sprinklers/Undrained	34,458	0	0	0
Surface/Undrained	658,851	5	7	7
IX. Florida	1,347,860			
Sprinklers/Drained	105,771	5	7	46
Surface/Drained	800,052	5	47	85
Sprinklers/Undrained	373,175	0	0	0
Surface/Undrained	68,862	5	6	6

* No credit for fertilizer savings.

** Does not include rice cropland.

*** Does not include upslope drainage.

Source: Toups Corporation, Water Pollution Abatement Technology: Capabilities and Costs, Irrigated Agriculture, 1976.

The cost figures shown for the high option in Table II-65 are based on the assumption that the only irrigation return flow entering drains on drained land is that which percolates past the root zone on the drained land. This is an erroneous assumption in many cases, because most of the water flowing in many such drains was applied to land at higher elevations, percolated through the root zone to the water table and was moving laterally downslope toward a surface stream when it was intercepted by the drain. Thus, in many cases, the quantity of return flow collected by drains would be from two to six or even 10 times the quantity that percolates through the root zone on the drained land. Since this is not always the case, it is estimated that the total quantity to be treated might be two to four times the assumed quantity, and that the total cost of the high option might be about twice the cost obtained by summing total costs from Table II-65.

Total estimated annualized and investment costs for the three options are shown in Table II-66. Investment costs for irrigators for the low option are relatively low (compared to the other options) because it was assumed that most irrigators would purchase IMS as a service from others rather than making the investment required to provide it to themselves. Costs shown are the estimated costs of providing tailwater recovery systems where such systems would be less expensive than IMS.

TABLE II-66: TOTAL ESTIMATED NATIONAL COSTS OF CONTROL OPTIONS*

Control Option	Investment Cost ($ Billion)	Annualized Cost ($ Million/year)
Low	0.385	186
Medium	3.5	433
High	5.8-12.5	639-1255

* No credit for existing controls.

Source: Toups Corporation, Water Pollution Abatement Technology: Capabilities and Costs, Irrigated Agriculture, 1976.

d Energy and Manpower Requirements

Energy and manpower requirements for the control options are as indicated in Table II-67. Annual manpower requirements range from 9,000 man-years for the low option to 23,000 for the high option. Annual energy requirements range from 107 million KWH for the low option to 5,500 million KWH for the high option.

TABLE II-67: SUMMARY OF ENERGY AND MANPOWER INPUTS

Control Option	Installation Energy KWH(Mill.)	Installation Manpower Man-yrs	Annual Energy gal-gas (+) KWH(Mill.)	Annual Manpower Man-yrs
Low	7,895	3,459	341,530	107	8,850
Med*	36,210	12,725	81,510	3,094	22,022
High**	36,210	12,725	64,240	5,468	23,185

*Medium option (for all regions) does not include installation and annual energy and manpower requirements for canal and lateral lining.

**High option (for all regions) does not include (*) above, or energy and manpower requirements for installation of desalination systems.

Source: Toups Corporation, Water Pollution Abatement Technology: Capabilities and Costs, Irrigated Agriculture, 1976.

4. Nonpoint Agricultural Sources

Runoff from agricultural cropland may deliver sediment, fertilizer, pesticides, and organic material to surface waters.

Non-irrigated cropland in the United States was estimated to total about 380 million acres in 1967, roughly 90 percent of the total cropland. The volume of runoff from precipitation can be predicted with reasonable accuracy, but the quantities of pollutants dissolved and suspended in such runoff is much less amenable to accurate estimation. Estimates of sediment delivery can be made, and associated quantities of nitrogen, phosphorus, pesticides, and BOD can be estimated if one assumes them to be present in sediment in proportion to their concentrations in soil. The present estimates of quantities delivered to surface waters and the quantities estimated to be delivered after compliance with one system of control measures are shown in Table II-68.

TABLE II-68: QUANTITIES OF POLLUTANTS ESTIMATED TO BE DELIVERED TO SURFACE WATER ANNUALLY IN AGRICULTURAL RUNOFF BEFORE AND AFTER IMPLEMENTATION OF CNI-RECOMMENDED CONSERVATION PRACTICES

	Quantity Delivered to Surface Waters	
Pollutant	Present	After Implementation
Sediments	1,800 million tons	921 million tons
Nitrogen	4.3 million tons	2.2 million tons
Phosphorus	1.5 million tons	0.8 million tons
BOD	8.6 million tons	4.4 million tons
Pesticides	1.8 million pounds	0.9 million pounds

Source: Midwest Research Institute, Water Pollution Abatement Technology: Capabilities and Costs, Control of Water Pollution from Selected Nonpoint Sources, 1975.

The only measures evaluated for reducing pollutant contributions to streams were those recommended by the Soil Conservation Service in its 1967 Conservation Needs Inventory (CNI). This CNI indicates that about 158 million acres - 40 percent - of nonirrigated cropland needs to have better soil conservation practices applied to it. The measures recommended and their costs are shown in Table II-69. Potential benefits accruing from implementation of these conservation practices have not been considered.

Implementation of these practices is estimated to require a capital investment of $2.6 billion.

The cost of preventing large quantities of sediment and pollutants associated with sediment from reaching surface waters by better soil conservation practices is seen to be about $0.73 per ton of sediment saved. It is not clear that any mechanism now exists, however, that could dictate implementation on all the land needing treatment, even if all investment costs were borne by the government.

TABLE II-69: COST OF IMPLEMENTING CONSERVATION PRACTICES INDICATED BY CNI TO BE NEEDED IN CONTINENTAL U.S.

	Acres Requiring Treatment	Total Annualized Cost	Annualized Cost/acre ($/AC/yr)
Annual Cover	60,576,185	$287,000,000	$4.75
Sod	22,116,005	101,200,000	4.58
Contour	16,033,297	7,900,000	0.49
Terrace	316,218	500,000	1.73
Permanent Cover	15,848,194	100,000,000	6.36
Drainage	43,003,645	139,500,000	3.24
Total	157,893,544	637,400,000	$4.04

Source: Midwest Research Institute, Water Pollution Abatement Technology: Capabilities and Costs, Control of Water Pollution from Selected Nonpoint Sources, 1975.

F. SELECTED NONPOINT SOURCES

1. Introduction

Certain nonpoint sources may contribute large quantities of pollutants to the nation's waters on a temporary or intermittent basis. Construction and timber harvesting are two activities that may cause large temporary increases in the contribution of sediments and other pollutants to receiving waters. Inactive mines, subsurface disposal, and salt water intrusion may contribute pollutants either continuously or intermittently, depending on local circumstances. These nonpoint pollutant sources are significant to the Commission's study of the requirements of P.L. 92-500 because they may in some instances overwhelm and negate the reductions achieved through point source effluent limitations. More commonly, however, point sources are of primary concern during low-flow conditions of streams when nonpoint sources (except for sources such as acid drainage from inactive mines) are either non-existent or of minimum impact. Nonpoint pollutants are usually contributed during high flow conditions when point sources have little or no impact on water quality.

All data presented herein should be considered to be gross approximations rather than precise estimates because of the shortage of reliable data on any of these subjects.

2. Silviculture and Timber Harvesting

About 500 million of the 2.3 billion acres of land in the 50 states are in commercial forests. About 1.7 and 1.5 million acres were harvested in 1965 and 1970, respectively(37).

Logging operations, logging road construction and maintenance, and site preparation for reforestation are the components of silviculture and timber harvesting operations that have the greatest potential for increasing the contribution of pollutants (chiefly sediment) to surface waters. All of these operations disrupt the overhead canopy and the soil surface to some extent. Both disruptions increase erosion potential.

Logging operations are the major cause of increased sediment yield in the Northeast and Pacific Northwest, while site preparation for reforestation of upland forests predominates in the Southeast. Site preparation frequently involves bulldozing, windrowing, and burning the scrub hardwoods which grew in the shelter of the harvested timber and must be removed before pines can be re-established(36).

The effect of a change in logging practice -- from skidding felled logs to a loading point by use of tractors to non-tractor yarding (high lead, skyline, balloon) -- was examined for the Northeast and Northwest.

This change is estimated to decrease sediment yield on the order of one-half ton per acre, and to increase logging costs by $39 to $130 per acre(36).

The effect of a change in site preparation method for upland forests from bulldozing and burning to chopping with a drum chopper was examined for the Southeast. This change is estimated to reduce sediment yield by as much as 70 percent (14 tons/acre, average) and to reduce the cost of site preparation by $26 to $39 per acre(36). It would not be applicable to flatland coastal areas. A disadvantage of the method is that it requires more frequent controlled burning of the growing forest to control scrub hardwood size, thereby increasing air pollution to some extent.

3. Construction

About 1.6 million acres of land are disturbed annually by construction activities, 90 percent for highways and roads, and 5 percent each for urban residential and urban non-residential construction.

The annual sediment yield from uncontrolled construction sites is estimated to average 200 million tons, an average of 124 tons per acre of disturbed land and 11 percent of the yield from the 380 million acres of non-irrigated cropland.

Controls such as sedimentation basins, diversion ditches, sodded ditches, grade stabilization, and other effective practices can be used to control sediment production. In addition to reducing the sediment contribution to surface waters, such controls may yield benefits in the form of reduced quantities of fill dirt that must be hauled to the construction site.

Costs are estimated to range from about $910 to about $1,482 per acre, (average $1,170 per acre) for a reasonable mix of the above measures(36). This would total $1.8 billion per year.

The proposed sediment controls are predicted to reduce sediment yield by about 70 percent, or 140 million tons per year(36).

4. Inactive and Abandoned Coal Mines

The primary water quality problems associated with inactive mines are sediment production from denuded areas and acid production from exposed reactive areas. Sediment production problems may occur in all areas where mining has been practiced, but acid mine drainage is confined primarily to the Appalachian coal fields. Total acreage utilized for all mining activities in the nation from 1930 to 1971 is shown in Table II-70.

TABLE II-70

LAND UTILIZED FOR MINING IN UNITED STATES 1930-1971

Use	Acres Utilized
Surface Mined	2,170,000
Waste area for surface mines	733,000
Subsided or disturbed by underground mines	105,000
Waste area for underground mines	190,000
Waste area for milling	454,000
Total	3,652,000

Source: CONSAD Research Corporation, The Cost Model for Mining, Report to EPA, March 1975.

Vegetative buffer strips along affected streams have been shown to be effective in abatement of sediment delivery. The width required is a function of land slope, with 145 feet estimated to be required for a 30 percent slope. The cost of establishing such vegetative buffers is estimated to average $520 per acre, or about $9,000 per mile of affected stream ($18,000 per mile if sediments are delivered from both sides). About 5,000 miles of stream are reported to be affected by sediment in Appalachia(38).

Acid production from surface mined lands can be controlled most economically by reclaiming (including revegetation and silt control) the affected land at a cost ranging from $130 to $5,200 per acre, and averaging $2,100 per acre. About one-third of all acres of inactive surface coal mines in Appalachia are estimated to need such reclamation(38).

Over half of all acid mine drainage is discharged from inactive underground mines(39). The cost of neutralization with limestone was reported in 1969 to range from $0.20 to $0.50 per thousand gallons, depending upon the strength and quantity of the acid(39). About 5,700 stream miles in Appalachia are affected by acid mine drainage.

5. Subsurface Disposal

The deliberate use of subsurface excavations for waste disposal is a growing practice that poses a continuing threat to the nation's groundwater quality. Presently, the wastewater derived from about 32 million people is discharged to septic tanks or cesspools, about 300 million tons of municipal and industrial solid waste are buried in landfills

each year, and around 300 industrial wastewater injection wells are in operation in the country(40). The subsurface is also used inadvertantly for disposal of liquids spilled on the surface and leaked from pipelines, pits, lagoons and storage tanks.

The threat to groundwater quality -- and ultimately to surface water quality -- by subsurface disposal can never be entirely eliminated. In most cases, it can be minimized by judicious site selection, utilization of sound and proved design procedures, and careful management and operation of the facility. In rare cases, it must simply be recognized that groundwater quality deterioration will be an inevitable consequence of development, and appropriate plans must be made to deal with the resulting problem.

6. Salt Water Intrusion

Only eight of the 50 states do not report salt water intrusion problems(40). Seawater intrusion into coastal aquifers as a result of overpumping fresh groundwater is a ubiquitous problem in most coastal states. Upstream encroachment of seawater as a result of deepening of channels for navigation and of reduction of streamflow because of increasing consumptive uses upstream presents problems to municipalities, industries and agriculture(40).

More than two-thirds of the nation is estimated to be underlain by saline water. Frequently, saline water and fresh water are in direct contact in an aquifer. In other cases, fresh and saline water aquifers that were originally separated by impermeable strata have been connected inadvertantly by improperly completed or sealed oil and gas wells or by other disruptions of the earth's surface(40).

Salt water intrusion can be controlled or prevented in several ways that are simple in concept, but that may be very difficult, expensive, or impossible of implementation.

Seawater intrusion into bays and estuaries can be controlled (conceptually at least) by increasing freshwater inflows, construction of navigation locks, or allowing navigation channels to silt up. Seawater intrusion into coastal aquifers can be controlled by decreasing withdrawal, increasing freshwater recharge, or construction of hydraulic or mechanical barriers between the fresh and saline parts of the aquifer.

Intrusion of underlying brine into freshwater aquifers through improperly completed or abandoned wells can be controlled by finding and sealing the offending wells(40).

One or more of the above solutions is likely to be effective in solving the problem in any particular area, but the cost of implementation cannot be generalized because of the extreme dependency of the optimum solution on site specific conditions.

G. OBSERVATIONS AND FINDINGS

Publicly Owned Treatment Works

1. Technology exists to achieve the 1977 "secondary treatment" and 1983 "best practicable waste treatment technology over the life of the works" requirements for publicly owned treatment works. As now interpreted by EPA, virtually no difference exists between them. EPA has defined secondary treatment as follows:

Characteristic of discharge	Unit of measurement	Maximum Average Concentration 30 Consecutive Days	7 Consecutive Days
Biochemical oxygen demand (5-day)	mg/l	30[a,b]	45[b]
Suspended solids	mg/l	30[a,b]	45[b]
Fecal Coliforms	No. per 100 ml	200[c]	400[c]
pH	pH units	between 6.0 and 9.0 at all times	

[a] Or, in no case more than 15 percent of influent value.
[b] Arithmetic mean.
[c] Geometric mean.

Source: 40 CFR 133. "Secondary Treatment Information," Federal Register Vol. 38, No. 159, pp. 2298-2299, August 17, 1973.

Recently, EPA has proposed that the fecal coliforms requirement be removed from the definition of secondary treatment and that disinfection be practiced only where required to achieve water quality standards.

2. Of the approximately 16,000 treatment facilities in place in 1974, over 80 percent provide some form of secondary treatment (often not achieving effluent limitations consistent with EPA's definition) and about 5 percent provide some type of treatment more advanced than secondary. More than 3,000 untreated discharges are estimated to still exist.

3. About 78 percent of the facilities with some type of construction need are smaller than one MGD capacity (equivalent to about 10,000 contributory population), but these plants only account for about 7 percent of the projected 1990 flow in plants requiring construction. Plants larger than 20 MGD (about 200,000 contributory population) constitute only 2 percent of the facilities, but account for 61 percent of the flow.

4. In 1970, about 144 million people -- 70 percent of the total population -- were connected to public sewer systems. An estimated 210 million (82 percent) of the projected 1990 population of 256 million will be served by sewers.

5. The Commission has used the 1973 and 1974 EPA Needs Surveys as the primary source of information for identifying publicly owned treatment works which need to construct treatment or collection facilities to meet more stringent effluent limitations, serve increased populations or simply upgrade existing facilities. The Commission independently derived costs to provide for projects capable of serving the projected 1990 population and not funded as of June 1974. It modified population estimates by state and local governments to conform with acceptable estimates. While effluent limitations projected in the Needs Survey by state and local governments are intended to produce compliance with the 1983 interim goal, there is considerable debate and uncertainty over whether the projections are based on adequate information. Since the Commission was unable to provide better site-by-site projections of the application of effluent limitations, its estimates are based on the Needs Survey. Cost estimates for all required facilities compared to those of EPA in the 1974 Needs Survey are shown in Table II-17, page II-39.

6. The 1974 EPA Needs Survey contains six categories, with two further subdivided. Category I, Secondary Treatment, and Category II, Treatment to Meet More Stringent Effluent Limitations, provide for all treatment plant needs except those associated with control of combined sewer overflows and storm sewer discharges. The total estimated cost for Category I, Secondary Treatment ($10.8 billion) and Category II, Treatment to Meet More Stringent Effluent Limitations ($24.8 billion), is $35.6 billion. While the total is considered reliable, the individual components may not be strictly correct because state and local governments sometimes reported facilities in the wrong category.

7. In an effort to report what effect different effluent limitations have on costs, the Commission also has estimated what portion of the treatment plant costs is associated with secondary treatment and what portion is necessitated by treatment to meet more stringent effluent limitations. This estimate totals $27.8 billion for 1) plants which require secondary treatment only and 2) the secondary treatment portion of plants required to meet more stringent effluent limitations. The remaining $7.8 billion is attributable to treatment more advanced than secondary treatment needed to comply with water quality standards (both existing and as projected to meet the 1983 interim goal) or state and local standards requiring more stringent effluent limitations than the EPA definition of secondary treatment.

8. Although EPA has, in effect, not required stricter minimum limitations for BPWTT (the 1983 requirement) compared to secondary treatment, the Commission did estimate the cost of achieving a more stringent minimum effluent limitation than secondary treatment as defined by EPA. The Commission examined a level similar to that once considered by EPA, requiring a limitation on ultimate oxygen demand when the wastewater temperature exceeds 20° C. Meeting this effluent limitation would entail strict control of BOD, ammonia reduction or both. Facilities serving a population of fewer than 10,000 and located outside SMSA's or those discharging to ocean waters were not included. The additional cost to achieve this higher level of treatment is estimated to be $1.4 billion.

9. Sewage collection system costs are covered by two categories (each with two subcategories) in the 1974 Needs Survey. After exploring alternative means of providing independent estimates, the Commission determined that the costs submitted in the 1974 Needs Survey for Categories IIIA, Infiltration/Inflow Correction, and IIIB, Major Sewer System Rehabilitation, were as reliable as could be obtained. The costs estimated by the 1974 Needs Survey were $6.9 billion for IIIA, and $9.5 billion for IIIB. The Commission's estimates are $13.0 billion for Category IVA, New Collectors and $13.5 billion for Category IVB, New Interceptors.

10. Category V, Correction of Combined Sewer Overflows, is difficult to assess since EPA is not applying a technology based effluent limitation to combined sewer systems. Best practicable waste treatment technology will be utilized to fix requirements on combined sewer systems on a case-by-case basis. The Commission has estimated national costs for a spectrum of effluent limitations which might be applied to combined sewers. Cost estimates range from $1.5 billion for treatment of only that volume which can be stored in-line to $88.4 billion for providing secondary treatment of all combined sewer flows. In its cost estimate of total publicly owned treatment works costs, the Commission has selected a combination of primary treatment for all systems discharging to effluent limited waters and secondary treatment for those discharging to water quality limited waters. The estimated cost for this combination is $79.6 billion, with over 80 percent attributable to storage facilities.

11. Category VI, Treatment and/or Control of Stormwaters, presents difficulties similar to those for combined sewers. There are not uniform standards upon which to base technologies and costs, since effluent limitations or control or treatment measures for storm sewer discharges have not yet been considered by EPA. The Commission has assessed several alternative technologies, with national costs ranging from $160 billion for removal of debris to $430 billion for physical-chemical treatment. For purposes of estimating national totals, the Commission has estimated the costs for control or treatment systems

which will remove sediment and destroy bacteria from storm runoff from the urbanized areas contained within the nation's 243 SMSA's. The estimated cost is $199 billion, $92 billion of which is attributable to stormwater collection.

12. Commission projections based upon Needs Survey responses and other technical data indicate that a preponderance of publicly owned treatment works will use some form of biological system to achieve secondary treatment. The larger biological systems will use mostly activated sludge, with the smaller ones employing activated sludge, trickling filter and lagoon-type systems almost equally. Physical-chemical processes will be used where phosphorus removal or strict control of suspended solids is required. Nitrogen reduction is infrequently required but technically feasible. For proposed and existing treatment plants which require new construction by 1990 to achieve compliance with effluent limitations, the projected numbers of plants using the more common technologies are estimated as follows:

Activated Sludge	6,000
Trickling Filter	4,500
Aerated Lagoon	1,000
Oxidation Pond	3,500
Physical-Chemical	100
Land Application	1,000

13. Aerated lagoons and oxidation ponds often do not meet the suspended solids limitations of the secondary treatment definition promulgated by EPA, and additional upgrading is necessary. The solids are mostly algal cells used in treating the wastewater, and this type solid may not exert the detrimental effect normally exerted by the suspended solids present in secondary effluent. Some argue that the Act does not require a uniform definition of secondary treatment for all types of technologies employed by publicly owned treatment works. EPA thus far has taken this approach, but may be reconsidering its definition.

14. The estimated raw sludge production from publicly owned treatment works (not including separate stormwater treatment) in 1972 was 4.7 million tons per year (dry weight). By 1990, an increase to about 14 million tons (dry weight) is expected. Processes which convert the sludge to gases -- portions of which are usable as fuel -- can reduce the 1990 totals to about 10 million tons (dry weight). Sludges are difficult to dewater, and will be even more difficult as higher levels of treatment go into effect. Large quantities of water will accompany the sludge to disposal sites or will require evaporation where sludge is treated thermally.

15. Treatment of separate storm sewer discharges would add about 10 million tons of sludge per year (dry weight). Sludges from storm sewer treatment are not readily converted to gases.

16. Land application of wastewater and sludges has gained considerable attention in recent years. Only a small percentage of publicly owned facilities will utilize land treatment for wastewater; however, many will resort to land (either in the crop production mode or by landfilling) for disposal of municipal sludges. Many states have regulations which restrict land application of wastewaters unless they have previously been treated to some degree, usually a level approximating secondary treatment. The cost of a land treatment system in those cases becomes equal to, or more expensive than, activated sludge, trickling filter or lagoon systems. While many municipalities now practice or contemplate landfilling of sludges, land application combined with production of crops is a promising sludge utilization technology. A major deterrent is health concern about consuming crops fertilized with residuals from human and industrial wastes. Institutional problems are severe. Large metropolitan areas must invariably seek disposal sites in neighboring political subdivisions, since suitable quantities of land are not usually available within their boundaries.

17. Annual operating manpower is projected to increase from 107,000 people estimated to be required to adequately operate existing facilities in 1973 to 185,000 people by 1990, when the facilities reach their design capacity, exclusive of control of separate storm sewer discharges. Control of storm sewer discharges could add 24,000 people to the 1990 total.

18. Electrical energy demands for all municipal systems (except control of separate storm sewer discharges) are estimated to increase from 7.6 to 22 billion kilowatt-hours per year between 1973 and 1990; fossil fuels from 72,000 to 87,000 billion BTU's per year. Converting the two types of energy to a common base, an increase of 106 percent is required, equivalent to 27 million barrels of oil per year (76,000 barrels per day). The increase amounts to 0.20 percent of the 1973 national energy use, while the total energy requirement in 1990 for publicly owned treatment works (except storm sewers) equals 0.41 percent of the 1973 national energy use. If control of separate storm sewer discharges were included, the 1990 energy requirement expressed as a fraction of the 1973 national energy use would increase an additional 0.04 percent.

19. If all publicly owned point-source discharges (except separate storm sewers) are controlled, 45, 13 and 13 percent decreases in the discharge of biochemical oxygen demand, suspended solids and phosphorus, respectively, are expected by 1990 as compared with 1973 (allowing for the increased population and assuming that the total 1973 load for storm sewers is still being discharged in 1990). However, the discharge of nitrogen will not decrease, since increased contributions will offset removals by facilities specifically designed to remove nitrogen. If separate storm sewer discharges are also controlled, the reduction in BOD, suspended solids and phosphorus will be 52, 60 and 16 percent, respectively, while nitrogen reduction stays about the same. Considering

only the pollutants associated with wastewater systems (including combined sewers but excluding separate storm sewers), 58 percent reduction in BOD, 61 percent reduction in suspended solids and 14 percent reduction in phosphorus will be achieved by the controls to be implemented by 1990.

Industry

1. For the most part, technologies are or will be available to meet the 1977 "best practicable control technology currently available" (BPT) and the 1983 "best available technology economically achievable" (BAT) requirements promulgated by EPA. Potential problems exist where technology must be transferred from one application to another and where technologies may not be able to consistently achieve short-term (24 hour) effluent limitations.

2. The technologies which will be employed for achieving the BPT effluent limitations are predominately end-of-pipe treatment. The technologies for achieving BAT incorporate more process changes, although additional end-of-pipe treatment is indicated in most cases.

3. For purposes of subcategorizing broad industrial classifications, the subcategories used by EPA in developing effluent limitations are generally suitable for application of common types of technologies.

4. Some difficulty may be expected in applying effluent limitations for some industries with multiple process waste streams discharging into a common treatment facility since effluent limitations are normally associated with an individual process stream. The technologies required for the combined process waste may be different from those employed if the wastes were segregated. Effluent limitations have not been issued (and apparently will not) for all products which contribute to every waste stream. In these cases, some allowance must be made for the increased pollutants attributable to the products for which no effluent limitations have been promulgated.

5. The EPA effluent limitations specify numerical effluent requirements, not technologies. However, use of specific technologies was considered in deriving the effluent limitations. In some cases, it will be necessary to use more sophisticated, and more expensive, technologies to assure compliance than were contemplated by EPA in developing the effluent limitations.

6. In some cases, technologies in use for one process will have to be transferred to another (or even another industry) to achieve compliance with the effluent limitations. In other words, "practicable" and "available" technologies are not now being used within a given industrial category or subcategory in the specific manner that will be required.

7. While it will usually be possible to achieve the effluent limitations on the basis of long-term averages (monthly and yearly), limitations inherent in EPA's suggested technologies will sometimes preclude achieving the short-term (24 hour) limitations. Either technologies other than or in addition to those contemplated by EPA will have to be installed or those discharges using the technologies suggested by EPA will violate the short-term limitations during some time periods.

8. The statistical methods employed by EPA to relate short-term to long-term effluent limitations were not always consistent. Considering the lack of background data, perhaps only long-term effluent limitations can be adequately prescribed until additional information is developed.

9. The total capital costs to comply with BPT and pretreatment requirements for industry as it was structured in June 1973 is $42.1 billion; the incremental capital cost above BPT to comply with BAT and pretreatment requirements for industry as it was structured in June 1973 is $31.5 billion. The total O&M cost in addition to 1973 requirements to comply with BPT and pretreatment requirements for industry as it was structured in June 1973 is $7.3 billion per year; the incremental O&M cost above BPT to comply with BAT and pretreatment requirements for industry as it was structured in June 1973 is $6.4 billion per year. The costs do not take into account new plants or plant closures, both of which will affect actual expenditures.

10. Technologies installed to meet the 1977 and 1983 effluent limitations will require considerable additional energy. Converting all energy requirements to one common type of fuel, the equivalent of 169,000 barrels of oil per day would be required to meet the new energy demands of the BPT requirements for industrial capacity as it existed in June 1973; the equivalent of 211,000 barrels of oil per day would be required to meet the additional energy demands of the BAT requirements for industrial capacity as it existed in June 1973. The additional energy equals 0.48 percent of the 1973 national energy use for BPT and an additional 0.60 percent for BAT.

11. The above figures do not take into account the energy penalty resulting from installation of cooling towers at steam electric power plants. From 0.06 to 0.40 percent of the 1973 national energy use could also be required by 1983 to account for the cooling tower penalty. The actual loss will depend upon the number of steam electric power plants which must comply with new regulations.

12. A significant portion of industry discharges wastes to publicly owned treatment facilities. Normally, industries discharging to municipal systems tend to be smaller water users located in metropolitan areas. Pretreatment standards for industries discharging to municipal systems have not been finally established by EPA, and the range of possibilities

presented to date in different EPA documents under consideration at one time or another would have drastically different impacts. Commission studies assumed pretreatment equivalent to BPT for "incompatible" pollutants, the EPA position at the time the studies were conducted (i.e. prior to July 1, 1975.). The predominant portion of the 1977 costs for some industries is attributable to compliance with pretreatment requirements rather than direct discharges to navigable waters.

13. Reliable estimates of what technologies will be required for water quality limited waters and at what cost have not been possible to obtain on an industry-by-industry basis. Where information was available, technology more stringent than required for achieving BPT but generally less stringent than required for achieving BAT will be required when discharging to water quality limited waters.

14. Industrial plants which start construction of a new facility or add significantly to existing facilities must comply with new source performance standards (NSPS), which the Act requires be equivalent to "best available demonstrated control technology". The technologies considered necessary to meet these standards are often similar to those for achieving BAT, and some difficulty may be encountered where transfer of technology is required. However, more options are available when designing new facilities than retrofitting existing facilities, which should mitigate the transfer difficulties in most cases.

15. Some technological solutions rely upon significant reduction in water usage or recovery of by-products. While the full potential of such approaches has not been fully developed, this type solution to meeting effluent limitations is expected to become more prevalent.

16. Residuals remaining after treatment ("sludges") must be disposed of or reused. There is potential for reuse of some sludges, and research is underway in that direction. However, even recovery of by-products still leaves a significant disposal problem for the unusable portion. Incineration and landfilling are commonly employed methods of disposal. Incineration must be performed in a manner that does not transfer the pollutants to the atmosphere; land disposal must assure protection of groundwaters and crops. Landfilling is the most commonly practiced technique of ultimate disposal of industrial sludges.

17. Since EPA has not established toxic standards, it was difficult to adequately assess the technological solutions available to achieve control of toxicants and the possible costs of these technologies. Under preliminary regulations, several industries will be impacted significantly by toxic controls. An adequate evaluation of this issue was simply not possible, although techniques to achieve compliance were explored and technologies are clearly available for some industries; for others, major changes in process or treatment technologies may be necessary.

Innovative Technology

1. Technologies are available, or will become available in the foreseeable future, to achieve or closely approach the elimination of the discharge of pollutants (EOD), a stated goal of the Act.

2. The Commission has defined EOD as follows:

> "The elimination of the discharge of pollutants shall apply to removal of those constituents which are added during use of the water. The resultant discharge must be of equal or lower concentration than that of the original supply."

Since the Act does not define EOD, various interpretations have been prepared. The chosen interpretation is important in assessing possible technologies and costs.

3. For some subcategories of some industries, the BPT and BAT effluent limitations will achieve EOD. EOD usually is achieved by eliminating the discharge of water, not by treatment and discharge. Most applications involve relatively small water users, where the wastewater can be treated and recycled. The most significant case requiring EOD is the BAT limitation for metal finishing.

4. The dominant technological consideration for achieving EOD is the capability for removing dissolved salts normally not covered by BPT or BAT effluent limitations. Removal of these salts creates large quantities of brines, which are difficult to dispose of in an acceptable manner.

5. Technologies capable of achieving EOD are considerably more costly than those for achieving BPT or BAT.

6. Technologies for achieving EOD are energy intensive.

7. Land application is often regarded as a technological solution for achieving EOD. While land application usually accomplishes somewhat more effective removal of BOD, suspended solids and nutrients from untreated wastewaters than most conventional secondary treatment processes, it will not, by itself, achieve EOD. Additional technologies to remove dissolved salts and other contaminants would be required, just as would be required following other secondary processes. In effect, land application is similar to secondary treatment but serves as an efficient "pretreatment" system for the add-on innovative technologies which must also be employed for achieving EOD.

8. To accelerate development of technologies capable of achieving EOD, research and development efforts should be concentrated on dissolved salt removal technologies, as well as on land application.

Agriculture

1. Drainage systems have been installed on about 55 million acres of non-irrigated land and on about five million acres of irrigated land. Although concentrations of all pollutants except dissolved mineral salts are similar in drainage from irrigated and non-irrigated land, permits are required only for return flows from irrigated land. While subsurface drainage from non-irrigated land does not present a problem with dissolved mineral salts, nitrate concentrations are sometimes quite high.

2. Techniques that will control irrigation return flow pollutants have generally been applied because of their beneficial impact on crop production, rather than their capability for reducing pollutants. Increasing irrigation efficiency is the main thrust of these efforts, and is beneficial in reducing salts in return flows where leachable salts are present in the soil.

3. The techniques producing the greatest reduction in pollutant discharges are improved irrigation scheduling, tailwater recovery, installation of sprinklers and lining of canals. Each technique is not always applicable or capable of being implemented for every irrigated area since site-specific considerations are of prime importance.

4. Increased irrigation efficiency may have an adverse effect upon both the quality and the quantity of water in receiving streams where flow during normally dry periods has been augmented by return flows from alluvial groundwater basins. In lands without installed subsurface drainage, the quantity replenishing the groundwater will be reduced and groundwater quality may be impaired.

5. Improved irrigation scheduling can be obtained under service contracts. A major limitation is the availability of water in the needed quantity at the right time. Where it can be employed, irrigation demands can be reduced by 20 percent, resulting in a decrease in volume of irrigation return flow of up to 40 percent. Crop yield may increase an average of 15 percent. The discharge volume of most pollutants is reduced from 20 to 40 percent, and the cost, assuming major structural changes in the delivery system are not required, is estimated at about $5 per acre per year.

6. If tailwater recovery is practiced, the cost would approximate that of an irrigation scheduling service but benefits to crop production may not be as great. Tailwater recovery will also prevent discharge of sediments and pesticides to surface waters.

7. Although more expensive and energy intensive, sprinkler systems have been installed extensively in recent years to increase irrigation

efficiency. Their effectiveness in controlling pollutants is about the same as improved irrigation scheduling.

8. Desalting point source irrigation return flows is very expensive, up to $130 per acre per year, and its benefit is severely limited since only about 12 percent of irrigated land is drained, making it difficult to collect the water for desalting. Return flows from land without subsurface drainage systems are returned as nonpoint sources and would not be impacted by the desalting treatment systems.

9. Agricultural pollution controls involve a complex matrix of variables. Site-specific considerations are of prime importance, whether considering water quality or crop yields. In some cases, water rights may be affected by water pollution control policies.

10. Control of runoff from feedlots is required under the point source provisions of the Act. The national cost for controlling feedlots is very dependent upon which feedlots are placed under regulation. The most recent proposal by EPA in November 1975 would require control of all feedlots larger than the equivalent of about 1,000 animal units and all those smaller contributing to pollution. The total capital costs for all feedlots over 1,000 animal units for achieving BPT (control runoff from 10 year, 24 hour storm) is estimated to be $113 million, with an additional $35 million required for achieving BAT (25 year, 24 hour storm). If all potential problem feedlots were controlled, about $724 million capital costs would be required for BPT and an additional $172 million required for BAT. The cost per head will vary widely depending upon climatic factors and the size of the facility.

Nonpoint Sources

1. The nonpoint contribution of sediments and other pollutants to surface waters by runoff from non-irrigated cropland could be reduced by almost one-half by applying recommendations of the Soil Conservation Service to all cropland needing improved practices. About 160 million acres -- 40 percent of all non-irrigated cropland -- would benefit from application of these recommendations. The estimated investment cost would be about $2.6 billion, with the total annualized cost estimated at $0.65 billion per year.

2. Control of other selected nonpoint sources was assessed in a cursory manner. Promising control strategies are usually related to changing operating techniques rather than by treatment.

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III. THE ECONOMICS OF WATER QUALITY

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A. FINDINGS AND OBSERVATIONS -- ECONOMIC AND SOCIAL IMPACTS

1. The Setting

With an annual GNP approaching $1.5 trillion, individual components of economic activity, such as those costs and benefits from the implementation of P.L. 92-500, are almost lost in the total economy. Those interactions that can be measured are associated with dramatic upswings or downswings in the economy, and are characterized by broadly varying economic conditions reflected in the many dimensions of daily economic activity. The state of the economy conditions both the likelihood that achievement can be fully realized on schedule and what the dimensions of the positive and negative impacts resulting from that achievement will be. For virtually every measure that exists, the economic fluctuations independent of the Act dominate those that may occur due to the Act.

Independent of the interaction between general economic conditions and impacts of the Act is the need to specify those segments of the public and private sector that will be of questionable economic viability whether the forces impacting them are from the economy in general, or the Act in particular -- and note that the Act's resultant expenditures may compound this situation.

With this as background, an important bit of hindsight relates to the timing of the Act's passage. By most standard measures, the past three years were an inopportune time for attempting to accomplish the Act's requirements in terms of the economic climate. Economic capabilities of both the public and the private sectors have been severely constrained. One cannot evaluate past progress under the Act or what might be a reasonable course in the future without recognizing the simple fact that progress is not independent of the state of the economy.

While these forces are beyond the control of the Commission, they have been considered in the Commission's assessments. Many economic questions have been addressed that would not have been so important at other times. Inflationary impacts, capital market constraints, unemployment, interest rates and supply constraints are among many dimensions that would not have been as critical during many other periods of history. More intensive examination of these issues has been required.

Not only have these conditions contributed additional uncertainty, but a spate of national policies initiated or considered to combat these symptons have complicated the Commission's assessment. Price controls, energy policies, tax cuts and debates over the rate of money supply growth have been critical to determining the economic impacts of the Act so far, and will continue to do so in the foreseeable future. The

impacts of these policies can substantially alter or override any impact uniquely associated with the Act itself.

There have been some opportunities during the past three years to take advantage of the economic situation in a manner that would have generated some substantial economic pluses beyond those originally intended. Public works programs traditionally have been used to provide stimulus and employment during periods of depressed economic activity. Mention of accelerated publicly owned treatment works construction grant programs for this role has occasionally appeared during the past year, but while no specific employment-related program has developed, stimulative impacts of a beneficial nature have been identified by our studies.

2. The Economics of the Act

Assessing the goals and requirements of the Act includes an analysis of the economic impacts of a mechanism that was not designed primarily to be economically efficient. The task is to try to separate the economics associated with the specific mechanism itself from the impacts resulting from attaining the specific requirements and goals of the Act by that mechanism.

Economics is the science of allocating scarce resources to meet felt needs. This Act identifies the "need" as water quality adequate to "provide for the protection and propagation of fish, shellfish, and wildlife and provide for recreation in and on the water". Logical economic analysis would examine the most efficient allocation of resources to attain these ends within the Act. However, this Act prescribes the steps toward attainment as well, and thus as analysts, we are placed in the position of assessing the economic impact of a mechanism which already may be judged to be economically inefficient.

The Commission recognized this dilemma explicitly and implicitly and, consistent with its statutory assignment, chose to defer study of alternative resource allocation mechanisms. All attention was focused on the impacts of implementing the mechanism specified in P.L. 92-500. Thus, while the language tends to presume that the Commission may be measuring the impact of, for example, the 1983 BAT requirement, it is in fact measuring the impact of that requirement met by a specific technology/regulatory mechanism, as specified in P.L. 92-500. Achieving that same generally defined 1983 requirement by some other mechanism might result in different impacts. The Commission's economic impact assessment actually examines both the mechanism and the requirement, and there is no precise way to separate differential impacts of the mechanism from those of the requirement itself. This dilemma is reflected in the comments of many reviewers who apparently wished to have more

information regarding the economic trade-offs between alternative mechanisms.

As a consequence, should decision-makers conclude that the impacts of this specific program are "too severe" and wish to propose alternatives or changes, some consideration must be given to whether the change should be in the ultimate requirements or goals, in the mechanisms designed to attain those ends, or in both. While discussions have focused on such ends as changing dates, proposing exemptions, etc., it is not unreasonable to presume that while these changes may alter the impacts, they may not improve efficiencies, and may even increase them. Conversely, a change in the mechanism alone might reduce negative impacts, introduce greater efficiencies in resource use and, further, might result in greater benefits at lesser costs without a change in the basic water quality targets.

Given these observations and the many complicating assumptions necessary for Commission studies of both the public and the private sector, the findings summarized below characterize the measurable economic and social impacts of the goals and the requirements of the Act. As intended, these focus upon the 1977 and 1983 requirements, and the 1983 goal.

The 1977 BPT requirements are unambiguously stated. Technologies can be readily identified which will achieve most of the specifications of the promulgated effluent limitations. Associated costs can be used to derive resultant economic impacts. These are calculated by industry, subcategory, region, and dimensions of consumer related impacts such as price increases. Most important, however, there is some evidence that these impacts will not fully materialize because industry does not appear to be proceeding at a rate equal to the Commission's calculation of the expenditure level necessary to attain the required technologies by the mandated deadlines. One possible consequence of this observed pattern is that extreme efforts would be required to "catch up" and achieve mandated levels by 1977 and substantial negative economic impacts would result. This may not be realistic.

Aside from the many possible explanations of our findings regarding the severity of actually meeting the prescribed levels for 1977, it is more fruitful to attempt to assess what the actual pattern of expenditures means. The most logical explanation for the divergence between planned expenditures and our calculated costs of BPT is two-fold. First, industry appears to be consciously moving in the direction of attaining something roughly equivalent to secondary treatment for publicy owned treatment works. Requirements beyond this level are being (or have been) widely contested, or else are not yet fully promulgated. Secondly, there

is some evidence that industry* may have underestimated the cost of compliance.

In neither of these instances does it appear rational, for economic reasons, to propose modification of the BPT requirements because of the severity of the calculated impacts, unless from an enforcement point of view. The level of currently planned expenditures will not result in significant negative economic impacts, except in isolated cases. Efforts which attempt to force industry to on-time compliance with final effluent limitations would create severe consequences throughout many segments of industry. This would be due primarily to the short time period remaining to July 1, 1977, and the substantial increases in expenditures that would be necessary. Even these probably could not be sufficient to overcome the technical impossibility of compliance by that date.

Altered time-phasing, such as that utilized in both our macro- and micro- examinations, could alleviate much of these severe impacts. The mechanism for this extension does not follow directly from the mechanisms in the Act, however. A key characteristic is that the required expenditures be somewhat evenly distributed over time. Simply shifting the BPT deadline to 1980 or 1983 will not guarantee such distribution. Also, the further the time extension, the more population and economic growth (including some inflation) as they impact water quality, become relevant to the calculation.

3. Industrial Impact Findings

- As the price of water and the costs of waste disposal increase, there is a decrease in the quantities of water used and waste generated.

- Subsequent to industry's patterns of response, accumulated capital and O&M expenditures are expected to be $36.0 billion and $6.8 billion respectively for BPT; and an additional $23.2 billion and $5.8 billion for BAT. Cumulative new sources costs until 1983 are about $19.9 billion additional, with associated O&M minimal for the time period.

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* This refers to the aggregated expectations of individual firms within industry as opposed to those estimates of industrial leaders or industrial trade associations.

- The cumulative capital expenditures for BPT and BAT for the Chemicals, Steam Electric Power, Iron and Steel, Paper, Mining, and Petroleum Refining industries as a percentage of BPT and BAT requirements for all industry are: BPT - 50 percent; BAT - 43 percent; BPT and BAT combined - 47 percent.

- Two types of price impacts were calculated by the Commission. First, for selected industries, price impacts were calculated based upon a detailed static analysis of each industry's markets and plant-by-plant costs. Secondly, for all sectors of the economy, dynamic price impacts were calculated based on (1) each industry's own pollution abatement costs, (2) changes in costs of goods and services purchased from other industries due to pollution control, and (3) various indirect effects on productivity, inflation, and aggregate demand. The first calculation is referred to as the "direct" price impact and the second as the "cumulative" price impact.

- Of the industries selected for detailed study, the direct price increases due to implementing their BPT requirements are projected to be three percent or less, with most of these industries facing price increases of less than two percent. Metal Finishing may incur price increases up to 40 percent. The cumulative price forecasts are greater than the direct impacts since they reflect a wider range of impacts due to implementation of the BPT requirements. The average cumulative price increases by 1985 due to BPT for all sectors is 6.2 percent, with price increases of over seven percent for instruments and fabricated metal products; which make extensive use of metal finishing services, and for mining and furniture.

- Additional price increases due to BAT are smaller than those due to BPT. Direct price increases due to implementing BAT requirements exceeded one percent in only one case, Metal Finishing, which is predicted to incur price increases up to 20 percent. Cumulative BAT price increases, taking account of all economic interactions are predicted to average 2.8 percent in 1985. Again, the sectors with the greatest price increases, ranging from 3.0 to 4.6 percent are for those industries that make extensive use of metal finishing services, such as instruments, fabricated metal products, non-auto transportation equipment, and non-electrical machinery, and for chemicals.

- Beyond those firms that would close due to depressed profits, the profit level for remaining industry is not substantially impacted. The Steam Electric Power industry is an exception, with a .3 - .7 absolute decline in percent rates of return on rate base.

- Capital expenditure requirements due to the Act may serve as a constraint to capacity expansion. For pollution abatement expenditures as a percent of total capital spending, Iron and Steel jumps from 4 percent in 1974 to 27 percent in 1976; Pulp and Paper from 7 percent in 1974 to 26 percent in 1976; Chemicals from 4 percent in 1974 to 33 percent in 1976; and Textiles from 2 percent in 1974 to 12 percent in 1976. (All based on assumed BPT compliance in 1977.)

- Industry, government, and independent surveys indicate that planned abatement expenditures for 1975 are only slightly higher than 1974 actual expenditures and lower than planned expenditures for 1974.

- The Commission's examination of selected major water-using industries revealed that a small segment of capacity in each industry bears disproportionately high abatement costs relative to the majority of production capacity in the respective industry. This high cost segment represents approximately 5 percent of capacity in Textiles and paper, 10 percent in metal finishing, and 1-2 percent for Petroleum Refining and Iron and Steel. These segments are vulnerable and may disappear due to competitive disadvantages arising from pollution abatement expenditures. These capacity segments consist primarily of small plants with older, less efficient facilities, with higher production costs.

- Plant closures are significant in Pulp and Paper, Metal Finishing, Textiles, Fruits and Vegetables, Feedlots (including dairies), and Meat Packing. Generally they are the old, small, single-plant firms, that in many cases could not remain economically viable over the next decade regardless of water pollution control requirements.

- The BPT requirements will have a greater economic impact on industry than the BAT requirements. The BPT requirements alone will result in nearly identical numbers of plant closures and changes in industrial organization as the BPT and BAT requirements combined because most plants that might close as a result of the BAT requirements would already have closed due to BPT. Potential constraints on capacity expansion are more likely to occur due to the BPT requirements than the BAT requirements because the required expenditures are larger and must occur during a shorter time period and because plant closures are projected to occur by 1977, if at all. Changes in the level of stringency do not change which plants in an industry are most adversely affected. The segment of industry with disproportion-

ately higher costs for BPT requirements is the same segment with disproportionately higher costs for the BAT requirements.

- The majority of plant closures are for plants which are on municipal systems and are defined by EPA as having incompatible pollutants. Since the subject of pretreatment regulations remains in a state of flux, the exact number of plant closings of this type must remain an estimate based upon pretreatment guidelines suggested at the time the Commission studies were completed (June, 1975).

- Regional impacts are concentrated in the Northeast, and to a lesser extent, in the Middle Atlantic and North Central regions. This is due principally to the concentrations of metal finishing facilities, small pulp and paper mills, old textiles mills, small feedlots, particularly dairies, and old fruit and vegetable canning plants. The Northeast seems the least able to reemploy (in the same industries) the resources dislocated as a result of the Act.

- Because of the estimated plant closures, the capacity of these industries probably will slightly become more concentrated. In no case, however, is this result exclusively because of water pollution control requirements. Rather it is a reflection of existing trends in the industry which P.L. 92-500 tends to exacerbate.

- Shortages of capital and skilled manpower could impact industry's ability to meet the BPT standards by 1977 due to the low level of spending during 1973-1975, and the substantial acceleration that would be required by 1977. However, these supply shortages are not expected to materialize because planned industry outlays currently do not coincide with those required levels that could lead to shortages. Except for isolated cases, potential supply and capacity shortages do not seem probable.

- Since long-run price impacts are expected to be small, the impact of the Act on international trade and international investment is expected to be insignificant.

4. Agricultural Impacts

- For a hypothetical set of controls on irrigation return flows and erosion, national shifts in the production of commodities on dry and irrigated land are not substantial in the absence of extremely high export levels. Regional shifts are dramatic, however, due

to the differential magnitudes of irrigation return flow and erosion controls needed in different regions. The resulting price impacts are 18 percent by 1985 for a combination of high irrigation return flow compliance and erosion control, both of which approach the elimination of discharge. These price increases must be regarded as only surrogates for the full complexity of the resulting economic impact.

5. Impacts on Publicly Owned Treatment Works (POTW's)

- Two cost scenarios were examined. One was based on projected EPA outlays and assumed 72 percent of Federal funds would be spent for treatment plants and 28 percent for interceptor sewers. The second was based on the funding of all needs except control or treatment of separate storm sewer flows by 1985. The resulting total capital expenditures by Federal, state and local government from 1975-1985 in 1975 dollars are $60.9 billion for the first scenario and $158.1 billion for the second. Including effects of inflation, the first scenario requires Federal appropriations of $52.3 billion and the second $184.4 billion. The latter sum is ten times the original appropriation contained in P.L. 92-500.

- Even with these increased expenditures, complete funding of treatment plants could not be achieved before 1985 for the first scenario and 1980 for the second. Even these dates may be optimistic because they are contingent upon unrealistically low design capacities, limited funding for other categories, and an allotment formula that insures that these funds are provided to states on a "Needs" basis.

- The relative shares of federally eligible capital expenditures are 75 percent Federal, seven percent state and eighteen percent local. However, in the first scenario all collector sewer expenditures are left to local government. This gives them a 37 percent share of total capital expenditures between 1975-1985. In neither scenario is the local share of capital expenditures significantly larger than historical trends in such expenditures, due to the Federal government's assumption of a significant portion of sewer costs traditionally supported by local government. However, operating costs and annualized costs are significantly higher than historical trends. Even with full Federal funding of all categories, the state/local share of total annualized costs is 41 percent in the second scenario.

- Impacts upon state and local revenues and expenditures were assessed separately. Local budgets were aggregated to the state level. These aggregated flows were used to identify those states where localities might experience imbalances between revenues and expenditures under alternative expenditure levels and alternative assumptions about expenditures and revenues. These data are hereafter referred to as "local aggregates". For 1975-1980, using present expenditure trends, without an increase in present revenue effort (taxes as a percent of income), 40 states could encounter deficits. Increasing revenues in line with recent trends results in lowering this number to 28 states. If all states moved to the degree of revenue effort of the highest state, nine would have deficits. The most likely trend in revenues and expenditures suggests 21 states and 21 local aggregates could face fiscal problems in 1975-1985.

- A survey of recent grant recipients noted that funds budgeted for recreation and parks was a primary choice to undergo reductions to avoid these deficits. This presents disturbing implications with respect to the ability of communities to use the newer high-quality water for recreation.

- While financial prospects for many state and local governments are not good, the projected sewer system expenditures do not create a major demand on expected revenues. The question is less one of the impacts of P.L. 92-500 on state and local government, but rather one of the impact of poor state and local financial outlooks on achieving the goals of P.L. 92-500.

- The use of local aggregates conceals the very different requirements placed on different types of communities. Forty percent of the population has no reported treatment plant needs at all; either they have adequate present facilities or they do not plan to be sewered by 1990. Of those communities with treatment plant needs, costs vary both by the magnitude of needs and by size of community, with the smallest communities having the greatest per capita costs due to economies of scale. Thus a small community with no need to have treatment beyond the secondary level would have local capital costs of over $200 per capita. The greatest impacts, however, are for those communities with major combined sewer overflow problems. The local share of captial costs for these communities could exceed $450 per capita.

- Over two-thirds of POTW capital costs usually are financed with bonded debt. Use of sewer service charges has grown from 20 percent of all municipalities in 1945 to 61 percent in 1960 and 85 percent in 1969. Property taxes are used by a significant number

of communities and play a prominent role in repayment of capital expenditures and debt service. While most communities use some type of flow-based charge system for industrial users, only 20 percent account for waste loads through surcharges, and for a significant number of these the surcharge program exists only on paper.

- The shift to user charges and industrial cost recovery will require significant changes in billing and monitoring practices for the vast majority of communities.

- Federal law and regulations provide for a subsidy of about 45 percent of capital costs for industrial users of POTW, even with industrial cost recovery, because capital cost recovery provisions do not require interest payments. Industries with compatible waste can gain substantial advantages by discharging to publicly owned treatment systems. The industrial user of a public system, therefore, gains the advantage of both economies of scale which may account for a saving of up to 80 percent for small users and a substantial subsidy. However, a direct discharger able to take full advantage of accelerated depreciation for pollution abatement expenditures, state and local tax relief, and industrial revenue bonds for financing, may realize subsidies almost as large.

- Cost savings for POTW's could result from improved capacity forecasting, shorter design lives, and better choice of technological approach. The first two can result in systems operating closer to capacity, thus reducing efficiency. In addition, hydraulic overload problems that plague many systems today could be more quickly encountered in the future for some systems. For lower cost technologies the effect on performances is less clear, although they might lead to improved performance since less costly alternative technologies normally require operators with less skills then the higher cost technologies. Further, lower operating costs may relieve local financing burdens. The ability of some state and local governments to implement better cost effective programs may be limited by the low salaries for environmental engineers.

- Operating performance of treatment plants has been a serious problem in the past. 1974 survey data reveals that over 30 percent of all treatment plants for which adequate data were available were failing to meet design criteria. Over 56 percent of the plants did not have adequate data to make an assessment of their performance. The 1973 EPA Needs Survey indicated that over 18 percent of all facilities reported that they were operating

above design capacities. Over 39 percent of the facilities serving over 150,000 people were operating above design capacity. The combination of rapidly growing operating expenditures and poor financial outlooks for many communities may accentuate this problem. A shift from property taxes to user charges would provide an increased revenue base and separate POTW's from tax structures as use increases.

- o Recent operator training appears adequate to satisfy the current numbers of operators needed. However, increased training is needed to improve operator proficiency. Also, in the near future a program to expand training and/or increase municipal treatment plant operator salaries will be necessary to assure that an adequate number of operators are available for the more sophisticated treatment plants forthcoming. The importance of training to treatment plant efficiency suggests that steps be taken to guarantee that treatment plants are staffed by qualified personnel.*

6. Macroeconomic Impacts

- o The Wharton Econometric Forecasting Model was used in the analysis of macroeconomic impacts. The Strategic Environmental Assessment System (SEAS), based upon the INFORUM/input-output model was used

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* An October 16, 1975 comment by John C. White, Regional Administrator, EPA Region VI, reads as follows:

"In Region VI, more than fifty percent of the wastewater treatment facilities need operator training for upgrading class certification and in addition, facilities need more certified operators to provide sufficient numbers of adequately trained operators for efficient operation and proper maintenance. Of those certified operators employed by municipalities operating treatment facilities, too many have been assigned dual responsibilities that do not allow the operator to spend the required time at the facility. Experienced, certified operators are leaving this field annually. The turn-over occurring in states in this Region vary from 12 to 30 percent. Advance waste treatment (AWT) unit processes and operations will be required to meet NPDES permits in high density populated areas. Few certified operators have been trained to operate and maintain AWT processes and operations. There is an acute need for professional quality instruction and certification, and of equal significance is the need to increase salaries, with professional recognition for certified operators."

to forecast economic/environmental interrelationships. Long run macroeconomic forecasting is difficult with even the most sophisticated tools. The estimated impacts presented here should be considered with this in mind.

- Thirteen alternative scenarios were analyzed to estimate a range of possible impacts. The impacts on Gross National Product, prices, employment, and investment due to P.L. 92-500 are smaller than the normal fluctuations in these variables.

- Inflation is 9 percent above baseline projections in 1985 indicating an inflation rate that is .9 percentage points higher due to the imposition of pollution abatement standards. The conventional price indices do not assign a value to "free goods" such as water and air. Therefore, improved water quality is not taken into account in assessing the average price of goods and services.

- The impact on GNP and employment is stimulative through 1982 and depressive in 1983-1985. The unemployment rate could be .9 of a percent lower in 1977-1980 and then much higher in 1984-1985 due to the Act. Unemployment has ranged from 3.5 to 9 percent over the last ten years.

- Impacts on plant and equipment investment and housing are generally mildly negative. The stimulative effects of the abatement expenditures tend to offset the depressive effects via increased cost and prices. The most negative effects are projected to be in the latter years when both residential and non-residential investment are 3-4 percent below baseline projections.

- Productivity is positively effected in years of high uenmployment and unused capacity, since an increase in output often is possible without proportional increases in overhead costs. The increased costs of production becuase of abatement tend to offset these positive impacts so that in most years productivity declines slightly -- that is, total employment increases more (or decreases less) than total output.

- Results of alternative scenario analysis include:

  --A "smooth" pattern of total industrial expenditures (1975-83) yields smaller impacts throughout the period than in the strict compliance case where disproportionately large expenditures occur in 1976-77. This "smooth" scenario is more realistic in that it coincides much more closely with industry's planned expenditures on water pollution control (1976-78).

--The additional impacts associated with BAT (over BPT and NSPS) are minimal. They represent about one-third of the total price impacts after 1980 and less than one-fifth of the negative impacts on GNP and employment.

--If actual industrial expenditures turn out to be one-half of Commission estimates macroeconomic impacts will also be about one-half of those forecast.

--High levels of public expenditures would add to stimulative impacts and less so to inflationary impacts.

--If the economy continues to have high unemployment rates in the 1980's, the economic impacts will be little different from those forecast with a lower rate of unemployment. The major difference is that public expenditures would tend to be a more potent stimulative force given the higher levels of unemployment.

--If 25-50% of the abatement investments are in productive equipment (product and process change) the inflationary effects would be significantly less than otherwise. Stimulative impacts would also last 2-3 years longer and the depressive effects in the later years would be much smaller.

--The addition of air pollution abatement expenditures (about one-third the size of industrial water pollution abatement expenditures) tends to increase all impacts proportionately.

o The Strategic Environmental Assessment System (SEAS) was used to make projections of pollution levels corresponding to the different economic scenarios.

--Baseline

Industrial pollution <u>in the absence of P.L. 92-500</u> (assuming no improvement in abatement after 1971) by 1985 would be 163 percent of the 1971 levels as measured by BOD, 156 percent of the 1971 COD level, 140 percent of the Suspended Solids level of 1971, and 101 percent of the 1971 Dissolved Solids level.

Public discharges, however, assuming the continuation of historical trends of public spending, would tend to be stable for BOD and SS 1971-1985. Increased treatment would offset population growth. Dissolved solids discharges would grow 27 percent over the period given the low levels of removal for these pollutants with conventional waste treatment techniques.

--Compliance

Industrial discharges in 1985 would be 24 percent of 1971 levels for BOD given full compliance with P.L. 92-500. Without BAT effluent limitations, the 1985 BOD level would be 46 percent of the 1971 levels.

Industrial discharge of Suspended Solids would be 6 percent of the 1971 level with full compliance, and 21 percent without BAT effluent limitations.

For Chemical Oxygen Demand (COD) the comparable percentages would be 42 percent full compliance, 73 percent without BAT.

For Dissolved Solids-- 62 percent full compliance, 83 percent without BAT.

Public discharges in 1985 would be 31 percent of the 1971 level for BOD, and 35 percent of the 1971 level for Suspended Solids given the increased expenditures and treatment associated with P.L. 92-500. Dissolved Solids are forecast to grow 32 percent in spite of the increased treatment.

Industrial and municipal discharges are projected to be remarkably similar by 1985 given compliance. In 1971 industrial discharges were 34 percent greater than public for BOD and 5 times the public level for suspended solids.

Average cost per ton of reduction in industrial discharge is approximately 1/3 the cost of reduction for public treatment systems for both suspended and dissolved solids. The greater cost effectiveness in reducing industrial discharge is largely due to greater concentration in industrial wastes.

7. Supply Constraints

- o Strict industrial and municipal compliance with the 1977 and 1983 deadlines would cause severe shortages of sanitary engineers needed to design and construct water pollution abatement facilities. Chances of shortages of materials, especially pipes, valves, and fittings, structural clay products, service industry machinery, industrial controls, and cement and gypsum increase if the deadlines are strictly enforced.

- o Spreading water pollution control expenditures over a longer period can eliminate shortages substantially, though problems seem likely to remain for pipes, valves and fittings, and the skill levels and capabilities of POTW operators.

- o Current unemployment levels in the construction industry indicate that shortages of construction labor will not be an impediment to achieving the Act's requirements.

- o Current over-capacity in the water pollution control equipment industry should provide adequate supply of this specialty equipment. A reasonably "smooth" pattern of pollution abatement expenditures should cause relatively low additional price increases.

- o Tight supplies of chlorine, caustic soda, lime, and soda ash can occur in the future, primarily from demands for other uses. Even major changes in wastewater treatment demand will not add significantly to the total demand. Recent experiences by municipalities with chemical shortages may stimulate better methods of insuring adequate supplies in the future.

8. Benefits

- o Attainment of the goals and the requirements of the Act results in substantial impacts upon certain leisure time activities. These impacts may be quantified partially in economic terms.

- o Certain types of real estate near selected water bodies will expereince increased value due to improved water quality. This value is $92.5 million annually in 1985 and 2000.

- o New flows of economic activity resulting from the reopening of beaches due to the Act's achievement will result in annual values of $158 million in 1985 and $212 million in 2000, as a low estimate, and $521 million and $701 million, respectively, as a high estimate.

- o Increased values to marine resource use, both commercial and recreational fishing, will result in economic gains of $3.9 billion in 1985 and $5.2 billion in 2000.

- o Freshwater fishing activities resulting from attaining 1985 goals will bring gains of $220 million in 1985 and $217 million in 2000, as a low estimate, and $521 million and $701 million, respectively, as a high estimate.

- Other boating will increase dramatically under the influence of improved water quality, amounting to $498 million annually in 1985 and $528 million, as a low estimate and $1.2 billion and $1.7 billion, respectively, as a high estimate.

- An approximation of the cumulative "worth" of these measurable positive impacts of P.L. 92-500 may be obtained by deriving the discounted present value for these activities. Using discount rates ranging from zero percent for the time period 1972-85 to 4 percent for 1972-2000, resultant present values range from a low of $33.3 billion to a high of $88.1 billion. Discounting at 4 percent to infinity yields a present value approaching $200 billion.

- These measures of gain include only the direct effects of changes in the referenced activities. They do not include either indirect benefits from changes in the level of these activities or measures of changes in any other water-related leisure activities. They also do not include measure of potential health benefits in quantifiable economic terms, or any monetary value of avoiding irreversible environmental damages or preserving water quality at specified levels for use by future generations.

9. Social Impacts

- The major groups affected by plant closures are white males (electroplating, pulp and paper) and women (textiles). Minorities do not bear a disproportionate share of job losses. The majority of the negative employment impacts occur as a result of the 1977 requirements.

- The expenditure peaks in 1977 and 1983 sustain positive employment from 1977 through 1983 with price and productivity effects bringing a sharp downturn to negative employment impacts by 1983. Without the 1983 requirements, the extent of impacts is moderated, but the pattern is similar.

- The average annual cost per family for treatment plant and interceptor sewer needs and for BPT is $306. The costs per family for both BPT and BAT and all municipal categories except urban runoff is $522. In each case this is based upon the families actually to be serviced by these projects, not all families in the United States.

- The Federal income tax and user charges are the two most important mechanisms in financing the publicy owned treatment works program. User charges weigh particularly heavily on low income groups,

while the Federal income tax is more progressive. One important consequence of Federal funding is to shift burdens from lower income groups and from regions like the South where incomes are low relative to the rest of the nation.

- Price increases caused by the Act weigh most heavily on the lowest income families and next upon upper middle income families.

- The benefit of increased property values accrues mainly to middle and upper middle groups. Improved water quality benefits are distributed to lower income groups, if adequate access exists.

B. WATER AS AN ECONOMIC RESOURCE

From the beginning of recorded history, water has played a crucial role in man's economic activities. This historical pattern was repeated in the United States where development followed the geographic dispersion of water. Highly concentrated population centers evolved along ocean shores, bays, estuaries, and river mouths. Inland development patterns followed the principal rivers, and cities grew up along them.

Water has been a mode of transportation and an integral part of many production processes. Industrial, agricultural, and municipal activities were keyed to the availability of water. It was used for power, steam generation and cooling, for drinking, and to enhance agricultural productivity.

The motivation to develop along water bodies related to an economic evaluation of water in industrial and agricultural production, municipal supply and the transportation of industrial goods. Aside from cost differences due to transportation, storage, and ground water extraction, water was essentially a free resource. Exceptions to this rule evolved initially in arid western states where water has been relatively scarce.

As economic growth occurred, water passed from the free stage to a resource with competing economic values. The price of water at different locations and for different uses became more relevant to economic decision-making. The actual quantities and prices associated with varying rates of water use play a role in determining the costs and impacts of meeting the Act's requirements and goals. This may take the form of the individual entrepreneur's decision to reduce both the amount of water being used and the quantities of resulting water-borne wastes, explicitly and primarily as a conscious strategy in minimizing the costs of abatement.

Studies indicate that there are current trends in reduced water use. In part, these trends relate to regional water scarcities, but there are other reasons. The increasing cost of water affects those industries using huge quantities. Evolving technologies introduce new production procedures which generate water savings. Knowledgeable plant managers can reduce water use by applying existing technologies more carefully.*

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* Ralph Stone, in a communication to Mr. Wendell E. Johnson, American Society of Civil Engineers, Environmental Engineering Division, states "American industries can often reduce water pollution by changing their manufacturing processes to use other less polluting methodologies such as substituting dry for wet processes." (7)

William R. Adams, Jr., Commissioner, State of Maine, Department of Environmental Protection, reports in a February 4, 1976 communication to the Commission that, "In some instances, abatement programs have actually helped Maine industries save money. For example, one pulp and paper company has offset wastewater treatment costs through fiber recovery from better housekeeping practices." (1). This observation is supported by Emil Zars at a Commission public hearing in San Francisco, January 10, 1976, where he stated, "Primary to my suggestions is a conviction that pollution is a sign of poor housekeeping." (13). Further, at that same hearing, W.R.Z. Willey observed, "Increased efficiency in water use -- water conservation -- decreases the need for abatement expenditures." (12). He also commented that the report recognizes the economic relationship to water use, but noted that the baseline forecasts used here may not. He further commented that the staff report forecasts are based on a history of inefficient water use and, therefore, provide an inflated estimate of required abatement expenditures relative to a more efficient water use pattern. If these statements about water use efficiency are correct, then Willey's observations concerning a bias in required abatement expenditures are correct.

There is also the opportunity to segregate water used for various production processes. While this may not lower total water use, it may reduce water use for parts of the production process and thus reduce or alter the character of waste loads. Figures III.B.1 through III.B.5 illustrate the trend in water use and withdrawal.

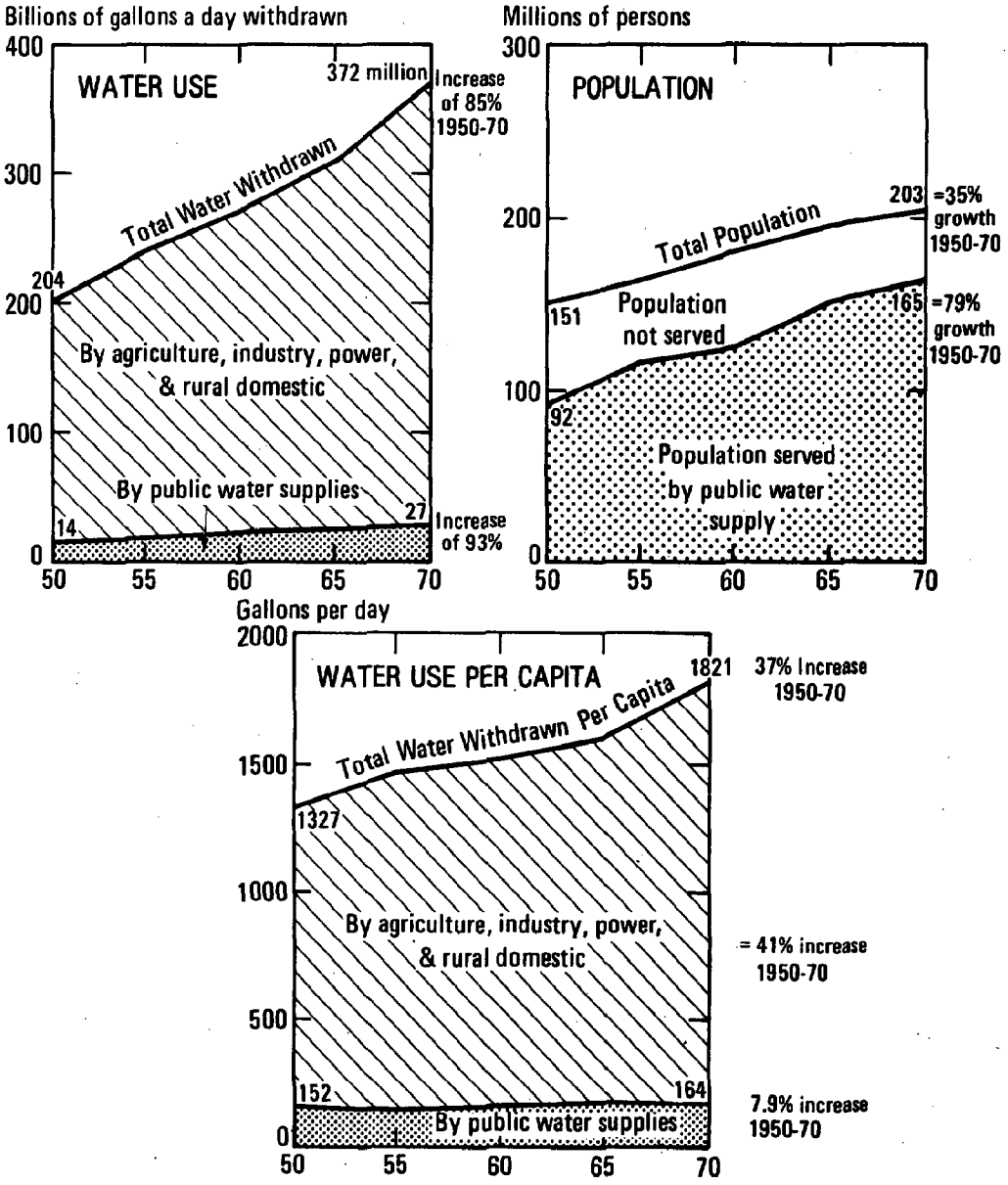
Water use per unit of output is trending downward. Estimates of costs and impacts of pollution control may be overstated when this trend is not considered. Decline in water use as a response to economic forces suggests that in the face of additional water-related costs there is the possibility for further reductions to meet the Act's requirements.

Figure III.B.6 summarizes the key dimensions of water use in manufacturing, including the recently released 1972 data. There has been a slight and gradual downward change in the use of water per unit of output. The trend predominates in the major water-using industries, with the exception of steam electric power, where intake quantities have increased dramatically. Figure III.B.7 illustrates regional differences in water use.

Growth in leisure time activities, including recreation, hardly needs documentation. As quoted in ORRRC Report No. 13 (1968), "the demand for outdoor recreation 40 years hence may increase as much as five to ten times over what it is now." (6). Participants in fishing have increased from 25 million in 1960 to 35 million in 1970. (Figure III.B.8). This does not measure the full impact of changes in the length

Figure III.B.1

INCREASE OF WATER USE IN U.S. & POPULATION SERVED 1950-70

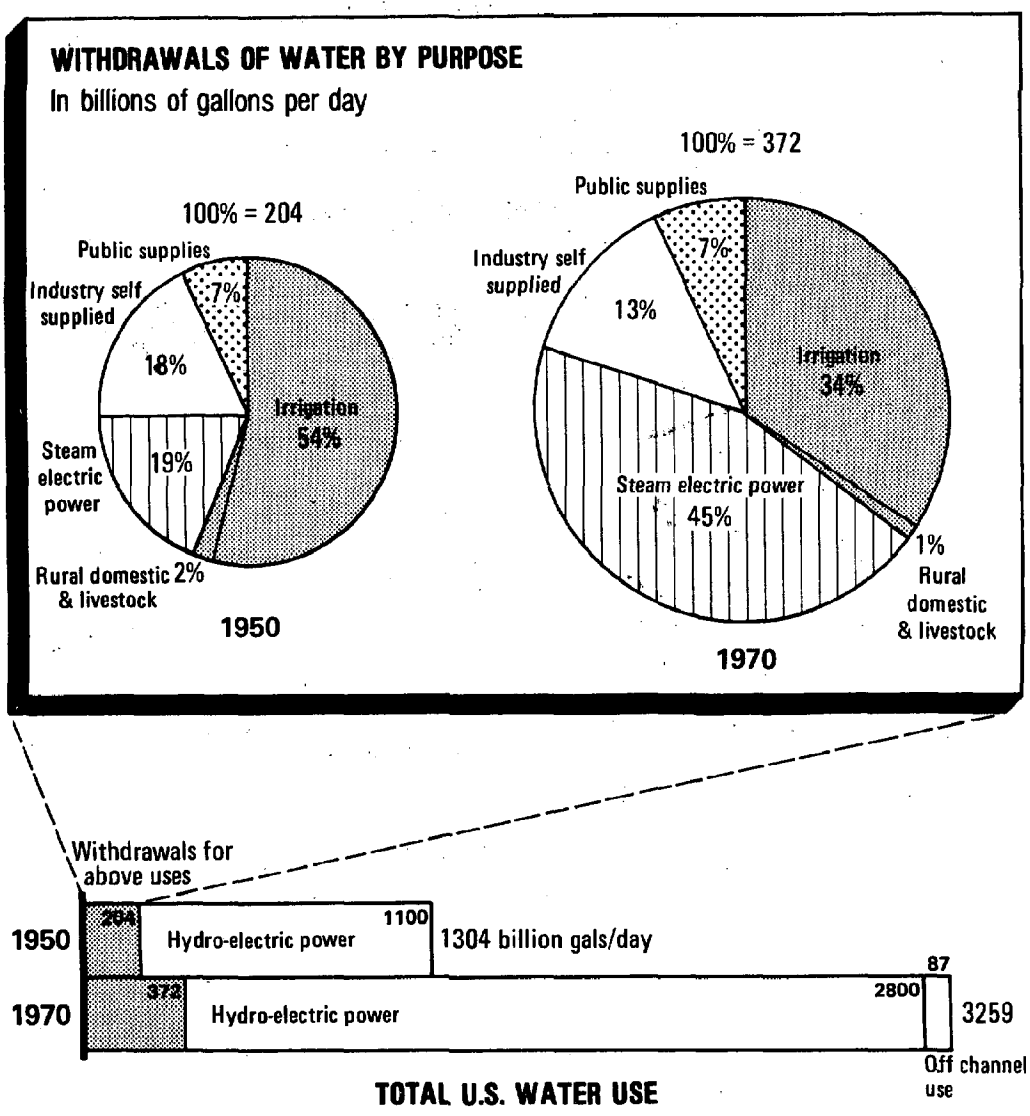


Source: National Commission on Water Quality. Redrawn from Murray, Richard C. & Reeves, E.Bodette. "Estimated Use of Water in the U.S. in 1970", Geological Survey Circular 676, 1972. p.11, fig.8.

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Figure III.B.2

SHIFTS IN WATER USE BY PURPOSE 1950-1970

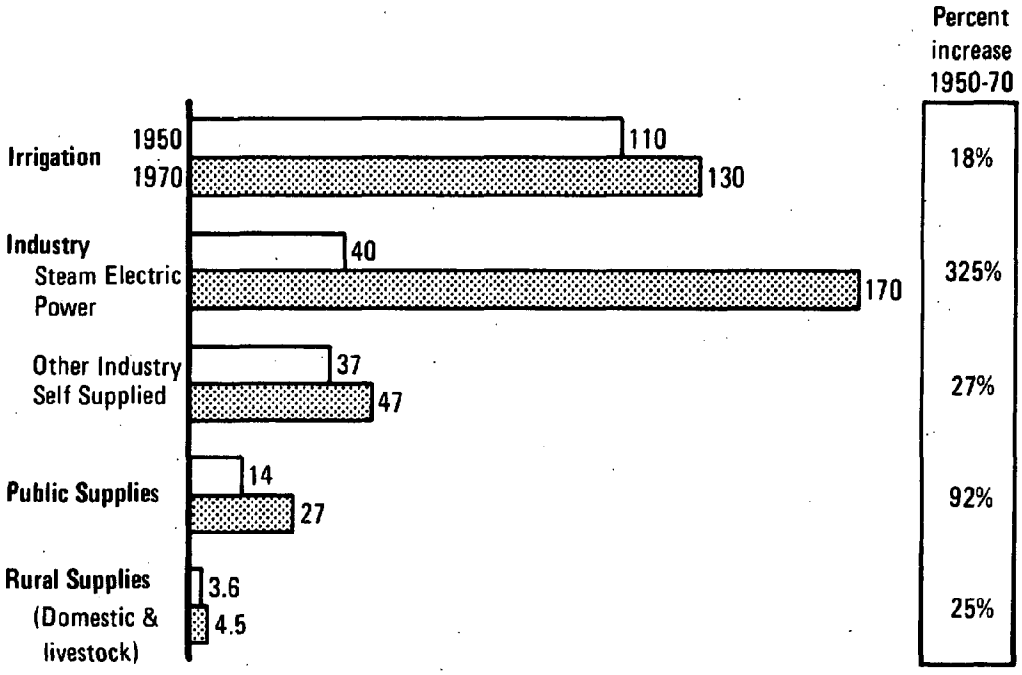


Source: Natl. Commission on Water Quality. Redrawn from Murray, Richard C. & Reeves, E. Bodette. "Estimated Use of Water in the U.S. in 1970", Geological Survey Circular 676. 1972. p. 10, fig. 12.

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Figure III.B.3

AMOUNT OF WATER WITHDRAWN BY PURPOSE 1950-1970
In billions of gallons/day

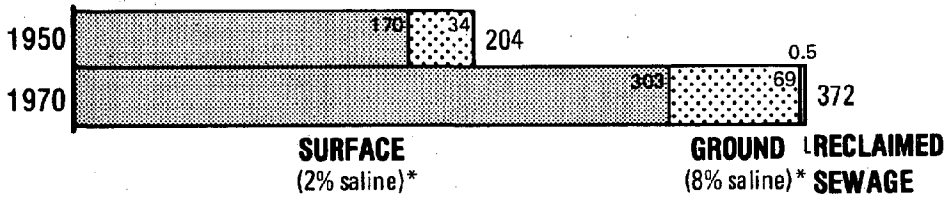


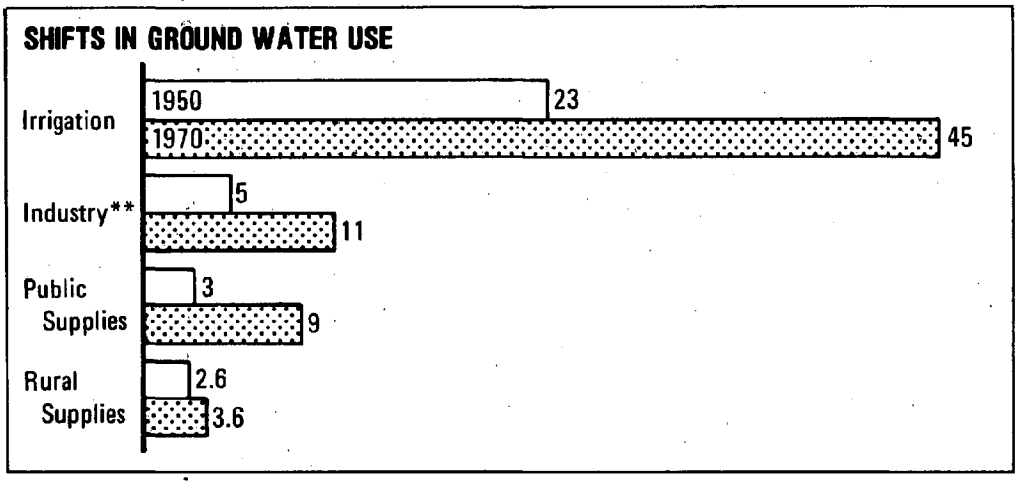
Source: Natl. Commission on Water Quality. Redrawn from Murray, Richard C. & Reeves, E. Bodette. "Estimated Use of Water in the U.S. in 1970", Geological Survey Circular 676. 1972. p. 10, fig. 12.

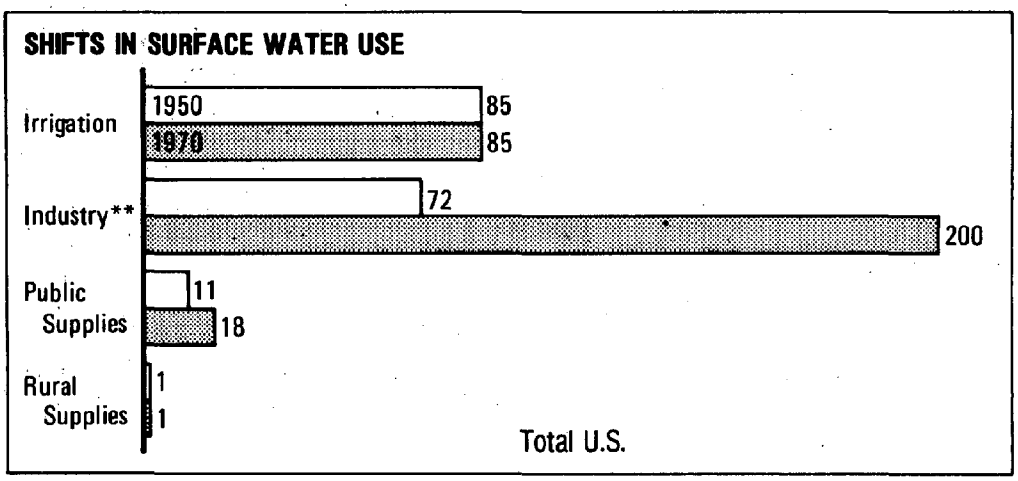
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Figure III.B.4

TYPE OF WATER WITHDRAWN 1950-1970
In billions of gallons/day







* Use of saline ground water increased 113% 1965-70

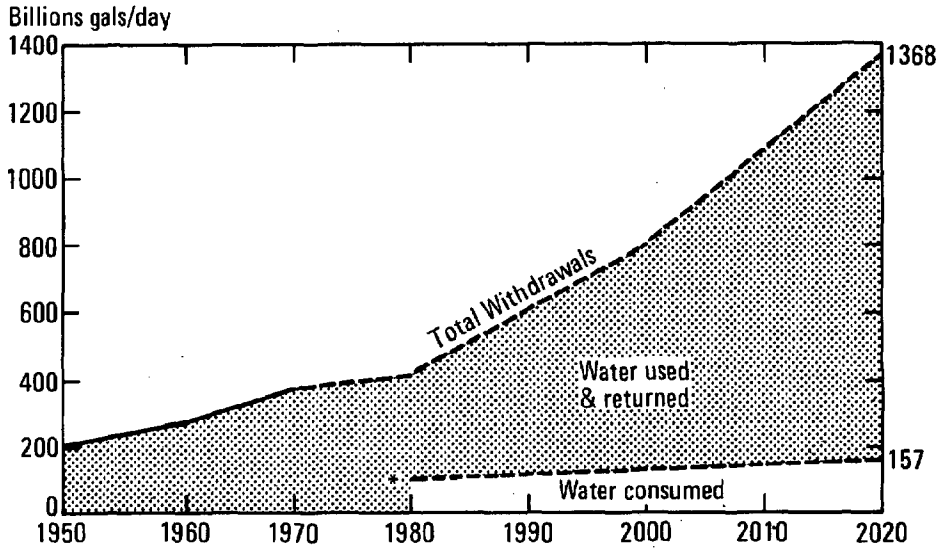
** Includes steam electric power which accounts for the major increase in 1970 surface water

Source: Natl. Commission on Water Quality. Redrawn from Murray, Richard C. & Reeves, E. Bodette. "Estimated Use of Water in the U.S. in 1970", Geological Survey Circular 676. 1972. p. 10, fig. 12.

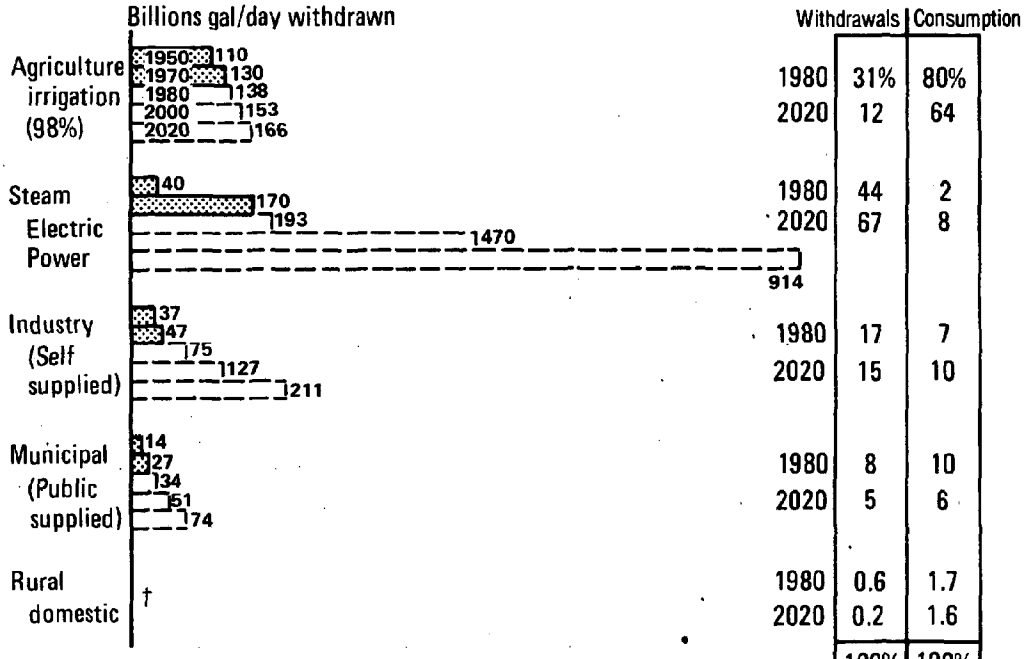
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Figure III.B.5

PROJECTED WATER USE IN U.S. 1980-2000



USE BY PURPOSE



	PERCENT OF Withdrawals	Consumption
Agriculture irrigation (98%) 1980	31%	80%
2020	12	64
Steam Electric Power 1980	44	2
2020	67	8
Industry (Self supplied) 1980	17	7
2020	15	10
Municipal (Public supplied) 1980	8	10
2020	5	6
Rural domestic 1980	0.6	1.7
2020	0.2	1.6
	100% both periods	100%

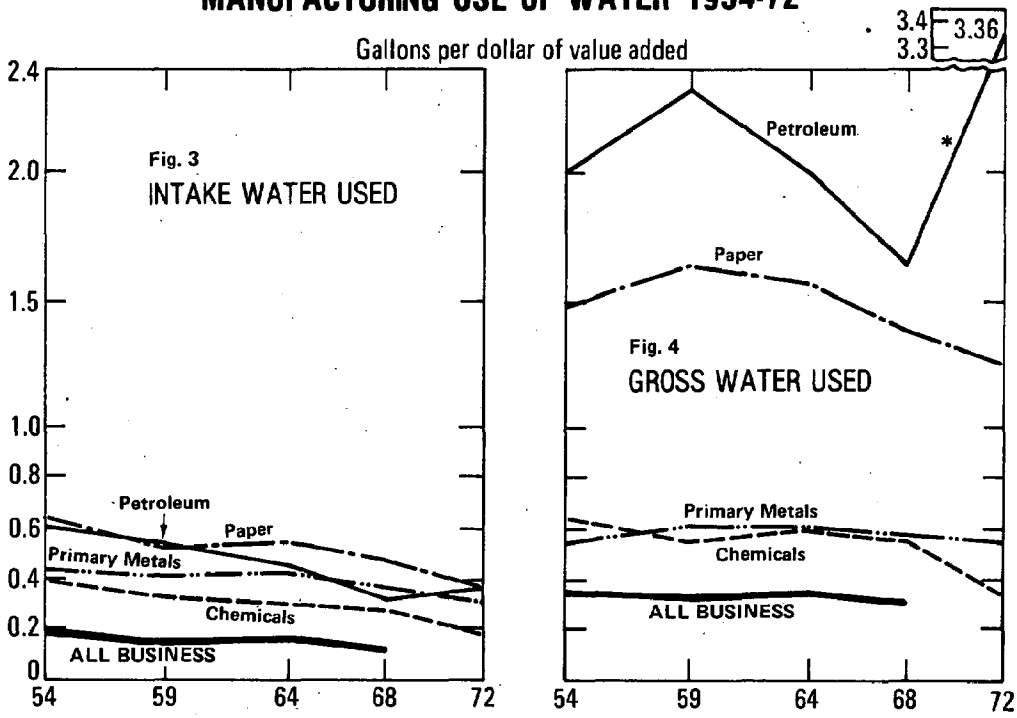
* Data on past water consumption not currently available.
† Under 3 billion gal/day, all years.

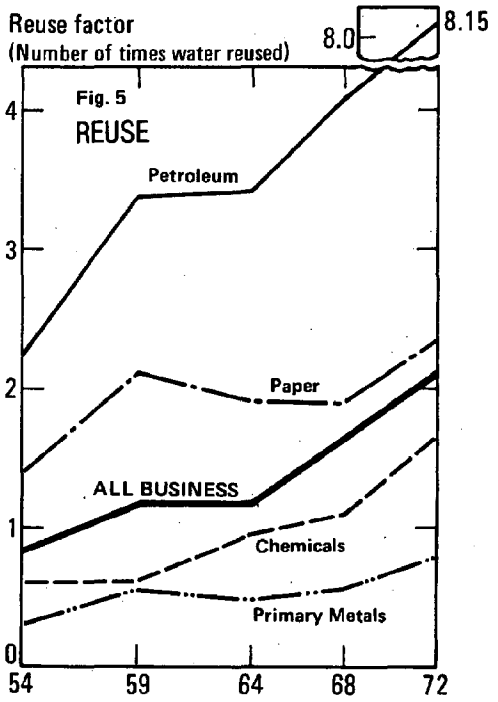
Source: Natl. Commission on Water Quality. Redrawn from Murray, Richard C. & Reeves, E. Bodette. "Estimated Use of Water in the U.S. in 1970", Geological Survey Circular 676. 1972. p. 10, fig. 12.

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Figure III.B.6

MANUFACTURING USE OF WATER 1954-72





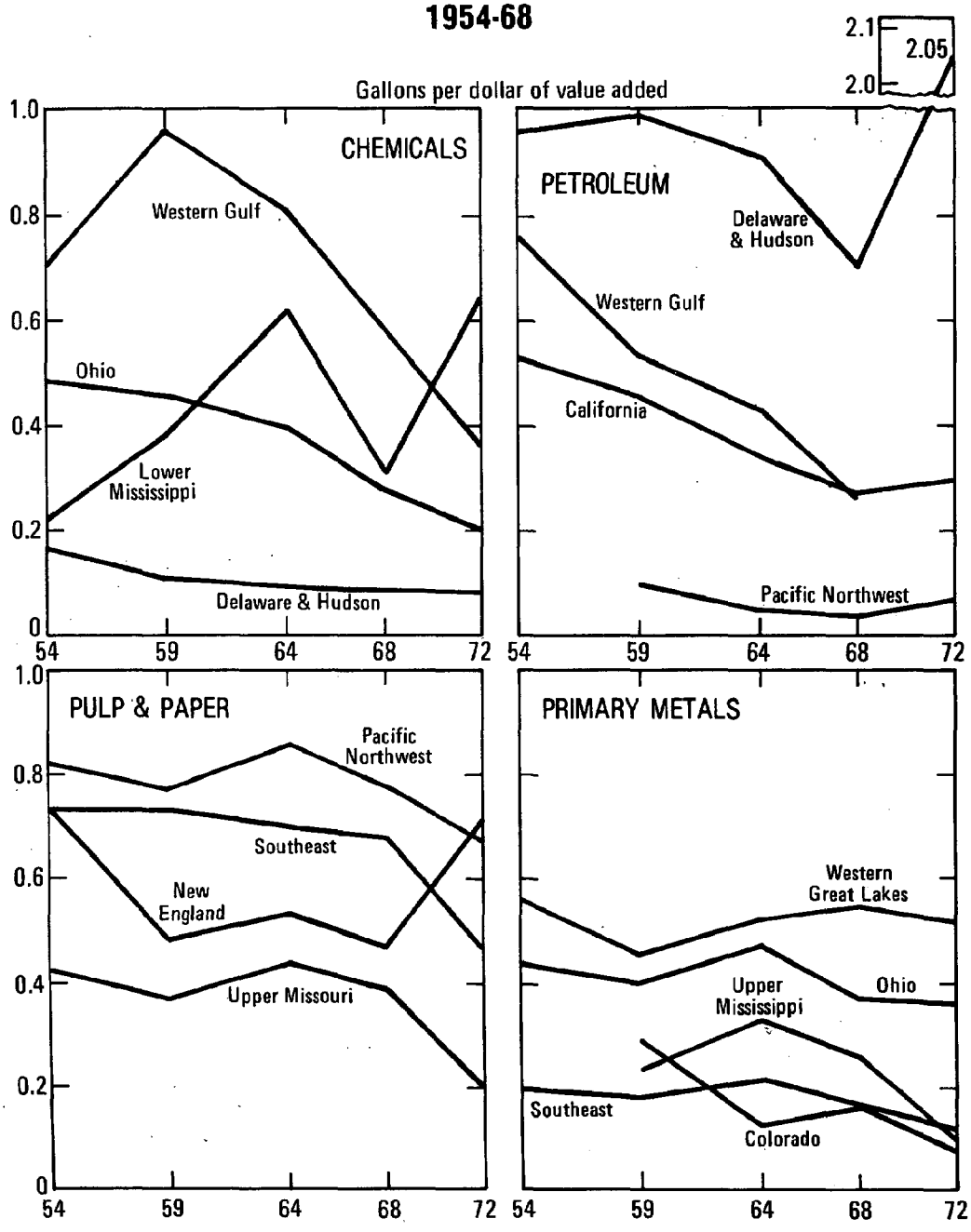
*The sharp rise in gross water use per dollar of value added in the petroleum refining industry over the period 1968-1972 is likely attributable to both a change in reporting methods and a decline in value added.

Source: Natl. Commission on Water Quality. From National Bureau of Economic Research. "Changing Water Use in Manufacturing", 1975.

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Figure III.B.7

REGIONAL WATER USE BY MANUFACTURING 1954-68

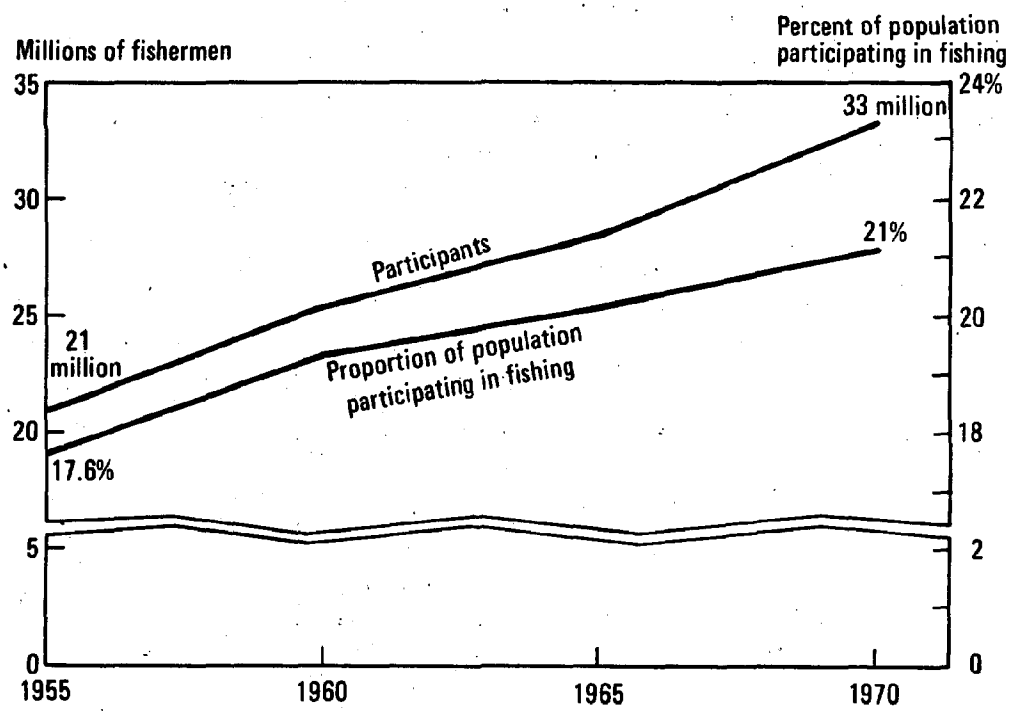


Source: Natl. Commission on Water Quality. From National Bureau of Economic Research, "Changing Water Use in Manufacturing", 1975.

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Figure III.B.8

FISHING PARTICIPATION IN THE UNITED STATES



Source: Natl. Commission on Water Quality. From U.S. Fish & Wildlife Service USDI, "1970 Nat. Survey of Fishing & Hunting", Resources Publication 95.

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of the participation activity and the associated increase in the growing levels of expenditures per day of participation.

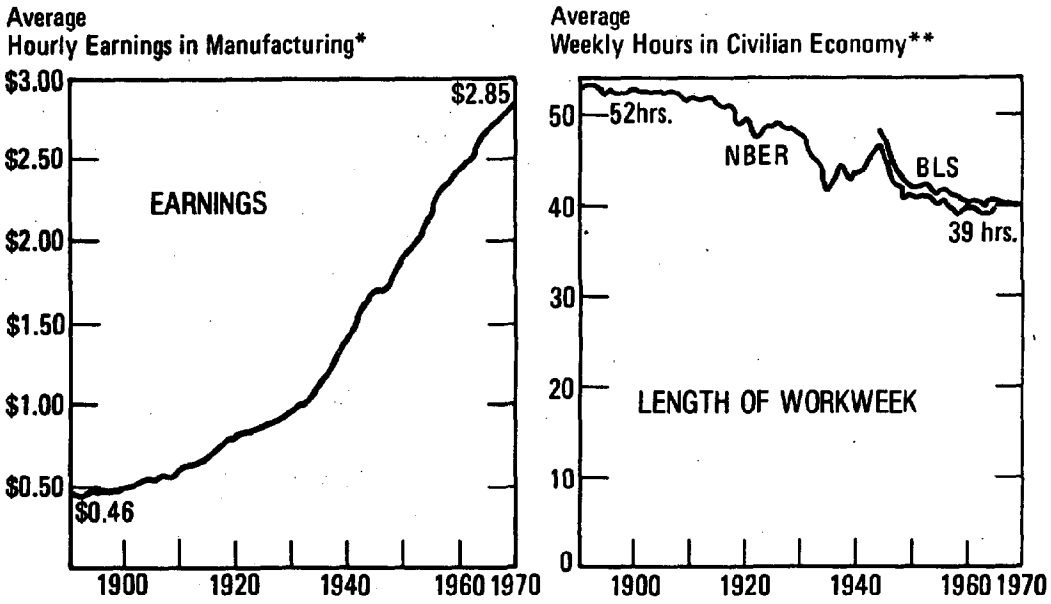
These studies also predicted various dimensions of future fishing activity. Numbers of fishermen were to increase by 168 percent from 1976 to the year 2000, with fishermen days doubling. Sports catch for existing water would increase 133 percent from 1960 to 2000 to 850 million pounds. This growth would develop in proportions consistent with historical patterns for the various water body types and regions (5).

These statistics are consistent with historical trends in determining recreation activity. Figure III.B.9 shows a continued rise in average hourly earnings combined with a decline in average weekly hours worked. These are further reflected in a rise of both payrolls and employment supporting the recreation industry. (Figure III.B.10). Aggregate personal disposable income has been increasing two-fold every ten years recently, with average hourly earnings increasing continuously since World War II (9). Recreational expenditures as a percent of rising disposable personal income have risen slightly to 6 percent in 1973. They have risen even more as a percent of personal consumption expenditures (PDI - Savings).

While not all of this information directly documents the use of water for recreation and leisure purposes, it does confirm that these activities are continuing to increase as a function of the economic standard of living. As growth occurs, pressures on relatively fixed water resources also grow. The continuing increase in recreational activities in the future must be considered when evaluating the impacts of achieving or not achieving the Act's goals and requirements.

Figure III.B.9

RISE IN EARNINGS & DECLINE IN HOURS WORKED 1890-1970



* (Earnings) 1890-1950 Nat Bur Econ Research (NBER) in 1957 dollars; 1950-1970 Bur Labor Statistics in 1967 dollars.

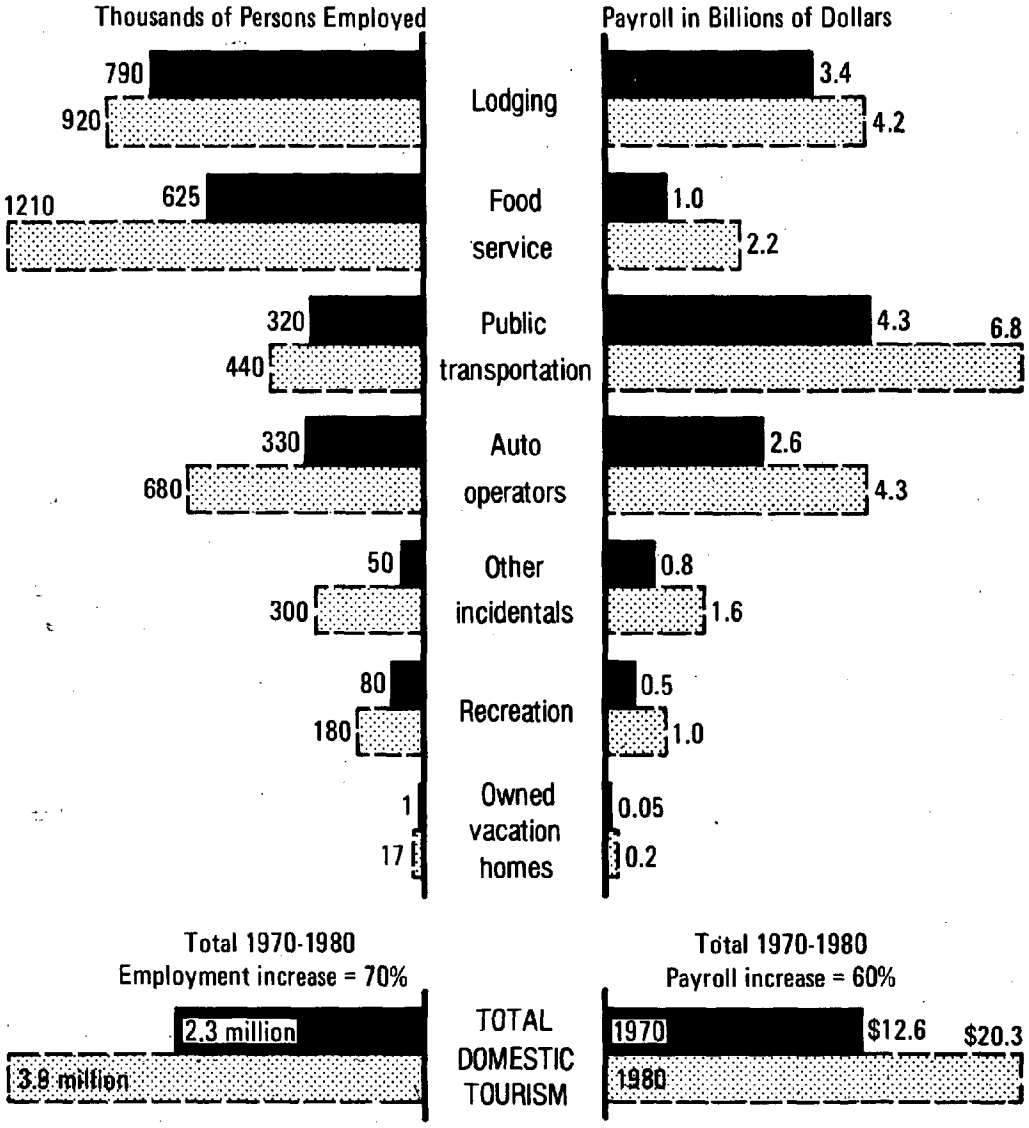
** (Workweek) 1890-1965 Nat Bur Econ Research (NBER); 1945-1970 Bur Labor Statistics.

Source: Natl. Commission on Water Quality. From Dept. Commerce, Bur. Econ. Analysis, "Long Term Economic Growth 1860-1970", June 1973

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Figure III.B.10

PRIVATE EMPLOYMENT & PAYROLL ATTRIBUTABLE TO DOMESTIC TOURISM 1970 and 1980



Source: Natl. Commission on Water Quality. Figures derived from graph of The Conference Board, "Domestic Travel and Tourism Road Maps of Industry", No. 1741, July 1, 1974.

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(2) Leone, Robert A., Ginn, J. Royce, and Lin, An-loh. Changing Water Use In Selected Manufacturing Industries. National Bureau of Economic Research. A study for the Institute of Water Resources, Corps of Engineers, Department of the Army. Contract #DACW 31-72-C-0044, December, 1973.

(3) _____. Changing Water Use In Manufacturing, Addendum for NCWQ based on preliminary data from 1977 Census of Water Use in Manufacturing. September-October, 1975.

(4) Murray, Richard C. and Reeves, E. Bodette. Estimated Use of Water in the U.S. in 1970, Geological Survey Circular 676, Washington, D.C., 1972.

(5) Outdoor Recreation Resources Review Commission. Sport Fishing, Today and Tomorrow. Report #7. Superintendent of Documents, U.S. Government Printing Office, Washington, D.C., 1962.

(6) _____. Federal Agencies and Outdoor Recreation. Report #13. Superintendent of Documents, U.S. Government Printing Office, Washington, D.C., 1968.

(7) Stone, Ralph. Communication to Mr. Wendell E. Johnson, American Society of Civil Engineers, Environmental Engineering Division.

(8) The Conference Board. Road Maps of Industry. No. 1741. Domestic Travel and Tourism. New York. July, 1974.

(9) U.S. Bureau of Economic Analysis. Long Term Economic Growth: 1960-1970. Washington, D.C., 1973.

(10) U.S. Fish and Wildlife Service. 1970 National Survey of Fishing and Hunting. U.S. Department of the Interior, Resource Publication 95, Washington, D.C., 1972.

(11) U.S. Water Resources Council. The Nation's Water Resources. U.S. Government Printing Office, Washington, D.C., 1968.

(12) Willey, W.R.Z. Environmental Defense Fund. Communication to the Commission, January 10, 1976.

C. TRENDS IN ECONOMIC ACTIVITY AS RELATED TO THE NATION'S CAPACITY TO ACHIEVE THE GOALS AND REQUIREMENTS OF P.L. 92-500: INDUSTRIAL, MUNICIPAL AND MACROECONOMIC

The health of the economy can be a principal determinant of the nation's capability to achieve the Act's goals and requirements. Likewise, the capability of individual enterprises to achieve requirements and goals will be greatly influenced by the overall conditions of the nation's economy.

The Commission's economic impact analyses examined the ramifications of the efforts toward compliance in terms of traditional measurable variables. These included impacts upon prices, costs, profits, capital requirements, employment, and changes in industry structure due to plant closings. These variables are changing within the context of, and in part due to, activities in the economy, such as economic growth, patterns of consumption, the price of capital, levels of productivity, employment, resource scarcity, macroeconomic policies, and other factors.

A baseline from which to calculate impacts must be dynamic. Dimensions of impacts due to the Act can be ascertained only by separating out trends that are independent of the Act. The following section examines forces that will determine the patterns of progress toward achievement and the magnitude of the economic impacts resulting from this progress. The detail of the baseline calculation will be repeated in subsequent discussion summarizing the impact results.

In some of the industry studies, the Commission used detailed baseline projections of prices, output, plant closings, water use, and industrial organization. In other studies it was sufficient to illustrate that changes in baseline conditions would not appreciably alter the conclusions.

A "dynamic baseline" requires the projection of a minimum of two sets of variables: (1) macroeconomic conditions in the absence of the Act, (2) microeconomic or industry level conditions in the absence of the Act.

The first set of variables focuses on the overall economy over the next ten years, including rates of growth in GNP, unemployment, inflation, and interest rates. The second, at the level of the individual industry, focuses upon its rate of growth, mix of production technologies, pattern of water use, shifts in product mix, rates of capital obsolescence, and trends in industrial organization. In addition to the macroeconomic and microeconomic conditions a third set of variables, examining trends

in industrial water pollution control expenditures has been added. Water pollution control is not new. Local and state regulations and Federal acts and amendments existed for many years prior to 1972. These trends have to be factored into the analysis too.

Macroeconomic Baseline Projections

The size and nature of the impacts studied are sensitive to the macroeconomic baseline forecasts. The effect of the Act upon prices and employment depends on the degree of existing employment. The standard baseline used by the Commission to forecast national economic activity was obtained from the Wharton Model, with interindustry detail provided by the University of Maryland Interindustry Forecasting Model (INFORUM) (15). The results are summarized in Figures III.C.1 and III.C.2.

Several aspects of this baseline forecast should be noted. In the 1975-1980 period, gross private domestic investment, particularly residential construction, are projected to have extraordinarily high rates of growth. In the recession of 1974-1975, investment and housing expenditures declined far more rapidly than the general economy. Thus, 1975-1980 growth rates are large because they assume rebound in residential construction. In 1980-1985 all types of investment are estimated to have a slightly lower than average growth rate, while the growth of consumption of durables and services is slightly greater. Total government purchases as a percent of GNP drop from 19 percent to 18 percent from 1975-1985 as does personal consumption expenditures which decline from 67 percent to 63 percent. Private investment absorbs this reduction, moving from 13 percent to 19 percent of GNP.

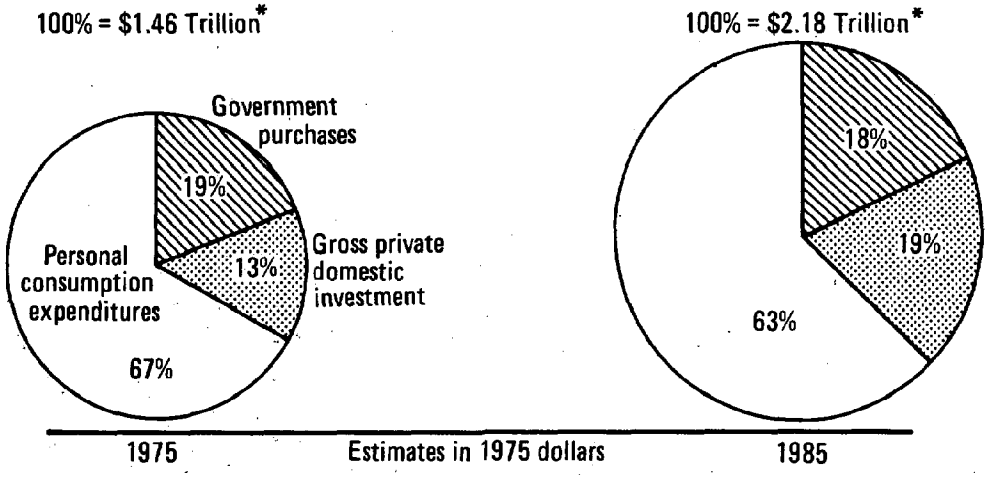
Three factors account for the declining growth rate between the periods, 1975-1980 and 1980-1985. First, the 8.5 percent unemployment for 1975 makes it possible for employment to increase more rapidly than the labor force, thus realizing a lower level of unemployment in 1980. Second, the labor force growth is projected to be greater in 1975-1980 than in 1980-1985. Third, productivity, or output per man hour, is projected to increase less rapidly in the second period. Productivity commonly increases more rapidly during cyclical expansions. During 1980-1985 there are both lower rates of growth in productivity in most sectors and a shift in the mix of production toward sectors with lower productivity and lower growth rates.

Three caveats should be made about this or any other long-term projection of economic activity from econometric models. First, assumptions made external to the model are important determinants of the resulting projections. Second, the accuracy of any attempt to forecast cyclical patterns beyond a year or two diminishes rapidly as the period lengthens. Third, the components of the models use data for a period

Figure III.C.1

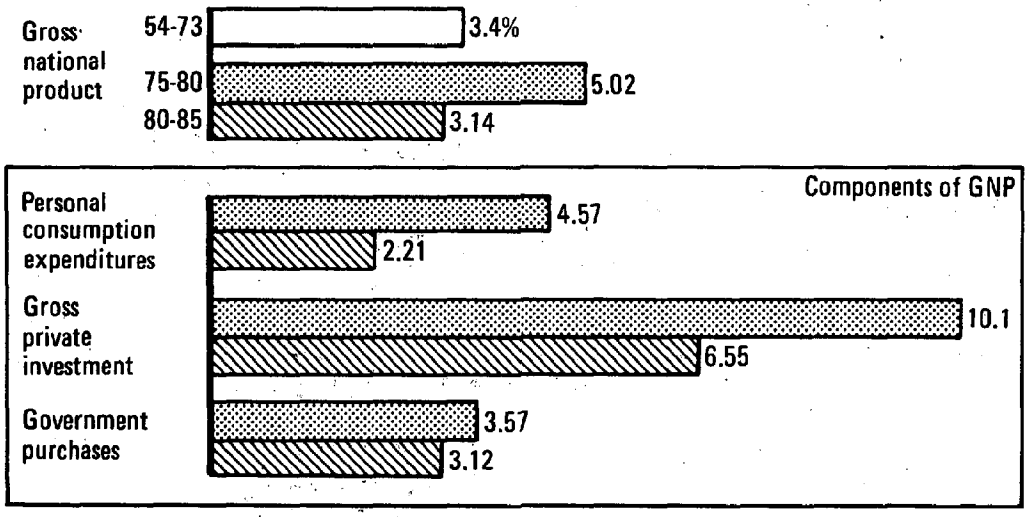
BASELINE ECONOMIC PROJECTIONS 1975-85

CHANGES IN COMPOSITION OF GROSS NATIONAL PRODUCT



COMPARATIVE ANNUAL GROWTH 1975-80; 1980-85

(Percent August)



* 1975 excludes 1% net imports; 1985 excludes under 0.5% net imports.

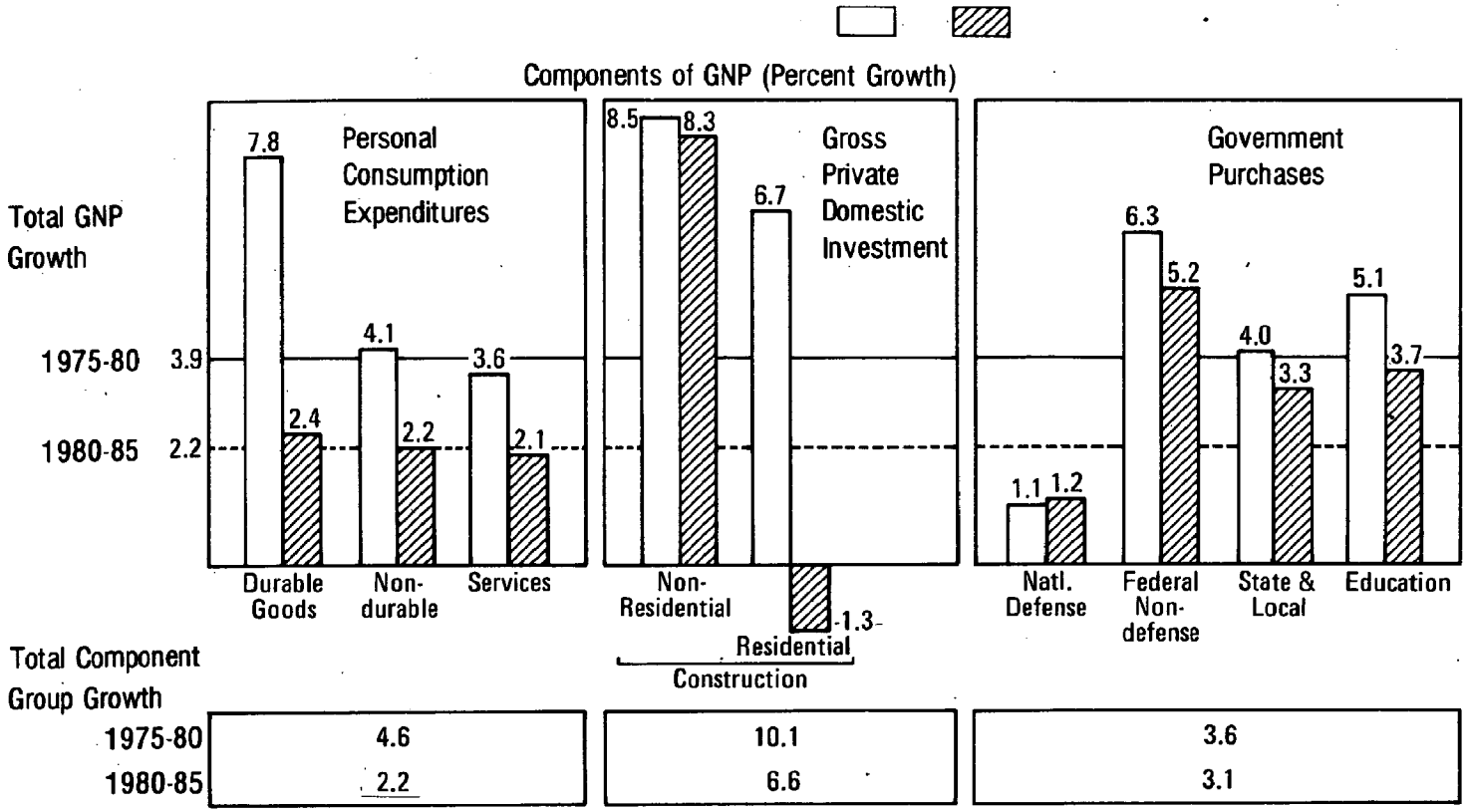
Source: Natl. Commission on Water Quality. From CONSAD Research Corporation, "Macroeconomic Impacts of P.L. 92-500", 1976.

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Figure III.C.2

ANNUAL GROWTH PROJECTIONS

Average annual for 5 yr. periods 1975-80, 1980-85



Source: Natl. Commission on Water Quality. From CONSAD Research Corporation, "Macroeconomic Impacts of P.L. 92-500", 1976.

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of relatively "normal" economic growth and employment -- i.e., no major depression or war. The projections of economic activity are derived from assumptions regarding population, labor force, government fiscal and monetary policy, and technological change. Beyond the future expansion phase of the current business cycle, no cyclical forecasts are made.

Industry Level Baseline

1. Output Projections: the INFORUM Model also projected standard baseline growth rates for individual industries. Figures III.C.3 through III.C.6 present these baseline projections of output, employment, plant and equipment, investment, and productivity over the next ten years for ten of the industrial categories studied.* The INFORUM baseline projections provide a common starting point for these industries, which constitute much of the primary manufacturing segment and reflect the general level of national economic activity.

2. Trends in Plant Closings and Industrial Structure: Potential impacts of the Act are plant closures and associated shifts in industrial structure. Plant closures in response to economic change are not unusual or totally undesirable. Exit (closure) and entry (new plants) into an industry are part of adjustment to more efficient production when markets and technologies are changing. Table III.C.1 presents baseline information on the historical rates of plant closures from 1967-1974 for six of the industries under study.

TABLE III.C.1: ANNUAL RATES OF PLANT CLOSING IN SELECTED MANUFACTURING INDUSTRIES, 1967-1974

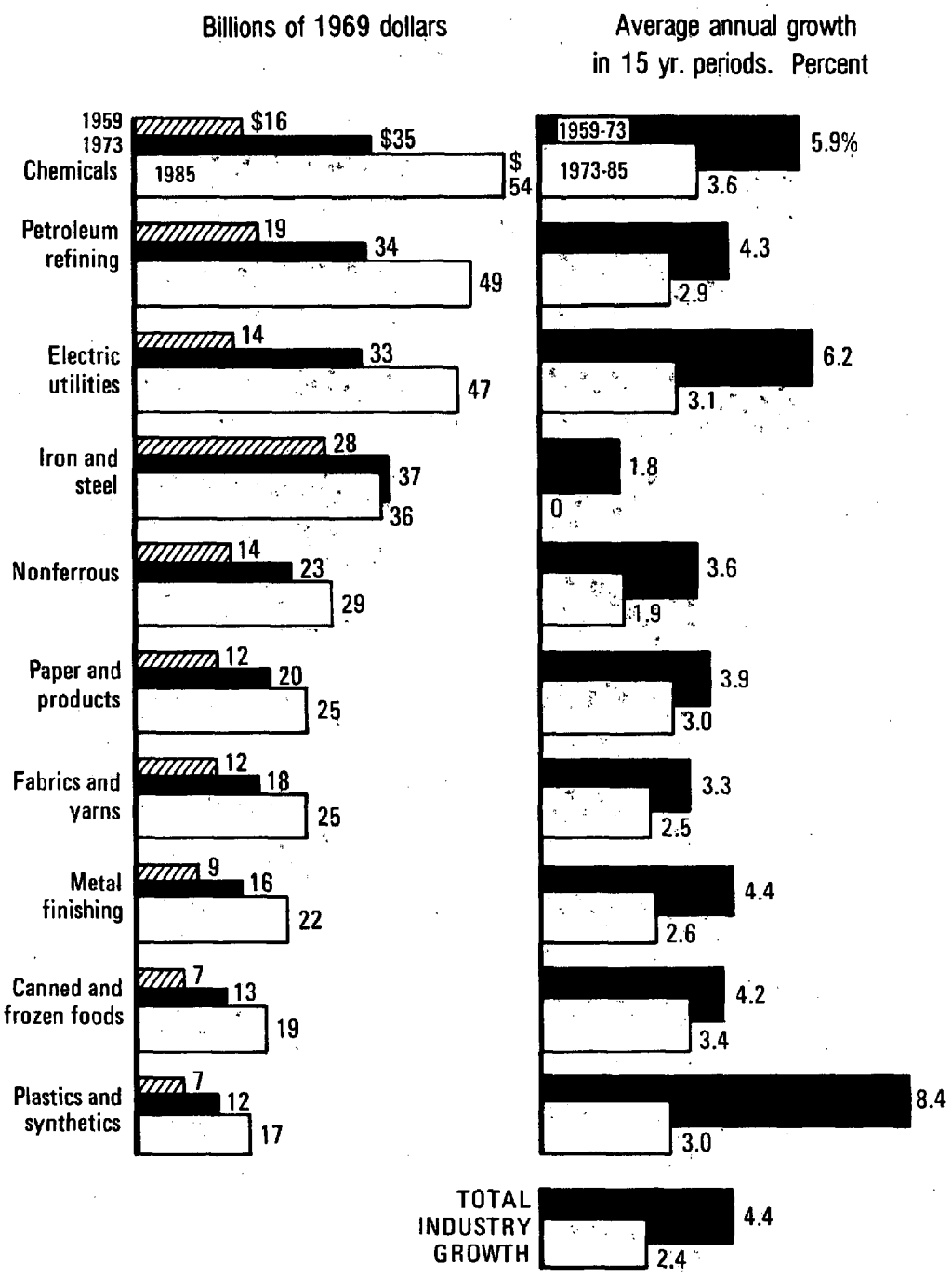
Industry	Closures Per 100 Plants
Textiles	2.2
Pulp and Paper	1.7
Petroleum Refining	4.7
Iron and Steel	1.7
Nonferrous Metals	4.0
Electroplating	1.3

Source: NCWQ. From National Bureau of Economic Research, "Economic Impacts of Water Pollution Control Act of 1972, Plant Closures and the Regional Consequences of Water Pollution Control". 1975.

* These are the largest major water-using industries and the categories studied in-depth by the Commission.

Figure III.C.3

BASELINE OUTPUT PROJECTIONS 1959-1985

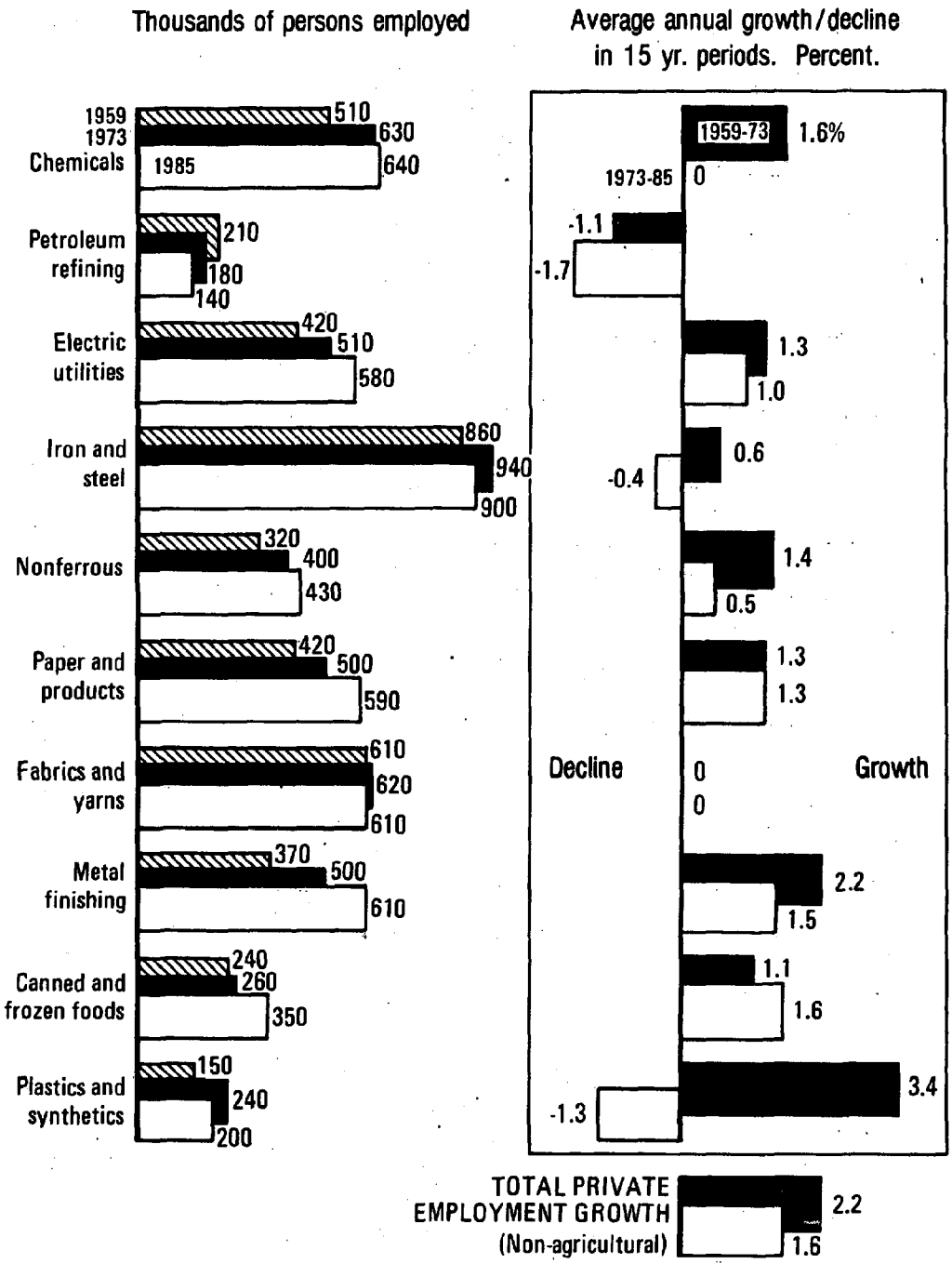


Source: Natl. Commission on Water Quality. From University of Maryland Interindustry Forecasting Model (INFORUM), May 1975.

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Figure III.C.4

BASELINE EMPLOYMENT PROJECTIONS 1959-1985

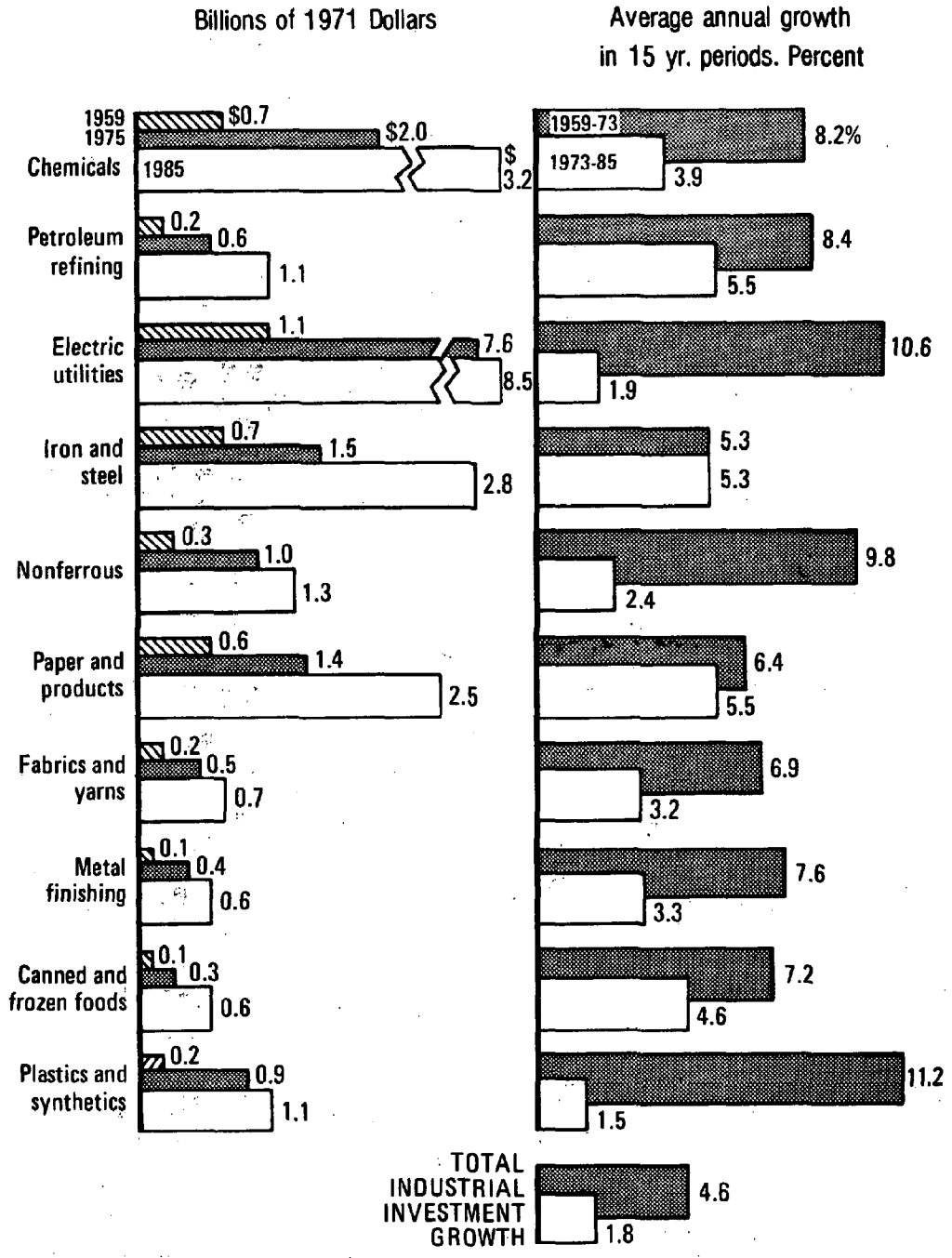


Source: Natl. Commission on Water Quality. From University of Maryland Interindustry Forecasting Model (INFORUM), May 1975.

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Figure III.C.5

BASELINE PLANT AND EQUIPMENT INVESTMENT PROJECTIONS 1959-1985



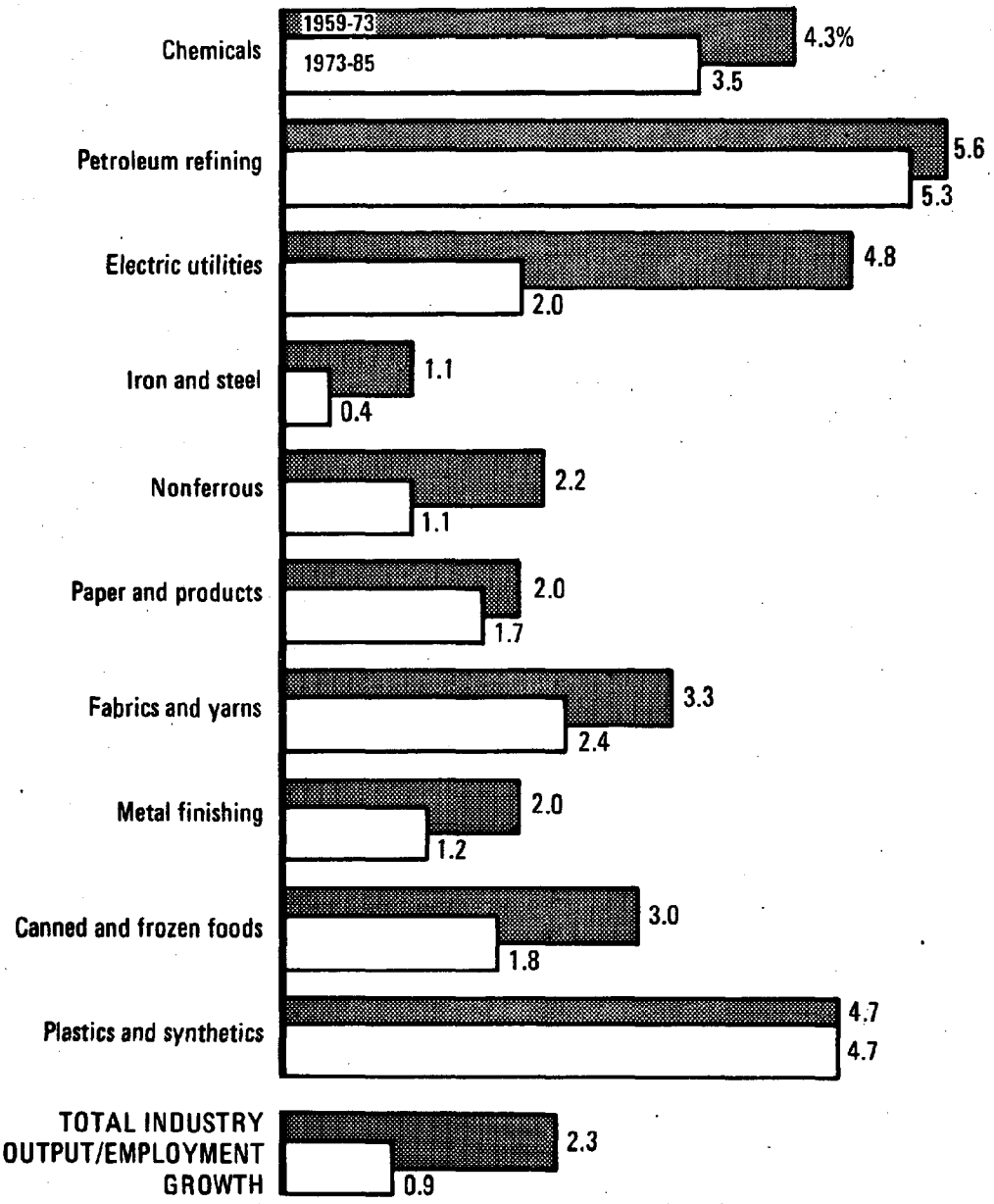
Source: Natl. Commission on Water Quality. From University of Maryland Interindustry Forecasting Model (INFORUM), May 1975.

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Figure III.C.6

BASELINE PRODUCTIVITY PROJECTION 1959-1985

Average annual growth in 15 yr. periods. Percent



Source: Natl. Commission on Water Quality. From University of Maryland Interindustry Forecasting Model (INFORUM), May 1975.

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Within the industries studied, there was definite variance in the incidence of closures among plant types. In Pulp and Paper some sectors had an absolutely and proportionately high incidence of closures. Building Paper and Building Board Mills (SIC 2661) has 45 percent of that industry's closings between 1967 and 1974, but only 12 percent of the industry's establishments as measured in 1972. Closings in the Paper Mill sector (SIC 2621) were roughly proportional to the sector's share of the existing plants in the industry -- i.e., 41 percent of the closings and 45 percent of the establishments. Conversely, only 13 percent of closings were paperboard plants (SIC 2631) -- a sector that comprises over 35 percent of the industry.

Differences within the Textile industry also illustrates the importance of the particular product manufactured. Of 22 subcategories within textiles, six categories -- with 32 percent of existing establishments -- accounted for 60 percent of plant closures. Twenty-one percent of all plant closings were in Narrow Fabrics (SIC 2241). Hosiery (SIC 2252) and Knit Outerwear mills (SIC 2253) accounted for 10 and 14 percent of closures respectively. Other examples of sectors with higher than average closings include wool weaving mills, woven carpet and rug mills, and miscellaneous knitting mills.

Commission studies examined existing and projected trends in industrial structure and concentration. Table III.C.2 presents existing trends in employment, number of plants, and size of plants, in terms of employment, for six industries. Net plant closures can explain employment trends. The decline in Petroleum Refining industry jobs coincides with a sharp decline in the number of refineries. In Electroplating simultaneous increases in the average size and number of establishments contributed to employment gains. Although the number of operating textile establishments actually decreases, the growth in the size of surviving plants caused an industry-wide employment gain.

Projections of market structure data for selected agriculture-related industries indicate that the general trend is toward a declining number of establishments. Employment is rising in eight of the Food Processing industries, but declining in the other seven. New capital expenditures and value of production are generally moving upward, the only notable exceptions are creamery butter, flour and other grain products. Heavy concentration of new capital investment is projected for the North Central states. In short, businesses in the agricultural industries are expected to become larger and more centralized as they handle increasing levels of production, while small firms will have difficulty staying competitive (7).

3. Trends in Production Processes and Product Mix: Changes in industry's input (labor and materials) prices, production technologies and product mix often impact its water use and residuals generation

TABLE III.C.2: Changes in Employment and in the Number and Size of Establishments in Selected Manufacturing Industries (1958-1972)

Industry	Change in Employment (Percent)	Change in Number of Establishments (Percent)	Change in Employment Per Establishment (Percent)
Textiles			
SIC 22	+15.5	-6.1	+23.1
Pulp and Paper			
SIC 2611	-25.3	+1.7	-26.6
SIC 2621	- 1.2	-1.4	+ 0.4
SIC 2631	+19.9	+8.3	+10.7
SIC 2661	-30.1	--	--
Petroleum Refining			
SIC 2911	-31.0	-27.6	- 4.7
Iron & Steel			
SIC 331	- 4.3	+36.3	-29.8
SIC 332	-20.3	-15.1	+41.6
Nonferrous Metals			
SIC 333	+24.2	+56.3	-20.6
SIC 334	+23.6	- 1.5	+25.5
Electroplating			
SIC 3471	+50.4	+23.5	+21.8
SIC 3479	+75.8	+49.3	+17.8

Source: NCWQ. From National Bureau of Economic Research. "Economic Impacts of Water Pollution Control Act of 1972; Plant Closures and the Regional Consequences of Water Pollution Control", 1975.

patterns. An impact analysis which focuses solely on the costs of water pollution clean-up for industry's present production technologies and product mix can misinterpret the impact of the Act.

For example, a major production process change affecting water use in the Pulp and Paper industry has been the continuing shift from sulfite to sulfate pulping. Sulfite pulping requires roughly 50 percent more intake and discharge water than does sulfate pulping. However, the effluent from the bleaching of sulfite usually is much lower in BOD and color than in that from the bleaching of sulfate pulp. The total resultant BOD remains relatively stable. Between 1947 and 1973 sulfite wood pulp dropped from 20 percent to 4 percent of total wood pulp production; sulfate wood pulp increased from 45 percent to 67 percent over the same period. Figure III.C.7 presents baseline projections of the relative shares in the production of pulp and paper between "product/process groups", indicating relative stability in the next decade. Figure III.C.8 illustrates trends in product mix in the Iron and Steel industry. By 1983, open hearth furnaces are projected to be eliminated. It would be wrong to assume that all such facilities, even though they are in operation today, will have to meet the water pollution control limitations for 1983.

Two cases in the agricultural industries illustrate the need to consider production changes. If grain prices rise, it becomes more costly to maintain established feedlots. Grass-fed beef would become more economical. If such a shift should occur, water pollution control problems at feedlots would diminish. In the Leather Tanning industry the U.S. Department of Agriculture estimates that a shift from salt-cured to fresh hides would result in about a 12 percent reduction in water pollution control costs, in addition to other substantial economies.

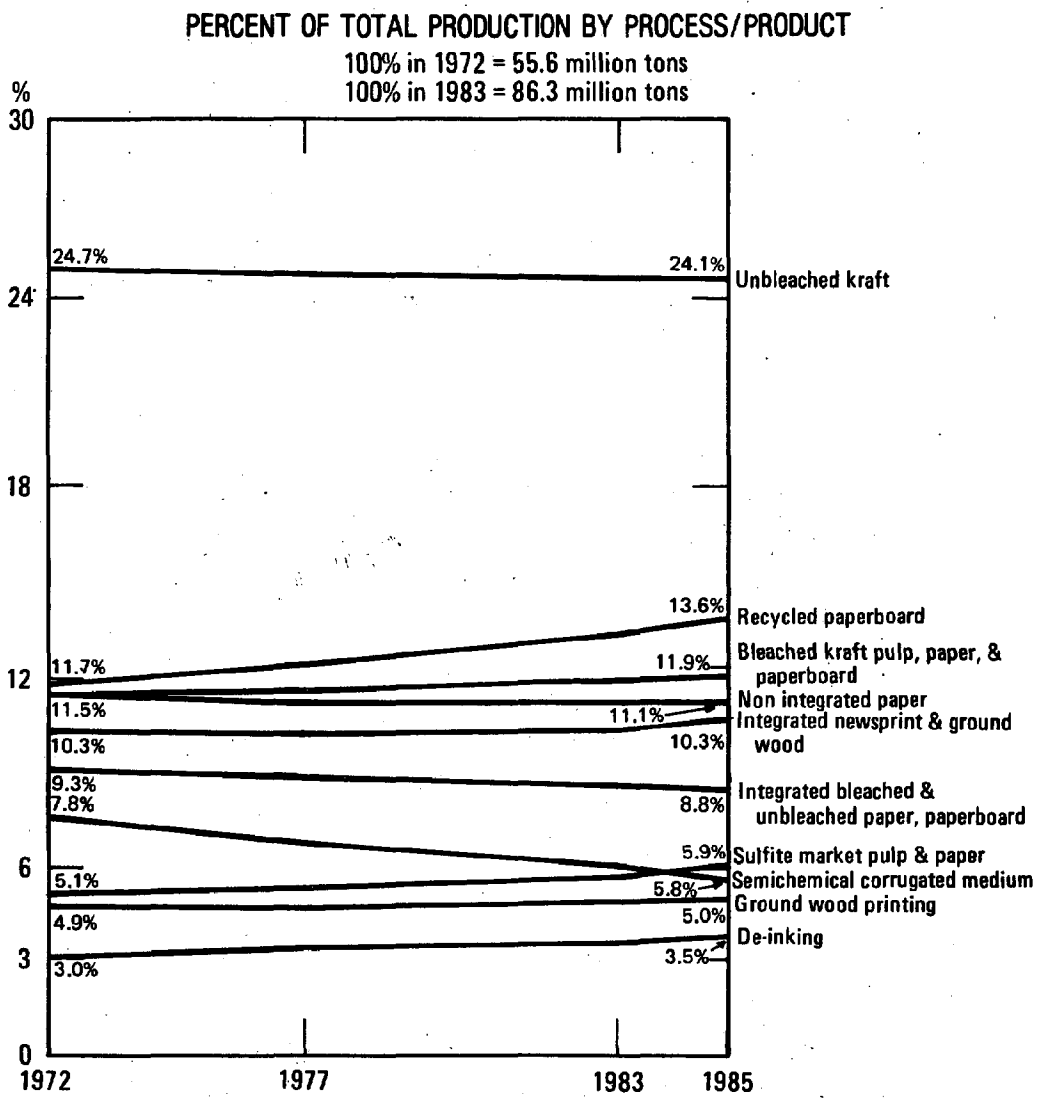
Trends in Municipal Abatement Activities

Any analysis of the Act's impacts on municipal abatement must examine past accomplishments in the absence of significant Federal funding levels. Figure III.C.9 shows the 1973 sewered population and the populations served by various levels of treatment. This overstates the existing degree of achievement. A population is counted as being served by a given treatment level, if the wastewater ultimately empties into a treatment plant. It does not take into account that many of these plants have inadequate capacity to actually treat the wastewater.* Over 19 percent of all facilities that reported this information in the 1973 Needs

* "It should be noted that many of the secondary facilities reported (e.g., trickling filters and waste stabilization ponds) could not meet secondary treatment effluent requirements." (1)

Figure III.C.7

TRENDS IN PROCESS/PRODUCT MIX
PULP & PAPER BASELINE PROJECTION

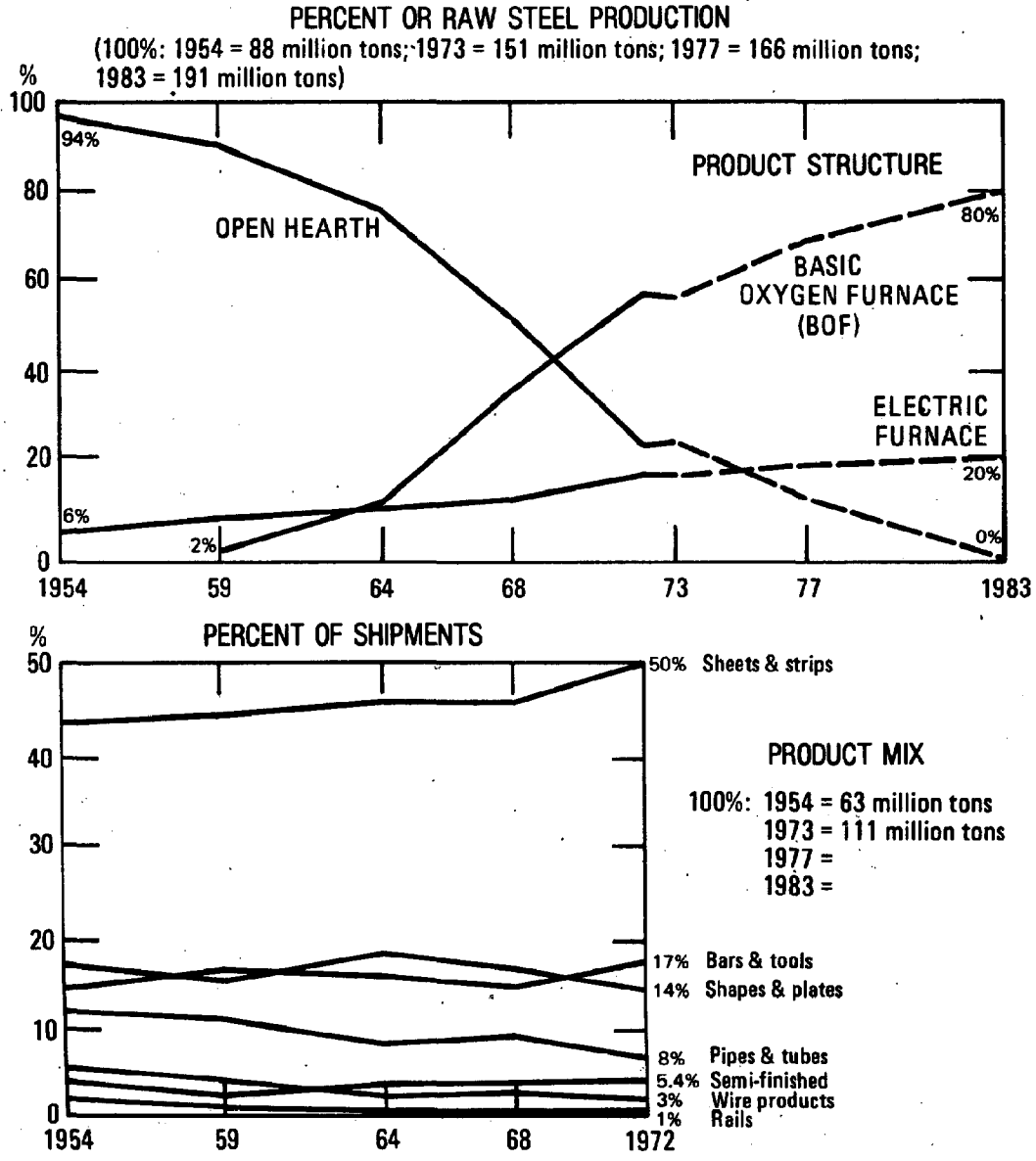


Source: Natl. Commission on Water Quality. From the Conference Board, Inc. "A Pilot Study on Measuring the Economic Impact of Water Pollution Abatement - - Pulp, Paper & Paperboard Mills", 1975.

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Figure III.C.8

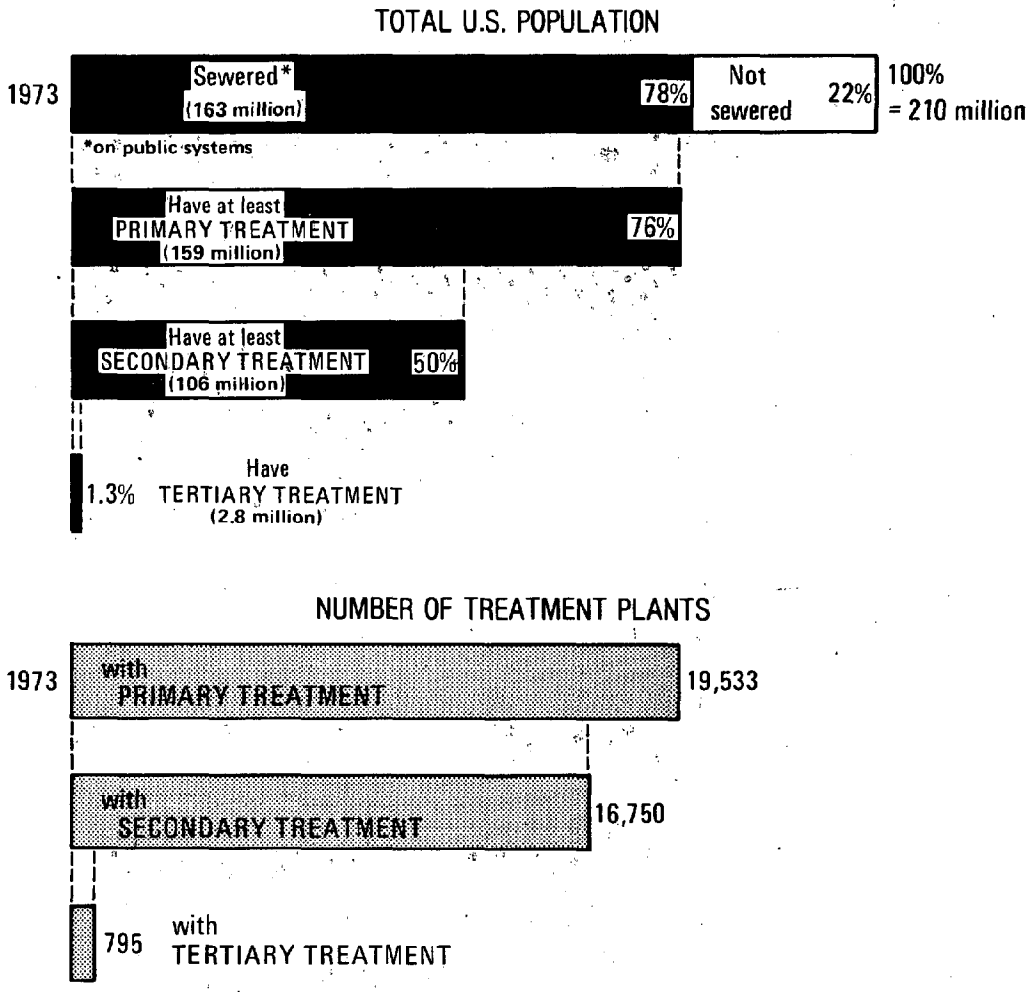
TRENDS IN PROCESS/PRODUCT MIX
IRON & STEEL BASELINE PROJECTION



Source: Natl. Commission on Water Quality. From The Conference Board, Inc., "A Pilot Study on Measuring the Economic Impact of Water Pollution Abatement -- The Blast Furnaces and Steel Mills Industry", 1975.
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Figure III.C.9

1973 LEVEL OF ACHIEVEMENT FOR PUBLICLY-OWNED WASTEWATER TREATMENT WORKS



Source: Natl. Commission on Water Quality. From U.S. Environmental Protection. "Economics of Clean Water, 1973", pp. 19-20. Number of plants from EPA report to NCWQ; original source given as February 1974 EPA "Point Source Inventory".

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Survey had inadequate capacity in their present treatment plants (11). This problem was even more severe in those plants serving over 150,000 people, which reported over 33 percent of facilities with inadequate capacity.

The 1973 levels of achievement were not the result of a sudden spurt of effort in the late 1960's due to the environmental movement. Figure III.C.10 shows the growth in percentage of population sewered and with at least primary or at least secondary treatment. In 1940, 50 percent of the population was sewered. Of those with sewers, 50 percent received at least primary treatment and 28 percent at least secondary treatment.* All three trends rose sharply through the 1950's and less sharply in the 1960's.

This leveling off was not due to declining expenditures but reflects population increases and the trend of accelerating cost of treatment per person. Figure III.C.11 shows the dollar values of contracts awarded for collector sewers, interceptor sewers, and treatment plants. Figure III.C.11 also shows the level of Federal outlays, which were 15 percent or less of the costs of contracts awarded for treatment plants and interceptor sewers. For collection sewers, financing was entirely local until authorized by P.L. 92-500.

Many large cities discharging directly into major rivers, lakes, or oceans dominate the population that currently has only primary treatment. Table III.C.3 lists nine SMSA's of which major portions lacked secondary treatment in 1972. Together they account for almost one-third of the sewered population that still lacks secondary treatment.

TABLE III.C.3: METROPOLITAN AREAS SUBSTANTIAL PORTIONS OF WHICH LACK SECONDARY TREATMENT

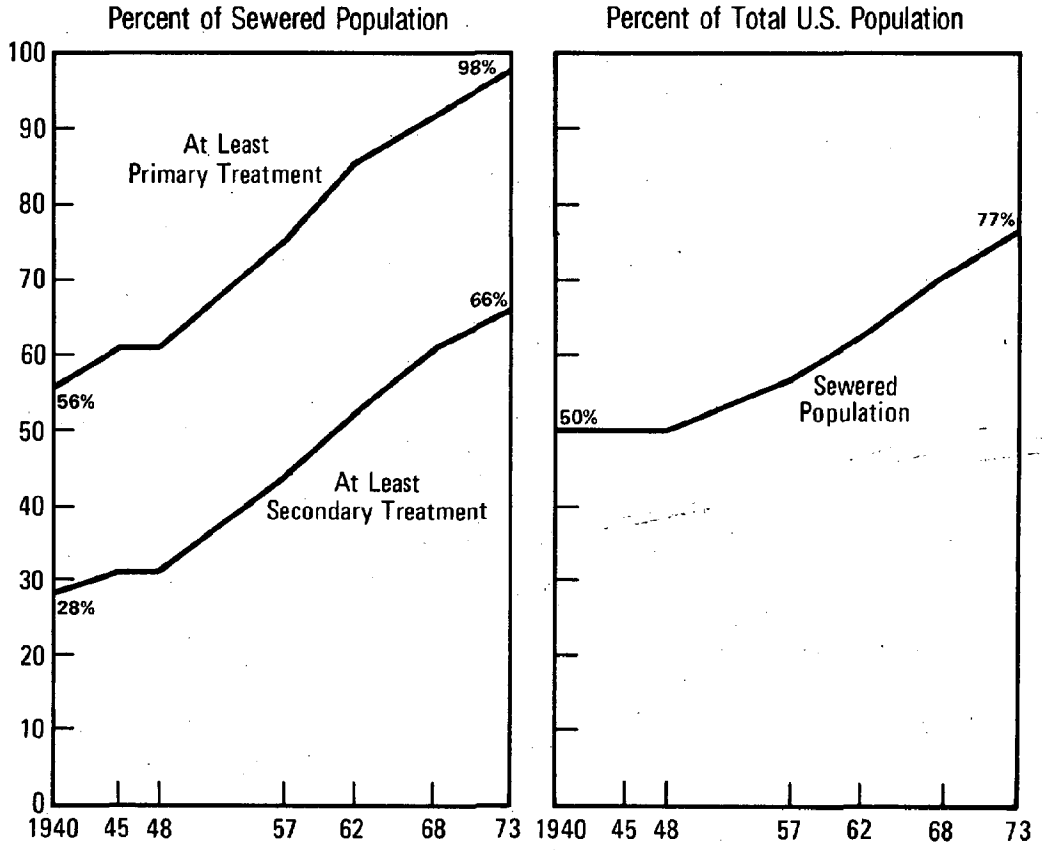
Boston	St. Louis
Detroit	San Diego
Kansas City	San Francisco
Los Angeles	Seattle
Philadelphia	

Source: NCWQ. From Association of Metropolitan Sewage Agencies. Survey prepared for NCWQ. 1975.

* EPA has noted that there can be confusion when comparing statistics for conventional biological secondary treatment with presently defined secondary standards (2).

Figure III.C.10

TRENDS IN LEVEL OF ABATEMENT BY PUBLICLY-OWNED TREATMENT WORKS

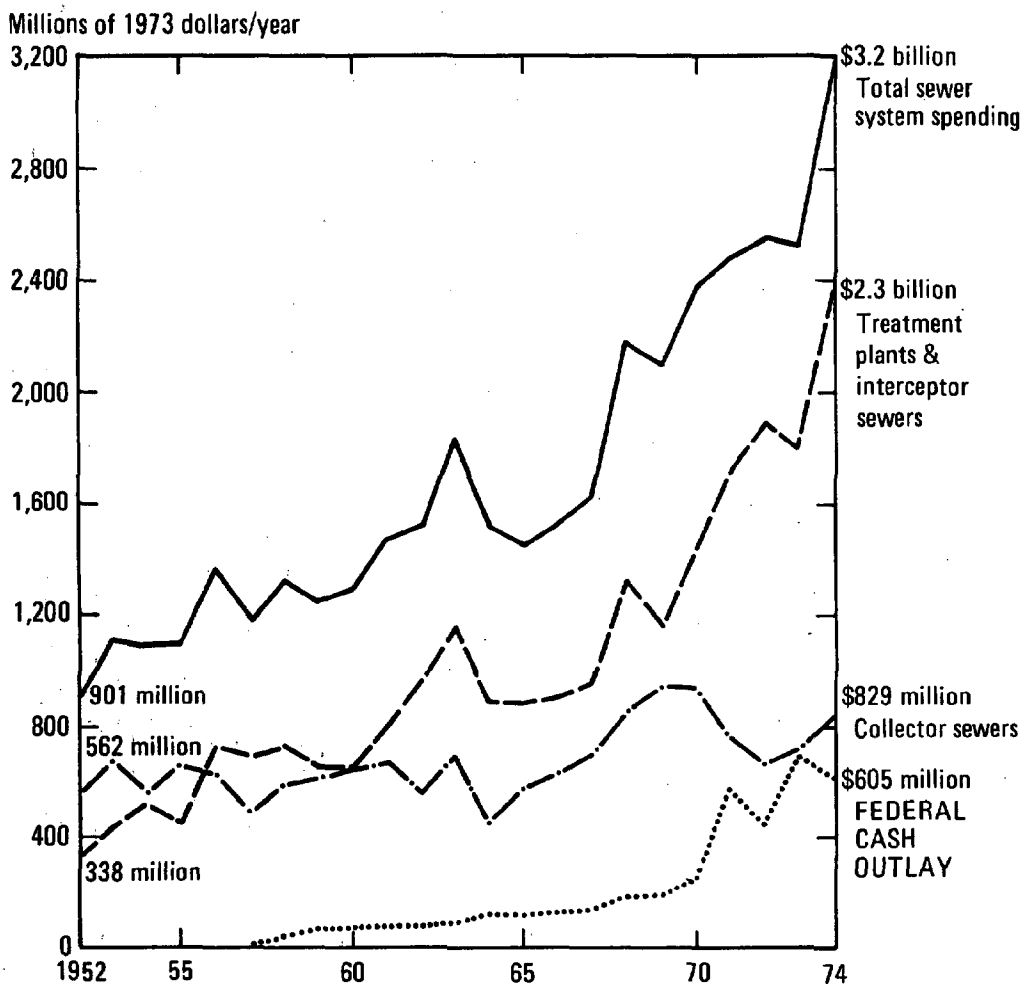


Source: Natl. Commission on Water Quality. From U.S. Environmental Protection Agency, "Economics of Clean Water, 1973", pp. 19, 20.

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Figure III.C.11

CONTRACTS AWARDED FOR SEWER SYSTEMS & FEDERAL CASH OUTLAYS



Source: Natl. Commission on Water Quality. From U.S. Environmental Protection Agency, 1971 Sewage Facilities Construction Report for 1952-1971; and USEPA, Communication to the Commission, for years 1972-1974.

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Communities may be more willing to spend money on treatment plants to the extent that the resulting water quality improvements accrue locally. A study of the Merrimack Valley found that the portion of the community directly bordering the river has a significant influence on levels of expenditure (9). The demand for collectors is largely influenced by the degree to which septic tanks become a nuisance or a public health problem. A study of the Boston SMSA showed that almost all communities with population densities of over 750 persons per square mile have sewers (13). This further demonstrates the importance of population density as the key determinant of demand for sewering.

In summary, the Commission attempted to consider the consequences of changes in inputs, production technology, and final demand in its industrial impact analysis to the extent that such factors appeared to dramatically influence the costs of abatement over time. Trends in key dimensions of municipal abatement are also examined. These forces, in addition to those factors discussed in Part B above, set the stage for the impact assessment.

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(6) CONSAD Research Corporation. Macroeconomic Impacts of P.L. 92-500, 1975.

(7) Development Planning and Research Associates. Economic Impacts of Water Pollution Control Act of 1972; The Feedlot Industry, Canned Fruits and Vegetables, and Other Industries. 1976.

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(11) _____. Cost Estimates for Construction of Publicly Owned Treatment Facilities, 1974 "Needs" Survey. 1975.

(12) _____. Economics of Clean Water-1973. Washington, D.C. 1973.

(13) _____. Evaluation of CEQ Report on Interceptor and Urban Sprawl.

(14) _____. Sewage and Construction Facilities, 1952-1971, Washington, D.C., 1971.

(15) University of Maryland Interindustry Forecasting Model (INFORUM). College Park, 1975. Various runs under National Commission on Water Quality direction.

D.1) INDUSTRIAL AND AGRICULTURAL REQUIREMENTS AND IMPACTS*

The analysis of economic "impacts" is the measurement of the change of certain economic indicators from baseline conditions due to the requirements of the Act. This section presents the Commission's assessment of the impacts on selected American industries as measured by changes in the following economic variables from the baseline discussed in Section III-C of this chapter:

1) Capital Requirements
2) Distribution of Capital Requirements Among Industries
3) Prices
4) Output
5) Profits
6) Short-term Transition Impacts Due to Capital and Capacity Shortages
7) Distribution of Capital Requirements Between Plants in Selected Industries
8) Plant Closures and Industrial Organization
9) Regional Consequences
10) International Trade

In this analysis the Commission distinguished between short-term transition costs** and potential long-term increases in the costs of production. Water pollution control costs will likely decrease over time as industry incorporates the rising cost of water use in the design and operation of production capacity. New plants and equipment are designed to meet new standards of product quality, performance, and,

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* Only the Commission in-depth industry studies and certain agriculture-related industries are analyzed in the full range of industry impacts. Other industries, interindustry ramifications, and overall impacts are covered in the macroeconomic section, Section III.F. Table III.D.9 lists those industries not analyzed in detail and relates them to the macroeconomic sectors.

** Roughly, those costs occurring during the compliance periods of 1977 and 1983.

with the proper incentives, water usage and effluent generation.* Products manufactured by polluting processes will be at a competitive disadvantage if less-polluting substitutes are available. Figure III.D.1 presents two sets of estimates of industrial responsiveness to higher costs of water use and effluent discharge. The estimates illustrate that as the price of water use increases, the use of water decreases, and that as the costs of waste treatment rise, the amount of waste decreases.

1. Capital Requirements

The Federal Water Pollution Control Act Amendments of 1972 require extensive expenditures for industrial water pollution abatement over the next eight years. The Commission's estimates of the capital and operating and maintenance expenditures which will result as individual industries comply with the BPT and BAT effluent limitations are presented in Table III.D.1. The cost estimates for the in-depth industries (except Iron and Steel) reflect plant closings, where they will occur (i.e., the estimates do not include expenditures for capacity which the Commission projects to close rather than meet the requirements of the Act). For "other" industries these numbers occasionally differ from Table II-30 due to unique analytical steps for that industry (see supporting documents for explanation). All impact analyses reported below began with the numbers generated in the Technology studies reported in Chapter II.

To comply with the Act a plant has six principal options, none of which are mutually exclusive:

(1) install wastewater treatment technology

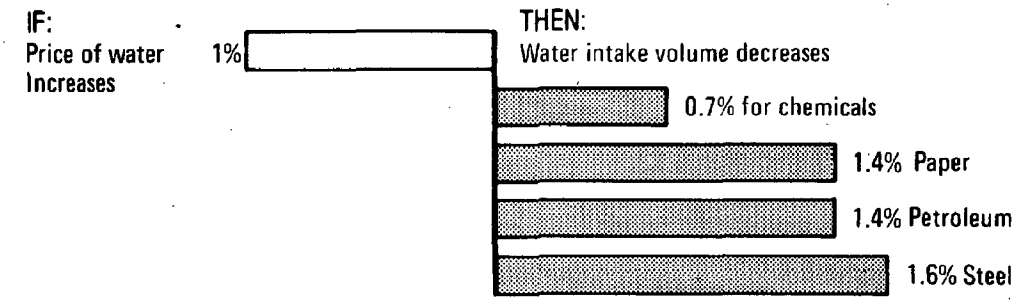
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* In some industries other regulatory programs may counter this trend, thus precluding cost reductions for water pollution abatement. Health regulations in food processing industries may require increased water use for sanitation purposes, these regulations being further compounded by noise regulations. In other industries air quality regulations may produce increased water use together with generation of water-borne residuals. While the Commission's mandate precluded examination of the combined effects of multiple regulatory programs, we acknowledge that these combined effects may be relevant to broad questions of industry viability and vitality as measured by profits, return to equity, availability of capital for "productive" investment, etc. This suggests that any considerations of program modifications may require consideration of information beyond that provided in this report as it relates exclusively to the impacts of P.L. 92-500.

Figure III.D.1

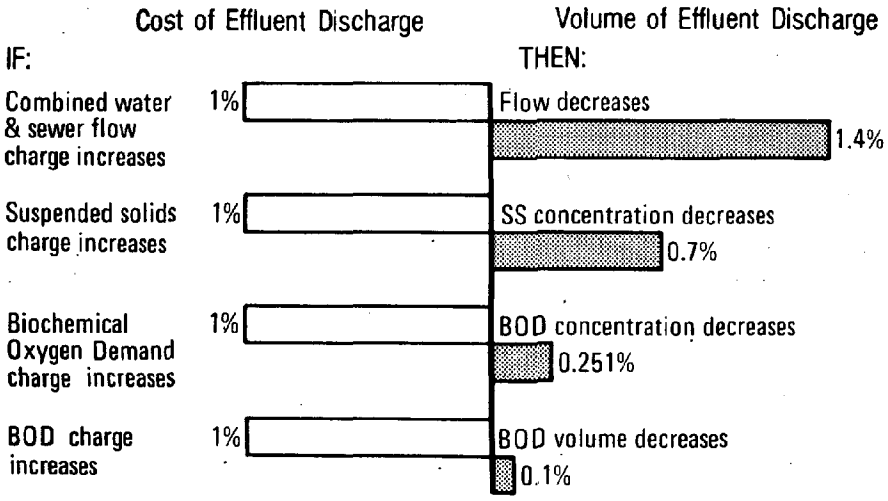
INDUSTRY RESPONSIVENESS TO COST OF INTAKE WATER AND WASTE DISCHARGE

PRICE OF WATER



Source: "Changing Water Use in Selected Manufacturing Industries", by Robert Leone,Jr., J.Royce Ginn, and An-loh Lin. December 1973.

COST OF WASTE



Source: National Bureau of Economic Research Draft Report "A Cross-Section Analysis of Industrial Waste Water Dischargers", 1975.

Natl. Commission on Water Quality
February 1976

I N D U S T R Y

Economic Impact Expenditure Estimate
(Millions of 1975 Dollars)

Indepth[a]	BPT (1977) Capital	BPT (1977) Annual O&M	BAT (1983) Capital	BAT (1983) Annual O&M
Fruits & Vegetables	167	15	96	10
Inorganic	805	178	261	104
Organic	3325	487	2990	2242
Misc. Chemicals	965	163	650	228
Iron and Steel	2080	322	556	202
Metal Finishing-Job[b]	1715	328	780	168
Captive[b]	7418	2275	7428	1365
Petroleum Refining[b]	829	142	1184	429
Plastics & Synthetics	209	33	286	29
Pulp and Paper[b]	2194	111	437	20
Steam Electric[c]	3740	1420	2030	260
Textiles	458	58	203	61
	23905	5532	16901	5118
Other				
Ore Mining and Dressing[d]	610	25	0	0
Coal Mining[d]	1700	95	0	0
Petroleum & Gas Ext.[d]	234	18	1070	61
Mineral Mining & Proc.	730	72	0	0
Meat Products & Rendering	148	20	181	10
Dairy Products	188	13	73	5
Grain Mills	33	2	8	1
Cane Sugar Processing	153	17	170	13
Beet Sugar	90	17	69	5
Canned & Preserved Seafood	41	12	120	12
Misc. Food & Beverages	5	1	5	1
Timber Products	14	1	25	8
Furniture and Fixtures	8	3	0	0
Bldg. Paper & Board	120	12	0	0
Paint and Ink	23	22	0	2
Soap and Detergent	10	1	2	0
Phosphate Mfg.	73	9	14	1
Fertilizer Mfg.	77	50	64	23
Paving and Roofing	6	6	4	1
Rubber Processing	220	18	48	12
Leather Tanning	77	20	47	7

TABLE III.D.1 continued

	BPT		BAT	
	Capital	Annual O&M	Capital	Annual O&M
Glass Mfg.	42	5	16	3
Cement Mfg.	34	4	9	1
Concrete, Gypsum, Plaster	100	26	0	0
Asbestos	4	1	9	4
Insult. Fiber	14	6	0	0
Ferroalloy Mfg.	48	16	13	3
Nonferrous Metals[b,e]	f 40	21	31	7
Machinery & Mechanical Prod.	3900	390	3900	390
Transportation Industry	1200	130	140	39
Water Supply	1200	160	100	3
Auto & Other Laundries	25	4	21	1
Foundries	180	26	0	0
Fish Hatcheries	50	10	47	31
Structural Clay	5	1	0	0
Pottery	3	1	4	3
Steam Supply	0	0	0	0
Nonferrous Mills	260	25	0	0
Feedlots				
Beef	100	8	30	0
Hog	178	9	59	0
Dairy	152	10	46	0
All Other Industries	12095	1287	6325	647
In-depth Industries	23905	5532	16901	5118
Total	36000	6819	23226	5765

a. Cost estimates for all Indepth industries (except Iron and Steel) and 7 of the Other Industries (Meat Products and Rendering, Dairy Products, Grain Mills, Leather Tanning, Nonferrous Metals, Fertilizer, and Feedlots) represent costs only for those plants which are projected to remain open.

b. Municipal user charges included.

c. Growth included.

d. These cost estimates were based upon a preliminary contractor report. The Commission believes the cost estimates presented in Table II-30 are more accurate; the cost estimates presented here are included because they were used in the impact analysis.

TABLE III.D.1 continued

e. These cost estimates were based upon a preliminary contractor report. The differences in these estimates and those presented in Table II-30 are principally due to two factors: (1) the estimates in Table II-30 include $83 million for two bauxite refineries on the Mississippi River to meet BAT requirements, not included in the cost estimates above, and (2) the nonferrous metals estimates in Table II-30 do not attempt to take account of treatment facilities in place as of January 1973 for primary aluminum smelting and refining, a subsector of Nonferrous Metals.

f. Excludes Metal Finishing.

Supplemental Notes to D.II

1. Costs reported relate to a specific set of existing treatment technologies. As such, they do not take into account possible managerial respones to these costs which entail the substitution of relatively long-cost inputs for higher-cost factor inputs over the long term.

2. Cost reported do not account for possible technological innovations either in wastewater treatment or basic production processes, except where such trends are readily acknowledged (e.g., the eventual retirement of open hearth furnaces in the steel industry).

3. All the individual costs reported in this table are estimated with varying degrees of uncertainty. As such, they are not intended to be either high or low-side estimates of costs, but reflect the judgment of the Commission's contractor's and staff.

4. Costs reported do not include depreciation or indirect charges. Detailed discussion of these costs are included in the individual in-depth contractor studies. It is possible to use this table to formulate an approximate present value estimate of compliance costs which account for depreciation, interest and eventual replacement of capital facilities. Assuming a 10 percent annual rate of return to equity after taxes and a 10 year capital life, the 1975 present value of all future expenditures for water pollution associated with those technologies and industries reported in this table is approximately $195.6 billion. See Appendix D.II for details.

5. See Appendix D.II for a more detailed characterization of the information in this table.

Source: National Commission on Water Quality
February, 1976

(2) initiate process or in-plant changes to eliminate or reduce the need for wastewater treatment

(3) change product specifications to eliminate those characteristics of products which generate pollution

(4) change the inputs into the polluting processes

(5) discharge wastes into a municipal system

(6) dispose of wastes on the land or in the air.

The Commission's estimates of required expenditures largely assume that industry uses wastewater treatment technology or discharges to municipal systems. For specific industries and specific subcategories, other options are considered, but the vast majority of the Commission's estimates of expenditures are for wastewater treatment technology. Since some plants have opportunities for effluent control through in-process changes, the estimates may result in an overstatement of the required expenditures. Conversely, some plants confront specific abatement problems which the Commission's studies were unable to detect or adequately address. The result in these cases is an understatement of the costs.

The estimates of required expenditures do not take into account administrative variances for BAT requirements, nor do they include any estimates of expenditures to meet water quality standards. The estimates are based on compliance with EPA effluent limitations as promulgated and do not reflect actual plant-by-plant permit requirements. Final EPA effluent guidelines were not available for some industries. In such cases the costs are based upon EPA's contractor reports and the Commission's judgment of what the guidelines likely will be.* Pre-treatment costs are included in the majority of the estimates, but user costs associated with municipal systems were included for only some of the in-depth industries. (See Table III.D.1)

2. Distribution of Capital Requirements Among Industries

As illustrated in Table III.D.2**, industries will bear different

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* See Chapter II for a complete discussion of the status of the effluent guidelines used.

** This classification of industries is different than the list prepared in Table III.D.1 due to the nature of investment projections in the macroeconomic models.

percentages of the water pollution control expenditure -- relative to the total level of industrial commitment and the size of the projected capital spending of each industry. The capital expenditures of six industries -- Chemicals, Electric Utilities, Iron and Steel, Paper, Mining, and Petroleum -- constitute about 48 percent of the total industrial capital expenditures for water pollution abatement over the period 1975-1983. Capital expenditures for Metal Finishing and Machinery and Mechanical Products constitute a comparable percentage. This brings the total for these industries to over 90 percent of the total industrial water pollution abatement expenditures over the period 1975-1983. Metal Finishing, Chemicals, Pulp and Paper, and Mining have the highest percentage of water pollution abatement expenditures compared to total plant and equipment investment. Electric Utilities and Petroleum are near the industry average.

3. Prices

Estimates of industrial capital and operating and maintenance expenditures indicate the level of resources required by the Act. These serve as a starting point for the calculations of economic impact. A stream of costs is developed for each industry and subcategory studied, representing full costs of compliance per unit of product in each subcategory. Principal additional dimensions of these flows, aside from the base capital and O&M figures, are the costs of capital and depreciation charges, derived from formulas reflecting the unique capital structure of each segment studied. The elements of these formulas are too numerous and varied to report herein and are referenced in supporting documents.

Estimates of how these expenditures translate into price, output, and profit changes are summarized in Tables III.D.3 and III.D.4, providing a measure of economic impacts. Since these expenditures are representative of averages for industry subcategories, continued operation by higher cost producers in the short run may result in higher prices for that short-run period. The Commission's price estimates are more representative of those resulting in the subsequent adjustment period.* These estimated price increases will be reached over about a ten year period**, and represent the difference in prices over baseline levels

* The Short Term Transition Impacts section (pp. III-67 -III-72) discusses the likely magnitude of such short term price increases.

** The macroeconomic section and the Short Term Transition Impacts discussions which follow, address the implication of the timing of both the requirements and the ensuing impacts.

TABLE III.D.2: INTERINDUSTRY COMPARISON OF WATER POLLUTION ABATEMENT EXPENDITURES (1975-1983)

Industrial Categories	Abatement Capital Expenditures (BPT, BAT As A % of Total Industry Abatement Capital Expenditures	Abatement Capital Expenditures (BPT, BAT As A % of Total Investment in Each Industry[a]
Agriculture	1.1	e
Mining	7.3	13.9
Iron and Steel[b]	4.8	7.2
Nonferrous Metals	.6	1.6
Leather	.2	2.1
Stone, Glass and Clay	.4	1.2
Lumber	.1	.2
Furniture	--	.2
Printing & Publishing	--	--
Food & Beverages	2.6	2.4
Textiles	1.1	5.7
Paper[c]	4.6	8.3
Chemicals	16.5	13.8
Petroleum Refining	3.4	1.9
Rubber	.5	1.7
Tobacco	--	--
Apparel	--	--
Electrical Machinery Ordnance and Miscellaneous Nonelectrical Machinery Motor Vehicles Aircraft Other Transportation Fabricated Metals Instruments	42.4[d]	13.0[d]
Transportation	2.3	.9
Utilities	11.9	1.8
Commercial	.1	--
	100.0	

a. Total industry investment refers to annual investment levels by industries not total capital in place. Wharton Control Baseline November, 1975 - See macroeconomic section.

b. Includes Iron and Steel (in-depth study) and Ferroalloys and Foundries.

c. Includes Builder Paper and Board.

d. Distribution among these industries is uncertain due to the uncertain distribution of captive metal finishing operations.

e. Investment data not available.

Source: Industry investment from CONSAD Research Corporation, "Macroeconomic Impacts of P.L. 92-500", 1976; Abatement investment from Table III.D.1

TABLE III.D.3

INDUSTRIAL IMPACT - PRICES, PROFITS, AND OUTPUT; MANUFACTURING

Industry	Percentage Change In Prices		Percentage Change In Profits		Percentage Change In Output	
	BPT Only	BPT and BAT	BPT Only	BPT and BAT	BPT Only	BPT and BAT
Pulp and Paper	3	4	N.A.[a]	N.A.[a]	N.A.[a]	N.A.[a]
Iron and Steel	.8	1.1	2.9	3.7	-.5	-1.2
Petroleum Refining	<1	<1	N.A.	N.A.	<1	<1
Textiles	.2-2.5	.3 - 4.7	N.A.	N.A.	N.A.	N.A.
Metal Finishing	40	60	N.A.	N.A.	-5%	-8%
Steam Electric	.5	<1	.5 - 1[c]	.3 - .7[c]	Negligible	Negligible
Chemicals[d]	2.8	3.4	N.A.		Negligible	Negligible
Aluminum	.4	.5	Negligible	Negligible	-1.7	-1.7
Copper	<.1	<.1	Negligible	Negligible	-.3	-1.2
Lead	.3	.3	Negligible	Negligible	-.3	-.3
Zinc	.1	<.1	Negligible	Negligible	-1.0	-.3

a. Not available
b. Estimate for job shops only
c. Absolute decline in rate of return on rate base
d. Includes 100 major chemical products, not the entire sector

Source: National Commission on Water Quality. From economic reports on each industry. 1975.

TABLE III.D.4

INDUSTRIAL IMPACT - PRICES, PROFITS AND OUTPUT; AGRICULTURE-RELATED

Industry	Percentage Change In Prices		Percentage Change In Profits		Percentage Change In Output	
	BPT Only	BPT and BAT [a]	BPT Only	BPT and BAT [a]	BPT Only	BPT and BAT [a]
	1977	1983	1977	1983	1977	1983
Canned and Preserved Fruits and Vegetables	.26	.42	-16%	-25%	.13	.23
Beef Feedlots	.08	.1	-25.	-5.	-.02	-.05
Dairy Feedlots	.37	.43	N.A.	N.A.	-.11	-.18
Hog Feedlots	.6	.70	-20.	-20.	-.1	-.2
Dairy Products	.20	.29	-1.3	-6.5	-.07	-.13
Leather Tanning	1.6[b]	2.2[b]	-65.%	-92.%	-10.[b]	-7[b]
Fertilizer	1	1.3	-4.7	-7.4	Negligible	Negligible

a. Percentage difference from baseline in 1983.
b. Due to economic growth and depending on the elasticities of supply and demand, it is possible for a higher percent price rise to have a smaller percent output decrease.

Source: NCWQ. From Development Planning and Research Associates, Inc., "Economic Impacts of Water Pollution Control Act of 1972 on Selected Food Industries", Vols. III, IV, VI, VIII and IX. 1976.

attributed to water pollution control requirements.* The price impacts do not include any estimate of the likely reduction in impact as new capacity with lower abatement costs per unit of output replaces existing facilities (4). (Also see Figure III.D.1) These estimates of price increases do not include the consequences of interindustry price changes, which are presented in the macroeconomic section.

With the exception of the price increases for metal finishing services, the price increases listed in Tables III.D.3 and III.D.4 for meeting the BPT requirements are projected to be 3 percent or less, with most industries facing increases of less than 2 percent. The additional price impacts of meeting the BAT requirements are generally less than the increases attributable to BPT requirements. Of these industries, only Metal Finishing, Pulp and Paper, and Mining experience a cumulative price increase greater than or equal to 4 percent, due to BPT and BAT standards.** The price increases for metal finishing services will be widely distributed throughout the economy, increasing the price of a final product about 2 percent in most instances.

4. Output

Changes in industrial output are similarly small relative to baseline projections. In the agriculture-related industries only Leather Tanning shows a projected reduction in output over 1 percent due to BPT and BAT requirements. With the exception of Metal Finishing, changes in output in the industrial sector are expected to be less than 2 percent due to BPT and BAT. Metal Finishing would exceed this level due to reductions in demand for Metal Finishing, including substitution of other products.

5. Profits

The impact of pollution control expenditures on industrial profits depends on the degree to which the costs are passed on to consumers. In the extreme case where no costs cannot be passed forward the costs will be absorbed by the firm and also partially by the state and Federal governments through reduced income from taxes on corporate profits. The extent to which governments absorb these costs will depend on the marginal tax rate of the firm. For a firm that remains profitable but owns some marginal plants, government could absorb up to half the costs

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* Thus, the estimated price increases are not an annual compounding, rate of price increase.

** The price increase for mining is 7.98 percent in 1983; CONSAD Scenario 1 (See Macroeconomics Section).

of pollution control. On the other hand, the firm with no taxable corporate income will absorb all the costs, if they cannot be passed on. These effects are chiefly relevant in the short-run. Once industry has adjusted fully to the imposition of pollution control costs, the dominant effect upon profits will be through reduced output due to higher prices.

6. Potential Short Term Transition Impacts Resulting from Capital and Capacity Constraints

Increases in production costs as a result of pollution control requirements impact upon price and output to create a new supply and demand equilibrium. During the adjustment to this new equilibrium, impacts may be either higher or lower, depending upon the particular market conditions and the cyclical state of the economy. A temporary price increase exceeding the cost of water pollution abatement may occur if industrial capacity expansion is constrained by abatement requirements. The demand for products could exceed available supply and could result in a shortage. Cash flow would increase due to the price increases. Thus, profits would rise until new capacity is built to relieve the shortage. These potential interim supply and demand equilibria are temporary and unstable and would not be expected to last longer than two to three years.

The two most significant sources of constraints on capacity expansion are: (1) plant closures, and (2) diversion of available capital resources into pollution control. Plant closures do not significantly impose capacity constraints in the agriculture-related industries. Only three manufacturing industries face the possibility of enough plant closures to impose capacity constraints: Pulp and Paper, Metal Finishing, and Textiles.*

For several industries the capital expenditures necessary to meet the Act's requirements may constrain capacity expansion due to capital diversion from plant and equipment investment into pollution abatement. The year-by-year water pollution abatement expenditures required to meet the BPT and BAT regulations** as a percent of total capital spending are shown in Figures III.D.2 and III.D.3 in relation to the historical data on water pollution abatement expenditures. Iron and Steel jumps from 4 percent in 1974 to 27 percent in 1976; Pulp and Paper from 7 percent in 1974 to 26 percent in 1976; Chemicals from 4 percent in 1974

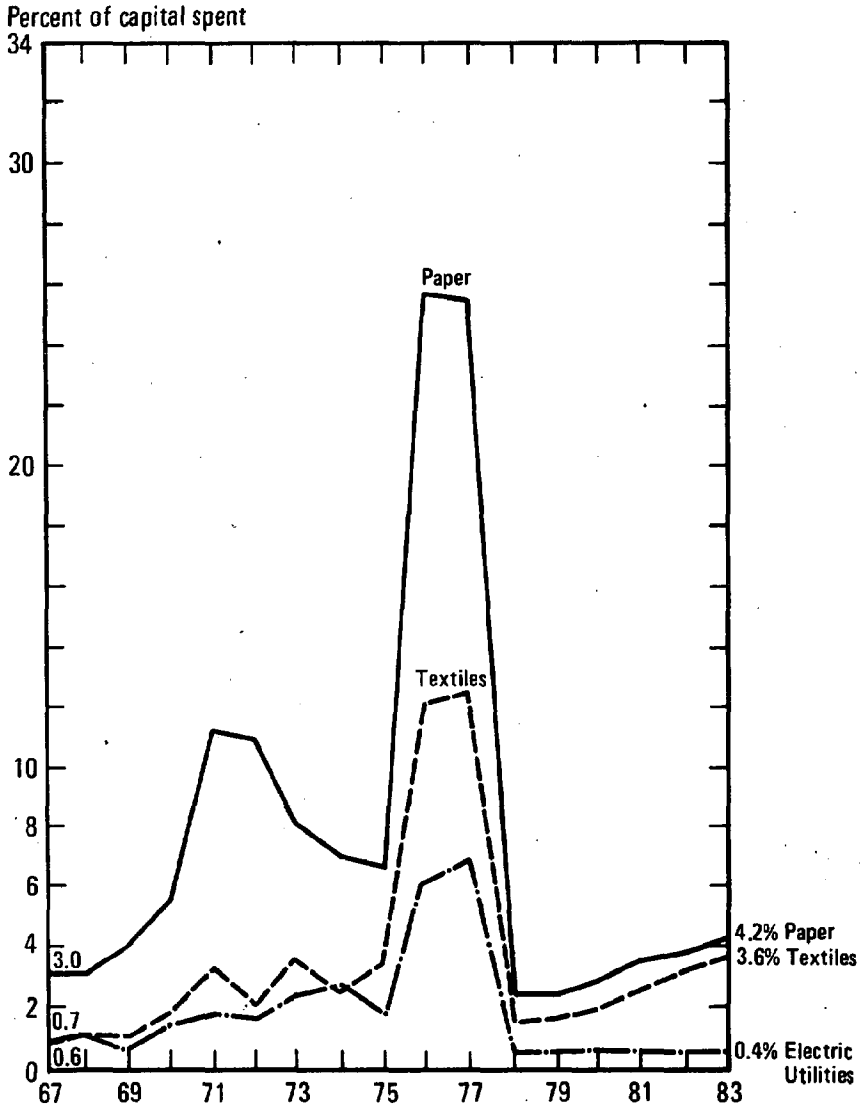
* The dynamic analysis of these industries shows that while plant closures as a percentage of capacity are large, this does not result in a significant capacity constraint.

** BPT expenditures are spread over 1975-1977 and BAT expenditures are spread from 1978-1983.

Figure III.D.2

PERCENT OF CAPITAL EXPENDITURES ON WATER POLLUTION CONTROL

Paper, Textile, Electric Utilities Industries 1967-1983



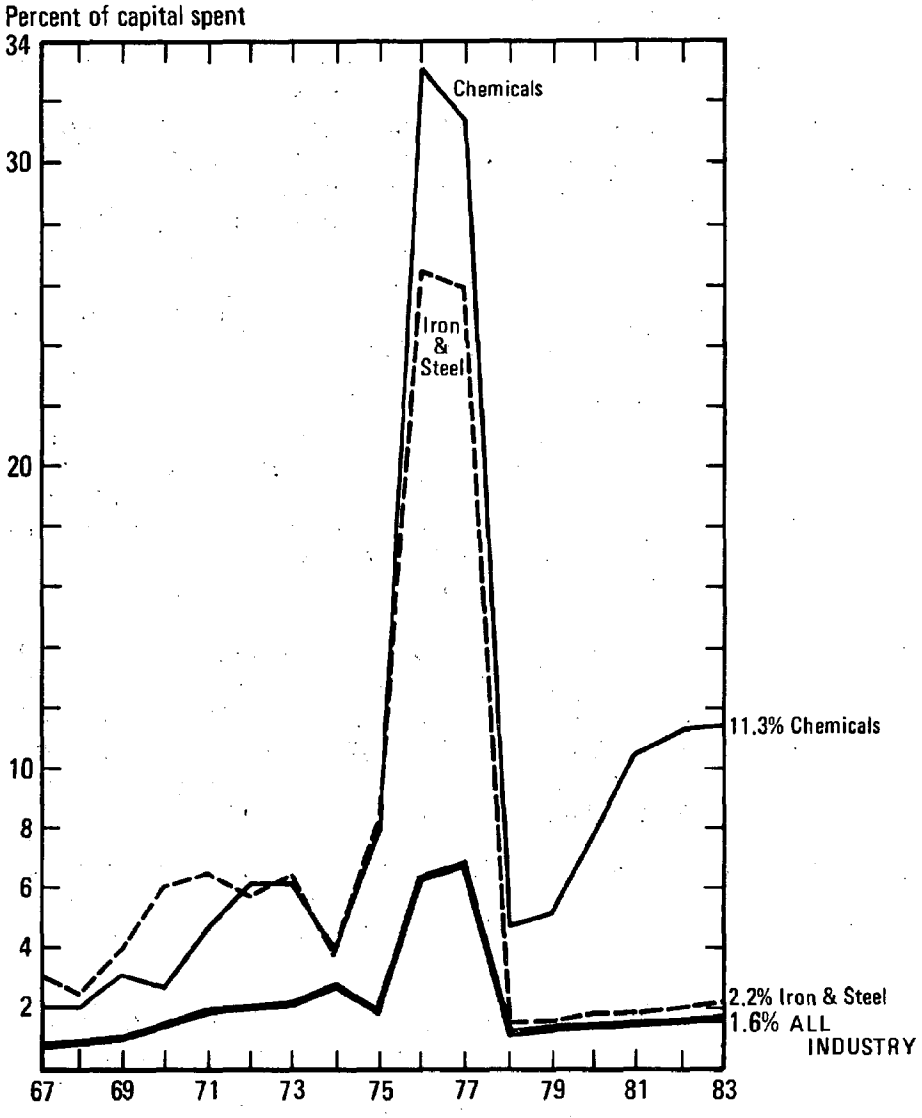
Source: (Historical data) McGraw-Hill Economics Department, "8th Annual McGraw-Hill Survey – "Pollution Control Expenditures", 1975. (Projection) NCWQ cost to meet Act's requirements and from CONSAD Research Corporation. "Macroeconomics Inputs of P.L. 92-500", 1976.

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Figure III.D.3

PERCENT OF CAPITAL EXPENDITURES ON WATER POLLUTION CONTROL

Chemical and Iron & Steel Industries Compared to All Industry 1967-1983



Source: (Historical data) McGraw-Hill Economics Department, "8th Annual McGraw-Hill Survey – "Pollution Control Expenditures", 1975. (Projection) NCWQ cost to meet Act's requirements and from CONSAD Research Corporation, "Macroeconomics Inputs of P.L. 92-500", 1976.

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to 33 percent in 1976; and Textiles from 2 percent in 1974 to 12 percent in 1976.

These are dramatic increases over past trends, and could potentially divert capital resources from other plant and equipment investment. The July McGraw-Hill survey of capital expenditures* (9) indicates, however, that industry's planned expenditures will not reach a level to assure full compliance by July 1, 1977. Figures released by Cremeans, et al. also lead to the same general conclusion (27).

Supporting information of a different form is found by Oregon Research Institute (20). Here, response to Question 26A "How good is the chance that industry in your state will be able to meet the requirement of BPT by 1977?" was as follows--industry: 41 percent good, 27 percent about even, 32 percent poor; consulting engineers: 24 percent good, 18 percent about even, 58 percent poor; municipalities: 30 percent good, 19 percent about even, 51 percent poor; and environmentalists: 31 percent good, 25 percent about even, 44 percent poor. Only EPA and state water pollution control agency representatives felt chances of compliance were good, (57 percent and 52 percent respectively).

However, a comment from a California official merits consideration. "In our state we believe the vast majority of our dischargers can meet the 1977 goal by the early 1980's. We further believe it is too early to make a realistic amendment to the 1983 and 1985 goals; and we believe amendments of those deadlines and the general effort necessary to meet them should be delayed until the results of meeting the 1977 goal can be carefully appraised about 1980 or 1981." (1)

The National Canners Association, with heavy concentrations in California, observes, "We concur with this statement (summary NCWQ finding that achieving the 1977 deadline on schedule will be unlikely) especially since the effluent guidelines and standards for the majority of the commodities processed by the fruit and vegetable processing industry have yet to be promulgated." (19).

Iron and Steel and Chemicals have planned to spend 6 percent in 1975; Pulp and Paper, 8 percent; and Textiles, 2 percent. All of these are water pollution expenditures as a percentage of total capital expenditures.

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* The American Paper Institute's survey of capital expenditures plans also indicates this gap between projected capital requirements and planned investments. "The Economic Impacts of Effluent Guidelines Compliance by the American Paper Industry" by URS Research Co., prepared for the American Paper Institute. 8th Annual McGraw-Hill Survey--Pollution Control Expenditures, May 16, 1975. (26).

Surveys of planned capital expenditures are only rough estimates and are useful in most industries for only one or two years. Less than two years remain, however, until the BPT compliance date of July 1977. This gap between projected capital requirements to meet BPT and capital expenditures plans is too large to be dismissed as a survey error. There are six possible explanations:

1) The Commission's cost estimates may be too high; industry may have found less expensive ways of reducing effluent discharges than end-of-pipe wastewater treatment technologies.

2) Much of industry may be intending to meet a BPT requirement other than those identified in the Commission's technology studies.

3) Industry may be making commitments for the equivalent of secondary treatment and not planning to meet the precise EPA promulgated effluent numbers. A proportion of the Commission's cost estimates of meeting the BPT requirements is for treatment beyond the equivalent of secondary. Industry may not be making investments to meet requirements which it feels will have no water quality benefits and which may be overturned by present litigation.*

4) Industry may be underestimating the cost of compliance.

5) It is possible that the planned expenditures will reach each palnt's permit conditions, but that the permit conditions are less stringent than the EPA promulgated guidelines.

6) Some industries do not have final effluent guidelines, and these industries may not "plan" expenditures until these guidelines are fully promulgated and any possible subsequent litigation is completed.

The concern in the industrial community over the problems of raising sufficient capital for pollution control equipment and plant expansion reflects, in part, the increasing risk of planning for both pollution

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* An Elaboration of this point is offered by the National Canners Association. "Another possible explanation is that EPA has issued guidelines with requirements so unacceptable to industry that most of the guidelines have been challenged in the courts. Industrial plants are not likely to make capital investment plans to achieve objectives which they believe to be unrealistically strict when there is the possibility for judicial relief." (Comments in a letter to the Commission from Edwin A. Crosby, Vice President and Director of Agricultural and Environmental Affairs, National Canners Association, February 6, 1976.) (19).

control equipment and profitable plant and equipment investment. The time between the decision to commit funds for capital investment and the start of actual production has been increasing in the basic manufacturing industries, and is now typically as long as five years for new facilities. This lag requires economic forecasts which inspire some degree of confidence. The risks of making such investment decisions have increased greatly in the last few years. Oil prices have quadrupled, and future energy prices are highly uncertain. Capital goods inflation has been continuing at unprecedently high rates.

Water pollution control requirements have contributed to this economic uncertainty. Effluent guidelines are continually changing. Permit requirements differ from published guidelines and from plant to plant. Municipal systems remain to be built. The conditions for industrial entry into the municipal systems are unclear. User charges have yet to be widely established. Subcategory definitions shift. The toxics program is in disarray, and industry does not know what is expected. Water quality-limited requirements are unsettled. Effluent guidelines for many industries and subcategories remain to be promulgated. This atmosphere of confusion as to what is expected of industry in terms of water pollution abatement has contributed to an increase in the risk component of the traditional investment calculation.

The majority of the capacity in most of the industries with large projected percentages of capital outlays for pollution control is composed of the major corporations in the American economy. Pulp and paper, Steam Electric Power, Petroleum Refining, Chemicals, and Iron and Steel largely consist of corporations with access to national financial markets. Their ability to raise funds will depend upon the balance sheets of the individual companies and upon the state of the economy, and particularly upon the capital markets. As discussed in the macroeconomic section of this report, no significant crises are foreseen in the coming years for the capital markets in general as a result of water pollution control requirements. However, it is possible that some firms might find themselves temporarily unable to meet all of their investment goals because of individual circumstances.

Many firms in the Electroplating industry are small, privately-owned shops which depend upon local sources of investment funds. Many of the firms in this industry will find themselves with internal assets that are insufficient as collateral for the required pollution control investments.

7. Distribution of Capital Requirements Between Plants in Selected Industries: Intra-industry Impacts

For some industries the impact of the Act on individual plants,

particular subcategories, or specific product lines in an industry can be severe. The estimates of required industrial water pollution abatement expenditures and industry-wide price, output and profit impacts do not address the differential burdens on different plants or subcategories of plants within a specific industry. Different effluent guidelines may be set for each subcategory depending upon such factors as location, age of facilities, and production technologies. Plants within the same subcategory may face different costs per unit of output due to variations in size, age, local climate, land availability and plant-specific characteristics.

The impact of these requirements upon the distribution of BPT and BAT costs per unit of output in selected industries is reflected in Figures III.D.4 and III.D.5. The distribution of abatement costs per unit of output between plants in an industry can be an important indication of the potential economic impacts of the Act. If a plant faces significantly different abatement costs than its competition, it becomes increasingly difficult to maintain a profitable enterprise unless market conditions allow the plant to recover its costs.

Four characteristics of these cost distributions are similar for the Iron and Steel, Textiles, Pulp and Paper, Metal Finishing, and Petroleum Refining industries. First, a major percentage of the capacity for each of the five industries exhibits similar pollution abatement expenditures per unit of output. In Petroleum Refining, costs per unit are virtually equivalent throughout that industry. In the other four the distribution of per unit abatement costs in the 90 percent of each industry's capacity with the lowest costs per unit of output is slightly more uneven.

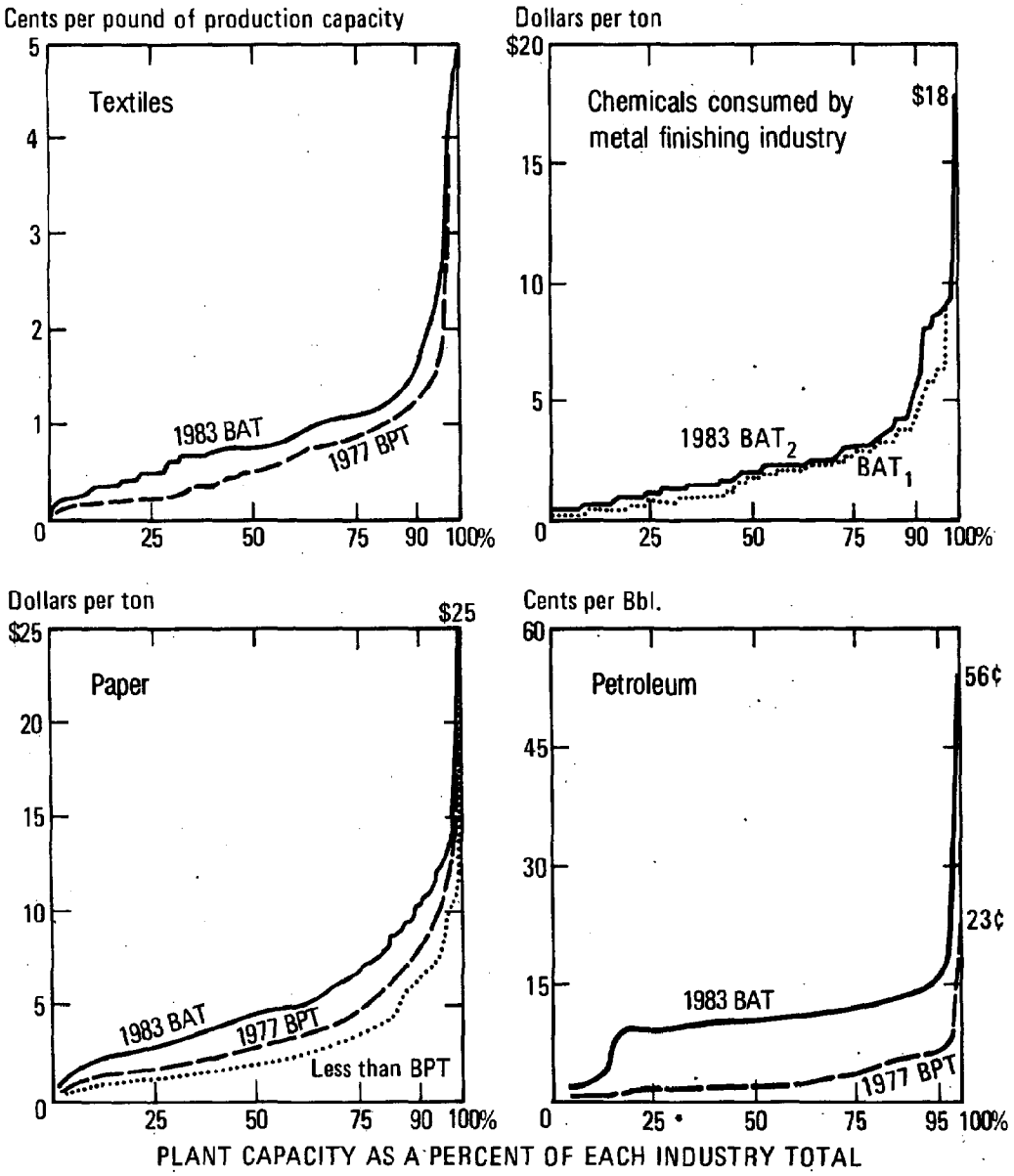
Second, all five industries exhibit dramatically rising abatement costs for a small portion of total capacity. This suggests that only that small portion is vulnerable and may disappear due to competitive disadvantage arising from pollution abatement expenditures. For Textiles and Paper, this high cost segment consists of about 5 percent of capacity; for Metal Finishing approximately 10 percent of capacity; for Petroleum Refining and Iron and Steel, the high-cost segment consists of 1-2 percent of capacity.

Third, in all five industries a close examination of the composition of the high abatement cost segment of capacity reveals that it principally consists of small plants. This is in large part attributable to economies of scale in wastewater treatment. Small plants in these industries are also more likely to be older, less efficient facilities with higher production costs than most of their competition. Large, modern plants, in general, face lower abatement costs per unit of output than the rest of the industry.

Figure III.D.4

DISTRIBUTION OF WATER POLLUTION ABATEMENT COSTS AMONG PLANT CAPACITIES IN INDIVIDUAL INDUSTRIES

1977 and 1983 LEVELS



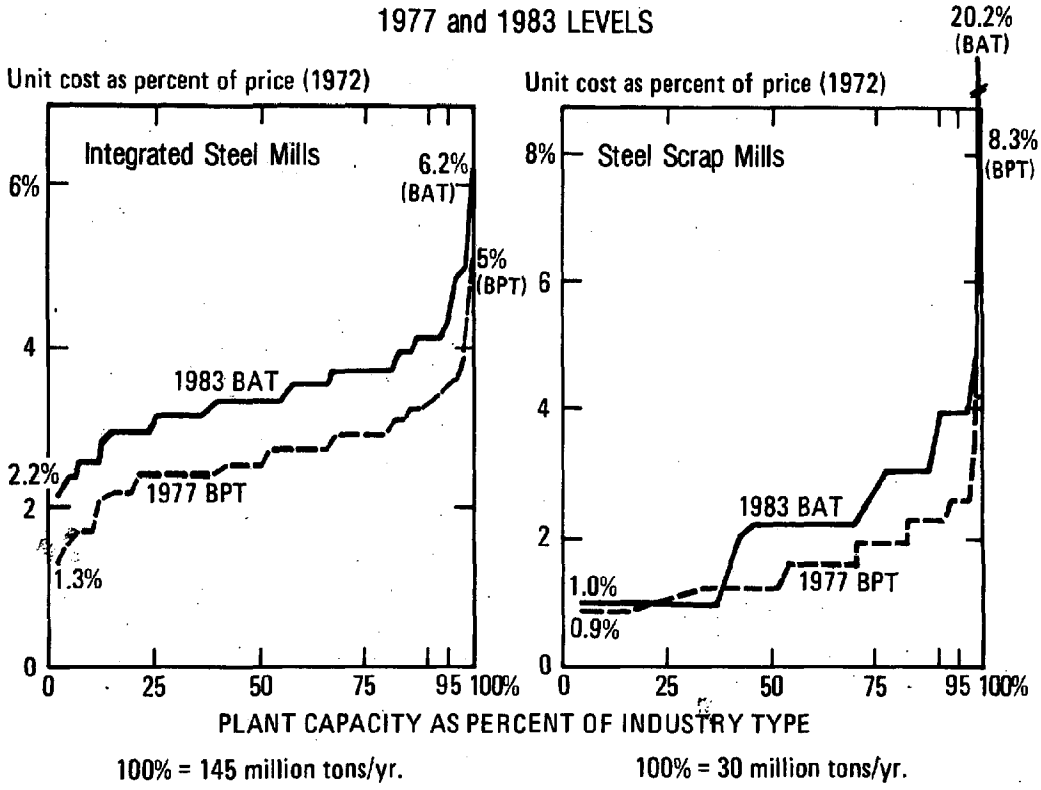
BAT = Best available technology BPT = Best practicable technology

Source: Natl. Commission on Water Quality. From reports prepared by National Bureau of Economic Research.
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Figure III.D.5

DISTRIBUTION OF WATER POLLUTION ABATEMENT COSTS AMONG STEEL PLANT CAPACITIES

1977 and 1983 LEVELS



BAT = Best available technology BPT = Best practicable technology

Source: Natl. Commission on Water Quality. From National Bureau of Economic Research "Economic Impacts of Water Pollution Control Act of 1972; Iron and Steel Industry", 1975.

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Fourth, changes in the stringency of the water pollution control requirements do not significantly affect the distribution of abatement costs among plants in an industry. In other words, the same plants that are most heavily impacted by the BPT control levels in general also are the plants most heavily impacted by BAT.

8. Plant Closures and Industrial Concentration

The principal impacts of the Act fall upon a small segment of each industry with disproportionately higher costs, as exhibited in Figures III.D.4 and III.D.5. Although the Commission did not analyze the economic situation of specific plants, it believes that the estimates presented in Tables III.D.5 and III.D.6 are representative of the magnitude of both the plant closures and changes in industrial concentration which will result from the Act's implementation. These estimates of plant closures in the manufacturing industries represent the number of endangered plants* in the high-cost segment of capacity in each industry. The historical rates of plant closures presented in the baseline projections indicate that many of these old, marginal facilities would have closed by 1985 without the burden of additional abatement costs imposed by P.L. 92-500.**

One hundred and eight pulp and paper mills with 3.1 million tons of capacity were closed during the period 1969-1973, a closure rate that is significantly higher than the pre-1969 average. Although a few were later reactivated, the closures were in some cases partly attributable to pollution controls (21). The Commission estimates trends toward large, integrated forest products companies and a greater degree of concentration in the industry. Over a ten year period the influence of water pollution abatement is expected to accelerate these trends only slightly.

In Pulp and Paper, 47 of the 80 endangered mills (Tables III.D.5 and III.D.6) are non-integrated paper making facilities producing fine tissue, and coarse paper, including facilities using waste paper. The bleached kraft subcategory, however, accounts for the largest share of

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* Endangered plants are defined as those whose water pollution abatement costs per unit of output are more than 20 percent greater than the water pollution abatement costs per unit of output of the plants at the 90th percentile of industry capacity (or subcategory capacity where data permitted) as ordered in Figures III.D.4 and III.D.5.

** Willey accurately observes, "It should be noted that it is efficient for the economy as a whole for such plants to cease production, even though these are short-run distributional impacts." (28).

TABLE III.D.5: DISTRIBUTION OF INDUSTRIAL IMPACTS - PLANT CLOSURES, SUBCATEGORIES, PRODUCTS, AND REGION: MANUFACTURING

Industry	Number of Plant Closures[4] BPT/1977	Percentage of Capacity BPT/1977	Number of Plant Closures BAT/1983	Percentage of Capacity (Incremental)	Most Impacted Subcategory	Most Impacted Products	Most Impacted Region
Pulp and Paper	Max. 80	4.5%	No change[5] from '77	No change[5] from '77	Dissolved Sulfite Nonintegrated Paper	Bleached Paper	Northeast North Central
Iron and Steel	N.A.[2]	1.7%[1]	N.A.[2]	2.2%[1]	Independent Forming and Finishing	Hot and Cold Finished Products	North Central
Petroleum Refining	10	1%	No change[5] from '77	No Change[5] from '77	Topping Lube	High Sulfur fuel Lubricating Oils	Mid-Atlantic Gulf Coast
Textiles	479	4.8%	No change[5] from '77	No change[5] from '77	Wool Dyeing Fabric Finishing	Wool	New England Mid-Atlantic
Metal Finishing	7	7.3%	7	11.2%	Small job and captive shops		California, Illinois Ohio, Michigan, New England
Steam Electric	N.A.[2]	Negligible	No change[5] from '77	No change[5] from '77	Construction Retrofits		Northeast North Central
Chemicals[6]	13	Negligible	No change[5] from '77	No change[5] from '77	Small volume Producers		New Jersey, Ohio, West Virginia, Delaware
Aluminum	Negligible	<1%	Negligible	<1%	Secondary Aluminum		Pacific Northwest Gulf Coast
Copper	Negligible	Negligible	Negligible	Negligible	Secondary Copper Smelting and Refining	Refined Copper	East Coast (New Jersey)
Lead	Negligible	Negligible	Negligible	Negligible	Primary Lead Smelting	Western Prime Lead	Missouri
Zinc	Negligible	Negligible	Negligible	Negligible	Primary Zinc Smelting	Slab Zinc	Pennsylvania and Illinois

1- Decline in productive capital stock, not necessarily due to plant closures.
2- Not available
3- Estimate of cost capacity due to retrofit downtime and loss in efficiency - 650,000 kilowatts; 3,900,000 kilowatts.
4- Cumulative over the period; not net of baseline closures.
5- All closures due to P.L. 92-500 were assumed to occur by 1977.
6- Includes only 100 major chemical products, not the entire sector.
7- Estimate of the number of captive metal finishing shops highly uncertain.

Source: National Commission on Water Quality. From economic contractor reports. 1975.

TABLE III.D.6: DISTRIBUTION OF INDUSTRIAL IMPACTS - PLANT CLOSURES, SUBCATEGORIES, PRODUCTS, AND REGION: AGRICULTURE-RELATED

Industry	Number of Plant Closures[1] BPT/1977	Percentage of Capacity BPT/1977	Number of Plant Closures BAT/1983 (Incremental)	Percentage of Capacity	Most Impacted Subcategory	Most Impacted Products	Most Impacted Region
Canned and Preserved Fruits and Vegetables	107	4%	128[2]	5%	Dehydrators and Freezers	Citrus, Potatoes Processing	Florida, Northwest
Beef Feedlots	7,300-15,800	1 to 3%	800-1,200	<1%	Less than 500 head		Northcentral, Southeast
Dairy Feedlots	15,500-33,500	2 to 5%	690-1,000	< 1%	Less than 100 head		Equal National
Hog Feedlots	13,700-27,400	2 to 5%	1,460-2,800	< 1%	Less than 1,000 head		Northcentral Southeast
Dairy Products	164	1%	96[2]	.5%	Small Butter and Evaporative Milk		Northcentral, New York, Pennsylvania, California
Leather Tanning	38	12%	31[2]	8%	Entire Industry		Northeast
Fertilizer	20	1.5%	0[2]	0	Phosphates	Urea Di-ammonium Phosphate	Florida

1- Difference in number of plants projected with and without P.L. 92-500 in 1977.
2- Closures due to BPT and BAT by 1983. This is the difference in the number of plants in 1983, with and without P.L. 92-500. This difference may be smaller than the 1977 difference because of plants projected to close by 1983 without P.L. 92-500.

Source: NCWQ. From Development Planning and Research Associates, Inc., "Economic Impacts of Water Pollution Control Act of 1972 on Selected Food Industries"; Vols. III, IV, VI, VIII and IX. 1976.

endangered industry capacity in any one subcategory (30.5 percent). Dissolved sulfite and non-integrated paper are projected to be the subcategories most severely impacted.

The distribution of vulnerable pulp and paper mills has interesting implications for future process and product changes. Since the bleached kraft subcategory contains a relatively large proportion of vulnerable mills, reductions in the level of bleaching may be implemented to reduce abatement costs. Although the possibility of such cost reductions exists, it is not clear how acceptable a reduction in paper brightness would be to the market, despite the potential savings.

The impact of P.L. 92-500 on Electroplating and Metal Finishing threatens a fundamental restructuring of an industry due to water pollution control requirements. In addition to the insistence by the EPA that their most recent pretreatment requirements would alleviate much of the negative impacts upon this and other industries, a further observation has been made by an official of a leading metal finishing state. Robert B. Taylor, Director of Water Compliance and Hazardous Substances, Connecticut Department of Environmental Protection, said at the hearing before the National Commission on Water Quality in Boston, Massachusetts, January 12, 1976, "I feel that I can state categorically that electroplating and associated metal finishing wastes can be adequately treated to meet the objective of the Act without imposing a standard of treatment that, in effect, is going to destroy the industry." (23). However, in another observation related more directly to EPA's proposed pretreatment requirements, F.L. Rockefeller of Cranston Print Works Co. notes, "Joint municipal-industrial treatment has been encouraged by EPA to achieve economies in scale and economies in land use. Advantages of joint treatment are, however, effectively negated by EPA requirements, that industry pre-treat to a degree approaching the standards for treated effluent quality. The costs to industry under this arrangement should be double what they could be in a separate treatment facility." (24).

Although the requirements are not expected to substantially affect the volume of metal finishing done in the economy, they are expected to have a significant impact on the number of establishments in the industry because of the unequal distribution of abatement costs between different plants. This unequal distribution is largely attributable to economies of scale in wastewater treatment. As shown in Figure III.D.5, 10 percent - 15 percent of the industry's capacity faces abatement costs markedly different from the rest. This represents about 50 percent of the metal finishing facilities in the industry, the vast majority of which are a part of a much larger industrial operation.

While the potential numbers of plant closures are large, the plight of the small job or captive shops is understandable. Independent

shops are typically small; 57 percent had fewer than 10 employees in 1967. Many of the small job shops are single-plant firms and loans for capital investment are typically made against the owner's rather than the business's assets. Since the shop does not own the goods it handles, fixed assets are low. In such an economic environment, even if the metal finishing shop wanted to make the required investment, it is unlikely to obtain financing.

Any capacity shortage is not expected to last long. Approximately 90 percent of capacity is projected to be able to meet the requirements and entry into the industry will still be easy relative to most other manufacturing industries. Disruptions in services undoubtedly would occur, however, if this percentage of facilities actually closed by July 1977, or shortly thereafter. While the shift in industrial organization results in fewer, more capital-intensive metal finishing operations, the industry will remain competitive. Unlike pulp and paper the Commission does not anticipate the metal finishing industry becoming concentrated into a limited number of larger corporations.*

Petroleum Refining presents the opposite example -- an industry with very few high-cost plants and negligible plant closures. The shift in the Petroleum Refining industry toward larger, modern refineries occurred during the 1950's and 1960's, and the Act is not expected to significantly impact industrial organization of concentration. The two percent of capacity with significantly higher costs than the rest of industry is largely insulated from competitive pressures and is projected to be able to pass on pollution control costs. Many of these high-cost refiners produce specialty motor oils which compete in a much different market than the bulk of refinery products, such as gasoline and jet fuel. Other high-cost refiners produce asphalt in local markets and are not anticipated to close due to pollution control. A maximum of ten small refiners seem endangered by the Act.

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* Impacts upon Metal Finishing are highly contingent upon the EPA pretreatment regulations. There is some indication that revised regulations currently under consideration could provide some relief for many of the endangered metal finishing enterprises, as would be partially true also for Textiles, Pulp and Paper, and certain food processing establishments.

The Textile industry faces potential closures constituting approximately 5 percent of capacity.* Over 62 percent of the mills in the wool dyeing industry are vulnerable. They represent 9.4 percent of the subcategory capacity. The trend away from wool product consumption may be accelerated by high abatement costs. Small woven and knit fabric finishing operations also will face disproportionate impacts.

In the agriculture-related industries, plant closures are concentrated in Feedlots, particularly dairies, Canned and Preserved Fruits and Vegetables, and Meat Products. Water pollution control requirements accelerate the existing trends in these industries toward larger, modernized, capital-intensive operations. Many small dairies and meat processors are currently only marginally profitable and at a competitive disadvantage in their respective industry. For many food-related industries access to a municipal system is critical if they are to avoid disproportionately higher costs than the rest of the industry.

In summary, the impacts of water pollution controls usually fall most heavily on the small, old, single-plant firms which are often marginal operations and least able to bear the additional costs.** Metal Finishing is the only case where water pollution control requirements mandate a radical change in the industrial structure.*** In most others, water pollution controls are one of many factors forcing industry toward

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* The projected plant closures in the Textile industry are based upon an assumption that pretreatment requirements would be approximately equivalent to BPT guidelines. EPA has subsequently indicated that such stringent pretreatment requirements may not be promulgated, in which case the plant closures projected by the Commission would be greatly overestimated.

** Lest we presume that these are merely numbers in an abstract exercise, the following comments from a food processor deserve attention:

"This week Agripac announced the closing of one of these plants, its 20,000 ton plant at Corvallis because of the impending substantially higher cost of complying with the tightened wastewater discharge permit requirements beyond the presently achieved 85 percent reduction.

"The closing of this Corvallis plant results in the loss of employment for 22 full-time employees, and approximately 590 seasonal employees. Many of the seasonal employees were college students attending Oregon State University, and their earnings from summer employment paid a good portion, if not all of their tuition and other college expenses." (2).

***This does not imply an increase in the industry's concentration ratio.

greater capital intensity, economies of scale, and modernization. Conversely, smaller businesses in many of the industries produce specialty products or operate in local monopoly markets and will not be as heavily impacted as they appear when compared with the rest of the industry.

9. Regional Impacts

The impacts of the Act are concentrated in particular geographic regions and upon certain subcategories and products. Petroleum refiners in the Mid-Atlantic region face significantly higher abatement costs per unit of output. Sixty-eight percent of the vulnerable capacity in the Pulp and Paper industry and 87 percent of the vulnerable mills are located in the Northeast, Mid-Atlantic and Northcentral regions, although these areas account for only 3.1 percent of total industry capacity. New York and New Jersey have 28 of the 80 endangered mills.

Potential plant closures in Textiles are relatively equally split between the Northeast and the South. The Northeast, however, faces a higher rate of plant closures relative to the number of mills in the region. Forty percent of the textile mills in New England and 50 percent of the mills in New Jersey are endangered, compared to 20 percent in the South. The percent of capacity represented by these endangered mills is much lower. Similarly, Metal Finishing and Iron and Steel facilities are concentrated in the industrial Northeast and Northcentral regions.

In the agriculture-related industries, regional impacts differ. Moisture excess areas such as the Southeast have the greatest proportion of Feedlot closures. The impact on Fertilizer establishments is concentrated in Florida, while the impacts on Leather Tanning is concentrated in the Northeast.

Based upon historical closure trends in Iron and Steel, Pulp and Paper, Textiles, Petroleum Refining, Electroplating and Nonferrous Metals, and upon the Commission's estimates of projected plant closures, the Northeast faces the most direct employment impacts from the Act. As illustrated in Table III.D.7, during the period 1967-1974, the Northeast, with 24.5 percent of national employment in these six industries, had 58.8 percent of the employment loss from plant closures. Three states, in this region, New York, New Jersey and Connecticut, accounted for 44.5 percent of those national closure-related employment losses in these six industries. In contrast, during the period 1967-1974, the South had 44.6 percent of the national employment in these industries and only 23.6 percent of the employment loss due to closures.

TABLE III.D.7

REGIONAL DISTRIBUTION OF JOB LOSS DUE TO PLANT CLOSURES IN THE FOLLOWING INDUSTRIES:

Iron and Steel, Pulp and Paper, Textiles, Petroleum Refining, Electroplating, and Nonferrous Metals (1967-1974)

	Census Region			
	Northeast	North Central	South	West
Distribution of Employment in Plants that closed, by Region (percent)	58.8	13.0	23.6	4.6

REGIONAL DISTRIBUTION OF EMPLOYMENT AND EMPLOYMENT TRENDS IN DESIGNATED INDUSTRIES

	Census Region			
	Northeast	North Central	South	West
Regional Distribution of Designated Industry Employment, 1972 (percent)	24.5	24.4	44.6	6.5
Percent Change in Designated Industry Employment, 1967-1972	-15.6	-3.7	+3.6	+0.7

Source: NCWQ. From National Bureau of Economic Research, "Economic Impacts of Water Pollution Control Act of 1972; Plant Closures and the Regional Consequences of Water Pollution Control". 1975.

The key issue in assessing the severity of the regional economic impact of plant closings is the ability of displaced workers to find new jobs.* The Northeast has borne the brunt of past plant closures and has shown the least growth of any part of the country in recent years. Conversely, the South has had relatively few closures in the past and has shown the strongest growth rate. Thus, the South appears in the best position to cope with possible future closings. Thus, not only does the Northeast confront a disproportionate share of the nation's projected plant closures due to the Act, it also seems to be the region least able to accomodate additions to the industrial labor supply.**

This issue provides insight into alternative compensating strategies. As noted in the statement of W.W. Adams of California (1), alternative options do exist for compensating or minimizing the impacts of the Act on an industry, a town or a region that could take the form of aid or assistance, rather than relaxation of requirements.

10. International Trade

The Commission also examined the effects of water pollution abatement requirements on international trade -- an issue of growing public concern. Increases in price create pressure to shift consumption towards substitutes, in many cases an imported version of the same product. The effects on net imports, domestic production, and domestic prices due to the BPT and BAT effluent limitations were estimated using a set of econometric models that described the domestic and imported sectors of the individual industries. In most of the industries with high pollution abatement costs, the volume of trade is small compared to domestic production. Even major percentage changes in the volume of trade will not significantly affect the domestic industry.

The projected changes presented in Table III.D.8 assume competing foreign industries will bear no pollution abatement costs. In general, the impact on the level of net imports is still minor with the exception of the pulp sector (10 percent increase).

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* See Social Impacts section for discussion of local, community impacts.

** During the compliance period, these industrial employment impacts are counterbalanced by stimulative impacts in the supplying industries and in construction activity for publicly owned treatment works. Thus, while re-employment opportunities for displaced workers in their own industries are least likely in the Northeast, the overall employment impacts are positive until 1984. See Section III.H for amplification.

TABLE III.D.8

MAXIMUM INTERNATIONAL TRADE IMPACT IN 1980 AND 1985 ON SELECTED INDUSTRIES OF BPT AND BAT EXPENDITURES

Industry	Net Imports as A Fraction of Domestic Consumption		Percentage Change in 1980 in ...			Percentage Change in 1985 in ...		
	Year	Percent	Net Imports	Domestic Production	Domestic Price	Net Imports	Domestic Production	Domestic Price
Steel	1974	7.9%	3.0[e]	-.63	1.6	6.0[e]	-1.1	2.0
Aluminum	1973	.9	.403	.457[a]	.219[b]	.467	-5.919[a]	2.771[b]
Copper	1973	5.0	.159	.042	.128	.382	.107	.888
Pulp and Paper								
Pulp	1973	8.0	3.31	-.66	.08	10.19	-1.12	-.19
Paper	1973	3.5	1.30	-.36	.53	2.23	-.71	1.04
Newsprint	1973	69.1	.44	-1.11	.11	.94	01.91	.25
Paperboard	1973	.1	-1.15	-1.12	.73	-.43	-4.24	.84
Red Meat								
Beef	1974	5.3[c]	1.142[c]	-.152	.242	1.612[c]	-.136	.161
Pork	1974	2.7	1.186	-.373	.742	1.525	-.468	.787
Leather Tanning								
Shoes	1972	36.1	.316	.169[d]	.284	.614	-.432[d]	.552
Leather			-.965	2.097			-2.879	2.644
Hides			-.361	-.791[d]		.833	-1.293[d]	
Textiles								
Apparel	1972	5.9	1.396	-.122		3.210	-.185	.641
Carpet				-.166	1.115		-.283	1.909

[a] Primary aluminum

[b] Secondary Aluminum

[c] Includes veal net imports

[d] Using ending trend assumption

[e] Gross imports (not net)

Source: NCWQ. From Public Research Institute, "The Effects of Effluent Discharge Limitations on Foreign Trade in Selected Industries", 1976.

11. Steam Electric Power

The steam electric power industry poses a special problem for an analysis of the economic impact of water pollution abatement requirements. To a large degree, the industry's future economic condition depends upon the way in which various governmental regulatory bodies resolve the increasing requirements for additional revenues and other regulated aspects associated with that industry's operation. Unlike other sectors of American industry, the investor-owned portion of the electric utility industry, which is by far the dominating share, is strictly regulated as to consumer rates, marketing areas and, in many cases, location and type of plant and equipment.

At this juncture, uncertainties plague the industry and its future economic stability. These are:

- o Impact of government actions on the prices of fuel, coal, oil, natural gas and uranium.
- o Changing regulator trends toward a new rate setting and pricing procedures.
- o State and Federal policy toward continued expansion of nuclear generating capacity and disposal of radioactive wastes.
- o Siting of new generating capacity.
- o Federal policies and programs impacting capital markets.
- o Environmental regulations for air and water pollution control.

First, Federal energy policy continues to be in a state of flux. Since future fuel prices and availability in part determine the growth in demand for electric power and, thus, the amount of new generation capacity required over the next decade, the uncertainty of future fuel prices contributes to an unstable investment climate. Changes in land-use regulations, strip mining controls and off-shore drilling rights provide additional examples of potential regulatory factors affecting future energy prices.

Second, regulatory policy at the state level is being seriously re-examined in light of new economic and environmental realities. Under public pressure, many regulatory commissions are questioning recurring utility rate increases, and look skeptically at the utilities' projected needs of increased generating capacity. Because many utilities currently have large capacity reserves, there is inefficient utilization of capital facility. The burden of these inefficiencies can only be borne by

consumers or stockholders. New pricing policies, such as charging more for electricity during times of highest demand, summer-winter prices differentials, and phase-out of the declining block-rate structure, are being considered by some state regulatory commissions. Indeed, the wisdom of rate base, rate of return regulation is even coming under question. The results of some of these regulatory changes could be to reduce the rate of growth in demand for electric power below historical levels, thus further reducing the need for additional future generating capacity.

Third, many questions surround the future development of nuclear generation. The steam electric power industry currently faces extensive regulations for the siting, construction, operation and waste disposal of nuclear units, and the future seems to promise additional public scrutiny. In addition, the future cost of nuclear generating capacity is highly uncertain, given the excess cost inflation in nuclear plant construction, and the poor showing of the present operating units in terms of operating efficiency and dependability.

Fourth, regulatory scrutiny of the siting of new generating capacity has been increasing, entailing additional lead time, planning design and construction costs.

Fifth, equity capital poses a problem for the industry. The uncertainties surrounding the industry's future have turned the market bearish toward new stock offerings. Much of the current concern over capital short-fall reflects, in reality, a concern as to the disposition of regulatory commissions toward pending and probable future requests for rate hikes.

Finally, air and water pollution control regulations have produced intense public debate, and both remain uncertain pending the outcome of current litigation. Air pollution control requirements represent the bulk of the projected steam electric power industry's pollution control bill. EPA's policy toward granting Section 316(a) exemptions, allowing a power plant to continue using once-through cooling, and the applicability of state water quality standards to thermal discharges, are major uncertainties contributing to the difficulty of investment planning in the industry.

In addition to these regulatory uncertainties, the industry is faced with an imponderable regarding consumer response to price increases. How elastic is the demand for electrical power? Real prices for electricity declined during the 1950's and 1960's at about 2 percent per year, and have only recently begun to climb. Thus, there is little experience or statistical basis for estimating long-term consumer response to increases in the price of electricity. This lack of data prevents

an adequate economic analysis of the consumer response to higher prices. Available estimates of industrial, commercial and residential response to higher prices do, however, indicate at least a substantial short term consumption reduction, but how lasting this will be is uncertain.

To examine some of the implications and interactions of these factors and future economic conditions in the steam electric power industry, the Commission utilized a computer model which simulated the financial statistics for both publicy owned and privately owned utilities at the regional level over the period 1973-1983. Alternative scenarios were constructed to estimate possible future economic circumstances within the industry. These results were compared with scenarios with alternative water pollution control requirements -- both more and less stringent than those set by EPA. Due to the imprecision of the modelling process and the future uncertainties of the industry, great significance should not be given the precise numerical estimates, but the Commission believes the direction and magnitude of the impacts projected due to water pollution control are reasonable.

A key assumption built into the model is that real dollar increases in rates are constrained to no more than five percent in any one year. With this assumption, real average prices rise four to five percent annually over the next 10 years. Thus, by 1983, the rate of return on rate base will have declined by 2.7 percent (absolute decline as percent of rate base) for investor-owned firms, and by 3.2 percent (as percent of equivalent rate base) for publicly owned firms. The pattern of return on common stock equity is even more severe with a decline in return on equity from about 14.1 percent (nominal return) in 1973, to plus or minus one percent (real rate of return) in 1977, and thereafter increasing only moderately to 1983. Throughout the scenario, return on common stock equity never attained the level achieved during 1973.

The scenarios projected a generally worse picture for New England, the Mid-Atlantic region, and the Midwest (Ohio, Michigan, West Virginia, Kentucky and Indiana) than for the rest of the nation. Publicly owned utilities are projected to fare worse than investor-owned utilities. The percentage change in annual total operating costs over the period 1973-1983 is anticipated to be 124 percent for publicly owned utilities, compared to 73.5 percent for investor-owned utilities. Average residential prices charged by publicly owned utilities are projected to rise 54 percent over the period, compared with a 50 percent increase for investor-owned utilities.

The constraint on real rate increases of 5 percent in any one year resulted in a significant blunting of demand, containing the average annual growth rate in consumption to 2.2 percent. This is much lower

than industry and governmental forecasts. As mentioned previously, the Commission's estimates of demand elasticities should be used with caution. These projections may well be too low. The demand elasticities themselves, however, were more conservative than most previous estimates. The forecasting problem arises because of uncertainties in coupling them with large price increases. The estimates of growth in demand do not, however, change the estimated water pollution control capital expenditures or significantly diminish the results of the impact analysis because capacity additions planned as of January 1975, were assumed to be unaffected.

Since the estimates from the model are a simulation and not designed to reach equilibrium conditions, the results should be seen as tracing alternative assumptions with regard to future parameters affecting the industry. If fuel prices increase more than is projected, pressure on prices will be even greater. If real rate increases larger than five percent in any one year are granted, demand may be curtailed further. To the extent that additional rate increases are granted, the realized rate of return on rate base and the rate of return on common equity will rise. If capacity expansion plans are cancelled, pressures for rate increases may diminish.

Water pollution control requirements do not influence the industry as much as the escalating cost of fuel, the costs of complying with air pollution control requirements, and the total investment needs of the industry. Water pollution control requirements are projected to have the following incremental effects:

- Real dollar total operating costs will increase by 3-5 percent by 1983, while overall costs for other reasons increase about 100 percent.
- Electricity prices will increase 0.5-1 percent.
- Rate of return on rate base will decrease by about 0.5-1 percent* as a percentage of the rate base by the mid to late seventies, with recovery to about 0.3-0.7 percent decline in rates of return on rate base by 1983.

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* Total change, not an annual rate of decline.

The incremental effect of water pollution control expenditures over the baseline has a negligible impact on projected demand. Water pollution control expenditures* are estimated to be about two percent of total industry investment over the period, and about 13 percent of pollution control investments. The Northeast and Northcentral regions continue to be the most heavily impacted although results differ depending upon the economic parameter selected. While publicly owned utilities confront a more difficult period than investor-owned utilities in the baseline scenario, they are relatively less impacted by water pollution control requirements than privately owned utilities.

Although the impact of water pollution controls on such industry-wide economic variables as prices, demand, rate of return on rate base, and capital investment is not large in relation to the magnitude of the industry's operations, the actual dollar outlays for capital and operating and maintenance expenditures are sizeable. Estimates of capital expenditures for water pollution control in the various scenarios range from $5.79 billion to $11.75 billion, depending largely on the number of 316(a) exemptions assumed to be granted.** Annual costs in 1975 dollars are between $1 and $2 billion.

Despite the pervasive uncertainty in the analysis, the cost estimates and economic assessment do not indicate serious difficulties in achieving either the high or low estimates of expenditures for water pollution control. The economic impact of water pollution control requirements is less than the impacts of projected fuel cost increases and air pollution control requirements. Although the economic future of the

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* Capital expenditures for water pollution control in this case are assumed to be $5.85 billion ('75 dollars).

** A description of the nature of the 316(a) and 316(b) exemption clauses of the Act, and how they were treated in the Commission analyses of the Steam Electric Industry can be found in Chapter II, "Thermal Limitations" Section C, 4c. The analysis of the expected effect of these exemptions, based upon a limited amount of data, yielded the following fractions of capacity by type of receiving water likely to qualify for Section 316(a) exemptions: Ocean -- 80 percent; Estuary -- 38 percent; River -- 80 percent; Lake -- 90 percent; River Impoundment -- 0 percent; Other Impoundments -- 100 percent, Man-made ponds -- 100 percent. In contrast, EPA's economic analysis assumed the following: Ocean -- 100 percent; Estuary -- 50 percent; River -- 74 percent; Lake -- 50 percent. (See "Economic Analysis of Effluent Guidelines for Steam Electric Power Plants", Temple, Barker and Sloane, Inc., December, 1974.)

Steam Electric Power industry is dismal under several plausible scenarios, water pollution control requirements are not one of the primary causes of the difficulties, nor is relaxation of the stringency or coverage of the water pollution control regulations a solution to the industry's problems.

12. Other Industries

Section III.D.1 analyzed the "in-depth" industries and a limited number of agriculture-related industries. Many other industries may anticipate impacts as great as those studied in-depth. In particular, Mining, Beet Sugar, and Seafood Processing may have greater impacts than many of the industries examined in detail in this section. However, no detailed analysis was conducted of these industries. General price and output effects by major industrial sectors may be found in Section III.F. of this chapter. Table III.D.9 lists those industries not examined in-depth by equivalent macroeconomics sector. The table presents: (1) the predicted 1985 price and output effects for each sector from the macroeconomic analysis (Scenario F-1); (2) a judgmental ranking based on size of pollution abatement costs compared to revenues of each industry; and (3) brief comments on special impacts based upon EPA economic impact reports. In many cases the Commission industry studies represent only a small portion of a sector. For example, Soap and Detergents phosphate manufacturing, and Paint and Ink are only a small part of the total Chemical industry. The price and output impacts listed are for the whole industry, including Organic and Inorganic Chemicals and Plastics and Synthetics.

D.2) AGRICULTURAL CROP PRODUCTION: ECONOMIC IMPACTS OF HYPOTHETICAL POLLUTION CONTROL STRATEGIES

1. Introduction

P.L. 92-500 explicitly identifies certain agricultural practices as coming under the NPDES program; feedlot production and return flows from irrigated agriculture. EPA's initial proposals restricted controls to operations above a certain size. Court rulings rejected EPA's proposal to exempt operations below a specified size. Control mechanisms are not yet specified for these agricultural point source discharges, which were intended eventually to be fully within the purview of the permit mechanism.*

* EPA has recently announced that it will reassess its whole approach to the control of pollutants emanating from these agricultural production activities, with immediate attempts at comprehensive control to receive a low priority.

TABLE III.D.9: ECONOMIC IMPACT OF P.L. 92-500 UPON INDUSTRIES NOT ANALYZED IN DETAIL IN SECTION III.D.

Macroeconomic Sector[a]	Percentage Price Increase 1985[a]	Percentage Output Change 1985[a]	NCWQ Industry Title[b]	Magnitude of Impact[c] (H-High, M-Medium, L-Low)	Comments
Mining	+8.5	-4.0	Ore mining and dressing	H	Meeting BPT requirements will require a very high percentage of total investment due to pollution abatement. Many small mines and wells using low grade resources may not be able to continue operation.
			Coal mining	H	
			Oil and gas extraction	H	
			Mineral mining and processing	H	
Primary Metals	7.2	-3.0	Ferroalloy manufacturing		
			Foundries		
			Nonferrous mills		
Stone	5.3	-1.9	Glass	M	6-8 plants, representing 15-20% of capacity for hand blown glass, may be forced to close.[d]
			Cement	M	
			Asbestos	M	
			Concrete gypsum and plaster	L	
			Pottery	L	
			Insulation fiberglass	L	
			Structural clay	L	
Lumber	5.3	-1.4	Timber products	L	Some plant closures in the hard plywood sector.[d]
Furniture	7.9	-7.0	Furniture and fixtures	L	
Food	10.8	-4.9	Beet sugar	H	Beet sugar and seafood processing may be subject to a significant number of plant closures, up to 27% of capacity for beet sugar. Both industries are seasonal, so employment impacts may not be as significant as the number of plant closures. Some plant closings are also anticipated in cane sugar.[d]
			Canned and preserved seafood	H	
			Cane sugar	M	
			Miscellaneous food and beverages	L	
Paper	6.3	-	Builders paper and board	H	Up to 17 mill closings. They represent a small portion of productive capacity.[d]
Chemicals	5.4	1.0	Paint and ink	M	
			Soap and detergents	L	
			Phosphate manufacturing	M	
Rubber	0.2	0.5	Rubber processing	M	22 plant closing constituting .8% of industrial capacity.[d]
Transportation	5.8	-.7	Transportation industries	M	Major impact on independent trucking operations.
Utilities	2.9	6.3	Water supply		BPT requires capital expenditures as great as one year's capital expenditures in the industry. This means 1976 capital expenditures would need to increase 50% for pollution abatement if there were to be no cutback in other investment.
			Steam supply		

a. See III-F for a full discussion of the results and methodology used for these estimates.
b. Titles used on Table III.D.1.
c. Based approximately on size of annualized pollution abatement costs versus total revenue.
d. From EPA economic impact analysis.

Source: NCWQ, 1975.

EPA has only the responsibility to study a broad range of non-point sources of pollutants, with possible future recommendations for the control of these sources forthcoming. For certain regions agricultural contributions to non-point loadings have been identified as critical. Recognizing that an analysis of the relative impact of non-point sources is necessary to determine the impact of P.L. 92-500 on point-source agricultural discharges, the Commission studied the economic impacts of a hypothetical control program for non-point pollution from non-irrigated agriculture.

Two research thrusts regarding irrigated and non-irrigated agriculture were integrated into one effort. First, costs were estimated for three levels and types of control of returns from irrigated agriculture. Costs also were developed for the equivalent of implementing the National Inventory of Soil and Water Conservation Needs, 1967 (hereafter CNI). These two sets of cost data were then entered into a national multi-regional model of agricultural production in the United States. This is a reduced version of a model used to provide the results of the agricultural component of the current Water Resources Council National Water Assessment. Nine alternative scenarios, reflecting the alternative cost data, alternative assumptions about export levels, and alternative assumptions regarding energy developments were examined. (Table III.D.10). Information also was used to identify any productivity gains associated with changed irrigation or conservation practices, with these gains serving in part to offset the costs of compliance with the hypothesized controls.

This analysis is not sufficient to delineate the entire range of potential economic impacts of the imposition of pollution controls on irrigated and non-irrigated crop production. Resource limitations precluded detailed farm-by-farm, crop-by-crop examination of those impacts that would be felt by individual enterpreneurs. Unquestionably for at least the "severe" (high) scenarios, many farms would suffer severe consequences equivalent to "plant closings" in the industry studies. This result is supported in part by the information provided subsequently on income effects. The analysis isolates broad policy considerations relating to shifts in agricultural production among crops and between regions, with results for alternative scenarios being the shifts between irrigated and non-irrigated agriculture and resultant impacts on water use, production levels, prices, income and returns to land. Both irrigated and non-irrigated agriculture should be subcategorized into the principal forms of farming activity and detailed technology and economic assessments conducted to properly assess the microeconomic enterprise-by-enterprise dimensions of potential impacts.

Additionally, the study of the impacts of attaining the Conservation Needs Inventory presumes that the practice indicated within that inventory will be followed precisely, ignoring individual enterprise in using

TABLE III.D.10

The Nine Alternative Futures of the ISU Analysis

NAME	Return Flow** Compliance	ACP*** Conservation	Energy Water Diversion	Exports
* BASE	trend	no	trend	trend
* HIGH-RF	high	no	trend	trend
LOW-RF	low	no	trend	trend
* ACP	trend	yes	trend	trend
* ACP-RF	high	yes	trend	trend
ENERGY	trend	no	trend	trend
ENERGY-RF	high	no	high	trend
EXPORT	trend	no	trend	trend
EXPORT-RF	high	no	trend	high

* These are the four target models for analysis.

** See Technology Section for descriptions of control technologies.

*** Adequate Conservation Practice, as defined by the Conservation Needs Inventory

Source: NCWQ. Iowa State University, Center for Agricultural and Rural Development. "Economic Impacts of Water Pollution Control Act of 1972; Irrigated and Non-irrigated Agriculture", 1975.

less costly methods of attaining equivalent soil loss reductions.

2. Impacts of Alternative Controls Upon Irrigated Agriculture

Impacts of low, medium and high control options (see technology section for description) were assessed for the production of barley, corn, corn grain, cotton, legume hay, non-legume hay, oats, sorghum, sorghum silage, soybeans, sugar beets, summar fallow, and wheat. These impacts were assessed in the context of national markets, but with the determining resource allocation mechanisms confined to the 17 western states. Costs per acre in the assessment are provided in Table III.D.11. These costs resulted in annual costs for the four principal scenarios as indicated in Table III.D.12.

Four of those scenarios examined reflect the range of the alternatives and the impacts. These include E'* demands with water use for energy and high return flow compliance levels, and E' high-export demands with trend water use high return-flow compliance.

The two high-export scenarios produce impacts that are both dramatic and national in dimensions (Table III.D.13). While the levels of irrigated agriculture and water used substantially differ when comparing the energy scenario and the high-export scenario, these changes are trivial compared to the changing levels of economic returns to land and water. These levels dramatize an important fact; aggregate agricultural production does not suffer decreased returns from imposing these scenario dimensions. Rather, the shifts in the distribution of these returns is the proper point of focus. These short term interregional adjustments must of necessity result in substantial disruption, although the dimensions of disruption are not examined in the Commission studies.

Aside from the enterprise-level disruptions, the product-level impacts are perhaps most important. While aggregate production levels do not fluctuate substantially and aggregate returns to land and water increase, the sizeable adverse impacts upon crop production levels and associated prices need further examination (Table III.D.14). Here the information is dual in nature. High exports with high return flow compliance produce substantial price increases. More pertinent, however, is the fact that these price levels are actually lower than those associated with high exports and trend level return flow control. At high

* Present OBERS projections of Agricultural Sector Economic Activity prepared under the direction of the Water Resource Council (In Press).

TABLE III.D.11

Cost per acre to comply with specified levels of return flow water quality limitations by 1985 under different irrigation systems.

Water Resource Region	set irrigation & % of compliance level	land type and irrigation method			
		drained sprinkler	drained flood	undrained sprinkler	undrained flood
		percent or dollars per acre			
Missouri	% of irrig.	0.3	8.6	12.1	79.0
	Low	5.00	5.00	0.00	5.00
	Medium	24.40	54.40	0.00	5.20
	High	50.60	80.60	0.00	5.20
Arkansas-Red-White	% of irrig.	0.5	3.8	14.8	80.9
	Low	5.00	5.00	0.00	4.70
	Medium	9.60	39.60	0.00	4.70
	High	36.40	66.40	0.00	4.70
Texas Gulf and Rio Grande	% of irrig.	0.3	4.0	19.3	76.4
	Low	5.00	5.00	0.00	4.7
	Medium	13.80	43.80	0.00	4.7
	High	46.00	76.00	0.00	4.7
Upper and Lower Colorado	% of irrig.	0.1	8.3	3.2	88.5
	Low	5.00	5.00	0.00	4.80
	Medium	32.00	62.00	0.00	4.80
	High	72.40	102.4	0.00	4.80
Great Basin	% or irrig.	0.2	15.4	7.8	76.6
	Low	5.00	5.00	0.00	5.00
	Medium	28.30	58.30	0.00	5.10
	High	60.30	90.30	0.00	5.10
Pacific-Northwest	% of irrig.	3.4	8.3	31.1	57.2
	Low	5.00	5.00	0.00	5.00
	Medium	32.40	62.40	0.00	5.30
	High	65.30	95.30	0.00	5.30
South Pacific	% of irrig.	1.2	21.2	17.6	60.0
	Low	5.00	5.00	0.00	5.00
	Medium	17.70	47.70	0.00	5.10
	High	59.80	89.80	0.00	5.10

Source: NCWQ. From Center for Agricultural and Rural Development, Iowa State University. "Economic Impacts of Water Pollution Control Act of 1972; Irrigated and Non-irrigated Agriculture", 1975.

TABLE III.D.12:
Annual expenditures for return flow controls by major river basins under alternative agricultural futures and return flow control levels in 1985.

Expert level	E PRIME		ENERGY	HIGH EXPORT
Water use	E'	E'	E'	E' high
Return flow	trend high	trend low	energy high	trend high
River Basin	(thousand dollars)			
Missouri	35,748	26,698	35,748	75,847
Arkansas-Red-White	16,378	15,451	16,371	20,511
Texas-Gulf	10,564	10,107	10,564	11,887
Rio Grande	1,991	2,190	1,991	8,384
Upper Colorado	2,115	1,527	1,931	4,786
Lower Colorado	8,739	4,417	8,739	12,126
Great Basin	2,869	2,872	2,869	8,412
Columbia-North Pacific	14,157	13,282	14,157	33,487
California-South Pacific	14,087	13,458	14,087	86,400
Total	106,648	90,002	106,457	261,840

Source: NCWQ. From Center for Agricultural and Rural Development, Iowa State University. "Economic Impacts of Water Pollution Control Act of 1972; Irrigated and Non-irrigated Agriculture", 1975.

TABLE III.D.13:
SELECTED SUMMARY IMPACTS STATISTICS REFLECTING ALTERNATIVE SCENARIO COMBINATION OF EXPORTS, WATER USE AND RETURN FLOW CONTROL, 1985

Export Level / Water Use / Return Flow	E PRIME												ENERGY					
	E' TREND HIGH						E' TREND LOW						E' TREND HIGH					
River Basin	Acres Irrigated (Mill)	Acre Feet Used (Mill)	Labor Expenditures	Land Values Change $/acre	Water Values $/Ac.ft.	Land & Water Returns	Acres Irrigated (Mill)	Acre Feet Used (Mill)	Labor Expenditures	Land Values	Water Values	Land & Water Returns	Acres Irrigated (Mill)	Acre Feet Used (Mill)	Labor Expenditures	Land Values	Water Values	Land & Water Returns
Missouri	6.9	17.0	567	6.86	9.10	767	6.5	17.0	551	7.80	3.70	840	6.9	17.0	567	6.90	9.10	770
Arkansas-Red-White	4.2	6.6	310	10.94	18.73	565	4.2	6.7	301	11.66	7.25	575	4.2	6.6	311	10.98	18.74	567
Texas Gulf	3.7	8.2	239	5.95	19.88	264	3.7	8.2	237	7.03	5.51	286	3.7	8.2	239	5.97	19.89	265
Rio Grande	0.9	2.2	22	0.0	7.74	9	1.0	2.2	24	0.00	0.00	11	0.9	2.1	22	0.0	7.67	10
Upper Colorado	0.4	3.0	10	4.58	6.73	8	0.4	3.0	12	1.81	6.86	8	0.4	2.9	9	5.02	6.77	7
Lower Colorado	1.1	5.5	48	1.46	8.44	43	1.1	5.5	49	2.31	14.79	57	1.0	5.5	48	1.46	8.64	44
Great Basin	0.6	3.5	18	2.27	7.19	15	0.7	3.5	28	4.25	3.57	28	0.5	3.5	18	2.31	7.21	15
Columbia-No. Pacific	4.9	16.4	122	7.77	5.29	177	5.1	16.4	120	1.22	6.74	183	4.9	16.4	122	7.83	5.29	178
California-So. Pacific	5.8	21.1	175	0.95	9.91	83	6.3	21.1	200	2.75	0.77	99	5.8	19.6	175	0.98	9.91	83
New England			6	4.36		3			6	4.34		3			6	4.24		3
Mid Atlantic			96	11.06		94			97	11.69		102			96	11.02		95
So. Atlantic-Gulf			193	2.99		61			195	3.42		70			193	3.02		61
Great Lakes			214	25.37		557			215	26.08		573			214	25.42		558
Ohio			254	32.04		953			255	33.56		998			254	32.12		956
Tennessee			43	7.30		21			43	8.33		24			43	7.36		21
Upper Miss.			517	41.04		2524			518	43.30		2064			517	41.14		2530
Lower Miss.			304	27.06		534			401	28.69		565			303	27.12		535
Souris-Red-Rainy			72	4.66		87			72	4.55		85			72	4.70		87
Total/Average	30.1	82.1	3211	16.64 (Ave)	10.18 (Ave)	6765	29.0	83.7	3226	18.66 (Ave)	4.68 (Ave)	7172	28.4	81.9	3211	16.69 (Ave)	10.21 (Ave)	6785

Source: NCWQ. From Center for Agricultural and Rural Development, Iowa State University. "Economic Impacts of Water Pollution Control Act of 1972; Irrigated and Non-irrigated Agriculture", 1975.

TABLE III.D.13 continued;
SELECTED SUMMARY IMPACTS STATISTICS REFLECTING ALTERNATIVE SCENARIO COMBINATION OF EXPORTS, WATER USE AND RETURN FLOW CONTROL, 1985

Export Level	HIGH EXPORT											
Water Use	E' HIGH TREND						E' HIGH TREND					
Return Flow	HIGH						HIGH					
River Basin	Acres Irrigated (Mill)	Acre Feet Used (Mill)	Labor Expenditures	Land Values	Water Values	Land & Water Returns	Acres Irrigated (Mill)	Acre Feet Used (Mill)	Labor Expenditures	Land Values	Water Values	Land & Water Returns
Missouri	7.7	17.0	639	155.40	63.63	15512	7.4	17.1	639	87.93	20.99	8547
Arkansas-Red-White	4.5	7.9	338	170.18	74.92	7807	4.3	7.6	333	97.29	56.36	4553
Texas Gulf	3.7	8.5	224	137.32	67.82	3640	3.7	8.6	219	81.05	47.50	2209
Rio Grande	1.9	4.2	61	103.04	30.58	304	1.8	4.2	62	36.04	17.43	126
Upper Colorado	0.8	3.0	22	111.64	22.99	163	0.8	3.0	20	59.41	15.31	89
Lower Colorado	1.1	6.0	50	233.22	26.90	425	1.1	5.9	50	79.36	8.64	136
Great Basin	1.3	3.5	42	84.87	42.80	313	1.0	3.5	35	50.37	27.60	176
Columbia-No. Pacific	5.7	16.8	151	170.76	17.00	2766	5.2	16.6	149	97.15	9.88	1588
California-So. Pacific	7.4	28.0	240	157.00	16.06	1225	7.2	26.7	226	42.72	11.45	449
New England			17	86.99		100			17	33.40		39
Mid Atlantic			106	207.30		1857			105	123.40		1104
So. Atlantic-Gulf			230	151.84		3560			235	82.86		1944
Great Lakes			237	232.55		5232			237	141.07		3175
Ohio			271	268.39		8104			271	167.88		5070
Tennessee			64	142.41		539			64	81.66		309
Upper Miss.			540	301.04		18659			539	189.09		11721
Lower Miss.			291	213.98		4241			281	131.43		2608
Souris-Red-Rainy			89	82.71		1553			89	50.55		949
Total/Average	34.1	95.0	3619	192.57 (Ave)	37.20 (Ave)	76002	32.6	93.2	3570	113.33 (Ave)	20.83 (Ave)	44,793 (Ave)

Source: NCWQ. From Center for Agricultural and Rural Development, Iowa State University. "Economic Impacts of Water Pollution Control Act of 1972; Irrigated and Non-irrigated Agriculture", 1975.

TABLE III.D.14

PRODUCTION AND PRICE EFFECTS OF ALTERNATIVE SCENARIOS OF EXPORT LEVELS, WATER USE AND ALTERNATIVE RETURN FLOW CONTROLS, 1985

Export Level / Water Use / Return Flow	E PRIME								ENERGY				HIGH EXPORT								
	E' TREND HIGH				E' TREND LOW				E' ENERGY HIGH				E' HIGH TREND TREND				E' HIGH TREND HIGH				
	Total Acres Harvested	Irrigated Acres Grown	Crop Production	Prices	Total Acres Harvested	Irrigated Acres Grown	Crop Production	Prices	Total Acres Harvtd.	Irrigated Acres Grown	Crop Production	Prices	Total Acres Harvtd.	Irrigated Acres Grown	Crop Production	Prices	Total Acres Harvtd.	Irrigated Acres Grown	Crop Production	Prices	1972 Normalized Prices
	(mill.)	mill. Acres	mill. units	$/unit																	
Barley (bu)	12.7	0.2	618		13.1	0.5	642		12.9	0.2	621		7.2	0.7	350		7.3	0.5	351		
Corn (bu)	63.3	3.6	6076	1.12	63.8	1.4	6022	1.14	63.3	3.6	6073	1.12	74.5	4.0	6900	3.53	74.1	3.7	6881	2.47	1.42
Cotton (bales)	9.4	1.3	11	147.31	9.1	1.4	11	147.91	9.4	1.3	11	147.37	8.9	1.6	11	246.66	8.7	1.7	11	200.01	
Hay (tons)	63.3	8.2	178	28.22	63.2	11.4	185	27.63	63.4	8.2	179	28.24	68.2	7.8	187	87.58	61.0	7.1	185	61.55	34.47
Oats (bu)	14.5	0.0	837		14.9	0.0	858		14.6	0.0	839		7.9	0.0	447		9.0	0.0	511		
Silage (tons)	14.1	3.0	182		13.8	2.1	171		14.1	3.0	182		21.8	4.6	275		21.5	4.6	275		
Sorghum (bu)	14.8	4.0	861.2		14.8	4.0	868		14.8	4.0	861		13.7	3.0	757		13.7	3.0	772		
Soybeans (bu)	80.0	0.6	2620	5.13	80.0	0.6	2619	5.16	80.0	0.6	2620	5.13	88.1	1.2	2871	15.17	88.1	1.1	2845	10.63	3.70
Sugar Beets (tons)	1.8	1.1	33		1.8	1.1	33		1.8	1.1	33		1.8	0.7	33		1.8	0.7	33		
Wheat (bu)	52.3	0.3	1482	1.84	52.3	0.6	1482	1.84	52.3	0.4	1482	1.84	59.8	4.3	1887	8.76	59.8	4.1	1887	5.89	1.72
Pork (cwt)				36.34				36.57				36.35				81.70				61.68	36.40
Beef (cwt)				61.65				62.42				61.69				160.44				117.63	61.75
Aggregate (index)				101				101				101				247				183	100

Source: NCWQ. From Center for Agricultural and Rural Development, Iowa State University. "Economic Impacts of Water Pollution Control Act of 1972; Irrigated and Non-irrigated Agriculture", 1975.

demand and, therefore, high price levels, the productivity contributions resulting from the high control technology provide a counterbalancing effect because the higher prices produce a high value for this increased productivity. This productivity impact on price is only noticeable in the case of the high exports.

While Tables III.D.13 and III.D.14 do show substantial regional adjustments for certain dimensions, flexibility constraints within the model confine regional adjustment within assumed limits, significantly modifying these adjustments. The existence of differential returns to land and water by region suggests that more extreme regional adjustments would have been indicated by the analysis had the adjustment constraints been relaxed. These constraints also contribute substantially to price impact, since they preclude full regional adjustment and resulting relief (response) to price stimulus. This further suggests the conclusion that whereas reactions to alternative scenarios were moderate nationally, regional adjustments of considerable magnitude are generated by the imposition of irrigation return flow controls. In the absence of a more precisely defined intermediate level of control, however, as well as associated productivity information, these impacts materialize only for the "high" control level, which is equivalent to EOD.

3. Impacts of Erosion Control Upon Non-Irrigated Agriculture

Impact patterns of controls upon non-irrigated agriculture are substantially different from irrigated agriculture in their regional dimensions, although the nationwide impacts are about the same. In this analysis the contiguous United States is examined by regions of agricultural productions as defined by the Water Resources Council. While some impacts upon production levels and return to land and water and prices are felt in regions where irrigated agriculture predominates, these are not the regions where erosion control is proposed under the CNI. It is not surprising that the impacts are felt mostly in the Delta states and east of the Mississippi River -- in the Atlantic and South-central states, such as Tennessee, because of the high natural vulnerability of soils and gradients to erosion, and in the Corn Belt due to the intensive cultivation of unstable soils. In the Upper Colorado and Southern California there are actually some acreage increases when only erosion control practices are initiated for non-irrigated lands because production shifts from dryland to irrigated land due to comparative advantage (Table III.D.15).

As with irrigation controls, erosion controls cause some substantial price increases (Table III.D.16) although the pattern is somewhat different. Most notable is the increased production of grasses, which because of the upward pressure of grain prices, leads to increased prevalence of grass-fed beef and lower beef prices. The overall impact

TABLE III.D.15:

SELECTED SUMMARY IMPACT STATISTICS REFLECTING ALTERNATIVE COMBINATIONS OF CONTROL PRACTICES FOR IRRIGATED AND NON-IRRIGATED AGRICULTURE, 1985

	Acres of Cropland Cropland Utilized			Acres of Cropland Irrigated			Average Land Value Change			Average Water Value Change			Total Returns to Land and Water		
	E' Base	E' Erosion Control	E' Erosion & Return Flow Control	E' Base	E' Erosion Control	E' Erosion & return flow control	E' Base	E' Erosion Control	E' Erosion & return Flow control	E' Base	E' Erosion Control	E' Erosion & return Flow control	E' Base	E' Erosion Control	E' Erosion & return Flow control
	Mill.Acres			Mill. Acres			$/Acre			$/Acre-ft.			Mill. dollars		
Missouri	86.7	81.1	81.2	7.4	6.9	6.5	7.37	4.92	1.77	9.79	9.41	9.42	830	884	861
Arkansas-Red-White	37.9	36.4	36.5	4.3	3.4	3.4	10.06	2.42	2.45	19.03	16.71	16.83	572	563	593
Texas Gulf	20.6	14.9	15.1	3.7	3.5	3.4	5.85	0.0	0.0	19.60	17.33	17.72	259	206	215
Rio Grande	0.5	0.3	0.3	1.1	1.1	1.1	0.23	0.0	0.0	10.54	16.06	16.80	24	49	51
Upper Colo.	0.2	0.1	0.1	0.4	0.6	0.4	4.49	0.32	0.0	6.48	2.99	2.62	7	12	11
Lower Colo.	0.3	0.0	0.0	1.1	1.1	1.1	10.64	25.48	0.34	8.64	7.75	7.52	55	78	75
Great Basin	1.0	0.6	0.7	0.6	0.6	0.6	0.70	0.0	0.0	7.00	6.82	6.96	12	23	25
Columbia-No. Pacific	11.5	9.8	9.9	5.2	4.5	4.2	10.07	1.18	0.0	5.13	2.43	2.44	210	175	180
California-So. Pacific	2.5	1.7	1.7	6.2	6.7	5.9	1.96	1.56	0.0	9.99	10.64	10.84	96	268	261
New England	0.7	0.5	0.5				4.38	0.00	0.00						
Mid Atlantic	9.5	8.7	8.7				10.36	3.32	5.53						
So. Atlantic-Gulf	22.8	19.4	19.7				2.87	0.89	1.20						
Great Lakes	23.2	21.1	21.1				24.76	16.80	18.62						
Ohio	30.1	26.2	26.2				30.96	2.13	11.97						
Tennessee	2.9	2.2	2.3				6.18	0.0	0.0						
Upper Miss.	62.6	57.4	57.4				39.73	15.93	15.99						
Lower Miss.	21.0	20.5	20.5				27.32	0.0	11.81						
Souris-Red-Rainy	19.9	18.6	18.6				4.76	0.19	0.19						
Total	353.9	319.7	320.6	30.1	28.5	26.7	16.55	5.64	6.32	10.35	10.16	10.37	6762	12817	12962

Source: NCWQ. From Center for Agricultural and Rural Development, Iowa State University. "Economic Impacts of Water Pollution Control Act of 1972; Irrigated and Non-irrigated Agriculture". 1975.

TABLE III.D.16:

PRODUCTION AND PRICE EFFECTS OF ALTERNATIVE COMBINATIONS OF CONTROL PRACTICES FOR IRRIGATED AND NON-IRRIGATED AGRICULTURE, 1985

	Acres of Crops Harvested				Acres Grown Under Irrigation				Crop Production			Prices (Farm Level)		
	1971-1973 Ave.	E' Base	E' Erosion Control	E' Erosion & return flow control	1971-1973 Ave.	E' Base	E' Erosion Control	E' Erosion & return flow control	E' Base	E' Erosion Control	E' Erosion & return flow control	E' Base	E' Erosion Control	E' Erosion & return flow control
	Million acres				Million acres				Million Units			$/ Unit		
Barley (bu)	10.1	12.9	26.2	25.6	0.4	3.0	2.3		630	1366	1341			
Corn (bu)	60.9	63.2	47.2	47.3	3.9	3.4	3.1		6059	4657	4669	1.11	2.67	2.68
Cotton (Bales)	12.2	9.4	9.9	9.6	1.1	2.2	2.3		11	11	11	147.21	309.69	315.10
Hay (ton)	60.8	62.7	40.3	39.6	9.0	7.7	7.4		178	113	113	27.98	35.48	35.54
Oats (bu)	14.5	14.7	18.8	19.0	0.0	0.0	0.0		848	1096	1107			
Silage (tons)	12.0	14.1	4.6	4.5	3.1	0.1	0.1		180	55	55			
Sorghum (bu)	13.9	14.8	11.4	11.5	4.1	1.9	1.6		846	612	608			
Soybeans (bu)	48.2	79.9	80.1	80.1	0.7	0.9	0.9		2619	2678	2679	5.12	23.97	24.24
Sugar Beets (tons)	1.3	1.9	1.8	1.8	1.1	1.1	1.0		33	33	33			
Wheat (bu)	47.9	52.5	52.3	52.3	0.4	2.1	1.9		1482	1537	1535	1.83	2.75	2.76
Pork (cwt)												36.25	45.51	45.65
Beef (cwt)												60.89	46.00	46.20
Aggregate Index												100	117	118

Source: NCWQ. From Center for Agricultural and Rural Development, Iowa State University. "Economic Impacts of Water Pollution Control Act of 1972; Irrigated and Non-irrigated Agriculture", 1975.

of the erosion control program upon prices is a 17 percent increase above base. The further addition of the return-flow compliance brings some shifts back to dryland farming and an additional 1 percent price increase. These observations are for the standard E' demand scenario, with no analysis made of the impacts of both erosion control and return flow control in the presence of E' high-export assumptions.

The basic results of the analysis are summarized in Table III.D.17. With dryland acreages ranging from 367.5 million acres to 319.7 million acres and irrigated acreages ranging from 34.1 million acres to 26.7 million acres, high acreage levels for both dryland and irrigated land are associated with the highest price increase, 147 percent above the base. This price level can be reduced from 147 percent to 83 percent by instituting high compliance on return flow, given the productivity contributions.* A high level also is associated with the highest returns to assets and labor and the highest level of water use.

4. Summary Observations

Without high export levels in two of the five principal scenarios examined, national shifts in the production of commodities between dry and irrigated land are not substantial. Price effects reach a maximum of 18 percent above base in 1985 for a combination of both high irrigation return flow and erosion control as detailed in the CNI. Regional shifts are dramatic, however. Changing returns to land, labor and water suggest considerable regional adjustments due to shifting comparative advantage resulting from different magnitudes of irrigation return flow and erosion control "needed" in different regions.

Productivity gains are critical to the analyses, in many instances counterbalancing the increased cost of compliance. This result is especially true of an alternative future which assumes high exports. In this instance, the results suggest that if high exports prevail, any attempts at return-flow compliance must be using methods that ensure increased productivity.

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* As noted previously, these price effects are highly dependent upon (1) the flexibility constraints which prevent full regional adjustment, (2) the compensating impact of productivity gains, and (3) the mandatory production targets which drive the analysis, in particular the E' high export requirements. In the absence of these configurations exports would be reduced due to higher prices thus lowering aggregate effects, but regional shifts would be greater in the absence of flexibility constraints.

TABLE III.D.17;
Summary of the impacts of alternative controls on return flow and erosion under varying agricultural futures in 1985.

Alternative	Dry	Irrigated	Water used	Expenditures for labor	Returns to assets	Commodity prices [1]
	(million acres)		(million ac/ft)	(million dollars)		(index)
E' base	353.9	30.1	84.5	3,239	6,762	100
E' energy water	353.9	30.0	84.4	3,240	6,764	100
E' high export	366.6	34.1	95.0	3,619	76,002	247
E' high return flow compliance	355.4	28.4	82.1	3,211	6,765	101
E' low return flow compliance	355.3	29.0	83.7	3,226	7,172	101
E' energy water-high return flow compliance	355.5	28.4	81.9	3,211	6,785	101
E' high export-high return flow compliance	367.5	32.6	93.2	3,570	44,793	183
E' erosion control	319.7	28.5	72.3	2,717	12,817	117
E' erosion control and high return flow compliance	320.6	26.7	69.7	2,693	12,962	118

[1] An index of the farm level supply price of the commodities required to maintain equilibrium in the agricultural sector.

Source: NCWQ. From Center for Agricultural and Rural Development, Iowa State University. "Economic Impacts of Water Pollution Control Act of 1972; Irrigated and Non-irrigated Agriculture", 1975.

While the results of this analysis are informative as to the order of magnitude and the form of the resulting impacts, they should only be construed as representing the relative numerical dimension of the measured impacts subject to the adjustment alternative input to the analyses -- trade levels, costs, adjustment constraints. Actual compliance would involve enterprise level adjustments reflected in part by the shifts in returns to land, labor and water. The resulting price impacts would be determined in a dynamic competitive market which would mitigate against the actual price extremes depicted for farm products. The predicted price rises would price U.S. products out of international markets. Therefore, reduced demand would preclude the attainment of the levels depicted. Furthermore, relaxation of the regional flexibility constraints in the model would allow far greater regional adjustment than actually predicted. This also would mitigate against price rises. Nevertheless, the dramatic prices depicted do serve as a reasonable surrogate for the loss of international markets, drastic regional adjustment, moderate but higher actual price increases, and the social impacts associated with disruption in existing production patterns. The latter remain even without assumed high export demands.

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E. IMPACTS OF THE PUBLICLY OWNED TREATMENT WORKS PROGRAM

Introduction

For publicly owned treatment works, P.L.92-500 establishes a set of treatment requirements, a funding mechanism to aid states and localities in meeting these requirements, and restrictions on the methods local governments may use in financing their share of facility costs. Publicly owned treatment works serve a variety of users and are subject to review according to different criteria at various levels of government. Therefore, the determination of the costs is a complex problem. Once determined, the costs must be allocated among three levels of government. Each level has a variety of fiscal mechanisms at its disposal for raising revenues and each mechanism has different consequences with respect to who ultimately bears the costs. The timing of the predicted costs is not clear, due in part to the unresolved question of whether publicly owned treatment works must meet the requirements in the Act if public funding is not provided, and in part to a lack of clarity as to what requirements should be associated with the specified compliance dates.

Given these considerations, this section is divided into three headings: (1) Expenditure Patterns, which develops the two basic scenarios and presents their capital and operating costs, the dates of achievement of funding of the various categories of needs, and the split of these expenditures among the Federal, state and local government; (2) Financing the State and Local Shares, which deals with general state and local financial outlook, the Act's requirements with respect to methods of financing, the distribution of costs among users, and operating performance; and (3) Alternative Federal Funding and Cost Effectiveness Decisions, which examine alternative priorities among categories, different allotment formulas, prefinancing and cost effectiveness rules. In each section, the impacts of the Act are determined by comparing its requirements to either the present situation or projections of historical trends.

1. Expenditure Patterns

a. Scenario Development: Two scenarios are analyzed. Scenario E-1 is based upon projections of Federal outlays. Scenario E-2 is constructed by setting target dates of accomplishment for different needs categories and scheduling expenditures that can meet these goals. Determination of the level of Federal expenditures for scenario E-1 is based on:

(1) EPA projections of Federal cash outlays by fiscal year through 1978(19). These projections were converted to a calendar year basis to fit other Commission materials.

(2) These outlays were converted to purchasing power in 1975 dollars, using projections of inflation for fixed business investment (from the

Wharton June 1975 Macroeconomic projection: The average rate of inflation for 1978-85 was 6.2 percent per year).

(3) Beyond 1978, Federal outlays were projected at the rate necessary to maintain an annual rate of Federal expenditures of $3.5 billion (1975 dollars).

The resulting projections for estimated Federal outlays and their buying power in 1975 dollars are shown in Table III.E.1. To attain a purchasing power of $35.4 billion in 1975 dollars, actual Federal outlays must be $52.3 billion for the period from 1975 to 1985.

For Scenario E-2, a funding schedule was constructed which could meet all treatment plant and interceptor needs by 1980 and all remaining needs except urban runoff by 1985. Assuming 75 percent Federal funding, the resulting Federal expenditures in both 1975 dollars and in estimated actual outlays can be derived. The choice of 1980 as a target date for Category I, II and IVB needs is based on the fact that it is not now possible to meet these needs by 1977; 1980 was considered to be a more realistic date to provide time for the necessary planning, design and construction. Even this date would cause serious problems with respect to adequate supplies of design engineers and operating personnel (see Section III.G.). The estimated Federal outlays in 1975 dollars are then $119 billion, and the estimated Federal outlays, including inflation, are $184 billion, over ten times the Federal appropriation level in P.L.92-500. Total capital expenditures and the expenditures by category are shown in Table III.E.2.

Because scenario E-1 does not provide adequate funding for all needs, total expenditures can only be calculated after determining which needs are to be Federally funded and which needs local governments would still meet in the absence of Federal funding. For scenario E-1, it was assumed that all funding would go toward financing projects from treatment plants and interceptor sewers (categories I, II and IVB), and that 72 percent of the Federal funds would be for treatment plants (categories I and II), and 28 percent for interceptor sewers (category IVB).* It was further assumed that local government would continue spending at historical rates for collector sewers. The expenditures by categories and whether they are Federally funded is shown in Table III.E.2. Alternative priorities for categories are examined in section 3 of this chapter.

Table III.E.2 also shows the expenditures that would occur for 1975-1985 if historical trends in sewer systems expenditures for the period 1955 through 1970 continued. This period was chosen to avoid introducing a bias due to the significant rise in expenditures in the early 1970s

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*These percentages are from Commission Costs and Capabilities of Technology Estimates of relative needs.

TABLE III.E.1 Federal Outlays and Their Purchasing Power for Scenarios E1 and E2
1975-1985 (billions of dollars)

	Year	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	Total
Scenario E1	Federal Current Dollar Outlays[a]	1.795	2.640	3.680	4.126	4.633	5.041	5.366	5.701	6.064	6.428	6.813	52.3
	Purchasing Power in 1975 dollars[b]	1.795	2.447	3.245	3.437	3.500	3.500	3.500	3.500	3.500	3.500	3.500	35.4
Scenario E2	Federal Current Dollar Outlays[c]	2.6	6.4	8.5	10.4	13.2	16.2	19.1	22.6	26.2	28.6	30.2	184.4
	Purchasing Power in 1975 dollars d	2.6	5.9	7.5	8.7	9.9	11.2	12.5	13.8	15.2	15.6	15.6	118.5

a. Through 1978 based on EPA projections as given in EPA, Construction Grants Fact Sheet. After that date, computed as the current dollar outlay necessary to maintain 1975 dollar expenditures of 3.5 billion dollars, using June 1975 Wharton Macroeconomic projection of the deflator for fixed business investment.

b. Through 1978, the 1975 purchasing power of EPA projected outlays using deflator for fixed business investment from June 1975 Wharton Macroeconomic projection, thereafter projected at 3.5 billion dollars a year.

c. Purchasing power inflated to current dollar expenditures using inflator for fixed business investment Wharton June 1975 Macroeconomic projection.

d. Individual years essentially arbitrary: the goal was a steadily increasing stream of expenditures which could easily meet I, II and IVB needs by 1980 and all needs except urban runoff by 1985.

SOURCE: NCWQ, February, 1976

TABLE III-E.2.: Estimates of Capital Costs and Capital Expenditures (1975-1985) in Billions of 1975 dollars.

Category	Estimates of Costs		Capital Expenditures (1975 - 1985)				
			Scenario E1			Scenario E2	Historical
	1974 Needs Survey	NCWQ Estimates[a]	Federally Sponsored Expenditures (75% Federal 25% State-Local)[b]	Not Federally Sponsored (100% State-Local)[c]	Total	All Expenditures Federall Sponsored (75% federal, 25% State-local)	Trends[d]
I. Secondary Treatment	16.4	10.8 } 35.6	33.9	0	33.9	10.8	14.5
II. More Stringent Treatment Required by Water Quality	20.4	24.8				24.8	
IIIA. Correction of Sewer Infiltration/Inflow	6.9	6.9	0	0		6.9	
IIIB. Major Sewer Rehabilitation	9.5	9.5	0	0		9.5	
IVA. Collector Sewers	22.8	13.0	0	13.8	13.8	13.0	13.8
IVB. Interceptor Sewers	23.1	13.5	13.2		13.2	13.5	10.4
V. Correction of Combined Sewer Overflows	40.4	79.6	0	0		79.6	
Subtotal	139.5	158.1	47.1	13.8	60.9	158.1	38.7
VI. Treatment and/or Control of Stormwaters	305.5						
Total	445.0						

a. For derivation, See Table II-17

b. Given 35.4 billion dollars in real federal funds available (See Table III-E.1), with 75% grants the federal government can sponsore 47.1 billion dollars in projects. It was assumed that 72% of these funds would be for categories I and II and 28% for category IVB. (This rate is from Commission technology estimates.)

c. Based on time trend of contract awards for collector sewers.

d. Based on time trends of contract awards for collector sewers and waste treatment facilities (assumed splite: 55% treatment plants and 45% interceptor sewers).

Source: NCWQ and U.S. Environmental Protection Agency, "Cost Estimates for Construction of Publicly Owned Wastewater Treatment Facilities, 1974 'Needs Survey'". 1975.

from increased Federal support under P.L.84-660 and P.L.92-500.* Scenario E-1 represents a 75 percent increase over historical trends in sewer system expenditures with most of the increase in expenditures on treatment plants. Scenario E-2 presents sewer system expenditures over 400 percent greater for the period 1975 to 1985.

b. Dates of Accomplishment: Dates of accomplishment are based on Commission technology cost estimates by category. The assumption used in these estimates of building for 1990 capacity probably results in an underestimate of actual design capacity and, thus, an underestimate of costs. On the other hand, the treatment plant categories include a great deal more spending for tertiary treatment than EPA actually has allowed in its review of these needs. Finally, the needs survey has a number of problems as a data base (20).

Given these caveats, Table III.E.3 shows the dates by which various categories will be completely funded under the two scenarios. For scenario E-1, which is based upon EPA projected outlays (the projected outlays are far higher than those of recent years), secondary treatment plus treatment beyond secondary where required by water quality limitations is not accomplished until 1986. Under scenario E-2, these requirements are met by 1980, based on the assumption that no more than $13 billion will be spent on other categories by that date.

TABLE III.E.3. Dates for Complete Funding for Publicly Owned Treatment Works Categories

	Scenario E-1	Scenario E-2
I and II	1986[a]	1980[c]
III	Not funded	1985
IVA	1985[b]	1985
IVB	1986[a]	1980[c]
V	Not funded	1985
VI	Not funded	Not funded

a. Assumes Federal expenditures continue at the rate given in scenario E-1 through 1986.

b. Funded by local governments.

c. Assumes these categories are given first priority on funds for 1975-1980.

Source: NCWQ estimates based on expenditure patterns shown in Table III.E.2 and Commission technology estimates of costs of categories.

*Based on time trends of contract awards for collector sewers and for treatment facilities (treatment plants and interceptor sewers).

c. Distribution among Levels of Government: From 1955 to 1970, total Federal expenditures never rose above 15 percent of total contract awards for treatment plants and interceptor sewers (see III.C). However, P.L.84-660 grants averaged 44 percent of eligible costs for grants that exceeded $1 million from 1967 to 1972. Many eligible projects that were not Federally funded were constructed, although some of these may have taken place in the hope of reimbursement. Under P.L.92-500, grants have averaged 75 percent of eligible expenditures(4). No adequate data base exists to determine the division of capital expenditures between state and local government, but most state grant programs are tied to the availability of Federal grants. For purposes of analysis, it was assumed that existing state grant programs will be fully funded by the states at authorized levels. Under this assumption, state governments would fund 7 percent of the capital costs for eligible projects, and 18 percent of the capital costs will be paid for by the local government.*

While states with grant programs frequently offer much larger grants than 7 percent, only 28 states have true grant programs. Table III.E.4 shows the number of states with each type of assistance program. One common form of assistance is through state loans, rather than outright grants. This method commonly provides a loan at the interest rate relative to the state's credit rating. Such a loan can lower interest costs to local governments by up to 30 percent.** The form of support also has the advantage of giving the greatest degree of support to those sewage authorities with the most pressing financial problems. Administrative costs, plus the risk of default implicit in any loan, are the financial burden to the state.

TABLE III.E.4: FORMS OF STATE FINANCIAL ASSISTANCE

States with only grant programs	25
States with only loan programs	8
States with both grant and loan programs	3
No financial assistance	14

Source: NCWQ. From Meta Systems, "Economic Impacts of Water Pollution Control Act of 1972; Municipal Options." 1975.

*Derived from computer printout provided by Urban Systems Research and Engineering, WQ5AC001, of state-by-state divisions of state and local costs. Weighting of states is based on percentage of category I, II and IVB needs.

**With a local net interest cost of 7 percent, this would require a divergence of 2 percentage points on the net interest cost between state and local bonds. Such a divergence, though larger than average, could be due to both differences in credit rating and in underwriting costs.

Table III.E.5 shows the Federal, state and local shares of capital, operating and annualized costs under each of the two scenarios and extrapolates an historical trend. Compared to historical trends, scenario E-1 requires lower capital expenditures on sewer systems by state and local government. Scenario E-2, on the other hand, requires a $3.3 billion in additional state-local capital expenditures. Operating and annual costs tell a different story. Incremental operating costs at least double over historical levels for both scenarios. The combination of greater depreciation costs and higher operating costs insure that annual costs for state and local government are higher under all scenarios than with the historical trends, despite the decrease in state-local capital expenditures.

Table III.E.6 shows the percentage of capital and annualized costs borne by each level of government under each scenario. (Operating costs are assumed to be a local expenditure; this omits state support of operating costs in New York, but is accurate for all other states.) For scenario E-2,

TABLE III.E.6. Percentage Shares of Total Sewer System Cost Borne by Federal, State and Local Government

		Federal	State	Local
Capital Expenditures	E-1	58%	5%	37%
	E-2	75%	7%	18%
Operating Costs	E-1	0	0	100%
	E-2	0	0	100%
Annualized Costs	E-1	37%	4%	59%
	E-2	58%	5%	36%

Source: NCWQ, 1976.

where all needs are Federally sponsored, the relative percentages of capital costs are 75 percent Federal, 7 percent state, and 18 percent local. Scenario E-1 put a greater capital cost burden on state and local government. This brought a split of 56 percent Federal, 5 percent state, and 39 percent local. Annual costs, which include capital costs, depreciation costs and operating costs are the best measure of the total costs of sewer system expenditures, however. For annualized costs, the Federal share is 58 percent when all categories are fully funded under scenario E-2. This falls to 37 percent for scenario E-1.

TABLE III.E.5 Federal, State and Local Shares of Sewer System Costs
(Billions of 1975 dollars)

	Scenario E1				Scenario E2				Historical Expenditure Trends		
	Total	Federal	State	Local	Total	Federal	State	Local	Total	Federal	State-Local
Capital Expen. (1975-85)[a]	60.9	35.3	3.3	22.3	158.1	118.5	11.1	28.5	38.7	2.6	36.3
Incremental Operating Costs[b] (1985)	1.52	0	0	1.52	1.98	0	0	1.98	.77	0	.77
Annualized Costs (1985)[c]	6.66	2.47	.23	3.96	14.2	8.30	.77	5.12	3.88	.18	3.70

a. Totals from Table III.E.2. For federally funded sponsored expenditures in scenarios D1 and D2 a split of 75% federal, 7% state and 18% local is assumed. Non-federally sponsored expenditures are assumed to be 100% local, historical trends are assumed to be 15% federal for treatment plants and interceptor sewers and 0% federal for collector sewers.

b. Incremental operating costs in 1985 are defined as operating costs above 1972-1973 levels. Operating costs based on Commission technology estimates, see Chapter II. They are assumed to be 100% local, and do not take account of the New York state operating grant program.

c. Annualized using an interest rate of 7%, treatment plant life of 20 years, sewer life of 50 years, all depreciation costs borne by local government,

Source: NCWQ. 1976.

2. Financing the State-Local Share

Financing of the Federal share involves questions of national economic policy, discussed in section III.F (Macroeconomic Impacts).

As previously noted, only under scenario E-2 are capital costs for state and local government higher than historical trends. Under scenario E-1, they are lower. Thus, in the aggregate, the capital costs that will have to be borne by state and local government may not represent an added burden. However, the fact that capital expenditures may be no greater than past trends is not helpful if past trends lead to overall fiscal problems for state and local government. On the other hand, operating costs will be significantly higher and may present a serious problem. These observations are reflected in the statements and testimony of municipal officials and also by the Michigan Municipal League(14).

a. State-Local Financial Outlook: The Commission study of the state and local government financial outlook did not take into account sewer system expenditures explicitly; rather, the goal was to determine the general fiscal outlook. To assess the financial outlook, a set of state-by-state forecasts of revenues* and expenditures was made. For local government, the forecasts are for the total sum of all revenues and expenditures for all local governments within a state. These units are termed local aggregates. This aggregation was necessary to keep some bounds on the forecasting exercise, and also because of the diversity of forms that local authorities can take. Figure III.E.1 shows the types of local authorities and their expenditures in 1972.

Three sets of expenditure forecasts were made:

(1) Based upon 1970 patterns of expenditures with respect to income, population, unemployment and school-age population. This was the lowest expenditure forecast;

(2) Based upon past trends for each state; and

(3) Based upon the recent American Enterprise Institute's aggregate state-local spending forecasts.

These expenditure trends were matched with three revenue paths:

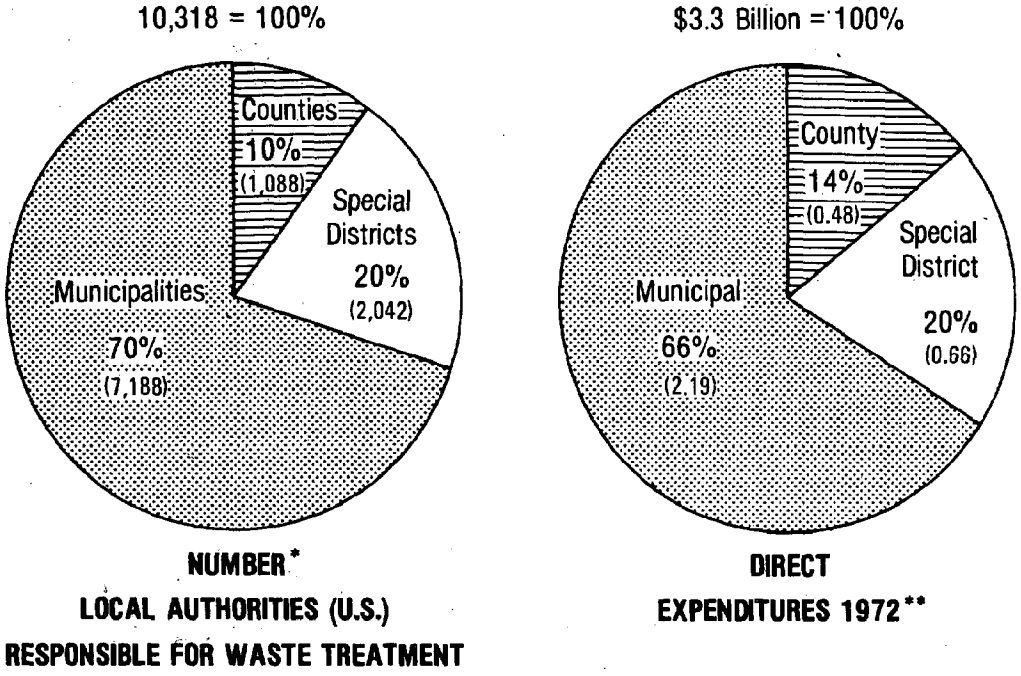
(1) Present levels of revenue effort (taxes as a percentage of personal income);

(2) Present trends in revenue effort; and

*Revenues are defined to include estimated grants from the Federal government.

Figure III.E.1

LOCAL AUTHORITY RESPONSIBILITY FOR PUBLICLY OWNED WASTEWATER TREATMENT COSTS



NUMBER* LOCAL AUTHORITIES (U.S.) RESPONSIBLE FOR WASTE TREATMENT

DIRECT EXPENDITURES 1972 **

Source: *Percentages from examination of grant recipients under PL92-500 and PL84-600.
Total numbers are estimates except for special districts.
**From Census of Governments. Direct expenditures include both capital and operating costs.

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(3) Degree of revenue effort equivalent to the highest state or local aggregate.

Tables III.E.7 and III.E.8 show the number of state or local aggregates that would incur a deficit under each combination of revenue and expenditure. Using present expenditure trends, examination of Table III.E.7 for the period 1975 to 1980 indicates that without an increase in present revenue effort, 40 states could expect to encounter aggregate deficits for this period. If present trends in revenue effort continue, 28 states would expect to encounter deficits, while if all states moved to the degree of revenue effort of the highest state, nine would encounter deficits.* Focussing on a continuation of present trends in revenue and expenditures, 28 states and 21 local aggregates will face fiscal problems in the period 1975-1980, while 44 states and 40 local aggregates can expect fiscal problems in the period 1980 to 1985(26).

As a qualifier, W. R. Z. Willey points out:

> . . . The report (November Draft of above statements) does not, however, forcefully point out that such "recent trends", i.e., the 1970-75 period, have occurred in the context of a significant national recession with its concomitant drag on governmental tax revenues and capital market vitality. At present, most leading economic indicators show an upturn in the national business cycle. The stock market has rebounded dramatically. Monetary and capital markets are improving. Two-thirds of capital costs of publically-owned (sic) treatment works are covered by bonded debt. . . Personal and corporate income are on the upswing. These factors imply that the state and local revenue pictures are in for significant improvements, so that the report's analysis of projected deficits resulting from the Act is overestimated.

To illustrate the relative importance of sewer system expenditure within the overall picture, Tables III.E.9 and III.E.10 show for state and local aggregates, projections of revenues, deficits and sewer system expenditures on a state-by-state basis for the year 1979. In almost all cases, sewer system expenditures are a minor demand on revenue.

The use of local aggregates tends to conceal the fact that, rather than being evenly spread across the entire state, requirements will be very different among communities and more concentrated in some. Over 40 percent of the 1990 population will either not be served by sewers or will have no

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*Note carefully that this is not a prediction that nine states will engage in deficit spending; it says, rather, that nine states cannot continue a given pattern of revenues and expenditure trends without encountering a deficit.

TABLE III.E.7: STATE FINANCIAL OUTLOOK: NUMBER OF STATES WITH PROJECTED DEFICITS

A. 1975-1980

	Present Revenue Effort	Present Trend in Revenue Effort	Revenue Effort of Highest State
1970 Expenditures Patterns	0	0	0
Present Expenditure Trends	40	28	9
American Enterprise Institute Expenditure Forecast	50	38	10

B. 1981-1985

	Present Revenue Effort	Present Trends in Revenue Effort	Revenue Effort of Highest State
1970 Expenditures Patterns	50	0	0
Present Expenditure Trends	43	44	31
American Enterprise Institute Expenditure Forecast	50	50	34

Source: Data Resources, Inc. Economic Impacts of Water Pollution Control Act of 1972; State and Local Revenues and Expenditures. 1975.

TABLE III.E.8: LOCAL AGGREGATES FINANCIAL OUTLOOK: NUMBER OF LOCAL AGGREGATES[a] WITH PROJECTED DEFICITS

A. 1975-1980

	Present Revenue Effort	Present Trend In Revenue Effort	Revenue Effort of Highest Local Aggregates
1970 Expenditure Patterns	1	0	0
Present Expenditure Trends	37	21	43[b]
American Enterprise Institute Expenditure Forecast	51	48	16

B. 1981-1985

	Present Revenue Effort	Present Trend in Revenue Effort	Revenue Effort of Highest Local Aggregates
1970 Expenditure Patterns	2	0	0
Present Expenditure Trends	50	40	48[b]
American Enterprise Institute Expenditure Forecast	51	49	42

a. Includes all states and the District of Columbia

b. In some cases it was found that higher revenues resulted in more than proportional increases in expenditures.

Source: NCWQ. From Data Resources, Inc. Economic Impacts of Water Pollution Control Act of 1972; State and Local Revenues and Expenditures. 1975.

TABLE III.E.9: STATE GOVERNMENT FINANCIAL CAPACITY

STATE	PROJECTED DEFICIT (a)	TOTAL REVENUES (a)	STATE SHARE OF SEWER SYSTEM CAPITAL EXPENDITURES (b)(c) (Scenario E1)
	-- ALL MILLIONS OF DOLLARS --		
Alabama	6.3	3548.4	0
Alaska	-924.4	1097.8	3.1
Arizona	17.2	2313.0	1.0
Arkansas	525.2	1780.6	0
California	2598.0	27901.6	40.0
Colorado	34.9	2678.6	1.0
Connecticut	-1295.8	3181.2	5.7
Delaware	-296.3	767.2	1.6
Florida	-383.3	7614.0	0
Georgia	-1072.1	4478.1	0
Hawaii	-470.3	1634.1	3.4
Idaho	-69.1	867.4	2.5
Illinois	-2618.2	11556.2	0
Indiana	-426.4	4125.9	6.5
Iowa	41.9	2646.5	0
Kansas	-86.1	1962.0	0
Kentucky	-58.0	3590.5	0
Louisiana	110.3	3807.6	0
Maine	-231.8	1020.8	2.1
Maryland	-672.2	4764.5	22.6
Massachusetts	-2885.1	6524.7	15.5
Michigan	-2423.6	10989.0	6.5
Minnesota	200.9	5073.9	3.3
Mississippi	17.7	2513.8	0
Missouri	-862.7	3579.9	9.9
Montana	3.8	873.0	0
Nebraska	-114.3	1279.1	2.2
Nevada	20.6	857.6	0
New Hampshire	136.3	1016.2	6.0
New Jersey	-1629.0	7355.0	30.4
New Mexico	158.0	1469.0	.9
New York (d)	-1918.2	27047.5	44.8
North Carolina	-512.8	5059.7	10.2
North Dakota	57.7	625.6	0
Ohio	-1251.3	9266.2	0
Oklahoma	-884.2	2427.2	0
Oregon	16.6	2684.8	0
Pennsylvania (e)	-3542.1	13731.0	0
Rhode Island	-61.3	1195.1	2.2
South Carolina	-142.6	2613.0	0
South Dakota	5.1	595.2	.3
Tennessee	-403.1	3715.9	0
Texas	39.4	10012.3	0
Utah	82.7	1560.2	0
Vermont	-257.6	743.9	1.5
Virginia	14.4	5176.2	8.8
Washington	-967.9	4577.7	7.9
West Virginia	-75.6	2187.7	0
Wisconsin	-126.0	5542.0	3.7
Wyoming	10.1	573.7	0

(a) Source: NCWQ. From Data Resources, Inc. "Economic Impacts of Water Pollution Control Act of 1972; State and Local Revenues and Expenditures", 1975.

(b) Source: NCWQ. From Urban Systems Research and Engineering. "Economic Impacts of Water Pollution Control Act of 1972; Incidence of Costs". 1975.

(c) Includes only grant program expenditures. All loan programs are excluded (See text).

(d) Does not take account of New York State Operations grant program.

(e) Pennsylvania has a grant program which pays back two percent of local share of eligible costs. This program is not accounted for here.

TABLE III.E.10: LOCAL GOVERNMENT FINANCIAL CAPACITY

STATE	PROJECTED DEFICIT (a)	TOTAL REVENUES (a)	LOCAL SHARE OF SEWER SYSTEM CAPITAL EXPENDITURES (b)(c) (Scenario 1)	OPERATING COSTS (b) (Scenario 1)
	-- ALL MILLIONS OF DOLLARS --			
Alabama	406.6	2430.2	19.6	5.4
Alaska	222.6	1002.6	6.9	3.7
Arizona	-311.2	2131.4	16.7	3.0
Arkansas	380.1	1375.1	24.7	6.7
California	4382.4	31523.7	34.2	4.7
Colorado	158.6	2514.4	3.1	3.0
Connecticut	-649.3	2923.5	44.9	5.5
Delaware	-4.9	523.8	5.9	2.2
Dist. of Columbia	-500.5	2513.4	1.3	.8
Florida	-98.9	7079.4	77.1	21.5
Georgia	136.4	4608.8	30.8	11.6
Hawaii	8.2	397.9	9.7	5.0
Idaho	-49.0	512.5	7.2	2.5
Illinois	1932.4	10433.2	71.0	26.8
Indiana	-297.9	4703.7	27.8	9.6
Iowa	167.1	2754.7	16.9	6.1
Kansas	139.9	1942.1	27.4	6.0
Kentucky	133.5	1821.7	34.7	7.4
Louisiana	288.6	3196.8	27.8	5.7
Maine	-72.3	595.0	3.7	3.1
Maryland	1030.2	5583.2	28.5	26.6
Massachusetts	-195.7	5633.5	27.2	15.1
Michigan	-614.3	10196.1	30.1	19.1
Minnesota	-665.5	5154.6	15.7	8.1
Mississippi	110.1	1755.6	10.1	4.1
Missouri	178.9	3766.0	26.0	9.7
Montana	14.3	547.7	2.9	1.0
Nebraska	563.0	1526.6	3.6	2.6
Nevada	217.4	880.6	5.1	2.0
New Hampshire	-60.5	562.5	11.1	4.3
New Jersey	-1681.5	8080.7	49.7	29.8
New Mexico	-129.2	844.0	3.9	1.1
New York (d)	-6807.8	35122.4	199.6	52.7
North Carolina	-200.8	3541.9	31.0	11.9
North Dakota	44.8	385.6	6.5	.8
Ohio	-526.5	8815.6	78.3	27.1
Oklahoma	-11.6	1763.2	24.5	7.6
Oregon	226.4	2254.9	13.1	3.5
Pennsylvania (e)	-1745.7	9819.2	99.5	18.6
Rhode Island	-65.3	613.4	10.7	2.1
South Carolina	253.1	1764.2	26.5	8.3
South Dakota	141.0	524.9	1.2	.8
Tennessee	642.1	3341.2	31.3	7.8
Texas	426.8	9096.2	75.2	23.2
Utah	27.8	842.9	7.3	2.5
Vermont	9.1	325.7	2.8	1.4
Virginia	-130.0	3837.9	15.7	12.9
Washington	-714.1	3222.4	21.5	7.7
West Virginia	-48.8	936.0	63.5	15.1
Wisconsin	-234.5	9204.3	35.4	10.8
Wyoming	7.9	431.8	2.6	1.0

(a) Source: NCWQ. From Data Resources, Inc. "Economic Impact of Water Pollution Control Act of 1972; State and Local Revenues and Expenditures", 1975.

(b) Source: NCWQ. From Urban Systems Research and Engineering. "Economic Impact of Water Pollution Control Act of 1972; Incidence of Costs", 1975.

(c) Includes only grant program expenditures. All loan programs are excluded (See text).

(d) Does not take account of New York State Operations grant program.

(e) Pennsylvania has a grant program which pays back two percent of local share of eligible costs. This program is not accounted for here.

treatment plant needs(13). Also, costs will vary both by the magnitude of the need and size of community, with the highest costs to small communities due to economies of scale.

Thus, while some communities will face no local costs due to treatment plant needs, a community of less than 5,000, with no treatment plant and a requirement of beyond secondary treatment, could incur local capital costs of over $200 per capita. (Derived from cost data contained in Meta Systems, 1975(11).) The greatest possible community impacts, however, occur in scenario E-2 for communities that must deal with combined sewer overflow control. The local share of these capital costs is over $450 per capita.*

The Commission sponsored a survey of grant recipients of either P.L.92-500 or P.L.84-660 in recent years to determine the methods of financing used by these facilities. About 10 percent of those surveyed stated that cutbacks in other expenditures had played a role in the financing. The cutbacks most commonly mentioned were natural resources and recreation, police, fire and road maintenance.

b. Required Methods of Financing versus Past Methods: Over two-thirds of capital costs for state-local sewer expenditures are normally financed through bond issues(21). Table III.E.11 shows the types of bonds used by recent grant recipients.

TABLE III.E.11. Bonds Used by Local Government to Finance Local Share of Grants under P.L.84-660 and P.L.92-500[a]

	General Obligation Bonds	Special Assessment Bonds	Sewer Revenue Bonds	Other (includes state loans)
Percentage Using[b]	48.6	4.4	26.1	31.4

a. 226 respondents from authorities receiving grants of over $1 million under either Act since 1967.

b. Add to over 100 percent due to use of more than one type of financing.

Source: Urban Systems Research and Engineering, 1975.

*Derived using Metcalf and Eddy(13) estimates of the cost of combined sewer overflow and the total population served by combined sewers, and assuming a 25 percent local share of capital costs.

General obligation bonds are backed by the full tax revenues of the city, while revenue bonds are backed solely by the revenues of the sewer system. Usually, revenue bonds carry a higher interest rate than general obligation bonds, but offer the governmental entity some other advantages. In many states and cities, debt limits do not apply to revenue bonds, there are fewer restrictions on underwriting practices, and they are less likely to require voter approval.

For maintenance and operation costs and repayment of bonds, the most popular system at present is some form of sewer service charge. The use of sewer service charges has grown from 20 percent of all municipalities in 1945, to 61 percent in 1960 and 85 percent in 1969(24). However, other taxes to supplement or sustain O&M and debt service costs may be used by a given community as well as sewer service charges. Table III.E.12 shows the types of financing methods used in a survey of communities that had received grants of over $1 million under P.L.84-660 and P.L.92-500(25).*

On the average, for those surveyed, 57 percent of operating and maintenance costs are financed by user charges; 20 percent by property tax; 14 percent by industrial contribution; and 9 percent from other revenue sources. For capital costs, sewer or water charges account for 75 percent of the financing, property taxes for 20 percent, and 5 percent from other sources.

Data on types of taxes and charges tend to conceal the variety in the types of user charges among communities. Table III.E.13 shows some of the methods used to establish the base and variable portions of sewer service charge. Most communities use some type of flow-based charge for industrial users, but only 20 percent account for waste loads through surcharges. For a significant number of these, the surcharge program exists only on paper(24).

P.L.92-500 imposes two specific requirements upon grant recipients with respect to financing methods -- industrial cost recovery and user charges.

Industrial cost recovery provisions require industrial users to pay their portion of the Federal share of capital costs over a 30-year period. No interest or debt service payments are required. The industrial share must be determined on the basis of waste loads and water volume, with a

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*A full and adequate data base from which to assess the use of property taxes is not available. However, three sources give somewhat similar results. The Urban Systems survey found 25 percent using property taxes for capital repayment. A survey by DuPre(5) found 27 percent used property taxes, while a 1970 AMSA survey of large authorities found 33 percent reporting that they planned to use property taxes for some portion of operating costs in the period 1971-75(3).

TABLE III E.12: Methods of Financing Local Shares of P.L. 92-500 and P.L. 84-660 Grants

Financing Method	Percentage of P.L. 92-500 and P.L. 84-660 Grant Recipients Using A Particular Financing Method[a]	
	For Repayment of Capital Costs	For Maintenance and Operating Costs [b]
Property	25	20
Special Assessment	8	1
Special Industrial Contribution	3	NA
Sewer Service Charge	54	NA
Sewer Service Charge to Industrial Users	NA	72
Sewer Service Charge to Other Users	NA	81
Water Supply Charge	15	12
Other Charge	4	10
Local Sales	.4	0
Local Income	0	0
Other Taxes	NA	10
Other Towns	3	10
Other	5	10

NA. Not Available

a. 226 respondents from authorities receiving grants over $1,000,000 under either Act since 1967.

b. May total over 100 percent due to the use of more than one tax.

Source: NCWQ. From Urban Systems Research and Engineering. "Economic Impacts of Water Pollution Control Act of 1972; Incidence of Costs", 1975.

TABLE III.E.13: Forms of User Charge Systems: Rate Bases for Minimum and Variable Charges, 1969

	Percentage Of Municipalities Surveyed Using:			
	Rate Base for Minimum Charge		Rate Base for Variable Charge	
	Residential[a]	Industrial[a,b]	Residential[a]	Industrial[a,b]
Flat Rate	36	12		
Flow	22	32	67	87
Derived from Water Bill	29	37		
Surcharges				20
Other	11	21	6	11
None			27	9

a. Total may not sum to 100 percent due to rounding error.

b. Excludes commercial (wholesale and retail trade, services, etc.)

c. Total exceeds 100 percent due to use of more than one type of charge.

Source: NCWQ. From Urban Data Services, Inc. "Sewer Service and Charges", 1970.

variety of cost accounting methods acceptable as methods of defining the capital share. Industrial users need not pay for excess capacity unless they have specifically requested it for their use. They may withdraw at any time without further obligation to either the community or the Federal government.*

The Federal government gets one-half of the repayments, with the rest going to the local community, which must use 80 percent of its share for grant eligible construction. The community may use 20 percent for any purpose except for operating and maintenance costs of the facility.

The other statutory requirement -- that of user charges -- must be based upon volume or waste loadings for each user or use class. A volume-based user charge may be used for wastes the strength of domestic use. With wastes of greater strength, a user charge which incorporates waste loading must be used. As noted in the discussion of user charge systems, only 20 percent of all municipalities had surcharges that took into account waste loadings in 1969.

Major administrative changes would be necessary for many communities to implement industrial cost recovery and user charges because this will require implementing surcharge systems and altering existing financing mechanisms to ensure they reflect proportionality among classes of users. In addition to changes in billing and bookkeeping methods, some form of monitoring or metering will be needed. For those systems without a water metering system, the change to metering could result in substantial costs. Even for systems that already have some form of water meter, this is not a simple change. Where there is significant residential use of water for lawn and garden use, water use metering results in more than proportional costs to residential users.**

Industrial cost recovery involves highly complex accounting problems. Some of these problems are similar to those of rate making for traditional public utilities such as electricity and telephones. However, even in these areas, the proper capital recovery methods are subject to debate.

c. Distribution of Costs among Users: Because industrial cost recovery allows the capital costs to be recovered over a 30-year period without interest or depreciation, industrial users receive a substantial subsidy. Assuming an interest rate of 7 percent, industrial users of municipal

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*Local communities may require more binding agreements, however.

**One solution to this, in areas of suitable climate, is the use of winter water use for residential sewer bills.

systems receive a subsidy from the Federal government of 44 percent of capital costs, compared to 75 percent received by all other users.*

The distributional impact of shifting to user charges depends on the nature of the original system and precisely what types of user charge systems are considered allowable. Table III.E.14 shows how costs are distributed among users under different formulas for an industrialized hypothetical community. Two features are notable. The shift from an ad valorem tax to virtually any other charge system chiefly benefits commercial users, and any system that takes into account waste loadings shifts costs from residential to other users.

This comparison may be somewhat misleading, however, since many systems now use a mix of ad valorem taxes and surcharges. Table III.E.15 shows how costs are distributed among users in the Los Angeles County Sanitation District, which uses a combination of ad valorem taxes and surcharges. The effect of moving from this type of system to a flow and waste-based user-charge system would be to shift the burden of charges away from commercial users to residential users and users with property tax exemptions, such as schools, hospitals, etc. A question not clearly answered by current regulation is what constitutes a user class. Is it sufficient that non-industrial users as a class should pay their share of the costs and no more, or must sectors of this non-industrial class, such as commercial, multi-family and single family residences, each pay their exact share as well?

While Federal requirements apply only to grant recipients and that portion of the system sponsored by the grant, the requirements have, in many cases, caused communities to alter their whole charge system, including methods of repayment. Spectacular increases in industrial costs frequently result. However, these increases will not necessarily drive industrial users out of the system.

Two factors will encourage industrial users with compatible wastes to use publicly owned treatment works: economies of scale which, for small users, can reduce costs of treatment as much as 80 percent, and the implicit Federal subsidy on capital, noted above. Industries building their own systems also may receive an implicit Federal subsidy through accelerated depreciation and the use of tax-exempt bonds for pollution control. (See Section III.F. for further discussion of this use of the tax-exempt bond

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*Based on comparing the present value of a 30-year stream of payments for 75 percent of the capital costs to the actual capital cost. This will, in most cases, be a minimum estimate of the size of the subsidy. The actual subsidy for a particular firm will depend on a number of complex factors, such as the relevant discount rate for the firm, whether debt, equity or industrial revenue bonds are considered as the alternative, and the Federal, state and local tax treatment and definition of pollution abatement facilities.

TABLE III.E.14: PERCENTAGE DISTRIBUTION OF USER CHARGES AMONG USERS FOR A HYPOTHETICAL COMMUNITY[a]

	Residential	Commercial	Industrial	Other
1. Distrbution of Flow and BOD among users:				
a. Flow to treatment plant	42.2	11.2	41.8	4.8
b. BOD	33.1	10.8	51.2	4.9
2. Charge Formulas:				
a. Constant Rate per Gallon[c] (sprinkling included)	56.0	8.5	31.8	3.7
b. Flat Fee Modified[d] by user type	77.7	7.8	14	1.5
c. Flat Fee & Constant[e] cost per gallon	78.3	7.1	13.1	1.5
d. Flat Fee & constant[f] cost per gallon and constant rate per pound of BOD removed above normal concentration	72.1	6.9	19.6	1.4
e. Constant cost per[g] gallon and constant cost per pound of BOD	38.1	11	46.1	4.9
f. Property Assessment	66.3	25.7	8.0	0

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a Data based insofar as possible on an unnamed real city, Industrial Flow is somewhat higher than average.

b Schools, Hospitals, etc.

c $.16 per 1000 gallons

d Approximate charges: flat monthly fee of $1.20 for residential and commercial customers and $2.40 for industrial customers plus $.04 per 1,000 gallons of water.

e Approximate monthly charges: residence--$1.20, gasoline stations, car washes, restaurants, laundries--$2.40, hotels,--$3.20, other commercial customers--$2.00, schools, hospitals--$12.00, industrial customers--$40.00

f Approximate charges: $1.00 per month for residential and commerical customers and $2.10 per industrial customer, $.04 per 1,000 gallons of water used for all customers, and $.015 for each pound of oxygen demand that causes the biochemical oxygen demand concentration to exceed that of domestic sewage.

Source: Johnston, James. "The Distribution of the Burden of Sewer User Charges Under Various Charge Formulas", National Tax Journal. 1969.

TABLE III.E.15: Los Angeles County: Percentage Distribution of Flow, Effluent, and Charges Among Users for Fiscal Year 1973

1. Distribution of Flow, COD, and Suspended Solids

	Percentage from Industrial Users	Percentage from Non-Industrial Users
a. Flow	33	67
b. COD	51.7	48.3
c. Suspended Solids	40.6	59.4

2. Percentage Distribution of Total Tax Burden

	Industrial Users	Non-Industrial Users
a. Ad Valorem	15.7	64.5
b. Surcharges	19.8	0
c. Total	35.5	64.5

Source: Los Angeles County Sanitation Districts Communication to the Commission. 1975.

market.) An industry that can take full advantage of both of these implicit subsidies may obtain as great a subsidy as that received by users of publicly owned treatment works.

Thus, there seems to be no economic reason why industrial cost recovery and user cost regulations should drive a typical user with compatible wastes out of the municipal systems. Indeed, the industrial user of a municipal system frequently will gain a substantial competitive advantage over direct dischargers. A second and highly significant long-term effect on the efficiency of water use and the treatment facility of user charges that vary with flow and waste loadings is that they provide an incentive to industrial users to reduce both flow and waste loadings.* (See Figure III.D.1.)

d. System Performance: At present, treatment plant performance represents a serious problem. EPA found that over 30 percent of all treatment plants for which adequate data were available were failing to meet design criteria. Over 56 percent of the plants surveyed did not have operational performance data adequate to serve as the basis for a performance assessment(18). Table III.E.16 shows the reasons for deficiencies reported by EPA in 1973 and 1974.

A second source of evidence concerning performance problems comes from the State of New York operation and maintenance grant system. This grant mechanism is performance-based, but has been very lenient in handling systems with performance problems. Nevertheless, about one-third of all treatment plants in the state have chosen not to be a part of the program (10). One study has suggested that the major reason for the lack of participation was that a 33 percent grant was too small a financial incentive to stimulate communities to pay their share for adequate operation(8). A final source of information concerning operating problems is in the 1973 Needs Survey, where over 18 percent of all facilities reported that they were operating above design capacities. Over 39 percent of facilities serving over 150,000 people were operating at above design capacity(12). While the Act provides remedies for infiltration/inflow problems and for inadequate capacity through Federal funding, it is not yet clear how well the system will work in dealing with other types of operating problems.

Two economic factors may affect the operation of treatment works. The greatest increase in costs over historical trends at the local level is from increased operating costs for treatment plants. Other Commission studies have noted that many communities are more concerned about financing operating costs than capital costs(15). In a tight fiscal situation, it may prove difficult to find adequate funds to operate the facilities. The change in user-charge mechanisms also may have some influence.

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*It should be noted that a charge system can guarantee proportionality among major user classes without providing for the kind of user-by-user monitoring that encourages more efficient use of water and effluents.

TABLE III.E.16

REASONS FOR OPERATING DEFICIENCIES REPORTED IN CLEAN WATER 1973 AND 1974

Type of Problem	Percentage of Facilities (1973)	Percentage of Facilities (1974)
Hydraulic Overload	20	26
Infiltration Inflow	40	9
Structural	14	
Operator Related	49	71
General Maintenance	17	
Inadequate Lab or Testing	24	21

Source: U.S. Environmental Protection Agency. Clean Water--Report to Congress, 1973. 1973.

U.S. Environmental Protection Agency. Clean Water--Report to Congress, 1974. 1974.

Ad valorem taxes have the advantage of rising somewhat with inflation, thus requiring fewer rate increases than user charges. User charges, on the other hand, have the advantage of rising to correspond with increased use of the system, and encourage more efficient use of the system.

3. Alternative Federal Funding Decisions and Cost-Effectiveness Rules

The previous two sections have assumed that the technology costs were representative of how needs would actually be met for design capacity and technologies selected. The sections also assumed that categories will be funded with priorities indicated, and that local authorities will proceed with construction as Federal funds become available. The purpose of this section is to examine the impacts upon dates of accomplishment and expenditures if these assumptions are removed.

a. Priorities among Categories: Scenario E-1 makes the simplistic assumption that all Federal funds will be spent for treatment plants and interceptor sewers (categories I, III and IVB), while scenario E-2 assumes only $13 billion is available for other categories before 1980. Both scenarios neglect the requirement for infiltration/inflow control where cost-effective, and the fact that EPA does not insure that only categories I, II and IBV would be funded even if this were deemed desirable. EPA estimates that past grant awards had the following breakdown in terms of dollars: 52 percent treatment plants, 30 percent interceptor sewers, and 18 percent other non-treatment plant expenditures(1). If this pattern of federal funding were to continue in the future, using scenario E-1, categories I and II would not be fully funded until 1990. The effect upon total sewer system spending and the state-local share would depend upon the extent to which other non-treatment plant expenditures replaced locally funded collector sewer expenditures and the extent to which they constituted spending for previously unfunded categories. If the non-treatment plant spending were for categories other than collector sewers, the resulting total expenditures and their shares would be virtually identical to those of scenario E-1, except for the categories breakdown. If a significant portion were for collector sewers, then total sewer system expenditures would be lower and the state-local share of spending also would be lower.

b. Allotment Formulas: The dates of accomplishment previously discussed depend upon ability to fund all needs as they arise. However, the measurement of needs, particularly on a state-by-state basis, has, in fact, proved very difficult. This presents problems for an allotment formula constructed on the basis of a given percentage of funds available in a given year to each state. The basis for this allotment has been the EPA Needs Survey, but serious questions have been raised about the Survey's validity(2)(12).

Three allotment formulas will be considered here: One based upon treatment plants and interceptor sewer needs from the 1974 EPA Needs Survey (I, II and IBV categories); one based half upon population and half upon needs

(one-half I, II and IVB, and one-half population); and the old formula based upon earlier needs surveys.

For scenario E-1, an allotment formula based upon the most recent assessment of treatment plant and interceptor sewer needs would seem most appropriate if the goal is the most rapid fulfillment of backlogged treatment needs. One objection to this is that many of the differences between states may represent the result of under and overestimates by individual states. However, this is not universally true. Some states with high per capita needs have not overestimated them; others with low per capita needs have not underestimated them. One example is a comparison of West Virginia and New Mexico. At least one study gives credit to both states for a fairly accurate estimate of needs(10). Table III.E.17 shows their respective dates of accomplishments under alternative allotment formulas. As this table shows, allotment formulas can very seriously alter dates of achievement on a state-by-state basis. A question of the relative equity of distribution

TABLE III.E.17. Date of Achievement of all I, II and IBV Needs under Alternative Allotment Formulas, Assuming 1974 Needs Survey Proportions Are Approximately Accurate for Scenario E-1.

	Allotment Formulas		
State	I, II IVB	I, II, IVB Plus Population	Old Allotment Continues Indefinitely
West Virginia	1986	1991	2000(?)
New Mexico	1986	1981	1987

Source: NCWQ, 1976.

between states arises if a state with low treatment plant needs completes these needs, should it receive grants for projects like collector sewers while other states still have serious treatment plant needs?

c. Prefinancing: The historical relationship between increases in the construction cost index and the rate of interest that must be paid on municipal bonds is such that it is almost always cheaper to undertake a major construction project sooner, rather than later. For this reason, many communities have become frustrated with delays in treatment plant construction caused either by difficulty in obtaining approval of plans or by a low position on state priority lists, or both. Considering the length of time that some communities may have to wait for Federal funding under scenario E-1, the

Commission analyzed ways to assist communities faced with delays. One approach is prefinancing, which allows communities to proceed with the assurance that they will receive their share of Federal financial assistance at a later date.

With 75 percent Federal financing, prefinancing arrangements may not be an economically advantageous proposition for local governments. Table III.E.18 shows the interest costs versus the construction savings that a community would incur by prefinancing, with an interest rate of 5 percent and a rate of inflation of 10 percent.* Prefinancing is not advantageous as a purely economic proposition because the community must bear the interest costs on the full costs of construction, while the construction cost savings are on only one-fourth of this cost. In general, prefinancing becomes more economically attractive with high inflation, low interest rates, longer delays in Federal funding, and low Federal grants. Thus, with a 55 percent grant, prefinancing would be of interest under the conditions shown in Table III.E.18.

d. Capacity Decisions: The costs presented thus far in the study are based upon building facilities to meet the flows associated with the 1990 population. The actual capacity decisions that communities must make are more complex. Design of an individual facility must be based on a determination of the population and industrial flow that will be using that facility in the future. But, even with an accurate projection of flows, cost effectiveness problems remain, such as how much capacity to build initially or what design year to build for. These two questions are not unrelated. Conventional economic theory suggests that when there are major uncertainties associated with future capacity, it is better to build for less capacity initially, and wait to see the extent to which anticipated needs actually materialize. The consequence, however, of this cautionary approach can be major environmental impacts if the actual growth rate outstrips the treatment facility's capacity.

The result of using 1990 flows probably yields lower cost estimates. If scenario E-1 were applicable, the last treatment plants built would have design lives of only four or five years if they were built for only 1990 capacity. By comparison, typical design lives for treatment plants are 20 to 25 years and for some, design lives of over 50 years are common. One study, which examined a sample of communities on the urban fringe, found interceptor sewers with an average design life of over 100 years, and a median life of over 50 years(24). However, EPA has noted that the sample of facilities was not typical, and was approved before present cost effectiveness guidelines were in effect(22).

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*The divergence is larger than likely to occur. It is used to show that, even under very favorable circumstances, prefinancing is not economically advantageous.

Table III.E.18: Costs and Savings of Prefinancing With 5 Percent Interest Rate, 10 Percent Rate of Inflation, and a 75 Percent Federal Grant.

	INTEREST COST PER $1,000,000 OF LOCAL SHAREa $	CONSTRUCTION COST SAVINGS PER $1,000,000 OF LOCAL SHAREb $
3-Year Delay	600,000	331,000
5-Year Delay	1,000,000	610,000
10-Year Delay	2,000,000	1,593,000

a. Derivation: .05 x 4,000,000 x Length of Delay

b. Derivation: $1,000,000 compounded at 10 percent annually

Source: NCWQ. 1975.

Quantifying the existence and importance of the excess capacity problem is difficult, however, especially with respect to population and flow forecasting. In the 1973 EPA Needs Survey, 32 percent of all communities reported planning for excess capacity of over 50 percent, and 17 percent reported excess capacity of over 100 percent. This excess capacity was most often reported for smaller communities, with those under 25,000 having 18 percent in the over 100 percent excess capacity category. Those with over 150,000 population reported only 4.6 percent with over 100 percent excess capacity(11). One solution to this capacity estimation problem is "top down" control of population estimates by EPA and the states. Such a system is used by the State of California.

Small changes in treatment plant capacity do not, however, appear to have major effects upon the costs of treatment plants. A change of the design year for treatment plants for 1990 to 1985, equivalent to change of present design life of 15 years to 10 years, results in only a 10 percent reduction in total capital costs(12). In the context of scenario E-1, a design life of 15 years for all treatment plants increases the total cost estimated by less than 10 percent.*

In contrast to these possible capital savings, lowering design capacity would create significant additional burdens for state and local governments. If the Federal government does not fund the necessary incremental capacity when it is required, the effect will be to increase the local annual costs significantly above those shown in Table III.E.5. Further, operating costs may be lower in systems with greater excess capacity(9). In many systems, excess capacity also can be used directly to improve removal efficiency and help handle peak load flows.

e. Technological Choice: The burden of these technological design and operation decisions falls most heavily upon the local governments and the states, placing a heavy requirement on jurisdictions to acquire and maintain expert technologically trained staff. There are only about 3,500 sanitary engineers for 50 states and over 10,000 treatment authorities (Section III-G, Supply Constraints). Moreover, relatively low municipal and state pay scales (Table III.E.19) make it more difficult to attract and retain the most qualified personnel.

Further on-the-job experience is not always the best preparation for the kinds of design decisions that need to be made. The typical treatment authority lacks experience in these decisions since it has a new treatment plant or significant expansion only once every 20 years. (Derived from

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*Derived using Series E population growth, industrial flow growth equal to growth in manufacturing output, and a scale factor of .7 for increasing costs.

Table III.E.19: Salaries for Engineers in State Environmental Agencies in 1973.

	Salary of Average Engineer in Environmental Division		Salary of Top Engineer in Environmental Division	
	Below Average for Civil Engineers	Below Median for College Educated	Below Average for Civil Engineers	Below Median for College Educated
Number of States	42	39	17	7

Source: NCWQ. From U.S. Environmental Protection Agency. "Fiscal Year 1973 Program Review", 1973, and U.S. Department of Commerce, Bureau of the Census, "Statistical Abstract of the United States 1974", 1974.

contract awards historical data.) As a consequence, the consulting engineer must play a critical role. However, as discussed in Section III-G, even under scenario E-1, there is a barely adequate supply of design engineers with sanitary engineering backgrounds. The key design decisions with respect to overall approach and cost effectiveness, though critically important, account for a small portion of the engineer's total fee(12). Also, the consulting engineer will be judged by his client more on how well and expeditiously he succeeds in getting design approval, and much less on the innovation and cost effectiveness of the solution or the associated risks.

Some evidence of this is provided by examining technological choices indicated on the EPA Needs Survey. Activated sludge is presently the method used in 33 percent of existing facilities, and 72 percent of those indicating a planned technology to meet needs requirements report that activated sludge is the technology choice(12). This is despite the fact that activated sludge has significantly higher costs than aerated lagoons and trickling filters for both capital and operating and maintenance. The reasons for this may be that it is easier to design an activated sludge plant that will clearly meet the current definition of secondary treatment than it is to design a facility using stabilization ponds or trickling filters to meet the requirement.

If communities were to choose the least-cost solution, rather than the choice indicated on the 1974 Needs Survey, both capital and operating costs could be reduced by about 32 percent(12). This represents a maximum cost savings, however, because it fails to take into account special local problems. The impact on performance of choosing least-cost options, rather than those indicated in the EPA Needs Survey, is more difficult to estimate. Data on actual performance of different systems, compared to design performance, are conflicting. One study of operator skills shows, however, that unskilled operators find it much easier to obtain high performance from trickling filters than activated sludge systems(8).

In terms of total costs, far more important cost effectiveness decisions are available with respect to combined sewer overflow control in scenario E-2. The cost used here assumes the use of primary treatment and disinfection for all combined sewer overflows and secondary treatment and disinfection on water quality limited streams. This represents both a very high level of control, and also may not be the most effective method of control. Results cited in the technology section (Chapter II) suggest that offline storage of the first flush, combined with treatment of the stored runoff at existing plants, could achieve roughly comparable levels of control for a total capital cost of $6.7, as against the $79.6 billion suggested in scenario E-1. For a full discussion of the various options for combined sewer overflow and their cost effectiveness, see Chapter II.

4. Summary

P.L.92-500 will require vastly greater Federal funding than now appropriated. At any level of appropriation, full funding of any major needs category before 1980 is unlikely. Even this date can only be met by establishing clear-cut priorities among categories and providing mechanisms to assure that the necessary funds go to the states with the greatest needs. While the bulk of the capital expenditures will be supported by Federal grants, state and local governments must bear a share of the capital costs and the full burden of the operating costs. Commission forecasts of fiscal trends suggest that state and local governments may have difficulty financing their portion of expenditures. While the required expenditures are small relative to total state and local revenues, many states and localities will face serious fiscal problems, particularly after 1980, thereby impairing their ability to obtain revenues to insure adequate operation of publicly owned treatment works. Already, in response to a survey of present grant recipients, 10 percent indicated that they had used or planned to use expenditure cutbacks as a means of financing their grant shares.

The Act's requirements with respect to local financing mean that the majority of communities must alter their financing methods. While most communities now use some form of user charge, they also may use ad valorem taxes, which may not adequately reflect costs by user or user class. The resulting switch to user charges has the advantage of encouraging greater efficiency in the use of municipal systems and may serve to partially isolate sewer system finances from the general fiscal problems of the local governmental unit. Because of the implicit Federal subsidy on capital, the proposed industrial-municipal payment mechanism will not ordinarily discourage users with compatible wastes from using municipal systems.

Cost savings for POTWs could result from improved capacity forecasting, shorter design lives and better choice of technological approach. The first two can allow systems to operate closer to capacity where they function more efficiently. For lower cost technologies, the effect on performance is less clear, although such technologies normally lead to improved performance since they require less-skilled operators. Further, lower operating costs may relieve local financing burdens. The ability of state and local governments to implement better cost effective programs may be limited by the relative scarcity of skilled environmental engineers and the inability of the governmental units to pay competitive salaries.

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F. MACROECONOMIC IMPACTS

1. Introduction

a. Background

Implementation of the Act began in 1973 during the worst peace time inflation in the country's history, a very inauspicious time for the launching of a major new program. Double-digit inflation persisted throughout 1974 despite the onset of what became the deepest recession since the Great Depression. We have experienced more than 9 percent unemployment, a 60 percent decline in housing starts, 45 percent drop in stock prices, 15 percent fall in industrial production and 10 percent loss in per capita income. What's more, this recession was preceded by other extraordinary economic events.

Interest rates set historical records in the 1969-1970 "credit crunch", with the average corporate bond yield reaching 9 3/4 percent. Records were broken again in 1974 - with the average yield going to 10.3 percent and average short-term rates exceeding 12 percent.

In 1971 the imposition of wage and price controls and the first of two devaluations of the U.S. dollar emphasized the seriousness of our economic problems. All of this had its impact on the Act's implementation, to date, and will continue to exercise an influence over its future implementation and the associated impacts. The interrelationship of the Act with the predictive forces of the overall economy is what this chapter is about.

b. Objective

The objective of the macroeconomic impact component of this study was to integrate the data developed in the studies of industry technology and public treatment systems into alternative forecasts of the general economy over the next decade. The resultant measure of the economic impact of P.L. 92-500 is the difference between parallel forecasts of alternative futures with and without the Act. The results of this econometric forecasting are, therefore, the basis for this chapter.

The quantity of our specific data as well as the complexity of the U.S. economy required the use of a large scale computer model. Econometric models are useful in that their results are internally consistent and based upon a much more complex set of simultaneous considerations than could be handled without them. However, a broad caveat about this work is necessary. Although these models have proven mildly successful with short term forcasting, their usefulness in

long term forecasting and analysis is limited. Thus, we would place greater emphasis on the comparative differences between equivalent alternative futures with and without the Act than upon the actual numerical results for a distant year in any particular scenario. Further, part of the design of alternative scenarios is intended to provide different views of the future so that the consequences of alternative economic futures can be evaluated. We have attempted to answer the question, "What will be the impact of P.L. 92-500 if the future economy is . . . (several alternatives)?" rather than, "What will be the impact of P.L. 92-500 if the future economy is . . . (one unequivocably predicted alternative)?".

There is a tendency to overestimate obvious impacts since only the more direct routes of impact are easily simulated. Many of the less direct or secondary effects are difficult to quantify or integrate into the model. For example, research will undoubtedly be stimulated by the requirements of P.L. 92-500, leading to less costly and more efficient abatement techniques and even profitable side effects, such as material recovery and more efficient production technology. Less obvious are the possible effects of resultant improved health and worker morale on labor productivity. The majority of these less obvious impacts had to be ignored. The results presented here are, therefore, necessarily incomplete.

A first approximation of the economic importance of the water pollution abatement expenditures in the next decade may be made by means of comparison. While $100 billion is 7 percent of GNP in 1975, it is .5 percent of the $20 trillion GNP forecast for the next ten years - or $35-40 per person per year. Defense and Public Education budgets will total over $900 billion each over the same period. Over the same time period Americans will spend $1 trillion on medical services and drugs, $1.2 trillion buying new cars, $600 billion on petroleum products, $400 billion on advertising, $300 billion on computers, $200 billion on alcoholic beverages, and $150 billion on tobacco products.

2. Summary

a. Methodology

The study used the Wharton Annual and Interindustry Model of the U.S. economy to forecast impacts of P.L. 92-500 on the U.S. economy(5). Impacts of interest include those on major economic indicators as well as on prices, output and investment at the sectoral level.

This section summarizes the methodology used to modify the model to incorporate the economic impacts of additional industrial and municipal abatement spending due to P.L. 92-500. These modifications are discussed briefly below.

The investment levels for each industry in the final demand calculations were increased in order to include the estimates of capital spending for abatement purposes. This was done for each year's calculations with the amount of adjustment in any year depending on assumed levels and phasing of costs.

For each industry the proportions of abatement investment assumed productive and nonproductive was specified to determine the amount of this investment to be added to regular (productive) capital stock. In most simulations the proportion that is productive was assumed to be zero. As productive and nonproductive stock have different roles in the model's calculations, only productive stock affects employment by industry. Conversely, total capital stock determines the level of depreciation costs that enters into the industry price equations.

The user cost of capital variable for each industry was increased to reflect the estimated spending by industry to comply with New Source Performance Standards over the forecast period. This captures the effects that these requirements are expected to have on regular plant and equipment spending. Since the marginal cost of capital is increased, some investment projects that are forecast in the absence of these standards may no longer be undertaken. Figure III.F.1 schematically presents investment feedbacks.

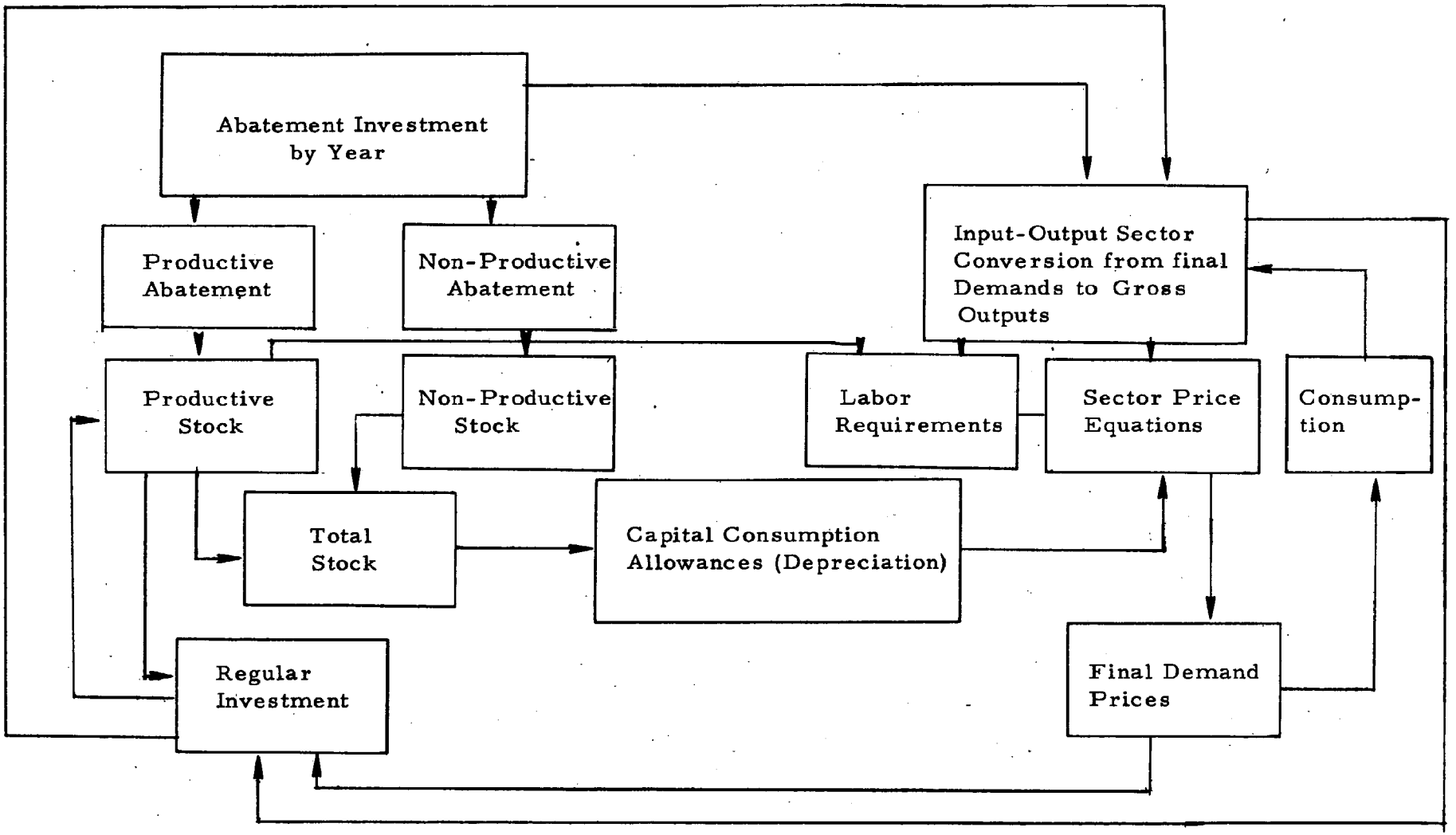
The labor requirements by industry were adjusted to include the labor component of abatement operating costs for each industry. This tends to reduce productivity in abating industries since this additional labor is considered nonproductive.

The price equations were modified to capture the additional abatement costs in each industry. Since the adjustments to capital stock and labor requirements mentioned above directly feed into the price equations (through unit depreciation and labor costs) only additional adjustments for interest costs were needed for most industries. In those industries where a depreciation cost term was not included in the price equation, the adjustment included the effect of these costs as well.

These adjustments to sector and final demand prices capture all the indirect effects of prices increases in one industry on other industries in the system. Thus, if the price of steel goes up because of abatement, all final demand goods that directly or indirectly use steel as inputs (e.g., autos) reflect the effects of these increases. Price feedbacks are diagramed in Figure III.F.2.

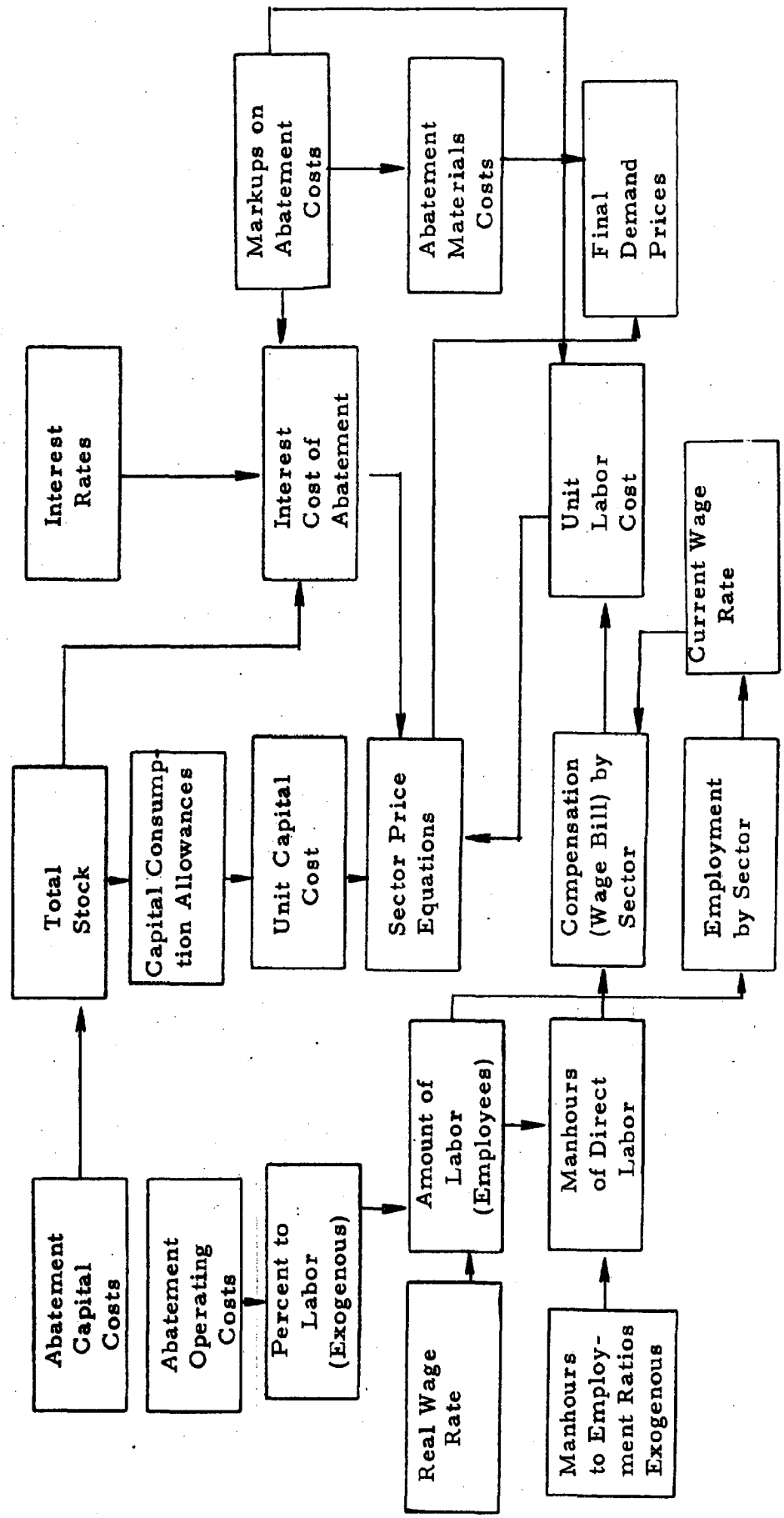
Adjustments were also made to sector output levels to capture the direct and indirect effects of materials purchased for operations component of costs. Thus, the output of industries like electric

FIGURE III.F.1: FEEDBACKS OF ABATEMENT INVESTMENT



Source: NCWQ. From CONSAD Research Corporation, "Macroeconomic Impacts of P.L. 92-500", 1976.

FIGURE III.F.2: PRICE FEEDBACKS OF ABATEMENT



Source: NCWQ. From CONSAD Research Corporation, "Macroeconomic Impacts of P.L. 92-500", 1976.

utilities, chemicals, etc., which supplied abatement operating materials will increase. This is intermediate output and does not in itself automatically increase final sales (or GNP). The impacts of capital costs are captured by the adjustment to the investment levels described earlier. The latter feed directly into the input-output calculations.

Finally, the amount of Federal grants-in-aid was increased to reflect Federal financing of additional Publicly Owned Treatment Works. State and local spending was increased to capture the spending for both capital and operating purposes. All spending by government is included in GNP, but the operating costs for industries is treated as an intermediate good and does not directly affect GNP.

With these modifications, the model simulated the interaction of abatement expenditures with economic activity. Thus, these costs became an integral part of the dynamic solution to the model and affected levels of prices, output and investment, etc.

A total of thirteen scenarios were run using different assumptions about the level and phasing of expenditures and other variables. Twelve of these considered the impacts of costs for water pollution abatement only. The last scenario analyzed the combined impacts of air and water pollution abatement.

The first ten scenarios consist of two sets in which identical assumptions were made about the phasing and level of abatement costs (i.e., 1=6, 2=7, 3=8, 4=9, 5=10). The economic growth forecasts used as a baseline were different in these two sets. For Scenarios 1-5 a "control" solution is used. A tight money "lower growth" alternative baseline is used in Scenarios 6-10. These baselines are described in detail below.

b. Major Results

Under the assumptions of a full employment (by 1985) control baseline and adherence to compliance schedules (Scenario 1: BPT in 1977 and BAT in 1983) the scenario results indicate that abatement expenditures do serve as a stimulus to the economy initially; however, about midway through the forecast period the forecasted real GNP level drops below baseline. By 1985 GNP is about 3 percent below baseline. There is a steady pressure on the inflation rate. The GNP price deflator is about 9 percent above baseline in 1985 indicating an inflation rate that is about .9 percentage points higher due to the imposition of pollution abatement standards. The unemployment rate follows the pattern of real GNP. It initially dips below baseline, reaching about .4 percentage points below baseline by 1978; however, it is about .9 percentage points above baseline by 1985.

Price increases are widely felt through all sectors of the economy including sectors that do not have significant abatement costs. Generally, the largest price increases are found in sectors with high levels of abatement costs with price increases of over 10 percent in the following industries: Fabricated Metals, Chemicals, Furniture, Mining, Instruments, and Textiles. Impacts on investment for many industries at the industry level indicate a significant peaking of investment in 1977. Industries where investment levels increase by more than 25 percent over baseline level in order to meet the 1977 BPT schedule include: Fabricated Metals, Non-electrical Machinery, Non-auto Transportation, Chemicals, Mining, Paper, Iron and Steel, and Electrical Machinery.

Under the assumption of a smoothing out of abatement investment (Scenario 2) the impacts are slightly milder. The rate of inflation and unemployment do not rise as much when abatement investment is "smoothed" and the stimulus to GNP is sustained somewhat longer. The primary difference is found at the industry level where the large peaks in investment levels are dampened considerably.

If a "high" municipal abatement scenario is used along with the other assumptions of Scenario 1 (Scenario 3) the pressure on prices is slightly greater. Real GNP and unemployment rates show improvements over Scenario 1. In Scenario 4, with no BAT expenditure for industry, the increase in the annual inflation rate is .6 percentage points compared to .9 percentage points in Scenario 1, and .8 percentage points in Scenario 2. Impacts on GNP and unemployment rates are also proportionately, milder than in Scenarios 1 and 2 which included BAT expenditures. The incremental economic impact of BAT is not great. (Comparing Scenarios 2 and 4). Finally, in Scenario 5, assuming a level of costs one half those of Scenario 1, the impacts on inflation are reduced considerably. Prices rise by .4 percent compared to .9 percent in Scenario 1.

With slower economic growth (Scenarios 6-10), impacts of abatement expenditures are largely comparable to impacts estimated in the high growth scenarios (Scenarios 1-5) baseline. The major difference is found in the "high-municipal" expenditure case (Scenario 8), where because of the depressed economy, this stimulus of public expenditures increases industry output and keeps prices below (and GNP above) what they are forecast to be in the low municipal scenario (Scenario 6). This is different than the result obtained with the full employment baseline and suggest that abatement expenditures can serve as a useful short run stimulus under less than full-employment conditions.

Three other scenarios were run (Scenarios 11 through 13). The first two attempt to test the sensitivity of impacts to the assumption that a portion of abatement investment is productive. The portions assumed productive in these scenarios were 25 and 50 percent, respectively. The

other assumptions were the same as in Scenario 1 (compliance schedule, control baseline). Results indicate that the stimulative effects are stronger and inflationary pressures weaker under these assumptions. Finally, a scenario in which air and water pollution abatement costs were both included suggests that the incremental impacts of water pollution abatement costs are comparable to those seen in the scenario in which air polluiton abatement was not included in the baseline. The combined effect of air and water abatement tends, however, to increase the rate of inflation. The GNP deflator in 1985 is about 13 percent higher than the baseline compared to 9 percent in Scenario 1 (in which only water pollution abatement costs were included). The eventual drop in GNP growth rate is greater as well. GNP is 4.2 percent below baseline in 1985 compared to 2.9 percent in Scenario 1.

3. Description of Scenarios

a. Data Inputs

The basic input data on costs for meeting BPT and BAT standards used in these scenarios is given in Table III.F.1 for the Commission industry categories. (Operating and maintenance costs are on an annual basis.) These costs were then allocated to the industry sectors of the Wharton Model; the latter are generally at a two-digit level of Standard Industrial Classification (SIC). Costs derived from this allocation are given in Table III.F.2. This table also lists costs associated with growth in industries for the period 1976 through 1985. These were derived from the SEAS* cost model which estimated costs at the Commission subcategory and industry level and were subsequently aggregated to the Wharton sector level.

The levels of municipal expenditure are specified in Table III.F.3. Only Scenarios 3 and 8 use the high estimate of municipal expenditures. The assumed phasing and level of industrial expenditures for the thirteen scenarios is given in Table III.F.4. Table III.F.5 lists the complete set of assumptions about other variables and Table III.F.6 gives total industrial and municipal capital costs by year for each scenario. The pattern of expenditures in Table III.F.4 refers to the percentage allocation of costs by year, ending with the year the relevant standard is met. (For example, the 10% - 40% - 50% pattern for BPT costs in

* U.S. Environmental Protection Agency, Strategic Environmental Assessment System (SEAS).

TABLE III.F.1

INDUSTRY

Economic Impact Expenditure Estimate
(Millions of 1975 Dollars)

Indepth[a]	BPT (1977) Capital	BPT (1977) Annual O&M	BAT (1983) Capital	BAT (1983) Annual O&M	1975-83 NSPS
					K
Fruits & Vegetables	167	15	96	10	47
Inorganic	805	178	261	104	351
Organic	3325	487	2990	2242	1873
Misc. Chemicals	965	163	650	228	380
Iron and Steel	2080	322	556	202	647
Metal Finishing-Job[b]	1715	328	780	168	3967
Captive[b]	7418	2275	7428	1365	f
Petroleum Refining[b]	829	142	1184	429	294
Plastics & Synthetics[b]	209	33	286	29	91
Pulp and Paper[b]	2194	111	437	20	734
Steam Electric[c]	4089	989	1275	16	900
Textiles	458	58	203	61	275
	24254	5101	16146	4874	9559
Other					
Ore Mining and Dressing[d]	610	25	0	0	146
Coal Mining[d]	1700	95	0	0	0
Petroleum & Gas Ext.[d]	234	18	1070	61	266
Mineral Mining & Proc.	730	72	0	0	496
Meat Products & Rendering	148	20	181	10	64
Dairy Products	188	13	73	5	0
Grain Mills	33	2	8	1	0
Cane Sugar Processing	153	17	170	13	8
Beet Sugar	90	17	69	5	2
Canned & Preserved Seafood	41	12	120	12	38
Misc. Food & Beverages	5	1	5	1	4
Timber Products	14	1	25	8	33
Furniture and Fixtures	8	3	0	0	2
Bldg. Paper & Board	120	12	0	0	13
Paint and Ink	23	22	0	2	2
Soap and Detergent	10	1	2	0	2
Phosphate Mfg.	73	9	14	1	46
Fertilizer Mfg.	77	50	64	23	50
Paving and Roofing	6	6	4	1	1
Rubber Processing	220	18	48	12	299
Leather Tanning	77	20	47	7	13

TABLE III.F.1 continued

	BPT		BAT		
	Capital	Annual O&M	Capital	Annual O&M	1975-83 NSPS
					K
Glass Mfg.	42	5	16	3	26
Cement Mfg.	34	4	9	1	12
Concrete, Gypsum, Plaster	100	26	0	0	36
Asbestos	4	1	9	4	3
Insult. Fiber	14	6	0	0	3
Ferroalloy Mfg.	48	16	13	3	11
Nonferrous Metals [b,e] [f]	40	21	31	7	39
Machinery & Mechanical Prod.	3900	390	3900	390	8295
Transportation Industry	1200	130	140	39	137
Water Supply	1200	160	100	3	28
Auto & Other Laundries	25	4	21	1	8
Foundries	180	26	0	0	0
Fish Hatcheries	50	10	47	31	--
Structural Clay	5	1	0	0	2
Pottery	3	1	4	3	1
Steam Supply	0	0	0	0	--
Nonferrous Mills	260	25	0	0	33
Feedlots					
Beef	100	8	30	0	225[g]
Hog	178	9	59	0	--
Dairy	152	10	46	0	--
All Other Industries	12095	1287	6325	647	10344
In-depth Industries	24254	5101	16146	4874	9559
Total	36349	6388	22471	5521	19903

a. Cost estimates for all Indepth industries (except Iron and Steel) and 7 of the Other Industries (Meat Products and Rendering, Dairy Products, Grain Mills, Leather Tanning, Nonferrous Metals, Fertilizer, and Feedlots) represent costs only for those plants which are projected to remain open.

b. Municipal user charges included.

c. These BPT and BAT cost estimates were used as an input to the macroeconomic analysis. This total BPT and BAT cost estimate is consistent with the Steam Electric Power cost estimate presented in Table II-30. The allocation of this total between BPT and BAT, however, is different in this presentation because it is based on an earlier contractor estimate. The NSPS cost estimates presented here are based on a growth rate for electricity demand which is higher than was estimated in the Steam Electric Power industry study.

d. These cost estimates were based upon a preliminary contractor report. The Commission believes the cost estimates presented in Table II-30 are more accurate; the cost estimates presented here are included because they were used in the impact analysis.

TABLE III.F.1 continued

e. These cost estimates were based upon a preliminary contractor report. The differences in these estimates and those presented in Table II-30 are principally due to two factors: (1) the estimates in Table II-30 include $83 million for two bauxite refineries on the Mississippi River to meet BAT requirements, not included in the cost estimates above, and (2) the Nonferrous Metals estimates in Table II-30 do not attempt to take account of treatment facilities in place as of January 1973 for primary aluminum smelting and refining, a subsector of Nonferrous Metals.

f. Metal Finishing BPT and BAT costs are excluded from Machinery and Mechanical Products BPT and BAT costs but Metal Finishing Captive NSPS costs are included in Machinery and Mechanical Products NSPS costs.

g. Includes all Feedlots.

Source: National Commission on Water Quality

TABLE III.F.2: Abatement Expenditure Estimates by Wharton Model Sector
(Millions of 1975 dollars)

	BPT		BAT		New Source (1975-85)*	
	Capital	Annual O&M	Capital	Annual O&M	Capital	Annual O&M
Agriculture	480	37	182	31	438	30
Mining	3274	210	1070	61	1069	66
Iron and Steel	2308	364	569	205	1231	231
Nonferrous Metals	300	46	31	7	94	16
Electrical Machinery	1753	411	1749	273	1232	230
Nonelectrical Machinery	2989	700	3023	461	2106	393
Motor Vehicles	1880	441	1874	291	425	79
Non-auto Transportation	2227	523	2224	343	1808	337
Stone, Clay, Glass	208	50	42	12	107	23
Fabricated Metals	3335	718	2392	426	5948	1161
Lumber	14	1	25	8	8	1
Furniture	8	3	0	0	3	1
Instruments	634	149	632	97	792	148
Misc. Manufacturing	215	51	214	32	99	18
Food	825	97	722	57	268	27
Textiles	458	58	203	61	324	46
Paper	2314	123	437	20	1128	57
Chemicals	5487	943	4267	2629	3344	1229
Petroleum Refining	829	142	1184	429	358	127
Rubber	220	18	48	12	91	10
Leather	77	20	47	7	1	1
Transportation	1200	130	140	39	312	34
Utilities	5289	1149	1375	19	2149	373
Commercial	25	4	21	1	8	2
Total	36349	6388	22471	5521	23343	4640

* Totals differ from Table III.F.1 due to the use of the period 1975-1985 rather than 1975-1983.

Source: NCWQ. From CONSAD Research Corporation, "Macroeconomic Impacts of P.L. 92-500", 1976.

TABLE III.F.3: INPUT DATA FOR "INCREMENTAL" MUNICIPAL EXPENDITURE ESTIMATES (Millions of 1975 dollars)*

	'Low' Municipal Case		'High' Municipal Case	
	Capital	O&M	Capital	O&M
1975	502	17	606	7
1976	1388	60	4808	56
1977	2370	142	7028	127
1978	2682	234	8360	211
1979	2610	324	10056	312
1980	2538	412	11632	429
1981	2490	498	13206	563
1982	2442	581	14902	714
1983	2370	663	16600	881
1984	2298	742	17084	1053
1985	2252	826	16720	1222
Total	23942	4499	121002	5575

* See Section III.E. (Scenarios E1 and E2). Slight differences from totals in Section III.E are due to the use of a different calculation method.

TABLE III.F.4: ASSUMPTIONS ABOUT LEVEL AND PHASING OF INDUSTRIAL COSTS

Scenario		Year Standard Met (If Any)	Level of Cost	Pattern (Percentage Allocation by Year)
1	BPT	1977	Table III.F.2.	10-40-50
	BAT	1983	Table "	10-12-15-18-21-24
2	BPT	<1983*	Table "	5.6-7.2-8.9-10.6-11.8-12.7-13.5-14.4-15.3 for combined costs
	BAT	1983	Table "	
3	BPT	1977	Table "	10-40-50
	BAT	1983	Table "	10-12-15-18-21-24
4	BPT	1980	Table "	10-12.6-15.7-18.7-20.7-22.3
	BAT	Not Met	Table "	
5	BPT	1977	.5 Level of Table "	10-40-50
	BAT	1983		10-12-15-18-21-24
6	BPT	1977	Table "	10-40-50
	BAT	1983	Table "	10-12-15-18-21-24
7	BPT	<1983*	Table "	5.6-7.2-8.9-10.6-11.8-12.7-13.5-14.4-15.3 for combined costs
	BAT	1983	Table "	
8	BPT	1977	Table "	10-40-50
	BAT	1983	Table "	10-12-15-18-21-24
9	BPT	1980	Table "	10-12.6-15.7-18.7-20.7-22.3
	BAT	Not Met	Table "	
10	BPT	1977	.5 Level of Table "	10-40-50
	BAT	1983		10-12-15-18-21-24
11	BPT	1977	Table "	10-40-50
	BAT	1983	Table "	10-12-15-18-21-24
12	BPT	1977	Table "	10-40-50
	BAT	1983	Table "	10-12-15-18-21-24
13	BPT	1977	Table "	10-40-50
	BAT	1983	Table "	10-12-15-18-21-24

*** See text for explanation.**

Source: NCWQ. From CONSAD Research Corporation, "Macroeconomic Impacts of P.L. 92-500", 1976.

TABLE III.F.5: ADDITIONAL ASSUMPTIONS ABOUT ABATEMENT COST AND OTHER VARIABLES

Scenario	Economic Growth Baseline	Municipal Costs	Air Pollution Costs	Productivity of Abatement Investment
1	Control*	'Low' Case (Exhibit 3.3)	Not Included	Zero
2	"	Low	"	"
3	"	High	"	"
4	"	Low	"	"
5	"	Low	"	"
6	Low-Growth	Low	"	"
7	"	Low	"	"
8	"	High	"	"
9	"	Low	"	"
10	"	Low	"	"
11	Control	Low	"	50% Productive
12	"	Low	"	25% Productive
13	"	Low	Included	Zero

*Full employment by 1980.

Source: National Commission on Water Quality

TABLE III.F.6: PHASING OF CAPITAL COSTS (INDUSTRY AND MUNICIPAL)
1975-1985
(In millions of 1975 dollars)

Scenario		75	76	77	78	79	80	81	82	83	84	85	75-80 Total
1,6,11	Industrial	3030	14452	17478	4640	5102	5792	6484	7176	7868	2334	2334	76690
	Municipal	502	1388	2370	2682	2610	2538	2490	2442	2370	2298	2252	23942
	Total	3532	15840	19848	7322	7712	8330	8974	5618	10238	4632	4586	100632
2,7,12	Industrial	2988	6192	7082	7990	8628	9110	9536	10018	10478	2334	2334	76690
	Municipal	502	1388	2370	2682	2610	2538	2490	2442	2370	2298	2252	23942
	Total	3490	7580	9452	10672	11238	11648	12026	12460	12848	4632	4586	100632
3,8	Industrial	3030	14452	17478	4640	5102	5792	6484	7176	7868	2334	2334	76690
	Municipal	606	4808	7028	8360	10056	11632	13206	14902	16600	17084	16720	121002
	Total	3636	19260	24506	13000	15158	17424	19690	22078	24468	19418	19054	197692
4,9	Industrial	3000	6180	7090	7998	8604	9090	2334	2334	2334	2334	2334	53632
	Municipal	502	1388	2370	2682	2610	2538	2490	2442	2370	2298	2252	23942
	Total	3502	7568	9460	10680	11214	11628	4824	4776	4704	4632	4586	77574
5,10	Industrial	1515	7226	8739	2320	2551	2896	3242	3588	3934	1167	1167	38345
	Municipal	502	1388	2370	2682	2610	2538	2490	2442	2370	2298	2252	23942
	Total	2017	8614	11109	5002	5161	5434	5732	6030	6304	3465	3419	62287
13	Industrial	6800	18894	24228	11920	8588	7740	8136	8190	8566	2836	2962	108860
	Municipal	502	1388	2370	2682	2610	2538	2490	2442	2370	2298	2252	23942
	Total	7302	20282	26598	14602	11198	10278	10626	10632	10936	5134	5214	132802

Note: Totals for industry have been adjusted for BPT expenditures in 1972-74.

Source: NCWQ. From CONSAD Research Corporation, "Macroecnomic Impacts of P.L. 92-500", 1976.

Scenario 1 indicates that 10 percent of BPT costs are incurred in 1975, 40 percent in 1976 and 50 percent in 1977.)* A brief description of each scenario is given below.

b. Scenario 1

The "control" baseline is used. Table III.F.4 indicates BPT standards are met by 1977 and BAT by 1983. The level of costs is that given in Table III.F.2. The pattern for BPT costs is a 10-40-50 allocation and that for BAT 10-12-15-18-21-24, indicating a peaking of investment in 1977 for BPT and 1983 for BAT. Municipal costs use the "low" case figures in Table III.F.3. None of the abatement investment is considered productive.

c. Scenario 2

The pattern of expenditure for every industry is "smoothed" by combining the total of BPT and BAT costs for each industry and assuming a fixed pattern of investment starting in 1975 and ending in 1983. The pattern is given by the following percentages: 5.6 - 7.2 - 8.9 - 10.6 - 11.8 - 12.7 - 13.5 - 14.4 - 15.3, for the nine years. Thus, each industry will have undertaken expenditures to meet BPT at some point prior to 1983 (unless it had zero BAT costs, in which case it will meet BPT in 1983; this is true for only the furniture industry). However, this point will differ from industry to industry depending on the relative magnitude of BPT and BAT costs.

The low municipal case is assumed here as well and the other assumptions are the same as in Scenario 1 (control baseline, zero productivity of abatement investment).

d. Scenario 3

Same as Scenario 1, except municipal pattern assumes the "high" case of Table III.F.3.

e. Scenario 4

BAT standards are assumed not to be met in the forecast period and, in fact, no BAT costs are incurred at all. The level of BPT costs

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* Operating costs are always assumed to rise in proportion to the fraction of capital stock in place. Thus, with a 10-40-50 pattern for capital expenditure, O&M costs in the three years would be 10-50-100 percent of estimated annual BPT operating costs.

are the same as in the previous scenarios but yearly expenditures are assumed to be in the following percentages: 10 - 12.6 - 15.7 - 18.7 - 20.7 - 22.3. BPT standards are assumed met in 1980, and the low municipal case is assumed. The control baseline is used and it is assumed that none of the abatement investment is productive. A comparison of this scenario with Scenario 2 gives an estimate of the economic impact of BAT requirements.

f. Scenario 5

The industrial costs used here are one-half that of the previous four scenarios, for all components (BPT, BAT and New Source) with phasing being identical to Scenario 1. The "low" level of municipal costs, the "control" baseline and zero productivity of abatement is used.

g. Scenarios 6 through 10

These scenarios use the same assumption as Scenarios 1 through 5 respectively, except that the "low growth" baseline is used instead of the "control" baseline.

h. Scenarios 11 and 12

These two scenarios analyze the sensitivity of impacts to the assumption (discussed in the previous section on methodology) that some of the abatement investment may be productive. The former assumes that 25 percent of the investment is productive and the latter that 50 percent of abatement capital is productive. The other assumptions are the same as in Scenario 1 (control baseline, compliance schedule, "low" municipal costs).

i. Scenario 13

This last scenario analyzes the combined impacts of air and water pollution abatement costs. The level of air pollution abatement costs by industry is given in Table III.F.7 and are estimated from recently available studies. Assumptions about costs for water are taken from Scenario 1. For air costs the same pattern was used for all industries with a peaking of costs in 1978 implying delayed compliance with air standards.

4. Analysis of Scenario Results

a. Introduction

This section summarizes the major results from the scenario runs. The focus is on the impacts on the overall economy, but the analysis describes industry impacts as well. This includes analysis of price,

TABLE III.F.7: ESTIMATED COSTS FOR AIR POLLUTION ABATEMENT
1975-1985 (Millions of 1975 dollars)

Industrial	Capital	Operation & Maintenance
Agriculture	$ 112	9
Mining	246	43
Iron and Steel	3,856	421
Nonferrous	2,764	521
Electrical Machinery	52	65
Motor Vehicles	282	130
Stone, Clay & Glass	2,045	441
Furniture	108	134
Food	1,443	121
Textiles	126	9
Paper	2,866	627
Chemicals	1,941	235
Petroleum	1,310	124
Printing and Publishing	29	7
Utilities	9,567	1,449
Commercial	4,873	932
	31,620	5,268
Municipal	549	410
	$32,169	$ 5,678

Source: NCWQ. From U.S. Environmental Protection Agency, Strategic Environmental Assessment System, 1975. (Unofficial Preliminary Estimates)

output and investment impacts at the Wharton sector level. Because of the large volume of computer output involved; the comparison tables do not include details for all the variables. These are available in the full report of the Commission. Occasional references are made to results which are not documented in the summary tables presented here but are taken from these detailed computer outputs for each scenario.

b. Scenarios 1 through 5

(1) Description of (Control) Baseline

This solution is targeted at full employment in the early 1980's. It carries the assumptions of the Wharton Quarterly Model March forecast in the near term (1975-1976).*

The solution forecasts a slow recovery with unemployment still high at 8.4 percent in 1977 (see Table III.F.8). The recovery is assisted by an accommodating monetary policy and the consequent boom in the housing market as private housing starts reach a peak of 2.3 million in 1978.

Real GNP grows at an average of 4.1 percent through 1985 and at 5 percent for the period 1975-1980, with the highest rates of growth in 1977 and 1978 at 7.7 percent and 6.3 percent, respectively.

The rate of inflation as measured by the GNP price deflator averages 5.4 percent (1975-1985) with a peak of 6.7 percent in 1980, while the consumer price index rises an average of 5.3 percent per year through 1985.

Personal disposable income in current dollars increases at 8.7 percent per year through 1985, while personal consumption expenditure rises an average of 8.8 percent per year through 1985.

Money supply grows at an average of 8.2 percent per year through 1985, with a peak growth of 14.1 percent in 1979.

Corporate profits show a strong initial recovery with growth of 27.2 percent and 20.5 percent in 1976 and 1977, respectively.

Since this baseline assumes continued dependence on foreign oil, the trade balance deteriorates as the economy recovers, reaching deficits of $36 billion by 1985.

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* A listing and discussion of the major assumptions is given in CONSAD's report to the National Commission on Water Quality.

TABLE III.F.8: Control Baseline Summary Tables

ITEM	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
GNP (Current $)	1464.27	1616.94	1824.81	2032.07	2246.91	2459.82	2698.05	2934.31	3182.47	3413.83	3692.70
% Change	4.83	10.43	12.86	11.36	10.57	9.48	9.68	8.76	8.46	7.27	8.17
GNP (58$)	788.00	824.71	888.27	943.97	981.22	1006.45	1045.11	1077.50	1106.72	1130.36	1174.81
% Change	-4.07	4.66	7.71	6.27	3.95	2.57	3.84	3.10	2.71	2.14	3.93
Consumption Expenditure (58$)	526.49	540.11	580.22	616.55	644.07	658.53	675.38	688.72	700.80	712.17	734.55
Fixed Investment ($58)	104.23	112.76	127.31	141.18	146.63	154.19	170.42	183.13	192.89	199.16	213.83
Residential Invest. ($58)	20.21	26.70	28.46	33.67	30.74	27.95	28.47	26.77	23.05	24.44	26.06
Non-residential Invest. ($58)	84.02	86.06	98.85	107.51	115.89	126.24	141.95	156.36	169.84	174.72	187.77
Governmental Purchase ($58)	149.20	154.30	160.10	166.00	171.90	177.80	183.70	189.60	195.50	201.40	207.30
GNP Deflator	185.82	196.06	205.43	215.27	228.99	244.40	258.16	272.33	287.56	302.01	314.32
% Change	9.27	5.51	4.78	4.79	6.38	6.73	5.63	5.49	5.59	5.03	4.08
Consumer Price Deflator	177.01	187.72	196.66	205.45	216.90	230.53	243.38	256.60	270.75	283.99	295.50
% Change	8.83	6.05	4.76	4.47	5.57	6.29	5.57	5.44	5.51	4.89	4.05
Money Supply	770.79	826.28	888.93	996.17	1136.31	1263.07	1356.21	1444.62	1523.07	1605.92	1692.81
% Change	10.26	7.20	7.58	12.06	14.07	11.15	7.37	6.52	5.43	5.44	5.41
Bond Rate	9.17	8.83	8.38	7.62	7.07	6.96	7.06	7.34	7.66	7.82	7.75
Short Rate	6.16	6.85	6.50	6.07	6.05	6.45	6.98	7.18	7.33	7.11	6.87
Corporate Profit (Current $)	122.26	155.47	187.33	201.93	225.26	244.96	263.28	277.09	293.10	308.14	339.12
Unemployment Rate	8.80	8.52	8.37	6.87	5.33	4.55	3.98	3.83	4.03	5.13	5.47
Government Surplus (Current $)	-79.33	-87.28	-71.04	-53.22	-37.53	-23.88	- 6.61	11.57	15.95	8.13	-3.22

Source: NCWQ. From CONSAD Research Corporation, "Macroeconomic Impacts of P.L. 92-500", 1976.

(2) Analysis of Scenario 1 (Compliance, High Growth)

Scenario 1 assumes compliance dates are met: BPT by 1977 and BAT by 1983. Investment expenditures are spread over the three years 75-77 for BPT and the six years 78-83 for BAT.

Impacts on Major Economic Indicators

Real GNP rises initially under the stimulus of increased spending on pollution control, reaching a peak of 0.9 percent above base case projection by 1977. However, the stimulus gradually subsides and by 1980, real GNP falls below base, sagging to 2.9 percent below the base projection by 1985. The general price level represented by the GNP deflator rises steadily throughout the term reaching 9 percent over base in 1985. On average it rises at 6.3 percent a year as compared to 5.4 percent in the base case projection. In other words, inflation, as measured by this indicator, is 0.9 percent higher with the addition of pollution abatement standards.

The unemployment rate, following the pattern of the overall economy, declining initially with a maximum decrement of 0.4 percentage points in 1978, but eventually rises above the base projection by 1983, reaching 0.9 percentage points above base in 1985.

Residential construction (in constant dollars) declines throughout the forecast period, reaching 7.3 percent below base in 1985.

The trade balance shows a strong improvement, after an initial increase in the deficit with a trade surplus in 1984 as opposed to the base forecast of a deficit of $22 billion. Table III.F.9 presents a summary comparison of Scenario 1 with the "control" baseline.

Macroeconomic Impacts: Price Effects

Sector price equations were adjusted to capture pollution abatement costs. It is assumed that pollution abatement costs are passed on like other expenditures, entering the sector price equations through the unit labor cost and unit depreciation terms. Interest costs are also included.

Pressure on prices remains steady throughout the decade. One source of continuous pressure is the capital consumption allowance which rises steadily throughout this period due to the addition of abatement equipment to capital stock. Also, unit labor costs rise due to the addition of abatement labor. The drop in output due to price increases adds further pressure until employment adjusts. Final prices of durable goods rise slightly more than non-durable goods prices, since demand for these slackens more than for non-durables. Prices for services

TABLE III.F.9: Comparison of Scenario 1 and Control Baseline

ITEM	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
GNP (58$)											
Scenario 1	790.14	831.83	896.58	945.92	982.04	1005.44	1041.35	1069.12	1093.54	1107.78	1140.97
Control	788.00	824.71	888.27	943.97	981.22	1006.45	1045.11	1077.49	1106.72	1130.36	1174.82
% Difference	.27	.86	.94	.21	.08	-.10	-.36	-.78	-1.19	-2.00	-2.88
Consumption Expen. (58$)											
Scenario 1	526.93	540.32	580.17	616.00	642.55	655.39	669.96	679.67	688.00	694.56	709.55
Control	526.49	540.11	580.22	616.55	644.08	658.53	675.38	688.72	700.80	712.12	734.55
% Difference	.08	.04	-.01	-.09	-.24	-.48	-.80	-1.31	-1.83	-2.47	-3.40
Fixed Investment (58$)											
Scenario 1	105.86	119.96	135.73	142.84	148.18	155.51	171.19	182.72	191.04	191.76	201.84
Control	104.23	112.76	127.31	141.18	146.63	154.19	170.42	183.13	192.89	199.16	213.83
% Difference	1.56	6.39	6.61	1.18	1.05	.86	.45	-.22	-.96	-3.72	-5.61
Residential Invest. (58$)											
Scenario 1	20.20	26.62	28.23	33.37	30.48	27.65	28.06	26.14	22.19	23.14	24.15
Control	20.21	26.70	28.46	33.67	30.74	27.95	28.47	26.77	23.05	24.44	26.06
% Difference	-.05	-.28	-.81	-.87	-.84	-1.06	-1.46	-2.34	-3.72	-5.34	-7.34
Non-residential Invest. (58$)											
Scenario 1	85.65	93.64	107.50	109.47	117.69	127.86	143.13	156.58	168.85	168.62	177.69
Control	84.02	86.06	98.85	107.51	113.89	126.24	141.95	156.36	169.84	174.72	187.77
% Difference	1.94	8.46	8.75	1.82	1.56	1.28	.83	.14	-.59	-3.49	-5.37
Government Purchase (58$)											
Scenario 1	149.46	155.02	161.36	167.46	173.37	179.28	185.19	191.11	197.02	202.92	208.84
Control	149.20	154.30	160.10	166.00	171.90	177.80	183.70	189.60	195.50	201.40	207.30

TABLE III.F.9 continued page 2

ITEM	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
% Difference	0.17	0.47	0.78	0.88	0.85	0.83	0.81	0.80	0.78	0.76	0.74
GNP Deflator (1958 = 100.0)- Scenario 1	185.87	196.76	207.12	217.97	233.19	250.76	267.30	284.85	304.03	323.42	342.62
Control	185.82	196.06	205.43	215.27	228.99	244.40	258.16	272.33	287.56	302.01	314.32
% Difference	.03	.36	.82	1.25	1.83	2.60	3.54	4.60	5.73	7.09	9.00
Consumer Price Deflator Scenario 1	177.03	188.23	197.86	207.41	220.07	235.46	250.56	265.60	284.13	301.77	319.35
Control	177.01	187.72	196.66	205.45	216.90	230.53	243.38	256.60	270.75	283.99	295.50
% Difference	.01	.27	.61	.95	1.46	2.14	2.95	3.90	4.94	6.26	8.07
Money Supply Scenario 1	771.07	829.04	895.30	1004.83	1145.08	1273.06	1367.99	1458.08	1537.03	1622.14	1713.19
Control	770.79	826.28	888.93	996.17	1136.31	1263.07	1356.21	1444.62	1523.07	1605.92	1692.81
% Difference	.04	.33	.72	.87	.77	.79	.87	.93	.92	1.01	1.24
Bond Rate Scenario 1	9.17	8.84	8.41	7.68	7.15	7.04	7.15	7.43	7.76	7.93	7.87
Control	9.17	8.83	8.38	7.62	7.07	6.96	7.06	7.34	7.66	7.82	7.75
Short Rate Scenario 1	6.17	6.88	6.57	6.14	6.11	6.52	7.05	7.26	7.41	7.21	6.98
Control	6.16	6.85	6.50	6.07	6.05	6.45	6.98	7.18	7.33	7.11	6.87
Corporate Profit (Current $) Scenario 1	124.12	167.25	203.21	208.41	233.09	254.52	275.18	292.49	313.14	325.96	366.49
Control	122.26	155.46	187.33	201.93	225.26	244.96	263.28	277.09	293.10	308.14	339.12
% Difference	1.52	7.58	8.48	3.21	3.48	3.90	4.52	5.56	6.84	5.78	8.07

TABLE III.F.9 Continued page 3

ITEM	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
Unemployment Rate											
Scenario 1	8.70	8.31	8.03	6.48	4.94	4.21	3.76	3.80	4.22	5.62	6.35
Control	8.80	8.52	8.37	6.87	5.33	4.55	3.98	3.83	4.03	5.13	5.47
Net Exports (Current $)											
Scenario 1	3.7	-5.7	-8.1	-11.1	-7.1	-1.2	-3.6	- .4	8.0	16.2	19.1
Control	4.3	-3.9	-6.8	-13.1	-11.3	-8.8	-15.8	-19.3	-18.9	-22.4	-36.3
Government Surplus (Current $)											
Scenario 1	-78.62	-83.63	-65.77	-49.69	-31.27	-13.96	7.91	30.59	39.43	33.89	28.94
Control	-79.33	-87.28	-71.04	-53.22	-37.53	-23.88	-6.61	11.56	15.95	8.12	-3.22
Housing Starts											
Scenario 1	1183.60	1791.13	1815.87	2253.07	1982.35	1745.76	1800.33	1635.26	1279.96	1340.26	1401.54
Control	1184.06	1795.05	1829.87	2268.11	1993.61	1760.25	1822.37	1674.38	1339.92	1434.76	1541.52
% Difference	-.04	-.22	-.76	-.66	-.56	-.82	-1.21	-2.34	-4.47	-6.59	-9.08

Source: NCWQ, From CONSAD Research Corporation, "Macroeconomic Impacts of P.L. 92-500", 1976.

are the least affected because they carry negligible pollution cost.

Macroeconomic Impacts: GNP and Employment

The scenario results suggest that abatement expenditures initially serve as a stimulus to the economy. Real GNP stays above base through the 70's; thereafter, it gradually drops below the projected level. This weakening of the economy is due partly to fiscal drag from increasing tax burdens resulting from increased inflation, wherein the effective tax rate increases due to progressive tax schedules and government receipts increase dramatically. Instead of the projected $3 billion Federal deficit in 1985, the abatement scenario registers a $29 billion surplus. Similarly, state and local governments show a $15 billion increase in surpluses. These surpluses thus become the prime cause of the declining GNP in the 1980's, both of which would likely be countered by tax adjustments. All other macroeconomic impact dimensions are conditioned similarly by these surpluses.

Unemployment follows the pattern of the overall economy. It stays below base through the initial period, rising above base only in 1983. Employment is relatively strong partly because of the additions of labor for abatement purposes, which reach a level of 1/2 million workers by 1985.

Macroeconomic Impacts: Effects on Investment

Nonresidential investment registers a sharp increase in the initial years, approaching 8.8 percent over base in 1977 as a result of the large concentration of BPT abatement investment. However, it starts declining thereafter and by 1983 falls below base.

Pollution abatement investment substitutes partially for "productive" investment, which falls below base initially from the higher user cost and prices, and later from decreased economic activity. Productive investment falls steadily through the forecast period, reaching 4 percent under base by 1985. By 1985, productive capital stock is approximately 2 percent lower than it would have been without the pollution abatement activity.

The housing market is only marginally affected in the early years; toward the end of the forecast the drop becomes more pronounced due to the weakness of the overall economy.*

* This analysis does not account for the potential stimulus provided by the increased availability of municipal sewage services as a result of the full implementation of P.L. 92-500.

Macroeconomic Impacts: Effects on Trade Balance

The export equation is not sensitive to changes in the economy, and is, therefore, barely affected. Imports, however, rise initially due to the increase in domestic prices, but fall below base later as the economy sags. This leads to a remarkable improvement in the current dollar trade balance. In 1984 a trade surplus of $16 billion is forecast as opposed to the projected $22 billion deficit in the control solution.

Macroeconomic Impacts: Other Effects

Personal consumption expenditures rise marginally in the early years, then fall below base by 1977, dropping to 3.4 percent below base by 1985. Demand for durable goods drops first, followed by the demand for non-durables and then services.

Corporate profits rise strongly at the beginning, registering an 8 percent increase in 1977, but levels off later to an average 4 percent over base, which does not keep pace with the increased inflation. Cash flows, however, stay strong as capital consumption allowances rise steadily to 8 percent over base by 1985.

Short term interest rates are only slightly affected, rising .1 of a percentage point above the projected level. Bond rates follow the pattern of the short-term rates with a slight time lag.

Sectoral Impacts - Scenario 1

Table III.F.10 presents price and output impacts at the Wharton sector level for this scenario. Several patterns appear in these results. While BPT costs are higher than the BAT cost for most industries, the major impact on prices is in the latter part of the forecast. Until 1977, the price increases are minor. The economy is relatively slack in the earlier years; thus, the effects of the stimulus on wage rates and labor costs does not occur until later years. An additional factor causing pressure on prices in later years is that regular (i.e., non-abatement) employment adjusts with a lag to the slackening of output that is observed; conversely, abatement labor requirements are rising steadily through the period, resulting in higher unit labor costs which in turn contribute to the price increases observed. Price increases of over 10 percent (above baseline) are predicted in the following industries: fabricated metals (11.6%), chemicals (11.3%), furniture (10.6%), mining (10.2%), instruments (10.2%), textiles (10.1%). These industries, except for furniture, have major share of abatement costs.

Some of the industries which are experiencing price increases do not have any direct abatement costs. This is due in large part to the

TABLE III.F.10: Price and Output Impacts: Scenario 1
(Percentage Changes From Baseline)*

Sectors	Price Changes 1977	Price Changes 1985	Output Changes 1977	Output Changes 1985
All Industries	.8	9.0	.9	-2.9
Agriculture	.8	5.8	-	3.5
Mining	1.7	10.2	-.8	-3.5
Manufacturing	1.3	9.1	-	-2.9
Durable Goods	1.3	9.1	-	-3.2
Primary Metals	1.2	9.6	-.7	-4.4
Electrical Machinery	1.5	7.4	-	-1.4
Non-Electrical Machinery	1.4	9.6	-	-3.0
Motor Vehicles	.8	8.5	-	-2.1
Non-Auto Transportation	1.6	9.4	-	-1.4
Stone	.9	8.3	-	-3.1
Fabricated Metals	2.2	11.6	-.8	-7.4
Lumber	.7	8.5	-	-2.5
Furniture	.6	10.6	-	-12.6
Instruments	1.6	10.2	-	-2.8
Non-Durables	1.3	9.2	-	-2.4
Food	.8	10.1	-	-5.5
Textiles	.9	8.7	-	-1.1
Paper	1.4	8.6	-	-
Chemicals	2.9	11.3	-	-2.2
Petroleum	1.4	9.2	-.6	-2.8
Rubber	1.1	6.9	-	-.6
Tobacco	.5	6.8	-	2.4
Apparel	.6	8.9	-	-8.1
Leather	.8	8.5	-	-2.4
Printing and Publishing	.5	7.8	-	-1.7
Transportation	.7	8.6	-	-1.3
Communication	-	5.7	-	1.7
Utilities	2.1	8.4	-	-8.6
Commercial and Other	.5	9.5	-	-3.9
Government	-	-	.8	1.5

*Note: - = < .5%

Source: NCWQ. From CONSAD Research Corporation, "Macroeconomic Impacts of P.L. 92-500", 1976.

fact that wage rates in these industries follow those in leading sectors and keep labor costs at a high level. In addition, the higher prices in durable goods lead to higher depreciation costs which influences prices in all industries.

Price increases are widely spread across the economy. Sectors with the largest abatement costs, such as chemicals and fabricated metals, have the largest price increases. However, some sectors with only moderate levels of abatement costs (for example the food sector) shows above average increases, indicating significant indirect effects.

The impacts on industrial outputs are relatively minor in the early years. In later years, outputs of durable goods industries are more significantly affected than those of nondurable goods, reflecting the relatively larger decline in personal consumption expenditures in the former category as well as the effects of a decline in fixed (productive) investment on the output of heavy industries. Changes in the pattern of industry investment are shown in Table III.F.11. These investment figures include both abatement as well as regular investment expenditures. The largest changes are seen in 1977, reflecting the peak year, in which 50 percent of BPT capital expenditures are assumed to take place. It is interesting to note that while total nonresidential fixed investment in that year increases by 8.8 percent, changes in individual industries range from a small decline in the printing industry (which has no abatement costs) to an increase of over 100 percent in the fabricated metals industry. Other industries which show increases of more than 25 percent are: nonelectrical machinery (89%), non-auto transportation (96%), chemicals (47%), mining (47%), paper (39%), iron and steel (36%), electrical machinery (26%). Some evidence of the relative importance of abatement investment can also be seen from Table III.F.12 which shows abatement capital stock as a fraction of capital stock at the end of the period. In most industries unproductive stock at the end of the period is being forecast as being less than five percent of the total stock.

Some decline in levels of productive investment are to be expected. User cost of capital is increasing partly due to required investment in new sources, as well as the price increases in capital goods industries. Table III.F.13 gives the pattern of productive investment for Scenario 1. While some industries with high new source costs, such as fabricated metals, reduce productive investment significantly, the the changes appear to be weakly related to new source costs for most industries. For example, productive investment in chemicals and paper, with significant new source costs, is affected only mildly. However, the apparel industry reduces investment significantly despite no abatement costs. The pattern of productive investment in many industries thus appears to be more directly linked to changes in demand for their goods

TABLE III.F.11: SCENARIO 1: IMPACTS ON TOTAL INVESTMENT BY INDUSTRY (Percentage Change from Baseline)*

	1977	1985
All Industries	8.8	-5.4
Farm	4.3	2.3
Mining	46.9	-3.8
Durables		
Iron and Steel	36.0	-5.9
Nonferrous Metals	5.0	-2.8
Electrical Machinery	26.0	-3.4
Non-electrical Machinery	88.8	-7.7
Motor Vehicles	22.8	-2.0
Non-auto Transportation	96.0	-5.1
Stone, Clay Glass	3.1	-2.5
Fabricated Metals	102.1	3.2
Lumber	-	-
Furniture	-	-13.0
Instruments	22.5	-
Miscellaneous	6.2	-
Non-Durables		
Food and Beverages	7.3	--
Textiles	20.4	.7
Paper	39.4	.8
Chemicals	46.5	.5
Petroleum	3.6	-2.8
Rubber	7.5	-2.8
Tobacco	-	-4.9
Apparel	1.0	-19.6
Leather	10.2	-3.6
Printing	-1.1	-1.1
Transportation	2.0	-4.3
Utilities	8.2	-8.3
Communication	-	1.8
Commercial and Other	1.1	-9.9

*Note - = < .5%

Source: NCWQ. From CONSAD Research Corporation, "Macroeconomic Impacts of P.L. 92-500", 1976.

TABLE III.F.12: SCENARIO 1: ABATEMENT CAPITAL STOCK AS A FRACTION OF TOTAL STOCK (1985)*

	1985 (Percentage)
Agriculture	-
Mining	8.8
Durable	
Iron and Steel	4.3
Non-ferrous Metals	1.0
Electrical Machinery	5.8
Non-electrical Machinery	6.9
Motor Vehicles	6.1
Non-Auto Transportation	2.1
Stone Clay glass	.6
Fabricated Metal Products	17.6
Lumber	-
Furniture	-
Instruments	6.5
Miscellaneous	1.1
Non-Durables	
Food and Beverages	1.2
Textiles	4.4
Paper	5.6
Chemicals	9.3
Petroleum	.9
Rubber	.9
Tobacco	-
Apparel	-
Leather	.6
Printing and Publishing	-
Transportation	-
Utilities	1.0
Communication	-
Commercial and other	-

*Note - = $\leq .5\%$

Source: NCWQ. From CONSAD Research Corporation, "Macroeconomic Impacts of P.L. 92-500", 1976.

TABLE III.F.13: SCENARIO 1: IMPACTS ON PRODUCTIVE INVESTMENT
(Percentage Change from Baseline)*

	1977	1985
Non-residential Fixed Investment	--	-6.0
Farm	--	2.1
Mining	-2.4	-7.9
Durables		
Iron and Steel	-2.1	-7.7
Nonferrous Metals	-.9	-3.0
Electrical Machinery	--	-5.5
Non-electrical Machinery	-3.7	-9.3
Motor Vehicles	-1.0	-3.2
Non-auto Transportation	-22.5	-20.0
Stone, Clay Glass	-.8	-2.8
Fabricated Metals	-7.4	-10.9
Lumber	--	--
Furniture	-1.3	-13.0
Instruments	--	-3.6
Miscellaneous	--	--
Non-Durables		
Food and Beverages	--	--
Textiles	-.9	-1.6
Paper	-2.1	-2.0
Chemical	-2.1	-3.9
Petroleum	--	-3.0
Rubber	--	-3.2
Tobacco	--	-4.9
Apparel	1.0	-19.6
Leather	--	-3.6
Printing	-1.1	-1.1
Transportation	-1.1	-4.5
Utilities	--	-8.5
Communication	--	1.8
Commercial and Other	1.1	-9.9

*Note - = < .5%

Source: NCWQ. From CONSAD Research Corporation, "Macroeconomic Impacts of P.L. 92-500", 1976.

as reflected in changes in output. Also, in some industries (food and paper are examples), product price increases also compensate somewhat for the higher user cost of capital and keep expected profit levels high. This tends to offset some of the declines in investment levels.

(3) Analyses of Scenarios 2 through 5

Macroeconomic Impacts: (See Table III.F.14)

Scenario 2 (Smooth, High Growth)

In this scenario it is assumed that instead of meeting two specified compliance dates for BPT and BAT, pollution abatement costs are spread more evenly so as to grow steadily through 1983. Total costs are the same as in Scenario 1.

As might be expected, the effects on the economy are less pronounced without the large concentrated shocks reflected in Scenario 1.

Prices rise slightly less in Scenario 2 than in Scenario 1, with an average rate of inflation of 6.2 percent. This compares to 6.3 percent in Scenario 1 and 5.4 percent in the "control" baseline. Real GNP remains over base through 1980, before sliding down and going below base in 1981 instead of in 1980. Likewise, the employment picture is a little brighter as the unemployment rate rises by 70 percent of the increment in Scenario 1.

Personal consumption expenditures (constant dollars) are also stronger, dropping below base in 1978 instead of in 1977. Durable goods expenditure shows the most improvement, following the same pattern as nondurable goods. Services, as before, are the least affected.

Nonresidential investment exhibits a more stable pattern, remaining about 3 percent above base until the late 70's, with a maximum increment of 3.7 percent in 1976, instead of the 8.7 percent in Scenario 1. Thereafter it starts weakening, going below base in 1984. The housing market shows the same pattern as in Scenario 1, but the effects are less pronounced. Housing starts dip 7.4 percent below base in 1985 instead of the 9.1 percent of the earlier run.

The trade balance in current dollars also improves dramatically by 1985, registering almost as much improvement as in Scenario 1.

The pressure on the money market, with free reserves as an indicator, shows little change, with a slight "loosening" at the beginning, and "tightening" later following the new pattern of pollution abatement investment.

TABLE III.F. 14 Scenario Comparisons (Scenarios 1-5 Against Baseline)

	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
Real GNP (1975$)	1464.3	1532.3	1650.5	1754.0	1823.1	1870.1	1941.8	2002.0	2056.2	2100.3	2182.8
Percent Difference:											
Scenario #1	.27	.86	.94	.21	.08	-.10	-.36	-.78	-1.19	-2.0	-2.88
Scenario #2	.30	.45	.44	.41	.33	.19	-.05	-.46	-.84	-1.68	-2.45
Scenario #3	.28	1.15	1.30	.61	.60	.52	.33	-.03	-.37	-1.15	-2.04
Scenario #4	.27	.43	.45	.43	.35	.22	-.31	-.69	-1.04	-1.42	-2.06
Scenario #5	.16	.49	.56	.22	.16	.07	-.07	-.32	-.54	- .91	-1.35

GNP Deflator (Price Index)	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
Baseline	185.8	196.1	205.4	215.3	229.0	244.4	258.2	272.3	287.6	302.0	314.3
Percent Difference:											
Scenario #1	.03	.36	.82	1.25	1.83	2.60	3.54	4.60	5.73	7.09	9.00
Scenario #2	.01	.25	.56	.94	1.44	2.13	3.02	4.07	5.18	6.42	8.13
Scenario #3	.03	.35	.81	1.27	1.89	2.71	3.75	4.93	6.14	7.52	9.46
Scenario #4	.03	.22	.48	.80	1.25	1.85	2.53	3.29	4.04	4.95	6.24
Scenario #5	.01	.17	.39	.61	.90	1.29	1.77	2.32	2.86	3.49	4.39

TABLE III.F.14 (Continued)

Unemployment (Percent)

	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
Baseline	8.8	8.5	8.4	6.9	5.3	4.5	4.0	3.8	4.0	5.1	5.5
Rate:											
Scenario #1	8.7	8.3	8.0	6.5	4.9	4.2	3.8	3.8	4.2	5.6	6.4
Scenario #2	8.7	8.3	8.1	6.6	5.0	4.2	3.7	3.7	4.1	5.5	6.2
Scenario #3	8.7	8.3	7.9	6.4	4.8	4.0	3.6	3.6	4.1	5.5	6.2
Scenario #4	8.7	8.4	8.2	6.6	5.0	4.2	3.8	3.8	4.2	5.6	6.2
Scenario #5	8.8	8.4	8.2	6.6	5.1	4.3	3.8	3.8	4.1	5.4	5.9

Personal Consumption Expenditures

	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
Baseline (1975$)	931.9	956.0	1027.0	1091.4	1140.1	1165.5	1195.5	1219.0	1240.4	1260.6	1300.1
Percent Difference											
Scenario #1	.08	.04	-.01	-.09	-.24	-.48	-.80	-1.31	-1.83	-2.47	-3.40
Scenario #2	.12	.07	.01	-.05	-.15	-.32	-.59	-1.07	-1.55	-2.13	-2.95
Scenario #3	.09	.13	.13	.07	-.03	-.23	-.54	-1.06	-1.56	-2.19	-3.09
Scenario #4	.08	.06	.02	-.03	-.11	-.27	-.53	-.97	-1.38	-1.80	-2.46
Scenario #5	.05	.04	.04	.00	-.07	-.19	-.36	- .66	- .94	-1.24	-1.69

Table III.F. 14 Continued

Residential Investment

	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
Baseline 75$	41.9	55.4	59.1	69.9	63.7	57.9	59.1	55.6	47.7	50.6	54.1
Percent Differences											
Rate:											
Scenario #1	-.05	-.28	-.81	-.87	-.84	-1.06	-1.46	-2.34	-3.72	-5.34	-7.34
Scenario #2	-.05	-.21	-.45	-.52	-.70	-1.01	-1.50	-2.32	-3.28	-4.41	-6.06
Scenario #3	-.05	-.29	-.81	-.83	-.67	- .67	- .88	-1.61	-2.93	-4.47	-6.42
Scenario #4	-.05	-.20	-.41	-.46	-.61	-.85	-1.16	-1.60	-2.37	-3.49	-5.20
Scenario #5	-.02	-.13	-.38	-.40	-.36	-.42	-.59	-1.01	-1.69	-2.62	-3.73

Nonresidential Investment

Baseline 75$	149.4	153.0	175.8	191.2	206.0	224.4	252.4	278.0	302.0	310.6	338.8
Percent Differences											
Scenario #1	1.94	8.46	8.75	1.82	1.56	1.28	.83	.14	-0.59	-3.49	-5.37
Scenario #2	2.00	3.66	3.45	3.45	3.29	2.94	2.32	1.49	.70	-2.81	-4.45
Scenario #3	1.95	8.78	9.16	2.22	2.07	1.88	1.44	0.73	0.04	-2.80	-4.66
Scenario #4	1.93	3.60	3.42	3.40	3.21	2.86	-.31	-1.03	-1.71	-2.61	-4.01
Scenario #5	.98	4.23	4.42	1.04	.93	.81	.60	.18	-.19	-1.55	-2.49

Source: NCWQ. From CONSAD Research Corporation, "Macroeconomic Impacts of P.L. 92-500", 1976.

Scenario 3 (Compliance, High Growth, High Municipal Expenditures)

In this run, the "high" municipal scenario (Table III.F.3) is used. The other assumptions are the same as in Scenario 1.

Because of this added expenditure by the government, the pressure on prices is slightly greater. Prices rise 9.5 percent over base by 1985. This additional inflation is of the "demand pull" rather than the "cost-push" variety.

Real GNP is stronger showing a maximum increment of 1.3 percent in 1977 and not dipping below base until 1982. As a result, employment is higher, with a maximum decrement of .6 percentage points in the unemployment rate in 1979.

The major difference from Scenario 1 comes in corporate profits, which remain strong through the decade, with increments triple those of the standard abatement scenario through much of the period. This is because price increases are not totally offset by increased expenses.

The improvement in the trade balance is not as strong here because of increased imports due to increased domestic activity.

Scenario 4 (Smooth, High Growth, No BAT)

In this run, BAT standards are assumed not to be met and the BPT compliance date is delayed to 1980. New source standards are unchanged.

With decreased abatement expenditures, the impact on prices is lessened, with a maximum increment of 6.2 percent in 1985. The average rate of inflation is 6.0 percent or .6 percent above baseline.

The stimulus to real GNP is also less, as it dips below base by 1981. However, due to the reduced inflation, its maximum decrement in 1985 is only 2.1 percent.

Residential investment follows the same pattern as Scenario 1 with milder effects.

The improvement in the trade balance is diminished, registering only 80 percent of the increment in Scenario 1.

Scenario 5 (Compliance, Low Industrial Expenditures, High Growth)

In this run all costs (except municipal) are half those in Scenario 1. The time phasing is unchanged.

With this decrease in pollution abatement expenditure, the price impacts are substantially reduced. The GNP price deflator shows a maximum increment of only 4.4 percent in 1985, or less than half the increment in Scenario 1. The average inflation rate over the decade is 5.8 percent per year as compared to 6.3 percent in Scenario 1.

Real GNP is only moderately affected in this run, with a maximum increment of .6 percent in 1977 and a maximum decrement of 1.3 percent in 1985.

Sectoral Impacts (Scenarios 2 through 5)

As pointed out in the previous discussion of macroeconomic impacts, the rate of inflation is lower in Scenario 2 with its smoothed pattern than in Scenario 1. Table III.F.15 gives the price impacts at the industry level for these scenarios. (Scenario 1 is included to ease comparison.)

The generally smaller price impacts in Scenario 2 can be partly explained by some of the dynamic features of the model. Because of the smaller accumulation of nonproductive capital stock, associated depreciation costs tend to be lower. In addition, levels of operating costs of abatement are lower for the years prior to 1983 because of the smoothing out of BPT costs. In addition, demand in later years falls relatively less in the smoothed case. These factors combine to keep unit costs lower here than in Scenario 1. Scenario 3 shows a small but distinct pressure on prices in the later years as a result of the demand pull of the considerably higher levels of municipal spending. For durable goods price increases over baseline in 1985 are 8.2 percent compared to 9.1 percent in Scenario 1; prices of nondurable goods rise to 9.9 percent over their baseline level compared to 9.2 percent in Scenario 1.

The price impacts in Scenario 4 (with the assumption of no BAT costs) show that the incremental effects of BAT costs (compare Scenario 2 and 4) are relatively small. This is expected since for most industries BPT and new source costs together are the major part of total abatement costs. However, even in industries like machinery and fabricated metals in which BAT costs are comparable to BPT costs, the difference in price impacts between Scenario 2 and 4 is comparable to the price difference for sectors like paper and primary metals where BAT costs are relatively small. A significant source of the price pressures in such industries are factors other than direct abatement costs; this would include increased input costs due to abatement in other industries as well as increased depreciation and wage costs. Finally, price impacts for Scenario 5 (which had assumed industrial abatement costs at one-half the level of Scenario 1)

TABLE III.F.15: IMPACTS ON PRICES - SCENARIOS 1-5
(Percentage Change from Baseline)*

Scenarios	1977					1985				
	1	2	3	4	5	1	2	3	4	5
All Industries	.8	.6	.3	.5	--	9.0	8.1	9.5	6.2	4.4
Agriculture	.8	.5	.8	--	--	5.8	5.2	6.1	4.0	2.8
Mining	1.7	.8	1.7	.8	.8	10.2	9.5	10.9	7.4	5.0
Manufacturing	1.3	.9	1.3	.7	.6	9.1	8.3	9.7	6.2	4.3
Durable Goods	1.3	.9	1.3	.8	.6	9.1	8.2	9.6	6.3	4.2
Primary Metals	1.2	.7	1.2	.7	.6	9.6	8.7	10.0	6.7	4.7
Electrical Machinery	1.5	.9	1.6	.8	--	7.4	6.0	8.0	4.9	2.6
Non-electrical Machinery	1.4	.9	1.4	.8	.7	9.6	8.8	10.1	6.6	4.5
Motor Vehicles	.8	.6	.8	--	--	8.5	7.7	9.0	4.8	4.1
Non-auto Transportation	1.6	1.0	1.6	.9	.8	9.4	8.7	9.9	6.4	4.5
Stone, Clay, and Glass	.9	.7	1.0	.6	.5	8.3	7.6	8.9	5.7	4.0
Fabricated Metals	2.2	1.5	2.2	1.4	1.1	11.6	10.7	12.1	8.4	5.5
Lumber	.7	.5	.7	--	--	8.5	7.7	9.1	5.9	4.2
Furniture	.6	--	.6	--	--	10.6	9.4	10.9	7.3	5.0
Instruments	1.6	1.1	1.6	1.0	.8	10.2	9.4	10.7	7.0	4.8
Non-Durable Goods	1.3	1.0	1.3	.7	.6	9.2	8.5	9.9	6.1	4.5
Food and Beverages	.8	.5	.8	--	--	10.1	9.1	11.3	6.9	4.9
Textiles	.9	.6	.9	.6	.5	8.7	7.9	9.2	6.0	4.2
Paper	1.4	.8	1.4	.7	.7	8.6	7.9	9.0	6.1	4.2
Chemicals	2.9	2.4	2.9	1.5	1.4	11.3	10.9	11.3	6.9	5.4
Petroleum	1.4	1.2	1.4	.8	.7	9.2	8.4	9.7	5.9	4.5
Rubber	1.1	1.0	1.3	.7	.5	6.9	6.4	7.6	4.7	3.3
Tobacco	.5	--	.5	--	--	6.8	6.1	7.2	4.8	3.4
Apparel	.6	.5	.6	--	--	8.9	8.0	9.4	6.1	4.3
Leather	.8	.5	.7	--	--	8.5	7.6	9.0	5.9	4.2
Printing	.5	--	.5	--	--	7.8	7.0	8.2	5.4	3.8
Transportation	.7	.5	.7	--	--	6.6	7.8	9.3	6.1	4.3
Communication	--	--	--	--	--	5.7	5.0	5.9	3.9	2.8
Utilities	2.1	1.7	2.2	1.4	1.2	8.4	7.8	8.8	6.1	4.6
Commercial and Other	.5	--	--	--	--	9.5	8.5	8.9	6.6	4.7
Government	--	--	--	--	--	--	--	--	--	--

*Note - = <.5%

SOURCE: NCWQ. From CONSAD Research Corporation, "Macroeconomic Impacts of P.L. 92-500", 1976.

indicate that price impacts are reduced proportionately if industrial costs are lower than estimated.

The output changes for Scenarios 2 through 5 are small, less than one-half those in Scenario 1 (Table III.F.16). The industries most affected are the fabricated metals, utilities, furniture, and apparel industries. Output levels are responding to changing patterns of final and intermediate demand caused by changes in the relative price structures. In turn, however, the output changes have lagged impacts on unit costs and the price changes themselves.

Finally, there are significant differences in the pattern of impact on gross investment across these scenarios (Table III.F.17). The large shocks resulting from pollution control costs in Scenario 1 are reduced considerably with the assumption of a smoothed pattern of investment. For example, while the change in investment for the fabricated metals industry in 1977 (compared to baseline) was 102 percent for Scenario 1, it is about 50 percent for Scenario 2. For the paper industry the difference is even more significant. The increase in investment is 12 percent in Scenario 2 compared to 39 percent in Scenario 1. The relatively large share of BPT costs in total abatement spending for this industry is being smoothed over a considerably longer period.

c. Scenarios 6-10 (Impacts under a "low-growth" baseline assumption)

(1) Description of Alternative Baseline

An alternative baseline scenario was implemented by assuming tighter money than in the control baseline. (See Table III.F.18). It is essentially identical to the Wharton Annual Model solution for June 1975 entitled, "Tight Money in 1977-1979" (5). The two policy instruments that were varied over the period 1977 to 1985 include the discount rate and the nonborrowed reserves. All other exogenous variables are the same as in the control solution. The rate of growth of nonborrowed reserves was reduced and the discount rate increased to 7.8 percent by 1979 and held at that level through 1985. Table III.F.19 compares this scenario to the control baseline.

The effect of this tight monetary policy is low growth in the economy for the period 1978-1980 and 1983-1985. Tight money policy throughout the remainder of the 1970's produces unemployment rates averaging 7.5 percent (6.7 percent in the period 1981 through 1985). One result of the operation of the economy at this slack level is a reduced demand for imports and large trade surpluses toward 1985. Other results include continuation of large deficits in the Federal sector as tax revenues fail to climb to meet expenditure levels due to poor performance of the tax base.

TABLE III.F.16: IMPACTS ON OUTPUT - SCENARIOS 1-5
(Percentage Changes from Baseline)*

Scenarios	1977					1985				
	1	2	3	4	5	1	2	3	4	5
All Industries	.9	--	1.3	.5	.6	-2.9	-2.5	-2.0	-2.1	-1.4
Agriculture	--	--	--	--	--	3.5	3.1	4.3	2.3	1.8
Mining	-.8	--	-.6	--	--	-3.5	-3.2	-3.1	-3.1	-1.6
Manufacturing	--	--	--	--	--	-2.9	-2.5	-2.5	-2.1	-1.3
Durable Goods	--	--	--	--	--	-3.2	-2.7	-2.7	-2.4	-1.4
Primary Metals	-.7	--	--	--	--	-4.4	-3.9	-3.8	-3.5	-2.1
Electrical Machinery	--	--	--	--	--	-1.4	-.8	-1.0	-1.1	--
Non-electrical Machinery	--	--	--	--	--	-3.0	-2.7	-2.6	-2.4	-1.4
Motor Vehicles	--	--	--	--	--	-2.1	-1.7	-1.7	-1.5	-1.0
Non-auto Transportation	--	--	--	--	--	-1.4	-1.2	-1.3	-1.0	-.6
Stone, Clay, Glass	--	--	.8	--	--	-3.1	-2.5	-2.2	-2.3	-1.4
Fabricated Metals	-.8	-.5	-.5	-.6	--	-7.4	-6.8	-6.8	-5.8	-3.4
Lumber	--	--	.6	--	--	-2.5	-1.9	-1.7	-1.9	-1.1
Furniture	--	--	.9	--	--	-12.6	-10.5	-11.2	-8.9	-6.0
Instruments	--	--	--	--	--	-2.8	-2.4	-1.9	-2.0	-1.2
Miscellaneous Mnfg.	-.6	--	--	--	--	-4.9	-4.4	-4.5	-3.4	-2.3
Non-Durable Goods	--	--	--	--	--	-2.4	-2.2	-2.2	-1.5	-1.1
Food and Beverages	--	--	--	--	--	-5.5	-4.9	-6.9	-3.7	-2.5
Textiles	--	--	--	--	--	-1.1	-1.0	-.8	-1.0	-.6
Paper	--	--	--	--	--	--	--	.7	--	--
Chemicals	--	--	--	--	--	-2.2	-2.3	-1.5	-1.0	-1.0
Petroleum	-.6	-.6	-.5	--	--	-2.8	-2.7	-2.4	-.7	-1.3
Rubber	--	--	--	--	--	-.6	--	--	-.5	--
Tobacco	--	--	--	--	--	2.4	2.4	2.8	1.5	1.2
Apparel	--	--	.7	--	--	-8.1	-7.0	-7.8	-5.8	-3.9
Leather	--	--	--	--	--	-2.4	-2.0	-2.2	-1.9	-1.2
Printing and Publishing	--	--	.8	--	--	-1.7	-1.3	-.9	-1.3	-.8
Transportation	--	--	.6	--	--	-1.3	-1.0	-.8	-1.0	-.6
Communications	--	--	--	--	--	1.7	1.7	2.2	1.3	1.1
Utilities	--	--	--	--	--	-8.6	-8.5	-8.7	-7.5	-6.7
Commercial and Other	--	--	.7	--	--	-3.9	-3.2	-3.1	-2.8	-1.9
Government	.8	.8	2.3	.8	.8	1.5	1.5	5.1	1.3	1.2

*Note - = < .5%

Source: NCWQ. From CONSAD Research Corporation, "Macroeconomic Impacts of P.L. 92-500", 1976.

TABLE III.F.17: IMPACTS ON TOTAL INDUSTRY INVESTMENT (SCENARIOS 1-5)
(Percentage Change from Baseline)*

Scenarios	1977					1985				
	1	2	3	4	5	1	2	3	4	5
Total Non-residential Investment	8.8	3.5	9.2	3.4	4.4	-5.4	-4.5	-4.7	-4.0	-2.5
Agriculture	4.3	1.4	4.4	1.6	2.1	2.3	1.9	3.4	1.5	1.2
Mining	46.9	12.7	46.9	15.6	23.1	-3.8	-2.8	-2.6	-3.2	-1.5
Durable Goods										
Iron and Steel	36.0	10.5	36.6	13.2	17.8	-5.9	-5.2	-5.3	-4.4	-2.8
Nonferrous Metals	5.0	1.4	5.3	1.8	2.5	-2.8	-2.6	-2.3	-2.3	-1.3
Electrical Machinery	26.0	12.4	26.0	10.5	12.8	-3.4	-4.3	-3.2	-3.3	-3.5
Non-electrical Machinery	88.8	40.6	90.5	34.0	44.1	-7.7	-6.9	-6.7	-6.6	-3.6
Motor Vehicles	22.8	9.4	23.0	7.5	11.3	-2.0	-1.6	-1.4	-1.4	-1.0
Non-auto Transportation	--	--	--	--	--	--	--	--	--	--
Stone, Clay, Glass	3.1	.9	3.2	1.0	1.6	-2.5	-2.0	-1.0	-1.9	-1.1
Fabricated Metals	102.1	51.3	102.4	49.7	50.1	3.2	3.9	4.1	4.7	1.7
Lumber	--	--	--	--	--	--	--	.9	--	--
Furniture	--	--	--	--	--	-13.0	-11.4	-11.9	-9.4	-6.4
Instruments	22.5	12.0	23.1	10.6	11.2	--	.5	1.1	.9	--
Miscellaneous	6.2	2.8	6.2	2.4	3.1	--	--	--	--	--
Non-Durable Goods										
Food and Beverages	7.3	3.0	7.4	2.7	3.6	--	--	1.5	--	--
Textiles	20.4	7.8	21.0	8.0	10.2	.7	.7	1.2	.9	.5
Paper	39.4	12.0	40.0	14.5	19.5	.8	.9	1.8	.6	.5
Chemicals	46.5	19.1	47.8	18.2	23.2	.5	.6	1.5	2.3	.5
Petroleum	3.6	2.1	3.7	1.3	1.8	-2.8	-2.6	-2.5	-1.6	-1.2
Rubber	7.5	2.2	8.3	2.8	3.9	-2.8	-2.2	-2.0	-2.2	-1.4
Tobacco	--	--	--	--	--	-4.9	-4.7	-5.2	-3.8	-2.5
Apparel	1.0	.7	1.9	.7	.7	-19.6	-17.4	-19.2	-13.7	-9.2
Leather	10.2	3.6	10.7	3.6	5.2	-3.6	-2.1	-2.5	-2.3	-1.5
Printing and Publishing	-1.1	-.7	-1.1	-.6	-.5	-1.1	-1.2	--	-.8	--
Transportation	2.0	--	2.2	.5	1.0	-4.3	-3.9	-3.9	-3.1	-2.0
Utilities	8.2	2.7	8.3	3.1	4.2	-8.3	-6.6	-8.0	-6.6	-3.8
Communications	--	--	--	--	--	1.8	1.7	2.4	1.4	1.1
Commercial and Other	1.1	.7	1.9	.7	.8	-9.9	-8.3	-8.8	-7.1	-4.8

*Note - = < .5%

Source: NCWQ. From CONSAD Research Corporation, "Macroeconomic Impacts of P.L. 92-500", 1976.

TABLE III.F.18: Alternative "Low Growth" Baseline Summary Tables

ITEM	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
GNP (Current $)	1464.27	1615.98	1813.72	1993.10	2163.71	2346.45	2578.41	2821.29	3073.17	3332.28	3614.23
% Change	4.83	10.36	12.24	9.89	8.56	8.45	9.87	9.42	8.93	8.43	8.46
GNP 58$	788.00	824.00	879.82	914.04	923.38	935.57	980.19	1025.55	1058.43	1087.56	1119.66
% Change	-4.07	4.57	6.77	3.89	1.02	1.32	4.77	4.63	3.21	2.75	2.95
Consumption Expenditure (58$)	526.49	539.81	576.20	600.12	609.62	614.55	635.70	661.12	682.19	701.10	720.32
Fixed Investment	104.23	112.33	122.67	126.75	120.34	121.18	136.50	149.47	154.87	160.15	166.34
Residential	20.21	26.42	25.68	26.28	19.34	16.93	22.62	27.63	29.48	33.56	35.95
Non-residential	84.02	85.92	96.99	100.48	101.00	104.25	113.88	121.84	125.39	126.59	130.39
Governmental Purchase	149.20	154.30	160.10	166.00	171.90	177.80	183.70	189.60	195.50	201.40	207.30
GNP Deflator	185.82	196.12	206.15	218.05	234.32	250.80	263.05	275.10	290.35	306.40	322.80
% Change	9.27	5.54	5.12	5.78	7.46	7.03	4.88	4.58	5.54	5.56	5.35
Consumer Price Deflator	177.01	187.76	197.18	207.60	221.24	236.07	247.82	259.08	272.85	287.16	301.84
% Change	8.83	6.08	5.02	5.28	6.57	6.70	4.98	4.54	5.31	5.24	5.11
Money Supply	770.79	821.78	846.14	892.74	965.55	1056.75	1149.76	1248.81	1358.89	1452.60	1541.27
% Change	10.26	6.62	2.96	5.51	8.16	9.45	8.80	8.61	8.81	6.90	6.10
Bond Rate	9.17	8.88	8.86	9.04	9.73	10.59	11.04	11.16	11.13	11.12	11.21
Short Rate	6.16	7.03	7.98	8.95	9.77	9.73	9.52	9.55	9.60	9.86	10.06
Corporate Profit	122.26	155.13	184.08	193.43	213.20	231.20	250.41	266.18	284.22	305.49	341.39
Unemployment Rate	8.80	8.55	8.70	8.10	7.96	8.11	7.48	6.46	5.70	5.89	6.13
Government Surplus	-79.33	-87.60	-74.63	-66.08	-65.57	-65.53	-54.93	-38.15	-31.43	-26.63	-26.22

Source: NCWQ. From CONSAD Research Corporation, "Macroeconomic Impacts of P.L. 92-500", 1976.

TABLE III.F.19

Comparison of Baselines: Control Versus Alternative Low Growth

Real GNP (75$)	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
Control	1464.3	1532.3	1650.5	1754.0	1823.1	1870.1	1941.8	2002.0	2056.2	2100.3	2182.8
Alternative	.00	-.09	-.95	-3.17	-5.89	-7.04	-6.21	-4.82	-4.36	-3.79	-4.70
% Difference											
Price Index (GNP Deflator)											
Control	185.8	191.6	205.4	215.3	229.0	244.4	258.2	272.3	287.3	302.0	314.3
Alternative	---	.03	.35	1.29	2.33	2.62	1.90	1.02	.97	1.45	2.70
% Difference											
Unemployment Rate											
Control	8.8	8.5	8.4	6.9	5.3	4.6	4.0	3.8	4.0	5.1	5.5
Alternative	8.8	8.6	8.7	8.1	8.0	8.1	7.5	6.5	5.7	5.9	6.1
% Difference											
Personal Consumption Expenditures (75$)											
Control	931.9	956.0	1027.0	1091.4	1140.1	1165.5	1195.5	1219.0	1240.4	1260.6	1300.1
Alternative	---	-.06	-.69	-2.67	-5.35	-6.68	-5.88	-4.01	-2.65	-1.55	-1.94
% Difference											
Residential Investment (75$)											
Control	41.9	55.4	59.1	69.9	63.7	57.9	59.1	55.6	47.7	50.6	54.1
Alternative	---	-1.05	-9.76	-21.95	-37.09	-39.41	-20.55	3.21	27.91	37.29	37.95
% Difference											
Nonresidential Investment (75$)											
Control	149.4	153.0	175.8	191.2	206.0	224.4	252.4	278.0	302.0	310.6	338.8
Alternative	--	-.17	-1.88	-6.55	-12.85	-17.42	-19.77	-22.07	-26.18	-27.55	-30.56
% Difference											

Source: NCWQ. From CONSAD Research Corporation, "Macroeconomic Impacts of P.L. 92-500", 1976.

Real GNP grows at an average rate of 3.2 percent as compared to 4.1 percent for the control. The distinct peak in the housing market is that the control solution forecast for 1978 is no longer observed. Instead, housing starts are forecast to reach a moderate level during 1976 through 1978 with a severe decline to 1980, and an eventual strong recovery that, in fact, predicts them reaching levels higher than the control solution by 1985.

The slower rate of capital accumulation keeps productivity at a low level compared to the control solution. This, combined with the assumption that prices for key sectors like agricultural goods and petroleum are identical to those in the control solution, keeps the rate of inflation comparable to that solution.

(2) Analysis of Scenarios 6-10

Macroeconomic Impacts (See Table III.F.20)

Scenario 6 (Compliance, Low Growth)

As with Scenario 1 real GNP rises initially with the stimulus from increased spending, reaching a peak level above the "low growth" baseline of 1.0 percent in 1977; there is a gradual decline in this effect, and it drops below base by 1980.

The GNP deflator rises at a rate of 6.6 percent a year in this scenario as compared to 5.7 percent for the baseline forecast indicating an inflation rate that is higher by .9 percent due to abatement costs. The unemployment rate drops below base immediately and stays below base until the last years of the forecast when it rises above the baseline. The maximum drop in the unemployment rate occurs during the period 1979 to 1981 when it is .5 percentage points below baseline, and the maximum increase is 1.0 percentage points in 1985.

Residential construction is barely affected until the latter years and drops to 5.4 percent below base in 1985.

Unlike the "control" solution the "low growth" baseline forecasts a gradually improving trade baseline. The impact of abatement spending is similar to that in Scenario 1 and the trade balance improves further by 1985, the increase in surplus amounts to $30 billion.

The large deficits that are forecast for both Federal as well as state and local governments are reduced considerably due to the effects mentioned in the analysis of Scenario 1. That is, the increase in inflation operates to significantly increase government tax revenues. The negative effects of this on personal consumption expenditures is

TABLE III.F.20: Scenario Comparison (Scenarios 6-10) against Alternative Baseline

Real GNP	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
Baseline (75$)	1464.3	1531.2	1634.9	1698.5	1715.8	1738.5	1821.4	1905.6	1966.8	2020.9	2080.6
Percent Difference											
Scenario #6	.27	.94	.97	.23	.13	-.03	-.24	-.64	-1.06	-2.11	-3.18
Scenario #7	.30	.45	.45	.43	.39	.29	.13	-.19	-.51	-1.53	-2.36
Scenario #8	.28	1.16	1.32	.65	.71	.74	.69	.47	.24	-.68	-1.56
Scenario #9	.27	.44	.46	.45	.40	.32	-.16	-.46	-.76	-1.34	-2.04
Scenario #10	.16	.49	.57	.23	.19	.13	.05	-.16	-.31	-.84	-1.55
GNP Deflator											
Baseline	185.8	196.5	208.	221.	238.8	257.3	272.2	287.5	307.2	328.9	352.9
Percent Difference											
Scenario #6	.03	.38	.90	1.37	1.91	2.60	3.46	4.52	5.79	7.33	9.31
Scenario #7	.01	.24	.55	.92	1.38	1.97	2.70	3.65	4.76	6.06	7.75
Scenario #8	.03	.34	.79	1.22	1.72	2.32	3.06	4.00	5.13	6.49	8.21
Scenario #9	.03	.21	.47	.79	1.20	1.72	2.25	2.94	3.75	4.79	6.09
Scenario #10	.01	.17	.39	.60	.84	1.15	1.53	2.02	2.57	3.25	4.11

TABLE III.F.20: Continued

Unemployment Rate

	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
Alternative Baseline	8.8	8.6	8.7	8.1	7.9	8.1	7.5	6.5	5.7	5.9	6.1
Rate:											
Scenario #6	8.7	8.3	8.4	7.7	7.5	7.7	7.2	6.3	5.7	6.3	7.2
Scenario #7	8.7	8.4	8.4	7.8	7.6	7.7	7.1	6.1	5.5	6.0	6.7
Scenario #8	8.7	8.3	8.3	7.6	7.4	7.5	6.8	5.9	5.2	5.8	6.5
Scenario #9	8.7	8.4	8.5	7.8	7.6	7.8	7.2	6.3	5.7	6.1	6.8
Scenario #10	8.8	8.4	8.5	7.9	7.7	7.9	7.3	6.3	5.6	6.0	6.6

Personal Consumption Expenditures

Alternative Baseline (75$)	931.9	955.4	1019.9	1062.2	1079.0	1087.8	1125.2	1170.2	1207.5	1240.9	1275.0
Percent Difference											
Scenario #6	.08	.13	.04	-.07	-.23	-.45	-.73	-1.18	-1.69	-2.58	-3.80
Scenario #7	.12	.08	.02	-.04	-.14	-.28	-.47	-.83	-1.21	-1.96	-2.91
Scenario #8	.09	.14	.15	.09	.02	-.09	-.24	-.57	-.93	-1.69	-2.65
Scenario #9	.08	.06	.03	-.02	-.11	-.24	-.42	-.76	-1.10	-1.73	-2.51
Scenario #10	.05	.05	.04	.01	-.05	-.14	-.25	-.49	-.68	-1.13	-1.93

TABLE III.F.20: Continued

Residential Investment	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
Alternative Baseline (75$)	41.9	54.8	53.3	54.5	40.0	35.1	46.9	57.2	61.0	69.5	73.8
Percent Difference:											
Scenario #6	-.05	-.43	-.93	-.95	-.76	-.74	-1.06	-1.88	-3.04	-4.11	-5.45
Scenario #7	-.05	-.21	-.47	-.54	-.72	-.93	-1.22	-1.73	-2.26	-2.97	-4.00
Scenario #8	-.05	-.28	-.82	-.87	-.46	.06	.01	- .60	-1.49	-2.44	-3.53
Scenario #9	-.05	-.20	-.41	-.49	-.64	-.79	-.91	-1.12	-1.63	-2.40	-3.51
Scenario #10	-.02	-.14	-.40	-.43	-.29	-.17	-.27	-.62	-1.11	-1.70	-2.29
Nonresidential Investment											
Alternative Baseline (75$)	149.4	152.7	172.5	178.7	179.6	185.4	202.5	216.6	222.9	225.1	231.8
Percent Difference:											
Scenario #6	1.94	8.60	8.94	1.94	1.89	1.80	1.45	.72	-0.11	-4.45	-7.33
Scenario #7	2.00	3.66	3.51	3.71	3.90	3.88	3.47	2.77	2.14	-2.83	-5.01
Scenario #8	1.95	8.80	9.33	2.41	2.55	2.78	2.70	2.25	1.82	-2.10	-4.31
Scenario #9	1.93	3.60	3.50	3.68	3.84	3.83	.23	-.46	-1.18	-2.67	-4.54
Scenario #10	.98	4.23	4.49	1.08	1.08	1.10	.99	.63	.39	-1.73	-3.48

Source: NCWQ. From CONSAD Research Corporation, "Macroeconomic Impacts of P.L. 92-500", 1976.

delayed here relative to Scenario 1; personal consumption expenditures drop below baseline in 1978 instead of 1977 in Scenario 1.

Corporate profits rise significantly in 1976 and 1977 and continue to stay above baseline with an average annual increase of 11.6 percent a year compared to 10.8 percent a year in the base.

The increased abatement investment increases nonresidential investment to 9 percent over base in 1977. Thereafter the stimulus subsides and by 1983 total nonresidential investment drops below base. The reduction in productive investment is largest in the later years indicating the lagged effect on investment of increases in user cost and durable goods price increases. Productive investment drops to 7.6 percent below base by 1985.

Scenario 7 (Smooth, Low Growth)

Real GNP rises above base but the stimulus is not as marked due to the smoothing out of investment. The drop below baseline comes in 1982 compared to 1980 in Scenario 6 and the decline by 1985 is somewhat less than 2.4 percent compared to 3.2 percent for Scenario 6.

The unemployment rate stays below base throughout most of the period though by 1984 it rises above the baseline forecast.

The GNP deflator rises throughout the period and in 1985 is 7.7 percent above baseline. The average annual rate of inflation is 6.4 percent compared to 5.7 percent in the baseline and 6.6 percent in Scenario 6.

The drop in personal consumption below base occurs in 1978 as in Scenario 6, with durables showing the most improvements over Scenario 6.

Residential construction is affected less than in Scenario 6 with a drop of 4 percent below base in 1985. The smoothing out of investment eliminates the significant change in total investment in 1977 that was observed in Scenario 6. The largest impact on fixed investment comes in 1980 even though abatement investment rises until 1983. After 1980 productive investment declines at a faster rate than the rise in abatement investment.

When compared to the corresponding scenario (Scenario 2) this scenario shows more sustained stimulative effects on GNP and employment. The inflationary impacts are similar to those in Scenario 2, however. In both scenarios the inflation rates rise about .7 percent.

Scenario 8 (Compliance, Low Growth, High Municipal Expenditures)

The stimulative effects of the additional municipal spending draws GNP above baseline until near the end of the forecast period. It drops below baseline by 1984 with a maximum decrease of 2 percent in 1985. Despite the additional stimulus the GNP deflator does not rise faster than in Scenario 6. The inflation rate is 6.5 percent compared to 6.6 percent for Scenario 6 and 5.7 percent for the baseline.

The unemployment rate shows a significant drop below base with the largest impacts coming in the period 1979 through 1983. The average unemployment rate for this period is 6.5 percent compared to 7.1 percent for the base. It should be noted that these are primarily induced effects of the municipal spending. Direct employment in treatment plants is not significantly higher than in Scenario 6. The "high" municipal case (see Table III.F.3) is primarily a change in the level of capital spending. Operating costs (and, therefore, direct labor requirements) are only somewhat higher than in the "low" municipal scenarios.

The difference in the rate of inflation between this scenario and Scenario 6 is caused primarily by a lower rate of inflation in the last two years of the forecast. This can be explained by analyzing the cyclical patterns in the "low growth" baseline. In the baseline unemployment drops to 5.7 percent in 1983 but rises again to 6.1 percent in 1985. The high levels of municipal spending during this period of slack demand tends to keep unit costs from rising at the same rate as in Scenario 6.

Scenario 9 (Smooth, Low Growth, No BAT)

This scenario assumed that only BPT and new source expenditures would be incurred. (The comparable scenario for the control baseline was Scenario 4.) The stimulative impacts on GNP in this scenario are milder than in Scenario 6 (in which BAT costs were included) and Scenario 8, with its high levels of municipal spending. The rate of inflation rises to 6.3 percent compared to 5.7 percent for the baseline. As in Scenario 6 the unemployment rate is below baseline until the final year of the forecast when it rises slightly over baseline.

When compared to Scenario 4, which was the comparable scenario with the full employment baseline, this scenario shows that both the inflationary impacts as well as the impacts on GNP are very similar between these two scenarios. With the slack economy only the high levels of expenditures assumed in Scenario 8 appears to have stimulative effects that are sustained long enough to show significantly different results than under a full employment baseline (Scenario 3).

Scenario 10 (Compliance, Low Industrial Expenditures, Low Growth)

This scenario shows results comparable to those of Scenario 5 with the full employment baseline. The impact on GNP is mild. The maximum increase is in 1977, the peak year of investment spending when GNP rises only .6 percent above baseline. As in Scenario 5, GNP drops below baseline toward the end of the period.

Sectoral Impacts (Scenarios 6-10)

Sectoral impacts for Scenarios 6 through 10 are presented in Tables III.F.21, III.F.22, and III.F.23. The price impacts under the low growth baseline are only marginally different in these scenarios than under the corresponding scenarios with a full employment baseline. The only exception is Scenario 8 with its assumption of high levels of municipal spending. Here the GNP deflator increases by 8.2 percent in 1985 compared to 9.5 percent for Scenario 3. This may at first glance seem contrary to expectations. One would expect that a depressed economy can be stimulated without price increase. While this is generally true for certain kinds of stimuli, it is not the case for industrial pollution abatement costs. Since these costs (BPT and BAT particularly) are unlikely to change significantly in the presence of a depressed economy, costs per unit of industrial output tend to be higher. Thus, we see the greater pressure on price. With the additional "demand-pull" stimulus from municipal spending industrial outputs tend to increase without corresponding increases in costs. The pressure on prices is thereby lower. The impact is strongest in the food sector which shows an increase of 9 percent above baseline compared to 11.3 percent in Scenario 3.

Analysis of impacts on total industry investment indicates results comparable to the full employment scenarios through 1977; beyond that date the depressive effect of the abatement costs on regular investment tend to reduce total investment to levels lower than in Scenario 1 through 5. The industries with the largest drop in investment include the utilities, apparel, furniture, and nonelectrical machinery industries.

With the lower costs the price impacts are considerably smaller; the inflation rate rises to about 6.1 percent, an increase of .4 percent over baseline. This too is comparable to Scenario 5 and once again indicates that with lower industrial costs and a low municipal scenario the assumption of a "low growth" economy tends to show impacts very similar to those in the full employment baseline.

TABLE III.F.21: Impacts on Prices - (Scenarios 6 - 10)
(Percentage Change From Baseline)*

Scenarios	1977					1985				
	6	7	8	9	10	6	7	8	9	10
All Industries	.9	.6	.8	.5	.4	9.3	7.8	8.2	6.1	4.1
Agriculture	.8	.6	.8	.5	-	5.9	5.1	5.3	3.9	2.7
Mining	1.8	.8	1.7	.8	.8	10.1	9.0	9.6	7.0	4.6
Manufacturing	1.5	.9	1.3	.7	.6	9.4	8.1	8.6	6.1	4.0
Durable Goods	1.5	.9	1.4	.8	.7	9.5	8.1	8.6	6.3	4.0
Primary Metals	1.3	.7	1.2	.7	.6	10.1	8.6	8.9	6.8	4.5
Electrical Machinery	1.6	1.2	1.6	.9	.7	8.1	6.8	7.7	5.1	3.6
Non-Electrical Machinery	1.7	.9	1.4	.8	.7	9.5	8.6	9.0	6.6	3.6
Motor Vehicles	.9	.6	.8	.5	-	8.9	7.4	7.9	5.7	3.8
Non-Auto Transportation	1.9	1.1	1.6	.9	.8	9.8	8.6	8.9	6.3	4.0
Stone, Clay, and Glass	1.2	.7	1.0	.6	.5	8.5	7.2	7.7	5.6	3.3
Fabricated Metals	2.5	1.5	2.2	1.4	1.1	12.4	11.0	11.4	8.6	5.2
Lumber	.9	.5	.7	-	-	8.6	7.3	7.8	5.6	3.4
Furniture	.8	-	.6	-	-	12.4	9.5	9.5	7.6	4.7
Instruments	1.9	1.1	1.6	1.0	.8	10.8	9.3	9.7	7.1	4.3
Non-Durable Goods	1.4	1.0	1.3	.7	.6	9.3	8.1	8.7	6.0	4.1
Food and Beverages	1.0	.5	.8	.5	-	9.5	8.2	9.0	6.4	4.1
Textiles	1.1	.6	1.0	.6	.5	9.0	7.6	8.0	5.9	3.9
Paper	1.6	.8	1.6	.8	.7	8.0	7.8	8.1	6.1	3.7
Chemicals	3.0	2.4	3.0	1.5	1.4	11.8	11.0	11.3	7.0	5.4
Petroleum	1.5	1.1	1.4	.7	.7	9.6	8.2	8.7	5.8	4.3
Rubber	1.2	.9	1.3	.7	.5	7.2	6.0	6.9	4.6	3.1
Tobacco	.6	-	.5	-	-	6.8	5.6	5.9	4.5	2.9
Apparel	.8	.5	.6	-	-	9.2	7.6	8.1	6.0	3.9
Leather	.9	.5	.7	-	-	8.8	7.3	7.7	5.7	3.8
Printing and Publishing	.7	-	.5	-	-	8.1	6.6	7.0	5.3	3.4
Transportation	.8	.5	.7	-	-	8.9	7.4	8.0	5.9	3.9
Communication	.5	-	-	-	-	5.8	4.7	5.1	3.8	2.5
Utilities	2.0	1.5	1.8	1.4	.9	8.7	7.7	7.8	6.2	4.0
Commercial and Other	-	-	-	-	-	10.1	8.2	8.5	6.5	4.5
Government	-	-	-	-	-	-	-	-	-	-

*Note - = < .5%

Source: NCWQ. From CONSAD Research Corporation, "Macroeconomic Impacts of P.L. 92-500", 1976.

TABLE III.F.22: Impacts on Output (Scenarios 6 - 10)
(Percentage Changes From Baseline)*

Scenarios	1977					1985				
	6	7	8	9	10	6	7	8	9	10
All Industries	1.0	.5	1.3	.5	.6	-3.2	-2.4	-1.6	-2.0	-1.6
Agriculture	-	-	-	-	-	3.2	2.6	3.4	2.0	1.0
Mining	-.8	-	-.6	-	-	-3.7	-3.3	-3.1	-3.1	-1.9
Manufacturing	-	-	-	-	-	-3.0	-2.3	-1.9	-1.9	-1.3
Durable Goods	-	-	-	-	-	-3.8	-2.8	-2.4	-2.5	-1.6
Primary Metals	-.7	-	-	-	-	-5.5	-4.3	-3.6	-3.8	-2.7
Electrical Machinery	-	-	-	-	-	-1.4	-.8	-.7	-.8	-.7
Non-Electrical Machinery	-	-	-	-	-	-3.5	-2.6	-2.1	-2.4	-1.2
Motor Vehicles	-	-	-	-	-	-2.4	-1.6	-1.4	-1.5	-1.2
Non-Auto Transportation	-	-	-	-	-	-1.4	-1.1	-1.0	-.9	-.6
Stone, Clay, Glass	-	-	.8	-	-	-3.3	-2.2	-1.4	-2.1	-1.3
Fabricated Metals	-1.0	-.6	-.5	-.6	-	-9.1	-7.9	-7.3	-6.7	-4.0
Lumber	-	-	.6	-	-	-2.2	-1.3	-.6	-1.4	-.7
Furniture	-	-	1.0	-	-	-19.8	-13.4	-11.4	-11.8	-7.9
Instruments	-	-	-	-	-	-3.0	-2.3	-1.5	-1.9	-1.2
Miscellaneous Manufacturing	-.7	-	-	-	-	-5.4	-4.4	-4.0	-3.5	-2.5
Non-Durable Goods	-	-	-	-	-	-1.9	-1.6	-1.3	-1.1	-.9
Food & Beverages	-	-	-	-	-	-1.5	-1.7	-2.3	-1.3	-.5
Textiles	-	-	-	-	-	-1.3	-1.0	-.7	-1.0	-.8
Paper	-	-	-	-	-	-	-	.5	-	-
Chemicals	-	-	-	-	-	-2.5	-2.5	-1.8	-1.1	-1.3
Petroleum	-.6	-.6	-	-	-	-3.2	-2.9	-2.8	-.7	-1.7
Rubber	-	-	-	-	-	-.7	-	-	-	-
Tobacco	-	-	-	-	-	2.6	2.5	2.9	1.6	1.0
Apparel	-	-	.7	-	-	-8.8	-6.5	-6.2	-5.7	-3.9
Leather	-	-	.5	-	-	-2.9	-1.8	-1.6	-1.9	-1.4
Printing & Publishing	-	-	.8	-	-	-2.0	-1.1	-	-1.2	-.9
Transportation	-	-	.6	-	-	-1.6	-.9	-.6	-1.0	-.8
Communications	-	-	-	-	-	1.7	1.6	2.0	1.3	.8
Utilities	-	-	-	-	-	-7.4	-7.4	-6.3	-7.3	-3.9
Commercial & Other	.5	-	.8	-	-	-4.6	-3.1	-2.5	-2.9	-2.2
Government	.8	.8	2.3	.8	.8	1.6	1.4	5.0	1.3	1.1

*Note - = < .5%

Source: NCWQ. From CONSAD Research Corporation, "Macroeconomic Impacts of P.L. 92-500", 1976.

TABLE III.F.23: Impacts on Total Industry Investment (Scenarios 6 - 10)
(Percentage Change From Baseline)*

Scenarios	1977					1985				
	6	7	8	9	10	6	7	8	9	10
Total Non-Residential Investment	8.9	3.5	9.3	3.5	4.5	-7.3	-5.0	-4.3	-4.5	-3.5
Agriculture	4.4	1.4	4.4	1.6	2.1	2.9	2.0	3.5	1.8	1.3
Mining	46.9	12.7	47.0	15.7	23.1	-5.7	-3.9	-3.7	-4.2	-2.2
Durable Goods										
Iron & Steel	37.0	10.8	37.5	13.6	18.3	-8.4	-6.3	-5.2	-5.3	-3.8
Non-Ferrous Metals	5.2	1.4	5.4	1.9	2.6	-3.3	-2.6	-1.7	-2.2	-1.4
Electrical Machinery	26.0	12.4	26.0	10.5	12.8	-1.2	-.6	.5	-1.1	-
Non-Electrical Machinery	99.5	45.9	102.5	38.5	49.9	-10.3	-8.4	-6.9	-8.0	-4.0
Motor Vehicles	22.9	9.5	23.1	7.6	11.3	-1.9	-1.1	-.5	-1.0	-.8
Non-Auto Transportation										
Stone, Clay, & Glass	3.2	.9	3.2	1.0	1.6	-2.1	-.9	1.2	-1.0	-.5
Fabricated Metals	105.6	53.2	106.0	51.6	51.8	3.9	5.7	6.6	6.7	2.5
Lumber	-	-	-	-	-	.5	.9	2.3	.8	.6
Furniture	-	-	-	-	-	-23.1	-16.8	-14.3	-14.3	-9.9
Instruments	22.7	12.2	23.3	10.7	11.3	-	.8	2.0	1.3	-
Miscellaneous	6.2	2.8	6.2	2.4	3.1	-	-	-	-	-
Non-Durable Goods										
Food & Beverages	7.3	3.0	7.4	2.7	3.6	-	.6	2.9	.8	.7
Textiles	21.0	8.1	21.6	8.3	10.5	-.7	-	-	-	-1.4
Paper	39.5	12.0	40.2	14.5	19.5	1.1	1.5	2.9	1.1	.8
Chemicals	47.8	19.6	48.9	18.7	23.8	-	-	1.0	2.1	-.6
Petroleum	3.6	2.0	3.7	1.3	1.8	-3.5	-3.0	-2.5	-1.3	-1.4
Rubber	7.9	2.3	8.6	2.9	4.1	-2.8	-1.5	-1.1	-1.8	-1.8
Tobacco	-	-	-	-	-	-5.9	-5.2	-5.0	-4.1	-2.7
Apparel	.9	.7	2.0	.7	.8	-25.2	-19.9	-19.7	-16.8	-11.3
Leather	10.5	3.8	11.1	3.7	5.3	-4.5	-1.6	-.9	-2.1	-1.4
Printing & Publishing	-1.1	-.7	-1.1	-.6	-.5	-1.0	-.5	1.8	-	-
Transportation	2.0	-	2.3	.6	1.1	-5.0	-4.0	-3.5	-3.2	-2.1
Utilities	8.2	2.6	8.3	3.8	4.1	-22.6	-14.5	-15.4	-15.0	-8.9
Communications	-	-	-	-	-	2.0	1.8	2.4	1.6	1.0
Commercial & Other	1.3	.7	2.0	.7	.8	-13.3	-9.6	-8.8	-8.5	-7.4

*Note: - = < .5%

Source: NCWQ. From CONSAD Research Corporation, "Macroeconomic Impacts of P.L. 92-500", 1976.

d. Scenarios 11-13

(1) Analysis of Scenarios 11 and 12 (Twenty-five and fifty percent productive abatement investment)

In these runs, it was assumed that 25 and 50 percent of the abatement investment was productive, respectively. These scenarios simulate situations where pollution control would not be all of the "end-of-pipe" variety, but would also involve changes of process and product mix which can increase efficiency by reducing waste. Cost data for both scenarios is the same as in Scenario 1. Scenario comparisons are presented in Table III.F.24.

In Scenario 11 the pressure on prices is less, as the GNP deflator rises to 7.3 percent over base in 1985, giving an average rate of inflation of 6.1 percent a year compared to 6.3 percent for Scenario 1. While real GNP does dip below baseline, the difference in 1985 is 1.5 percent below base compared to 2.9 percent for Scenario 1. The exogenously imposed increase in productive capital tends to substitute for the endogenously generated productive investment. Total investment in the later period is higher than in Scenario 1, however, reflecting the stronger overall economy. This is reflected in the impact on the housing market. While it still displays a cyclic pattern, it is far stronger, due to the better economic conditions.

Scenario 12 (50 percent productive) shows results comparable to those in the previous scenario, although price increases are somewhat smaller. The inflation rate is only slightly smaller. The surge in productive investment keeps fixed investment levels above the baseline throughout the forecast period. While GNP does drop below baseline the difference is smaller than in Scenario 11 (.4 percent compared to 1.5 percent).

Sectoral results are presented in Tables III.F.25, III.F.26, and III.F.27 for prices, output and total investment (including abatement). The most significant patterns are observed in the output impacts. While almost all sectors showed declines in output levels (in 1985) for Scenario 11, the results of Scenario 12 show increases in outputs of several industries. Results for total investment indicate that peak levels of 1977 investment for Scenario 1 are observed in Scenario 11 and 12 also. For a few industries like fabricated metals, the shocks are milder. The more significant changes are observed in 1985. For several industries the stimulus to productive investments tends to keep investment levels above baseline values despite some depressive effects through increases in the user cost of capital.

(2) Analysis of Scenario 13 (Air and Water Pollution)

In this run, the incremental impact of water pollution control is examined under the assumption that air pollution abatement will be undertaken. The water pollution costs are the same as in Scenario 1.

TABLE III.F.24: Scenario Comparison (Scenarios 11-13) Against Control Baseline

Real GNP	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
Control Baseline (75$)	1464	1532	1650	1754	1823	1870	1942	2002	2056	2100	2183
Percent Difference:											
Scenario #11	.27	.87	.89	.17	.24	.26	.10	-.25	-.53	-1.07	-1.49
Scenario #12	.28	.86	.83	.10	.35	.57	.48	.17	-.02	-.36	-.40
Scenario #13	.52	1.12	1.29	.53	.15	-.22	-.62	-1.22	-1.81	-2.88	-4.21
GNP Deflator											
Control Baseline	185.8	196.1	205.4	215.3	229.0	244.4	258.2	272.3	287.6	302.0	314.3
Percent Difference:											
Scenario #11	0.01	.28	.66	1.02	1.44	2.04	2.90	3.91	4.90	5.96	7.33
Scenario #12	0.00	.23	.56	.88	1.18	1.67	2.51	3.54	4.50	5.39	6.43
Scenario #13	0.05	.50	1.13	1.79	2.67	3.81	5.15	6.62	8.22	10.20	13.04
Unemployment Rate											
Control Baseline Rate:	8.8	8.5	8.4	6.9	5.3	4.6	4.0	3.8	4.0	5.1	5.5
Scenario #11	8.7	8.3	8.1	6.6	5.0	4.1	3.6	3.6	4.0	5.4	5.9
Scenario #12	8.7	8.4	8.2	6.6	5.0	4.1	3.5	3.5	3.9	5.2	5.6
Scenario #13	8.7	8.2	7.9	6.3	4.7	4.1	3.7	3.9	4.4	6.0	6.8

TABLE III.F.24: Continued

	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
Personal Consumption Expenditures											
Control Baseline (75$)	931.9	956	1027	1091	1140	1166	1195	1219	1240	1261	1300
Percent Difference:											
Scenario #11	0.09	0.05	-.01	-.08	-.11	-.20	-.45	-.92	-1.36	-1.80	-2.34
Scenario #12	0.09	0.05	-.04	-.12	-.04	-.01	-.21	-.69	-1.09	-1.39	-1.63
Scenario #13	0.12	0.05	0.00	-.11	-.36	-.75	-1.25	-1.96	-2.68	-3.61	-5.03
Residential Investment											
Control Baseline (75$)	41.9	55.4	59.1	69.9	63.7	57.9	59.1	55.6	47.7	50.6	54.1
Percent Difference:											
Scenario #11	-.04	-.22	-.66	-.70	-.65	-.74	-1.05	-1.76	-2.67	-3.75	-5.27
Scenario #12	-.03	-.17	-.55	-.61	-.59	-.63	-.93	-1.57	-2.10	-2.72	-3.88
Scenario #13	-.08	-.44	-1.09	-1.23	-1.30	-1.61	-2.16	-3.39	-5.40	-7.77	-10.61
Nonresidential Investment											
Control Baseline (75$)	149.4	153.0	175.8	191.2	206.0	224.4	252.4	278.0	302.0	310.6	333.8
Percent Difference:											
Scenario #11	1.95	8.37	8.27	1.32	2.08	2.72	2.63	2.27	2.00	0.00	-.50
Scenario #12	1.95	8.28	7.79	.83	2.60	4.15	4.41	4.34	4.44	3.21	3.86
Scenario #13	4.32	11.17	12.36	5.26	3.16	1.97	1.16	-.02	-1.15	-4.62	-7.37

Source: NCWQ. From CONSAD Research Corporation, "Macroeconomic Impacts of P.L. 92-500", 1976.

TABLE III.F.25: Price Impacts (Scenarios 11 and 12)
(Percentage Changes From Baseline)*

Scenarios	1977			1985		
	1	11	12	1	11	12
All Industries	.8	.7	-	9.0	7.3	-
Agriculture	.8	.6	.6	5.8	4.6	4.1
Mining	1.7	1.1	.5	10.2	8.9	8.4
Manufacturing	1.3	1.1	.9	9.1	7.3	6.3
Durable Goods	1.3	1.0	.9	9.1	7.3	6.2
Primary Metals	1.2	1.0	.7	9.6	7.8	6.7
Electrical Machinery	1.5	1.3	1.3	7.4	6.3	6.1
Non-Electrical Machinery	1.4	1.0	.7	9.6	6.5	4.3
Motor Vehicles	.8	.7	.5	8.5	7.0	6.1
Non-Auto Transportation	1.6	1.3	1.0	9.4	7.8	6.9
Stone, Clay, and Glass	.9	.8	.7	8.3	7.0	6.3
Fabricated Metals	2.2	1.7	1.3	11.6	9.6	8.4
Lumber	.7	.6	.5	8.5	7.1	6.4
Furniture	.6	.5	.5	10.6	8.2	6.9
Instruments	1.6	1.3	1.1	10.2	8.4	7.3
Non Durable Goods	1.3	1.2	1.0	9.2	7.5	6.5
Food	.8	.8	.8	10.1	7.6	6.1
Textiles	.9	.7	.6	8.7	7.1	6.3
Paper	1.4	1.2	.9	8.6	6.9	5.9
Chemicals	2.9	2.5	2.2	11.3	9.6	8.6
Petroleum	1.4	1.2	1.1	9.2	7.6	6.9
Rubber	1.1	1.0	1.0	6.9	5.7	5.6
Tobacco	.5	-	-	6.8	5.6	5.0
Apparel	.6	.6	.5	8.9	7.3	6.6
Leather	.8	.6	.5	8.5	6.8	5.9
Printing and Publishing	.5	.5	-	7.8	6.4	5.7
Transportation	.7	.6	.5	8.6	7.3	6.3
Communication	-	-	-	5.7	4.7	4.1
Utilities	2.1	2.0	2.2	8.4	7.4	7.8
Commercial and Other	.5	-	-	9.5	7.8	6.9
Government	-	-	-	-	-	-

*Note: - = < .5%

Source: NCWQ. From CONSAD Research Corporation, Macroeconomic Impacts of P.L. 92-500", 1976.

TABLE III.F.26: Output Impacts (Scenarios 11 and 12)
(Percentage Changes From Baseline)*

Scenarios	1977			1985		
	1	11	12	1	11	12
All Industries	1.0	.9	.8	-3.2	-1.5	-
Agriculture	-	-	-	3.2	3.5	3.4
Mining	-.8	-.5	-	-3.7	-1.7	-
Manufacturing	-	-	-	-3.0	-1.1	.5
Durable Goods	-	-	-	-3.8	-1.0	.8
Primary Metals	-.7	-.8	-.9	-5.5	-1.7	.6
Electrical Machinery	-	-	-	-1.4	-2.3	1.9
Non-Electrical Machinery	-	-	-.7	-3.5	-.6	2.8
Motor Vehicles	-	-	-	-2.4	-1.0	-
Non-Auto Transportation	-	-	-	-1.4	-.7	-
Stone, Clay, and Glass	-	-	-	-3.3	-.6	1.6
Fabricated Metals	-1.0	-.7	-.7	-9.1	-4.4	-1.7
Lumber	-	-	-	-2.2	-	1.9
Furniture	-	-	-	-19.8	-7.6	4.1
Instruments	-	-	-	-3.0	-1.1	-
Miscellaneous Manufacturing	-.7	-.5	-	-5.4	-3.1	-1.7
Non-Durable Goods	-	-	-	-1.9	-1.1	-
Food	-	-	-	-1.5	-2.4	-
Textiles	-	-	-	-1.3	-	-
Paper	-	-	-	-	.9	1.7
Chemicals	-	-	-	-2.5	-1.3	-.5
Petroleum	-.6	-.5	-.6	-3.2	-1.8	-1.3
Rubber	-	-	-	-.7	-	.9
Tobacco	-	-	-	2.6	2.5	2.6
Apparel	-	-	-	-8.8	-6.0	-4.8
Leather	-	-	-	-2.9	-1.2	-
Printing and Publishing	-	-	-	-2.0	-.6	-
Transportation	-	-	-	-1.6	-	.5
Communication	-	-	-	1.7	2.0	2.5
Utilities	-	-	-.5	-7.4	-9.0	-12.8
Commercial and Other	.5	-	-	-4.6	-2.2	-.9
Government	.8	.8	.8	1.6	1.5	1.5

*Note: - = < .5%

Source: NCWQ. From CONSAD Research Corporation, "Macroeconomic Impacts of P.L. 92-500", 1976.

TABLE III.F.27: IMPACTS ON TOTAL INVESTMENT (SCENARIOS 11 AND 12)
(PERCENTAGE DIFFERENCE FROM BASELINE)*

Scenarios	1977			1985		
	1	11	12	1	11	12
Total Non-Residential Investment	8.8	8.3	7.8	-5.4	-.5	3.9
Agriculture	4.3	4.2	4.0	2.3	2.9	3.0
Mining	46.9	45.1	43.2	-3.8	1.0	6.0
Durables						
Iron and Steel	36.0	31.6	27.3	-5.9	-2.4	.7
Non-Ferrous Metals	5.0	4.8	4.5	-2.8	-.5	1.6
Electrical Machinery	26.0	25.5	25.0	-3.4	-2.6	-1.2
Non-Electrical Machinery	88.8	91.8	94.7	-7.7	6.9	20.9
Motor Vehicles	22.8	20.8	18.7	-2.0	-3.8	-5.9
Non-Auto Transportation						
Stone, Clay and Glass	3.1	3.0	2.8	-2.5	.5	1.4
Fabricated Metals	102.1	81.1	60.2	3.2	5.3	7.1
Lumber	-	-	-	-	1.0	2.1
Furniture	-	-	-	-13.0	-9.1	-6.4
Instruments	22.5	19.6	16.6	-	1.9	3.5
Miscellaneous	6.2	6.6	7.1	-	1.6	3.1
Non-Durables						
Food and Beverages	7.3	7.8	8.3	-	-4.4	-8.7
Textiles	20.4	21.5	22.4	.7	1.6	2.1
Paper	39.4	37.0	34.7	.8	1.8	2.7
Chemicals	46.5	41.2	35.8	.5	.6	.5
Petroleum	3.6	3.2	2.9	-2.8	-2.0	-1.5
Rubber	7.5	7.4	7.1	-2.8	-.6	.9
Tobacco	-	-	-	-4.9	-3.9	-3.2
Apparel	1.0	.9	.7	-19.6	-14.4	-11.2
Leather	10.2	11.5	12.7	-3.6	.9	4.8
Printing	-1.1	-.9	-.8	-1.1	-	.7
Transportation	2.0	2.1	2.1	-4.3	-2.9	-1.9
Utilities	8.2	9.1	10.2	-8.3	2.6	12.9
Communication	-	-	-	1.8	2.0	2.5
Commercial and Other	1.1	.9	.6	-9.9	-5.8	-2.7

*Note: - = < .5%

Source: NCWQ. From CONSAD Research Corporation, "Macroeconomic Impacts of P.L. 92-500", 1976.

The pressure on prices is greater, as expected. The GNP deflator rises to 13 percent above base by 1985 compared to 9 percent in Scenario 1 (Table III.F.24). Since 4.7 percent of the rise comes from the air abatement costs, the incremental rise is 8.3 percent, or slightly lower than the impact of water abatement alone. (Table III.F.28)

Real GNP rises more in the early years under the added stimulus but with the higher prices, the slide is steeper, falling below base by 1980 and reaching 4.2 percent below base in 1985. Again, 1.8 percent of this drop is caused by the air standards, so that the additional drop in output due to the water standards is 2.4 percent by 1985.

Unemployment, as before, drops at first and then rises as the economy weakens. Here it shows a maximum decrement of .6 percentage points in 1979, and a maximum increment of 1.3 percentage points in 1985. The incremental effects of the water pollution costs on the unemployment rate are .3 and .7 percentage points in 1979 and 1985 respectively.

5. Impacts upon the Capital Markets of Water Pollution Control Investment

a. Background

The New York Stock Exchange in a 1974 study (9) compared their estimates of the total investment demands for business, housing, energy, pollution control, Federal government deficits, etc., with probable savings determined as a percent of probable GNP. The result was an estimated "capital gap" over the period 1974-1985 of approximately $650 billion.

Another study, published by the Brookings Institution (2), adopted a similar approach, but came to much different conclusions, at least for the seventies. Bosworth, et. al.'s estimates of capital requirements, economic growth, and probable savings yielded an estimated surplus of savings or "unallocated resources" amounting to $43.5 billion in 1980. Their estimate is based upon higher rates of savings than the NYSE study, and includes Federal government surpluses amounting to $30.7 billion in 1977 and $81.8 billion in 1980. "The estimates" they explain, "indicate that with normal growth and without unusual sacrifices the economy will be able to meet the capital demands that can reasonably be projected for the remainder of the decade. At the same time, very careful fiscal management will be required to avoid a capital market crunch or a renewal of inflationary demand pressures..." (2)

There are many uncertainties in projecting capital demands in a complex economy. For example, increased energy costs might be expected to lead to higher prices which would dampen demand for energy and reduce investment requirements. This appears to be happening to some extent,

TABLE III.F.28

Comparison Air Pollution Abatement with Control Baseline

Real GNP	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
Control	1464.3	1532.3	1650.5	1754.0	1823.1	1870.1	1941.8	2002.0	2056.2	2100.3	2182.8
Air Only Percentage Difference	.24	.35	.47	.49	.22	-.05	-.27	-.61	-.93	-1.27	-1.81
Price Index (GNP Deflator)											
Control	185.8	191.6	205.4	215.3	229.0	244.4	258.2	272.3	287.3	302.0	314.3
Air Only Percentage Difference	.03	.17	.37	.66	1.05	1.50	2.00	2.54	3.07	3.75	4.73
Unemployment Rate											
Control	8.8	8.5	8.4	6.9	5.3	4.6	4.0	3.8	4.0	5.1	5.5
Air Only Percentage Difference	8.8	8.4	8.2	6.6	5.1	4.4	3.9	3.9	4.3	5.5	6.1
Personal Consumption Expenditures (75$)											
Control	931.9	956.0	1027.0	1091.4	1140.1	1165.5	1195.5	1219.0	1240.4	1260.6	1300.1
Air Only Percentage Difference	.04	.03	.02	-.01	-.12	-.30	-.51	-.86	-1.20	-1.54	-2.07
Residential Investment (75$)											
Control	41.9	55.4	59.1	69.9	63.7	57.9	59.1	55.6	47.7	50.6	54.1
Air Only Percentage Difference	-.04	-.17	-.35	-.44	-.59	-.69	-.80	-1.16	-1.94	-3.09	-4.51
Nonresidential Investment (75$)											
Control	149.4	153.0	175.8	191.2	206.0	224.4	252.4	278.0	302.0	310.6	338.8
Air Only Percentage Difference	1.95	2.80	3.47	3.75	1.96	.40	-.35	-1.22	-2.01	-2.93	-4.17

Source: NCWQ. From CONSAD Research Corporation, "Macroeconomic Impacts of P.L. 92-500", 1976.

at least in the electric utility industry, and is central to the debate over deregulation of natural gas. A more complex study of the capital markets, therefore, must be done in the context of the entire economy.

Such a study has recently been published by Allen Sinai and Roger Brinner of Data Resources, Inc. (6). The authors have provided a useful definition of a capital shortage; namely, "... an economy in which the financial system fails to provide the necessary flow-of-funds to finance the economy's expenditures at reasonably stable rates of interest or where capital expenditures are insufficient to generate enough capacity to meet the demands of the economy at reasonably stable prices." (6). Their study uses the DRI macroeconomic model of the U.S. economy, and examines the question of capital availability under two different scenarios: the first, "Control - Long 5/75" in which the economy gradually grows out of the current recession to full employment in about 1981; and second, "Accelerated Recovery 7/75" in which very aggressive fiscal and accommodative monetary policy is used to achieve near full-employment in 1978, resulting in a very unstable economy with frequent recessionary cycles beyond 1978.

Sinai and Brinner's conclusion is that "...no capital shortage will appear during the next five years if the economic recovery is moderately paced and marked by relatively stable monetary and fiscal policies. Beyond 1980, however, the outlook is more clouded." (6). That is, when the economy reaches full employment in 1981, the demands on resources build up so that the rate of inflation increases and pressures begin to appear on the capital markets.

DRI's "Accelerated Recovery 7/75" scenario represents somewhat of an extreme over-reaction of fiscal policy. A recent study for the Senate Budget Committee used the DRI model to simulate a more successful "accelerated recovery". Assuming a $20 billion cut in personal income taxes for calendar years 1976, 1977, and 1978, and a ten percent growth in the money supply, this study found that a stable, but more rapid, growth to full employment would be possible without unduly straining the economy or impairing capital markets.*

In light of these recent studies and the continuing concern over these issues, it is appropriate to examine the possible range of impacts upon the capital markets resulting from government mandated investments in water pollution control.

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* Working memorandum prepared for the Senate Budget Committee by Donald A. Nichols; September 11, 1975.

b. Capital Requirements of P.L. 92-500

The engineering and economic studies conducted by the Commission and presented elsewhere in this report have defined the investment and operating costs associated with the implementation of P.L. 92-500. A investment of $60-$200 billion is estimated for the period 1975-1985. Of this total, $40-$80 billion would be for industrial water pollution control equipment and $20-$120 billion would be for municipal sewers and water treatment systems.

These investments will amount to approximately 0.4 percent to 1.3 percent of total GNP, 1975-1985. The industrial investment of $40-$80 billion will represent about 1.9 percent to 3.8 percent of total non-residential fixed investment. The municipal investment of $20-$120 billion will amount to approximately 0.7 percent to 4.1 percent of total government purchases of goods and services.

Given estimated levels of investments of approximately $60-$200 billion, what will be the net amount of additional securities that will be brought to the capital markets? The answer depends upon government policy, the extent to which water pollution control costs are passed on to consumers in the form of higher prices, and the general state of the economy.

First, the Federal government's share of these investments will come out of general Federal receipts, so that Federal bonds will be issued only if pollution control expenditures affect overall fiscal policy. Thus, the water pollution control program will not necessarily be responsible for bringing any Federal government securities to the marketplace.

A study prepared for the Commission by Data Resources, Inc. estimates that approximately 75 percent of state and local share will be financed through the sale of tax-exempt bonds (7). The remainder will be financed directly through government receipts. Thus, if state and local governments assumed 25 percent of the total investment in municipal sewers and water treatment systems, and 75 percent of this 25 percent were financed through municipal bonds, the total amount of bonds brought to the marketplace would be $3.75 - $22.5 billion. ($20b to 120b x .75 x .25)* The Federal share of all eligible expenditures for sewer systems is increased under P.L. 92-500. Thus, the state and local share is not

* See Section III.E., Table III.E.5 and surrounding text.

simply 25 percent of the expenditures caused by P.L. 92-500. (State and local governments will pay a smaller percentage share of projects which would have taken place without P.L. 92-500.)

The net demand for funds would be somewhat less than this, however, for after the first year funds accumulate to retire the existing bonds. If the bonds are amortized over an average period of twenty years, an amount equal to approximately one-fourth of the total would have been accumulated. Thus, the net demand on the capital markets would be $2.8-$16.9 billion.

The DRI study cited above made the extreme assumption that 75 percent of the industrial investment expenditures would be financed through the bond markets. Of these, 50 percent would be financed by tax-exempt pollution control bonds. Thus, the gross value of securities issued by industry would be $30-$60 billion, with $15-$30 billion in the form of tax-exempt securities.

The net volume of funds required from the capital markets for industrial investment in water pollution control facilities will depend upon the extent to which pollution control costs are passed along to customers in the form of higher prices.

A realistic assumption is that prices will increase at least to cover depreciation and interest on the pollution control investments. This depreciation represents additional savings, with the only offset being less saving by consumers due to the increase in prices (the marginal saving rate from the disposable income of consumers being six to eight percent). In this case, assuming a ten year "pay back" period for corporate investments, the net demand on the capital markets would be about 43 percent less than the gross (50 percent less six to eight percent), or about $13-$26 billion.

The total net demand for funds from the capital markets to finance water pollution control investments, therefore, will amount to approximately $16-$43 billion. If total net funds raised for all purposes maintains its historical ratio to GNP (.15), the total funds raised in the financial markets over the next decade will be 3 trillion dollars. Thus, the high estimate of net funds raised for water pollution control would be 1.4 percent of this total. Year to year fluctuations in total funds raised are as large as 35 percent. These estimates assume no change in Federal fiscal policy, 75 percent bond financing with a 20 year amortization period for state and local governments, and 75 percent bond financing with a ten year pay back period for industry.

These estimates do not take into account the "third order" effects produced by the general economy's reaction to the increased taxes, prices, and expenditures associated with the pollution control investments.

Increased prices and taxes, for example, will reduce real income and personal savings, thus increasing the pressure on the capital markets; but will also lead to less growth in product demand, hence reducing other investments. These third order effects are best considered with the help of a complete macroeconomic model of the U.S. economy.

c. Two Econometric Studies

To assess the impact of water pollution control investments empirically, the Commission has taken two approaches: first, a study specifically of the impacts on interest rates has been performed by Data Resources, Inc. (DRI); and second, the Wharton Long Term Econometric Model has been used to examine the impacts on the entire economy.

The DRI study (7) looks specifically at the impacts of P.L. 92-500 upon the level of interest rates. An econometric model of the capital markets was developed and used to obtain forecasts of the changes in the general level of interest rates on corporate and municipal bonds which might be induced by the Act, and to test the sensitivity of these forecasts to the volume of expenditures and the proportion financed by government grants.

The econometric model of the capital markets developed by DRI is a relatively simple supply = demand model of two non-Federal long-term securities markets, one for taxable securities, and one for tax-exempt bonds. Taxable securities include mortgages and corporate and foreign bonds. Tax-exempt bonds include all municipal securities, pollution control bonds, etc. Investors are separated into two categories: households/commercial banks, and "other". The total amount of bonds to be purchased by each sector is entered into the system as an exogenous variable, but the desired proportion of the stock of tax-exempt securities to the stock of total bonds is computed as a function of the differences between the yields on tax-exempt and taxable bonds. The supply of tax-exempt securities brought to the market each quarter is basically a function of (1) total predicted new construction expenditures by state and local governments, and (2) of interest rates. The supply of taxable securities brought to the market each quarter is a function of (1) total gross private domestic fixed investment, and (2) of interest rates.

With this model DRI used forecasts of the exogenous variables obtained from their model of the U.S. economy, and estimates of water pollution control financing requirements of approximately $71.6 billion for industry and $19-$34 billion for the state and local portion of abatement expenditures. This is the share based on total public spending

for water pollution control not just the increase in spending due to P.L. 92-500. They also assume that 75 percent of both industrial and state and local expenditures would be borrowed, and that 50 percent of corporate borrowing would be in the form of tax-exempt pollution control bonds.

The DRI study found an average change in interest rates over the 1975-1983 period of 1.07 percentage points for tax-exempt securities and 0.56 percentage points for taxable securities assuming their lower estimates of municipal expenditures. The corresponding figures assuming the high level of municipal expenditures are 1.31 percentage points and 0.65 percentage points. Almost half of the increase in interest rates in the tax-exempt market is due to the use of tax-exempt pollution control bonds by industry (see Section d below).

The changes in interest rates are determined without consideration of the simultaneous developments within the rest of the economy. Hence, they do not allow for any compensating fiscal or monetary policy, nor do they take into account the decrease in investment demand created by higher prices or the increase in savings brought about by higher interest rates. Nor do they take into account the reduction in net demand resulting from amortization. Finally, they assume no flow of funds to or from foreign countries. In light of the above and DRI's high investment expenditure estimates, it is reasonable to conclude that the interest rate increases predicted by DRI represent a significant overestimate of impact of P.L. 92-500.

As a means of analyzing the impacts of P.L. 92-500 in the context of the entire economy, the Commission used the Wharton Long-Term Econometric Model to simulate the U.S. economy under a variety of assumptions (5). The results of this study have been summarized in Sections III.F.1-4 above. The effects upon investment are negative. However, the magnitudes are considerably smaller than other studies, particularly the DRI study summarized above, have suggested. Interest rates rise, but only 0.1 percentage points. Housing starts decline gradually, reaching an annual level about five percent below the baseline in 1985.

Water pollution control expenditures have a slight but increasingly negative impact on "productive" corporate investment in the Wharton results. Virtually all of this impact is due to the increased prices and subsequent reductions in demand in affected industries rather than through effects of increased interest rates or "capital shortages".

Interest rates in the Wharton Model are determined primarily by changes in the Federal Reserve discount rate. Since this remains constant, the Wharton scenarios assume that monetary policy is adjusted to accommodate the increased investment so that there is little pressure on interest

rates. The fact that an increase in money supply of less than one percent by 1985 is required to achieve this accommodation indicates that the financial impact of the pollution control investments is not large.

In summary, these empirical studies of water pollution control investments provide a range of possible impacts upon the capital markets. Under the most stringent assumptions interest rates increase 0.5 to 1.3 percentage points. When analyzed in the context of the entire economy with accommodating monetary policy, the potential increases are much smaller - approximately 0.1 percentage points. Critical to an understanding of these differences is a comment by Roger W. Strassburg, Ph.D., Director of Environmental Affairs for the B.F. Goodrich Company, who states in a communication to the Commission that "one of the most noteworthy omissions of the report (November draft) is its virtual silence on the question of whether capital expenditures for pollution control are made in addition to, instead of, or partly in addition to other ("baseline") capital expenditures"(11). In fact, the DRI results assume all financing to be "in addition to", whereas the Wharton analysis reflects the full range of complementary and substitute capital investments and associated reactions that will likely occur.

d. Industrial Pollution Control Bonds

The Revenue and Expenditure Control Act of 1968 severely curtailed the increasingly popular use of tax-exempt "municipal" bonds to finance corporate capital expenditures. However, such financing was not eliminated for a few special purposes, one of which was corporate pollution control expenditures. Thus, state and local government bodies were allowed to issue tax-exempt bonds, the proceeds of which would go toward the construction of pollution control facilities for local industry. The bonds, although tax-exempt, would be backed by the credit of the individual industrial corporations rather than the issuing governmental unit. For example, The Brazosport Facts of January 8, 1976, reports that the Brazos River Harbor Navigation District Board of Commissioners will consider authority to issue additional pollution control bonds pursuant to a lease-purchase agreement with Dow Chemical Company. $60 million of such bonds were issued in 1974 for this district and the Texas Water Quality Board has approved a list of $59 million in additional projects (3).

The use of tax-exempt bonds to finance industrial pollution control investment expenditures began in 1971. That year $86 million of pollution control bonds (PCB's) were issued. Because this financing vehicle enables private corporations to borrow at the lower interest rates that prevail for tax-exempt municipal bonds, PCB's have become increasingly popular. In 1974 the annual volume of PCB's had increased to $1.65

billion, accounting for approximately 7.8 percent of the total tax-exempt market. By the end of 1974 approximately $4.1 billion of PCB's had been issued. Table III.F.29 summarizes the statistics relating to the growth of the industrial pollution control bond market over the 1971-1974 period.

The increasing volume of PCB's has caused some concern about the effect of these bonds upon the capital markets, the relative efficiency of the subsidy that they provide, and hence, about the desirability of using these bonds as a financing vehicle for industrial pollution control investments. These questions have been investigated as a part of the DRI study mentioned above and are summarized in the following section.

Using their model of the tax-exempt and taxable bond markets, DRI simulated the impact of PCB's upon interest rates. The results, presented in Table III.F.30, indicate that the use of PCB's throughout the period resulted in tax-exempt yields being 0.3 percentage points higher and taxable bond yields 0.1 percentage points lower than they would have been during 1974 if industrial borrowing for pollution control had occurred in the taxable bond market. Thus, the use of PCB's induced a shift in income distribution from Federal and state-local governments (or taxpayers) to private borrowers and investors.

TABLE III.F.30: IMPACT OF POLLUTION CONTROL BONDS ON INTEREST RATES 1971-1974

Year	Volume of Pollution Control Bonds	Estimated Change in Interest Rates	
		Tax-Exempt Bonds	Taxable Bonds
1971	$0.1 billion (current dollars)	+.01%	-.01%
1972	0.5 billion	+.07%	-.02%
1973	1.8 billion	+.24%	-.07%
1974	1.6 billion	+.30%	-.10%

Source: NCWQ. From Data Resources, Inc., Financing P.L. 92-500- The Impact of the Federal Water Pollution Control Act of 1972 on the Municipal Bond Market. 1975.

TABLE III.F.29

Industrial Pollution Control Expenditures and Pollution Control Bonds
1971-1974

Year	Industrial Pollution Control Expenditures(1)(3)	Volume of Pollution Control Bonds(2)(3)	Pollution Control Borrowing Ratio	Gross Tax-Exempt Bonds Issued(2)(3)	Tax-Exempt Market Share of PCB's
1971	$ 2.9	$0.086	3%	$24.4	0.4%
1972	3.7	0.548	15%	22.9	2.2%
1973	4.9	1.796	37%	23.0	7.8%
1974	5.3	1.648	31%	22.7	7.0%
1971-1974	$16.8	$4.078	24%	$93.0	4.4%

(1) DRI estimates based upon McGraw-Hill Annual Surveys.

(2) From the Federal Reserve System's Flow-of-Funds accounts.

(3) Billions of current dollars.

Source: NCWQ. From Data Resources, Inc., "Financing P.L. 92-500-The Impact of the Federal Water Pollution Control Act of 1972 on the Municipal Bond Market", 1975.

These shifts in income distribution have been roughly quantified by DRI and are presented for the year 1974 in Table III.F.31. Using DRI's assumption, the shift in bond yields led to an estimated $95 million cost in 1974 for governments, with a $29.7 million loss in Federal tax revenues and a $65.4 million loss to state and local governments in the form of lost tax revenues and higher interest payments. This $95 million loss to the public sector, that is to taxpayers, resulted in equal income increases for the private sector. The main beneficiaries were private borrowers; who paid $123.3 million less interest. Of this $123 million interest savings about $76 million accrued to mortgage borrowers and the remaining $47 million to businesses. Private investors, however, were net losers, having sustained a $28.3 million loss in after-tax income. Although the rise in tax-exempt bond yields provided investors with an additional $63.3 million income, the decline in taxable yields cost investors in corporate securities $91.6 million in lost income.

In summary then, the use of tax-exempt PCB's created a shift in income from taxpayers and users of conventional municipal services to private borrowers while at the same time providing a benefit to investors in tax-exempt securities but reduced income for investors in taxable securities.

To test the impact of PCB's over the 1975-1983 period DRI perfomed the same simulation as was summarized in the preceding section assuming that no PCB's would be issued, as opposed to 50 percent PCB's for industrial borrowing. The results without PCB's show a much lower increase in interest rates for tax-exempt issues and an almost insignificant addition to the increase in interest rates for taxable securities. The average differentials were 0.59 - 0.84 percentage points for tax-exempt bonds as opposed to 1.07 - 1.31 percentage points with PCB's; and 0.58 - 0.67 percentage points for taxable securities as opposed to 0.56 - 0.65 percentage points with PCB's.

Performing a series of calculations similar to those in Table III.F.31, DRI used three interest rate changes with and without PCB's to determine the net impact of PCB's on the private and public sectors over the 1975-1983 period. The results, using the low level of municipal water pollution control expenditures, indicate that the use of PCB's would cost the public sector approximately $12.8 billion over the period and provide a corresponding subsidy to the private sector. Federal income taxes are reduced by $2.98 billion and state and local income taxes by $0.19 billion. State and local interest payments are increased by $9.65 billion. The gain to the private sector is not made up so much by reduced interest payments on PCB's, which amount to only $3.25 billion, as by a net increase of $9.57 billion in investor income from the higher municipal interest rates. Thus, industrial establishments which invest

TABLE III.F.31
Effect of Pollution Control Bonds on Annual Expenditures and Receipts of Public and Private Sectors Arising from Gross Bond Issues in 1974

Public Sector		
Federal Government		
Decline in Investor Tax Payments	-$84.1	
Increase in Borrower Tax Payments	+ 54.4	
Net Loss to Federal Government		-29.7
State and Local Government		
Increase in Interest Paid on Tax-Exempt Bonds	- 63.3	
Decline in Investor Tax Payments	- 5.6	
Increase in Borrower Tax Payments	3.6	
Net Loss to State & Local Governments		-65.3
Total Loss to Public Sector		-95.0
Private Sector		
Reduction in Private Interest Payments	+123.3	
Increase in Investor Income From Tax-Exempt Bonds	+ 63.3	
Loss in Investor Income from Private Taxable Bonds	- 91.6	
Net Gain To Private Sector		+95.0

Assumptions: Marginal Federal income tax rate = 30%
Marginal State and Local income tax rate = 2%
Volume of private borrowing = $45,000 million
Volume of tax-exempt bonds without PCB's = $21,000 million
Volume of PCB's = $1,600 million.
Taxable bond yields: without PCb's = 8.5%; with PCB's = 8.46%
Tax-exempt bond yilds: without PCB's = 5.89%; with PCB's = 6.19%

Source: NCWQ. From Data Resources, Inc., "Financing P.L. 92-500- The Impact of the Federal Water Pollution Control Act of 1972 on the Municipal Bond Market", 1975.

in pollution control receive a $3 1/4 billion subsidy over the period, but at a cost of approximately four times that amount to the public sector.

Even considering the hypothetical nature of these simulations, the study is useful in pointing out the possible magnitude and direction of the income distributions produced by PCB's. Over the 1975-1984 period, private investors in pollution control equipment receive a significant subsidy, but the cost to the public sector is much greater.

e. Microeconomic Problems

Economic analysis which is directed at the level of the entire economy often overlooks problems which might arise at more localized levels. For example, small business has problems in raising capital in times of higher interest rates. This problem has already been recognized by Congress, which has provided in the Water Pollution Control Act of 1972 for special Small Business Administration loans for pollution control expenditures.

Although the amount of investment for water pollution control is relatively low when placed in the context of the whole economy, it is very high for some industrial sectors. The capital expenditures of eight industries - chemicals, steam electric power, iron and steel, pulp and paper, mining, petroleum refining, metal finishing, and machinery and mechanical products - constitute over 90 percent of the total industrial water pollution abatement capital expenditures. Although theoretically the capital markets should allocate funds to any industry with sufficient profit potential, the inefficiencies and lags in the system might create short-term financing problems for those industries with particularly large water pollution control investment requirements. Individual companies with particularly weak balance sheets may find that they cannot raise sufficient funds to meet all of their investment goals. Whether this will actually be the case will depend both upon the general health of the economy and upon the financial conditions of individual corporations. Because the dimensions, or even the likely occurrence, of such financial constraints cannot be determined without a careful examination of the individual corporations' balance sheets and investment plans, we can only comment on the possibility of these localized problems. In general, current economic projections imply that such financing problems will not occur on a large scale.

f. Conference on Capital Markets and Water Quality Needs

In June 1975 the Commission and The Conference Board jointly sponsored a conference of business, governmental and academic representatives to discuss the capital markets impacts of P.L. 92-500. A

summary and partial transcript of this conference has been published by The Conference Board (4). The participants of the conference were in fairly general agreement on four major points: (1) that the perceived need for capital investment over the next decade may be larger than it has been in the past relative to the expected supply of saving; (2) that this need is unlikely to be fully met if the present economic environment persists and if public policy toward capital markets does not change; (3) that the investment needs can be more easily met if the water pollution abatement expenditures are financed at the expense of consumption or other government programs rather than savings, and (4) that the use of tax-exempt Pollution Control Bonds to finance industrial pollution control was a very inefficient means of subsidization.

There was less general agreement over (5) the kinds of policies which should be pursued in order to increase savings; (6) the extent to which water quality needs can be met by employing idle resources rather than displacing other expenditures, and (7) what are likely to be the impacts on the financial markets and investment if water pollution control expenditures are met without any policy changes.

Business leaders, in particular, expressed concern over the financial problems of the American economy and argued that pollution abatement requirements will divert capital from capacity modernization and expansion, causing shortages and greater inflation. They suggested policy changes including the reduction in the 1983 BAT requirements for industry and various tax measures intended to redistribute income toward corporations and stockholders.

Some participants suggested that pollution control expenditures could serve as a countercyclical economic policy tool during recessions by stimulating employment and production. It was also argued that some forecasts of capital needs were overestimated because effects such as that of higher energy prices reducing energy demands were not being accounted for. One economist suggested that full employment and growth could be maintained with lower than forecasted investment if technology were slightly less capital-intensive.

As an exercise, Conference attendees, without prior notice, were split into groups to discuss the potential impacts of $100, $200, and $300 billion water pollution expenditure levels. From these four discussion groups and the reports of the group leader, a Conference Board editor has taken the final step of preparing a grand summary. This statement concludes that the $100 billion expenditure level would be accommodated, but with some difficulty and disruption. This disruption would occur mostly in the tax-exempt market, due mostly to its historically low level of utilization. Capacity growth problems in steam electric power generation and energy extraction and production industries, areas of

major concern without the additional burden of pollution control expenditures would be exacerbated. Impacts at $200 and $300 billion levels would obviously be more extensive. No formal consideration of external factors throughout the economy, such as the role of prices and profits, extra-national money flows and national monetary and fiscal policy, were included in these discussions. Discussion of impacts upon the tax-exempt bond market led once again to the conclusion that this served to highlight the many weaknesses of that market and the near unanimous conclusion that this mechanism should be eliminated. It should be noted that the severe disruptions associated with $100 and $200 billion levels of abatement refer to the tax-exempt market primarily. The disruptions take the form of removing the differential between taxables and tax-exempts. While this disruption would be viewed as a negative by those who are pro tax-exempts it would be viewed as a positive by the majority who were anti tax-exempts as this disruption would virtually eliminate that market.

6. Point Source Pollution Abatement

a. Introduction

One nagging, fundamental question that has plagued analysis and policy-makers alike is the role of the passage of time and the dynamic forces of economics upon the progress of pollution control efforts. Most studies of the impacts of these efforts are found in a totally static framework, using data sets from specific past-time periods. Thus, all data on costs, industry, environmental and regional are essentially 1973 based with most analysis based upon "what-if" exercises wherein these data sets are altered by the imposition of the relevant quantifications of parameters directly relating to the implementation of P.L. 92-500. Only in the economic analysis, particularly marcoeconomic, is emphasis placed upon capturing the dynamics of activities throughout the study period. Thus, we are not just super-imposing a 1983 BAT related set of statistics upon another set from 1973- we are actually attempting to depict the year 1983 and the relevant economic activities with and without the Act leading up to that period.

While the economic dimensions of that analysis are reported above, one additional set of information has not been reported -- the generation and control of selected residuals throughout this time period. Furthermore, it is also possible to link these dynamic adjustments to the important matter of energy use. Using these same general techniques it is possible to derive estimates of changing energy use patterns throughout the compliance period.

To conduct this analysis the Commission cooperated with the Environmental Protection Agency in the development of the Strategic Environmental Assessment System (SEAS). SEAS is a system of integrated computer modules

designed to make detailed forecasts of pollution levels, energy use and abatement costs. The forecasts are based upon economic projections of the INFORUM 185 Sector input-output model developed by Clopper Almon of the University of Maryland (1). The industrial output projections of INFORUM were further disaggregated and refined in SEAS focusing on those industries where particular products and technologies are associated with air and water pollution. The Commission's industry studies were the primary source of information on water pollution ("residual generation") and abatement cost by industry subcategory. EPA effluent guidelines were used as the basis of BPT and BAT removal efficiencies by subcategory.*

Subcategories defined by product and technology have distinct coefficients of residual generation (unit of residual/unit of economic output) and abatement requirements. Since the rates of growth of output vary substantially between subcategories, growth projections of total residuals generated are considerably refined by the disaggregated approach.

The following presentes the results of the SEAS projections at both the national and industry level. The estimates of residuals discharged by publicly owned treatment works are based upon Commission studies and SEAS.

b. Summary

It is axiomatic that environmental pollution tends to increase with economic growth. Thus, increasing stringent controls are necessary in many areas simply to prevent increased pollution. Over the 1971-1985 period the annual growth rates for industrial discharge of four categories of water pollutants in the absence of the Act are projected as:

TABLE III.F.32: PROJECTED GROWTH RATES, INDUSTRIAL POLLUTION BASELINE 1971-1985

	Average Annual Growth Rates 1971-1985
Biochemical Oxygen Demand	3.6%
Suspended Solids	2.5%
Chemical Oxygen Demand	3.2%
Dissolved Solids	0%

Source: NCWQ. From U.S. Environmental Protection Agency, Strategic Environmental Assessment System (SEAS). 1975. (Based upon an average 3.5% annual growth in GNP.)

* Resultant estimates of residuals generation should not be read for their precise accuracy but rather for their indication of general, relative magnitudes.

At these growth rates, industrial discharges would double every 19 years for BOD, 28 years for Suspended Solids, and 22 years for COD.

A summary of the projections of industrial pollution levels is presented in Table III.F.33. Levels for BOD, SS, COD, and DS are shown for 1977 and 1985 given different assumptions of compliance with BPT and BAT standards. Baseline projections are based on the assumption of no improvement in abatement practices after 1971. The lower half of the table presents the discharge levels in terms of an index where 1971 level = 100 for each category of residual. Discharge levels in 1977 range from 21% - 97% of the 1971 levels given compliance with BPT and 79% -102% given a delayed compliance (BPT by 1980). Discharge levels in 1985 range from 5% - 62% of 1971 levels given compliance with BAT in 1983 and 20% - 83% of 1971 levels given no compliance with BAT (and delayed BPT compliance).

Table III.F.34 presents the comparison of BOD and SS levels for public facilities and industry. Comparing the reductions in public versus industrial discharges in 1985, a rough measure of the relative importance of private and public abatement under P.L. 92-500 can be made.

TABLE III.F.34: PROJECTIONS OF POLLUTION LEVELS: INDUSTRY AND PUBLIC
(Annual Levels-Million Tons)

		1985		
	1971	Baseline	Compliance with P.L. 92-500[a]	Reduced Discharge
BOD				
Industrial	2.27	3.70	.54	3.16
Municipal	1.70	1.73	.51	1.22
SS				
Industrial	7.70	10.80	.44	10.36
Municipal	1.54	1.59	.53	1.06
DS				
Industrial	11.77	11.90	7.26	4.64
Municipal	9.14	12.53	11.82	.71

a. Scenarios #1, 2, 3 and 5 for industrial, Scenario #5 for municipal

Source: NCWQ. From U.S. Environmental Protection Agency, Strategic Environmental Assessment System (SEAS). 1975.

TABLE III.F.33: PROJECTIONS OF INDUSTRIAL POLLUTION, 1971 and 1985

		1977			1985		
	Level in* 1971	Baseline	BPT-1977[1]	BPT-1980[2]	Baseline	BAT-1983[3]	BPT-1980[4] No BAT
BOD	2.27	3.00	.94	1.98	3.70	.55	1.00
SS	7.70	9.55	1.69	6.08	10.80	.44	1.62
COD	3.68	4.89	2.57	3.73	5.73	1.54	2.67
DS	11.77	12.56	11.41	11.99	11.89	7.25	9.81
BOD	100**	132	41	87	163	24	44
SS	100	124	21	79	140	5	20
COD	100	132	70	101	156	42	73
DS	100	107	97	102	101	62	83

* Annual Level-Millions Tons

** Index: 1971 level = 100

Note: Baseline assumes 1971 treatment levels for all plants. All other scenarios assume New Source Performance Standards are met for all new plants.

1 Scenarios number 1, 3 and 5.
2 Scenarios number 2, and 4.
3 Scenarios number 1, 2, 3 and 5.
4 Scenario number 4.

Source: NCWQ. From U.S. Environmental Protection Agency, Strategic Environmental Assessment System (SEAS), 1975.

Estimated reductions in discharges in 1985 due to P.L. 92-500 are significantly greater for industrial than for public facilities. Industrial reductions of Biochemical Oxygen Demand are 2.6 times public reductions; Suspended Solids 9.8 times public, and Dissolved Solids 6.5 times public. This greater cost effectiveness in reducing industrial discharge is probably due to economies of scale since the average public treatment system is smaller than the average industrial one. There are also more technological options open to the average industrial discharger. Remaining levels of discharge projected for 1985 are remarkably similar for industry and public sources.

c. Baseline Description

The starting point for our analysis is a baseline run in which we postulate a future in which P.L. 92-500 does not exist; that the removal efficiency of each pollutant in each industry subcategory through the entire forecast stays constant at base year 1971 value. The levels of discharge of any pollutant in any sector is simply the difference between gross levels and amounts removed. Gross levels are derived by multiplying a "gross" coefficient expressed as tons of pollutant per unit of output times the relevant output levels. The amount removed is the removal efficiency (say, 90 percent) times gross level. Fixing removal efficiencies at their 1971 level thus has the effect of gradually increasing the forecast level of all pollutants over time since output levels generally increase over time. However, the growth rate will vary across pollutants because of differential growth across industries.

Table III.F.35 was compiled to give some idea of the scope and coverage of the RESGEN module.* Only point sources of pollution are considered. The forecasts are made at the subcategory level. These subsectors were grouped to the NCWQ industry level.

For each pollutant the table notes the industries for which pollution coefficients are specified. As indicated in the table, for several industries no pollutant data are available in SEAS at the present time. This was due partly to lack of necessary background information in the Commission and EPA documents. In most cases, these industries are judged to be minor sources of the pollutants being covered. In two cases, however, the level of pollutants involved are likely to be significant. These are the mining (both ore and coal) and the machinery and mechanical products industries. This is reflected in the associated cost levels for these industries as well.

* RESGEN is the Residuals Generation Model in SEAS.

TABLE III.F.35: RESIDUAL GENERATION MODULE AT NCWQ LEVEL*

Indepth:	BOD	COD	Suspended Solids	Dissolved Solids	Nutrients	Oil and Greases	Bases	Acids
Fruits and Vegetables	X		X	X				
Chemicals	X	X	X	X	X	X	X	X
Iron and Steel	X		X	X	X	X	X	
Metals Finishing - Job				X	X			X
Petroleum Refining	X	X	X			X		
Plastics (included in Chemicals)								
Pulp and Paper	X		X					
Steam Electric			X	X				
Textiles	X	X	X	X		X		
General:								
Ore Mining	No Data Specified							
Coal Mining	No Data Specified							
Petroleum & Gas Extraction						X		
Mineral Mining	No Data Specified							
Meat Products	X	X	X			X		
Dairy Products	X		X					
Grain Mills	X		X					
Cane Sugar	X		X					
Beet Sugar	X		X					
Canned and Preserved Seafood	X		X			X	X	
Misc. Foods and Beverages	X		X					
Timber Products	No Data Specified							
Furniture and Fixtures	No Data Specified							
Builder's Paper (included in Pulp and Paper)								
Paint and Ink	No Data Specified							
Soap and Detergents	X	X	X			X		

*Industries for which particular pollution coefficients are specified (for at least one subcategory) are indicated by an X. COD data is incomplete.

TABLE III.F.35 (continued)

General:	BOD	COD	Suspended Solids	Dissolved Solids	Nutrients	Oil and Greases	Bases	Acids
Phosphate Manufactures	(included in Chemicals)							
Fertilizer Manufactures	No Data Specified							
Paving and Roofing			X					
Rubber	X		X	X		X		
Leather	X		X	X	X	X		
Glass	X	X	X	X		X		
Cement			X	X			X	
Concrete	(included in Cement)							
Asbestos	X	X	X	X			X	
Insulation Fiberglass (included in Glass)								
Ferroally (included in Iron and Steel)								
Nonferrous Metals		X	X	X		X	X	
Machinery and Mechanical Products	No Data Specified							
Transportation	No Data Specified							
Water Supply	No Data Specified							
Auto and other Laundries	No Data Specified							
Foundries (included in Iron and Steel)								
Structural Clay	No Data Specified							
Pottery	No Data Specified							
Nonferrous Mills	(included in Nonferrous Metals)							
Feedlots	X	X	X		X			
Others:								
Forestry and Fisheries	X	X	X			X		

Source: NCWQ. From U.S. Environmental Protection Agency, Strategic Environmental Assessment System (SEAS), 1975.

Relevant data from the baseline scenario is given in Table III.F.36. The table lists, for each pollutant, the amount of pollutant in tons for each industry, together with each industry's share of the national totals for 1977 and 1985. An analysis of this table indicates that a few industries account for a major share of the total discharge for any given pollutant. Table III.F.37 emphasizes this fact for four of the pollutants concerned: Biochemical Oxygen Demand, Chemical Oxygen Demand, Suspended Solids, and Dissolved Solids. The relative share of each industry in the overall picture does not change significantly from 1977 to 1985, indicating that the effect of differential growth of sectors has a negligible effect on the importance of individual industries as dischargers.*

d. Scenario Analysis

The major results for Scenario 1 in which BPT and BAT standards are assumed met on schedule are given in Table III.F.38. This table presents impacts on levels of four pollutants: Biological Oxygen Demand, Chemical Oxygen Demand, Suspended Solids, and Dissolved Solids. Four sets of statistics are presented for each pollutant for 1977 and 1985. They are, in order of column:

- o The level, in tons, of each pollutant for each industry.**
- o The share of each industry in the total discharge of each pollutant that remains after compliance.
- o For each industry, the difference (in percentage terms) in the level of each pollutant between the baseline and compliance scenarios.
- o For each industry, its relative share of the total reduction in discharge of each pollutant at the national level.

The industries that are the largest dischargers of these pollutants in the baseline are generally the most important in contributing to the overall reduction in levels below baseline. For example, five

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* New Source Performance Standards equal to BAT requirements are assumed for all new plants in all cases other than the baseline, and tend to offset the effects of the growth factor.

** The numbers in this and other scenarios have been rounded to thousands of tons.

TABLE III.F.36: FORECASTS OF POLLUTANT LEVELS BY NCWQ INDUSTRY GROUP (1977 and 1985) FOR BASELINE SCENARIO*

	BOD				COD				Suspended Solids				Dissolved Solids			
	1977		1985		1977		1985		1977		1985		1977		1985	
Indepth:	Tons	% of Total	Tons	% of Total	Tons	% of Total	Tons	% of Total	Tons	% of Total	Tons	% of Total	Tons	% of Total	Tons	% of Total
Fruits and Vegetables	51,000	1.7	67,000	1.8	0		0		70,000	.7	91,000	.8	0		10,132,000	-
Chemicals	777,000	26.0	951,000	25.7	1,967,000	40.5	2,389,000	41.8	353,000	3.7	384,000	3.6	9,932,000	79.1	0	85.2
Iron and Steel	35,000	1.2	28,000	.8	0		0		1,777,000	18.6	1,782,000	16.5	0	1.2	199,000	
Metals Finishing (Job)	0		0		0		0		0		0		163,000		0	1.7
Petroleum Refining	24,000	.8	30,000	.8	107,000	2.2	136,000	2.4	11,000	-	13,000	-	0		0	
Pulp and Paper	1,154,000	38.4	1,500,000	40.6	0		0		1,099,000	11.5	1,596,000	14.8	0		0	
Steam Electric	0		0		0		0		68,000	.7	40,000	-	2,260,000	18.0	1,334,000	11.2
Textiles	210,000	7.0	255,000	6.9	1,126,000	23.2	1,374,000	24.0	247,000	2.6	0		0		0	
General:																
Petroleum and Gas Extraction	0		0		0		0		0		0		0		0	
Meat Products	206,000	6.9	258,000	7.0	78,000	1.6	95,000	1.7	121,000	1.3	151,000	1.4	0		0	
Dairy Products	20,000	.7	23,000	.6	0		0		5,000	-	6,000	-	0		0	
Grain Mills	17,000	.6	21,000	.6	0		0		12,000	-	15,000	-	0		0	
Sugar	46,000	1.5	54,000	1.5	0		0		180,000	1.9	211,000	2.0	0		0	
Canned and Preserved Seafood	34,000	1.1	45,000	1.2	0		0		26,000	-	34,000	-	0		0	
Miscellaneous Food and Beverage	20,000	.7	22,000	.6	0		0		8,000	-	9,000	-	0		0	
Paving and Roofing	0		0		0		0		2,260,000	23.7	2,347,000	21.7	0		0	
Rubber	5,000	-	5,000	-	0		0		12,000	-	14,000	-	0		0	
Leather	26,000	.9	23,000	.6	0		0		49,000	.5	42,000	-	0		0	
Glass	4,000	-	4,000	-	51,000	1.0	59,000	1.0	4,000	-	4,000	-	11,000	-	13,000	-
Cement	0		0		0		0		38,000	-	45,000	-	84,000	.7	98,000	.8
Asbestos	0		0		0		0		0		0		1,000	-	1,000	-
Nonferrous Metals	0		0		0		0		2,425,000	25.4	2,857,000	26.4	99,000	-	117,000	1.0
Feedlots	151,000	5	176,000	4.8	522,000	10.7	608,000	10.6	367,000	3.8	427,000	4.0	0			
Other:																
Forestry and Fishery Products	223,000	7.4	233,000	6.3	1,010,000	20.8	1,055,000	18.5	415,000	4.3	433,000	4.0	0		0	
Total	3,004,000	100.0	3,696,000	100.0	4,861,000	100.0	5,718,000	100.0	9,546,000	100.0	10,804,000	100.0	12,556,000	100	11,895,000	100

* - = <.5 percent Number of tons have been rounded to nearest thousand and elements may not add to totals because of rounding. COD data is incomplete.

* Chemical Oxygen Demand is incomplete. See text.

Source: NCWQ. From U.S. Environmental Protection Agency, Strategic Environmental Assessment System (SEAS), 1975.

TABLE III.F.37: LIST OF MAJOR INDUSTRY SOURCE BY POLLUTANT CATEGORY, 1985, BASELINE

Biochemical Oxygen Demand

Rank	Industry	% of Total
1	Pulp and Paper	40.6
2	Chemicals	25.7
3	Meat Products	7.0
4	Textiles	6.9
5	Forestry and Fishery Products	6.3
		86.5%

Suspended Solids

Rank	Industry	% of Total
1	Nonferrous Metals	26.4
2	Paving and Roofing	21.7
3	Iron and Steel	16.5
4	Pulp and Paper	14.8
5	Forestry & Fishery Products	4.0
		83.4%

Chemical Oxygen Demand

Rank	Industry	% of Total
1	Chemicals	41.8
2	Textiles	24.0
3	Forestry and Fishery Products	18.5
4	Feedlots	10.6
5	Petroleum Refining	2.4
		97.3%

Dissolved Solids

Rank		
1	Chemicals	85.2
2	Steam Electric	11.2
3	Metals Finishing (Job)	1.7
		98.1%

Source: NCWQ. From U.S.Environmental Protection Agency, Strategic Environmental Assessment System (SEAS), L975.

TABLE III.F.38: FORECAST OF POLLUTANT LEVELS FOR 1977 and 1985

1. Biochemical Oxygen Demand Indepth:	1977					1985			
	Net Tons	Percent of Total	Percent Below Baseline	Percent of Total Reduction		Net Tons	Percent of Total	Percent Below Baseline	Percent of Total Reduction
Fruits and Vegetables	32,000	3.4	38.0	.9		30,000	5.6	54.8	1.2
Chemicals	182,000	19.4	76.6	28.8		54,000	9.8	94.4	28.5
Iron and Steel	5,000	.5	85.0	1.4		2,000	-	91.5	.8
Metals Finishing (Job)	0	-	-	-		0			
Petroleum Refineries	17,000	1.8	29.1	-		5,000	.9	83.6	.8
Pulp and Paper	334,000	35.6	71.1	39.7		165,000	30.2	89.0	42.4
Steam Electric	0	-	-	-		0			
Textiles	54,000	5.7	74.5	7.6		41,000	7.6	83.4	6.8
General:									
Petroleum and Gas Extraction									
Meat Products	15,000	1.6	92.8	9.3		7,000	1.4	97.1	7.9
Dairy Products	4,000	-	80.4	.8		2,000	-	93.1	.7
Grain Mills	8,000	.9	51.8	-		4,000	.8	80.4	.5
Sugar	41,000	4.4	11.8	-		0	-	99.1	1.7
Canned and Preserved Seafood	27,000	2.9	20.5	-		15,000	2.7	67.4	1.0
Miscellaneous Food and Beverage	10,000	1.0	49.8	.5		6,000	1.0	74.9	.5
Paving and Roofing									
Rubber	1,000	-	86.3	-		1,000	-	86.5	-
Leather	4,000	-	86.7	1.1		1,000	-	95.4	.7
Glass	1,000	-	81.5	-		1,000	-	82.3	-
Cement									
Asbestos	0		-	-		0.0			
NonFerrous Metals	0								
Feedlots	0	-	100.0	7.3		0.0	-	100.0	5.6
Other:									
Forestry and Fisheries	204,000	21.8	8.3	.9		212,000	38.8	9.0	.7
Total	937,000	100.0		100.0		545,000	100.0		100.0

* Note : - = <.5 percent COD data is incomplete.

TABLE III.F.38: Continued

2. Chemical Oxygen Demand*	1977					1985			
Indepth:	Net Tons	Percent of Total	Percent Below Baseline	Percent of Total Reduction		Net Tons	Percent of Total	Percent Below Baseline	Percent of Total Reduction
Fruits and Vegetables	0								
Chemicals	1,120,000	43.5	43.1	37.1		419,000	27.3	82.5	47.1
Iron and Steel	0								
Metal Finishing (Job)	0								
Petroleum Refineries	102,000	4.0	4.8	-		26,000	1.7	80.9	2.6
Pulp and Paper	0								
Steam Electric	0								
Textiles	481,000	18.7	57.3	28.2		192,000	12.5	86.0	28.3
General:									
Meat Products	7,000	-	91.4	3.0		5,000	-	95.2	2.2
Dairy Products	0					0			
Grain Mills	0					0			
Sugar	0					0			
Canned and Preserved Seafood	0					0			
Miscellaneous Food and Beverage	0					0			
Paving and Roofing	0					0			
Rubber	0					0			
Leather	0								
Glass	1,000	-	98.6	2.2		1,000			1.4
Cement	0					0			
Asbestos	0					0			
Nonferrous Metals	0			-		0			
Feedlots	0		100.0	22.8		0		100.0	14.5
Others:									
Forestry and Fisheries	863,000	33.5	14.5	6.4		895,000	58.2	15.2	3.8
Total	2,574,000	100.0		100.0		1,537,000	100.0		100.0

*Note: Chemical Oxygen Demand is incomplete. See text.

TABLE III.F.38 Continued

3. Suspended Solids	1977				1985			
Indepth:	Net Tons	Percent of Total	Percent Below Baseline	Percent of Total Reduction	Net Tons	Percent of Total	Percent Below Baseline	Percent of Total Reduction
Fruits and Vegetables	34,000	2.0	51.3	.5	18,000	4.2	80.0	.8
Chemicals	121,000	7.2	65.7	2.9	70,000	16.2	81.8	3.0
Iron and Steel	313,000	18.6	82.4	18.6	26,000	6.0	98.5	16.9
Metal Finishing	0				0			
Petroleum Refineries	10,000	.6	3.9	-	5,000	1.1	63.2	-
Pulp and Paper	595,000	35.3	45.8	6.4	195,000	45.0	87.8	13.5
Steam Electric	49,000	2.9	28.9	-	0		100.0	-
Textiles	129,000	7.6	47.8	1.5	28,000	6.5	90.7	2.6
General:								
Meat Products	20,000	1.2	83.6	1.3	1,000	-	99.5	1.4
Dairy Products	1,000	-	77.2	-	0		94.4	-
Grain Mills	8,000	.5	31.9	-	2,000	-	85.4	-
Sugar	2,000	-	99.1	2.3	1,000	-	99.6	2.0
Canned and Preserved Seafood	16,000	1.0	37.4	-	8,000	2.0	75.2	-
Miscellaneous Food and Berverage	5,000	-	37.2	-	5,000	1.0	49.8	-
Paving and Roofing	0		100.0	28.8	0	-	100.0	22.6
Rubber	2,000	-	82.2	-	3,000	.6	82.6	-
Leather	9,000	.5	82.4	.5	1,000	-	97.3	-
Glass	2,000	-	85.1	-	0		95.2	-
Cement	24,000	1.4	36.9	-	0		100.0	-
Asbestos	0		56.8	-	0			
Nonferrous Metals	7,000	-	99.7	30.8	1,000	-	99.9	27.5
Feedlots	0		100.0	4.7	0		100.0	4.1
Others:								
Forestry and Fisheries	340,000	20.1	18.1	1.0	69,000	15.9	84.1	3.5
Total	1,687,000	100.0		100.0	433,000	100.0		100.0

TABLE III.F.38 Continued

4. Dissolved Solids	1977					1985			
Indepth:	Net Tons	Percent of Total	Percent Below Baseline	Percent of Total Reduction		Net Tons	Percent of Total	Percent Below Baseline	Percent of Total Reduction
Fruits and Vegetables	0					0			
Chemicals	8,969,000	78.6	9.7	84.3		5,762,000	79.5	43.1	91.3
Iron and Steel	0		95.9	-		0		96.2	-
Metal Finishing	85,000	.7	48.1	6.5		0		100.0	4.2
Petroleum Refineries	0					0			
Pulp and Paper	0					0			
Steam Electric	2,294,000	20.1	1.5	a		1,482,000	20.5	11.1	a
Textiles	0					0			
General:									
Meat Products	0					0			
Dairy Products	0					0			
Grain Mills	0					0			
Sugar	0					0			
Canned and Preserved Seafood	0					0			
Miscellaneous Food and Beverage	0					0			
Paving and Roofing	0					0			
Rubber	0					0			
Leather	0					0			
Glass	0		100.0	1.0		0		100.0	-
Cement	63,000	.6	24.7	1.4		0		100.0	2.0
Asbestos	1,000	-	8.3	a		0		100.0	a
Nonferrous Metals	0		100.0	8.2		0		100.0	2.4
Feedlots									
Others:									
Forestry and Fisheries									
Total	11,413,000	100.0		100.0		7,244,000	100.0		100.0

Note: a = These industries were not included in the calculations for this column because of increases in the pollutant levels above baseline in 1977.

Source: NCWQ. From U.S. Environmental Protection Agency, Strategic Environmental Assessment System (SEAS), 1975.

industries (pulp and paper, chemicals, meat products, textiles, and feedlots) account for over 90 percent of the reduction in levels of discharge. Of these, four also appear in Table III.F.37 which had listed the major dischargers of BOD. The same result is observed for COD and Suspended Solids and to a lesser extent for Dissolved Solids.

The industries that would be the most important dischargers in the absence of P.L. 92-500 continue to contribute a significant portion of the pollution that remains after compliance (Table III.F.39). However, the ranking of industries and their relative importance change. For example, for BOD the industries that will be the heaviest dischargers are the same ones as in Table III.F.37 with one exception; fruits and vegetables increases in relative importance). The ranking and relative shares change.

For suspended solids, the relative importance of industries between the baseline and compliance scenarios changes very significantly. The two largest polluters, the nonferrous metals and paving industries, remove close to 100 percent of suspended solids in their waste load and no longer contribute significant amounts of this pollutant. The chemicals industry enters the list of significant polluters however. For dissolved solids, the importance of industry groups is stable with the chemicals and steam electric power industries contributing almost all of the pollution.

It is interesting to ascertain whether the estimates of costs for these industry groups bear any relationship to their effectiveness in reducing national levels of the major pollutants. An attempt at analysis along these lines is presented in Table III.F.40, where the industries are ranked in terms of (1) their contribution to the total reduction for the four pollutants and (2) total capital costs.

The largest capital costs are concentrated in the in-depth industry categories. These industries also have a major share of pollutants discharged. However, particular industries within the "general" industry group tend to make significant contributions to reducing the load in specific pollutant categories. For example, the nonferrous metals category is important in reducing discharge of suspended solids and dissolved solids but, at eighteenth, is low in rank in terms of capital cost. Likewise, the paving industry and the feedlots industry make significant contributions at a relatively modest share of overall cost, the former for suspended solids, and the latter for both BOD and COD.

Beyond 1983 the total national discharge of these pollutants is likely to increase if abatement remains at BAT levels. This is simply because economic growth will encroach upon the improvements unless increasingly stringent standards are imposed or unless rapid improvements

TABLE III.F.39: MAJOR DISCHARGERS AFTER COMPLIANCE (SCENARIO 1) 1985

Biochemical Oxygen Demand

Rank	Industry	% of Total
1	Forestry and Fishery Products	38.8
2	Pulp and Paper	30.2
3	Chemicals	9.8
4	Textiles	7.6
5	Fruits and Vegetables	5.6
		92.0%

Chemical Oxygen Demand

Rank	Industry	% of Total
1	Forestry and Fishery Products	58.2
2	Chemicals	27.3
3	Textiles	12.5
4	Petroleum	1.7
5	Meat Products	.3
		100.0%

Suspended Solids

Rank	Industry	% of Total
1	Pulp and Paper	45.0
2	Chemicals	16.2
3	Forestry and Fishery Products	15.8
4	Textiles	6.5
5	Fruits and Vegetables	4.2
		87.8%

Dissolved Solids

Rank	Industry	% of Total
1	Chemicals	79.5
2	Steam Electric	20.5
		100.0%

Source: NCWQ. From U.S. Environmental Protection Agency, Strategic Environmental Assessment System (SEAS), 1975.

TABLE III.F.40: RANKING OF INDUSTRIES BY ANNUAL COST AND CONTRIBUTIONS TO TOTAL REDUCTION IN NATIONAL DISCHARGES (1985)

Indepth	BOD (Rank)	COD (Rank)	Suspended Solids (Rank)	Dissolved Solids (Rank)	Cost-Capital (Rank)	Capital Cost (Million $)
Fruits & Vegetables	-	-	-	-	14	263
Chemicals	2	1	6	1	1	9497
Iron & Steel	9	-	3	-	4	2636
Metals Finishing(Job)	-	-	-	2	5	2495
Petroleum Refining	9	5	-	-	6	2013
Pulp & Paper	1	-	4	-	3	2945
Steam Electric	-	-	-	-	2	5364
Textiles	4	2	7	-	9	661
General						
Petroleum & Gas Extrac.	-	-	-	-	7	1304
Meat Products	3	6	-	-	11	346
Dairy Products	11	-	-	-	12	280
Grain Mills	14	-	8	-	19	69
Sugar	6	-	-	-	10	482
Canned & Preserved Seafood	8	-	-	-	15	160
Misc. Foods & Beverages	14	-	-	-	22	10
Paving and Roofing	-	-	2	-	22	10
Rubber	16	-	-	-	13	268
Leather	11	-	-	-	16	122
Glass	16	7	-	5	17	93
Cement	-	-	-	4	20	43
Asbestos	18	-	-	-	21	13
Nonferrous Metals	-	8	1	3	18	71
Feedlots	5	3	-	-	8	701
Other						
Forestry & Fishery Pro.	11	4	5	-	-	-

Source: NCWQ. From U.S. Environmental Protection Agency, Strategic Environmental Assessment System (SEAS), 1975.

in process change are seen. For example, if BOD levels grow at an annual rate of 2.6 percent beyond 1985, then in 56 years (by 2041), Biological Oxygen Demand levels will return to 1971 levels.

Scenario 4 assumed only BPT standards, with compliance in 1980. Table III.F.41 gives results for this scenario at the sector level and Table III.F.42 gives a comparison of the baseline and Scenarios 1 and 4 for the major pollutant categories. 'BPT only' represents reductions in discharge from baseline ranging from 18 percent for Dissolved Solids, to 85 percent for Suspended Solids in 1985. With BAT the reductions range from 39 percent for Dissolved Solids to 96 percent for Suspended Solids in 1985. The desirability of the incremental standards depends on the environmental consequences of the different levels of discharge. A wide variety of pollutants must be analyzed (See Environmental Impacts Section). From this analytical exercise, however, it would appear that industrial discharges would be significant in 1985 even with full compliance with P.L. 92-500.* With only BPT standards discharges would be close to 1971 levels for Dissolved Solids and COD (83 percent and 73 percent of 1971 levels) and 44 percent and 20 percent of 1971 levels for BOD and Suspended Solids.

7. Energy Use

It is apparent that some demands for energy will increase due to the pollution abatement program. The increased demand for energy arises from two sources: (1) energy requirements due to the operation and maintenance of pollution control requirements, and (2) increased energy needs from induced production of pollution abatement goods and services. Any decreased energy use due to negative economic impacts on GNP is not taken into account here. Therefore, the results presented here are not projections of change in total use.**

Table III.F.43 shows that the general pattern of incremental energy use follows the pollution abatement investment pattern, peaking in years where investment is most concentrated. In the latter years, as the stock of pollution abatement investment builds up, operating costs account for an increasingly significant share of incremental energy use.

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* These projections could underestimate pollution levels if permits allow less stringent control than the promulgated effluent limitations, or if actual efficiencies in abatement are less than design efficiencies.

** Other factors which may influence energy use could not be estimated, e.g., the use of sludge as fuel or recovered materials being recycled creating energy savings.

TABLE III.F.41: FORECAST OF POLLUTANT LEVELS BY NCWQ INDUSTRY GROUP FOR 1977 AND 1985 (SCENARIO 4)

1. Biochemical Oxygen Demand*	1977				1985			
Indepth:	Net Tons	Percent of Total	Percent Below Baseline	Percent of Total Reduction	Net Tons	Percent of Total	Percent Below Baseline	Percent of Total Reduction
Fruits and Vegetables	42,000	2.2	19	.9	39,000	3.8	41.5	1
Chemicals	546,000	28.4	30	21.4	209,000	20.1	78	28
Iron and Steel	18,000	.9	50	1.6	4,000	-	84.7	.9
Metal Finishing (Job)	0							
Petroleum Refineries	20,000	1.1	14.5	-	18,000	1.7	41	-
Pulp and Paper	632,000	32.9	45	48.3	375,000	36	-	42.3
Steam Electric	0							
Textiles	131,000	6.8	37.5	7.3	61,000	5.8	75	7.3
General:								
Meat Products	111,000	5.8	46.3	8.8	16,000	1.5	93.7	9.1
Dairy Products	12,000	.6	40	.7	4,000	-		.7
Grain Mills	13,000	.7	25.8	-	9,000	.8	57.9	-
Sugar	44,000	2.3	5.7	-	48,000	4.6	11.5	-
Canned and Preserved Seafoods	31,000	1.6	10.2	-	31,000	3	30.3	-
Miscellaneous Food and Beverages	15,000	.8	24.8	-	10,000	1	55.2	-
Paving and Roofing	0							
Rubber	3,000	-	42.7	-	1,000	-	86.5	-
Leather	15,000	.8	43.2	10.6	3,000	-	88.6	.7
Glass	2,000	.1	38.5	-	1,000	-	82	-
Cement	0							
Asbestos	0				0			
Nonferrous Metals	0							
Feedlots	76,000	3.9	50	7.0	0		100.0	6.6
Other:								
Forestry and Fisheries	213,000	11.1	4	8.6	211,000	20.3	9.2	.8
Total	1,920,000	100.0		100.0	1,039,000	100.0		100.0

*Note - =<. 5 percent

TABLE III.F.41 Continued

2. Chemical Oxygen Demand*	1977					1985			
Indepth:	Net Tons	Percent of Total	Percent Baseline	Percent of Total Reduction		Net Tons	Percent of Total	Percent Below Baseline	Percent of Total Reduction
Fruits and Vegetables	0					0			
Chemicals	1,546,000	41.6	21.4	37		1,154,000	43.2	51.7	49.4
Iron and Steel	0					0			
Metal Finishing (Job)	0					0			
Petroleum Refineries	105,000	2.8	8.6	-		108,000	4.0	21.2	1.1
Pulp and Paper	0					0			
Steam Electric	0					0			
Textiles	804,000	21.6	28.6	28.2		510,000	19.0	62.9	34.6
General:									
Meat Products	41,000	1.1	45.6	3.0		7,000	-	92.2	3.5
Dairy Products	0					0			
Grain Mills	0					0			
Sugar	0					0			
Canned and Preserved Seafood	0					0			
Miscellaneous Food and Beverages	0					0			
Paving and Roofing	0					0			
Rubber	0					0			
Leather	0					0			
Glass	27,000	.7	47.6	2.1		1,000	-	98.6	2.3
Cement	0					0			
Asbestos	0					0			
Nonferrous	1,000	-	43.8	-		0	-	92	-
Feedlots	262,000	7.0	50	22.9				100	24.3
Other:									
Forestry and Fisheries	936,000	25.2	7.3	6.5		894,000	33.4	15.3	6.5
Total	3,721,000	100.0		100.0		2,674,000	100.0		100.0

*COD data is incomplete.

TABLE III.F.41 Continued

3. Suspended Solids	1977					1985			
Indepth:	Net Tons	Percent of Totals	Percent Below Baseline	Percent of Total Reduction		Net Tons	Percent of Total	Percent Below Baseline	Percent of Total Reduction
Fruits and Vegetables	14,000	-	80.3	1.5		39,000	2.4	57.3	.6
Chemicals	238,000	3.9	32.5	3.1		129,000	8	66.5	2.9
Iron and Steel	1,065,000	17.7	40	19.5		243,000	15	86.4	17
Metal Finishing (Job)	0					0			
Petroleum Refineries	10,000	-	2	-		11,000	.7	16.7	-
Pulp and Paper	831,000	13.8	24.4	7.3		653,000	40.4	59.1	10.7
Steam Electric	59,000	1.0	14.2	-		24,000	1.5	40.4	-
Textiles	188,000	3.1	23.9	1.6		132,000	8.1	56.5	1.9
General:									
Meat Products	70,000	1.2	41.8	1.3		21,000	1.3	85.8	1.7
Dairy Products	3,000	-	38.4	-		1,000	-	81.7	-
Grain Mills	10,000	-	15.9	-		8,000	.5	43.1	-
Sugar	98,000	1.6	45.8	2.2		2,000	-	99.2	2.4
Canned and Preserved Seafoods	21,000	-	18.7	-		19,000	1.1	45.4	-
Miscellaneous Food and Beverages	7,000	-	18.6	-		5,000	-	40	-
Paving and Roofing	1,359,000	22.6	39.9	24.7		0		100	26.7
Rubber	7,000	-	40.8	-		3,000	-	82.6	-
Leather	29,000	-	41.1	.5		6,000	-	85.6	-
Glass	3,000	-	27.5	-		1,000	-	70	-
Cement	32,000	.7	17.4	-		21,000	1.3	54	-
Asbestos	0					0			
Nonferrous Metals	1,289,000	21.4	46.9	31.1		7,000	-	99.7	32.6
Feedlots	184,000	3.1	50	5		0		100	4.9
Other:									
Forestry and Fisheries	377,000	6.2	9	1		292,000	18.1	32.6	1.6
Total	6,004,000	100.0		100.0		1,617,000	100.0		100.0

TABLE III.F.41 Continued

4. Dissolved Solids	1977				1985			
Indepth:	Net Tons	Percent of Total	Percent Below Baseline	Percent of Total Reduction	Net Tons	Percent of Total	Percent Below Baseline	Percent of Total Reduction
Fruits and Vegetables	0				0			
Chemicals	9,451,000	78.8	4.9	82.7	8,250,000	84.1	18.6	86.5
Iron and Steel	0	-	46.4	-	0		96.4	-
Metal Finishing (Job)	124,000	1.0	23.8	6.6	79,000	.8	60.1	5.5
Petroleum Refineries	0				0			
Pulp and Paper	0				0			
Steam Electric	2,279,000	19	-.8	a	1,425,000	14.5	-6.8	a
Textiles	0				0			
General:								
Meat Products	0				0			
Dairy Products	0				0			
Grain Mills	0				0			
Sugar	0				0			
Canned and Preserved Seafood	0				0			
Miscellaneous Food and Beverages	0				0			
Paving and Roofing	0				0			
Rubber	0				0			
Leather	0				0			
Glass	6,000	-	47.3	.9	0		100.0	-
Cement	74,000	.6	11.6	1.7	54,000	.7	45.1	2.0
Asbestos	1,000	-	-3.8	a	1,000	-	19.5	-
Nonferrous	53,000	-	47.8	8.1	0		100.0	5.4
Feedlots	0				0			
Others:								
Forestry and Fisheries	0				0			
Total	11,990,000	100.0		100.0	9,810,000	100.0		100.0

a = These industries were not included in the analysis for this column because of increases in levels above baseline in 1977.

Source: NCWQ. From U.S. Environmental Protection Agency, Strategic Environmental Assessment System (SEAS), 1975.

TABLE III.F.42: COMPARISONS OF SCENARIOS 1 AND 4 WITH BASELINE FOR FORECASTED LEVELS OF INDUSTRIAL POLLUTION (1977 and 1985)

		1977		1985	
	1971	Tons	Percent of Baseline	Tons	Percent of Baseline
BOD					
Baseline (Tons)	2,265,000	3,004,000	100	3,696,000	100
Scenario 1*	2,265,000	937,000	31	545,000	15
Scenario 4**	2,265,000	1,920,000	64	1,039,000	28
COD					
Baseline	3,677,000	4,861,000	100	5,718,000	100
Scenario 1*	3,677,000	2,574,000	59	1,537,000	27
Scenario 4**	3,677,000	3,721,000	77	2,674,000	47
Suspended Solids					
Suspended Solids	7,700,000	9,546,000	100	10,804,000	100
Scenario 1*	7,700,000	1,687,000	18	433,000	4
Scenario 4**	7,700,000	6,004,000	63	1,617,000	15
Dissolved Solids					
Baseline	11,770,000	12,556,000	100	11,895,000	100
Scenario 1*	11,770,000	11,413,000	81	7,244,000	61
Scenario 4**	11,770,000	11,990,000	95	9,810,000	82

* Scenario 1 assumes full compliance with BPT, BAT and New Source Performance Standards.

** Scenario 4 assumes delayed compliance with BPT(1980) and no compliance with BAT. New Source Performance Standards are assumed met for new plants.

Source: NCWQ. From U.S. Environmental Protection Agency, Strategic Environmental Assessment System (SEAS), 1975.

TABLE III.F.43: ENERGY USE*, SCENARIOS 1-5

	1971	1975	1977	1980	1983	1985
Base (10^{15} BTU)	70.5	77.0	83.0	90.5	96.3	100.4
Scenario 1	70.5	77.3	84.9	91.6	97.7	102.3
Difference		.3	1.9	1.1	1.4	1.9
% Difference		-**	2.3	1.2	1.5	1.9
Scenario 2	70.5	77.3	83.7	91.4	97.8	102.4
Difference		.3	.7	.9	1.5	2.0
% Difference		-**	.8	1.0	1.6	2.0
Scenario 3	70.5	77.3	85.2	92.1	98.4	103.1
Difference		.3	2.2	1.6	2.1	2.7
% Difference		-**	2.7	1.8	2.2	2.7
Scenario 4	70.5	77.3	83.8	91.8	97.3	101.6
Difference		.3	.8	1.3	1.0	1.2
% Difference		-**	1.0	1.4	1.0	1.2
Scenario 5	70.5	77.1	84.0	91.1	97.1	101.5
Difference		.1	1.0	.6	.8	1.1
% Difference		-**	1.2	.7	.8	1.1

* The increases shown do not take into account any decreased energy use due to negative impacts on GNP or energy savings resulting from material recovery or recycling.

** - = .5 percent.

Source: NCWQ. From U.S. Environmental Protection Agency, Strategic Environmental Assessment System (SEAS), 1975.

(a) Scenario 1 (Compliance, High Growth)

The largest increase in energy use occurs in 1977, the BPT standard year, when abatement investment is most concentrated. As may be expected, supplying industries for plant and equipment construction show increased output, and therefore, increased energy use.

Table III.F.44 compares direct versus indirect energy use by selected sectors. Some sectors (like chemicals) have large abatement costs and others (like steel) produce inputs to abatement investment. In 1977 a major portion of the energy use is due to increased outputs to meet investment requirements. By 1985, direct (operation and maintenance) energy needs accounts for the major part of the incremental energy use, as all BPT and BAT abatement investment has been completed and only new source abatement investment is being incurred. Some of the induced impact is due to increased regular investment that lags behind the induced output changes in previous years.

Energy use at the INFORUM industry level is given in Table III.F.45. Major impacts in 1977 are felt in the industries that supply materials for abatement. These include, cement and steel (for capital equipment) as well as the chemical industry (for operating account). By 1985, the largest percentage increases in energy use are found in the following sectors: fertilizers (36.6%), chemicals (16.2%), plastics (5%), and broad narrow fabrics (5%).

(b) Scenarios 2-5

In Scenario 2, the abatement investment is spread out more evenly. As a result, there are no "peaks" in incremental energy usage as in Scenario 1. The steadily increasing energy use is accounted for by the increasing pattern of investment through the period, and by the increasing operating activity as the stock of abatement equipment builds up.

Scenario 3 is the same as Scenario 1 except for a significant increase in municipal cost. The results are similar to those in Scenario 1, except that the level of energy use is somewhat higher.

In Scenario 4, BAT standards are dropped and the BPT compliance date delayed to 1980. Incremental energy usage peaks in 1980 at 1.4% over base, when the BPT standard is met.

Scenario 5 assumes the same investment pattern as in Scenario 1, but at only half the cost. The pattern of incremental energy usage, therefore, is the same as in 1, except at a lower level, reaching a peak of only 1.2 percent over base in 1977.

TABLE III.F.44: DIRECT AND INDUCED ENERGY USE IN SELECTED* SECTORS (SCENARIO 1) 1977 AND 1985

	Total Increase over Baseline (Trillion BTU)	Direct (O & M)	Induced
	1977		
Steel	347.6	13.51	334.1
Chemicals	412.0	201.6	210.4
Petroleum	119.2	29.5	89.7
Concrete	110.5	3.6	115.9
Asphalt	111.2	--	111.2
	1985		
Steel	161.8	105.5	56.3
Chemicals	1,296.5	1,086.0	210.5
Petroleum	255.3	235.5	20.0
Concrete	30.3	4.4	26.0
Asphalt	22.6	--	22.6

* Decreased energy use due to negative economic impacts on energy savings for process change, material recovery and recycling are not taken into account.

Source: NCWQ. From U.S. Environmental Protection Agency, Strategic Environmental Assessment System (SEAS), 1975.

TABLE III.F.45: ENERGY USE BY MAJOR INDUSTRIAL SECTORS*: SCENARIOS 1-5 (Trillions of BTU's)

1977	INFORUM Sector	Baseline*	Scenario 1 % Difference from Baseline	Scenario 2 % Difference from Baseline	Scenario 3 % Difference from Baseline	Scenario 4 % Difference from Baseline	Scenario 5 % Difference from Baseline
23	Meat Product	86.8	.5	.1	.5	.2	.2
24	Dairy Product	57.5	.3	.2	.3	.2	.2
25	Canned and Frozen food	120.8	.4	.2	.4	.3	.2
28	Sugar	101.4	.6	.2	.6	.3	.3
35	Broad and Narrow Fabrics	305.9	4.0	1.0	4.1	1.6	2.0
47	Pulp Mills	1074.3	2.2	.8	2.5	.9	1.1
48	Paper & Paperboard Mills	675.0	4.6	1.3	4.9	1.9	2.4
55	Chemicals	6285.6	6.6	1.9	7.0	2.7	3.4
59	Fertilizer	119.6	22.0	5.0	22.2	8.8	11.0
62	Plastics	234.8	5.0	1.6	5.5	2.1	2.6
69	Petroleum	4054.8	2.9	1.0	3.3	1.3	1.5
81	Cement-Concrete & Gypsum	915.1	13.1	6.2	17.6	6.4	7.5
83	Steel	4323.4	8.0	3.1	9.3	3.5	4.2
84	Copper	42.4	12.6	5.0	14.5	5.2	6.6
151	Railroad	682.6	4.1	1.7	4.8	1.8	2.2

* Decreased energy use due to negative economic impacts on energy savings resulting from material recovery or recycling are not taken into account.

TABLE III.F.45 Continued

1985	INFORUM Sector	Baseline*	Scenario 1 % Difference from Baseline	Scenario 2 % Difference from Baseline	Scenario 3 % Difference from Baseline	Scenario 4 % Difference from Baseline	Scenario 5 % Difference from Baseline
23	Meat Product	108.4	.4	.4	.6	.3	.2
24	Dairy Product	63.0	.2	.2	.3	.2	.2
25	Canned and Frozen Food	158.4	.4	.4	.4	.2	.2
28	Sugar	118.8	.6	.7	.7	.4	.3
35	Broad & Narrow Fabrics	361.1	5.0	5.2	5.2	3.8	2.5
47	Pulp Mills	1291.8	1.6	1.6	2.2	1.0	.8
48	Paper & Paperboard Mills	821.0	4.9	5.0	5.5	3.6	2.5
55	Chemicals	7980.9	16.2	18.5	17.2	5.2	8.1
59	Fertilizers	152.0	36.6	39.7	36.9	23.8	18.3
62	Plastics	318.8	5.0	5.1	6.0	2.9	2.5
69	Petroleum	5234.7	4.9	5.4	5.7	1.7	2.5
81	Cement, Concrete & Gypsum	1051.3	2.9	2.7	14.5	2.9	2.3
83	Steel	3860.7	4.2	3.5	6.7	2.7	2.2
84	Copper	38.3	1.8	1.3	5.5	1.6	1.3
151	Railroad	771.3	1.4	1.3	2.9	.9	.8

Source: NCWQ. From U.S. Environmental Protection Agency, Strategic Environmental Assessment System (SEAS), 1975.

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G. SUPPLY CONSTRAINTS

During 1972-1974 shortages* were pervasive. A survey by the Senate Permanent Subcommittee on Investigations identified shortages of 63 materials from aluminum and ammonia to urea and zinc (19). Arthur D. Little, Inc. in a study of 26 materials for the Department of Commerce, identified governmental regulations, financial considerations, capacity limitations, and domestic and international demand pressures as major factors contributing to shortages. Of the governmental regulations, price controls, energy policy, environmental regulations, and fiscal and monetary policies were identified as contributing most to shortages (2).

As these and other studies of shortages were being completed in late 1974 or early 1975, shortages were becoming less important as a national issue. The economy had cooled and moved into recession. Unemployment and inflation were the new national problems.

Shortages still occur. Shortages of materials or manpower to construct or operate municipal, industrial or agricultural water pollution abatement and control facilities could thwart efforts by governments and industry to meet the goals of P.L. 92-500. Shortages can cause delays in equipment and material deliveries. This in turn can cause delays in construction of new facilities and repair of older ones, making it impossible to meet predetermined deadlines for effluent limitations. Shortages of manpower to design, build or operate facilities can cause inefficient plant design, construction, and operation. Inefficiency wastes scarce pollution abatement funds. Shortages can escalate costs, and higher costs mean less water pollution abatement per dollar.

In light of the potential seriousness of shortages, the Commission analyzed the material and equipment needs of the Act. Figure III.G.1 shows the percentage of 1980 baseline production necessary to meet the industrial requirements of the Act. It was developed using the SEAS macroeconomic input-output model estimates of the materials and equipment needed to construct water pollution abatement facilities, and estimates of the 1980 baseline level of industrial production. Municipal resource needs are calculated using capital expenditures from municipal Scenario E-1 (see III.E). The figure presents all sectors of the economy where the average annual requirements of the Act represent 5 percent or more of 1980 baseline production. Seventy-five sectors were examined. To put these estimates into perspective, the percentage of sector production normally supplied to sewer systems and industrial construction (including abatement expenditures) is presented.

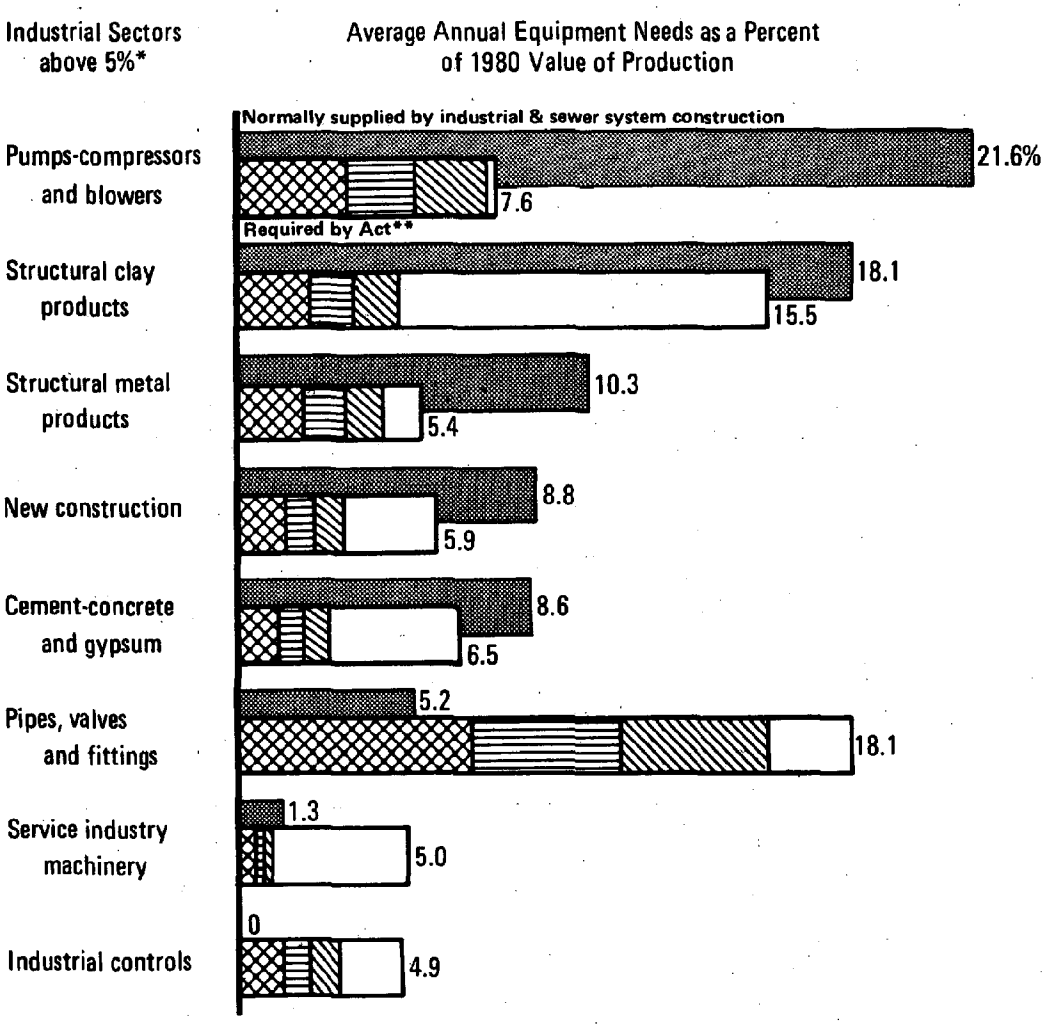
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* Shortages occur when the demand for a good or service is not offset by short term price increases that would otherwise balance supply and demand. Market responses to shortages are excessive delays, price increases and product allocation.

Figure III.G.1

MATERIAL & EQUIPMENT NEEDS OF THE ACT PL92-500

(DIRECT PURCHASES ONLY)



* 75 sectors examined. The other 67 were below 5%

** Equipment needs expenditures for pollution abatement were averaged over 10 years 1975-1985

Source: Natl. Commission on Water Quality. From University of Maryland Interindustry Forecasting Model (INFORUM). 1975.

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Of the eight sectors with requirements above 5 percent of 1980 production, only sector 100, pipes, valves, and fittings, appears to be placed under unusual demands. This sector also includes forged and cast metal pipes, valves and fittings which are heavily used by the petroleum, chemical, and energy industries, as well as for pollution abatement. Shortages of the castings and forgings used in the manufacture of valves have caused increasing delivery delays in recent years (20). This analysis of the requirements for water pollution abatement suggests that the delays will continue. All other sectors will need to expand by less than five percent above the production normally supplied to sewer systems and industrial construction, a level considered within normal production fluctuations.*

Two qualifications to this general conclusion are necessary. First, expenditures for pollution abatement were distributed evenly over the period 1975-1985. Substantial concentrations of expenditures in any year or years could make critical demands on many of the sectors. Table III.G.1 dramatically illustrates this point. Under the strict industrial compliance scenario 1 (See Section III.F) thirteen sectors of the economy would need to increase their production by more than ten percent over baseline levels and five by more than 15 percent. In this scenario, pollution abatement expenditures peak sharply in 1977 as industry attempts to meet the BPT deadline. In Scenario 2, both BPT and BAT are still achieved by 1983 but the expenditure pattern is smoothed. In this case only pipes, valves, and fittings remain as a likely supply problem. Second, the sectors used to analyze the resource needs are too aggregate to identify any but the most obvious shortages or any of the problems associated with them.** Still, even these aggregate estimates of resource needs will be useful should shortages similar to those in 1972-1974 reoccur. Water pollution abatement resource needs can be combined with other resource needs to produce an estimate of total national resource needs. This estimate will be necessary in designing means of alleviating specific shortages.

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* For example, GNP grew at more than five percent per year during the 1961-1966 period.

** For example, chlorine is just one of hundreds of chemicals in the industrial chemicals sector and chlorination equipment is just one of many pieces of equipment covered in the service industry machinery sector. Dramatic growth in the required production of chlorine can be camouflaged by the relatively modest performance of the other chemicals in that sector.

TABLE III.G.1: Changes in Output Resulting from Direct and Indirect* Purchases caused by P.L. 92-500

Sector	Scenario	Percentage Increase from Baseline Output in 1977	
		1 BPT - 1977 BAT - 1983	2 BPT & BAT - 1983
Valves, Pipes & Fittings		54.3	21.4
Pumps, Compressors, Blowers & Fans		20.7	8.3
Industrial Controls		18.1	7.6
Structural Clay Products		17.6	9.2
Structural Metal Products		15.8	6.3
Cement, Concrete, Gypsum		12.7	6.1
Copper		12.6	5.0
Other Stone & Clay Products		12.4	5.1
Special Industrial Machinery		12.2	4.7
Engineering & Scientific Instruments		12.1	4.6
Power Transmission Equipment		11.5	4.2
New Construction		10.4	4.6
Industrial Patterns		10.0	4.2

*The direct requirements for materials and equipment by abating sectors in turn lead to indirect requirements since these sectors will require additional inputs in order for them to meet the higher level of output. These second round impacts in turn cause further indirect effects and so on.

Source: NCWQ. From CONSAD Research Corporation, "Macroeconomic Impacts of P.L. 92-500", 1976

Five other more detailed study subjects directly affected by P.L. 92-500 were selected for analysis. The five are:

1. Design engineers and scientists
2. Construction labor
3. Water pollution control equipment
4. Municipal sewage treatment plant operators, supervisors, and technicians
5. Sewage treatment chemicals

The first three areas include the labor and special equipment used in the design and construction of water pollution abatement facilities. The last two are operating needs of the facilities. Materials and machinery used in constructing pollution abatement facilities are not included in this list because the materials and machinery are likely to be identical to that used in all types of contract construction, and pollution abatement construction is likely to be less than 10 percent of total contract construction. (See Figure III.G.1)

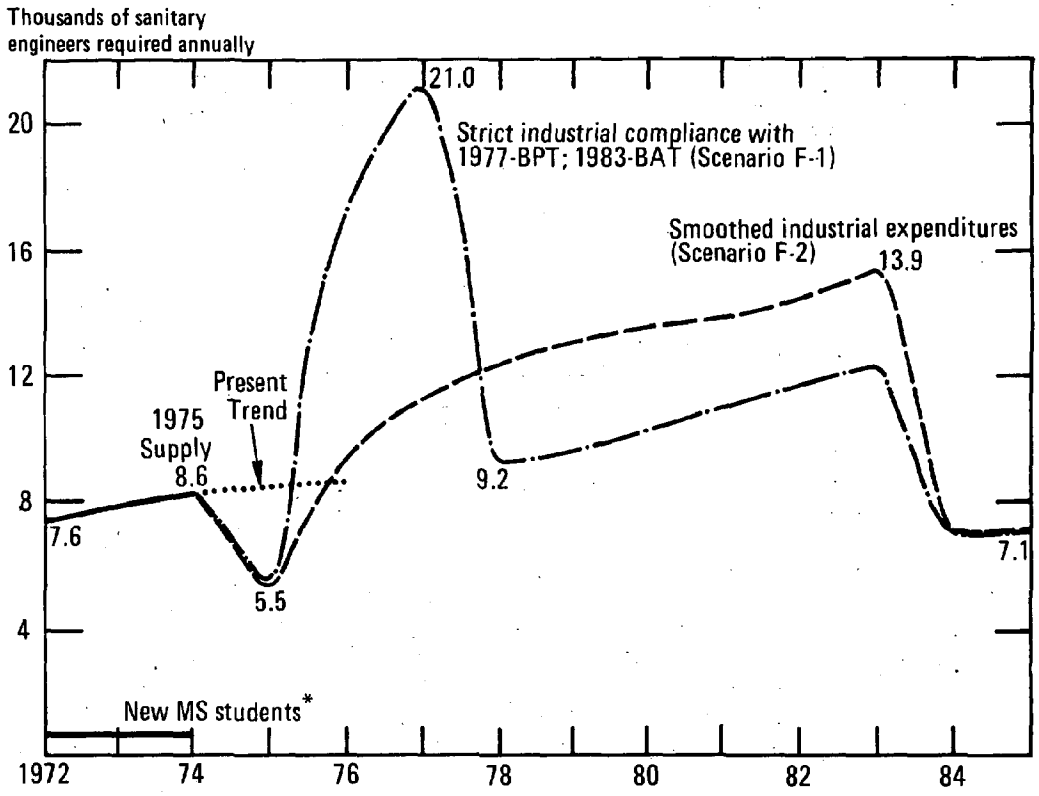
1. Engineers and Scientists

Engineers and scientists are needed to design municipal and industrial wastewater treatment plants, and a shortage in these professions could cause delayed, defective or inefficient plant design. Further, because of the extensive training needed, there is a substantial time lag for increasing the supply. A recent study by the Bureau of Labor Statistics addressed the adequacy of the supply of engineers and scientists (22). The study indicates that 1.6 man-years of civil engineer effort are used per million (1971) dollars spent on the design and construction of municipal sewage treatment plants. A survey of 941 consulting engineering firms indicates that over 50 percent of the professional staff engaged in water pollution control are sanitary engineers (16). The survey indicated that roughly 75 percent of the civil engineers are sanitary engineers and that roughly 90 percent of the sanitary engineers' time is spent on design and construction and treatment plant start-up. So, roughly $1.33 = \frac{(1.6 \times .75)}{(.90)}$ sanitary engineers are needed per million (1971) dollars of expenditure annually.

Roughly, the same employment rate of sanitary engineers will be required for industry. This assumption and an estimate of total annual expenditures on water pollution control allow an estimate of the number of sanitary engineers required by consulting firms and industry to design and build pollution abatement facilities. Figure III.G.2 presents estimates of these requirements under two alternative compliance schedules along with an estimate of the supply of sanitary engineers.

Figure III.G.2

SANITARY ENGINEERS REQUIRED FOR THE DESIGN & CONSTRUCTION OF WATER POLLUTION CONTROL FACILITIES



* New MS students in water pollution control engineering

Footnote: Estimates of the supply of sanitary engineers are based on the following formula:

$$SE_t = SE_{t-1}\,(1\text{-}DR) + MS_{t-1}\,(P_c + P_1)/100$$

$$SE_{1972} = C\,(1 + P_1/P_c)$$

Where SE_t = the number of sanitary engineers engaged in consulting and industry in year t.

DR = the death and retirement rate for civil engineers. (Reported by Dillon Hall of BLS to be 0.0187).

MS_t = the number of new MS students in environmental engineering in year t. Data reported by Paul H. King in 1974-1975 AEEP Graduate Enrollment Survey.

P_c = the percentage of new MS graduates in environmental engineering who are employed by consulting firms = 30.1

P_1 = The percentage of new MS graduation environmental engineering who are employed by industry = 11.1

C = The number of sanitary engineers employed by consulting firms in 1972. Data reported in "Manpower needs of consulting engineering firms", E.J. Middlebrook, et. al, Journal Water Water Pollution Control Federation, October, 1972.

Source: Natl. Commission on Water Quality. From University of Maryland Interindustry Forecasting Model (INFORUM). 1975.

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Under a strict industrial compliance schedule, (Scenario 1)*, a large shortage of sanitary engineers would occur in 1976-1977. This would be followed by a likely surplus between 1978 and 1980. The shortage probably could cause delays in the design of water pollution control facilities.

Even a smoothed industrial expenditure schedule (Scenario 2)* appears to require more sanitary engineers than are estimated to be available. The shortage is small in 1976 but appears to be growing as the number of new Master's students in environmental engineering continues to decline.

Table III.G.2 presents the pros and cons of a number of possible options to reduce or eliminate this potential shortage. The options include: (1) EPA support of students, either through university research of a revival of the EPA traineeship program; (2) prescription of accepted treatment plant designs and the circumstances in which each is most cost-effective; (3) development of a professional retraining course for engineers with related skills; and (4) reliance on existing market mechanisms.

There are several factors which could make the estimated shortage erroneous or less severe. First, the estimate of total water pollution control costs could be significantly overestimated. If the costs are more than 20 percent overstated and we superimpose a smooth industrial expenditure schedule, there does not appear to be a shortage. Second, since design precedes construction and the design phase makes the heaviest demands on sanitary engineers, much of the design associated with planned pollution abatement expenditures may be already completed. Third, the estimates of the number of sanitary engineers required per million dollars of pollution abatement expenditures are admittedly inexact. If the above calculations were more than 20 percent too high, no shortage would occur. Fourth, part-time students may partially fill the gap.** Finally, consulting firms and industry may be able to attract substantially more than their historic share of new graduates.

In conclusion, there appears to be an impending shortage of sanitary engineers for the design and construction of water pollution control facilities if the BPT and BAT deadlines of 1977 and 1983 are to be met.

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* For a more complete description of these scenarios see Section III.F.

** Paul King reports 1,362 part-time students in his 1974-1975 AEEP Graduate Enrollment Survey. (11)

Table III.G.2: Options for Reducing the Potential Shortage of Sanitary Engineers

OPTION	PROS	CONS
1. EPA Student Support	1. Could provide added incentive to expand supply	1. Not in the "market"; incentives may not reflect the true market conditions 2. Probably the earliest impact would be 1978.
2. Publish accepted design guidelines	1. Would reduce requirements for sanitary engineers 2. Would reduce design costs 3. Could have impact by 1976-1977	1. Would not encourage innovation in design 2. Would not be applicable to industry
3. EPA Short Retraining Course	1. Could expand the supply in six months to a year 2. Could employ surplus engineers from other fields	1. May not provide adequate depth of training 2. Retrained personnel may not seek a long term career in sanitary engineering
4. Rely on market mechanisms	1. Sensitive to changing market situation 2. Requires no administrative action	1. May require increased design cost 2. May take too long to provide extra manpower.

Source: NCWQ. 1975.

If the deadlines are relaxed or slipped by even a few years the shortage would be substantially diminished and perhaps even eliminated.

2. Construction Manpower

The current recession and high unemployment levels have led to talk of using the Act's municipal construction grants program to stimulate the economy and provide needed public works jobs. Estimates of the number of jobs* generated directly by publicly owned treatment works construction vary between 10,400 and 15,000 per billion 1975 dollars spent annually (15) (23).

As Figure III.G.3 illustrates, spending between $7 and $10 billion (1975) per year on publicly owned treatment works would increase overall construction employment, but would not restore it to the peak 1974 level. The employment generated would represent roughly 1.9 to 3.8 percent of the persons employed in contract construction.

Despite the current unemployment levels, there is some concern that the needed skills within the construction labor force for publicly owned treatment works might be different from the skills of the available manpower. The BLS study indicated that relatively more operating engineers, ironworkers, and cement finishers are used in publicly owned treatment works construction than in the construction industry in general. But the study concluded that apprenticeship training probably can expand sufficiently to supply the needs in these trades. Plumbing and pipefitting trades, although not heavily used in publicly owned treatment works construction, were identified as possible bottlenecks. This conclusion probably depends on an assumed 3 or 4 percent unemployment rate, a level which may not be reached until the late 1980's.

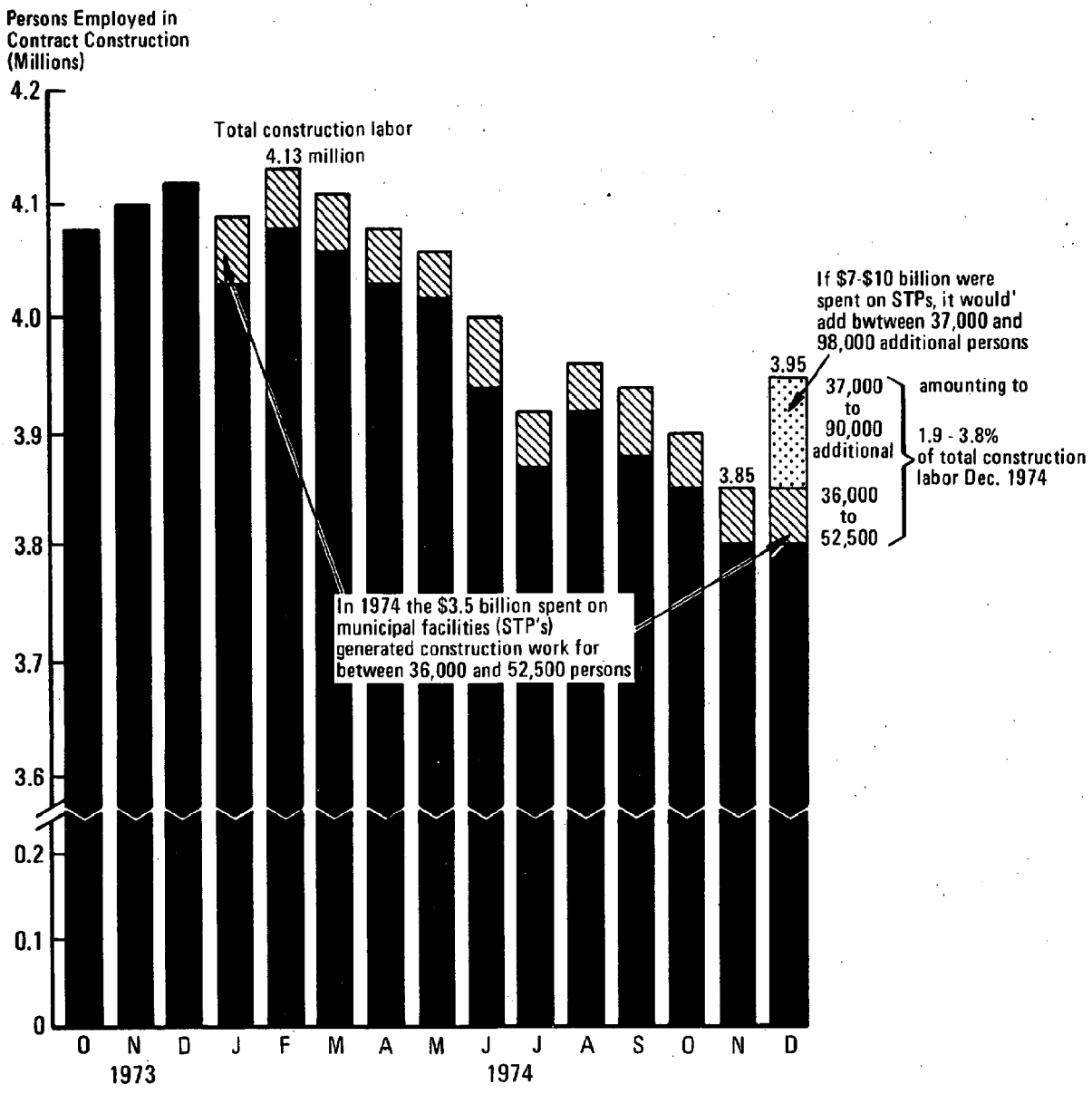
To summarize, the evidence presented in the BLS study indicates that skilled construction labor will not present an obstacle to municipal publicly owned treatment works construction in the current era of underemployment. This conclusion is further supported by another study done for EPA (5) indicating that the supply of plumbers, electricians, masons, and metal workers is quite elastic.** Thus for a modest increase

* A job equals one 2080 hour man-year.

** Specifically, a 1 percent increase in wages would result in a 3 percent increase in the number of plumbers, a 1.8 percent increase in the number of electricians, a 3.3 percent increase in the number of masons, and a 1.8 percent increase in the number of metal workers.

Figure III.G.3

EFFECT OF INCREASED SPENDING FOR MUNICIPAL SEWAGE FACILITIES (STPs) ON CONSTRUCTION LABOR EMPLOYMENT



Source: Actual employment: Federal Reserve Bulletin, Dec. 1974. STP construction in 1974: Natl. Commission on Water Quality. Employment in $billion 1975$. From Metcalf and Eddy Inc., "Assessment of Technologies and Costs for Publicly Owned Treatment Works under P.L. 92-500", 1975.

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in construction wages, a significant increase in manpower availability can be expected. (The labor for a $5.7 billion increase in construction could be supplied by a 1 percent increase in wages.)

3. Water Pollution Control Equipment

A study for EPA (1) included a section on water pollution control equipment. In the discussion of the water pollution control equipment industry the study indicated there is relatively free entry into the industry but currently there is little incentive to do so. Table III.G.3 presents selected financial ratios for companies with varying degrees of involvement in the manufacture of water pollution control equipment. The companies for whom expanded activity would be the easiest, those with minor business in water pollution control equipment, would have little incentive to expand their activities since the income ratios of those companies with a major share of their business in water pollution control equipment is smaller.

The financial ratios should improve somewhat for all of the companies as water pollution control equipment demand increases, since the industry was operating at only about half its capacity in 1970 (12). This improvement should be more dramatic for the "major" companies and should encourage other companies to expand their business in water pollution control equipment. Thus, based on the evidence available there should be an adequate supply of water pollution control equipment.

Increased production will increase industry's demands for materials, labor and capital, and, to attract the added supplies the industry will have to pay higher prices for them. Industry will, in turn, have to pass these costs on to their purchasers if their income is to be maintained. The EPA contractor developed a method to assess the impact of increased demand for water pollution control equipment on the price of the equipment; this method accounts for the increased costs of materials, labor and capital.

These methods are used with data developed by the Commission* to produce Figure III.G.4 which shows the ratio of inflated to constant dollar expenditures on water pollution abatement equipment under three alternative assumptions. The "baseline" scenario represents the situation

* NCWQ developed estimates of expenditures for water pollution abatement equipment using the historic trend in the percentage of municipal sewage treatment plant and industrial pollution abatement cost which is spent on pollution abatement equipment. This trend is extrapolated and combined with annual expenditure streams to produce estimated demand for water pollution abatement equipment.

TABLE III.G.3 COMPARISON OF FINANCIAL RATIOS FOR THE WPC EQUIPMENT INDUSTRY

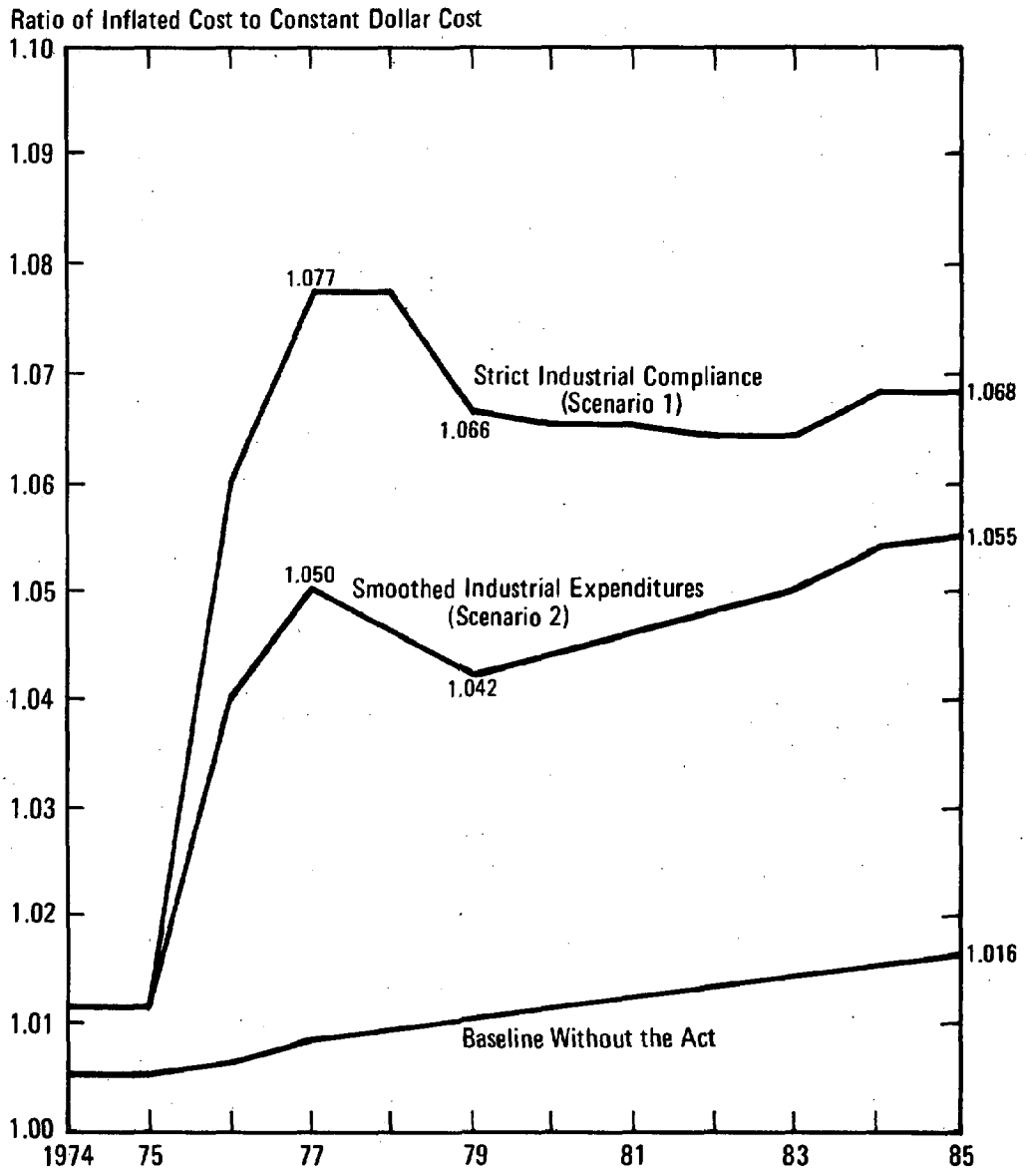
	Year	Net Income / Net Sales Percent	Net Income / Total Assets Percent	Total Debt / Stockholders Equity
MAJOR				
Selected companies with a major part of their business in water pollution control equipment (6)[a]	1971	3.71	4.86	.680
	1970	3.14	4.31	.862
	1969	3.67	4.65	.755
MINOR				
Selected companies with a minor part of their business in water pollution control equipment (10)[a]	1971	4.92	7.85	1.09
	1970	4.55	7.37	1.11
	1969	5.17	8.05	1.05

a. Number of companies in the sample

Source: NCWQ. From Arthur D. Little, Inc., "Economic Impact Study of the Pollution Abatement Equipment Industry", 1972.

Figure III.G.4

INFLATIONARY IMPACT OF EXPENDITURES ON WATER POLLUTION ABATEMENT EQUIPMENT



Source: Natl. Commission on Water Quality. From University of Maryland Interindustry Forecasting Model (INFORUM). 1975.

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as it might have taken place without the Act. The "strict compliance" scenario (Scenario 1) shows how the expenditures might be made to achieve requirements by the Act's deadlines. The "smoothed" scenario (Scenario 2 from III.F) shows how the expenditures could be made to reduce the inflationary impact while still achieving BPT, BAT by 1983 and secondary treatment for publicy owned treatment works by 1986.

This figure shows the ratio between the expenditures in constant dollars and the expenditures which would be necessary to purchase the same amount of equipment in inflated dollars.* The "strict compliance" scenario required 5.6 percent more to be spent; the "smoothed" scenario 4.0 percent; and the "baseline" requires less than 1 percent more than the constant dollar expenditures between 1970 and 1985.

Although the "smoothed" scenario causes less inflation of water pollution abatement equipment prices, total expenditures for water pollution abatement equipment probably could be minimized under a scenario somewhere between the "smoothed" and the "strict compliance" scenarios because prices have been rising fairly rapidly in the economy, and under the "strict compliance" scenario more purchases are made earlier at lower prices.

4. Sewage Treatment Chemicals

In the last half of 1973, municipalities experienced shortages or outages of water and wastewater treatment chemicals. A survey by EPA identified four chemicals in short supply: chlorine, soda ash, lime, and caustic soda (25). Chlorine is used as a biocidal agent to control the bacteria count in activated sludge and secondary sewage effluent. Caustic soda and soda ash are strong bases used to increase the pH in order to improve coagulation and flocculation. Lime is used to maintain the proper pH in the biological oxidation of sewage, as a coagulant aid, and in phosphorus removal. Inadequate supplies of any of these chemicals will reduce the efficiency of a secondary treatment plant.

Table III.G.4 provides estimates of wastewater treatment usage of these chemicals in relation to production and to the major user of each chemical. In all cases, wastewater treatment usage accounts for less than 5 percent of total production and less than 11 percent of the major

* Inflated dollars do not include the inflation of labor capital and materials caused by anything but the demand for those goods and services from the water pollution control equipment industry. Thus, these rates should be added to the rates from other causes if an estimate of the total inflated expenditures is desired.

Table III.G.4: USE AND PRODUCTION OF SELECTED WASTE WATER TREATMENT CHEMICALS

Chemical	WTT[a] Demand as Percent of Production	Major User Percent of Production	Total Production (Thousand of Tons)
Caustic Soda			
		Chemical Processing	
1974[1]	5[b]	46	11,350
1964[2]	1.1[c]	45	6,267
Chlorine			
		Organic Chemicals	
1974[3]	5[b]	66	11,088
1964[2]	3.5[c]	54	6,096
Lime			
		Steel	
1972[4]	2.6	37	20,330
1958[5]	1.2	32	9,211
Soda Ash			
		Glass	
1972[6]	3[c]	47	7,528
1964	0.6	39	5,502

a. Municipal and Industrial Waste Water Treatment.

b. Included in miscellaneous uses, percentage is smallest percentage listed.

c. Water treatment which includes water supply.

Sources:

1. "Chemical Profile, Caustic Soda", Chemical Marketing Reporter, August 12, 1974.

2. "Commodity Notes", Chemicals and Rubber Industry Report, June 1967, Bureau of Domestic Commerce, Dept. of Commerce.

3. "Chemical Profile, Chlorine", Chemical Marketing Reporter, August 5, 1974.

4. Petition to the Cost of Living Council for the Decontrol of Lime from Price Control Under Phase IV", Robert S. Boynton, Executive Director, National Lime Association.

5. "Lime", Robert S. Boynton and Kenneth A. Gutschick, from Industrial Minerals and Rocks.

user's share. Wastewater treatment use of these chemicals appears to have grown over the past 10 years, although the available data is inadequate to permit an estimate of this growth. P.L. 92-500 can be expected to cause growth in the wastewater treatment use in the next ten years, but even major changes in use of these chemicals can be easily counteracted by minor changes by the major users. For example, a 20 percent increase in wastewater treatment demand for lime could be completely counteracted by a 2 percent decrease in the steel demand for lime. Further, since the municipal demand for these chemicals does not depend on the general conditions of the economy the way the needs of the major users do, aggregate annual municipal demand should be more stable than the demand by other users. This evidence suggests that municipal wastewater treatment is not likely to cause any shortage in these chemicals.

Still, further shortages can occur. Rapid economic growth in any of the major using industries, combined with low investment in capacity because of low or irregular profitability, can cause a shortfall. And, publicly owned treatment works are vulnerable in shortage situations because they are not preferred customers. Short-term contracts, small volume, strict reliance on low fixed-price bid, and delayed payment have all made producers less willing to serve municipalities. To correct these problems the American Water Works Association has drafted a model contract which would allow prices to rise and fall according to market conditions and extend the term of the contract to more than one year. Widespread use of this contract and a general awareness of potential supply problems should make chemical shortage a minor problem for municipalities in the future.

5. Sewage Treatment Plant Personnel

Two potential problems are commonly identified in discussions of municipal sewage treatment plant personnel: (1) an adequate quantity of personnel in light of the substantial increase in the complexity of municipal treatment plants; and (2) adequate skills of personnel in light of the same change.*

* See for example, Study of Municipal Wastewater Treatment Plant Manpower and Training Needs and Resources, EPA, August, 1974 (26). Comments from EPA (6) focus on the matter of inadequate operator training while comments to the Commission from the Georgia Conservancy (February 6, 1976) stress that, "The elimination of EPA's traineeship program contributes to a shortage of professionally trained specialists at the post-graduate level in water quality management and facility design." (10).

An adequate number of personnel at publicly owned treatment plants depends on three basic factors: the number of new operators needed because of the increasing complexity of secondary treatment and the increased flow; the net losses of municipal sewage treatment plant operators due to death, retirement, promotion, and losses to other occupations or industrial treatment facilities, and the number of new operators being trained.

Table III.G.5 presents estimates of the number of new operators required because of increasing flow (those with existing secondary treatment) and because of increased flow and complexity (those with existing primary or less stringent treatment). Over half of the new operators needs occur in small facilities without existing secondary treatment.

The net attrition rate of publicly owned treatment plant operators is uncertain. Reported U.S. average turn-over rates for individual municipal treatment plant operators have varied from 8 percent to 11 percent (per/year) (24, 25). Further, at least part of those operators would likely be rehired by other municipal treatment plants. The rehire rate is heavily influenced by the salary paid by municipalities in relation to that paid to workers with comparable skills by other employers. Table III.G.6 makes this salary comparison. Publicly employed wastewater treatment plant operators receive substantially less than privately employed operators. They also receive less money than the average for workers engaged in production and non-supervisory activities. Privately employed operators, on the other hand, receive substantially more. Because private and industrial treatment plants represent attractive employment alternatives to municipal treatment plant operators, the municipal rehire rate suffers accordingly.

Table III.G.7 presents a range of estimates of the municipal sewage treatment plant operator net attrition rates under alternative assumptions about the turn-over rate and the rehire rate. Net attrition rates of 5 percent and 9 percent seem to provide lower and upper bounds on the actual municipal attrition rates.

The impact of this range of attrition rates on the operator replacement needs and on total operator needs between now and 1985 is presented in Figure III.G.5. At 5 percent, attrition losses cause an operator need which is at least as large as that from increased flow and treatment plant complexity.* At 9 percent, replacement needs are almost twice as severe.

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* Estimates of aggregate operator needs presented in Table III.G.5 are distributed between now and 1985 in the same way as projections of treatment plant expenditures.

TABLE III.G.5: NEW OPERATORS NEEDED BY 1985 FOR EXISTING FACILITIES THAT ARE UPGRADED OR EXPANDED

Existing Treatment (1974)	Flow Range[a] 0-1MGD	1-5MGD	5-20MGD	Total
Primary or Less	8879	4110	2538	15,527
Secondary	194	827	738	1,753
Total	9073	4937	3270	17,280

a- The 369 treatment plants with greater than 20 MGD flow have not been included because they generally provide their own operator training.

Source: NCWQ. From Dr. Loren Solnick, "Municipal Wastewater Treatment Plant Manpower: An Analysis and Forecast for 1985". 1975.

Table III.G.6: Water Treatment Plant Operators Monthly Salary Comparison, 1972

Wastewater[a]	Mean	Public	Private	Industrial
All Plants	556	534	717	751
Secondary Treatment	567	-	-	-
Small Communities	486	-	-	-
Beginning Operators	483			
Water[a]	547			
Water, Steam, and Sanitary Systems			739	
U.S. Average Production and Nonsupervisory[b]	603			

a- Source: "1972 Certified Water Utilities Operator Salary Survey- Report of Findings", Texas Water Quality Board

b- Source: "Employment and Earnings", U.S. Bureau of Labor Statistics, March, 1975 (Refers to December, 1972 the month in which the Texas Survey was conducted).

Table III.G.7: Net Attrition Rate[a] As A Function of Rehire and Turn-Over Rates

Turn-over Rate	Rehire Rate 20%	35%	50%
8%	7%	5%	4.8%
9%	7.5%	6.4%	5.3%
11%	9.1%	7.7%	6.3%

a. $NAR = (TR - DR)(1 - RR) + DR$

Where

NAR = Net Attrition Rate

TR = Turn-over rate

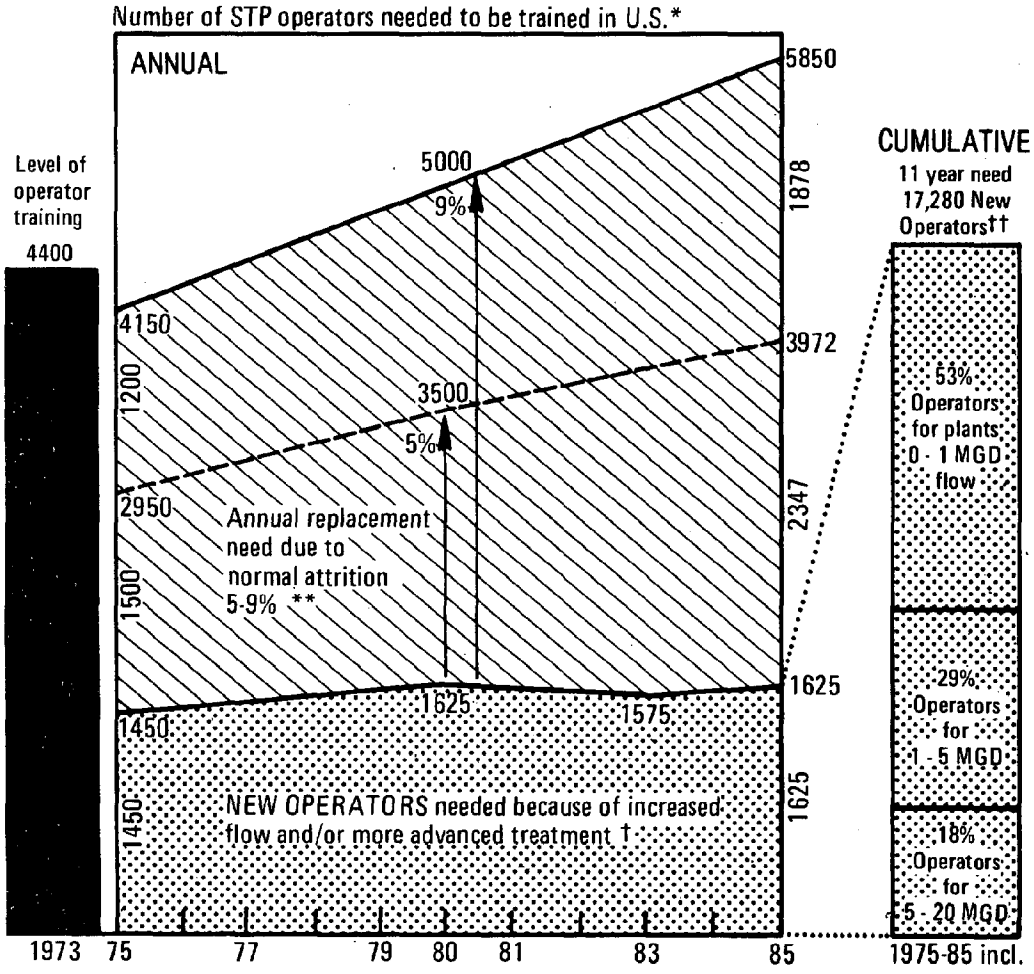
DR = Death and Retirement Rate (1.5%)

RR = Rehire Rate

Source: NCWQ, 1975.

Figure III.G.5

PLANT OPERATORS NEEDED FOR MUNICIPAL SEWAGE TREATMENT PLANTS (STPs) 1975-1985



* Projections based on estimated 29,700 operators in plants with flows of less than 20 MGD in 1974.

** See Table III.G.7

† Assumes secondary treatment by 1985

†† See Table III.G.5. This does not include the cumulative total of operators needed due to normal attrition.

Source: Natl. Commission on Water Quality
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The level of state operator training in 1973 also is presented in Figure III.G.5. This level of training appears to be adequate to meet operator needs at the present, but by 1976 it would be inadequate if the net attrition rate is 9 percent or higher. A program to increase operator salaries to reduce the attrition rate would appear advisable. Further, since the bulk of new operators needed because of added flow and secondary treatment will occur in small facilities which are likely to be in smaller, more isolated communities, the location of training courses relative to this need should be carefully considered.

The other aspect of the municipal sewage treatment plant personnel problem involves the level of skills in the existing work force. Another EPA report presents evidence that training can produce improvements in effluent in plants which are operating at high as well as at low efficiency (14). The report points out that while not all operating problems can be traced directly to inadequate operator skills, successful plant operation seems to be correlated with operator training.

These conclusions can be drawn from this evidence: first, the construction grants program should be augmented with a program to guarantee that adequately trained operators are employed to run new and expanded municipal treatment plants; second, operator training should be prescribed for treatment plants operating at below effluent standards, unless adequate operator skills can be proven; and third, unless municipal treatment plant operator salaries are made more comparable to salaries obtained in private employment, it will be difficult to attract and retain operators with adequate skills.

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H. BENEFITS

The various possible rates and levels of achievement of the goals and requirements of the Act will bring changes in the quality of the nation's waters and water-related environment. The Commission's findings with respect to these consequences appear elsewhere in Section IV. While these consequences can be quantified in various ways according to the traditional measures of water quality and environmental change, they cannot, of themselves, express the full value to society of the accomplishments of the Act.

Full implementation of the Act will require the expenditure of significant sums of money, both public and private. Much of the Commission's effort has been directed to determining the extent and incidence of these costs. Such information naturally gives rise to questions regarding the benefits to be derived -- what relationship do they bear to the costs? To whom do they accrue? Unfortunately the present state of the economic science permits only partial answers.

Benefits consist of increases in the net satisfaction experienced by individuals. Improvements in water quality can increase individual satisfaction in many ways -- some directly related to measurable variables, some indirectly related to measurable variables, and some which currently are not amenable to measurement. Those benefits which can be identified are expressed in terms of changes in willingness-to-pay, permitting, in principle, both quantitative estimates based on measured changes in market variables and the aggregation of those estimates for many individuals. Benefits which cannot be observed or identified also produce changes in individual willingness-to-pay, but since these changes are never manifested in any market, their magnitude or significance is uncertain.

Benefits can be categorized in terms of their impact on market variables:

1. Use-related benefits. Increases in individual satisfaction resulting from the use of water-related goods or services which have been impacted by water quality improvements in one of the following ways:

    a. the supply of the goods or service has been increased, or
    b. the demand for the goods or service has been increased.

2. Non-use-related benefits. Increases in individual satisfaction associated with improved water quality, but not with the use of marketable water-related goods or services.

Consider, for example, a prospective increase in fish populations from improved water quality. Commercial fish harvests would then be larger for a given fishing effort, and retailers would find themselves able to offer a given quantity of fish at a lower price -- an increase in the supply of fish. Consumers would realize a benefit from a lower price.

At the same time, sport fishermen would react to the increased fish population by obtaining greater satisfaction for each dollar spent in pursuing this activity, assuming that the relevant indicator is the time spent fishing, not the pounds of fish caught. Increased satisfaction means that the sport fisherman is willing to spend more time fishing at a given cost, an increase in the demand for sport fishing.

Finally, more individuals derive increased satisfaction from the knowledge of an increased fish population even though they do not engage in sport fishing and are infrequent consumers. When the individual considers the possibility of becoming a user at a future time, the potential value to future generations, or irreversible changes in the environment if improvements are not made such benefits can be attributed to option values. Other individuals may get satisfaction from the mere existence of enhanced environmental quality, without consideration of possible use, or may desire to bequeath an improved environment to future generations.

Whatever the motivation, non-use-related benefits share certain characteristics. No satisfactory empirical methods now exist to obtain quantitative measures of their magnitude, and it is often difficult to identify them. Still, there is evidence that individuals do place values on aspects of the environment without considering possible use. Contributions to "Save the Whale" campaigns come from persons who will never see a whale; reports of pollution of Lake Baikal deep in the U.S.S.R. brought protests from all over the world, etc. For these reasons, estimates of the benefits of water quality improvement must remain conspicuously incomplete, confined to those use-related benefits which can be measured with the aid of market variables.

To learn something of the magnitude of specific classes of measurable benefits expected to follow achievement of the Act, the Commission conducted studies of selected activities in which the levels may change as a result of changing water quality. No attempt is made to go beyond existing analytical methods or data bases, or to quantify all beneficial changes in dollars. Rather, the studies, using available tools, illustrate some of the linkages between water quality and individual satisfaction, and provide a partial estimate of aggregate benefits.

Timing of the Commission's studies required that the examination of benefits proceed simultaneously with environmental assessment analyses and, therefore, both were concluded at about the same time. Assumptions were necessary to enable the benefits studies to be completed within available time. Generally, benefits from the Act were assumed to be zero in 1972 and to increase yearly thereafter as the several requirements of the Act were achieved, with the maximum annual benefits occurring in 1985. Increased annual benefits thereafter reflect only population growth.

"Study Plans", February 1974, outlined the Commission's study design. For its economic impact studies, "As a first step, cost estimates for industrial and municipal requirements for 1977 will be used. Secondly, cost and benefit figures associated with the achievement of the 1983 requirements for industry and municipalities will be used to evaluate the effects on the economy, nationally, regionally and by various industrial sectors." (Emphasis added.) Discussing proposed social impact studies, the Commission stated, "Among the social factors to be considered are . . . available leisure and recreational opportunities . . . and the general quality of life resulting from achieving or not achieving the goals of the Act." The benefits studies are consistent with this announced intent to concentrate on the "benefit(s) . . . associated with the achievement of the 1983 requirements."

Delays in implementing the Act's requirements would shift this 1985 maximum annual benefit level to a later year by whatever number of years the implementation was delayed. Using the 1985 figure for a later year would result in an understatement of the benefits for that and subsequent years since population demands would have increased during the delay. Using the estimates in this manner would also assume no effect from lesser degrees of achievement of the Act's goals, such as irreversible losses caused by the delay.

As Commission study results have become known there has been increased interest in allocating costs, benefits and other effects between achievement of the 1977 requirements and achieving those for 1983. While the benefits studies were not designed to produce a distinct delineation, a rough, arbitrary estimate can be made by applying to the annual quantifiable benefits totals a percentage for each of the two deadline dates.

Unquantifiable intangible benefits are not so easily assignable. Since these reflect individual perception or subjective responses, they do not depend upon distinctions between results of the 1977 and 1983 requirements. For example, individuals may conclude that while the 1977 requirements will protect the quality of an adequate quantity of water for the present generation, only achieving the 1983 requirements will

assure this end for future generations. The Commission's studies did not address this intangible dimension.

Aside from separate assessments of benefits appearing in some of the regional studies, four major national studies were conducted:

1. Marine commercial and sports harvesting of shellfish and finfish(2),

2. Reopening beaches presently closed to swimming for water quality reasons (1),

3. Freshwater recreational activities(4), and,

4. Selected types of water-oriented residential property(3).

Marine Fisheries

The study of marine fisheries reviewed both commercial and sports fishing activities in the estuary, bay, and ocean waters contiguous to the 23 coastal states. The first step was a review of historical impacts of deteriorated water quality on fishing activity and fish harvests, including consideration of both harvestability and productivity. Beginning with information contained in the 1971 National Shellfish Register, published by EPA, a survey was conducted of all 23 states to obtain an estimate of shellfish areas closed to fishing in 1975, primarily because of bacterial contamination (5). Other data, including records of observed fish kills, catch statistics and survey responses, were used to explore the effect of water quality on fishery productivity.

The study of shellfish bed closings indicate that the potential 1975 catch from the closed areas would have been in excess of 700 million pounds (round weight) with a market value of more than $100 million. About one-third of this estimated value consists of species specifically named by the state contacted; the remaining two-thirds is comprised of mobile species, such as crabs and lobsters, unharvestable by reason of their temporary presence in a closed area. In other study results, fish kills in marine waters were found apparently not correlated with water quality, instead they displayed a basically random occurrence pattern. Cases of extinction of species due to water quality changes were investigated and found to be few in number and minor in significance.

Achievement of the Act is expected to affect marine fishery resources in two ways. It will permit the use of many presently unused shellfish areas, and it will increase the productivity of existing fisheries through improved water quality. The rates of reopening of shellfish beds in various states were estimated based on assumed patterns of com-

pliance with the Act. The expected changes in water quality are expressed by means of a marine Water Quality Index (WQI), defined to reflect the relative importance of specific water quality parameters for fishery productivity. The current value of the marine WQI was calculated for 130 specified sectors of coastal water, based on available measurements of water quality parameters. These indices ranged from a low value of slightly more than 8.0 to a high of 100.0 (ideal conditions). Compliance with the Act was then expressed in terms of resulting higher levels of marine WQI for each of the 130 sectors.

Estimates were made of quantitative changes in the productivity and harvestability for each of 10 separate fisheries with significant economic value, and future harvests and fishing activity with and without the water quality changes expected to result from compliance with the Act. The results indicate estimates of total biomass and species distribution for future harvests, and, in the case of sports fishing, estimates of the number of participants and the number of recreation days.

Commercial harvests of all 10 species studied will increase as a result of achieving the goals and requirements of the Act. These increased harvests will bring lower prices, hence benefits to consumers in the form of increased consumer purchasing power associated with commercial marine fisheries rises to more than $575 million per year by 1985, assuming that implementation of the Act proceeds on schedule.* Of this total, about $42 million in annual benefits or less than 8 percent, is attributable to increased harvestability through shellfish bed openings. The remaining benefits derive from water quality-induced productivity increases. These estimates are based on projected price reductions ranging from 10 percent (for lobsters) to more than 50 percent (for clams).

An increase in the value of sports fishing activity following a water quality improvement can be explained either as a change in the value a fisherman places on each day of fishing, therefore, he fishes more often, or as more recreational opportunities being available at the same cost, hence, increased participation. Observed relationships between participation rates and water quality are not uniform, since each fisherman perceives a different cost for any given day of recreation. In this study, consistent with the commercial fishery analysis, it has been assumed that increased participation in sports fishing results

* The nature of these calculations is such that a five-year delay in implementation would shift this number to 1990. This would result in an understatement of the 1990 benefits, as populations and demands in that year would be higher than in 1985. Also, this five-year shift would assume no lesser degree of achievement of the Act's goals, such as irreversible losses in the interim period.

entirely because more recreational opportunities are available at the same cost. Under this assumption, the increased activity of a given fisherman is explained in terms of a wider range of recreational opportunities available to him at any given cost.

Achieving the 1983 goals and requirements of the Act is expected to result in almost 237 million additional days of sport fishing per year by 1985, an increase equal to 76 percent of the total 1974 participation. The increased economic values associated with this trend is forecast to reach $3,300 million per year by 1985, assuming that implementation proceeds on schedule. Annual benefits from both commercial and marine sport fishing for 1985 total some $3.8 billion per year.

Both commercial and recreational fishing activities produce steadily rising benefits in succeeding years since the various provisions of the Act are assumed to produce changes. Since the water quality in 1985 and in succeeding years is assumed to be significantly better than it would have been without the Act, the 1985 benefit level can be assumed to continue as a fixed differential above benefits that would have been realized without the Act, with increased dollar values in future years resulting from population growth, rising incomes, etc.

Beach Reopenings

The second study investigated the impact of the Act on swimming activity. Although the safety and desirability of swimming are affected by a number of water quality parameters, the study was confined to examining changes in the supply of beaches meeting public health criteria, principally those related to coliform bacteria concentrations. The Commission surveyed 38 states containing the majority of water bodies available for swimming in the United States. Survey activities were confined to public and private swimming areas specifically identified as public beaches and subject to public health regulations. Systematically excluded were all areas or water bodies which could potentially support swimming but which were not designated "beaches".

This study identified the magnitude of increased participation which would result if all beaches which now have to be closed when water quality poses a hazard for swimmers, were opened.* The objective was to determine how much swimming would be regained as improvements in water

* Cause of closings were identified and beaches closed due to urban runoff were not assumed to reopen as a result of 1977 and 1983 compliance.

quality enable beaches to reopen. The first step was to survey the preponderance of water bodies in the country with designated public beaches and establish the magnitude of beach supply to be regained if all beaches reopened. Any new area designated as a beach, and approved for swimming by virtue of having been made acceptable for that use through implementing P.L. 92-500, is not included in these estimates.

Excluding private beaches and other areas where shoreline was not formally designated public beach, it is estimated that nationally 1,128 miles and 7,165 acres of public beaches currently are affected by water quality problems (Figure III.H.1). These estimates suggest that as much as 13 percent of both national beach miles and acreage are affected by poor water quality for varying durations of time. Closures averaged one month in duration.

The Commission's study uncovered two separate effects upon participation. The increase in swimming activity expected at reopened beaches is seen to result from a net increase in participation (new activity) and from a redistribution of pre-existing participation levels among the expanded inventory of beaches (diverted activity). The level of new activity is expected to be between 7.8 and 17.2 million activity days in 1985.* Diverted activity is forecast between 39.7 and 156.7 million activity days in 1985.

Assuming that the mean net benefit deriving from the addition of a new activity day is $7.50, and that the diversion of an activity day adds $2.50 in benefits (diversion results from the reopening of more attractive or more accessible beaches) total benefits can be calculated for future years. These estimates, combining benefits from new and diverted activity days, range from almost $158 million to more than $520 million for 1985.

Consistent with the other examinations of benefits, these gains are expected to persist into the future. By the year 2000, the low estimate of total benefits is $212 million for that year, and the high estimate more than $700 million. This continued growth in benefits is consistent with the presumption that swimming participation continues to exhibit a growth trend similar to that of total population.

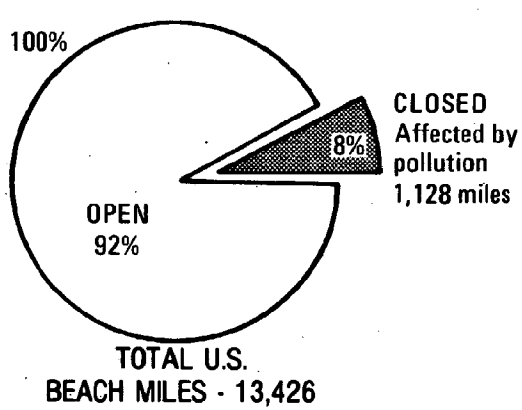
The geographic distribution of reopening of beaches appears to be concentrated in particular sections of the country. The greatest number of beaches currently affected by water quality problems occurs in New

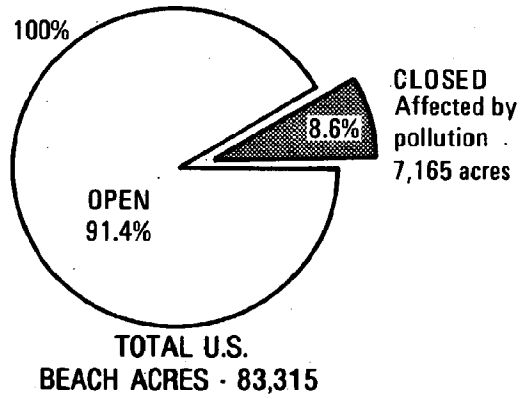
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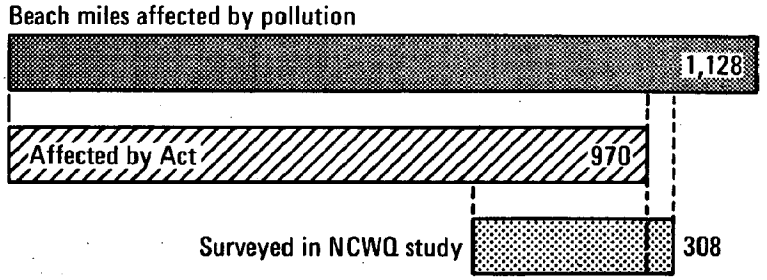
* Low and high estimates reflect alternate methods of estimating the fraction of national beach capacity now affected by water quality problems.

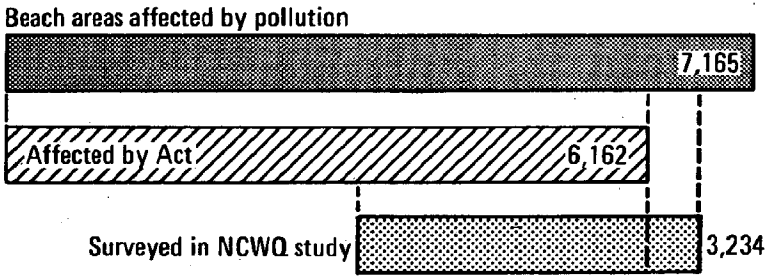
Figure III.H.1

NCWQ SURVEY & ESTIMATES* OF BEACHES** CLOSED DUE TO POLLUTION









* Minimum estimates. Maximum estimates are 57% over low for miles and 54% for acres.

** Lake, river and ocean beaches.

Source: Natl. Commission on Water Quality. From Battelle Memorial Institute, "Assessment of the Economic and Social Implications of Water Quality Improvements on Public Swimming", 1975.

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England, the Mid-Atlantic region, and the Great Lakes states. Since these areas contain significant portions of population, the reopening of beaches there will offer the greatest opportunity for participants to increase swimming as a recreation activity.

Recreation Activities

The third study reviewed the impacts of the Act upon recreational activities associated with freshwater, such as fishing, boating, water skiing, canoeing, sailing, swimming, etc. Early in the investigation it was determined that activities most clearly water quality-related are swimming (examined in the study described above), freshwater fishing, and boating (as distinguished from sailing, canoeing, etc.). This third study was designed to develop quantitative estimates of the expected impacts of the Act on freshwater fishing and boating.

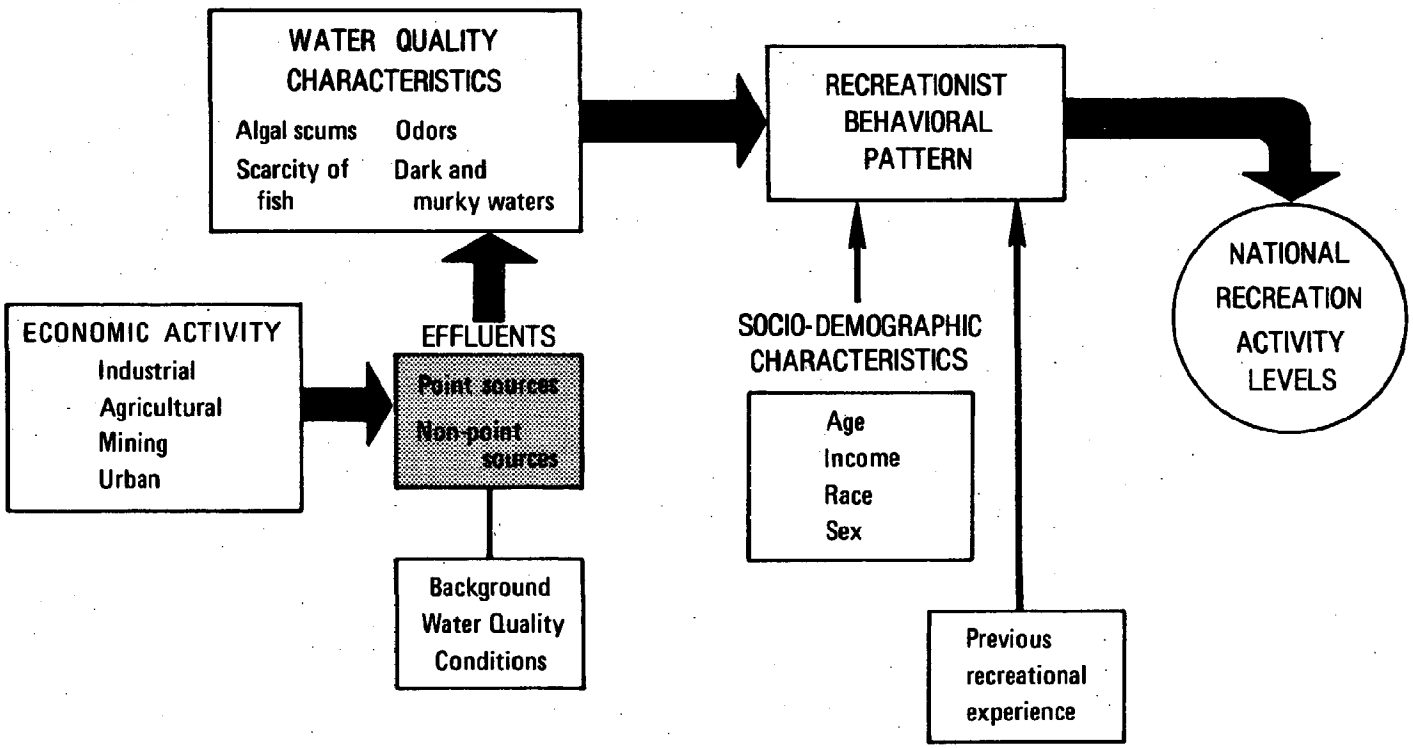
Three distinct types of data are required to delineate the necessary relationships. The first and most fundamental data include historical surveys of recreation activities necessary to establish existing patterns of participation in the recreational activities. Another set of historical data is required to delineate observed relationships between water quality and recreation participation levels for the subject activities. These relationships are used to project the probable impact of the Act on future recreation participation levels. Finally, the basic dimensions of socio-demographic influence on recreation participation must be determined to develop forecasts of future participation both with and without the Act. Superimposed on these data sets are certain institutional considerations which relate to the availability of the resource for specific activities. Figure III.H.2 characterizes the analytical steps in this study.

Both freshwater fishing and boating will increase substantially as a result of the Act. This increase is particularly striking for boating, which is estimated to grow by at least 50 million activity days, and perhaps as much as 115 million activity days by 1985.* Assuming that net benefits obtained from boating average $10 per activity day, these forecasts suggest 1985 benefits in the range of $500 million to $1,155 million. Continued growth in recreation participation after 1985 results in estimates of benefits ranging from $528 million to $1.7 billion for the year 2000.

* Low and high estimates for freshwater fishing and boating reflect alternate assumptions regarding future changes in the socio-demographic characteristics of the population, as well as variations in other assumptions.

Figure III.H.2

INFLUENTIAL FACTORS USED TO STUDY RECREATION PARTICIPATION IN FRESH-WATER FISHING & BOATING



Source: Natl. Commission on Water Quality. From National Planning Association, "Water Related Recreation Benefits Resulting from P.L. 92-500", 1975.

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Freshwater recreational fishing is also responsible for substantial gains. Activity levels are estimated from more than 26 million activity days to about 67 million days in 1985. Average daily benefits are estimated at $8.30, measured in 1975 dollars, based on a 1970 measurement of $6.00 per activity day (1970 dollars). This assumption leads to benefit forecasts of $220 million to almost $560 million for 1985, and $216 million to almost $800 million for the year 2000. These estimates do not include any benefits to be derived from increased participation or increased satisfaction associated with other water-related activities.

Water skiing, canoeing, sailing, and many other water-related activities depend in some way on water quality, but historical data was insufficient to clearly establish these dependencies for the purpose of this study. Benefits obtained from increased swimming have been estimated in the separate study already described. The benefit projections given above, then, represent only a portion of the use-related benefits to be realized from achieving the Act for the nation's freshwater resources.

Property Values

The three studies -- marine fisheries, swimming, and freshwater recreation -- all have examined primarily a single subcategory of benefit -- the use-related one which appears when the supply of some water resource service is increased. The fourth national study has been designed to investigate another type of use-related benefit -- those which appear as a result of changes in values attached to certain amenities provided to the owners and occupants of residential property near water bodies. The generally high prices associated with shorefront properties tend to support this assertion. Accordingly, an improvement in water quality, to the degree it can be perceived by present and prospective residents, can be expected to increase the satisfaction obtained from the use of shorefront property. This added benefit is explained by an increase in buyers' willingness-to-pay for any specified quantity of residential property.

Although the beneficial impact of the Act on residential property is manifested by increased willingness-to-pay, such increases cannot be directly measured with market data. Since real property is normally exchanged following negotiation between buyer and seller, market price can assume any level between a maximum determined by the buyer's full willingness-to-pay and a minimum determined by the seller. The exact price selected depends upon negotiated skills and other factors unrelated to the respective valuations of the property. Accordingly, no market demand curve for real property exists, except in the most general sense, and increases in market price are not necessarily indicative of increased willingness-to-pay. Still, if market prices for water-oriented residential property can be shown to be positively correlated with increases in water

quality, a strong presumption exists that benefits have occurred, although little can be said of their magnitude.

The purpose of this fourth study has been to determine whether objective changes in water quality bring about increases in the market value of nearby residential property, and to predict the magnitude of such increases following implementation of the Act. Since market values would be expected to respond to perceived, rather than objective, changes in water quality, the first step was to explore the relationship between water quality and perceptions of water quality.

Survey research was used to develop a Perceived Water Quality Index (PWQI), a weighted average of separate evaluations of wildlife support capacity, recreational opportunities and five different categories of aesthetic considerations. Seventeen study sites which had experienced recent improvements in objective water quality were selected. They are shown in Figure III.H.3. For each of these sites, a sample of residents was selected, and individuals were asked to quantify their perceptions of water quality before and after the change.

A second survey was conducted of water quality experts having objective knowledge of changes in water quality conditions at each site, and their perceptions were measured on the same PWQI scale. The perceptions of water quality experts, when suitably modified for the effect of public accessibility and water body type, were closely correlated with perceptions of residents.

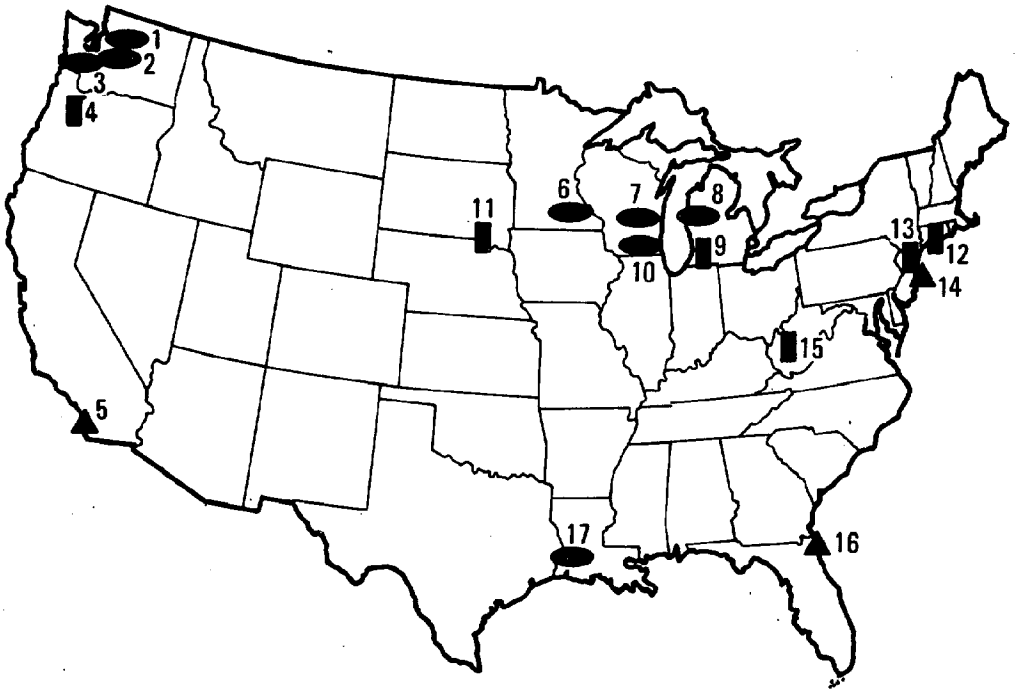
Data was obtained on market prices or representative properties in each of the study areas both before and after the water quality change. Statistical methods were used to explore the relationships between price changes, perceived water quality changes and other potential determinants of property value. Residents' PWQI was indeed influential in explaining increases in market price, and methods were developed to determine the portion of the increase attributable to this effect.

Based on the established relationship between objective water quality and residents' perceptions of water quality, national estimates of changes to be expected following achievement of the Act were developed in the PWQI. Based on data obtained from U.S. Geological Survey and Census maps and reports, regional and national estimates were obtained of the increases in residential property value likely to follow implementation of the Act.

The procedure yields an estimate of the aggregate increase in market value of residential property of $770 million, following achievement of the goals and requirements of the Act. Assuming that private land owners capitalize rents at an annual rate of 12 percent, this increase represents

Figure III.H.3

SITE LOCATIONS FOR PROPERTY VALUE CHANGE STUDY



WEST

1. Lake Washington, Wash.
2. Lake Washington, Wash.
3. Green Lake, Wash.
4. Willamette River, Ore.
5. San Diego Bay, Calif.

MIDWEST

6. Lake Minnetonka, Minn.
7. Marion Mill Pond, Wis.
8. Hart Lake, Mich.
9. Kalamazoo River, Mich.
10. Brown's Lake, Wis.
11. Big Sioux River, S.D.

NORTHEAST

12. Mystic River, Conn.
13. Rockaway River, N.J.
14. Navesink/Shrewsbury R., N.J.

SOUTH

15 Kanawha River, W.Va.
16. St. John's River, Fla.
17. Lake Charles, La.

KEY Lakes ⬬
Bays ▲
Rivers ▮

Source: Natl. Commission on Water Quality. From David M. Dornbusch & Co., "The Impact of Water Resource Quality Improvements on Residential Property Prices", 1975.
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an annual benefit level of almost $93 million per year by 1985. Since property values have been shifted upward in an essentially permanent manner, this benefit level can be assumed to persist indefinitely. As noted above, these results describe changes in market value only, and cannot be used as quantitative estimates of total benefits accruing to owners of water-oriented residential property.

Summary

The results of all four national studies are summarized in Table III.H.1. Annual gains are given for each of the use categories studied, and for the years 1980, 1985 and 2000. In all cases, dollar gains rise steadily from the base year, 1972, through 1985 when the 1977 and 1983 requirements of the Act are assumed fully implemented. Certain of the benefit measures remain constant after 1985, but some continue to grow through the year 2000 because of increasing participation in the benefited activity. The sum of quantified dollar gains for those benefit categories specifically investigated increases from $3.1 billion per year in 1980 to $4.8 billion per year in 1985, reaching almost $6.3 billion per year in the year 2000, considering only the low estimates. If the high estimates of benefits from public swimming and freshwater recreation are considered, the sum of all quantified gains increases from almost $4.2 billion per year in 1980 to $6.2 billion per year in 1985, reaching more than $8.5 billion per year in the year 2000.

The cumulative magnitude of these benefit estimates can be represented by calculating the present value of the future time-stream of benefits, given an appropriate discount rate and time horizon. The results of several such calculations are given on Table III.H.2. The first column contains 1975 present values for the categories of benefits specifically investigated, considering only those benefits which occur during the period of implementation (1972 through 1985) and discounting at zero percent. This provides estimates of the cumulative dollar gains expected during the period of implementation. These estimates are presented in this way so as to be comparable with estimates of cumulative costs of implementation for the same period, although it must be remembered that only a few categories of benefit have been considered, and that such an estimate does not include substantial benefits expected after 1985. The estimates of cumulative benefits for the period 1972-1985, as shown in Table III.H.2, range from almost $34 billion to more than $43 billion.

A preferable method for aggregating dollar amounts which occur over a period of years is to compute a present value using a discount rate which reflects the relevant social rate of time preference and risk allowance. Since all future benefit estimates have been calculated on the basis of 1975 prices, no allowance for future price inflation need

TABLE III.H.1: SUMMARY OF ESTIMATED BENEFICIAL IMPACTS OF P.L. 92-500 ON SELECTED ACTIVITIES (ALL FIGURES ARE INCREASES OVER PROJECTED BASELINE - 1972 INCREASES = 0.0; ALL DOLLAR FIGURES ARE IN MILLIONS OF 1975 DOLLARS)

Activity	1980		1985		2000[1]	
	Annual Activity Days (Millions)	Annual Benefit ($ Million)	Annual Activity Days (Millions)	Annual Benefit ($ Million)	Annual Activity Days (Millions)	Annual Benefit ($ Million)
Marine Fishing:						
Recreational	144.8	2,029.3	236.6	3,299.6	318.4	4,440.9
Commercial	--	401.4	--	575.1	--	774.0
Public Swimming:						
New Activity[2]						
(Low Estimate)	7.0	52.8	7.8	58.3	10.5	78.4
(High Estimate)	15.6	116.9	17.2	129.1	23.2	173.8
Diverted Activity[3]						
(Low Estimate)	36.0	89.9	39.7	99.3	53.5	133.6
(High Estimate)	141.9	354.8	156.7	391.8	210.9	527.3
Fresh Water Recreation:						
Fishing[4]						
(Low Estimate)	26.3	218.3	26.5	220.0	26.1	216.6
(High Estimate)	63.5	527.1	67.3	558.6	96.3	799.3
Other Boating[5]						
(Low Estimate)	30.6	306.0	49.8	498.0	52.8	528.0
(High Estimate)	69.5	695.0	115.5	1,155.0	174.2	1,742.0
Property Values:[6]						
Recreational	--	61.7	--	92.5	--	92.5

1- Population growth through 2000 assumed two percent per year.

2- Benefits for New Swimming Activity estimated at $7.50 per activity day.

3- Benefits for Diverting Swimming Activity estimated at $2.50 per activity day.

4- Benefits for Fresh Water Recreational Fishing estimated at $8.30 per activity day, based on 1970 estimate of $6.00 per activity day (1970 dollars).

5- Benefits for Fresh Water Boating estimated at $10.00 per activity day.

6- Property owners are assumed to discount their holdings at 12 percent per year.

Source: National Commission on Water Quality

TABLE III.H.2: AGGREGATE ESTIMATES OF BENEFICIAL IMPACTS OF P.L. 92-500 ON SELECTED ACTIVITIES (ALL FIGURES ARE 1975 PRESENT VALUES EXPRESSED IN MILLIONS OF 1975 DOLLARS)

Discount Period:	1972-1985		1972-2000
Discount Rate:	0%*	4%	4%
Marine Fishing	26,046	20,455	54,188
Public Swimming:			
(Low Estimate)	1,581	1,306	2,678
(High Estimate)	5,226	4,317	8,852
Fresh Water Recreation:			
(Low Estimate)	4,986	3,996	9,031
(High Estimate)	11,670	9,344	23,823
Property Values	706	572	1,267
Totals			
(Low Estimate)	33,319	26,329	67,164
(High Estimate)	43,649	34,688	88,130

* Discounting at 0 percent produces cumulated dollar amounts during period of implementation, regardless of time of occurrence.

Source: National Commission on Water Quality

be included. Estimates of the level of a discount rate which incorporates these considerations may vary, but few would suggest a rate higher than 4 percent. Calculations of present value based on a 4 percent discount rate, then, would represent conservative estimates of the present worth of the benefit streams under consideration. The second and third columns of Table III.H.2 contain the results of such calculations, giving present values of benefits expected during the implementation period (1972-1985, column 2) and during the period 1972-2000. In the first case, the present value ranges from less than $27 billion to more than $34 billion. The longer period produces estimates which range from less than $68 billion to more than $88 billion. Extending the time horizon beyond the year 2000 would produce still higher present values, approaching $200 billion if the indicated benefits are assumed to persist indefinitely after full implementation of the Act.

The Commission's studies of possible benefits from the Act fall far short of a true measure of total benefits for several reasons.

1. The studies have considered only use-related benefits. Non-use-related benefits exist, but economic theory and analytical techniques and required data currently available will not yield useful estimates of their identity or magnitude.

2. Only selected use categories were explored. A number of additional freshwater recreational activities can be expected to produce benefits comparable to those actually estimated. In these cases, however, available historical data on recreation patterns and relationships between participation and water quality would not permit their inclusion in the study. There are additional use categories which have not been considered in any study, either for lack of identification or lack of data. Benefits from abatement of human health hazards are not considered.

3. Results of the various studies may not be comparable. Each study was deliberately designed to utilize a methodology and data sources distinct from other studies, to the extent possible. This approach has produced considerable information concerning the adequacy and applicability of existing benefit estimation techniques, but it produces results which are not necessarily comparable. The relationship between benefits from saltwater fishing as opposed to freshwater fishing, for example, may reflect the relative adequacy of the benefit measure chosen and data available rather than a true ranking of the two classes of benefits.

4. Not all of the studies attempt direct measurement of benefits. One study, for example, predicts increases in the aggregate market value of residential properties as a result of improved water quality. As discussed earlier, this result is strong evidence for the presence of increases in willingness-to-pay, the proper measure of benefit, but it

does not provide a quantitative estimate of the magnitude of the benefit. In another case, the results of the swimming study are based on a simple, deliberately conservative, assumption regarding the relationship of benefits of participation days.

5. The data bases and methodologies used are often less than adequate for their intended purpose. Fundamental source materials for characterizing recreational behavior, identifying the determinants of such behavior, and documenting linkages between water quality and recreation frequently are incomplete, compiled on inappropriate bases, or out-of-date. The last usable national survey of recreation activity was conducted in 1970. The development of the relevant theoretical considerations and empirical procedures is in its infancy. Should there be continued interest in information relating to the quantification of economic impacts of water quality changes on leisure time activity, a basic and comprehensive data collection and analysis program needs to be initiated. Such a program does not now exist, and continuous data collection and analysis have not been sustained.

The studies have shown that achievement of the goals and requirements of the Act will result in significant economic benefits to many groups of recreational water users. Furthermore, owners of residential property located near water are shown to obtain benefits. The quantitative estimates presented in Tables III.H.1 and III.H.2 should be reviewed as partial measures of the magnitude of these benefits. Because many classes of potential benefits, including those related to health effects and all non-use-related benefits, have not been considered in these studies, the benefit estimates presented are believed to understate the true magnitude of economic benefits by an undetermined amount.

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(2) Bell, Frederick W. and Canterbery, E. Ray. Florida State University, Department of Economics. An Assessment of the Economic Benefits Which Will Accrue to Commercial and Recreational Fisheries from Incremental Improvements in the Quality of Coastal Waters. 1975.

(3) David M. Dornbusch and Company, Inc. The Impact of Water Resource Quality Improvements on Residential Property Prices. 1975.

(4) National Planning Association. Water-Related Recreation Benefits Resulting from P.L. 92-500. 1975.

(5) U.S. Environmental Protection Agency. 1971 National Shellfish Register.

I. SOCIAL IMPACTS

1. Introduction

Any definition of "social impacts" is debatable. When considering P.L. 92-500 the difficulty lies not in finding impacts but in selecting those areas which can be meaningfully analyzed and discussed. For this analysis the Commission avoided qualitative and subjective approaches and used the primary social impacts of the direct economic and environmental consequences of the Act as the basis for analysis.

These social consequences derive from changes in levels and composition of employment, migration, costs of pollution control and recreational activities. The analysis of social costs and benefits consists generally of assessing how different social groups or geographical regions are disproportionately affected by the Act's economic and environmental impacts.

Social costs may occur as job losses, higher taxes or prices of goods resulting from pollution control requirements. Other social "costs" may result from the failure to control municipal or industrial discharges. Some of these costs are addressed in the analysis of the Act's benefits. Others, such as possible impacts of an accumulation of toxic substances in absence of the Act, are not. Since environmental data on this hypothetical cost are incomplete, it is difficult to get a handle on its specific social impact.

For the social impact analysis, "benefit" is limited to changes in social behavior related to swimming, boating, sport and commercial fishing and employment generated by the Act. The people who have greatest access to these activities are those likely to be affected most.

An early and still valid presumption was that large numbers of workers may be displaced as a result of the law. The major negative impact on employment results from industrial plants shutting down or moving elsewhere. However, jobs created in construction and supply industries will outnumber the losses from predicted plant closures. While a plant closure means that individual workers will lose jobs in one area, jobs will become available in another. Thus, while a shutdown will cause losses in certain communities, it is not expected to produce a net loss of jobs nationally.

This does not mean, however, that no one will be adversely affected by the Act. Persons losing jobs or businesses because of the impact of industrial or agricultural water pollution control expenditures may not be qualified or geographically located so as to take advantage of the new or increased job opportunities resulting from implementation of

the Act. Too often individual impacts are lost in the summing of plusses and minuses in total employment; the losses are no less real and severe to those persons adversely affected. The fact that dislocations may be temporary or short-range is of little comfort to the unemployed.

2. Social Impacts: Demographic and Quantitative Analysis

a. Social Profile: The Commission focused on selected social characteristics of the United States as a whole, the four U.S. Census regions and selected river basins. The primary social characteristics chosen for analysis include: sex, race, age, income and migration and growth patterns. Variations in these characteristics (the social profile) are defined for the major Census regions.

1. Employment changes generated by shifts in direct industrial employment and jobs created by the Act.

2. Incidence of costs: (a) municipal taxes, (b) consumer price changes.

3. Incidence and distribution of benefits by region and by social group.

Economic and environmental impacts have social consequences. Those environmental changes produced by the Act will change recreational and water use patterns. These changes will be distributed among distinct population groups. In addition to the aggregate assessments there are a number of qualitative local impacts which are addressed in a series of case studies.

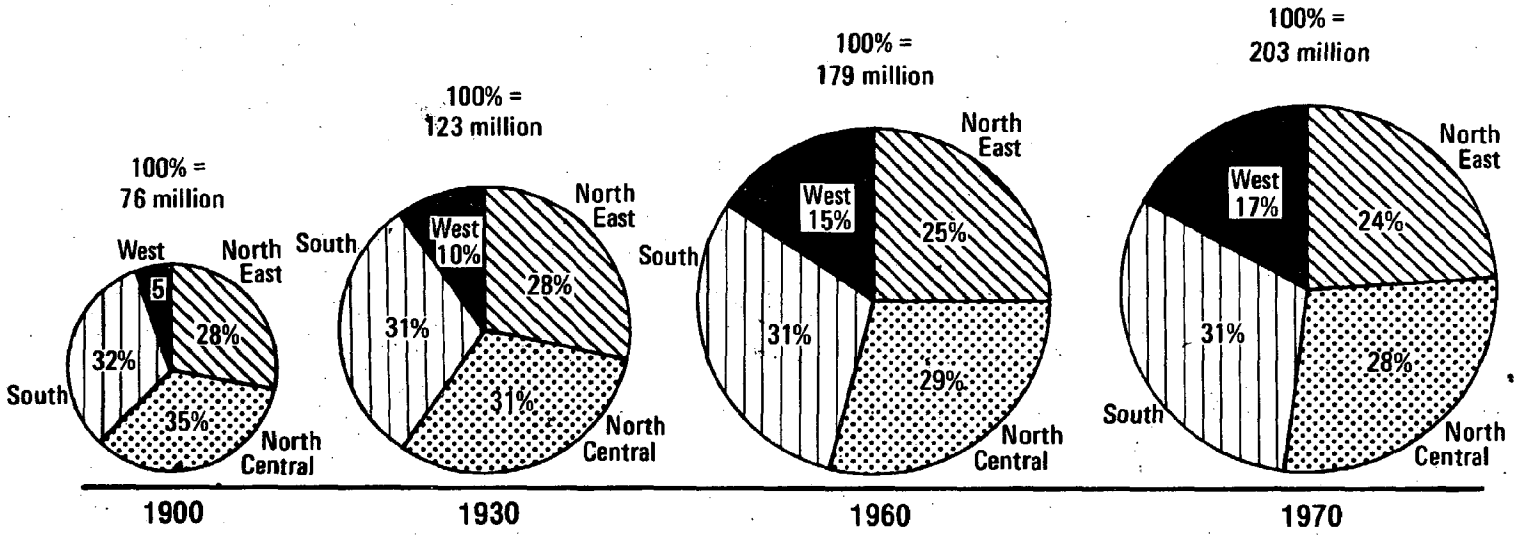
b. Population Baselines:

United States: The distribution of the U.S. population among the four Census regions has remained fairly constant (Figure III.I.1). It is projected to remain so into the 1990's. Both the U.S. and regional populations will continue to increase at a decreasing rate throughout 1990. Of the four census regions, the West will experience the largest population increase. In 1970 the U.S. population consisted of 51 percent women and 48.5 percent men. Whites accounted for about 87 percent, blacks about 11 percent and other minorities the remainder. Sex and race composition for the U.S. population are assumed to remain constant (10).

The average age will continue to shift upwards and is projected to accelerate through the end of the century. This is due to declining birth rates and increasing longevity. In 1970, 28 percent of the population was under 15 years. This percentage will decline to 22

Figure III.1.1

U.S. POPULATION GROWTH AND REGIONAL DISTRIBUTION 1900-1970



Source: Natl. Commission on Water Quality. From Human Resources Planning Institute, "The Social Impacts of P.L. 92-500", 1975.

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percent by 2000. The 15-24 age group will show a small decline during that period. Age group 25-44 will show the highest increase, from 23 percent to 29 percent. By 1990, more than half of the population will be in labor-force age categories.

The demand for recreational activities follows from the preference patterns by age category (8). Income distribution for 1970 shows the median family income to be $10,000 per year. Over 10 percent earned more than $15,000 and over 27 percent earned between $10-15,000. At the lower end of the scale, 8.3 percent made less than $3,000. Comparing 1970 income distributions to 1960, income distribution is narrowing with more families having incomes in the $10,000+ categories.

The Northeast and Northcentral regions have higher percentages of families in upper income levels ($10,000+) and fewer in lower levels (Figure III.I.2). The Western region has higher percentages in the upper income groups. The Southern region shows the greatest difference from either the U.S. average and the other regions. In this area the income distribution is concentrated toward the lower range, with 21 percent of the families earning less than $3,000 per year, compared to 8 percent nationally. Eleven percent earn between $3-5,000 (compared to 11.1 percent nationally), and 13.5 percent earn between $5-7,000 (compared to 13.5 percent nationally). 23.6 percent earn between $10-15,000 as compared to 27.3 percent nationally, and 19.4 percent make over $15,000 compared to nearly 30 percent nationally. The specific impacts that the population will experience from the Act are proportional to the income distribution.

c. Labor Force:

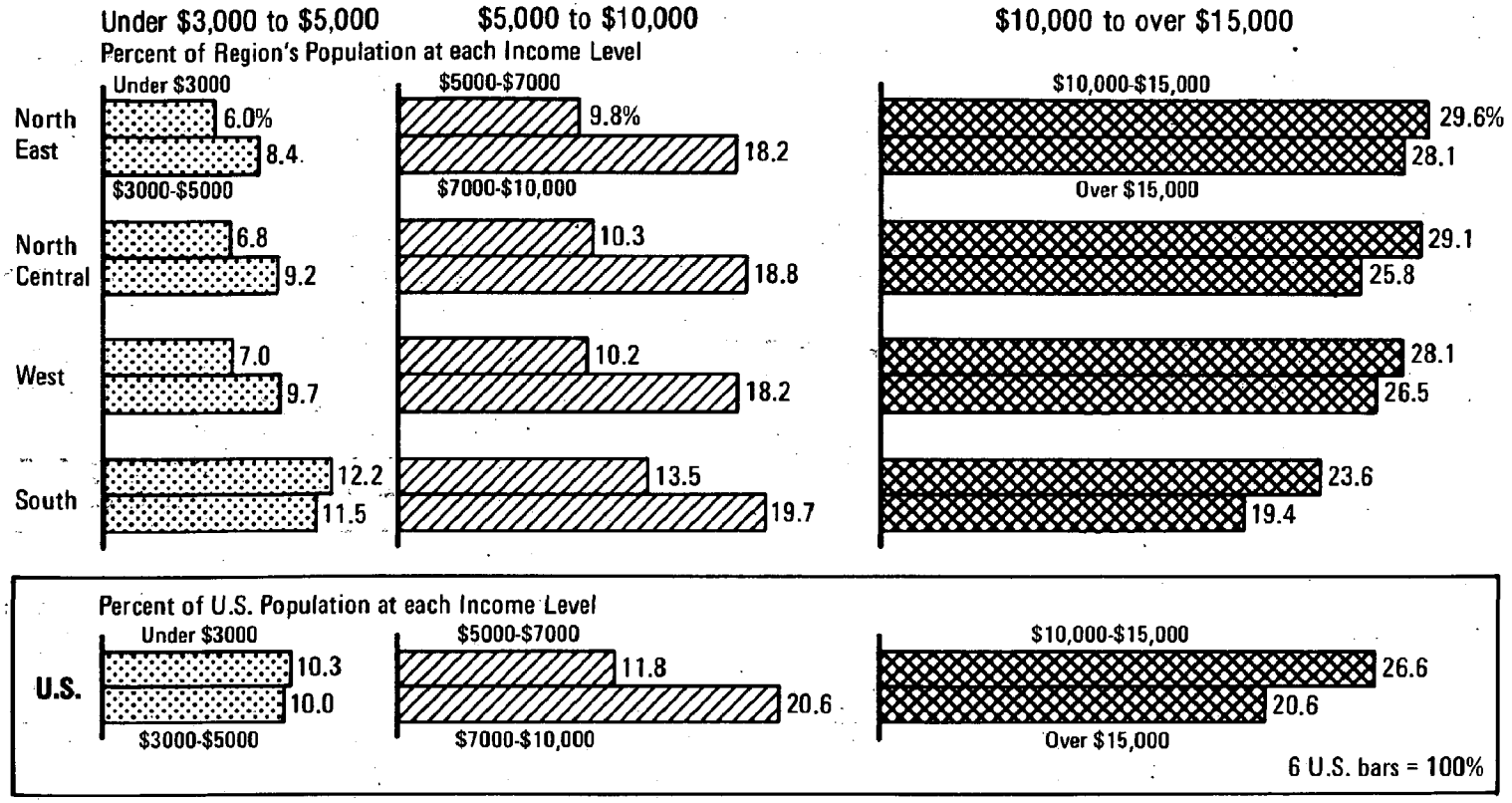
In 1970, 76,554,000 people were employed. This included 26.2 percent service industry, 25.9 percent manufacturing and 20.2 percent in wholesale and retail trade. Other categories -- transportation, communication, public utilities, agriculture, forestries, and fisheries -- accounted for 27.4 percent.

Major water-using industries accounted for 25.6 percent of total manufacturing employment. They are food processing, textiles, lumber and wood, pulp and paper, chemical products, petroleum refining, leather curing and tanning, primary iron and steel, primary nonferrous metals and electroplating.

The social characteristics of the population show differences in distribution among types of employment. The largest concentration of black employment, 36 percent, is in the service industries. Manufacturing has 24.3 percent blacks, and retail trade has 13.8 percent. White employment is more evenly distributed, with manufacturing, services, and

Figure III.I.2

INCOME DISTRIBUTION OF POPULATION BY CENSUS REGIONS 1970



Source: Natl. Commission on Water Quality. From Human Resources Planning Institute, "The Social Impacts of P.L. 92-500", 1975.

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trade having 26.2 percent, 25.1 percent, and 20.7 percent respectively. Age distribution does not appear to be a factor in employment characteristics of the water-using and non-water-using industries.

The profiles are for the year 1970 and may undergo some changes by the years 1977, 1983, and 1985.

Historical labor force participation rates are shown in the following table:

TABLE III.I.1: PARTICIPATION IN THE LABOR FORCE BY SEX AND RACE, 1955-1970

Year	"White" Male Percent	"White" Female Percent	"Black & Other" Male Percent	"Black & Other" Female Percent
1955	85.4	34.5	85.0	46.1
1960	83.4	36.5	83.0	48.2
1965	80.5	38.1	79.6	48.6
1970	80.0	42.6	76.5	49.5

Source: NCWQ. From Human Resources Planning Institute. "The Social Impacts of P.L. 92-500", 1975.

If trends shown in this table continue, the increase in the participation rate for women would change the composition of the labor force in future years. Declines in male participation rates would be reflected in changes in leisure time and working habits.

Some of the decline in the male rate results from the increasing age of the population, and greater numbers of retirees.

The decline in the white male employment also reflects shifts in the economy away from primary manufacturing to the service industries. This decline in employment will decrease the number of workers affected when the Act is implemented. The more rapidly growing sectors of the economy, such as services, will not be directly impacted.

When demographic and employment characteristics are examined on a census region basis, wider differences and variations occur.

(1) Northeast Census Subregion:

There were 19 million persons employed in this area in 1970 - 25 percent of all employment in the United States.

Table III.I.2 shows that the Northeastern water-using industries have relatively fewer females and black workers than the non-water-using sector.

TABLE III.I.2: CHARACTERISTICS OF LABOR FORCE; NORTHEAST REGION

	As A Percent of Total Employment	Percent Female	Percent Black
Water Using Industry	6.5	22.3	5.9
Non-water Using Industry	93.5	39.4	8.0

Source: NCWQ. From Human Resources Planning Institute, "The Social Impacts of P.L. 92-500", 1975.

(2) The Northcentral Census Region:

In 1970 this region had a total labor force of 21,650,000, with 1,351,000 persons or 6.2 percent of the total employment in water-using manufacturing industries.

In total, including all other directly impacted industries, the water-using industries account for 14.9 percent of the total male work force. Iron and steel is the largest employer, accounting for 2.67 percent of the total male work force in the region. Food processing was second with 1.23 percent of the male work force.

Women in this region are less likley to be directly impacted by the Act. Of all working women in the region, only 3.85 percent are employed in industries likely to be affected. Concentrations of women in the major water-using industries is in textiles.

Of the total black employment in the region, 8.1 percent was in the water-using industries. One-half of these are in primary iron and steel manufacturing. 11.2 percent of white employment occurred in industries likely to be affected by P.L. 92-500.

(3) South:

Of the total U.S. employment 29.8 percent of the 22.8 million occurred in the South. (Figure III.I.3) The water-using industries have a larger relative share of employment in the South than in the remainder of the United States. Of that employment, somewhat more is black, 18 percent, and thus, the impact of the Act may be more significant for the black population than for white.*

A major employer in the South is textiles. Textile employment in the South represents 71.6 percent of the U.S. textile industry. Southern mining has 52.4 percent of the U.S. mining total: lumber and wood 44.1 percent; petroleum refining 40.2 percent, and chemicals 39.2 percent. In assessing the impact of the Act the size of employment shares must be balanced against vulnerability factors, such as the growth rate of the area, re-employment opportunities, and the stimulative employment impacts of the Act in the particular region.

(4) West:

This region has the smallest percentage of the nation's work force, 16.8 percent. Manufacturing in the West accounts for 19.2 percent of the work force as opposed to 25.9 percent nationally. Western employment in the water-using industries represents 3.2 percent of the total.** Of those in the water-using industries, there were more males (24.2 percent) than females (14.9 percent), and more whites and other (22 percent) than blacks (17.4 percent). Any direct unemployment effects would impact white males with greater frequency.

(5) Regional Comparison:

An examination of the relative shares, by census region, for each major industrial sub-group shows the South and West to have larger shares for mining, and a concentration of construction employment in the South.

Manufacturing is still concentrated in the Northeast and Northcentral regions. The South, however, is an area of concentration of the water-using industries with a 37 percent share of employment in those industries.

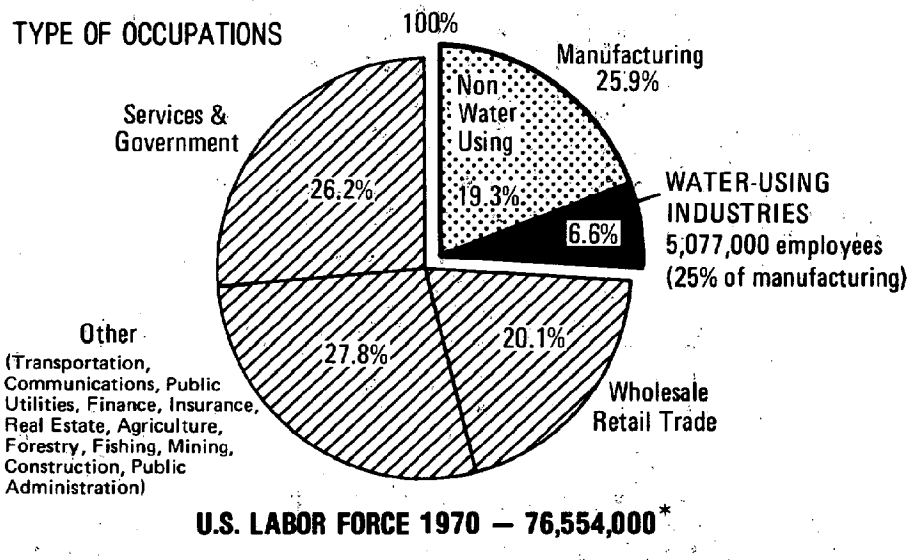
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* For the U.S., black workers are 9.6 percent of the labor force.

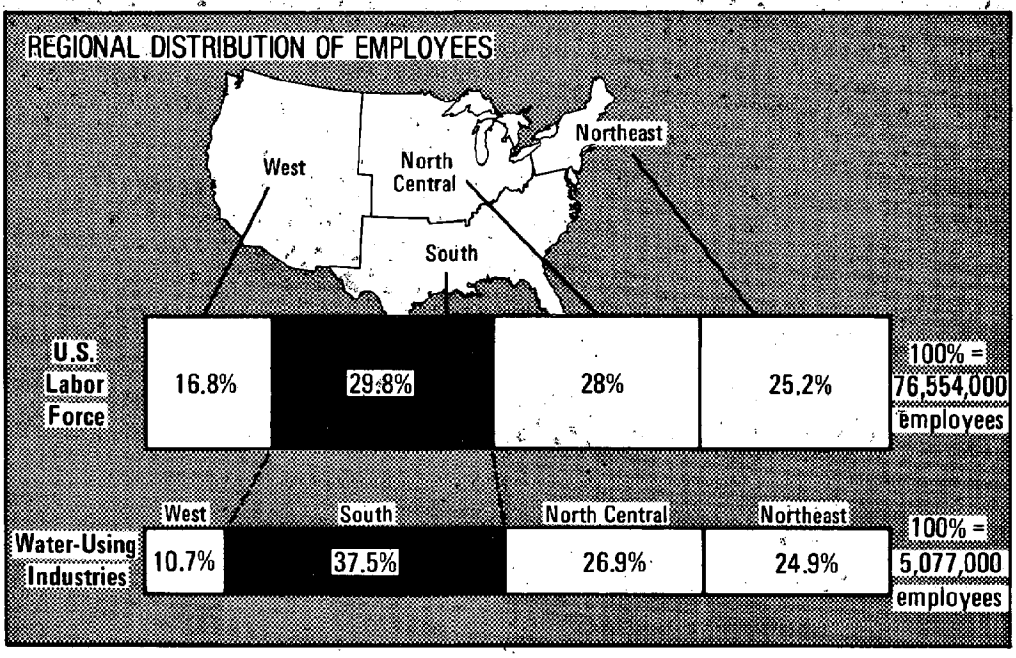
** This does not include irrigated agriculture.

Figure III.I.3

EMPLOYEES IN WATER-USING INDUSTRIES IN RELATION TO U.S. LABOR FORCE DISTRIBUTION



U.S. LABOR FORCE 1970 — 76,554,000*



*Civilian labor force.

Source: Natl. Commission on Water Quality. From Human Resources Planning Institute, "The Social Impacts of P.L. 92-500", 1975.

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The major locations of the water-using industries are shown in Table III.I.3 and Figure III.I.4.

The dependence of the South on water-using industries does not necessarily follow from the significance of water supply in choosing industrial locations. Other influences include the presence of raw materials and a historic dependence on extractive industries. In addition, the region's lower wage rates have attracted industries. This is a trend which will influence the regional impacts of the Act. Using a baseline of 100, wages for the Northeast are 95; the South 80; Northcentral 108; and West 99 (2).

The relative distribution of plant closings and wage rates from region to region shows a high degree of correlation. But wage rates are only one of the factors in plant closures. Others include age of plants and pollution costs, as well as regional growth patterns and their impact on industry viability.

The significance of this mix of factors influencing plant closure can be seen by comparing the distribution of vulnerable plants to the distribution of major water-using industry per se:

Industry	Primary Region of Vulnerability[a]
Textiles	Northeast, Northcentral
Iron and Steel	Northeast, West
Nonferrous Metals	West, South
Petroleum Refining	All regions experience long-run decline in employment.
Pulp and Paper	Northeast, Northcentral
Electroplating	All regions experience long-run growth

a. NCWQ. From National Bureau of Economic Research. Reports prepared for the Commission.

Table III.I.4 and Figure III.I.4 show the regional distribution of employment for the major water-using industries. The South Census region contains a large share of employment in this sector, and has a lower average wage rate. Wages in the most heavily impacted areas, the Northeast and Northcentral states, are 15 percent to 28 percent higher. This differential will accentuate the impact in these two regions, with possible loss of employment to the South.

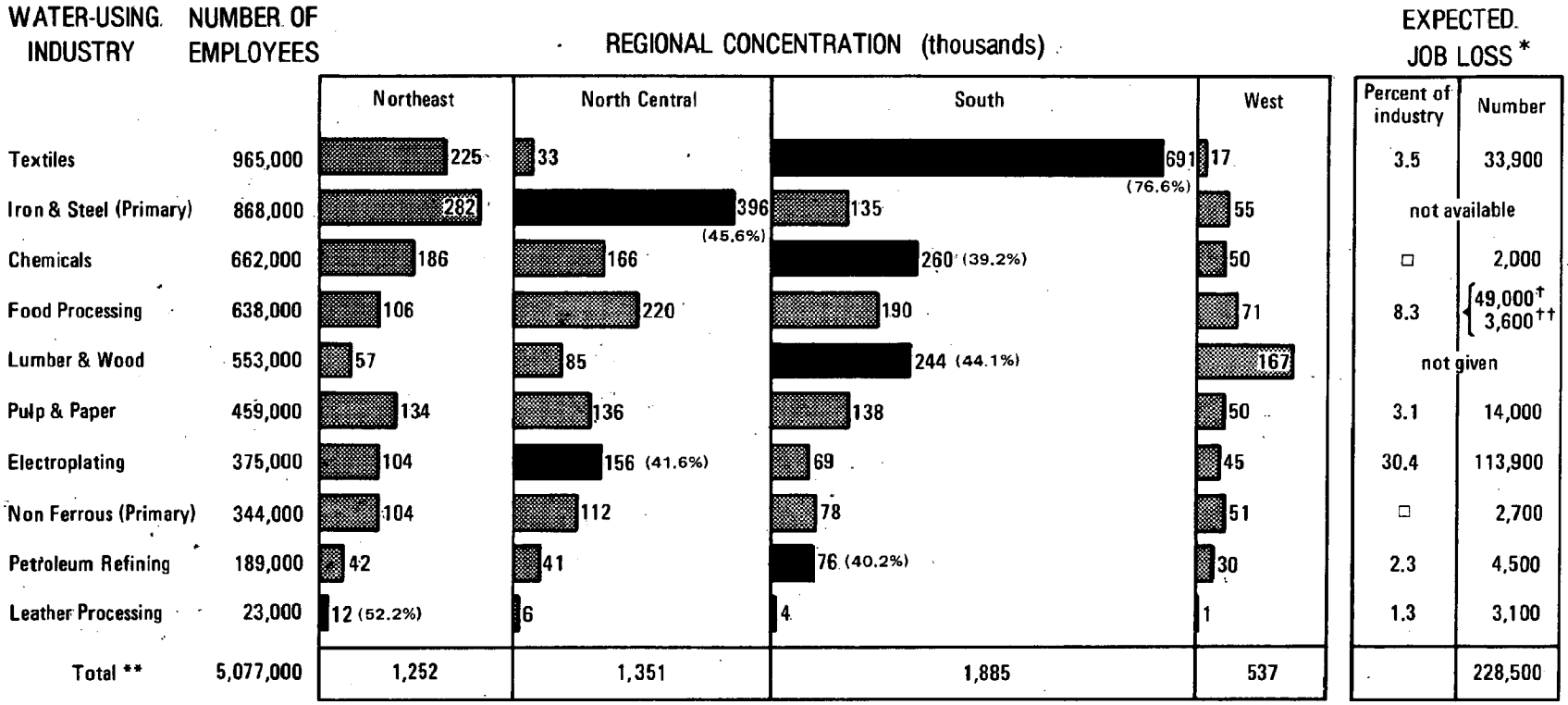
TABLE III.I.3: EMPLOYMENT SHARES OF WATER USING MANUFACTURING INDUSTRIES

RANK	UNITED STATES	NORTHEAST	NORTH CENTRAL	SOUTH	WEST
1	Textiles	Primary Iron & Steel	Primary Iron & Steel	Textiles	Lumber & Wood
2	Primary Iron & Steel	Textiles	Food Processing	Chemicals	Food Processing
3	Chemicals	Chemicals	Chemicals	Lumber & Wood	Primary Iron and Steel
4	Food Processing	Pulp & Paper	Electroplating	Food Processing	Primary Nonferrous Metals
5	Lumber & Wood	Food Processing	Pulp & Paper	Pulp & Paper	Pulp & Paper
6	Pulp & Paper	Electroplating	Primary Nonferrous Metals	Primary Iron and Steel	Chemical
7	Electroplating	Primary Nonferrous Metals	Lumber & Wood	Primary Nonferrous metals	Electroplating
8	Primary Nonferrous metals	Lumber & Wood	Petroleum Refining	Petroleum Refining	Petroleum Refining
9	Petroleum Refining	Petroleum Refining	Textiles	Electroplating	Textiles
10	Leather	Leather	Leather	Leather	Leather

Source: NCWQ. From Human Resources Planning Institute. "The Social Impacts of P.L. 92-500". 1975.

Figure III.I.4

EMPLOYEES IN WATER-USING INDUSTRIES BY NUMBER, REGIONAL CONCENTRATION, & EXPECTED JOB LOSS DUE TO THE ACT*



KEY

■ Major concentration of employees in each industry (over 39%)

* Job loss due to plant closures and indirect losses attributable to meeting 1983 BAT limitations. See Table III.I.5 and Figure III.I.5 for compensating job increases due to the Act.

□ Less than 1%

† Meat processing

†† Dairy processing

** Rounding of numbers accounts for difference in sum of regional breakdowns

Source: Natl. Commission on Water Quality. From Human Resources Planning Institute, "The Social Impacts of P.L. 92-500", 1975.

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TABLE III.I.4: 1970 PERCENT DISTRIBUTION OF WATER-USING INDUSTRIAL EMPLOYMENT BY CENSUS REGION

	Northeast	Northcentral	South	West
Food Processing	16.6	34.5	29.8	11.1
Textiles	23.3	3.4	71.6	1.8
Lumber and Wood	10.3	15.4	44.1	30.2
Pulp and Paper	29.2	29.6	30.1	10.9
Chemical Products	28.1	25.0	39.2	7.5
Petroleum Refining	22.2	21.7	40.2	15.9
Leather Tanned & Cured	52.2	26.1	17.4	4.3
Primary Iron and Steel	32.5	45.6	15.6	6.3
Primary Nonferrous	30.5	32.6	22.7	14.8
Electroplating	27.7	41.6	18.4	12.0
Total Water-Using Industries	24.7	26.6	37.1	10.6
Total Employment	25.2	28.3	29.8	16.8
Population	24.1	27.8	30.9	17.1

Source: NCWQ. From Human Resources Planning Institute. "The Social Impacts of P.L. 92-500", 1975.

When plants close industry frequently migrates to areas where labor and raw material costs are lower. Thus, the total impact would in these cases cause a net decline in wages and regional shifts in employment, but no net decline in total national employment.

(6) Employment Impacts:

P.L. 92-500 can have a wide range of employment impacts. These impacts include increased employment in treatment plant construction and the supply industries, and the negative impacts of plant closings. Overall the net effect of the Act is to increase employment over the decade 1975-1985. (Table III.I.5) The major direct labor requirements of the Act fall in the area of treatment plant construction, and allied activity generated by the direct and indirect* requirements in the water pollution control and related supply industries. The level of additional

* If direct requirements or employment impacts are those which involve the supply industry response to compliance demands, then indirect consequences are those additional responses of all other economic activity linked to the supply industries.

TABLE III.I.5: P.L. 92-500: IMPACT ON EMPLOYMENT 1975-1985

Totals Job/Year in Thousands

		75	76	77	78	79	80	81	82	83	84	85
Construction Direct and Indirect	(1)	89	296	472	193	138	145	176	209	214	79	86
Other Supply Industries Direct and Indirect	(2)	115	545	1051	836	363	350	506	576	593	537	569
Operating and Maintenance	(3)	26	119	247	271	279	295	308	315	323	564	575
Job Increases Total	(4)	230	960	1770	1300	780	790	990	1100	1130	1180	1230
Plant Closings	(5)			-91						-28		
Indirect Losses in Related Industries	(6)			-76						-34		
Job Losses Total	(7)			-167	-167	-167	-167	-167	-167	-299	-299	-299
Net Employment Impact Job Increases	(4) -(7)	230	960	1603	1133	613	623	823	933	901	951	1001
Equilibrium Forecast		92	195	329	393	424	412	349	204	8	-342	-888

Source: National Commission on Water Quality
From various Commission studies. February, 1976.

jobs per year in construction reaches a peak in 1977 at 472,000 (Table III.I.5 and Figure III.I.5) and remains in excess of 100,000 through 1983. Labor requirements in the supply industries show a similar pattern. The increases in operating and maintenance employment are projected to grow from 26,000 in 1975 to 575,000 in 1985. The total labor demand generated by the requirements of the Act would reach 1,770,000 in 1977 and 1,230,000 in 1985.*

The regional distribution of the direct and indirect labor impacts of the direct municipal construction expenditures is shown in Table III.I.6 and Figure III.I.6.

The levels of employment are highest in the Northeast and Northcentral regions, which are those areas most likely to have adverse industrial impacts.

TABLE III.I.6: REGIONAL DISTRIBUTION OF EMPLOYMENT GENERATED FROM THE TOTAL EXPENDITURES FOR THE CONSTRUCTION OF MUNICIPAL WASTEWATER TREATMENT FACILITIES 1975-1985, MAN-YEARS (SCENARIO 1)

Region	Total Percent	Direct Percent	Indirect Percent
Northeast	37.5	13.4	24.1
Northcentral	29.6	10.0	19.6
South	22.5	7.7	14.9
West	10.4	3.5	6.9
United States	100.0	34.0	66.0

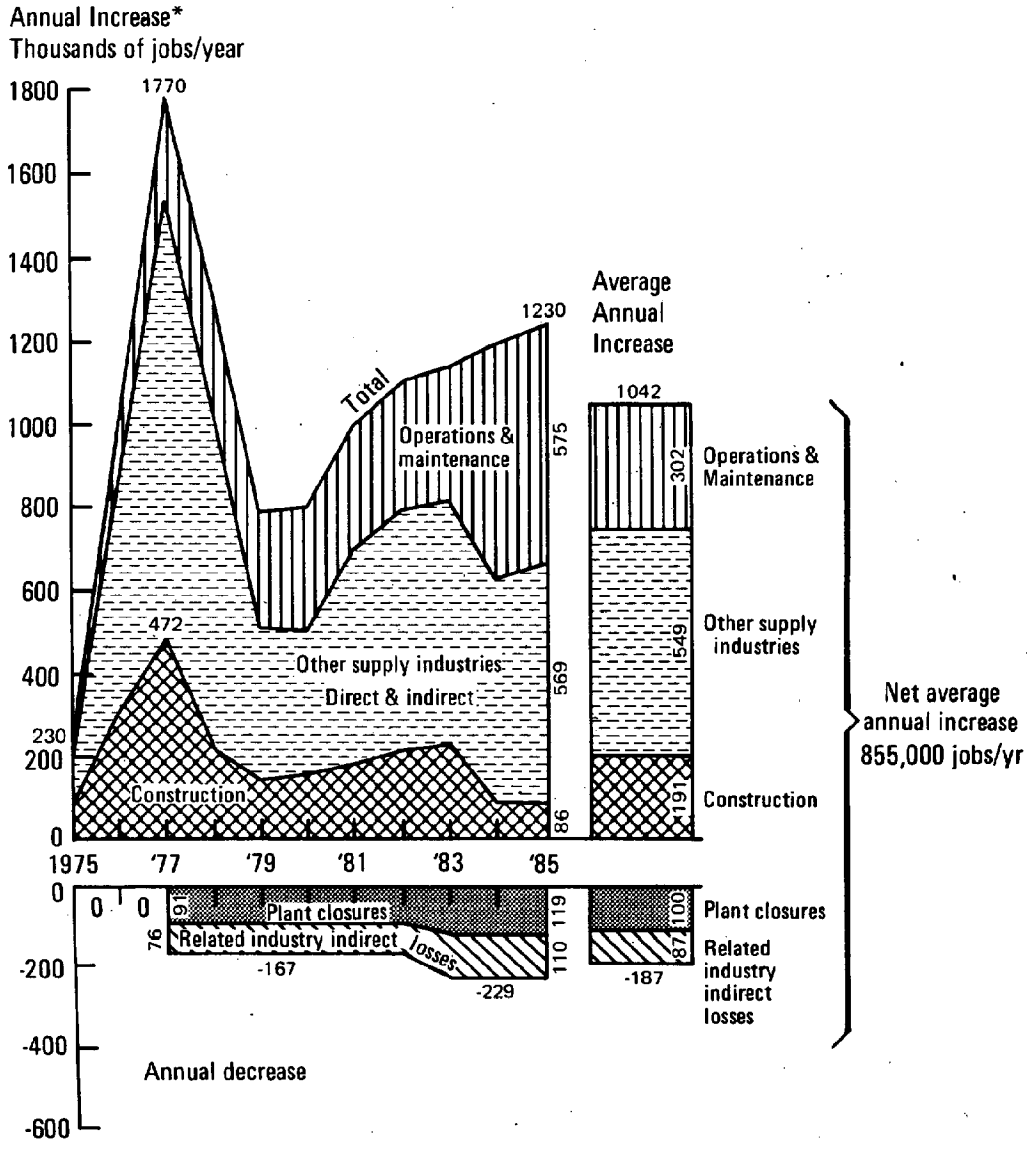
Source: NCWQ. From Human Resources Planning Institute. "The Social Impacts of P.L. 92-500", 1975.

The types of skills required are shown in Table III.I.7 and Figure III.I.6. The building of sewage treatment facilities will increase the need for construction workers and nonprofessional labor. This is in

* SEAS and Wharton Macroecnomic Models, Scenario 1. They assume BPT in 1977 and BAT in 1983, and a low level of municipal expenditure: $23 billion.

Figure III.I.5

IMPACT OF THE CLEAN WATER ACT PL92-500 ON EMPLOYMENT (MUNICIPAL & INDUSTRIAL) 1975-85



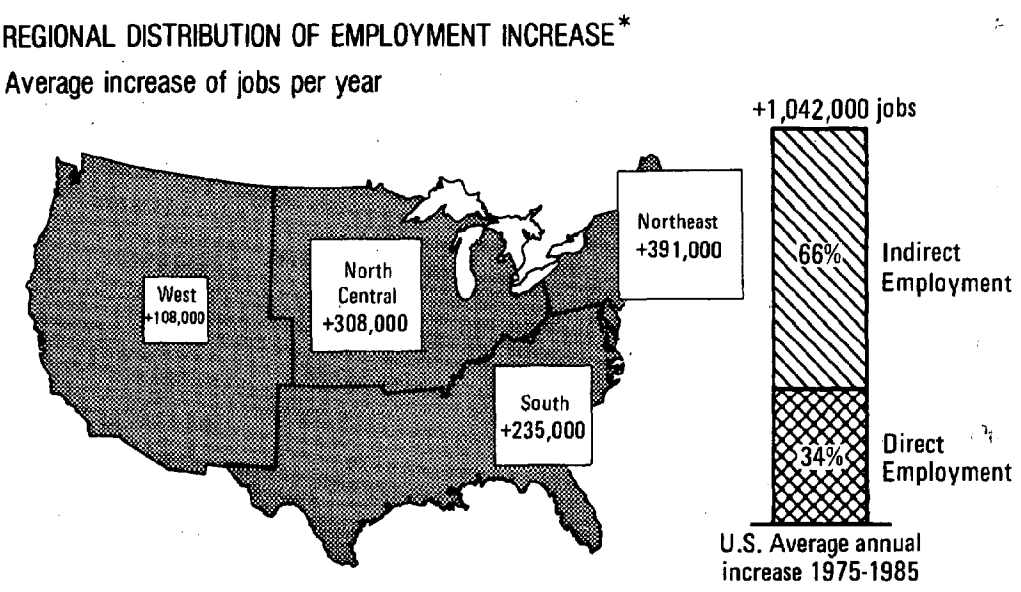
*Increase of employment due to the Act.

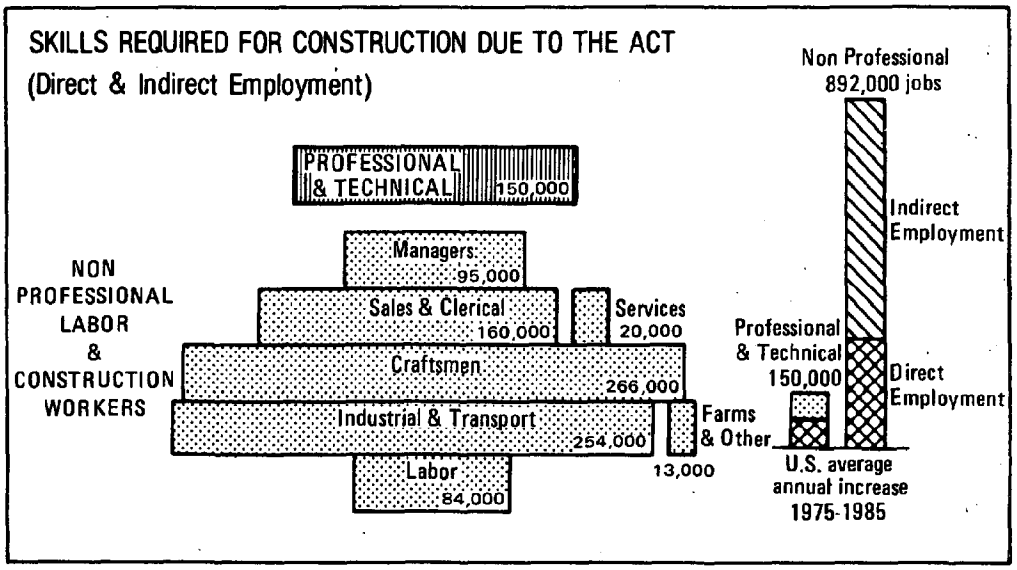
Source: Plant closings derived from various Commission contract studies. All other data derived from Strategic Environmental Assessment System, U.S. Environmental Protection Agency. 1975.

Natl. Commission on Water Quality
February 1976

Figure III.I.6

EMPLOYMENT GENERATED FROM TOTAL EXPENDITURES FOR CONSTRUCTION OF WASTEWATER TREATMENT FACILITIES 1975-1985





* Increase = additional employment due to the Clean Water Act, PL92-500.
Direct employment = Construction and planning
Indirect employment = In related supply industries and for operation & maintenance of completed facilities

Source: Natl. Commission on Water Quality from Strategic Environmental Assessment System, U.S. Environmental Protection Agency, 1975.
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TABLE III.I.7

Types of Jobs Generated by POTW Construction, Total, Direct and Indirect Employment

Occupation	Total	Direct	Indirect
Total	100%	100%	100%
Professional-Technical	14.5	22.0	10.5
(Engineers)	(4.5)	(8.0)	(2.6)
(Natural Scientists)	(.2)	--	(.3)
(Technicians)	(5.4)	(11.2)	(2.3)
(Other Professionals)	(4.1)	(2.1)	(5.2)
Construction and All Others	85.5	78.0	89.2
Managers	9.2%		
Sales Workers	2.8		
Clerical	12.5		
Craftsmen	25.5		
Industrial and Transport	24.4		
Services	1.9		
Farm	.6		
Labor	8.0		

Source: NCWQ. From Human Resources Planning Institute. "The Social Impacts of P.L. 92-500", 1975.

contrast to other pollution control areas such as air and nuclear safety, which require relatively more professional skills. The demand for construction labor is significant today, when these trades are experiencing 20 percent unemployment. One of the positive consequences of treatment plant construction expenditures in a period of high unemployment is that in addition to removing workers from unemployment rolls, it can save money in the long run. A study of public spending and unemployment shows that when persons who would have been collecting unemployment compensation are put to work, the cost to the Federal treasury is reduced by $3,250 per worker (3).

Some plants will be unable to meet the effluent guideline costs and will close. The most affected industries are textiles, pulp and paper and electroplating. Impacts by industry are listed in Table III.I.8. Plant closings are projected to be higher for BPT than BAT, the direct employment losses for BPT and BAT are 91,000 and 28,000 respectively. Production shifts in the water-using industries will cause job losses in related industries. For BPT this is 76,000 and BAT 34,000. At current levels of unemployment (June 1975 = 9 percent), the average length of unemployment would be 15.4 weeks (Table III.I.9). At a lower rate (June 1974 = 5 percent) it would be 10 weeks (5).

TABLE III.I.9: AVERAGE DURATION OF UNEMPLOYMENT JUNE 1974 - JUNE 1975

	June 1974	Dec. 1975	June 1975
Total Unemployed	4,769,000	6,601,000	7,896,000
Length of Unemployment less than 5 weeks	49.5%	47.6%	33.3%
5-14 weeks	31.0%	33.9%	30.9%
15-20 weeks	11.8%	12.1%	16.4%
More than 27 weeks	7.7%	8.3%	16.4%
Average Duration in Weeks	9.8	10.8	15.4

Source: NCWQ. From Klein, Deborah, "Unemployment in the First Quarter of 1975", Monthly Labor Review, August, 1975.

TABLE III.I.8: Jobs Lost Due to Potential Plant Closings

Plant Closings, Direct Impacts			Plant Closings, Indirect Impacts	
	1977	1983	1977	1983
Dairy Processing	981	504	1,427	784
Meat Processing	7,990	11,515	12,427	17,906
Textiles[a]	26,107	none	7,832	none
Pulp and Paper	9,405	none	4,702	none
Chemical Products	750	none	1,263	none
Petroleum Refining	780	none	3,747	none
Leather Processing	950	905	666	634
Iron and Steel	N.A.	N.A.	N.A.	N.A.
Nonferrous	685	411	1,010	606
Fertilizer Manufacture	236	none	398	none
Electroplating Job & Captive Shops	42,712	14,238	42,712	14,238
Total Job Losses	90,596	27,573	76,184	34,168
Total direct, BPT and BAT = 118,149			Total indirect, BPT and BAT = 110,352	

a. Maximum impact analysis assumes pretreatment requirements approximately equivalent to BPT effluent standards.

Source: NCWQ. From Human Resources Planning Institute. "Social Impacts of P.L. 92-500", 1975.

The majority of the job losses will occur in the Northeast and Northcentral states. Closures in textiles will affect women relatively more than in other industries. Women are 50 percent of the labor force in textiles. Electroplating closures will be concentrated in the North-central region. Pulp and paper closures will also affect the North-central region as well as the Northeastern region. In both industries, closures will primarily affect white males who are 80 percent of the labor force. (See Figure III.I.7).

Looking at the net direct and indirect impact of the jobs created and the jobs lost through plant closures*, the result is a positive increase to a peak of 1,153,000 jobs in 1977, and 933,000 in 1982, remaining over 900,000 through 1985. (See Table III.I.5 and Figure Table III.I.5.)

In addition to these employment impacts, there are a series of other macroeconomic effects which change the ultimate job totals. These include effects on income, price increases and changes in the interest rate. The resultant general impact of P.L. 92-500 on economic activity offsets the increased employment totals generated in construction, the supply industries and the major water-using industries. The result is positive overall but smaller. The effect is a net peak in 1979 of 424,000 which declines to minus 342,000 in 1984, and minus 888,000 in 1985. (See Figure III.I.8 and Table III.I.5.)

4. Incidence of the Direct Costs of P.L. 92-500

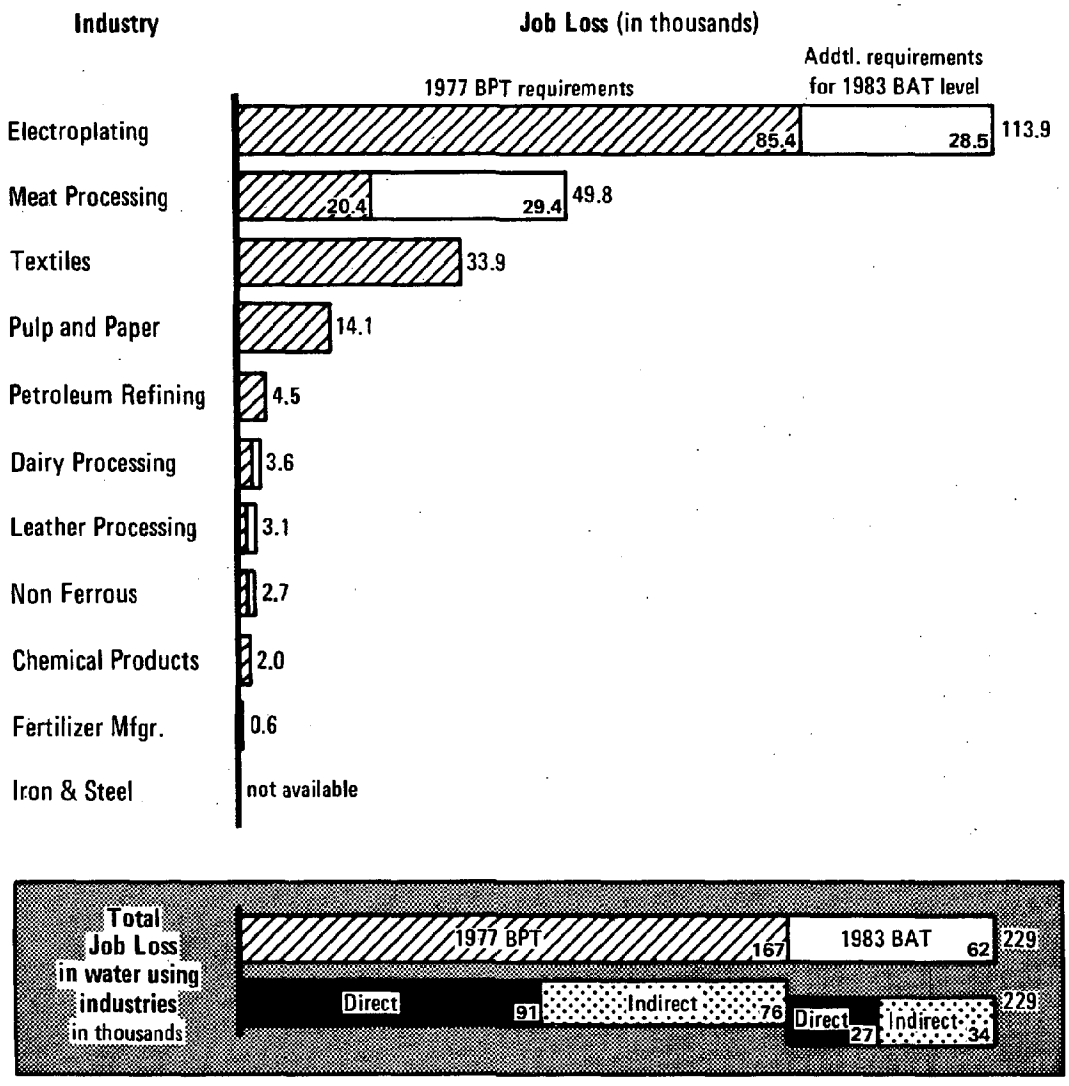
In earlier sections of this chapter, the costs have been expressed in billions of dollars and related to such large aggregate figures as GNP, total state and local spending, or total investment. The purpose of this section is to present the direct costs and their distribution as annual costs for families of various incomes, as a percentage of income for various income groups, and to compare the distribution of these costs to those of other taxes. "Direct-cost" is used here to refer to either the Federal, state and local tax increases necessary to sponsor the publicly owned treatment works program or price increases brought about through requirements placed upon industry. In both cases, these represent annual costs as a result of the programs. Such effects as losses in GNP due to unemployment, reduced economic growth, loss of corporate profits due to inability to pass on costs, or increases in interest rates are not reflected here. Similarly, possible offsets such as the stimulative effect of the program also are not considered.

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* Some problems exist in the relationship of threatened closures to actual closures. EPA's Economic Analysis Division observed closures from January 1971 through March 1975. 33,850 job losses were threatened and 12,557 occurred, a ratio of approximately three potential losses to one actual.

Figure III.I.7

JOB LOSS DUE TO PLANT CLOSINGS IN MAJOR WATER USING INDUSTRIES AS RESULT OF CLEAN WATER ACT REQUIREMENTS FOR 1977, 1983



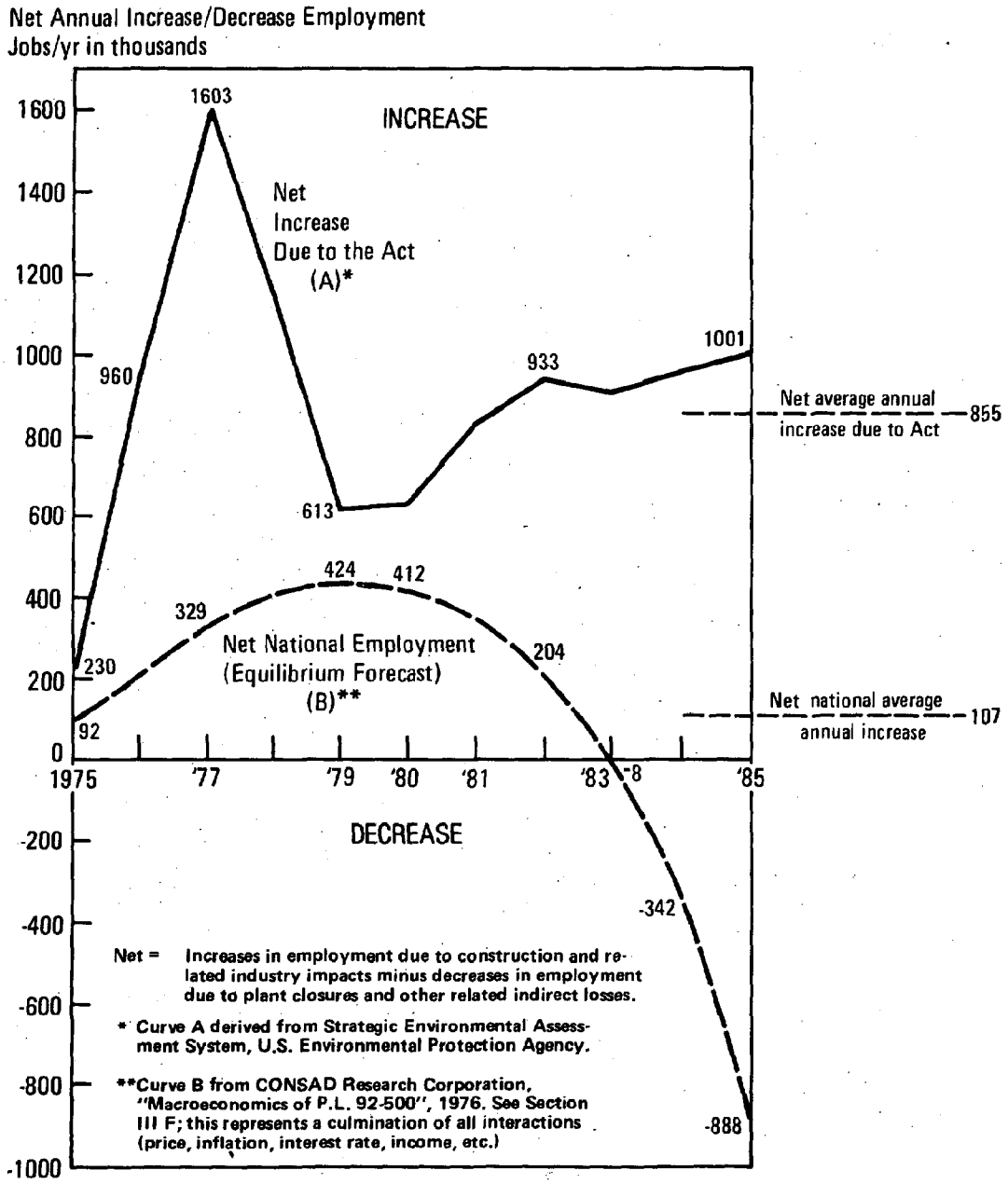
Job loss = loss of employment due to the act.
Direct impact = Job loss due to plant closures within industry category.
Indirect impact = Loss of jobs by supplier industries to that industry.
BPT = Best Practical Technology 1977; BAT = Best Available Technology 1983

Source: Natl. Commission on Water Quality. From Human Resources Planning Institute, "The Social Impacts of P.L. 92-500", 1975.

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Figure III.I.8

NET IMPACT OF THE CLEAN WATER ACT ON EMPLOYMENT COMPARED TO NATIONAL NET ESTIMATE OF EMPLOYMENT INCREASE/DECREASE



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Table III.I.10 and Figures III.I.9 and III.I.10 show the annual costs per family for the various elements of P.L. 92-500, and the total annual costs. The average annual cost per family for categories I, II and IVB (treatment plant and interceptor sewer needs) and industrial requirements other than BAT is $306 while for all needs except urban runoff and all industrial requirements the cost is $522 per family. Costs to the median family are below these average costs, with lower costs to low-income groups and higher costs to higher income groups. It will be noted that the costs borne through industrial price increases are significantly higher than those caused by tax increases from the publicly owned treatment works program. This may come as startling given the much higher capital costs given elsewhere in the report for POTW's as against industry. The reasons for this are threefold: (1) the POTW program costs used for this estimate are about 12 percent lower than the final Commission estimate, (2) the costs shown are annual costs; as a result, the fact that operating costs for industrial pollution abatement facilities are five to six times those for POTW's plays a very important role, and (3) the interest and depreciation costs for industry are much higher, due to the differences in interest costs of industry versus government borrowing and the shorter time horizon normally used for depreciating industrial equipment.

The costs are, however, averages for the nation and will be significantly different depending on the treatment needs of the community in which one resides. Thus, the tax increase for an average family in a community of under 5,000 with no treatment plant would be over $90 compared to the $68 shown as the national average for treatment plant and interceptor needs (6). Families in small communities have particularly high costs per family, both because of economies of scale in treatment and because a larger portion presently lacks adequate treatment facilities. Combined sewer overflow control needs, which form over half of the costs for all categories except urban runoff, are also highly concentrated in a small number of states and communities, particularly in older cities in Northeast and Northcentral regions. For a resident of a community with major combined sewer overflow needs, the annual costs per family would be closer to $300 compared to the national average of $145. One offsetting factor, however, is that the tax increases shown here were computed using the 1975 population. By 1985 they will have reduced by about 10 percent due to population growth.

Table III.I.11 and Figures III.I.11 and III.I.12 show the costs of Table III.I.10 as a percent of income. In all cases, the lowest income groups pay the highest percentage of their income for pollution abatement. For tax increases, the cost as a percent of income is generally decreasing. For price increases the upper middle income groups also pay a higher percentage of income than other groups. The net

TABLE III.I.10: COSTS PER FAMILY BY INCOME GROUPS IN THE YEAR 1985 (1975 dollars)[a]

Income Class (1975 Total Income)[b]	Tax[c] Increases Necessary for: Categories I, II, and IVB (Treatment Plant and Interceptor Sewer Needs)	Tax[c] Increases Necessary for: All Categories Except Urban Runoff	Price Increases[d] Caused By: BPT and New Source Requirements	Price Increases[d] Caused By: BAT Requirements	Price Increases[d] Caused By: All Industrial Requirements	Total Direct Costs Due To: Categories I, II, And IVB, BPT	Total Direct Costs Due To: All Categories and BPT & BAT and Industrial Requirements
0-6,700	$27	45	84	50	134	111	180
6,700-9,500	40	74	86	50	136	126	210
9,500-13,100	48	94	91	53	143	139	238
13,100-17,200	57	117	132	77	210	189	326
17,200-20,700 (Median Class)	62	133	306	179	484	368	617
20,700-29,000	81	177	350	205	555	431	732
29,000-37,500	126	287	525	309	834	651	1122
37,500-58,900	84	185	526	309	835	610	1020
58,900-152,700	214	485	532	312	844	746	1330
152,700+	1007	2392	532	312	844	1539	3237
Average Cost Per Family	68	145	238	139	377	306	522

a. Costs were converted from the current dollar indicated in the Urban Systems report to 1975 dollars using GNP deflator for tax increases, and a weighted average of University of Virginia price deflators for consumer durable, consumer nondurable and services. Weights were based on weighting of goods examined by Urban Systems.

b. Income used here is total income, a concept developed by Brookings Institute. It differs from the normal census definition of income by including unreported income, fringe benefits, undistributed corporate profits, and imputed rent on owned occupied housing.

c. Tax increased derived from Needs Survey estimates of costs by category and Metcalf and Eddy estimates of operating costs. The annualized costs were then distributed to the Federal, state and local level assuming a 75 percent Federal grant, and current state grant programs. Costs were then distributed among states using the allotment formula based on EPA corrected estimates of Needs. Price increases due to industrial cost recovery and user charges are not accounted for.

d. Price increases are derived from macroeconomic Scenario 4 for BPT and new source requirements and from macroeconomic Scenario 1, all industrial requirements. BAT requirements computed as the difference between these two results. Price increases are those developed by the University of Virginia price model which were then apportioned to income classes according to consumption pattern by income class.

Source: Urban Systems Research and Engineering, Inc. Economic Impacts of Water Pollution Control Act of 1972; Incidence of Costs. 1975.

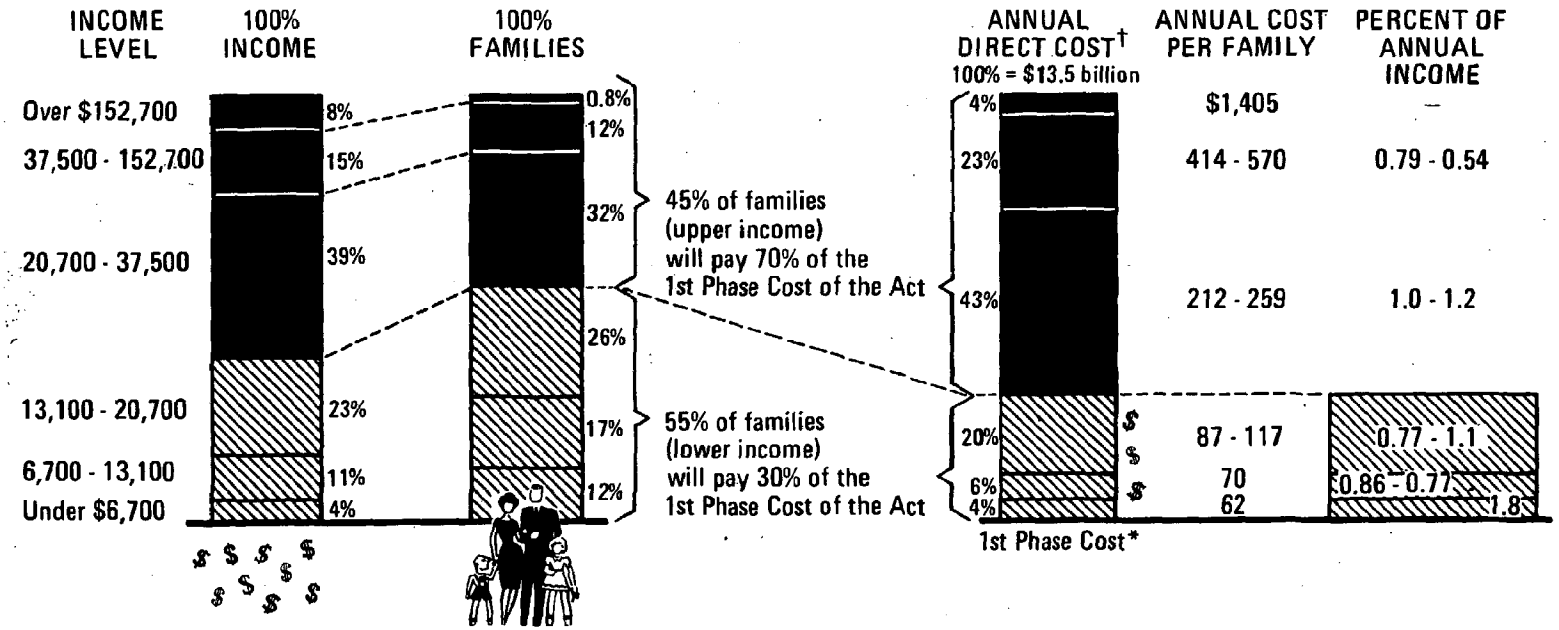
Figure III.I.9

ANNUAL COST PER FAMILY 1975-1985 BY INCOME LEVEL TO CONTROL WATER POLLUTION FROM MUNICIPAL & INDUSTRIAL DISCHARGES

(1st PHASE COST*)

$1255 billion of the U.S. annual "family income"** is earned by 64.8 million families

Each family will pay the cost of the Clean Water Act by annual tax and price increases



* 1st phase costs include industrial treatment at 1977 BPT level and municipal treatment of categories I,II,IVB,BPT. In 1975 dollars.

** See footnote on Figure III.I.11 for description of family income. Total income is estimated for 1975.

† Direct cost is that passed along to the consumer in terms of tax increases for municipal wastewater control and price increases for industrial wastewater control. Since the tax increases for municipal wastewater treatment are based on the annualized costs of the POTW program, and the price increases for industry treatment do not include costs borne through reduced profits or output, — the total of these increases is not comparable to the average annual costs (or percents) as shown in Chapter I.

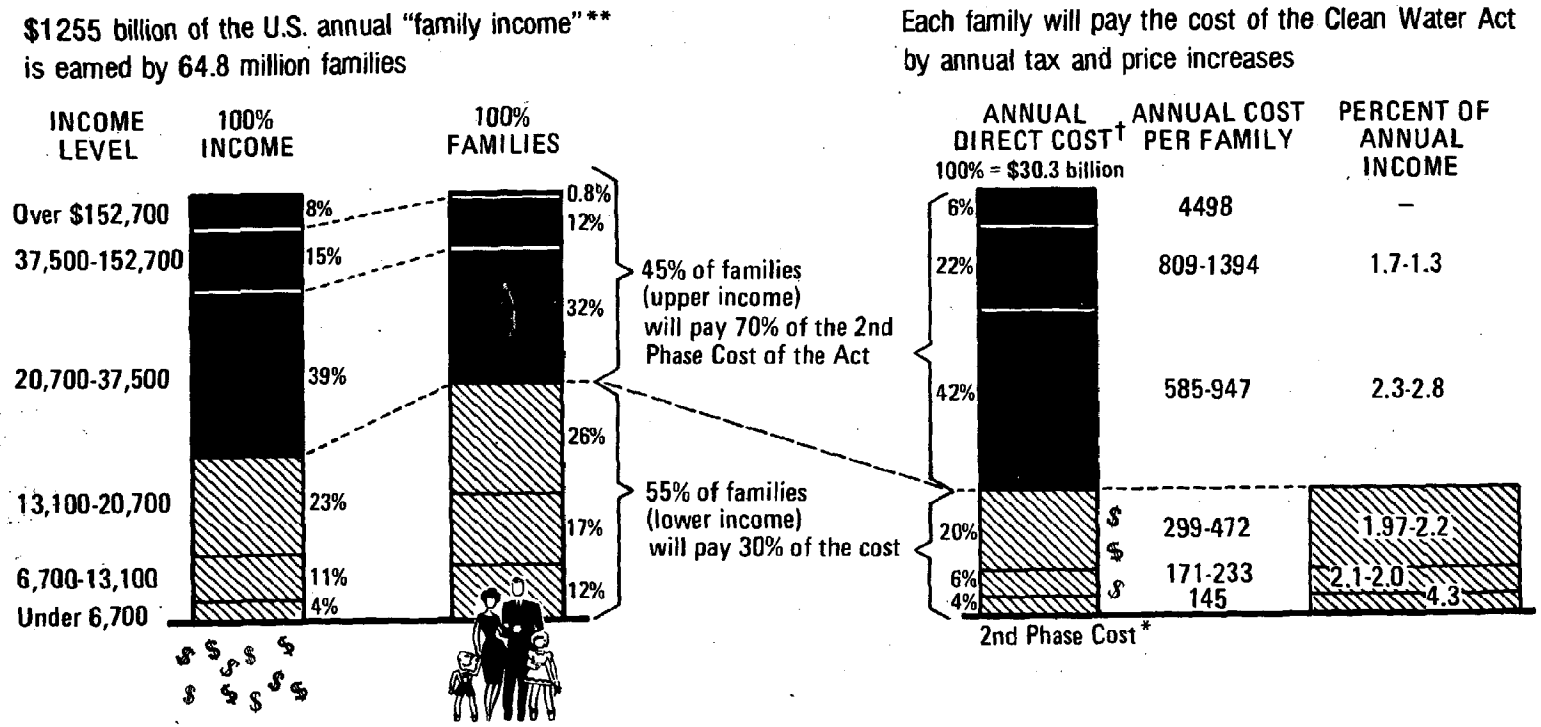
Source: Natl. Commission on Water Quality. From Urban Systems Research and Engineering, "Economic Impacts of Water Pollution Control Act of 1972; Incidence of Costs", 1975.

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Figure III.I.10

ANNUAL COST PER FAMILY 1975-85 BY INCOME LEVEL TO CONTROL WATER POLLUTION FROM MUNICIPAL & INDUSTRIAL DISCHARGES

(2nd PHASE COST*)



* 2nd phase costs include industrial treatment at 1983 BAT level and municipal-treatment of all categories I-V. In 1975 dollars.

** See footnote on Figure III.I.11 for description of family income. Total income is estimated for 1975.

† Direct cost is that passed along to the consumer in terms of tax increases for municipal wastewater control and price increases for industrial wastewater control. Since the tax increases for municipal wastewater treatment are based on the annualized costs of the POTW program, and the price increases for industry treatment do not include costs borne through reduced profit or output, – the total of these increases is not comparable to the average annual costs (or percents) as shown in Chapter I.

Source: Natl. Commission on Water Quality. From Urban Systems Research and Engineering, "Economic Impacts of Water Pollution Control Act of 1972; Incidence of Costs", 1975.

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TABLE III.I.11: COSTS AS PERCENTAGE OF INCOME BY INCOME GROUP (1985)[a]

Income Class (1975 Total Income)[b]	Tax[c] Increases Necessary for: Categories I, II and IVB (Treatment Plant and Interceptor Sewer Needs)	Tax[c] Increases Necessary for: All Categories Except Urban Runoff	Price Increases[d] Caused By: BPT and New Source Requirements	Price Increases[d] Caused By: BAT Requirements	Price Increases[d] Caused By: All Industrial Requirements	Total Direct Costs Due To: Categories I, II, and IVB, BPT	Total Direct Costs Due To: All Categories and BPT & BAT and Industrial Requirements
0-6,700	.62	1.05	1.93	1.12	3.05	2.55	3.03
6,700-9,500	.38	.70	.82	.46	1.28	1.20	1.53
9,500-13,100	.33	.63	.62	.35	.97	.95	1.26
13,100-17,200	.29	.60	.66	.40	1.06	.95	1.29
17,200-20,700 (Median Class)	.25	.52	1.23	.71	1.94	1.48	1.78
20,700-29,000	.25	.55	1.08	.62	1.69	1.33	1.65
29,000-37,500	.16	.364	1.20	.71	1.91	1.36	1.60
37,500-58,900	.13	.28	.83	.49	1.32	.96	1.04
58,900-152,700	.16	.36	.39	.22	.60	.55	.75
152,700+	.19	.45	.11	.06	.17	.30	.64

a. 1975 dollar prices over constant dollar income for the year 1985.

b. Income used here is total income, a concept developed by Brookings Institute. It differs from the normal census definition of income by including unreported income, fringe benefits, undistributed corporate profits, and imputed rent on owner occupied housing.

c. Tax increases derived from Needs Survey estimates of costs by category and Metcalf and Eddy estimates of operating costs. The annualized costs were then distributed to the Federal, state and local level assuming a 75 percent Federal grant, and current state grant programs. Costs were then distributed among states using the allotment formula based on EPA corrected estimates of Needs. Price increases due to industrial cost recovery and user charges are not accounted for.

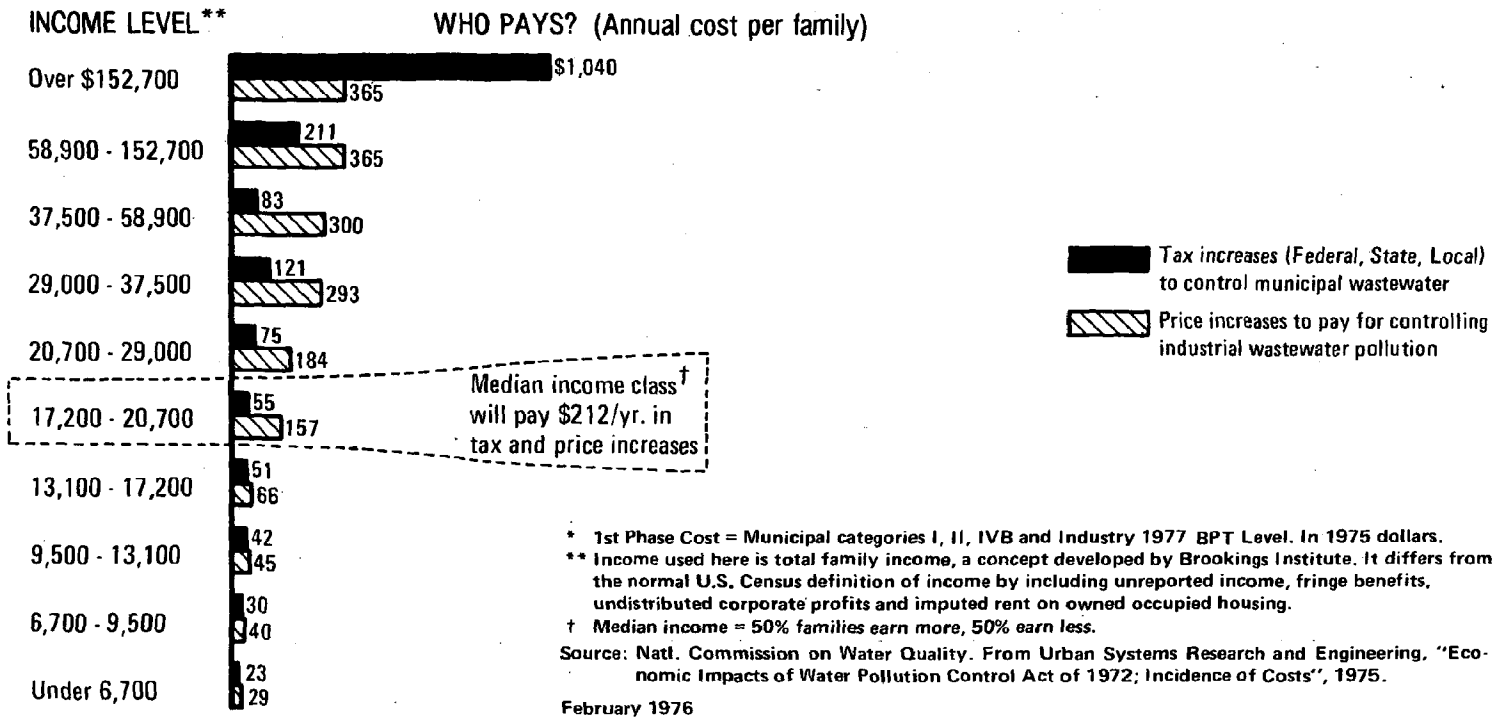
d. Price increases are derived from macroeconomic Scenario 4 for BPT and new source requirements and from macroeconomic Scenario 1, all industrial requirements. BAT requirements computed as the difference between these two results. Price increases are those developed by the University of Virginia price model which were then aportioned to income classes according to consumption pattern by income class.

Source: NCWQ. From Urban Systems Research and Engineering, Inc. Economic Impacts of Water Pollution Control Act of 1972; Incidence of Costs. 1975.

Figure III.I.11

DIRECT COST IN TAX & PRICE INCREASES FOR EACH FAMILY INCOME LEVEL TO CONTROL MUNICIPAL & INDUSTRIAL WATER POLLUTION

(1st Phase Cost *. Estimate for 11 Year Period, 1975-1985)



* 1st Phase Cost = Municipal categories I, II, IVB and Industry 1977 BPT Level. In 1975 dollars.

** Income used here is total family income, a concept developed by Brookings Institute. It differs from the normal U.S. Census definition of income by including unreported income, fringe benefits, undistributed corporate profits and imputed rent on owned occupied housing.

† Median income = 50% families earn more, 50% earn less.

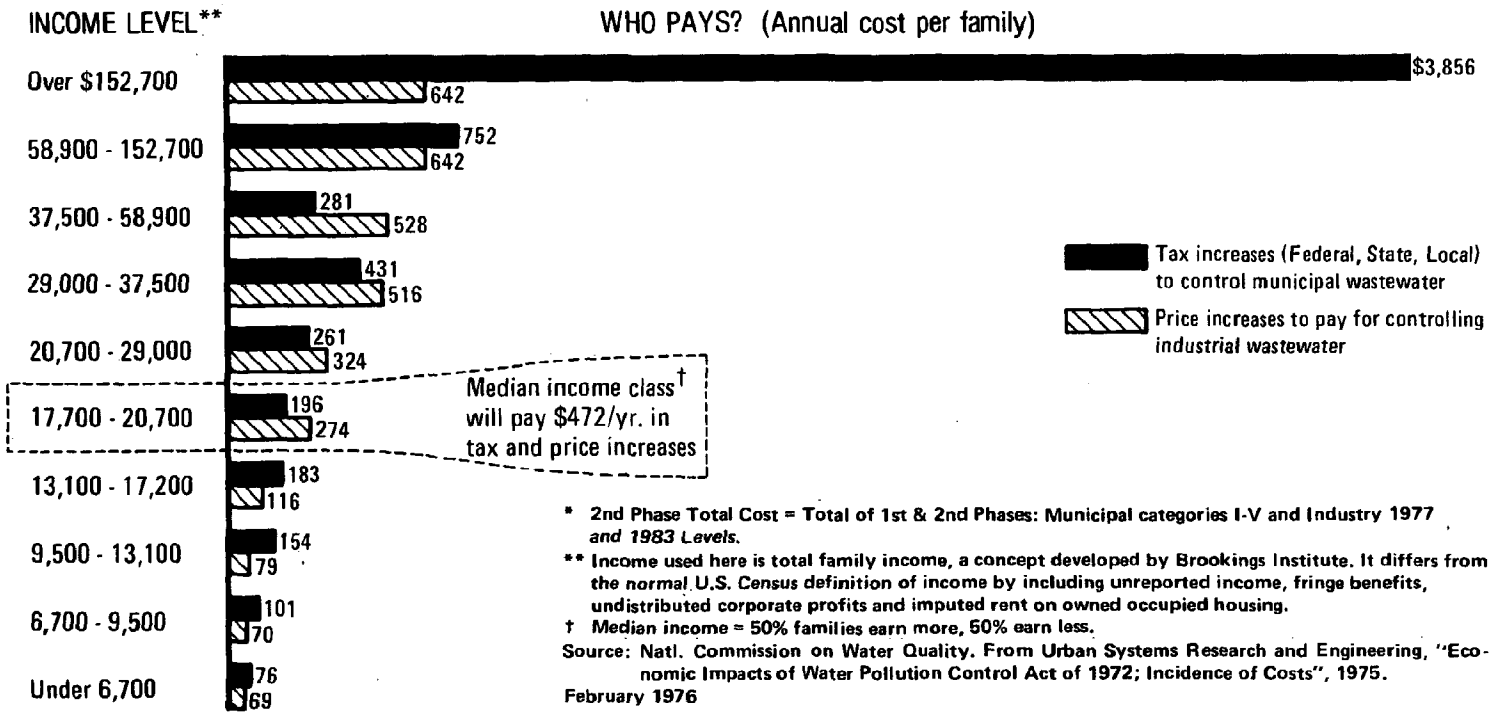
Source: Natl. Commission on Water Quality. From Urban Systems Research and Engineering, "Economic Impacts of Water Pollution Control Act of 1972; Incidence of Costs", 1975.

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Figure III.I.12

DIRECT COST IN TAX AND PRICE INCREASES FOR EACH FAMILY INCOME LEVEL TO CONTROL MUNICIPAL & INDUSTRIAL WATER POLLUTION

(2nd Phase Cost . Estimate for 11 Year Period, 1975-1985)



* 2nd Phase Total Cost = Total of 1st & 2nd Phases: Municipal categories I-V and Industry 1977 *and 1983 Levels.*

** Income used here is total family income, a concept developed by Brookings Institute. It differs from the *normal U.S. Census* definition of income by including unreported income, fringe benefits, undistributed corporate profits and imputed rent on owned occupied housing.

† Median income = 50% families earn more, 50% earn less.

Source: Natl. Commission on Water Quality. From Urban Systems Research and Engineering, "Economic Impacts of Water Pollution Control Act of 1972; Incidence of Costs", 1975.

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effect is to require the highest costs as a percent of income from the lowest income groups and from upper middle income families. With respect to tax increases, these results are slightly misleading because they assume there would have been no spending on sewer systems in the absence of the Act. If this factor were taken into account, the effect would be to lower the costs as a percentage of income to the lowest income classes because of the shift to the more progressive Federal taxes.

Table III.I.12 and Figures III.I.11 and III.I.12 show the relative burden of both the publicly owned treatment works program and of price increases due to industrial compliance, and compares them to the burden of various types of taxes. The burden is defined as the percentage of the costs of each tax or set of price increases borne by a given income class. The overall impact of the tax increases puts a greater burden on low income families than the Federal income tax, but low income groups bear a smaller share of costs than they do of all Federal, state and local taxes.

The key determinants of the burden of publicly owned treatment works programs are the Federal income tax and the user charge system. While the Federal income tax is progressive (it places the greatest burden on higher income groups), user charges are among the most regressive of all taxes. This is because of the small effect of income upon water use. The property tax, the most commonly proposed alternative to user charges, places a considerably lighter burden on low income families than user charges. Price increases show no consistent pattern when compared to other taxes. For the lowest income group, the share is much greater than the Federal income tax, but lower than for the total tax package. For the highest income group, the share is lower than under either tax.

Given the regional distribution of income in the United States for impact of user charges would be heaviest in the South, where average incomes are lower. In contrast, the more progressive distribution of costs based on Federal taxes would shift more of the burden away from lower income families generally and away from the South specifically.

5. Community Case Studies: Local Social Impacts

Turning to the impact of the Act on local social groups, as opposed to the distribution of impacts across large scale demographic profiles, a range of groups are involved as well as a geographically distributed series of issue-specific sites. Nine communities* were selected from

* These nine include: Ketchikan, Alaska; Loveland-Greeley, Colorado; Muskegon County, Michigan; the Maumee River in Ohio; the Merrimack Valley in New Hampshire; Block Island, Rhode Island; Fairfax County, Virginia; Escambia Bay, Florida; and Lake Washington in Seattle, Washington.

TABLE III.I.12: RELATIVE BURDEN OF TAX AND PRICE INCREASES IN COMPARISON TO OTHER TAXES[a,b]

Income Class (1975 Total Income)[c]	Tax Increase[d]	Price Increase[e]	Total Burdens BPT Price Increase and I, II and IVB Tax Increase	Total Burdens BPT & BAT Price Increase & All Categories Except Urban Runoff	Personal Income Tax	Total Taxes (Federal, State Local)	User Chargers	Property Tax	Percent of all House-holds in income group	Percent of All income to income group
0-6,700	3.3	3.7	3.6	3.6	.8	5.2	10.9	6.9	12.3	4
6,700-9,500	3.1	2.2	2.3	2.5	1.2	5.3	6.5	6.3	7.0	4.3
9,500-13,100	5.4	3.2	3.5	3.8	3.9	7.5	9.2	7.9	9.8	6.5
13,100-17,200	8.6	5.9	6.3	6.7	7.2	11.3	11.7	11.1	12.0	10.0
17,200-20,700 (Median Class)	11.3	15.8	15.2	14.5	10.1	13.7	14.1	13.1	14.3	12.7
20,700-29,000	25.6	30.9	30.2	29.4	26.3	26.7	25.0	24.7	24.5	25.8
29,000-37,500	13.3	14.8	14.6	14.4	14.7	12.9	8.4	11.7	7.8	13.7
37,500-58,900	9.3	16.2	15.2	14.3	10.3	7.1	9.4	6.2	8.5	13.0
58,900-152,700	8.6	5.8	6.2	6.6	10.5	4.8	3.8	5.2	3.0	7.0
152,700+	11.4	1.5	2.9	4.3	15.0	5.5	1.1	6.8	.8	8.0

a. Burden: Percentage of column heading supported by each income group.

b. Columns may not sum to 100 percent due to rounding error.

c. Income used here is total income, a concept developed by Brookings Institute. It differs from the normal census definitions of income by including unreported income, fringe benefits, undistributed corporate profits, and imputed rent on owner occupied housing.

d. Tax increases are derived from Needs Survey estimates of costs by category and Metcalf and Eddy estimates of operating costs. The annualized costs were then distributed to the Federal, state and local level assuming a 75 percent Federal grant, and current state grant programs. Costs were distributed among states using the allotment formula based on EPA corrected estimates of needs. Price increases due to industrial cost recovery and user charges are not accounted for.

e. Price increases are derived from macroeconomic Scenario 4 for BPT and new source requirements and from macroeconomic Scenatio 1 all industrial requirements. BAT requirements computed as the difference between these two results. Price increases are those developed by the University of Virginia price model which were then aportioned to income classes according to consumption pattern by income class.

Source: NCWQ. From Urban Systems Research and Engineering, Inc. Economic Impacts of Water Pollution Control Act of 1972; Incidence of Costs. 1975.

among 122 candidate sites, out of a possible total of 16,000 communities.

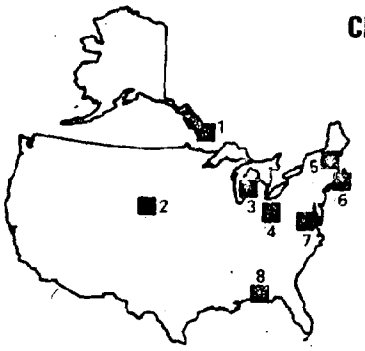
The nine selected sites were compared to census data population as a whole. The demographic indicators surveyed included: mobility, ethnic composition, family structure, educational attainment, employment structure, economic structure, income indicators, income structure, and other general demographic indicators. Of these factors, the only significant variations of the sites chosen from the national average were ethnicity and income levels. The communities chosen were on the average slightly more culturally cohesive and slightly less representative of low income population. Thus, the communities chosen were fairly typical of the distribution of characteristics for the population as a whole.

The impacts on social groups were assessed for each of the sites shown in Figure III.I.13. Some of these groups were specific to single issues and varied from site to site.

Figure III.I.13

CHARACTERISTICS OF 8 SITES

SOCIAL IMPACT STUDY



1. **KETCHIKAN** A sulfite pulp company town in Alaska faced with closure of it one industry because of the Water Pollution Act

2. **LOVELAND-GREELEY** New treatment plan being built in a fast growing water scarce Colorado community

3. **MUSKEGON COUNTY** Site of a sophisticated water management system in Michigan with zero-discharge technology, profit making orientation, using reclaimed water

4. **MAUMEE RIVER BASIN** Citizen participation and cleanup of the highly polluted industrial river in Toledo area, which discharges into Lake Erie. Agricultural as well as municipal and industrial interests compromise

5. **MERRIMACK VALLEY** Two industrial N.H. cities on a historically polluted river reflect contrasts of long standing negative attitudes with new city planning approaches

6. **BLOCK ISLAND** Effect of a proposed sewer system on this isolated, rural, mostly summer Long Island Sound community with competing citizen and tourist interests

7. **FAIRFAX COUNTY** Rapidly growing, densely populated Virginia suburban area adjacent to D.C., which adopted a sewer moratorium

8. **ESCAMBIA BAY** Commercial fishing suffered severe losses because of chemical and power plant pollution of this recreational Florida bay

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The impact of the Act on social groups can be summarized under the following headings:

Occupational groups

Special groups

Demographic groups

Occupation groups are impacted as follows:

a. Occupational Groups (See Figure III.I.14)

One: Those occupations which will incur social benefits as a result of the Act.

- Sanitary Engineering Professionals, Planning Professionals and Private Economic Engineering, and Environmental Consultants. Under all conditions the Act increases demand for the services of these occupational groups and provides them opportunities for involvement in the political decision-making and planning process.

- Employees of water-related leisure goods and services industries will be positively affected.

- Employees of waterfront industries and water-related service industries. From fishing tackle suppliers to recreational area food vendors, employees in these industries will receive benefits as the quality of the water increases.

- Commercial Fishermen. The fishing industry obviously will benefit from cleaner water and more plentiful fish.

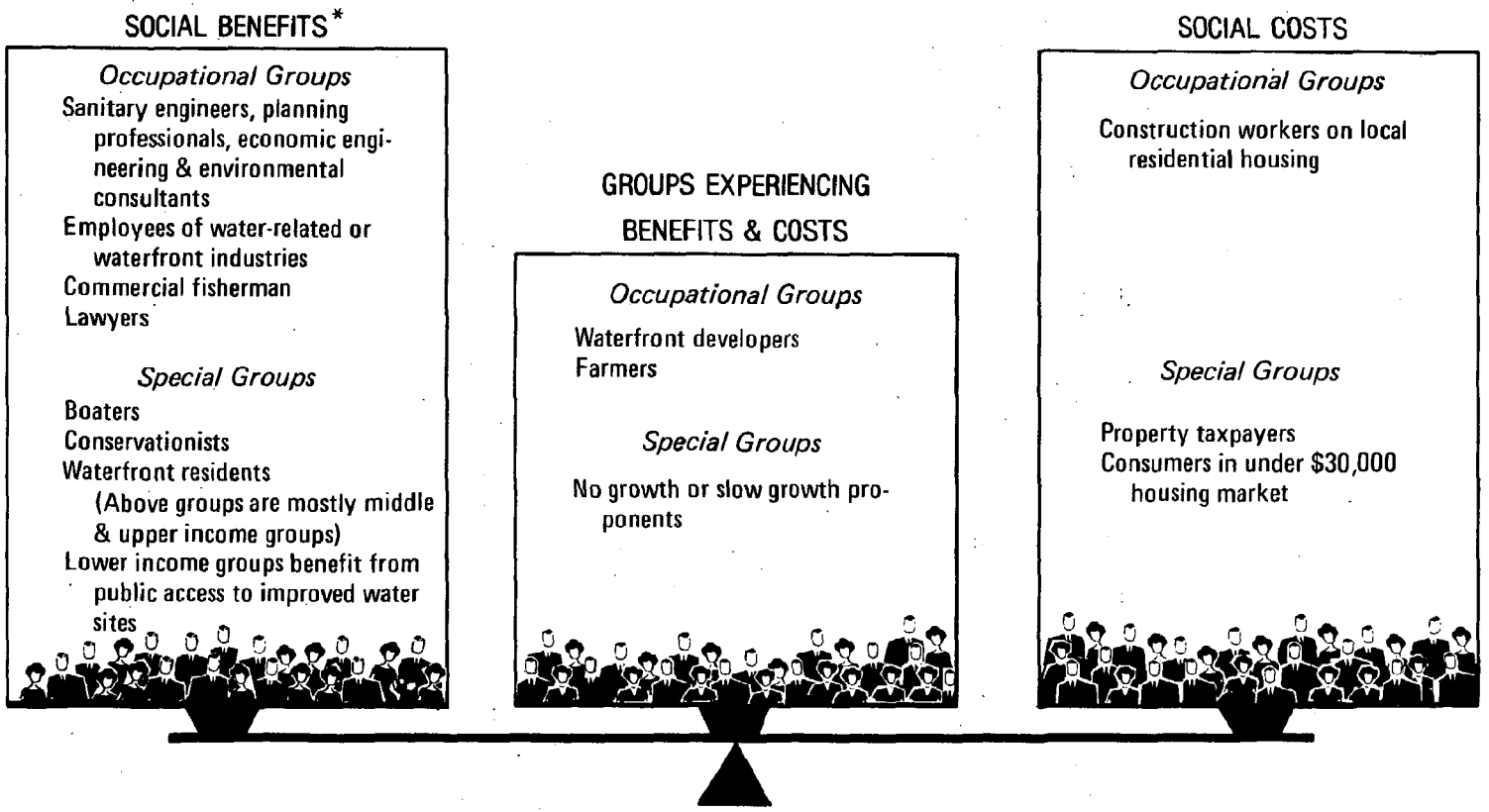
- Lawyers. The litigation and permit process resulting from the Act has and will continue to increase the need for lawyers' services.

Two: Those occupations which will receive a mix of social benefits and costs as a result of Act-initiated events.

- Waterfront residential and industrial property developers. The developers of such properties benefit from the increased desirability of their property, but also incur the costs associated with the general construction impacts of the Act.

Figure III.I.14

IMPACT OF THE CLEAN WATER ACT ON SOCIAL GROUPS



*Social benefits in this study are limited to changes in social behavior related to swimming, boating, sport and commercial fishing, and employment generated by the Act. Excluded from this chart is the portrayal of the unquantifiable aesthetic benefits accruing to all groups from the availability of cleaner water, and the benefit from stopping the acceleration of mans' degrading of the water. See pages I-68, III-239, 274, 276-278.

Source: Natl. Commission on Water Quality. From Human Resources Planning Institute, "The Social Impacts of P.L. 92-500", 1975.

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- o Farmers. The unique properties of the sites involved in this study demonstrate particularly complex cost-benefit polarities. The reader is referred to the Loveland-Greeley and Maumee case studies for examinations of land value and reductions in the nutrient content of the water as they impact farmers.

Three: Those occupations which will primarily incur social costs as a consequence of the Act.

- o Local residential housing construction workers. The short-term effect of the Act is to slow down the level of housing construction activity. This has a negative impact on local housing construction workers. On the other hand, long-term benefits accrue to workers in the building trades because of increased potential for waterfront and newly sewered land, and requirements for treatment plant construction.

b. Special Groups

The special groups category includes a range of interest areas, with the following distribution of impacts:

One: Special groups that will benefit from Act-related events.

- o Boaters. With the exception of some problems associated with increased tourism in fishing areas, the social impacts on boaters will be positive.

- o Conservationists. Although these are largely intangible benefits, conservationists will receive considerable social benefits from the implementation of the Act.

- o Waterfront Residents. Decreases in odor and increases in property values make this special group one that is particularly benefited by the Act.

Two: Groups that will receive both social costs and benefits from Act-related events.

- o No or Slow-Growth Proponents. The short-term effects of the Act may parallel the interests of politically organized no/slow-growth proponents. However, in the long run, as more sewage treatment capacity is created and sewer moratoria are lifted, growth in all sectors may be encouraged, contrary to the wishes of controlled growth advocates.

Three: Groups that will incur primarily social costs resulting from Act-initiated events.

- Potential Consumers in the under $30,000 housing market. Increases in costs associated with sewering and other compliance measures undoubtedly will contribute, along with inflation, to the decline of supply to this market.

c. Demographic Groups

Some nonquantified findings were available for demographic (social profile) groups. These can be compared to the demographic analysis of impacts at the regional and national level.

- Sex. Perhaps as a reflection of the dominance of males in the occupational and economic ownership groups, males seem to experience more of the social impacts more directly than females.

- Age. Clearly, the middle-age groups, those 31 to 60, will be involved in the majority of the social impacts noted in this study. Those in the younger age group were, however, also not far behind in terms of feeling the impacts of the Act.

- Minority Status. Minorities were underrepresented in case-study sites. However, the impacts of the Act in the housing area, on the construction industry, will have a significant negative effect on certain minority groups.

- Income Level. Moderate income individuals will be involved in almost all social beneifts and costs associated with the Act. High income individuals appear to be in a position to bear less relative and absolute cost than in the moderate and low income groups, particularly if they are in the property ownership groups. In contrast, the low income groups will receive relatively little benefit, outside of those who will partake of urban water recreational improvements; and this group will bear an especially large share of the costs due, in part, to the shift from property taxes to user charges.

d. Economic Ownership Groups

- Ownership of desirable waterfront residential property is concentrated among middle and upper income groups. The benefits of cleaner water accrue largely to these groups. The provision of public access to bodies of water improved as a result of P.L. 92-500 serves to distribute some of the benefits to lower income groups (4).

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IV. WATER QUALITY ANALYSIS

AND ENVIRONMENTAL IMPACT ASSESSMENT

IV. WATER QUALITY ANALYSIS AND ENVIRONMENTAL IMPACT ASSESSMENT

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IV. WATER QUALITY ANALYSIS AND ENVIRONMENTAL IMPACT ASSESSMENT

A. INTRODUCTION

Assessing environmental impacts associated with achieving or not achieving the requirements of the Act presented the Commission with a dilemma. Since many of the requirements will not take effect until some time after the Commission's work is finished, the task of assessing environmental changes was, by necessity, predictive. The state-of-the-art of predicting changes in environmental systems is limited. Only in the past few decades has concentrated scientific effort been applied to measuring and documenting changes caused by introducing specific amounts and types of pollutants into aquatic systems. Most of this research has been extremely limited in scale and geographic scope, and essentially devoid of analyses of long-term effects of substantial levels.

As the art advances, there is a time lag between initial development and wide-scale application of water quality measurement techniques. As a consequence, the body of long-term water quality data currently available is limited to a small group of traditionally measured characteristics including temperature, dissolved oxygen, turbidity, suspended solids, total dissolved solids, pH, biochemical oxygen demand, and, to a lesser extent, nutrients, coliform bacteria and toxics, such as heavy metals and pesticides. Measuring and predicting the environmental impacts of introducing certain pollutants into a controlled aquatic system is possible. However, relating that information to entire drainage systems, and accurately predicting effects resulting from introducing pollutants into or removing them from complex aquatic environments, usually stretches the application of ecosystem analysis beyond the present state-of-the-art and beyond the existing data base. Thus, the Commission's environmental assessment program is a unique and original attempt. Not only is information on which to base environmental predictions scarce, but also there is neither precedent nor established methodology for a study like this.

Recognizing these limitations, the Commission attempted to develop a methodology based on existing water quality data and judgmental analysis by experienced professional ecologists. Together with the guidance and advice from two selected panels organized by the National Academy of Sciences/National Academy of Engineering and the Institute of Ecology,* the Commission designed a methodology for predicting nationwide environmental impacts of achieving or not achieving the goals and requirements of the Act. The results represent a preliminary assessment, establish a

*See Appendix for list of TIE and NAS-NAE Committee Members.

successful precedent for future large-scale environmental assessments and provide generalized pictures of what the nation may expect in the way of environmental changes from its efforts at water pollution control.

The study results estimate where some of these improvements will be experienced, the degree of improvement for different areas, reductions in point-sources controls and the environmental implications of disposing of residual pollutants extracted from the treated wastewaters. Just as significant as these general findings, the methodology also lays a sound basis for applying more sophisticated analytical methods of environmental assessment to public policy. The results identify the need for continued refinement of the "state-of-the-art" for projecting environmental change, and concentrated research on the continuing responses of ecological systems to water quality changes.

1. The Concept of Chemical, Physical and Biological Integrity

A major objective of P.L. 92-500, as stated in Section 101(a), is "To restore and maintain the chemical, physical, and biological integrity of the Nation's water." Hence, the new concept of "chemical, physical, and biological integrity" of water requires understanding by the Commission in its various studies.

Of key importance to understanding this objective, however, is a precise interpretation of the word "integrity." While the House Committee on Public Works did not explicitly define the word in its report, it stated that "the word integrity as used is intended to convey a concept that refers to a condition to which the natural structure and function of ecosystems is maintained." The report further said that "natural is generally defined as that condition in existence before the activities of man invoked perturbations which prevented the system from returning to its original state of equilibrium" (H.R., p. 763). The Senate Committee made reference to sources which could be used to come to a definition of integrity for specific waters. They said, "The 'natural...integrity' of the waters may be determined partially by consultation of historical records on species composition; partially from ecological studies of the area or comparable habitats; partially from modelling studies which makes estimations of the balanced natural ecosystems based on the information available" (S.R., p. 1468).

Even with this guidance, the integrity concept is still difficult to define, primarily because few professional ecologists or environmentalists agree to a precise definition. The Commission, with assistance from the Institute of Ecology's Advisory Committee on Water Ecosystems, has examined differing opinions and philosophical approaches to defining the phrase, but is uncertain which viewpoint or philosophical approach most closely reflects the intent of Congress, as stated in the Act.

A simplistic application of this integrity concept could mean that quality of water which would exist in a "natural" physical and chemical state without any man-made contribution or disturbance, and "biological integrity" that water-related biomass which existed prior to any alteration or influence from man's technology. Even with so simple an approach, there are definitional difficulties. Did man's technology originate when he first took up a club, when he began using metal tools, when he began to produce his own food and congregate in permanent towns and villages, or only with the coming of the "industrial revolution"?

Obviously, man began to dominate, alter and manage his environment long before the twentieth century. To "maintain" a level of "chemical, physical, and biological integrity" requires, first, a choice of that level to which the nation's waters are to be "restored." Data to describe the present chemical, physical and biological condition of the nation's water is woefully inadequate. Any attempt to characterize the historical "integrity" of the nation's waters at historical intervals with any degree of accuracy from the fragmentary available information is impossible.

Although it has physical, biological and chemical components, ecosystem integrity as a single concept is preferable to dissection into "component integrities" for purposes of definition. The concept of ecosystem integrity relates to regulation of the structure and function of all components. To understand this concept requires understanding of several basic characteristics of ecosystems:

1) Interrelationships among species and their physical-chemical environments are results of long-term continuing evolutionary processes.

2) Due to interactions among species and with the environment, ecosystems tend toward short-term stability of biomass, and maintain characteristic rates of energy flow.

3) Ecosystems evolve toward a steady-state condition through species succession following short-term environmental disturbance.

4) Occasional natural disturbances (e.g. floods) are essential to maintain diversity in ecosystems.

5) Maintenance of life on earth depends upon the continued functioning of evolutionary ecosystem processes.

Although man is part of ecosystems and a product of evolution, his complex and sophisticated technology has given him an unprecedented capability to radically alter ecosystems. Man-induced changes occur at much faster rates than do natural ecosystem changes because of the

technology he is constantly perfecting. With some exceptions, man's disturbances of ecosystems often abruptly alter environments developed over long periods of time. Some consequences of these changes are disappearance of useful species, appearances of nuisance species, noxious conditions and human health hazards. Because of the difference between rates of natural and human-induced ecosystem changes, the concept of ecosystem integrity must account for mechanisms that regulated ecosystem structure and function prior to modification by man.

If natural ecosystem integrity is viewed as a phenomenon that should be "restored and maintained," difficulties arise when attempting to apply this concept as a measure of success for a water pollution control program. Is ecosystem integrity achieved when an aquatic environment provides optimum services required by man, or does the achievement of ecosystem integrity require restoring conditions existing prior to human impact? The fundamental question, then, is to what extent should man restrain or adapt his technology to limit his environmental impact more nearly to what would occur naturally, i.e., without his technology?

Those who interpret ecosystems integrity to mean "conditions prior to technological perturbations of man" feel the definition to be philosophically correct for several reasons. They say our knowledge of ecosystems is very incomplete, and that we may be changing and modifying ecosystems in ways we do not fully understand. Ecosystems are important, these proponents say, because someday we may need them for very different purposes than we do today. If ecosystems are managed only for current purposes, their capacity to meet unforeseen future uses may be destroyed. Certain "minority" groups wish to use ecosystems in ways quite different from conventional uses. Management of ecosystems for only conventional uses will deprive these "minority users." Persons arguing for restoration and maintenance of ecosystems as they were "prior to man's technological perturbations" believe the condition provides a maximum range of possible future human uses.

On the other hand, others believe using the environment and maintaining environmental quality at a level no higher than is required for current use is philosophically acceptable. They feel that it is impossible, and in fact undesirable, to achieve an environmental quality that existed prior to human technological impact without drastically reducing man's numbers. In short, they feel that man has been, and should continue to be, an integral component of the ecosystem in which he lives. Upgrading general environmental quality above a level needed for survival is an unnecessary expense which society can ill afford. Since our understanding of ecosystem conditions prior to human impact is incomplete and will remain so, it is foolish to strive for an environmental condition which remains undefinable.

Each of these philosophies can be supported by valid arguments. Thus, the dilemma facing the nation is how to incorporate into a water quality program a concept of chemical, physical, and biological integrity, or ecosystem integrity, that satisfies the full range of viewpoints. The resultant regulatory process should avoid unacceptable costs of unrealistically stringent environmental regulation, yet also destruction of our water environment. Those who formulate and direct the regulatory process inevitably face difficult questions of balance between environmental quality and economic consequences in controlling this nation's water pollution. Neither of the extreme philosophies summarized here, if applied exclusively as a basis of a pollution control program, will likely yield environmentally sound and economically reasonable results. Thus, the questions posed here must be answered using best sources of information available at a given time, rather than through a philosophically dogmatic approach.

Contractors performing 41 site-specific water quality and environmental studies, the primary focus of the Commission's national environmental impact assessment, were instructed to compare existing conditions and projected changes within each site to physical, chemical, biological and ecological characteristics of an "undisturbed setting" within or adjacent to the site. However, in a number of site-specific studies, environmental contractors found it impossible to document these characteristics for the "undisturbed setting." Often, there were insufficient data, historical or present. In some instances, contractors were only able to use a "hypothesized" set of environmental conditions representing some "undisturbed" level for comparison. For nearly all study sites, except in extreme headwater regions, there have been important changes in physical, chemical, and biological characteristics over time. Even where an "undisturbed setting" is described, there are pollutant discharges from upstream that prevent accurate characterization of such a setting.

Thus, the Commission cannot claim that its studies, even in a limited sense, have identified a "chemical, physical and biological integrity" to which the water there should be restored at these locations. These studies do, however, utilize all available information for the respective sites to analyze progress toward a water quality better than that existing today and one that will provide "for the protection and propagation of fish, shellfish and wildlife."

2. Interpretation of the 1983 Interim National Goal

Section 101(a)(2) of the Act states:

> "It is the national goal that wherever attainable, an interim goal of water quality which provides for the protection and propagation of fish, shellfish, and wildlife and provides for recreation in and on the water be achieved by July 1, 1983."

Similar language appears in another section of the statute. Section 302(a) authorizes special "effluent limitations (including alternative effluent control strategies)" for point-source discharges into "a specific portion of the navigable water" when, in the EPA Administrator's judgment, regular effluent limitations for 1983 "would interfere with the attainment or maintenance of that water quality . . . which shall assure protection of public water supplies, agricultural and industrial uses, and protection and propagation of a balanced population of shellfish, fish and wildlife, and allow recreational activities in and on the water . . ."

In interpreting this language the Senate Report (Report of the Committee on Public Works, U.S. Senate, October 28, 1971) states that "intangible social benefits . . . more difficult to calculate such as long-term improvement of water quality and reduction of estuarine and ocean pollution should not be ignored" (p.47). The Committee also acknowledges the "recreational and aesthetic values of maintaining a balanced population of shellfish, fish and wildlife in the particular waterway" (p.48).

To evaluate achievement or non-achievement of the 1983 interim goal within the context of the Commission's environmental assessment, a practical interpretation of the goal is required. Several interpretations of the goal are possible, and each interpretation entails a different approach for assessing achievement or non-achievement. The underlying assumption inherent in the Commission's interpretation has been that the goal is an ecological and environmental one and therefore must be stated in ecological and environmental parameters. For example, the goal specifies that there shall be "wherever attainable" a water quality which "provides for the protection and propagation of fish, shellfish, and wildlife . . ."

a. Fish

To the extent that some fish species are found in nearly all of the environmental study sites, that part of the interim goal is presently being achieved at these locations. Considering the type of fish present and that existing populations are low or restricted within a small habitat, the overriding and controlling factor may be the ability of

some species of fish to tolerate, or exist in, low to moderate levels of pollution. Stated another way, some fish can tolerate certain pollution levels for brief periods of time. Thus, depending upon the geographical location, type and levels of pollutants, and native species, some fish would be present.

Interpreting the goal becomes more complicated if a "high quality" game fish previously existed within the site, or presently exists within the "undisturbed" part of the site. The question of achievement then requires a totally different perspective, one for which an assessment is made of (1) historical species composition within the site, and (2) whether the species would likely return if physical, chemical, and biological support were to become available through reduction of point-source discharges. If this approach is selected, the next step is to evaluate possible management strategies for introducing or reintroducing those species. To complicate matters even further, for many parts of the country, data are not available to document historically existing species composition. In many areas, native fish species have been replaced by decades of stocking, introduction and reintroduction of new species. Thus, for many sites, the concept of indigenous species and the condition to which the system might revert when point sources are curtailed or eliminated becomes a matter of preference.

In order to obviate these and related problems, the following information was sought in studies at specific assessment sites: (1) What types and amounts of fish presently exist within the site? (2) Are the types and kinds of fish present similar to or different from those existing historically within the site? Within the "undisturbed setting"? (3) In view of the projected water quality and possible habitat changes within the site, will fish undergo marked changes in biomass or species composition? Answers to the last question were not evaluated from the standpoint of potential to support a sports fishery, since the analysis would have required studies to determine species adaptable to the site, perception by local fishermen and access to the site.

b. Shellfish

Achievement of the interim goal relative to shellfish is even more difficult to assess when considering shellfish. But it can be partially evaluated from answers to several questions asked of environmental contractors: (1) Do shellfish presently exist within the assessment site? If so, in what types and quantities? (2) Have they changed in biomass or range of habitat over recent time because of pollution? (3) Has their availability been limited because of accumulation of toxic substances or because they are a hazard to human health? (4) What are some of the projected changes in shellfish if point-source discharges are reduced or eliminated within the site? Within the limits of historical information for several sites, future changes have been predicted. But

on the basis of site assessments alone, too few data were available to form meaningful conclusions for the nation as a whole.

c. Wildlife

Achievement of the interim goal relative to wildlife is most difficult to assess. Few reports have been published describing the linkage between water pollution levels and wildlife populations, or the effects on wildlife. The movement of pollutants through the environment, including accumulation in specific wildlife populations, is poorly documented. Waterfowl, the most closely related to aquatic environments because of food sources and habitat requirements, do accumulate specific pollutants to the point of reproductive failure, physiological stress and, in some cases, death. However, two general problems emerge when trying to assess achievement of the interim goal for waterfowl: (1) they are generally migratory, which makes it difficult to document when and where damaging pollutants were assimilated; and (2) the food chain dynamics in many aquatic systems where waterfowl are found have not been well described. Hence, it is difficult to document site-specific relationships between potentially damaging pollutants and impacts on wildlife. Knowledge of such relationships would necessarily be an important prerequisite to any analytical procedure to evaluate the effects of reducing or eliminating pollutants from point or nonpoint sources.

A final observation relating to achievement or non-achievement of the interim goal for fish, shellfish, and wildlife is that while it may be possible to substantially reduce point-source pollutants by achieving the requirements for July 1, 1983, a recovery of the physical habitat that would support various fish, shellfish, and wildlife undoubtedly will take considerably longer to occur. Ultimate beneficial effects on fish, shellfish, and wildlife populations could take as long as 2-5 years, and possibly longer.

d. Potential for Recreation in and on the Water

The second part of the interim national goal requires a water quality that "provides for recreation in and on the water." To a marked extent, achievement or non-achievement of this part of the goal can be evaluated from the standpoint of meeting specific water quality standards for water-based recreational activities by achieving the requirements for July 1, 1983. This is not difficult to assess, since projected changes in water quality can be compared against Federal, state or local standards for water-based recreation. However, the most frequently used parameters depend upon levels of total coliform or fecal coliform bacteria present. Ideally, achievement should be based on compliance with a number of water quality criteria, in addition to bacterial standards. Such a standard set of parameters is not always

feasible because of natural variations in parent water quality characteristics which occur regionally and geographically. For example, to select a specific level of turbidity against which existing and projected water quality changes could be compared to determine achievement would be difficult, since in some parts of the country high turbidity levels occur naturally. Hence, for practical purposes, the evaluation depends upon health-related standards. It is feasible to select and record a number of water quality criteria which would be valid for future comparisons within a given geographic region, say within a MGR,* in addition to bacterial standards.

In addition to improved water quality, many types of water-related recreation would require restored and improved aesthetic conditions and changes in various physical features. These assessments are more difficult to make. For example, benthic deposits may take several years to oxidize, or they may be removed quickly by flooding or flushing of the water course and deposited downstream or in reservoirs. To the extent that relationships between water quality characteristics and permissible recreational use are understood and documented, primarily from those few case studies where improved water quality has resulted in recreational benefits and where deterioration has resulted in their loss, the Commission has been able to judge potential recreational benefits at the various environmental sites. Few data were available from the sites to support a comprehensive assessment of the degree of national achievement of this part of the interim goal.

For nearly all site assessments, prediction of the time frame within which changes that would support changes in water-based recreational opportunities might occur has been impossible.

B. METHODOLOGY

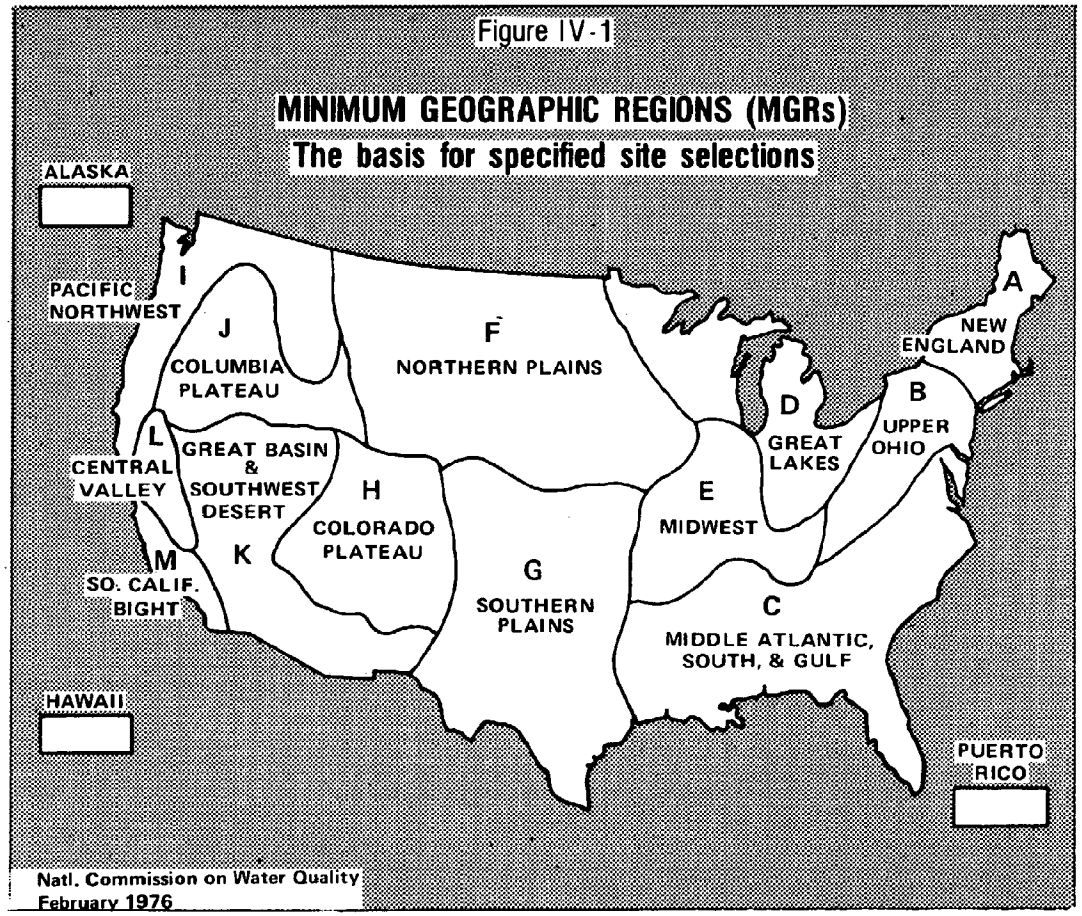
Recognizing the constraints placed on the Commission's assessment by both limited time and available funds, a study strategy was designed to optimize use of available data to provide a summary of the nation's geographic, hydrologic, demographic, meteorologic and environmental characteristics, and to demonstrate the range of water pollution problems experienced throughout the U.S.

On the basis of ecological characteristics, the contiguous U.S. was divided into thirteen "minimum geographic regions," (MGR's). These regions, shown in Figure IV-1, were defined using three primary criteria: (1) dominant geologic characteristics; (2) distribution of principal types of soils; and (3) potential natural vegetation patterns. Other characteristics used to distinguish regions were precipitation patterns, demography, water hardness, periods of major low-stream flow, industrial water use, sediment concentration and other water quality factors.

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*See below for explanation of MGR.

Figure IV-1



Selection Criteria

- Dominant geological features*
- Major soil types*
- Natural potential vegetation*
- Precipitation patterns
- Water hardness
- Stream sediment concentration
- Seasonal low flow periods
- Demographic characteristics
- Industrial water use
- Other water quality factors

*Major criteria

The strategy was to select specific locations on rivers, lakes and coastal estuaries within each MGR for intensive analysis. These "sites" provide a representative coverage of the environmental and water quality characteristics typical of each MGR, as well as Alaska, Hawaii, and Puerto Rico.

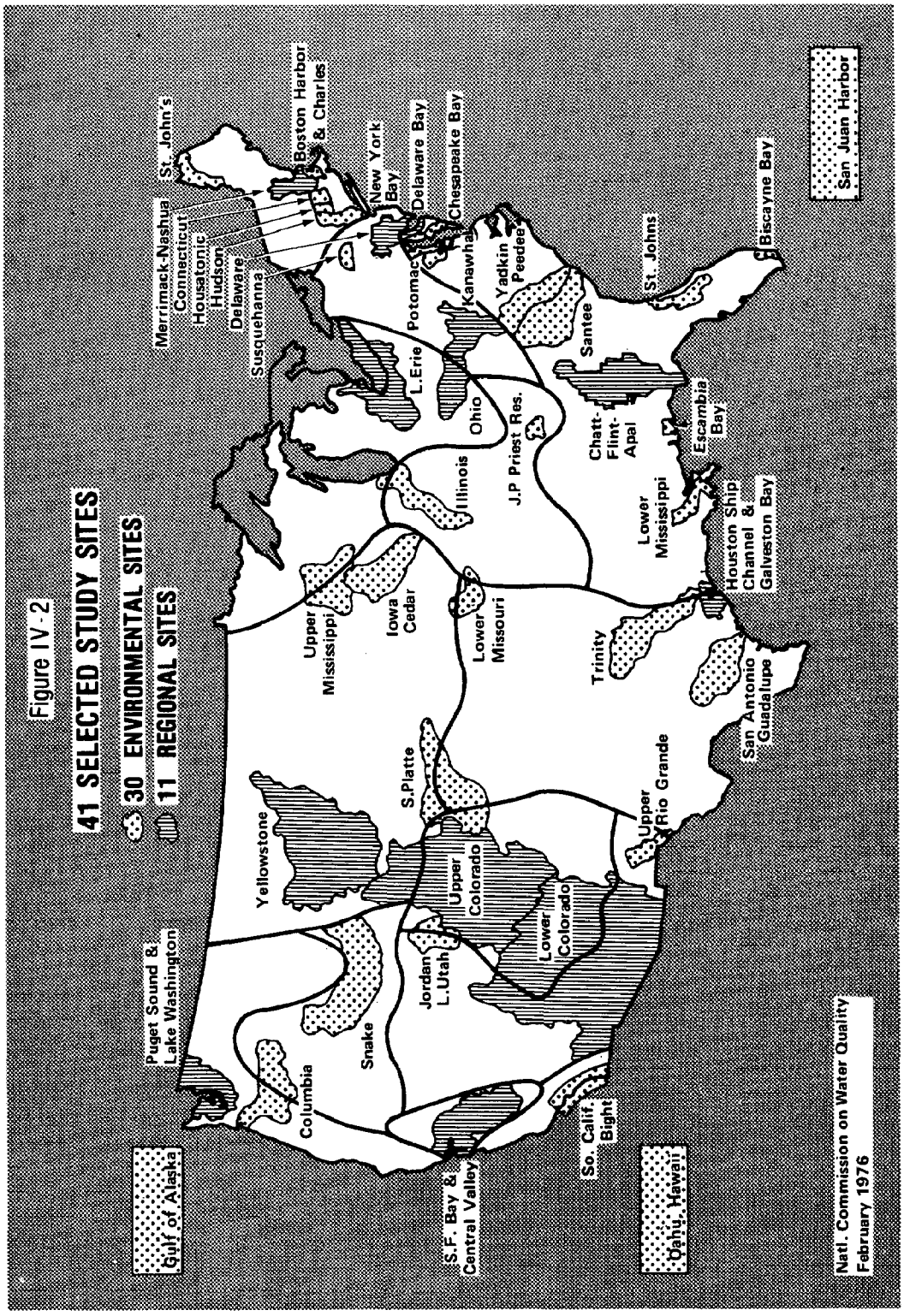
In addition to geographic coverage, the most important criteria considered in site selection were: (1) availability and applicability of a verified mathematic model for relating point-source discharges to resulting water quality within a particular water body; (2) existence of sufficient historical and baseline water quality and environmental data to support an impact assessment and projections of change; and (3) availability of professional ecological expertise for relating physical and chemical water quality changes to potential environmental changes at different sites. An attempt was also made to find sites where there were data specifically on fish, shellfish and wildlife, as well as recreation and aesthetic situations. Using these criteria, a total of 41 sites were selected for specific analysis (see map for location, Figure IV-2).

A consequence of this selection process is that sites where water quality problems are pronounced are dominant because these are the places for which water quality models have been developed. Areas without recognized problems are, in most cases, not places where historic or ongoing data collection and research are underway. There is an undeniable tendency to study problem areas and, to some extent, the emphasis of the analysis is on problem areas. Even so, a number of Commission sites were located in areas not severely polluted, and are considered "effluent limited" for the purposes of the NPDES program.

The 41 sites provide an assessment of nearly 6,600 river and stream miles, 10,600 miles of coastline, 5,900 square miles of estuaries and 5,300 square miles of lakes, reservoirs and impoundments. Counting the total surface of the watersheds where each of the sites is located, the studies collectively encompass a total of about 730,000 square miles of the U.S., or about 20 percent of the nation's land surface, containing an aggregate population exceeding 104 million.*

Additional sites might have provided a clearer, more accurate picture of potential environmental impacts for the nation. Indeed the Commission would have liked to have extended the number of site assessments to gain more coverage. Within the limits of the funds available for this portion of the study, the Commission believes that the coverage obtained through the regional strategy properly characterizes the major impacts which will be felt by implementing the Act. Additional study sites probably would not have improved this regional perspective appreciably.

*Based on 1970 U.S. Bureau of Census data.


Figure IV-2
41 SELECTED STUDY SITES
30 ENVIRONMENTAL SITES
11 REGIONAL SITES
Puget Sound & Lake Washington
Gulf of Alaska
Columbia
Snake
Yellowstone
S.F. Bay & Central Valley
Jordan L.Utah
S.Platte
Upper Colorado
Lower Colorado
So. Calif. Bight
Oahu, Hawaii
Upper Rio Grande
Upper Mississippi
Iowa
Cedar
Lower Missouri
Illinois
Ohio
L.Erie
J.P Priest Res.
Trinity
San Antonio
Guadalupe
Houston Ship Channel & Galveston Bay
Lower Mississippi
Chatt-Flint-Apal
Escambia Bay
Santee
Yadkin
Peedee
Kanawha
Potomac
Chesapeake Bay
Delaware Bay
New York Bay
Merrimack-Nashua
Connecticut
Housatonic
Hudson
Delaware
Susquehanna
St. John's
Boston Harbor & Charles
St. Johns
Biscayne Bay
San Juan Harbor
Natl. Commission on Water Quality
February 1976

C. THE WATER: ITS QUANTITY AND QUALITY

Integral to the assessment of the quality of any water body is a familiarity with its basic hydrological characteristics. Understanding critical flow and volume conditions of a hydrological system is essential to accurately predicting the response of the water's ecological system to pollutant discharge or their removal.

1. Hydrology

Flow and volume of water in both space and time are subject to natural variations due to climate and physical and geologic properties of the drainage basin. In many water systems, the natural hydrologic regime has been altered extensively by man through reservoirs and upstream water withdrawals, stormwater runoff, and intensive land development.

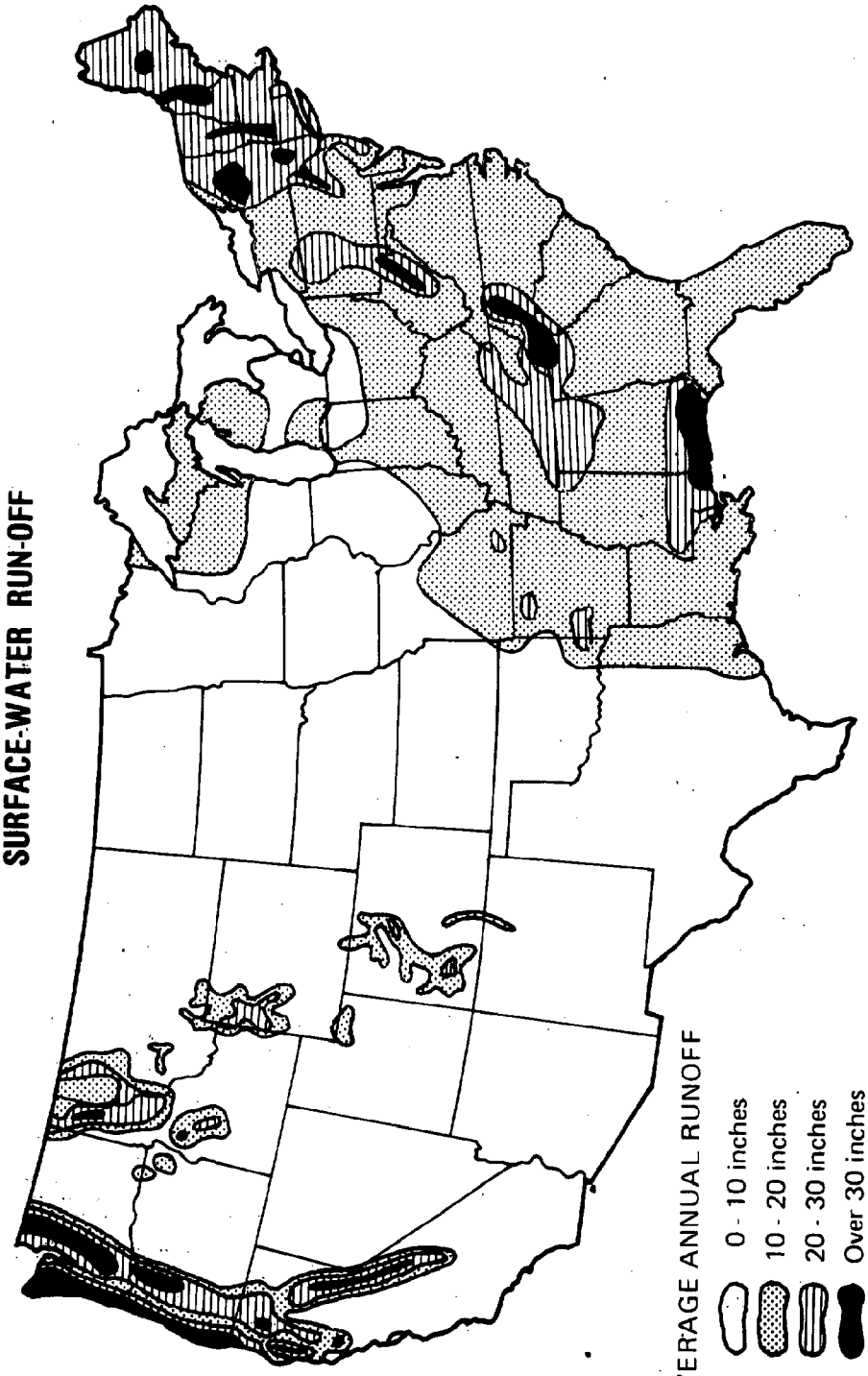
Surface water runoff varies widely across the nation (Figure IV-3). High runoff regions generally coincide with regions of high precipitation. The Pacific Northwest and Southern Alaska exhibit some of the highest runoff in the country. The Northeastern U.S. and portions of the Western Appalachian rank below the Pacific Northwest, but still are regarded as high runoff areas on an annual basis. Lowest runoff occurs in the arid Southwest and the semi-arid Northern and Southern Great Plains, even though some of the nation's largest rivers are in these areas.

Variations in stream flow from year to year result mainly from cyclical variations in precipitation. Lower than average precipitation in the Northeastern U.S. for several years in the mid-1960's resulted in lower than average stream flows, reduced water supplies and increased pollutant concentrations.

Measurement of hydrological occurrences in a water body is a critical element of an environmental assessment. Low stream-flow periods are well recognized by pollution control authorities as being most critical to the stream system receiving wastewater discharges. Low flows mean low dilution capacity and, when coinciding with high water temperatures, constitute a period when the ecosystem is most susceptible to damage. The seven-day/ten-year low flow condition (7Q10 flow) is commonly used by state regulatory authorities to assess critical water quality conditions. This measurement is determined through frequency analysis of recorded stream flows. It is defined as the lowest average flow for seven consecutive days, which could be expected once every ten years. In the arid Southwest, the seven-day/ten-year low flow is often zero. In these cases, a higher flow level such as the 7Q2 flow is used to assess water quality relative to established standards.

Figure IV-3

SURFACE-WATER RUN-OFF



Source: Water Atlas of U.S. 1973

Source: Natl. Commission on Water Quality
February 1976

For the purpose of relating biological and recreational benefits to water quality improvements, seasonal low-flow conditions were used by the Commission. Seasonal low flow means a monthly average flow selected from the lower quartile year, based on total annual discharge. This flow is higher than the 7Q10 flow and is more representative of normal hydrologic conditions.

Selection of this "steady-state", low flow regime as the basis for analysis eliminates the conditions (high rainfall, high runoff, high flow) under which the consequences of nonpoint-source pollutant contributions are likely to be most severe. Therefore, the Commission addressed nonpoint-source pollution problems separately.

In situations where the natural hydrologic regime has been altered by reservoirs or other flow control measures, the critical condition often was chosen to coincide with periods of minimum flow resulting from operation of the flow control system. Low flows at 18 of the study sites (46 percent) are regulated by dams for power production, irrigation, navigation, water supply, or fish and wildlife enhancement purposes. The Missouri River basin (Region F), for example, is dominated by seven reservoirs. Flow is maintained above natural levels during the summer season for navigation purposes. This increases dilution capacity. Maintenance of stream flow into estuaries via reservoir regulation can prevent salt water intrusion into fresh water intake zones.

Examples also could be cited where flow regulations have negative impacts. Irrigation diversions can deplete stream flow, although delayed percolation of irrigated water from ground storage can sustain flows during later dry weather periods.

Physical modification of a stream course can alter flow characteristics and aquatic habitats. Channelization for navigation and other purposes alters flow and circulation characteristics. Dams induce slow velocity, reducing reaeration and often allowing benthic deposits to accumulate. This is especially characteristic of some New England rivers controlled by mill dams. At the same time, dams in some areas may improve conditions downstream by increasing dissolved oxygen levels, reducing turbidity and controlling salinity intrusion in estuaries.

Estuaries, where critical pollutant concentration conditions often coincide with periods of minimum fresh water inflow and high temperature, also are influenced by tides and winds. Circulation characteristics of estuaries tend to be unique and result from complex interactions of their physical dimensions. Commission estuarine sites ranged from the relatively shallow Biscayne Bay to Puget Sound, which is several hundred meters deep. Magnitude of tidal range provides a general indication of

the size of tidally induced water velocities, and wind mixing is related to the extent of open water areas and depth. Tidal ranges for the outer coastal zone along the Gulf of Mexico and South Atlantic Coast are about one-half (0.5) meter. The tidal range increases along the North Atlantic and Pacific Coasts to about three to four meters in Boston Harbor and Puget Sound. Cook Inlet in Alaska exhibits a tidal range of about ten meters.

2. Measuring Present Water Quality

The environmental site studies reveal insight into the nature and regional distribution of national water quality problems. To provide a practical basis for assessing the general quality of water bodies studied, problems were grouped as follows:

- Oxygen depletion
- Eutrophication potential
- Physical characteristics and aesthetics
- Salinity
- Health hazards and toxics

Five commonly observed variables--dissolved oxygen, nutrients (nitrogen and phosphorous), turbidity and suspended solids, total dissolved solids, and coliform bacteria are used to characterize problem categories nationwide. These variables present a very limited picture of the total physical, chemical and biological characteristics of the study sites, but because they have been routinely collected for some time, they provide a practical basis for comparing between sites and regions. Other important variables--including temperature and toxic heavy metals and pesticides, for which data were insufficient for a regional characterization--are discussed later. Better definition of occurrence, sources and impacts of toxic substances is needed in view of the synergistic and longer-term effects of these pollutants.

To provide a general picture of conditions throughout the nation, an assessment of water quality problems related to the five variables for sites within each MGR was made using the ranking criteria summarized in Table IV-1. Numerical water quality levels used for ranking the significance of problems are based upon established criteria for maintaining aquatic life, recreational potential and other beneficial uses. Where possible, detailed data on the percentage of river miles exceeding the criteria were used to support the ranking. In some instances, judgment was exercised as to the areal extent of the particular water quality problem by using data collected at different points within the site. These assessments are based on seasonable low flow conditions.

The relative significance of water quality problems for sites within each MGR for the five water quality variables are summarized in

TABLE IV-1

SIGNIFICANCE OF WATER QUALITY PROBLEMS

Variable	Significance	Criteria
Dissolved Oxygen (DO) Depletion	Significant	Large segments of site have DO less than 4 mg/l;* some reaches anoxic.
	Moderate	Some reaches of site (local) have DO less than 4 mg/l.
	Minor	DO generally greater than 4 mg/l.
Nutrients (N.P)	Significant	Large segments of site have high nutrients[1] and eutrophication problems.[2]
	Moderate	Some segments have high nutrient levels and eutrophication problems.
	Minor	Nutrient levels generally low, eutrophication problems minor.
Turbidity (Tb) Suspended Solids (SS)	Significant	Large segments of site have SS greater than 80 mg/l,* turbidity greater than 50 JTU.†
	Moderate	SS levels greater than 25 mg/l* but generally less than 80 mg/l.
	Low	SS generally less than 25 mg/l.
Total Dissolved Solids (TDS)	Significant	Large segments of site have TDS greater than 500 mg/l.*
	Moderate	TDS levels greater than 200 mg/l but less than 500 mg/l.
	Low	TDS levels less than 200 mg/l.
Coliform Bacteria	Significant	Large segments of site have high coliforms (total greater than 1000 col./100 ml; fecal greater than 200 col./100 ml).‡
	Moderate	Coliform reference levels only exceeded intermittently.
	Low	Coliform levels generally below reference level.

[1]Nitrate (as N) greater than 0.9 mg/l,§ total phosphorous greater than 0.1 mg/l.*

[2]The occurrence of eutrophication problems is related to turbidity and low flow velocity reaches (e.g., reservoirs) as well as nutrient levels.

*Water Quality Criteria, 1972 ("Blue Book"), NAS-NAE, 1972 Dissolved Oxygen (p. 134), Turbidity/Suspended Solids (p. 129), Total Dissolved Solids (p. 90).

†Criteria for Water Quality, EPA, 1973 (Section 304(a)(1) guideline).

‡Water Quality Standards Digest, A Compilation of Federal/State Criteria on Bacteria, EPA, 1972.

§Biological Associated Problems in Freshwater Environments, FWPCA, 1966, pp. 132-3.

Source: National Commission on Water Quality
February 1976

Figure IV-4. These data suggest that a number of problems occur nationwide, while others are peculiar to different regions of the country. All 41 sites suffer to varying degrees from man-made pollution. Dissolved oxygen depletion problems are evident throughout the country in river and estuarine reaches below points of major wastewater discharges. Turbidity levels vary regionally according to natural background levels, although wastewater discharges, construction and agricultural activities add to the volume of suspended solids. Turbidity is highest in the West and Midwest. High nutrient levels occur throughout many study sites, but consequent production is inhibited where there are high turbidities which reduce light penetration. High total dissolved solids levels are associated with regions of high natural contributions, especially in the western states. Irrigation activities add to the totals in these regions. High TDS levels associated with marine waters are not considered except in instances where salt water is impacting fresh water supplies. High bacterial densities, originating from inadequately disinfected municipal discharges and urban and agricultural land runoff are common throughout the study sites. Problems with toxic substances were difficult to assess accurately. High concentrations of heavy metals are generally associated with industrialized and urban areas although mined lands were identified in several instances. High concentrations of pesticides are most commonly associated with runoff from agricultural areas.

a. Oxygen Depletion

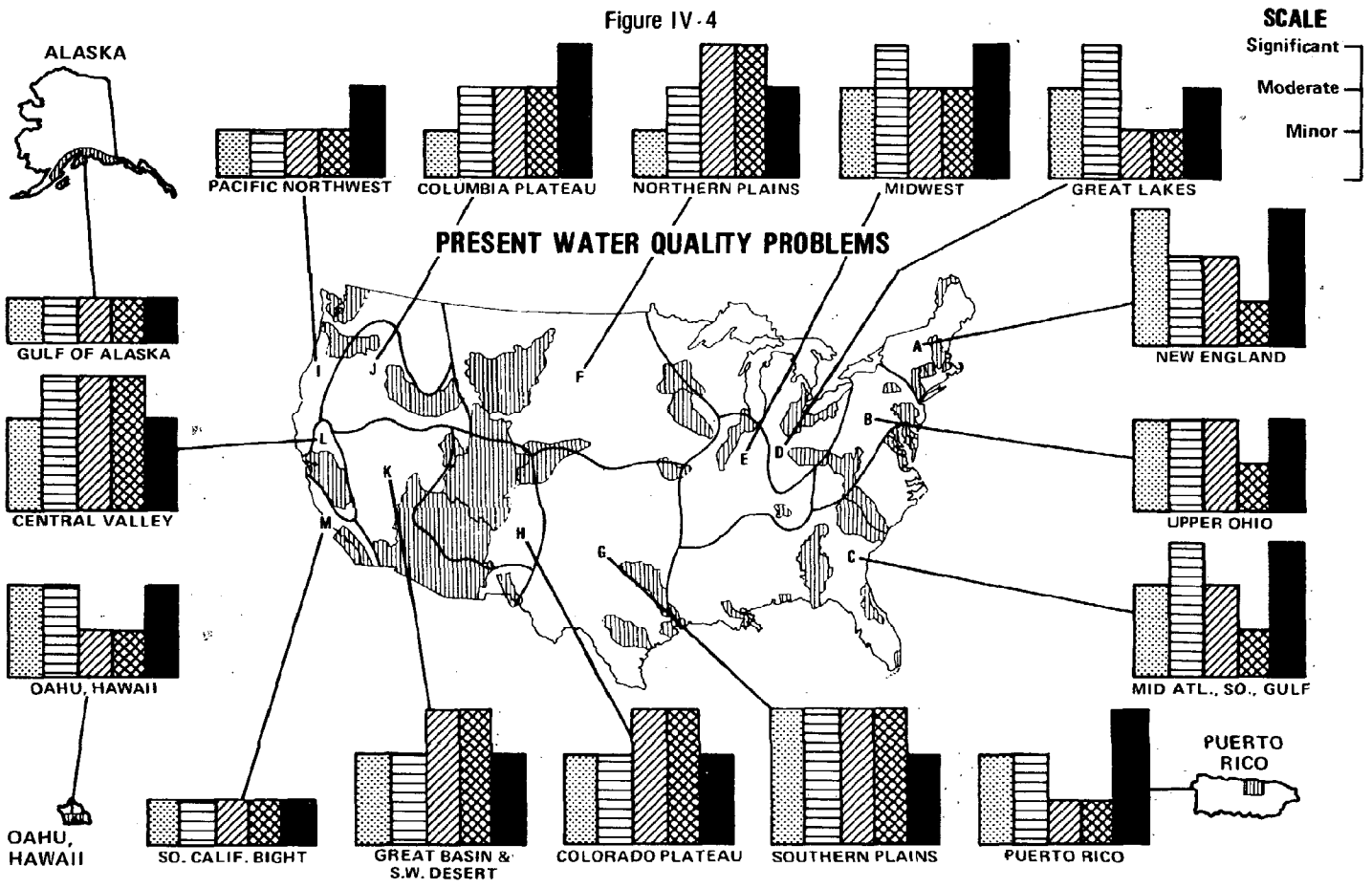
Dissolved oxygen significantly influences nearly all components of aquatic systems. Acute, chronic and sublethal concentrations are influenced by many factors (i.e., temperature, life stages), making precise minimum "safe" levels difficult to define. Lethal dissolved oxygen levels for most fish species are in the range of 1-3 mg/l. Severe (and more subtle) growth and reproduction inhibition may occur at levels up to 5-6 mg/l. The 4 mg/l level in Table IV-1 represents a level of protection which:

> Should permit the persistence of sizable populations of tolerant species and successful passage of most migrants. Much reduced production or elimination of sensitive fish is likely.*

This level obviously does not allow for "protection and propagation" of a "balanced and indigenous population," as stated in the goals of the Act. In actuality, this goal can only be achieved by maintaining the natural seasonal ranges (especially minimums) within which specific fish populations have evolved.

*Water Quality Criteria, 1972, NAS-NAE

Figure IV-4



Note: Assessment studies were conducted on specific river reaches or water bodies within each shaded area.

Source: Natl. Commission on Water Quality
February 1976

In addition to direct effects on fish, low DO can exaggerate other physiological effects (such as heavy metal toxicity), cause changes in invertebrate numbers and diversity, produce malodorous conditions due to anaerobic decomposition, and encourage conditions suitable for nuisance organisms, including bacteria.

Dissolved oxygen depletion in reaches of rivers and estuaries below major wastewater discharges is evident throughout the country. Levels are further reduced in regions of low stream flow, such as in the Southern Plains and Midwest regions. In the highly populated Northeast, a region of high runoff, DO depletions still occur, although improvements are evident in recent years as treatment systems are implemented. In many urban areas, the problem is complicated by combined sewer overflows and urban storm runoff which deliver pulse loadings of oxygen-demanding materials (i.e., BOD) to receiving waters.

-- Detailed data presented for 21 sites covering 4,600 river miles show that dissolved oxygen is currently depleted below 4 mg/l for 384 river miles (8 percent) in 13 sites during low seasonal flow conditions. This length increases to about 20 percent during critical low flow conditions (19 sites).

-- On a site-by-site basis, 20 of 41 sites (49 percent) were reported to have significant oxygen depletion problems during low flow periods. These sites are distributed throughout the country and are generally associated with major population centers. Eleven sites (27 percent) were reported to have DO levels generally above 4 mg/l for all seasons.

-- Oxygen depletions are primarily related to municipal and industrial point-source discharges of concentrated oxygen-demanding materials. Urban runoff and combined sewer overflows were noted as aggravating the problem at 15 sites (37 percent). Six sites (15 percent) had problems with oxygen depletion from benthic deposits.

-- Supersaturated gases below dams at the Columbia and Snake River sites cause physiological damage to migratory salmon and related species.

b. Eutrophication Potential

High nutrient levels can stimulate excessive aquatic plant growth causing oxygen depletion, odors, and aesthetic degradation. Often, very turbid water high in suspended solids will limit light penetration and inhibit plant growth. Municipal discharges, urban storm runoff, and

combined storm and sewer overflows account for much of the nutrient loadings in the Northeast. Land runoff is a large contributor in the agricultural areas of the Southeast, Midwest, and West.

-- Eighteen of 41 sites (44 percent) were reported to have high nutrient levels and eutrophication problems. An additional six (15 percent) were reported to have high nutrient levels, but eutrophication problems were limited by high turbidity.

-- A major identified nutrient source is municipal wastewater discharges (17 sites or 41 percent). Agricultural nonpoint sources were cited as significant nutrient contributors at 13 sites (31 percent). Urban stormwater runoff and combined sewer overflows were cited as additional sources of nutrients at five of the sites with eutrophication problems.

c. Physical Characteristics

The physical chracteristics of water, including temperature, turbidity and suspended solids, have strong influences on aquatic organisms and beneficial uses for man. The importance of temperature to aquatic organisms is well known, and the composition of aquatic communities depends largely on the temperature characteristics of their environment. The temperature regime of rivers and estuaries varies naturally in response to regional variations in climate. Cooling waters for steam electric power stations contain large quantities of heat, which causes or threatens to cause, either a warming of rivers, lakes, and coastal waters, or a rapid cooling when the artificial sources of heat are abruptly halted. Although site-specific data are required for detailed assessment of thermal discharge impacts, indications are (cf. III.D.6) that once-through cooling systems on estuaries currently create the most serious conditions. The thermal regime of a river also can be altered by large reservoirs in which the water stratifies. The upper layers become warmer than seasonal norms and lower layers become colder than normal. Depending upon the amount of water withdrawn and the level of withdrawal, the downstream thermal regime can be altered greatly.

-- Almost all of the study sites received cooling water from power plants and industries, but detailed data on the magnitude of the temperature influence was not definitive. Reservoir releases influenced river water temperature at six sites.

Excessive turbidity reduces light penetration necessary for many aquatic plant species and for sight feeding activities of predatory game fish. If the volume of suspended solids is reduced and the level of nutrients is neglected, problems associated with eutrophication can be

expected to be more widespread. Deposition of suspended materials eliminates substrate necessary for fish spawning and for bottom organisms. Aesthetic degradation also may occur. In addition, sediment can act as a transporting agent for other pollutants, such as nutrients, pesticides, organic matter and pathogens which are absorbed onto soil particles. Natural turbidity varies regionally and wastewater discharges, construction activities and man-induced erosion through various land uses can add to natural turbidity levels. In general, turbidity levels are highest in the "soft-rock" and arid areas of the country, including the Southwest, the Great Plains and Midwest. High natural color and turbidity levels also are associated with swamp drainage in the South Atlantic and Gulf Coast regions.

Any characterization of sediment as a pollutant requires recognition that flowing waters have fixed minimum sediment carrying capacities. If control of discharges reduces suspended solids to below these minimum levels, the flowing water will attempt to restore the minimums by scouring the beds and banks of the watercourse until the minimum carrying capacity is satisfied. Thus, all the nation's waters cannot be made crystal clear.

-- Twenty-two of 41 sites (54 percent) were identified as having significant turbidity or suspended solids problems. Of these, at 11 sites (27 percent) the high levels were attributed, at least in part, to point-source wastewater discharges. Nonpoint sources, including agricultural, urban and mined land runoff, dominated at 17 sites (41 percent). Point-source influences were most evident in the clear water regions (e.g., New England) while nonpoint sources dominated in the Great Plains, Midwest and Southwest.

Aesthetic degradation of water bodies often occurs as a result of excessive turbidity, algae growths, scum, floating solids and odors. Many of these problems are associated with other indicators of pollution, such as anaerobic waste decomposition where dissolved oxygen is depleted. Gross discharges of floatables are being reduced, although oil spills and urban runoff continue to be problems in many areas.

-- Oil spills were reported at five sites (12 percent) as a significant source of aesthetic degradation. Each of these sites included major harbors as part of the study area.

d. Salinity and Acidity

High total dissolved solids in inland waters are objectionable because of possible physiological effects, mineral taste, and economic consequences such as for irrigation, municipalities and certain industrial uses. Generally, rapid changes in TDS levels are detrimental to aquatic life. TDS problems are associated with regions of high natural background

concentrations--the Southwest and Northern and Southern Great Plains. However, man's activities, particularly intensive agricultural practices involving irrigation, contribute to the loads in each of these regions. Other activities, including industrial and domestic water uses, cause increases in TDS levels in all regions, particularly near major population and industrial centers.

-- Freshwater segments of six of 29 sites (20 percent) were reported to have TDS problems at the significant level (i.e., above 500 mg/l). All of these are associated with natural conditions and irrigation projects in western states.

-- At the mouths of rivers discharging into estuaries, salt water intrusion, caused by channelization or the withdrawal of inflowing fresh water, was noted at four sites. Salt water intrusion into fresh groundwater supplies, due to groundwater withdrawals, is also a concern in coastal areas.

-- Chloride levels in Lake Erie, although not a severe problem, are trending steadily upwards and have been related to road deicing salts and other domestic and industrial water uses.

Acid mine drainage is evident primarily at sites in the Appalachian coal mine regions drained by the Ohio, Delaware, Susquehanna and Potomac Rivers.

e. Health Hazards and Toxic Substances

Bacterial densities in water, expressed as coliform concentrations, are a standard measure of danger to human health. Coliform bacteria are used as a surrogate for indicating the presence of pathogens because of their relative ease of detection. The validity of coliform bacteria levels as an indicator of pathogens is often questioned, since many common and innocuous bacteria show up as positive in the standard test. High coliform bacterial densities, originating primarily from inadequately disinfected municipal discharges, urban storm runoff and combined sewer overflows are common throughout the country. Agricultural practices, such as stockgrazing and feedlots, and malfunctioning septic tanks also result in high bacterial level discharges. These storm runoff related sources correlate with rainfall frequency and intensity. Discharges occur often enough to cause public beach closings, particularly near urban areas.

-- Almost all of the study sites reportedly have bacterial problems at one time or another through the year. Thirty-two of 41 sites (78 percent) were recorded as having significant coliform bacteria problems.

-- At 19 sites (46 percent) significant coliform bacteria levels were attributed to municipal point-source discharges.

-- At 19 sites (46 percent), urban storm runoff and combined sewer overflows aggravated the problem. At 10 sites (24 percent) substantial contributions were attributed to agricultural land runoff. Many sites receive substantial contributions from both point and nonpoint source loadings.

Toxic substances and their effects are difficult to detect in the environment, yet represent great potential for ecological damage, even at very low concentrations. Concentrations of any substance exceeding an organism's normal tolerance range may be considered "toxic." Of all biological effects, this area is perhaps the least understood and potentially one of the most important. Acute tolerance limits have been established for many pesticides, some heavy metals and certain organic and inorganic compounds. Chronic effects are less well documented. Sublethal effects, such as possible alteration in reproductive or feeding behaviors, are virtually unstudied. Complex interations with other water quality constituents, such as synergistic effects, accumulations in organisms and magnifications through food chains make definition of "critical" toxics levels very difficult and continued research in this area is needed.

The Commission's environmental studies illustrate a wide range of toxic sources and problems in the nation as well as data limitations. Two major categories of recognized toxics--heavy metals, including mercury and cadmium, and pesticides--were the most commonly observed.

-- Concentrations of one or more of the heavy metals commonly exceeded suggested safe limits (Water Quality Criteria, NAS-NAE, 1972) in the water column or in fish tissue at 13 of 35 sites (37 percent). At an additional 9 sites, heavy metal concentrations sometimes exceeded safe limits or were evident in high concentrations in bottom sediments. Thirteen of 35 sites (37 percent) were found to have little problem with heavy metals, while detailed data were not presented for six sites. The most commonly cited heavy metals were mercury, zinc, lead, manganese, and iron. Major sources of heavy metals cited included industrial point sources, urban runoff and mine drainage.

-- Pesticide concentrations commonly exceeded suggested safe limits or were linked with fish kills at 13 of 26 sites (50 percent) in recent years where data were available. Presence of pesticides at an additional seven sites were noted as being sometimes above safe levels. Low concentrations of pesticides

appeared at six sites (15 percent). Detailed data were not available for the remaining 15 sites. The most commonly cited pesticides were DDT, Dieldrin, and Heptachlor. Runoff from agricultural land was cited as the major pesticide source at eight of the problem sites. Forested and urban land runoff was noted as a contributing source at a number of sites.

Other toxic substances were detected at a number of sites. Polychlorinated biphenyls (PCB's) were noted as exceeding safe concentrations in fish tissue and sediments at four sites--all associated with industrialized areas. Phenols linked with industrial discharges were cited as possible toxics at ten sites.

3. Pollutant Loadings

While a generalized picture of the present quality of the nation's waters is essential for perspective as a baseline profile, it is not a sufficient basis for developing environmental predictions. Also necessary is detailed information on the pollutants being discharged into the waters--including sources, characteristics, magnitude and timing of the discharge. Without these data for "pollutant loadings" there is no precise means to assess improvements expected to result from implementation of increasingly stringent limitations.

a. Point Sources

Since the Act's requirements concentrate on point-source control, a primary objective has been to relate quantity and quality of point-source discharges to receiving water quality at the 41 study sites. Point-source pollutant discharges are categorized into four major groups:

- Municipal treatment facilities
- Industries
- Irrigation return flows
- Feedlots

Information on the magnitude and character of point-source discharges comes mainly from National Pollutant Discharge Elimination System (NPDES) permits issued by the state agencies or EPA regional offices. In most cases, permits define point-source pollutant discharges using only a few routinely measured parameters (e.g., BOD_5, suspended solids, pH, and temperature) reflecting the more obvious water quality problems in the receiving stream. Supplementary data, obtained from any previous surveys, also were used to define seasonal variations in effluent quantities and qualities at a number of assessment sites.

Reported pollutant loadings at the study sites provide the relative contributions from the various point sources.

(1) Biological Oxygen Demand (BOD_5) (Based on information from 38 sites)

-- Municipal BOD_5 loadings far exceeded other point-source BOD_5 contributions at 18 sites (47 percent). Industrial BOD_5 loadings exceeded other point-source BOD_5 loadings at 11 sites (29 percent). Municipal and industrial BOD_5 loads were about equal at the remaining nine sites. Data on the magnitude of industrial contributions to the municipal system were scarce, but the few sites for which data were reported indicated a wide range.

-- Irrigation return flows contributed small amounts of BOD_5 at only a few sites--primarily in the Northern and Southern Great Plains.

(2) Suspended Solids (Based on information from 26 sites)

-- Municipal suspended solids loadings exceeded other point-source suspended solids loadings at 13 sites (50 percent). Industrial suspended solids loadings exceeded other point-source suspended solids loadings at seven sites (27 percent). Municipal and industrial suspended solids loadings were about equal in magnitude at four sites.

-- Irrigation return flows contributed suspended solids in amounts equal to or greater than other point sources at two sites located in the Northern and Southern Great Plains.

(3) Nutrients (Based on information from 18 sites)

-- Municipal nutrient (N and P) loadings exceeded other point sources of nutrient loads at 15 sites (83 percent).

(4) Total Dissolved Solids (Based on information from 4 sites)

-- Agricultural return flows contributed significantly to total dissolved solids loadings at two sites. Separation of TDS loadings between point, nonpoint, and natural sources was difficult in agricultural areas.

(5) Coliform Bacteria

-- Municipal discharges were major sources of coliform bacteria at virtually all assessment sites. Cattle feedlot operations were suspected of contributing substantial amounts of coliform bacteria at several sites in the western and southeastern agricultural states.

(b) NonPoint Sources

In many locales nonpoint-source pollution controls must complement point-source controls in order to achieve the 1983 interim water quality goal of the Act. They are diffuse by nature and are generally flow-dependent and intermittent. Storm runoff is a major transport mechanism, although groundwater contributions, especially in irrigated areas, occasionally can constitute a major pollutant source during low-flow periods. Nonpoint sources generally coincide with land-use activities and can be categorized as follows:

(1) Urban land: Urban runoff contributes wastes to receiving water bodies through storm sewers, overland flow, seepage and minor tributaries. Large quantities of suspended solids, organic matter, algal nutrients, coliform bacteria, heavy metals and pesticides often are associated with urban runoff. The "first flush" of storm runoff is typically highly contaminated. For the purposes of this assessment, urban land runoff includes that flowing from combined sewers and storm sewer drains although EPA has defined these as point sources.

(2) Agricultural land: Runoff from agricultural lands used for crops, animal production and pasture can contribute a wide variety of pollutants to receiving waters. The major pollutants are sediment, nutrients, dissolved solids, bacteria and pesticides.

(3) Forested land: Forested lands have relatively high water retention capacities, hence minimal amounts of surface runoff and accompanying soil erosion. Forest management and harvesting practices, such as clear-cutting, roadway development and usage, and application of herbicides and pesticides, however, can contribute to pollution.

(4) Mining land: Disruption of the earth's surface from mining activities causes physical and chemical modifications of associated aquatic environments. Major problems are sedimentation from surface mined areas, and acid discharge from both exposed surface and underground mines.

Natural characteristics of a drainage basin sometimes will combine to generate relatively large pollution loads when compared to man-induced pollution sources for the same area. Examples include high salinity (TDS) in the Colorado River Basin, low dissolved oxygen and high color of waters draining from swamps in South Carolina, and high stream sediment concentrations in sections of streams in the Midwest and West.

Ecological impacts of nonpoint sources depend upon the magnitude of their contribution, as well as their seasonal distributions. Unlike point sources, nonpoint-source pollutant contributions are highly variable. Therefore, their impacts are hard to predict. Urban runoff contributes to dissolved oxygen depletions in rivers, especially after storms. Organic solids carried in storm runoff can settle to channel bottoms, causing longer term DO depletion and aquatic habitat destruction. Nutrient contributions from nonpoint sources are normally highest during high-flow periods. The resulting eutrophication potential can be related to hydrologic storage capacities of reservoirs and lakes.

To assess potential gains from point-source controls, the magnitude of nonpoint source loadings must be known. Data developed to provide a national overview of relative waste loads from point and nonpoint sources are illustrated in Table IV-2. Total point-source pollutant loads were estimated assuming secondary treatment (including disinfection) for a national sewered population of 150,000,000 for the municipal sector, and uniform application of BPT for industries (six SIC categories). Nonpoint-source pollutant loads were estimated using relationships between population density and area runoff loading factors for three land-use categories (i.e., urban-suburban, agricultural, and forest).*

Data presented in the table do not include present (1973) point-source loadings which will be greatly reduced by the 1977 requirements. To illustrate, the NAS Study Committee on Water Quality Policy, using a methodology similar to Hydroscience, estimates that 1973 municipal and industrial BOD discharges constitute about 50 percent of the national total from both point and nonpoint sources. Achievement of BPT for industries and secondary treatment for municipalities would decrease the BOD load from these point sources to about one-fourth of the 1973 level. Nonpoint sources then become more significant relative to point sources.

Although these estimates were developed independently of the site studies, they do correspond with limited data developed for some of the sites and from other Commission sources.

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*See Technical Environmental Volume for more detailed explanation of data base used to develop load estimates.

TABLE IV-2

NATIONAL SUMMARY OF WASTE LOADS
REMAINING AFTER THE 1977 REQUIREMENTS ARE ACHIEVED

Variable	Point Source (1)	Nonpoint Source*	Total Point and Nonpoint	% Remaining at EOD
BOD ult. (2)	24.0	13.9	37.9	37
Sus. Sol. (2)	11.9	145.6	157.5	92
T. Nit. (2)	7.4	28.3	35.7	79
T. Phos. (2)	1.7	1.93	3.63	53
Fecal Col. (3)	1.95	87.85	89.8	98
Total Col. (3)	15.0	1368.0	1383.0	99
Oil/Grease (2)	3.9	0.5	4.4	11
Cadmium (4)	6.4	1.5	7.9	19
Zinc (4)	67.6	51.4	119.0	43

*Includes combined sewer overflows and urban runoff.

(1) Estimated Loads remaining after achievement of the 1977 requirement.
(2) In million pounds per day
(3) In number of bacteria - 10^{15}/day
(4) In thousand pounds per day

Source: Hydroscience, Inc., August 1975; "An Overview of Waste Loads and Urban-Suburban Stream Quality Response."

Several points can be noted concerning the relative magnitude of point- and nonpoint-source pollutant loads remaining even after secondary treatment for municipalities and BPT for industries is achieved. Large amounts of suspended solids, nutrients (N and P) and fecal and total coliform bacteria emanate from nonpoint sources. Although substantial reductions of these pollutants will be realized through achievement of point-source controls via 1977 requirements, nonpoint sources could obscure further gains if left uncontrolled. At the other extreme, additional point-source controls in oil, grease and cadmium would be highly effective in reducing discharges of these substances because of the low percentage contribution from nonpoint sources.

Data for precise determinations of relative magnitudes of nonpoint sources at the assessment sites is sketchy. Notwithstanding the generalized estimates presented above, it is evident that more detailed analysis for any given site within a region will be required.*

Accurate definition of nonpoint source loads probably will require additional data collection to determine exact sources, magnitudes and timing of pollutant loadings and impacts. A number of the site study reports did include estimates of nonpoint source loadings, however. And those estimates provide a partial basis for identifying regional trends.

-- Urban runoff and combined sewer overflows are a major source of BOD, nutrients, suspended solids and coliform bacteria and some toxics (e.g., heavy metals). This problem is prominent at sites in the northeastern states, but appears in every major metropolitan area receiving regular storm rainfall.

-- Agricultural land use is linked with major contributions of nutrients, suspended solids, dissolved solids, and pesticides, particularly in the Great Plains, Midwest, Southwest, Columbia Plateau and San Joaquin Valley (California) regions. In significant portions of those regions, agricultural activities only intensify naturally occurring problems especially with regard to suspended and dissolved solids levels. Farmlands in the West, Midwest and Southeast have been identified as sources of coliform bacteria.

-- Forestry practices which disturb the land surface have caused increased turbidity in streams of the Pacific Northwest and Appalachian regions. Pesticides have also been associated with insect control practices in forests in New England and elsewhere.

-- Mining activities cause sedimentation problems in the Appalachian and Rocky Mountains.

4. Predicting Future Water Quality

An ability to quantify probable cause-effect relationships between wastewater discharges and resultant water quality was basic to the Commission's site-specific studies. Mathematical water quality models were used to project changes associated with reductions in point-source loadings. These models simulate cause-effect relationships in natural hydrological systems, primarily under steady-state conditions. A common basis of the majority of these models is the principle of continuity or mass balance, which takes into account three factors:

*Requisite to EPA approval of a Section 208 areawide waste treatment management plan is the identification of nonpoint sources of pollution within the area and procedures and methods to control them.

- Inputs to the system.
- Transport through the system
- Reactions within the system

The validity of the modelling approach depends upon scientific knowledge of the physical, chemical and biological phenomena occurring in the various systems. Ideally, the state-of-the-art of modelling pollutant transport mechanisms and commonly measured pollutant variables is moderately advanced. Variables in this category include dissolved oxygen, nutrients, dissolved solids and bacteria. Modelling approaches for other variables--metals, synthetic chemicals and the eutrophication process--are not as advanced, and additional research is needed. Practically, the validity of any model depends upon the degree to which computed water quality agrees with observed data and patterns. For the site studies only commonly measured variables, such as dissolved oxygen and BOD, were modelled. Even for these variables many of the analyses were limited by availability of data for verification.*

In general, the predictions of future water quality are for seasonal low flows, where the effects of the abatement of continuous point-source discharges can be obtained from mathematical models. Generally speaking, future water quality will not be consistently as good as these predictions because the steady-state conditions selected for modelling eliminated storm-related loadings.

Using this modelling approach, projections of water quality were conducted for four effluent abatement levels at each site (see Table IV-3). The two-pronged effort for 1977 is an attempt to describe expected conditions in 1977 as well as theoretical water quality improvements that could be achieved assuming all permit limitations were met. Information on anticipated delays in operation of treatment or control facilities required by the Act at the 1977 actual level was developed for a number of sites through interviews with federal and state pollution control officials.**

*See Technical Environmental Volume for a detailed explanation of the model simulations and verification processes.

**The delays result from delays in facilities planning, design construction and funding. In some instances, NPDES permits for wastewater discharge have been written for present discharge conditions once a step-by-step schedule for compliance has been agreed upon.

TABLE IV-3

ABATEMENT LEVEL DESCRIPTIONS**

Level	Description
1977 Actual	Use NPDES permit conditions for both industrial and municipal point sources. If major municipal facilities obviously will not attain permit conditions, use actual expected levels.
1977 Theoretical	On effluent limited stretches: Industrial: Use EPA effluent guideline conditions; SIC code and production data from permit application. Municipal: Assume secondary treatment standards (EPA) unless stricter state water quality standards exist. On water quality limited stretches: This level would be equivalent to "Actual" above unless all load applications have been completed.
1983	Industrial: Limitations from EPA effluent guidelines; SIC code and production data from permits and/or permit applications. Municipal: Assume EPA's secondary treatment standards unless stricter state water quality requirements apply.
Elimination of Discharge	Elimination of all pollutants from point-source discharges. Return flow to be maintained.

** Instructions to Commission Contractors.

a. Dissolved Oxygen

Predicted increases in DO contentrations are illustrated in Figures IV-5 and IV-6. The aggregated DO improvement curves (Figure IV-5) are based on projected DO changes at 21 sites covering about 4,600 river miles. Anticipated improvements at 15 of the sites are portrayed in Figure IV-6. These curves illustrate the variability of response at different sites. All of the curves are based on projections for low seasonal flow conditions, which in most cases occur during summer. To illustrate the improvement at the present level, about 380 miles (8 percent) presently have DO less than 4 mg/l. This decreases to 36 miles (.8 percent) through achievement of the 1977 requirements (theoretical) and to 23 miles (.5 percent) for the 1983 requirements.

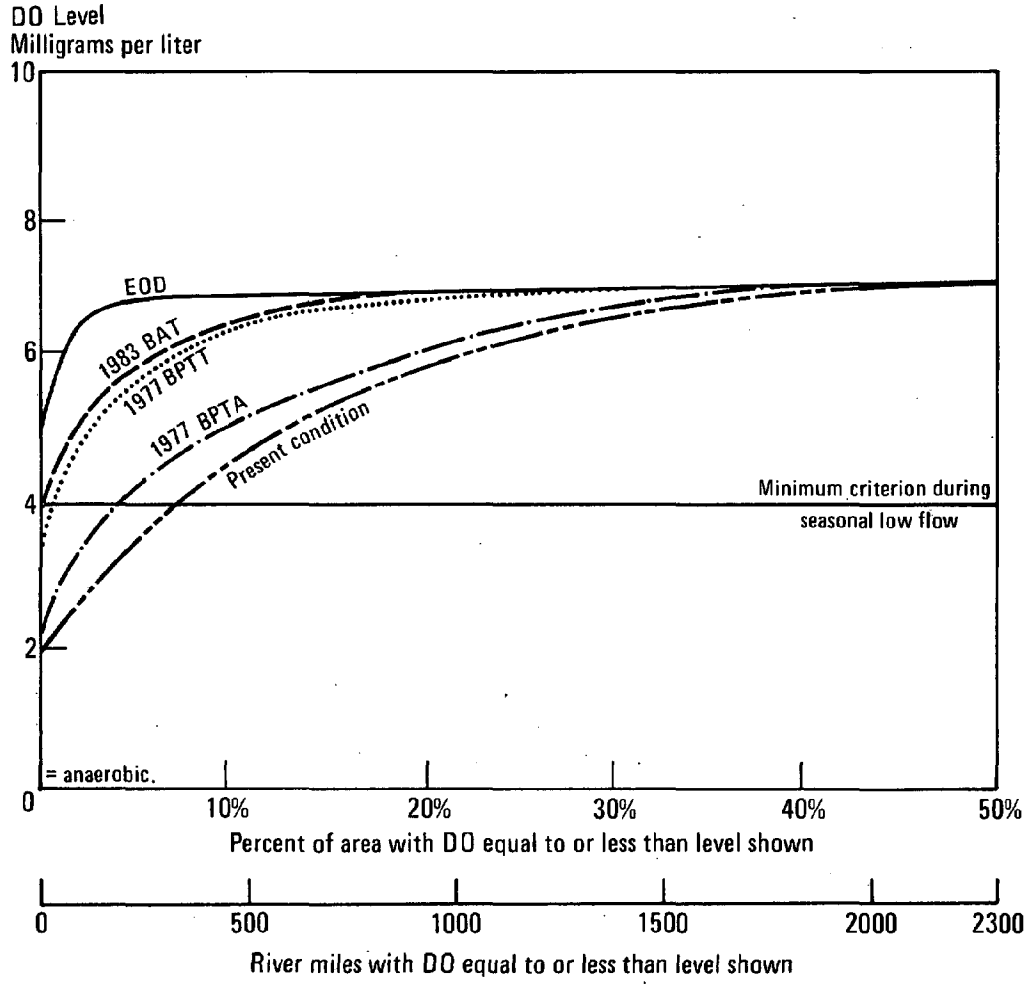
These projections do not include the effects of pollutants from nonpoint sources and, consequently, overestimate the actual improvement at many sites. Additionally, many streams exhibit diurnal fluctuations in DO due to algal photosynthesis and respiration. Dissolved oxygen levels often are naturally lowest at night and highest during daylight hours. Few of the site-specific analyses were able to define the effects of nonpoint-source pollutant loadings on biological processes.

Anticipated delays in completing wastewater treatment facilities are reflected by the 1977 "actual" level. Implementation of the 1977 "theoretical" level of treatment would bring substantial improvements over both present and 1977 "actual" DO conditions. The 1983 level adds only marginal overall DO improvements relative to the 1977 (theoretical) level, although certain river segments with low DO would be improved. Regionally, the greatest DO improvements are anticipated in New England (Region A), Upper Ohio (Region B), Middle Atlantic and South Gulf (Region C), and Great Lakes (Region D).

There was a wide variability between and within the study sites in achieving in-stream water quality standards for DO. Achievement of water quality standards is based on assessment at the critical low-flow level, which in most cases is the seven day/ten year low flow. Some state standards allow DO levels for select stretches to be below 4 mg/l at the critical low-flow level (7Q10). The basis for the variability relates to the dilution capacity of the receiving water body and the abatement level conditions used in the projections, and is important for interpreting the results. Generally, projected DO levels improved enough to meet the standards at sites where detailed load allocation studies provided the basis for the NPDES permits. The Trinity River in Texas is an example where relatively stringent load allocations have been developed by the State. For other sites, where EPA effluent guideline limitations were used, stream responses vary. For some reaches, DO improvement will be minimal over present conditions because DO currently

Figure IV -5

DISSOLVED OXYGEN IMPROVEMENT UNDER 4 LEVELS OF POLLUTION CONTROL ABATEMENT



*Based on projected improvements at 21 sites covering a total of 4600 river miles during seasonal low flow conditions.
Source: Natl. Commission on Water Quality compiled from environmental contractor reports.
February 1976

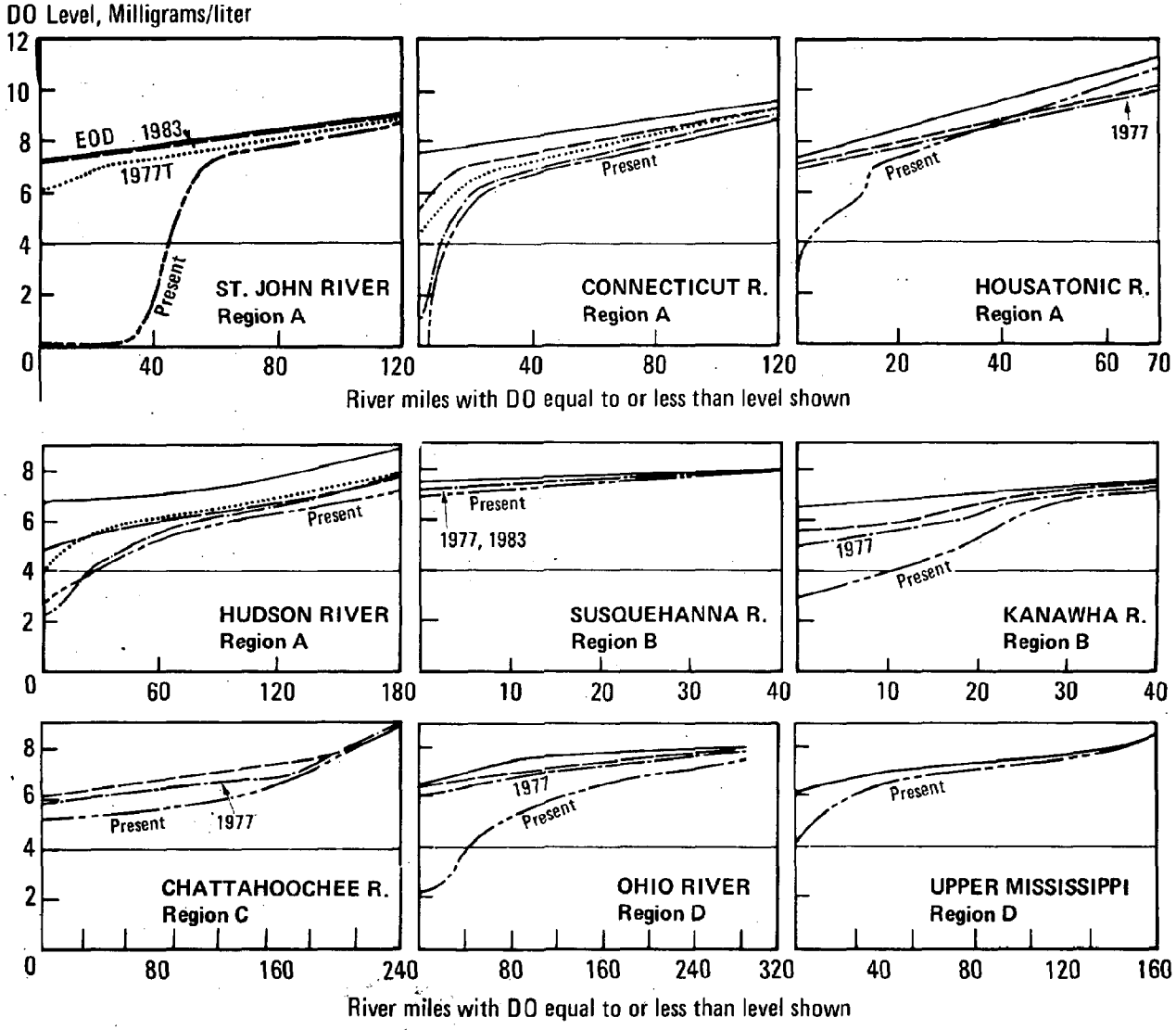
KEY ABATEMENT LEVELS

EOD
1983
1977 T
1977 A
Present

See Table IV-3 for explanation of abatement levels

Figure IV - 6

DISSOLVED OXYGEN IMPROVEMENTS AT SELECTED SITES (REGIONS A-D)



KEY ABATEMENT LEVELS

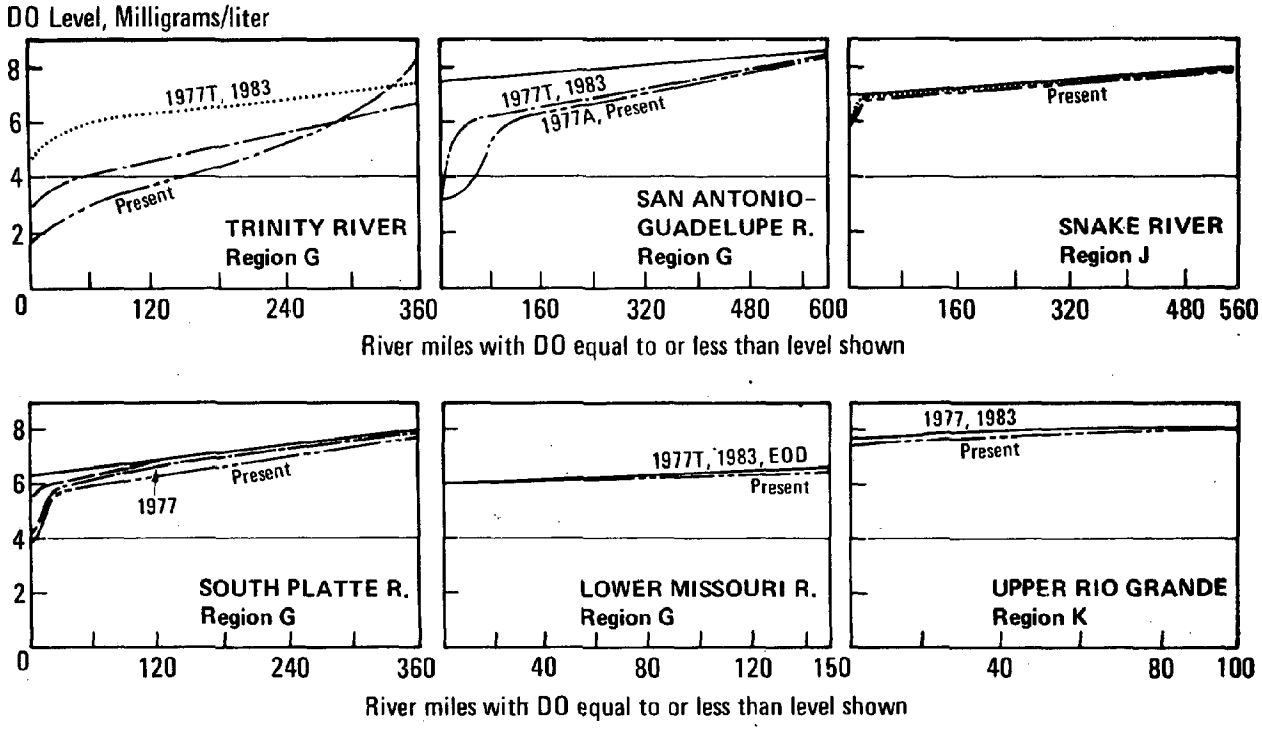
EOD
1983
1977 T
1977 A
Present

See Table IV-3 for explanation of abatement levels

* Based on seasonal low flow conditions
Source: Natl. Commission on Water Quality compiled from environmental contractor reports February 1976

Figure IV - 6 cont.

DISSOLVED OXYGEN IMPROVEMENTS AT SELECTED SITES (REGIONS G-K)



KEY ABATEMENT LEVELS

- EOD
- 1983
- 1977 T
- 1977 A
- Present

See Table IV-3 for explanation of abatement levels

* Based on seasonal low flow conditions
Source: Natl. Commission on Water Quality
compiled from environmental contractor reports
February 1976

is not severely depleted. In other reaches, effluent guideline limitations will not be adequate to achieve water quality standards, although the extent of violation will be reduced. For portions of 15 of 38 study sites (36 percent), projections indicated that more stringent treatment than for 1977 and 1983 limitations would be required.

A number of potential residual DO depletion problems would remain following achievement of 1983 requirements. Most important of these is the impact of nonpoint sources. Projections made for the Chattahoochee River below Atlanta indicated that DO periodically would drop to zero for an extended period of time in response to pulse loadings from urban runoff and combined sewer overflow. For very few of the site studies were contractors able to model this pulse-loading phenomena. Sludge blankets on stream bottoms in some locations can continue to cause DO deficits (e.g., Houston Ship Channel). With time, however, these deposits can be expected either to be decomposed, flushed out of the river by high flows, sealed over with naturally occurring sediment deposits, or, as in the case of the Channel, be partially removed as dredge spoil. Excessive algal productivity which causes oxygen depletions upon decay have been cited as a potential problem at several sites, even though point-source oxygen demanding pollutant loadings will be greatly reduced.

b. Eutrophication Potential

Higher point-source pollutant removal to meet in-stream dissolved oxygen standards does not necessarily reduce nutrient levels in receiving waters. Although there will be a noticeable decrease from present levels in total phosphorous if the 1977 and 1983 limits are met at many sites, the decrease will not significantly reduce the eutrophication now occurring at assessment sites. The reasons for this are twofold:

-- Secondary treatment of municipal wastewaters, a major point source of nutrients, is only marginally effective in removing phosphorous and, in many instances, can result in an actual increase in the soluble nitrogen concentrations in effluents.

-- At many sites, particularly in urban areas and in regions where agriculture is intensively practiced, nonpoint sources will continue to contribute large amounts of nutrients to receiving waters.

Review of the site study reports reveals potential continuing nutrient enrichment problems.

-- At the 1977 level, nutrient concentrations at 17 of 39 assessment sites (44 percent) will remain high enough to support nuisance plant growths. Only minor reductions will occur at

the 1983 treatment level, except for a few sites where advanced wastewater treatment or point-source relocations were evaluated. Although a number of other sites will continue to have high nutrient levels, high turbidity may limit eutrophication, as it does presently.

-- Municipal point-source discharges will remain as significant nutrient sources at 13 of the 17 sites where eutrophication problems are expected to continue. These problems are significant particularly in the Northeast. Nonpoint sources are potential continuing nutrient sources at 13 of the 17 problem sites. Agricultural nonpoint sources were cited at 12 sites as significant nutrient sources, particularly in the Midwest, Southern Plains, South Atlantic Coast, and the Central Valley regions. Urban stormwater runoff and combined sewer overflows were cited as continuing nutrient sources at five sites with continuing eutrophication problems.

c. Physical Characteristics

On a nationwide basis, high suspended solids and turbidity levels in streams are more commonly associated with natural and other nonpoint pollution sources. This is true for the Midwest and Great Plains where agriculture is a major land use and the soil is naturally erodable. Substantial improvements in suspended solids and turbidity levels at the 1977 level will occur at assessment sites in New England, for example, where natural turbidity levels are low. Improvements in those areas will result from reductions in loadings from municipalities and industrial point sources. In one case, the Nashua River in Massachusetts, continuing suspended sediment problems were projected for several years from fine-grained particulates accumulated in streams from industrial discharges over the years. In several instances reductions in turbidity and resulting increased light penetration are projected as factors allowing for increased plant growth and eutrophication problems. Another possible effect is more rapid dieoff of coliform bacteria resulting from increased exposure to sunlight.

-- For 13 of 38 sites (34 percent) significant reductions were reported in suspended solids and turbidity at the 1977 level. These changes resulted from reductions in pollutant discharges from industrial and municipal point sources. Seven sites were cited as having severe turbidity problems under present loadings.

Suspended sediment controls were assessed for irrigated lands along Clarks Fork in the Yellowstone River basin study. Calculations show that increased irrigation efficiency and sediment removal by treatment

would produce negligible reductions in the sediment concentration of the Clark's Fork. No environmental improvements are likely to occur from these abatement efforts because natural (including channel erosion) and other nonpoint sources are large. In the Maumee River basin, studies indicated that by applying proper conservation practices, tillage practices and crop rotation a one-third reduction in soil loss could result. Soil loss reduction leads to a corresponding decrease in nutrient (N and P) and BOD loadings, which are transported with the sediment.

Aesthetic degradation of water bodies by floating debris, oil, grease, scum and other materials attributable to point-source discharges will be reduced at the BPT level. Aesthetic problems associated with high turbidity and nuisance aquatic plant growths will be reduced only to the extent that pollutants causing the problems are controlled. Urban storm runoff and combined sewer overflows will continue to create aesthetic problems.

d. Salinity

Total dissolved solids levels are not projected to be greatly reduced by implementing point-source controls at the assessment sites. TDS problems in fresh waters occur primarily with irrigation projects and natural sources in the western states. Industrial and municipal wastewater discharges are known to influence dissolved solids levels in many areas, but the magnitude of the effects are not nearly as great as the effects from irrigation on an areawide basis.

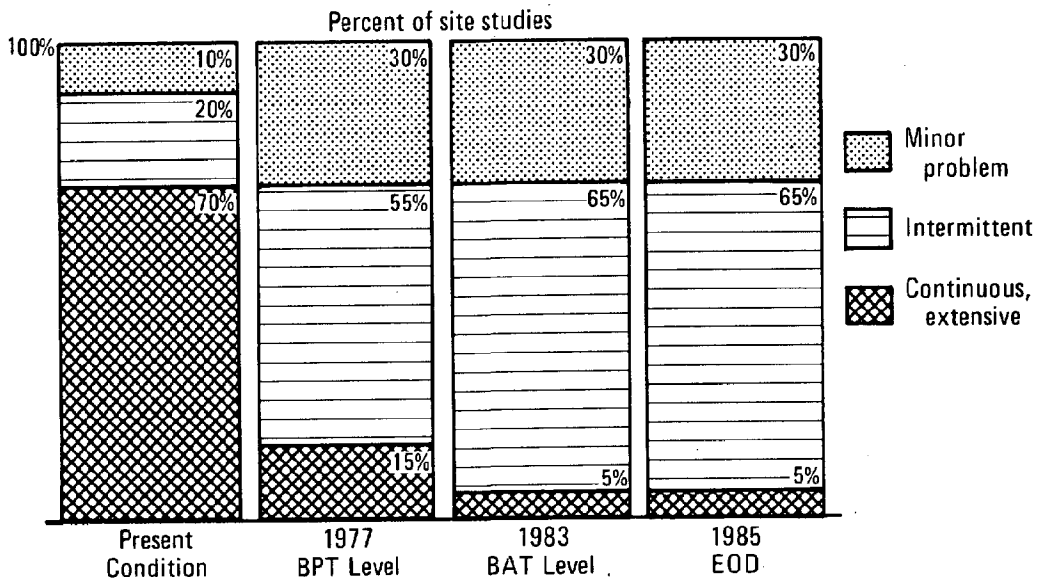
Improved irrigation control practices would decrease total salt loads in the Colorado and Yellowstone River basins. There would be little apparent environmental benefit, however. The combined salt loads from natural sources and irrigation will still be high enough to pose problems for water users. Improved irrigation practices for TDS control in the Tongue River of the Yellowstone basin would have pronounced effects on the seasonal distribution of stream flow. Increasing efficiency means decreasing the diversion rates during the high-flow months. This has the effect of reducing stream flows during the late summer months, since these late season flows historically have come from irrigation return flows percolating through the soil.

e. Health Hazards and Toxic Substances

Assessment of changes in coliform bacterial contamination problems is summarized in Figure IV-7. Widespread, continuous violation of coliform criteria levels is reduced significantly at the 1977 level when

Figure IV-7

COLIFORM BACTERIA ASSESSMENT SUMMARY FOR 41 SITES



Criteria set at 200 col/100 ml (fecal) or 1000 col/100 ml (total)
BPT = Best practicable technology; BAT = Best available technology; EOD = Elimination of discharge

Source: Natl. Commission on Water Quality
compiled from environmental contractor reports
February 1976

disinfection is practiced on all municipal treatment facilities. Control of combined sewer overflows at the 1983 level would reduce sewer bacterial loadings at several sites. Seventy percent of the sites will continue to experience periodic coliform bacterial contamination problems even if point-source discharges are eliminated because of nonpoint sources. Agricultural and urban land runoff are the major sources causing the problems.

Concentrations of many known harmful toxic substances, such as some of the heavy metals, will be reduced through effluent limits reflected in NPDES permits. Treatment to remove oxygen demanding wastes removes some heavy metals and toxic organics as well, although data for predicting the magnitude of this reduction and consequent reductions of toxic problems are sparse. An important aspect of the problem is that the toxic, sub-lethal, and synegistic effects of many substances discharged into the water are not known and consequently not listed in effluent permits. Chlorination of wastewaters can have detrimental effects. Excess chlorine residuals can be toxic to aquatic life. Also chlorination has recently been linked to generation of potential cancer-causing

substances in some drinking water and is being intensively studied. Nonpoint sources, such as urban and agricultural runoff, contribute significant amounts of toxic substances to receiving waters, however, and these undoubtedly will continue until nonpoint sources are controlled. Detailed investigations of the relative magnitude of contributions from these sources and resulting impacts are needed.

f. Thermal Effluents

Generation of electricity by burning fuels (fossil or nuclear) to drive steam turbines entails release of large quantities of heat to the environment. The amount of heat released generally amounts to 60-70 percent of the energy content of the fuel. Nuclear plants have about 50 percent greater heat release than an equivalent-sized fossil fuel plant. Traditionally, most of this waste heat has been removed from the generating station by cooling water drawn from natural or man-made watercourses. This massive transfer of heat energy raises the temperature of the water and dissipates the heat into the atmosphere. Since temperature is a physical environmental factor to which most aquatic life is very responsive, some changes in aquatic communities invariably ensue. Where the changes are noticeable, and either detrimental to the varied interests of man, or presumed to be detrimental to the overall functioning of the ecosystem, the waste heat has been called "thermal pollution." Indirect, but potentially important, environmental effects result from moving large quantities of natural water through the generating plant. This includes impingement of organisms at intakes and damage to small organisms drawn through the generating system with the cooling water (entrainment).

A necessary part of the Commission's study has been to predict the number of existing and planned steam electric power plants that by 1983 would be required by the EPA to use alternative cooling methods instead of the traditional "once-through" systems. These predictions have been necessary because the law describes heat as a pollutant, but allows exemption from thermal controls if an electric utility can show that such controls are unnecessary to protect a balanced, indigenous community of organisms (Section 316(a)). The law also provides that, in any event, the best technology shall be used to protect aquatic life at the intake structures (Section 316(b)). To undertake this estimate of thermal exemptions, the Commission developed independent criteria representing a combination of accumulated scientific knowledge and/or expert judgment regarding thermal ecological impacts.

Protection of a desirable, balanced community of organisms within the area influenced by a power plant depends on complex interactions among three groups of factors:

1) Design and operating characteristics of the power plant, particularly its cooling system.

2) Physical characteristics of the water bodies supplying cooling water and receiving the effluent.

3) Characteristics of the communities of aquatic biota indigenous to such waters, and particularly their susceptibility to heat-induced changes.

These factors were listed and assigned a numerical scoring system to allow independent quantification of the environmental consequences of each factor at a selected power plant site. The sum of the independent scores for a given plant was the basis for estimating the need for other than once-through cooling. A panel of three experts in aquatic ecology independently judged the acceptability of representative power plants. This was done for each of several types of water bodies: ocean, estuary, natural lake, river, impounded river, impoundments flooding originally terrestrial environments, and man-made lakes which have been an integral part of existing streams. A scoring system and criteria were established on the basis of detailed and reasonably complete data contained in Environmental Impact Statements for 27 nuclear steam electric power plants. A larger sample using all fuel types was then scored on the basis of available data (often incomplete) and similarity in specific features of cooling systems with the first sample. Numerical information thus obtained was then extrapolated to all once-through power plants greater than 300 megawatts capacity either existing or anticipated between 1960 and 1983. The analysis was applied to every steam electric power plant covered by EPA's thermal limitations currently using, or planning to use, once-through cooling. The results have been aggregated by region.

The findings vary from expectations of control needs and provide important implications for scientific and analytical aquatic ecology. On the basis of several different scenarios, it was determined that:

1) The need for alternative cooling systems is much less than had been estimated in many analyses. The percentage of plants which could continue once-through cooling without damage to indigenous populations are estimated to be: Oceans - 80 percent; Estuaries - 38 percent; Rivers - 80 percent; Lakes -90 percent; River/Impoundments - zero percent; Impoundments - 100 percent; Man-made Lakes - 100 percent. By comparison, the EPA in its analysis of the economic impact of thermal limitations estimated: Oceans - 100 percent; Estuaries - 50 percent; Rivers - 74 percent; Lakes - 50 percent.

2) It is possible that in many instances detailed and extensive field studies accumulating a massive body of documented findings for each site will be necessary to support the need for closed-cycle cooling.

3) Review of extensive, detailed, site-specific information by regulatory agencies charged with final determinations will be a major undertaking.

4) Implementation of Section 316(a) exemption procedures does not eliminate the need for further research on thermal and other water effects from steam electric power plants. Any generalized scientific findings resulting from individual case studies will be difficult to formulate. However, continued efforts, on such topics as the ecological effects associated with coastal siting, can provide valuable consistency in findings and elimination of duplication.

5) For any meaningful evaluation of the effects of power plants on populations of aquatic organisms the entire range of effects--thermal (as in Section 316(a)), intake related entrainment and impingement (as in Section 316(b)), and chemical (if present) -- must be considered together. Biological effects of intake structures and entrainment often constitute a greater impact on aquatic populations than the discharge of heated water. But alternative cooling systems often reduce environmental impacts largely by reducing the volume of cooling water required, thus reducing the number of organisms involved. Independent analysis of the separate provisions in Section 316(a) and 316(b) may not result in minimizing overall impacts.

Some water bodies are clearly more suitable for power plant cooling than others, and careful site selection could, in many cases, provide an environmentally acceptable alternative to closed-cycle cooling. Estuaries, with complex patterns of fresh and saline water and abundance of dependent marine organisms, appear particularly sensitive to impacts from once-through cooling. On the other hand, freshwater impoundments, whether off-channel reservoirs or man-made lakes or watercourses, appear to be either insensitive to thermal impacts or capable of adapting to them while maintaining a balanced aquatic community.

The Commission's study reflects an accelerating demand for aquatic research and analysis to support or reject the application for exemptions from thermal controls, a demand which could place a heavy load on the availability of qualified ecologists, biologists, taxonomists and other supporting manpower.

The need for "generic" technical data, i.e., scientific findings having broad application to many sites, appears to be critical. Whenever information can be developed on typical responses of particular species of organisms or of particular kinds of ecosystems, the results will save both money and time. Present guidelines for seeking exemptions from thermal discharge limits include selection of representative, important species. Concentrated efforts to determine thermal and other

requirements of such species would be timely. (Some such work is presently under way at the U.S. Environmental Protection Acency and the Energy Research and Development Administration.)

How closely the estimated exemptions will approximate the actual is difficult to predict. There simply have not been enough determinations by the EPA Regional Administrators to allow statistical projections based on actual experience.

Another source of uncertainty could be the predominant use of independent, site-specific evaluations by the Commission's contractors without considering the combined influences of several power stations or other nearby environmental influences on wide-ranging aquatic populations or on the total ecosystems of regional water bodies. Needs for regional approaches to examine power plant impacts have been professed widely, but there has been slow response by regulatory agencies. The impact of more regionally-oriented thinking on power plant siting and selection of cooling systems is difficult to predict.

Other uncertainties may occur from the action of individual states applying their own thermal limitations. Some authorities believe that exemption on the basis of Section 316(a) prevents subsequent enforcement of water quality standards by states, but this legal issue is far from resolved.

D. BIOLOGICAL, ECOLOGICAL, AND ENVIRONMENTAL IMPACTS

Although water quality is described and regulated by the chemical and physical parameters already discussed, their real significance to the aquatic environment is the effect they have on aquatic biological systems. Many people evaluate progress toward water pollution control not by the changes in dissolved oxygen, nutrients, or heavy metal concentrations. It is rather the abundance and variety of fish species, the occurrence of fish kills, the frequency of algae blooms, water clarity, or bacterial contamination that the public recognizes.

Changes in these and other components of the environment have a direct influence on human health, food resources, recreation and aesthetics. Even more profound is the influence of these changes on the natural processes of nutrient and energy cycling. These processes provide for the continuous support of oxygen and carbon dioxide cycles, plant and animal production, natural decomposition and an overal stability of environmental systems. Ideally, a biological assessment of the Act's impact would begin at this fundamental level, determining how abatement would affect these key relationships and functions. The present state of environmental science does not permit so basic an analysis, thus the Commission has dealt with more direct effects of

altered water quality. Certain ecological relationships and indicators which influence the national goals of "protection and propagation of fish, shellfish and wildlife" and "recreation in and on the water" are particularly emphasized.

1. Fish

With its goal of protection and propagation of fish, the Act reflects the public's special interest in fish populations. Fish are also indicators of the condition of aquatic systems. Ecological relationships for fish are better understood, and more site- and species-specific data are available than for other aquatic organisms. Fish act as continuous monitors of water quality in contrast to standard sampling and testing programs which may fail to identify brief episodes of polluted conditions. The absence or death of sensitive species provides biological evidence of such occurrence. Fish generally have long life cycles, so that infrequent fish census may provide more long-term information than more frequent counts of other organisms with shorter life cycles. Many sport or game fish are at the apex of complex aquatic food webs. Important changes in aquatic systems are reflected in their populations.

The Commission examined factors affecting fish populations and projected how point-source pollution abatement might alter fish distribution and reduce or eliminate fish kills. Figure IV-8 illustrates relative effects of dominant influences on fish communities at the assessed sites, aggregated regionally. The factors are not mutually exclusive and frequently occur together, e.g. physical modifications and turbidity, or turbidity and toxic* substances in storm runoff. These factors also may interact with important natural conditions such as temperature, light penetration, and bottom substrate.

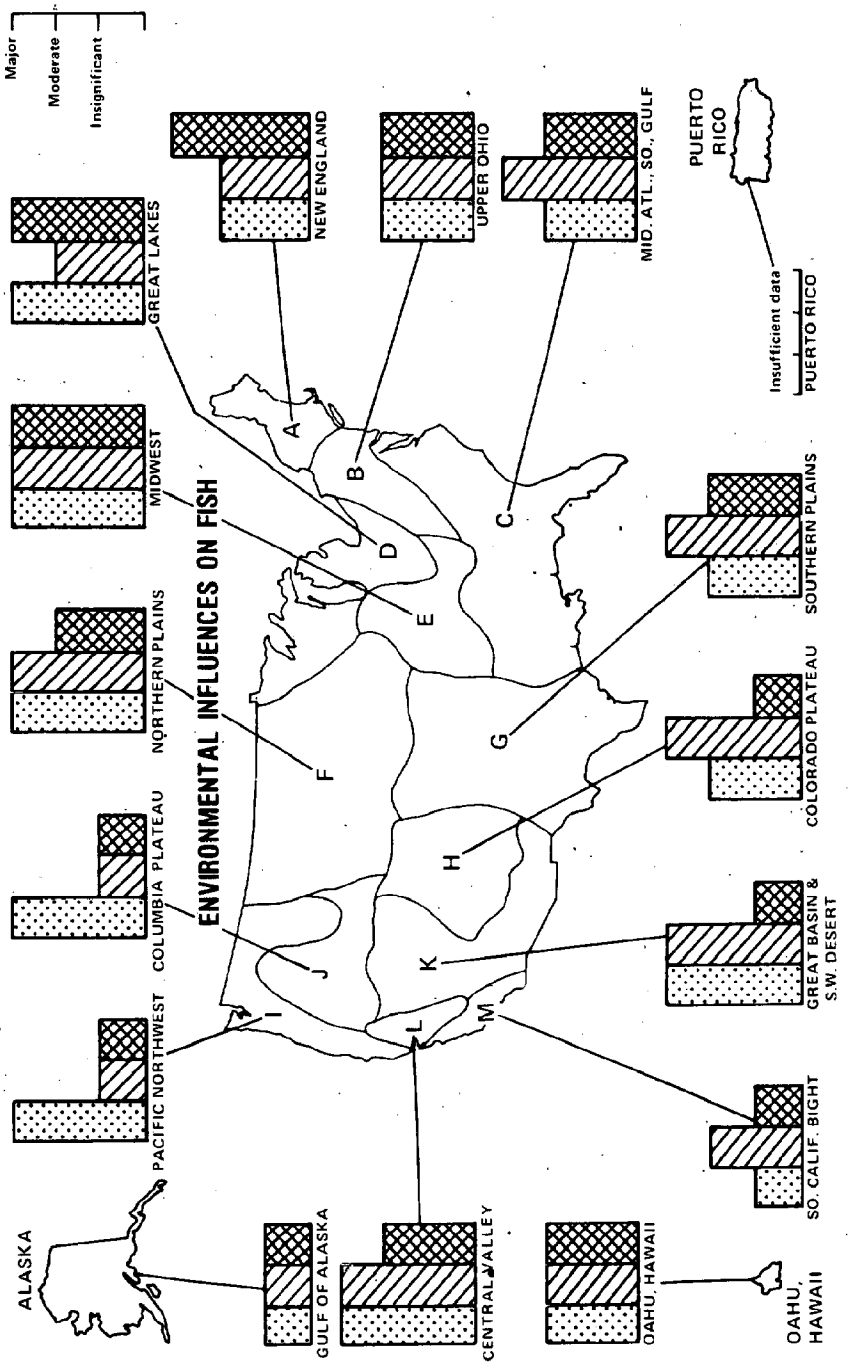
Most Midwestern, Southwestern and Southeast sites were influenced heavily by turbidity and sedimentation. Effects of physical modification on fish are evident nationwide and are especially obvious in the West and Northeast. Although depressed dissolved oxygen levels are a problem nationwide, the impact on fish appears more severe in the Northeast. Chemical substances are known to seriously impair fish populations in some areas, but insufficient data preclude a graphic presentation.

a. Fish distribution

Table IV-4 summarizes important influences on fish and general responses expected from implementation of point-source pollutant control. Data were not available at most sites to quantify the responses

*Influences due to toxic substances are not included in Figure IV-8.

Figure IV-8



Source: Natl. Commission on Water Quality compiled from environmental contractor reports February 1976

TABLE IV-4

Dominant Man-Influenced
Factors Affecting Fish Populations

General Categories	Examples	Influence of P.L. 92-500
Dissolved oxygen depletion	---	Major improvements in freshwater systems
Chemical substances	Heavy metals, phenols, pesticides, PCB's, etc.	Major overall improvement
Turbidity and sedimentation	High suspended solids, siltation of benthic habitats, benthic sludge deposition, excessive algal production	Localized improvement
Physical habitat alterations	Flow modifications, dams, channelization, dredging, shipping activity, temperature	Insignificant
Management practices	Game fish stocking, exotic species introduction, habitat management, rough fish removal	May benefit activity in previously degraded areas

Source: National Commission on Water Quality
Compiled from environmental contractor reports
February 1976

of entire fish communities to abatement of point-source pollutants. Accordingly, further analysis involved the following: (1) potential sport and game fish species native to each site were identified using historical data and the "undisturbed site" concept; (2) current species composition and distribution were examined relative to controlling environmental factors; and (3) projections were made of potential changes in game fish distributions at various abatement levels.

As a simplified, hypothetical example of the Commission's approach, consider a 40-mile river site that, under baseline conditions, may have 10 miles (25 percent) suitable for propagation of small-mouth bass. The rest of the reach may have non-sport fish dominated by carp. Achieving the 1977 requirments might improve DO conditions in 20 additional miles, so that 30 miles (75 percent) are available for the bass population. With the 1983 requirements, turbidity which prevented spawning may be eliminated in six more miles, so that a total of 36 miles (90 percent) would be available for the bass.

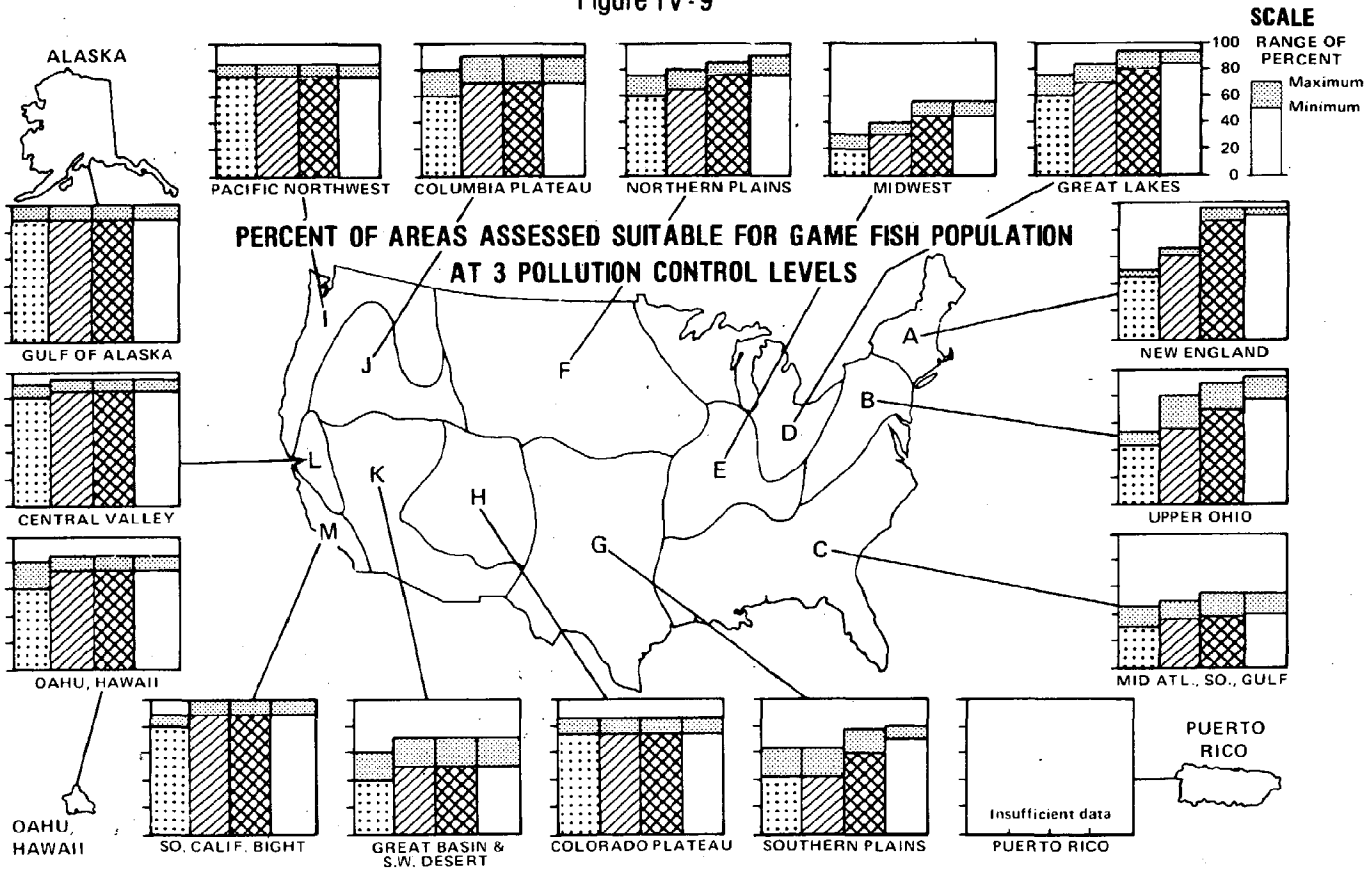
Seasonal low-flow conditions, representing annual stress conditions which typically determine fish distribution, were used to make these projections. The assumption was that the discharges achieved abatement requirements for critical low-flow conditions. Precise predictions were impossible at individual sites; hence, the Commission projected distributions over a range of river miles.

After distributions were established at individual sites, the site results were aggregated for each MGR to estimate the percent of the total assessed area in each region potentially suitable for sport fish populations.

The results of the regional aggregation are shown in Figure IV-9. Only the percentage of the assessed areas in each region that support, or may potentially support, populations of game fish are presented. The number or size of catch or ease of access for fishermen are not reflected. The changes are indicative primarily of improved DO levels. Toxic substances, turbidity and other influences are included where documented. Generalizing from this assessment,* abatement of point-source pollution is projected to produce the greatest extension of game fish habitats at sites in the Northeast, where each abatement level shows a potential increase in species distribution. In the Midwest, the 1977 requirements

*Data from individual sites have introduced some bias, since some sites are larger than others. Thus, region C's assessment is dominated by the relatively long Yadkin-Pee Dee River site, which is projected to show little extension of the range of game fish, even with elimination of point-source pollutant discharge (EOD). Puerto Rico was not included in this analysis because of insufficient data.

Figure IV-9



KEY

LEVELS OF TREATMENT

- Baseline Condition (present)
- BPT 1977 (Best practicable technology)
- BAT 1983 (Best available technology)
- EOD (Elimination of discharge

A-M = Geographic regions

Source: Natl. Commission on Water Quality compiled from environmental contractor reports February 1976

are not expected to cause major change, although 1983 levels (and to a lesser extent EOD) should increase the extent of suitable game fish habitat. For the sites in the Northwest, Southwest, and Alaska, point-source pollution abatement primarily will cause localized habitat improvement. In other regions, BPT conditions appear to provide maximum extension of improved habitat.

The relative changes shown in each region indicate the importance of point-source pollutants on game fish distribution. Thus, for the sites in Regions A and B, and to a lesser extent F and G, point-source influence is extensive. At the sites in other regions it is less significant, but only in the aggregate, however, because some part of almost every site was influenced heavily by point-source discharges. Factors other than point-source discharges, such as urban and agricultural runoff and natural turbidity, will continue to limit game fish habitat at some locations.

This summary does not show relative abundance or productivity of game fish populations. Some areas that currently provide, or are projected to provide, only marginally suitable habitat are included here as appropriate. Thus, for Lake Erie, although very sparse populations of game fish are found in the Cleveland area under baseline conditions, the area is classified "suitable" for game fish populations. Point-source abatement in the Cleveland area can significantly increase numbers and productivity of game fish. Likewise, the St. John's River in Florida currently supports an active sport fishery, but the productivity of these populations has declined significantly over the last 20 years. Point-source pollution abatement probably will increase fish productivity considerably there.

b. Fish Kills

Fish kills occur during brief episodes of local water quality conditions that exceed fish tolerances. Frequent causes are temporary introduction of toxic substances, low dissolved oxygen, or rapid shifts of temperature or salinity in estuarine waters. Kills often occur where under "normal" conditions fish already are stressed by low water quality, with the kills being triggered by some episode of additional stress. Abatement of point-source discharges can either eliminate the triggering stress or improve water quality so other stresses will not accumulate to cause a fish kill.

Twenty-one of the 41 assessed sites were documented as having experienced fish kills (Table IV-5). Confining the analysis to areas within the stressed sites with fish kills under baseline conditions, the Commission identified those sites that would probably have fish kills under projected conditions, and those which might show significant reductions in size or frequency of fish kills.

TABLE IV-5

Fish Kill Analysis of the 41 Assessed Sites

Abatement Level	Number of sites with fish kill problems (est.)	Estimated number of sites with previous kill problem eliminated	Estimated number of sites with reductions in kill intensity or frequency	Estimated number of sites with no change in kill intensity or frequency
Baseline	21	---	---	---
1977 Requirements	19	2	16	3
1983 Requirements	18	1	15	3
1985 Goal	14	4	9	5

Source: National Commission on Water Quality
Compiled from environmental contractor reports
February 1976

Fish kills were attributable to a number of factors, including accidental spills and continuous discharges of toxic substances, oxygen depletion from algal blooms, benthic oxygen demands, heavy organic contributions from agricultural and urban runoff, point-source discharges, pesticides in storm runoff, etc. Obviously, some of these factors would not be affected by point-source pollution abatement.

Although the quality of fisheries will generally improve, fish kills might increase in frequency or intensity with abatement of point-source discharge. A less tolerant fish community could develop in response to abatement. Thus when accidental spills or occasional stress conditions do occur, bass, for example, may die where the formerly predominant carp populations would have survived.

2. Shellfish

Oysters, clams, shrimps, crabs and lobsters are the shellfish organisms of concern. The Commission restricted its analysis to these commercially important species because they are the ones for which more information is available, a reflection of historical public interest.

Human influences have had a significant impact on shellfish populations at all 16 estuarine sites. As with fin fish, population numbers, biomass and productivity of shellfish were not predictable. The Commission did, however, determine for each estuarine site (1) whether shellfish and their habitat had been destroyed, damaged or improved by various human influences, (2) whether point-source discharges had been instrumental in any alternation, (3) whether point-source abatement potentially would restore any habitat, (4) whether shellfish beds were condemned for harvesting to protect public health, and (5) whether point-source abatement would open any previously condemned areas.

Table IV-6 lists and evaluates a number of man-induced influences on shellfish and their harvestability. The figures are conservative because many reports contained no information about several of these influences.

The category "indirect biological impacts" includes a variety of effects, such as alteration of food chains, or indirect destruction of an essential biological component of the habitat. For example, in Biscayne Bay excessive nutrients have produced heavy algal growth. This increases turbidity which destroys turtle grass beds, important habitat for crustacean shellfish.

At several sites growth and productivity of certain shellfish species apparently have been stimulated by the input of dissolved and particulate material. Dissolved materials can stimulate growth of bacterial and algal food for shellfish and organic particles can be used

TABLE IV-6

Human-Induced Factors Affecting Shellfish Populations at the Sixteen Assessed Estuarine Sites

Factor	Number and % of sites where the factor operates		Potential impact of PL 92-500
Over-harvesting	2	13%	Insignificant improvement
Contamination by bacteria and virus	14	88%	Significant improvement
Accumulation of tainting and contaminating material, including metals, petrochemicals, and pesticides	6	38%	Significant improvement
Shellfish kills by toxic substances, including metals, petrochemicals and pesticides	9	56%	Significant improvement
Destruction of habitat by dredging and filling operations	6	38%	Significant improvement (Section 404)
Accumulation of organic sludge resulting in:			
A. Low dissolved oxygen	7	44%	Significant improvement
B. Filling of beds	6	38%	Significant improvement
Siltation and turbidity from upland runoff	3	19%	Insignificant improvement
Man-induced salinity changes	3	19%	Insignificant improvement
Indirect biological alteration	4	25%	Significant improvement
Direct and indirect stimulation of the growth of some species	4	25%	Significant change

Source: National Commission on Water Quality
Compiled from environmental contractor reports
February 1976

directly by some shellfish. Of course, these inputs also can be harmful if the stimulated species is less desirable as a food source. Excessive algal and bacterial growth can be noxious or toxic, and excessive particulate materials become habitat-altering bottom deposits. At several sites, oyster and clam populations appear very robust, but are not harvestable because of bacterial contamination, thus allowing populations to grow to natural limits. Point-source pollution abatement at least partially should restore suitable habitat for shellfish at 13 of the estuarine sites (81 percent), with the degree of restoration varying widely among the sites and between abatement levels. Table IV-7 shows projections of the general influence of point-source abatement.

At 14 sites (88 percent), some or all shellfish beds are closed to harvesting because of excessive bacterial contamination. The Gulf of Alaska is completely open, and one other site supported no harvestable benthic shellfish. At 13 sites (81 percent), point-source abatement should open to shellfishing some areas which are now contaminated and closed. The amount of opened area should increase further with each level of abatement. The 1977 requirements will alleviate many problems caused by bacterial contamination from treatment plants; 1983 requirements should open still more areas <u>if</u> combined sewer overflows are controlled and disinfected. EOD would open still more area, but the area opened varies from site to site. For example, in San Francisco Bay there is a projected doubling in some tributaries, while in the Delaware River estuary only minor increases are projected. All 14 sites with some closed areas at baseline (1974) still will have some at EOD, primarily from urban storm runoff and other nonpoint sources.

At some sites secondary treatment will not eliminate completely bacterial contamination of shellfish if publicly owned treatment work effluents constitute a high percentage of receiving water flow. EOD may, in fact, be the only effective abatement level at some sites for organic, coliform-contaminated discharges. Such effluents actually may stimulate shellfish productivity, but the coliforms preclude harvesting. Chlorination of the treated wastewater may decrease the bacterial contamination sufficiently to allow harvesting, but chlorine and chlorination by-products may be toxic to some shellfish larvae even at low levels and thus decrease shellfish productivity.

3. <u>Wildlife</u>

Commission site studies did not yield enough data for a comprehensive national analysis of the effects of pollution on waterfowl and other birds. Lack of site-specific information generally results from the migratory nature of the birds. Thus the effects of pollution may not always occur where the bird is exposed. For example, a duck exposed in Florida may exhibit the effect of the pollutant later in the year after returning to Canada. This time lag between cause and effect is due to storage of certain pollutants in the body fat, from which they are excreted slowly. Thus, a

TABLE IV-7

Habitat Destruction and Harvestability of Shellfish at Sixteen Assessed Estuarine Sites: Current Conditions and Projected Impact of PL 92-500

Current (1974) Conditions	Number and % of Sites	
Sites with shellfish habitat destroyed	15	94%
Sites with shellfish areas closed for public health reasons	14	88%
* * * * * * * *		
Sites at which abatement should restore some habitat areas	13	81%
Sites at which abatement should open previously condemned shellfish areas	13	81%
* * * * * * * *		
Sites at which some shellfish habitat will remain unsuitable	15	94%
Sites at which some shellfish areas will remain condemned	14	88%

Source: National Commission on Water Quality
Compiled from environmental contractor reports
February 1976

detailed assessment of the effects water pollution might have on waterbirds was not possible at the study sites. In fact, analysis at the sites do not always contain enough detailed information to detect even the presence of pollutants in resident species. Faced with these inadequacies, the Commission has relied on available information not geographically confined to its study sites. This approach provides as complete an understanding of the subject as is possible with the present state-of-the-art.

Three major types of information are available for analyzing the effects of water pollution on birds. First, recent experimental research has documented the effects of particular types of pollutants on birds(1). Second, population distribution of various species of waterbirds within the continental U.S. is known(2). Third, some data exist on the use and distribution of various polluting substances throughout the country(3). Information from these sources was combined to produce a national picture of water pollution effects on birds. In addition, some case studies documenting specific pollutant effects on birds in certain geographical areas are available(4). These studies illustrate more specifically what has been hypothesized for the nation as a whole.

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(1) For example: White, Donald L. and Lucille F. Stickel. 1975. Impacts of Chemicals on Waterfowl Reproduction and Survival. Pp. 132-142 in Transactions of First International Waterfowl Symposium, St. Louis, Missouri, February 1975.

Blus, L. J., R. C. Stendell, S.N. Wiemeyer, H. M. Ohlendorf, J. A. Kerwin, and L. F. Stickel. 1975. Impact of Estuarine Pollution on Birds. Patuxent Wildlife Research Center and Migratory Bird and Habitat Research Laboratory, Laurel, Md. (in press).

(2) For example: Anderson, D. R. and C. J. Henry. 1972. Population Ecology of the Mallard: Review of Previous Studies and the Distribution and Migration from Breeding Areas. Resource Publication 105, Bureau of Sport Fisheries and Wildlife, U. S. Department of Interior.

(3) Environmental Protection Agency's Computerized Informational System: STORET (General Water Quality File).

(4) For example: Blus, L. J., A. A. Belise and R. M. Trouty. 1974. Relation of Brown Pelican to Certain Environmental Pollutants. Pesticide Monitoring Journal, Vol. VII, pp. 181-194.

Keith, J. D., L. A. Woods and E. G. Hunt. 1970. Reproductive Failure in Brown Pelicans on Pacific Coast. Trans. 35th North American Wildlife Conference, pp. 56-64.

Ludwig, J. P. and C. Tomoff. 1966. Reproductive Success and Insecticide Residues in Lake Michigan Herring Gulls. Jack Pine Warbler, Vol. 44, pp. 77-85.

Though lacking in quantitative results, this information provides, on a nationwide basis, a description of the relationship between pollution and birds to the maximum extent possible.

Water-borne pollutants from point and nonpoint sources is only one of a number of factors which account for reductions in waterfowl populations. These two sources of water pollution are not usually the major cause of reductions in waterfowl (duck) populations, but they can affect other birds which are indirectly linked to the water. Water pollution seems to be a particular problem for the "raptors" (birds of prey, such as hawks, eagles, etc.) because of their relative position in the food chain. Raptors may be affected adversely because they eat fish or birds which may contain high pollutant concentrations. Ducks, lower in the chain, feed largely on vegetation and invertebrates which often have lower concentrations of pollutants.

The most important factor in maintaining waterfowl (duck) populations is the protection of their breeding grounds--wetlands in parts of the northern U.S. and in Canada. However, exposure to pollution in the waterfowl wintering grounds in the U.S. may affect these birds even when the breeding grounds are undisturbed. This wetlands habitat presently is being lost rapidly due to dredge and fill activites, current agricultural and irrigation practices and other types of human incursions. Thus, while water pollution cleanup will have a beneficial effect on waterfowl populations, other problems remain. The correction of these problems might have greater impact than pollution control.

Birds are susceptible to pollution in three ways: (1) lethal effects to adults as a result of accumulation of high levels of pollutants; (2) metabolic effects that prevent or impair reproduction; and (3) embryotoxic effects due to pollutant accumulation in egg yolk supply. These effects are, of course, variable in regard to species response to individual pollutants, the method of ingestion, the chemical nature of each pollutant and the age and physical condition of the bird.

These effects occur through various physiological pathways. For example, those pollutants most often found to be persistent in bird tissues, i.e. aldrin-dieldrin, dichloro-diphenyl-ethane (DDE), polychlorinated biphenyl (PCB), and methyl mercury, usually are stored in the body's fat and/or protein reserves. Under normal conditions, pollutants enter the blood stream at a rate related to the amount stored and to the rate of metabolism of the animal; a portion of the released pollutants is excreted from the body as part of the normal bodily processes and a portion may be redeposited. The harm that may come from a chemical depends upon this "dose." Some chemicals may affect physiological processes at very low levels. The rate at which the pollutant is released from the fat will increase when fat resources are drawn upon in cold weather, when food is short, when the bird must

fly long distances, as in migration, and in certain phases of the reproductive cycle. Increased rate of use of fat may increase the "dose" to the point that effects will be produced that would not have been produced otherwise. In wintering grounds, the bird may ingest daily quantities of pollutants far below toxic or debilitating levels with no visible adverse effects. This intermittent dosage accumulates and is stored in the body's fat reserves, however. When spring migration occurs, stored fat reserves are mobilized and the pollutants are released to the bloodstream where they are carried to body organs and tissues and damage may occur. One threat is the redistribution of these released pollutants into the brain's fat reserves. This happens because pollutants once released from one fat reserve will tend to reconcentrate in the body's remaining reserves. Since the fat reserve in the brain is maintained until most other fat stores are utilized, the pollutants tend to accumulate in this reservoir and can affect the brain and central nervous system and kill the adult bird.

The other major effect that pollutants may have is caused by their excretion with fats into the developing egg yolk. The developing embryo will then use these fats for energy. Accumulation of certain kinds of pollutants in the yolk can cause embryotoxic effects. Thus, the basic habits and physiology of many species make them especially vulnerable during the migratory and nesting seasons. Table IV-8 presents most of the known effects that some commonly found water pollutants may have on birds.

An examination was made to determine possible correlation between the distribution of various water pollutants and the distribution of major concentrations of birds that potentially could be affected. While this methodology did not provide definitive correlations, it did identify areas where problems possibly exist. In some instances the case studies cited earlier proved to be good illustrations that correlation does exist between pollution and damage to bird populations in certain areas.

The present state-of-the-art in predicting the national effects of water pollution on wildlife such as reptiles, amphibians, and mammals is not able to show the effects of pollution. There is information, however, that shows that water-borne pollutants can have deleterious effects on the reproduction and life processes of water-linked mammals by way of their food chain. This suggests that there may be other as yet undiscovered effects. Much more research is needed to understand the specific links between water pollution and its effect on these forms of wildlife.

TABLE IV-8

Effects of Common Pollutants on Birdlife

PCB (poly-chlorinated biphenyl)	Decreased egg production Embryotoxic and/or mutagenic effects Altered parental behavior which reduces hatching success
Chlorinated hydrocarbons DDT, DDE, DDMU	Eggshell thinning Survival of young Altered adult behavior which reduces hatching success Affects salt gland, thyroid gland, adrenal gland
Chlorinated hydrocarbons Aldrin/Dieldrin	Survival of young and adults Altered adult behavior which reduces hatching success
Chlorinated hydrocarbons Endrin, Chlordane, Heptachlor	Although not as well researched as the chlorinated hydrocarbons above, the effects are possibly similar
Chlorinated hydrocarbons Mirex	Survival of young may be affected with very high concentrations
Mercury	Affects the central nervous system Survival of young Decreased egg hatchability
Cadmium Lead	In high concentrations, can result in death
Herbicides 2-4-D, 2-4-5-T	Indirect effect when habitat is destroyed Can have same effects of oil if sprayed in an oil solution
Oil	Direct effect through spills on both birds and habitat Affects hatching of eggs Prevents egg production Affects ability to survive in saline environments

Source: See Technical Environmental Volume; National Commission on Water Quality, March 1976.

4. Recovery Time

Ample scientific evidence exists to show that ecosystems do recover following a reduction in pollutant loading. Recovery in all cases is a return to some more natural state which is constrained by the prevailing physical, chemical, and biological regime in the drainage basin. The rate and degree of recovery of the ecosystem depends on many factors, however.

Rivers recover most rapidly because of their high flushing rates and the possibility of bottom scour which removes accumulated materials. Biological recovery is enhanced by the presence of recolonizing species in tributaries. An example of a site with potential for rapid recovery is the St. John's River in Maine, which could show improvement within a year. The Trinity River in Texas, on the other hand, has very thick bottom deposits, little current scouring action, and few tributary repopulation sources. This type of river could require many years to show significant improvement.

Lakes tend to have longer recovery times. Flushing rates are low, and sediments and dissolved materials accumulate readily. Ecological interactions slow recovery, as with continued DO depletions due to algal growth and decomposition, even after BOD loading has stopped. Moreover, water quality in lakes and reservoirs deteriorates natually due to natural eutrophication. Natural eutrophication, however, generally occurs at far slower rates than do human-induced water quality deteriorations. Man-induced changes have been reversed in several lakes. Sewage effluent diversion from Lake Washington and Lake Monona, Wisconsin, produced evidence of eutrophication reversal in less than five years. Similar results are indicated from an EPA demonstration project at Lake Shagawa in Minnesota. Larger lakes, such as Lake Erie, which have been stressed for long periods, may require many years to recover.

Recovery rates in both lakes and rivers can be accelerated by sound management practices. Pollution stress on aquatic ecosystems, coupled with introduction of exotic species, may alter fundamentally the species composition of the ecosystem. Alterations in species composition may persist following pollution reduction and prevent full recovery of the system. Additional management strategies, including selective fish stocking, physical habitat improvement, land use planning, and dredging of bottom sediments, may be necessary to complete or accelerate the recovery process.

Despite the apparent recovery capacity of aquatic ecosystems, future recovery of aquatic ecosystems under the Act's pollution abatement levels may be transient in the face of anticipated population and industrial growth. Phosphorus loading reductions in Lake Erie for

example, indicate an initial decline as each treatment phase is implemented, but also indicates a resurgence of water quality problems associated with population increase. This potential interference with recovery was not considered fully in the 30 environmental studies. Results of the regional studies, however, indicate potential worsening of the problems due to population and industrial growth.

5. Effects of Delayed Implementation

In addition to the degree of delay and potential growth considerations, the effect of delay depends on an environment's present condition and rate of change. If, under present input conditions, a system is not changing physically, chemically, or biologically, it is stable and presumably would remain so until input contributions change. Under these conditions, recovery times would be relatively unaffected by delayed implementation.

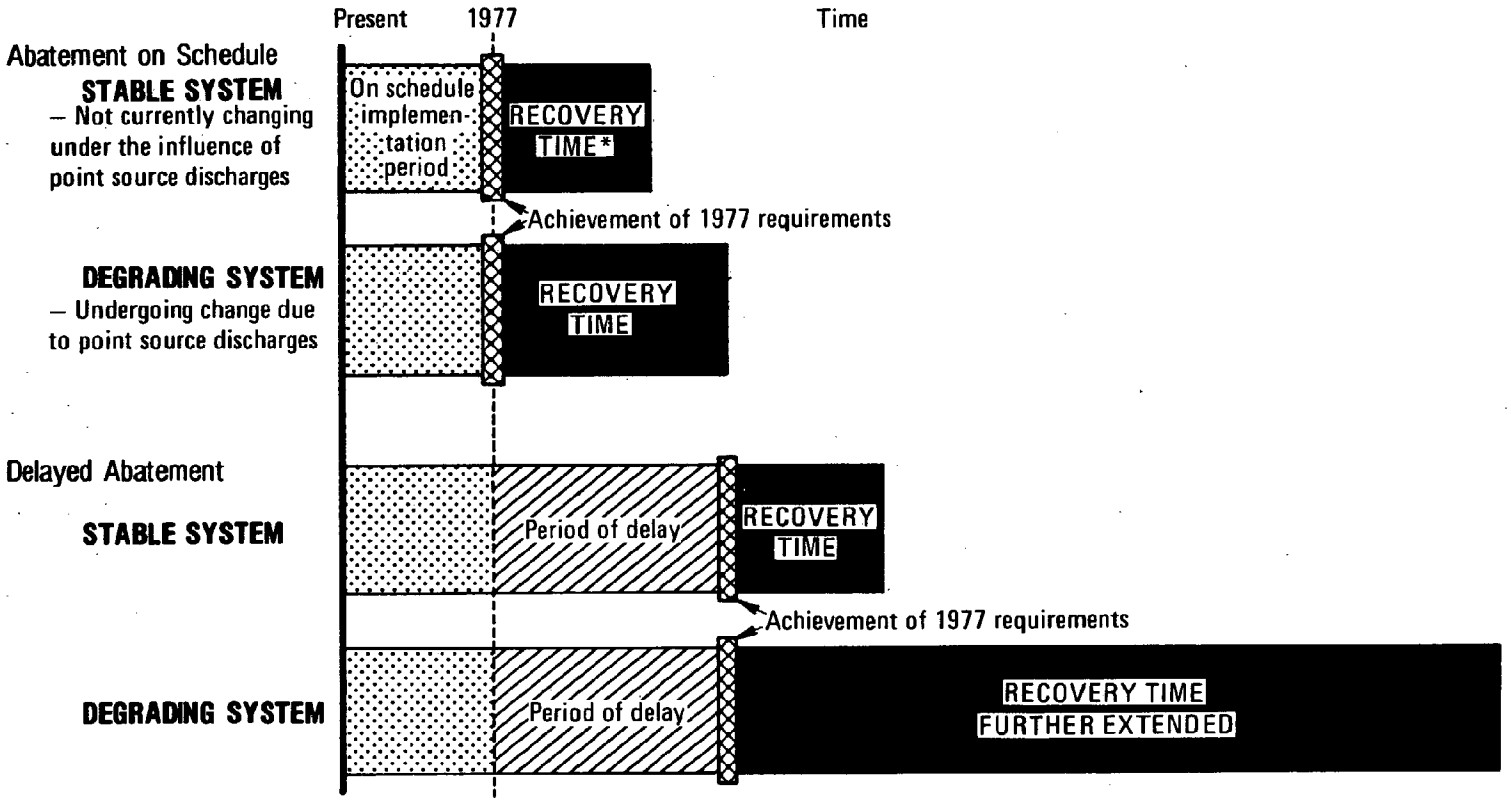
If, on the other hand, a system is being degraded, time required for recovery after delayed implementation is lengthened. If toxic substances, plant nutrients or oxygen-demanding materials are accumulating in sediments, delayed removal of these from discharges results in greater accumulation. Thus the time required for flushing, burying, decay or detoxification is lengthened. If a population (e.g. of trout or oysters) is declining due to point-source stress, delayed removal of that stress will cause further decline and possible local elimination of the species, thus requiring longer recovery time to some previous population level. Fewer remaining species populations will result in slower recovery. Competitive species may become dominant. Once undesirable more tolerant species are established, they may slow or prevent full biological recovery through food or habitat competition.

Figure IV-10 provides a hypothetical summary of this discussion. The two upper bars illustrate implementation on schedule. A degrading system, continuously changing under current discharge conditions, requires longer to recover. The two lower bars show the effects of delayed abatement. Long recovery periods result from the delay period itself as well as from further changes developing during the delay period. Recovery time depends greatly on the extent of ecosystem change before recovery begins.

If growth and additional stress from more and larger discharges are superimposed on these observations, the effects are magnified. Biological, chemical and physical changes are accelerated, system structure and function are further altered and potential recovery is endangered and requisite periods are lengthened.

Figure IV.10

HYPOTHETICAL EFFECT OF DELAYED POLLUTION ABATEMENT IN AQUATIC SYSTEMS



*Recovery Time = Time required for an aquatic system to return to some more natural state.

Source: Natl. Commission on Water Quality

February 1976

6. Environmental Impacts of Waste Residuals Disposal

a. Rationale

The Commission's residuals assessment was designed to estimate potential environmental effects of disposing of materials removed from wastewater onto land and into the atmosphere. Although a review of the present understanding of ecological effects of municipal wastes disposal into marine waters was included, the assessment was not designed to provide a comparative analysis of the relative ecological merits of placing residual materials into aquatic systems as opposed to land or air.

The residuals assessment also was designed to estimate total land suitable for safe use as disposal sites in different parts of the nation.

The estimates of land availability were based strictly on geophysical, hydrological and ecological conditions, and identify the total areas of the nation actually suitable for land disposal practices. The results of these analyses provide a scientifically sound basis for evaluating institutional arrangements that determine residuals disposal practices in the nation. Institutional assessments were not a part of the environmental sciences analysis, however, nor was there any analysis of the costs of transporting residuals to potential sites. The existence of adequate land for disposal does not, per se, mean such disposal is economically feasible.

b. The Residuals and Disposal Methods

Wastewater treatment technologies applied to municipal and industrial pollution point sources to achieve the treatment required by the Act will generate three categories of residual materials: liquid effluents, sludges, and atmospheric emissions. Most residual materials resulting from implementation of the Act will be municipal and industrial sludges. Estimates of national sludge volumes associated with the Act's requirements are presented in Table IV-9.

Roughly five million tons, dry weight, of sludge per year come from municipal wastewater treatment plants in the nation. That amount will increase to as much as six million tons per year following uniform national application of secondary municipal wastewater treatment, and could rise to as much as eight million tons per year following application of more stringent treatment technologies.

Municipal sludges are composed chiefly of organic compounds suitable for land disposal. They also contain large amounts (at low concentrations) of minerals and nutrient substances necessary to both natural and agriculturally important plant species, thus may be valuable as a base for fertilizers and soil conditioning materials.

TABLE IV-9

Potential Sludge Generation Rates*
(in 10^6 tons [dry weight]/year)

Industrial Category	Wastewater Treatment Level		
	Present Conditions	1977 Requirements	1983 Requirements
Inorganic Chemicals	17.07**	26.02**	32.00**
Iron and Steel	3.47	6.85	8.03
Pulp and Paper	1.08	2.24	3.41
Meat Products	0.42	0.92	1.09
Petroleum Refining	0.69	0.85	1.02
Textiles	0.19	0.52	0.74
Organic Chemicals	0.21	0.41	0.48
Plastics & Synthetics	0.14	0.24	0.32
Fruits & Vegetables	0.05	0.07	0.11
Electroplating	0.04	0.07	0.07
Total Industrial Sludge	23.36	38.19	47.27
Total Municipal Sludge	4.7	6.0	8.0

*National Commission on Water Quality, February 1976; compiled from environmental contractor report to the Commission. Figures account for potential population growth.

**Of the total residuals for Inorganic Chemicals, 12.71, 19.64, and 25.68 million tons/year respectively for the present, 1977, and 1983 projections are gypsum ($CaSO_4$) sludge produced from phosphoric acid manufacture, a segment of the Fertilizer Industry.

Estimated sludge volumes for current, BPT and BAT levels of industrial wastewater treatment also are presented in Table IV-9 for 10 of the industries studied in depth by the Commission. Maximum rates of generation of industrial sludges will occur at the BAT level. Generalities about qualitative characteristics of industrial sludges as a group are not possible, and there is insufficient existing information to permit description of exact compositions of sludges for particular industries. Although some industrial sludges consist primarily of organic materials similar to those in municipal sludges, and also suitable for land disposal and agricultural use, many industrial sludges contain materials unsuitable for introduction into living systems. Disposal of toxic and potentially harmful sludges will require long-term storage or destruction designed to prevent escape of harmful materials into the biosphere.

The volume of liquid effluents produced nationally and disposed of onto land (at 1977 and 1983 levels of municipal and industrial waste water treatment) will be minor when compared to the volumes of sludge produced for the same treatment levels. Many treated and untreated industrial and municipal effluents will contain dissolved and suspended organic material suitable for either direct application to agricultural land as a fertilizer or soil supplement, or storage and treatment in open lagoons. Certain types of industrial effluents contain substances extremely toxic to crops, domestic animals and wildlife, however, and will require special handling and disposal methods, long-term storage and permanent isolation from living systems.

Most atmospheric emissions generated through implementation of the Act will be direct products of incineration and other high temperature treatments of municipal and industrial sludges. Some gaseous emissions also will result from ammonia stripping of partially treated sewage and from sludge digestion. The major products of these technologies will be nitrogen dioxide, ammonia, carbon dioxide and low-vapor pressure minerals. In general only a small portion of the total amount of residual materials produced through the Act's implementation will be released into the atmosphere. These materials will, however, contain small amounts of substances such as heavy metals that are potentially harmful to humans and other organisms under certain exposure and atmospheric conditions. For that reason, atmospheric disposal technologies should be applied only in regions where air quality problems do not exist and are not likely to develop.

Available post-incineration treatment technologies can remove virtually all particulate materials from atmospheric discharges. Although the particulates occasionally will contain substantial amounts of harmful substances, those substances, together with ash and residues formed during high temperature treatment processes, will generally be suitable for controlled land disposal in areas not used for commercial

crop production. The solid residues in some cases will be of immediate potential value for the recovery of materials for industrial production processes.

Sludge digestion produces significant amounts of methane, which will be of increasing value as a thermal energy source.

c. Environmental Impacts

The results of the Commission's site-specific environmental assessments and national residuals study yield two major conclusions. First, little information is presently available concerning the physical characteristics of most types of residuals and the exact environmental effects of their disposal. Second, significant ecological problems are not likely to develop from disposal of residual materials generated by industries and municipalities if disposal methods and sites are selected with care.

Figure IV-11 summarizes the findings of the Commission's residuals studies. Total areas suitable for land disposal of sludges and effluents are shown in Figures IV-12 and IV-13, and are summarized for each minimum geographic region in the "Availability of Land Disposal Sites" section of Figure IV-11. In general, most areas of the nation contain suitable sites for controlled land residual disposal practices except for:

- State and Federal forests, parks, recreation areas, natural areas, preserves and wildlife refuges
- Wetlands and areas with extremely wet soils
- Flood plains
- Karstlands and similar limestone areas
- Areas with steep slopes
- Areas with high water tables

Although large areas of several MGR's are unsuitable for land disposal practices, considerably less than 1 percent of the total area of each MGR would be required for long-term use as disposal sites for the volumes of sludges and effluents generated at the 1983 level of wastewater treatment within that region, even if all of it were applied to land. Suitable sites, however, are not always located near the places where effluents and sludges are generated. This is particularly true for municipal sludges in densely populated areas of MGR's A, B, C, E, I, L, and M. Environmentally acceptable disposal of municipal sludges from those areas could require long-distance transport to suitable sites, with attendant costs. Densely populated areas of the East and West Coasts and the Midwest also have air quality conditions restricting local disposal of sludges through incineration. The availability of residual disposal methods and sites is particulary significant in MGR I, the Pacific Northwest, and in densely populated coastal areas of MGR's

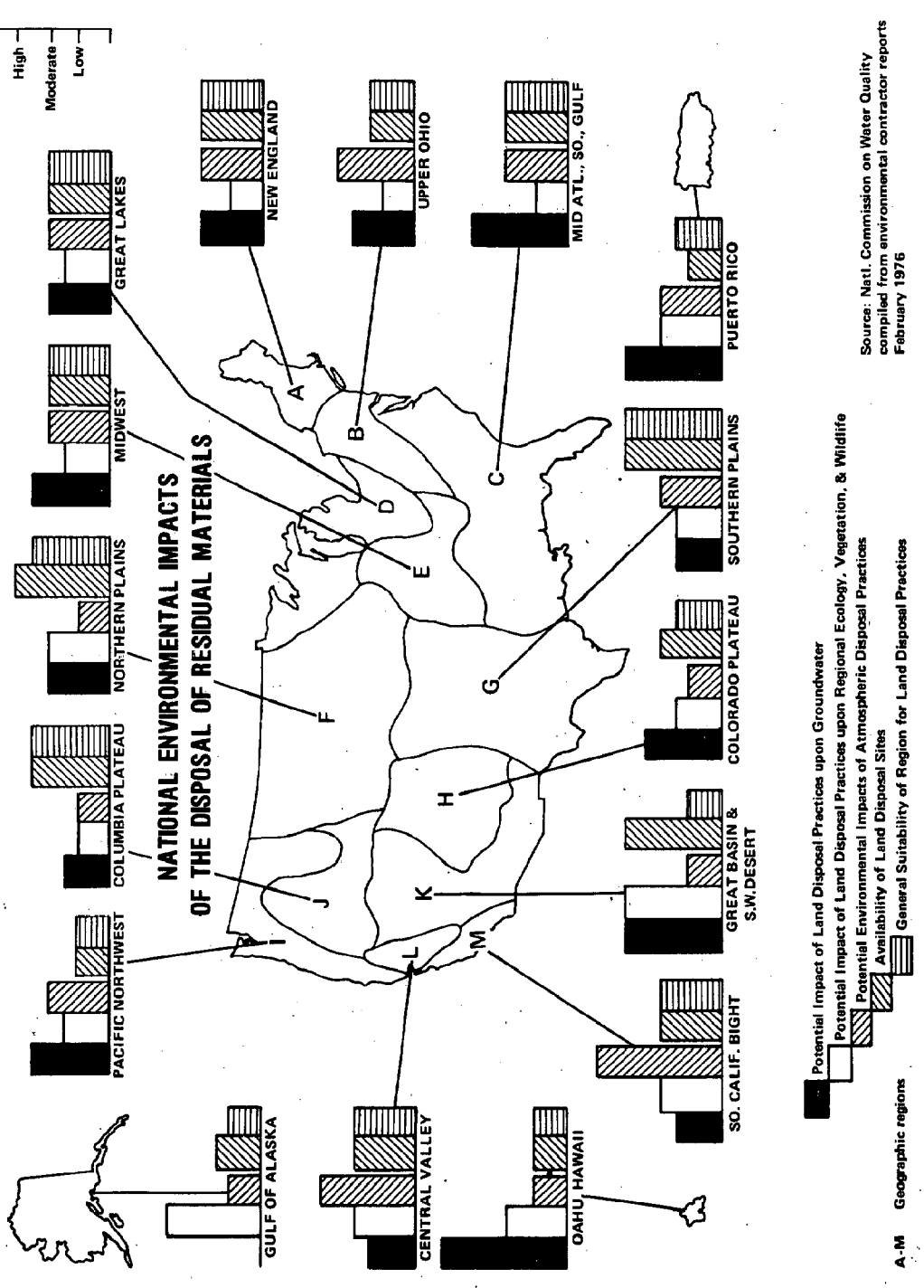
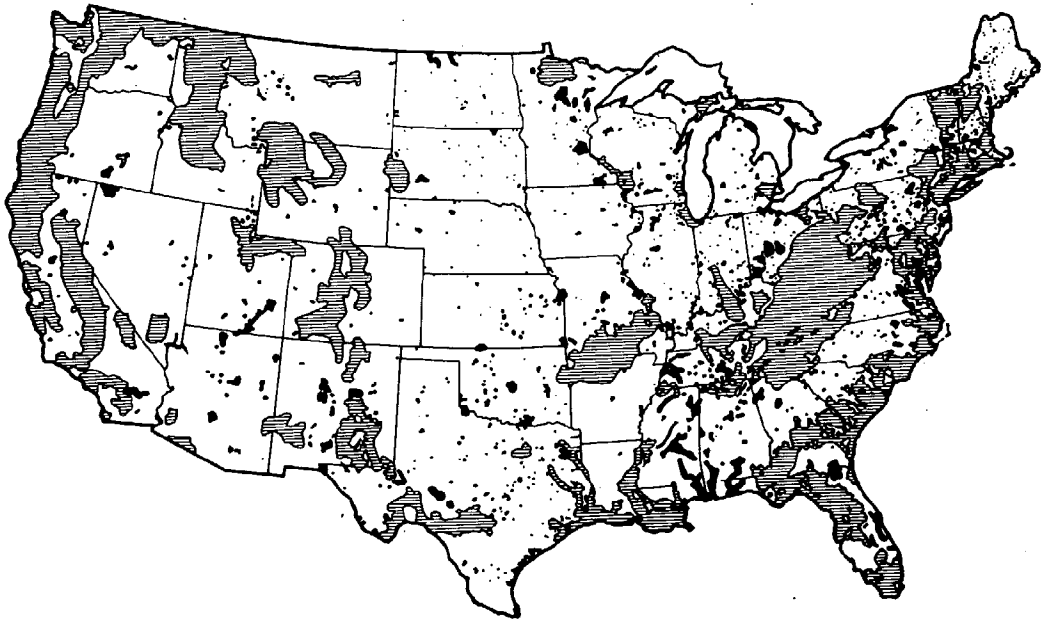

IMPACT SCALE
Severe
High
Moderate
Low
NATIONAL ENVIRONMENTAL IMPACTS
OF THE DISPOSAL OF RESIDUAL MATERIALS
PACIFIC NORTHWEST
COLUMBIA PLATEAU
NORTHERN PLAINS
MIDWEST
GREAT LAKES
NEW ENGLAND
UPPER OHIO
MID ATL., SO., GULF
PUERTO RICO
SOUTHERN PLAINS
COLORADO PLATEAU
GREAT BASIN & S.W.DESERT
SO. CALIF. BIGHT
CENTRAL VALLEY
OAHU, HAWAII
GULF OF ALASKA
A
B
C
D
E
F
G
H
I
J
K
L
M
Potential Impact of Land Disposal Practices upon Groundwater
Potential Impact of Land Disposal Practices upon Regional Ecology, Vegetation, & Wildlife
Potential Environmental Impacts of Atmospheric Disposal Practices
Availability of Land Disposal Sites
A-M Geographic regions
General Suitability of Region for Land Disposal Practices
Source: Natl. Commission on Water Quality
compiled from environmental contractor reports
February 1976

Figure IV-11

Figure IV-12

AREAS SUITABLE FOR LAND DISPOSAL OF WASTEWATER EFFLUENTS



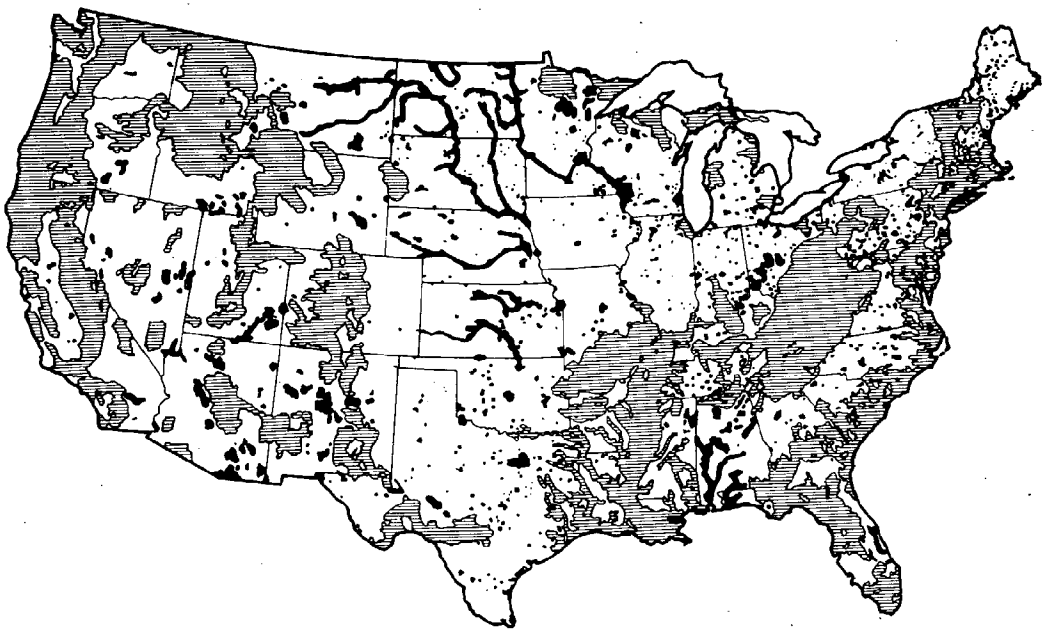
Areas generally suitable for land disposal of wastewater effluents

Areas only marginally suitable for land disposal of wastewater effluents

Source: Natl. Commission on Water Quality from environmental contractor reports to the commission
February 1976

Figure IV-13

AREAS SUITABLE FOR LAND DISPOSAL OF SLUDGE



Areas generally suitable for land disposal of sludge

Areas only marginally suitable for land disposal of sludge

Source: Natl. Commission on Water Quality from environmental contractor reports to the commission February 1976

A, B and C, since virtually all of those regions are suitable for only the most carefully planned land disposal practices.

Contamination of groundwater aquifers through land residuals disposal can be avoided through judicious examination of potential disposal sites before use, followed by careful monitoring of groundwater quality conditions at and near the sites during and after use. Although possible groundwater contamination will limit significantly the total areas of all MGR's suitable for safe use as disposal sites, potential groundwater problems generally will be prohibitive only in MGR K--the Great Basin Region--Hawaii and Puerto Rico.

Although very little information is available concerning the short- and long-term ecological effects of land disposal practices, available data suggest the overall ecological effects of adequately controlled land disposal practices to be limited and site-specific. Community structure changes dramatically at disposal sites. The changes usually result in a decrease in the number of plant and animal species present. Movement of chemicals in sludges and effluents through food chains appears to be significant only in organisms whose habitats are limited to the disposal sites. With the exception of MGR K, where unique climatic and geological conditions prohibit large-scale land disposal, significant or even measurable regional ecological problems are not likely to result from increased volumes of residuals being disposed onto land. Effects upon vegetation will be limited to the disposal sites, and noticeable effects on regional wildlife populations probably will not occur. In many parts of the nation, particularly in forested areas east of the Mississippi River, land disposal practices can produce locally beneficial ecological changes, such as increased growth rates in trees and other plants. This result argues for making carefully-selected Federal and State lands available for use as controlled disposal sites.

The wide variety of residual materials resulting from the Act's implementation requires that all general conclusions stated here be reviewed carefully for each specific residual material and each potential disposal site. Safe land disposal requires judicious site and method selection that consider carefully both the exact composition of each type of residual and the geophysical and ecological characteristics of the site. Residuals as a group will contain substances--including pathogens, parasites, pesticides and heavy metals--either known or suspected to have potentially negative effects on many species, including man. Disposal sites must be selected so that contamination of groundwater supplies and subsequent pollution of open waters by materials transported in groundwaters will not occur, and so that transport and concentration of toxic substances in terrestrial and aquatic food chains will be prevented. In some cases, this will require long-distance transport of residuals to safe disposal sites. Transportion of residuals, and primarily sludges, will probably be required in highly

urban areas and in geographic areas containing concentrations of particular types of industry.

It is both technologically possible, and biologically and ecologically safe and acceptable to man and other species, to dispose of most residual materials through land treatment, reuse and storage techniques. Incineration disposal methods will provide environmentally acceptable alternatives to land disposal in many areas including many regions having insufficient land to allow land disposal practices. Incineration will be neither permissible nor safe, however, in areas having local meterological characteristics that could cause development of dangerous air quality situations. Disposal of sludges and effluents into marine waters may be an environmentally acceptable disposal option, but should not be considered categorically so at this time. Although the limited amount of information currently available about the ecological effects of introducing effluents and sludges into marine waters suggests the negative effects of doing so are frequently minimal in some types of coastal areas, insufficient data exist to permit definitive evaluations of the overall short- and long-term environmental effects of placing sludges and effluents into marine ecosystems.

Major factors limiting disposal of the residuals produced by municipal and industrial treatment technologies are institutional and economic rather than ecological in nature. Although sufficient land resources seem to be generally available in the nation for environmentally safe disposal of most residuals, existing local and national institutional regulations and standards prohibit use of many suitable areas for land disposal purposes. Objections arise in part because the immediate and long-term environmental effects of land disposal practices are not fully known. Disposal site selection requires large-scale regional and national study programs designed to document the specific effects of sludges and effluents, and materials contained in them, on individual plant and animal species, and upon ecological communities in natural situations. This analysis must be coupled with rigorous examinations of each potential disposal site to assure minimum adverse environmental impacts.

E. SPECIAL ASSESSMENT STUDIES

1. Standing Waters

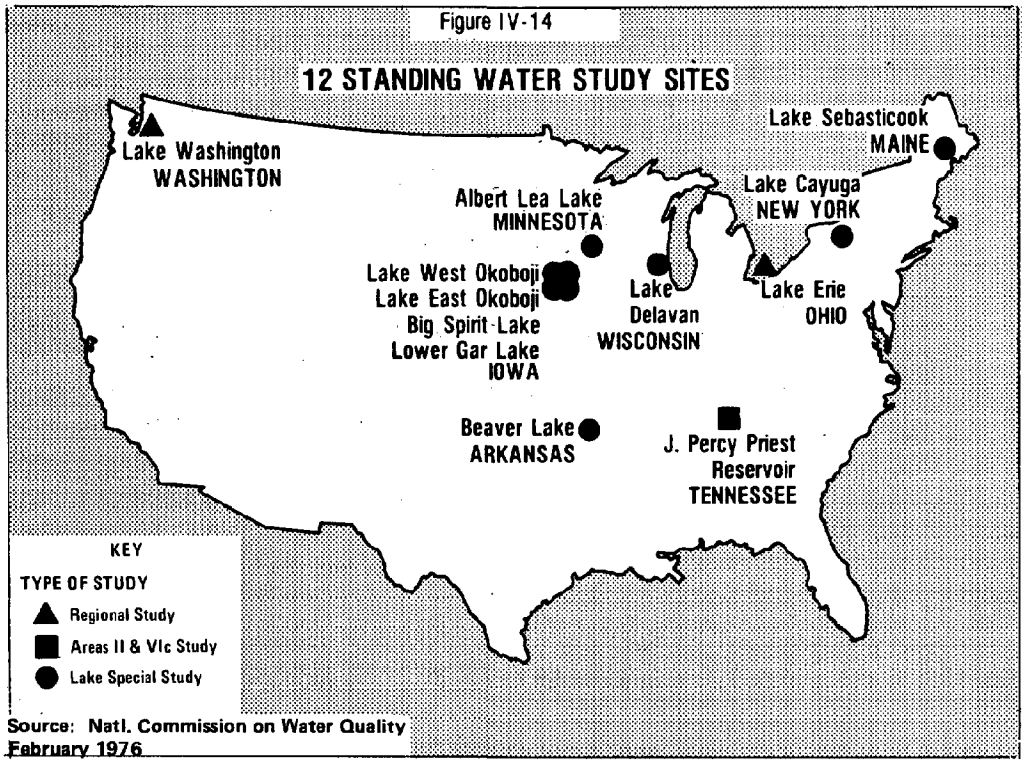
The Commission evaluated the ecological effects of implementing the Act upon lakes and reservoirs through three types of studies. One was an assessment of the J. Percy Priest Reservoir in Tennessee. A second major element was provided by the environmental sections of the Lake Erie and Puget Sound regional studies. The latter included a case

history of the ecological effects of pollution abatement on Lake Washington. The third, and most extensive, element was a special assessment of the effects of point sources upon nine other lakes. The water bodies selected for the latter study were chosen to represent a cross-section of both the types of lakes present in the country, and the types of municipal and industrial pollution problems experienced by the nation's lakes. The lakes investigated during the special study were Lake Sebasticook, Maine; Lake Cayuga, New York; Albert Lea Lake, Minnesota; Beaver Lake, Arkansas; Lake Delavan, Wisconsin; and West Okoboji, East Okoboji, Spirit and Lower Gar lakes, Iowa. Eight of these are of glacial origin, and one is an impoundment.

Location of the twelve water bodies studied is presented in Figure IV-14. Although the study sites were selected to typify the kinds of point and nonpoint source pollution problems prevailing in lakes in the nation, the number of lakes suffering from chronic or acute pollution from point sources actually available for investigation was limited by data availability. Much historical and current physical and biological information was required of each body of water included in this survey, but a suitable backlog of basic information exists for only a few lakes in the country. Data were necessary to document pollution related trends in the hydrologic and ecologic characteristics of the lakes likely to be altered by implementation of the Act. In spite of this constraint, however, the Commission believes the lakes chosen provide a reasonably accurate picture of both the general types of pollution problems suffered by lakes across the country, and the general kinds of changes that might occur following point-source pollution abatement.

Lakes in the U. S. are at various stages of physical, chemical and biological change because of nonpoint and municipal and industrial point-source pollution. Nationwide, more municipal wastewater treatment plants than industrial plants discharge into standing waters. Although pollution differs from lake to lake and each lake has its own peculiar response pattern, there are certain basic similarities in response. The results of the standing waters studies indicate that on the basis of amounts of soluble phosphorus and inorganic nitrogen entering each of the lakes investigated, together with the current general ecological conditions of lakes, a trend of rapid eutrophication is in progress. In several of the lakes studied here, the accelerated eutrophic trend is related directly to municipal and industrial point sources because their effluents are important and, in two cases, predominant sources of nutrients entering the water bodies. In the other lakes, however, land runoff is the dominant contributor of nutrients. The result of these excessive nutrient additions is frequent blooms of undesirable plants, particularly nuisance blue-green algae. In small shallow lakes, such as Albert Lea, nuisance algal blooms may persist from spring to fall. The blooms substantially increase turbidity, decrease the general aesthetic appeal of the bodies of water, disrupt the general well-being of other plants

Figure IV-14



and animals in the aquatic communities and, in some cases, render the waters unfit for recreational and other uses.

Secondary treatment by municipal wastewater treatment plants (20 - 30% removal of phosphorus) will not alter eutrophication potential in these lakes significantly. More advanced treatment or relocation of outfalls will be necessary for noticeable improvement to occur. Nutrient removal may be required of dischargers into water quality limited waters as a part of the 1977 requirements. The pollution abatement histories of Lake Erie and Lake Washington offer examples of recovery trends likely to occur in the lakes considered in the special study whose major pollution problems come from point sources, as well as in other lakes suffering eutrophication predominantly from point-source pollution. Eutrophication rates will decrease abruptly, perhaps within a matter of weeks in the case of small, shallow lakes, and will continue to decrease as nutrients contained in bottom sediments are utilized and new ecological balances develop. New ecological equilibria will evolve much slower in large, deep lakes such as Lake Cayuga. In all cases, however, the basic changes eventually will be accompanied by a number of obvious biological changes. Nuisance algal blooms will no longer appear, and the planktonic algal communities will cease to be dominated by blue-green species. Turbidity generally will decrease because of

decreasing algal blooms, and rooted aquatic plants will reappear in shallower sections of the lakes. The fauna of the lakes will increase in diversity as pollution-sensitive invertebrates such as insects, and verterbrates such as game fish species, are introduced or reintroduced to the communities. The net result of these general ecological changes will be lakes of higher aesthetic value and greater recreational potential than is presently the case.

Eutrophication is a natural phenomenon. Decreasing nutrient input to lakes through point-source pollution control will slow the process in many lakes, but the trend will not likely be reversed permanently. Moreover, accelerated eutrophication in many lakes in the nation, for example Percy Priest Reservoir, results chiefly from nutrients introduced by nonpoint sources, rather than by point-source effluents. In such cases, point-source control generally will have minimal effect on overall ecological conditions.

2. Marine Studies

The Commission evaluated the environmental effects of disposing of municipal wastes into nearshore marine waters in the vicinities of San Juan, Puerto Rico; Honolulu, Hawaii; Puget Sound; and the Alaskan, New York and Southern California bights. The comparative ecological and economic feasibility of ocean disposal of municipal effluents receiving less than secondary treatment was also analyzed for a number of those locations, as well as for the Miami, Florida, area. Because of a general scarcity of data about the effects of municipal wastes in marine waters, the assessments focused principally upon the Southern California Bight, an area for which there exists a reasonable amount of information. The findings from that location, however, may apply to other coastal regions physically and ecologically similar to it.

The basic findings of the marine studies are:

-- Most point-source pollution problems in the areas studied are caused by municipal discharges, although certain of the municipal effluents contain industrial wastes treated in municipal treatment plants. A major pollution problem in the New York Bight is offshore dumping of municipal and industrial sludges into relatively shallow waters overlying the continental shelf. Pollution by raw wastes from fish processing plants is currently a local problem in certain sections of the Alaskan Bight, but that situation probably will be remedied for the most part by application of primary wastewater treatment. In San Juan Bay and Pearl Harbor, both relatively shallow bays surrounded by densely populated areas, point-source problems are both aggravated and masked by nonpoint pollution from maritime traffic and storm runoff.

-- Disposal of partially treated municipal effluents through offshore outfalls is presently either planned or practiced in the Southern California Bight and in the vicinities of Honolulu, Hawaii, and San Juan, Puerto Rico. In the Southern California area, the water quality and environmental effects of discharging partially treated municipal effluents through offshore outfalls appear to be limited to the immediate vicinities of the outfalls when they are located in relatively deep waters having strong currents. Ecological changes recorded from the vicinities of the Southern California outfalls include changes in species diversity and biomass, and concentration of organisms that seem to find immediate use for substances contained in the effluents. Several fish diseases--including a fin rot condition and a skeletal disorder--appear at unusually high frequencies near some outfalls, but it is unclear whether the disorders are caused by the effluents or the unusual crowding of fishes near the outfalls. A number of other pathological disorders occur in fishes that occupy outfall areas in the Southern California region, and the disorders may be directly related to the outfalls. Fish diseases similar to those occurring in the immediate vicinities of the Southern California outfalls also appear at unusually high frequencies around municipal sludge dumping beds in the New York Bight.

-- Marine sludge disposal in the New York Bight damages the ocean bottom and water column as a habitat for many organisms, and appears to have a measurably toxic effect on both larva and adults of certain shellfish species. These effects seem to be limited to the immediate vicinities of sludge dumping sites, but continuing the dumping practice promises to cause more severe problems in part because of the limited circulation patterns in the shallow waters of the bight. Sludges dumped into the bight tend to concentrate rather than dispersing rapidly into the open ocean. The effects are measurable in bottom sediments collected in the vicinities of sludge beds. The sediments contain certain heavy metals in concentrations considerably higher than concentrations of the same metals in ambient sediments. Although sludges presently deposited in the New York Bight contain large amounts of metals and other actually and potentially toxic materials, most nutrients introduced to the bight appear to come from the Hudson River.

-- The major environmental problems related to discharges of municipal wastes into the relatively closed marine systems at Pearl Harbor and San Juan Bay seem to center around nutrients, coliform bacteria, turbidity and generally noxious aesthetic conditions. Nonpoint-source pollution is a predominant contributor to many of those problems, however. The primary impact

of P.L. 92-500 upon these bays will probably be a decrease in coliform bacteria content.

-- Although data are quite limited, few if any large-scale measurable environmental effects are apparent from releasing untreated and partially treated sewage and organic industrial wastes into the Alaskan Bight. Torrential currents disperse the wastes before effects can develop, and primarily for that reason implementation of the Act will have little or no effect upon water quality in the Alaskan Bight.

-- In open, freely-circulated coastal areas with deep waters receiving municipal effluents, maximum levels of environmental recovery will probably be achieved with secondary treatment, and will probably be limited to the immediate vicinities of outfalls. Adverse environmental effects associated with BAT will be insignificant when compared to changes resulting from application of secondary treatment of municipal effluents discharged through outfalls. The effects of EOD probably would be noticeable only in the immediate vicinities of outfalls.

-- There is a marked scarcity of data relating environmental situations to pollution for all coastal regions of the nation. Most existing information comes from the Southern California and New York bights, and that information is of a preliminary nature.

-- The assimilative capacity of deep, circulating marine systems seems to be such that introduction of municipal sewage effluents does not increase regional concentrations of most potential pollutant materials beyond natural background levels.

The Commission's marine studies indicate that large volumes of partially treated municipal wastewaters probably can be discharged into deep, freely-circulating coastal waters in certain areas without significant damage to local environments. Effluent limitations necessary to provide adequate local environmental protection can be derived from studies of metals in oceans, from an understanding of concentrations of different substances that are toxic to marine life, and from considerations of health and aesthetic factors. The marine studies indicate that wastewaters discharged to marine systems probably could be released safely when they meet scientifically established water quality criteria applying to particular locations rather than the uniformly defined national treatment levels. Diffuser outfalls of appropriate lengths and depths can be designed to cause maximum dispersion of effluents within offshore disposal areas. Adequate effluent limitations yielding minimal environmental effects in offshore receiving waters can be achieved by a variety of types and levels of wastewater treatment, if publicly owned treatment plants are carefully designed and operated.

The Commission's analyses indicate that plants treating something less than 10 million gallons of sewage per day may find higher treatment levels and shorter outfalls economical, without undue adverse environmental consequences. Redundancy sufficient to provide continuous environmental protection in case of partial failure should be included in such plants. Plants with capacities exceeding 10 million gallons a day will find it advantageous economically to use primary or advanced primary treatment, and to discharge through longer outfalls. Operating energy requirements are similar for primary, advanced primary and secondary treatment levels. Tertiary treatment requires about twice as much energy as the other levels; it ranges from an equivalent cost for small dischargers to about twice the cost for larger ones. The total savings from building optimum environmentally acceptable treatment-disposal system combinations for publicly owned treatment works discharging to nearshore coastal waters can be substantial when compared to the potential costs of meeting uniform national treatment levels.

The scarcity of data about the actual effects of placing municipal wastes into coastal waters indicates that scientific studies similar to those currently in progress in the New York Bight by the National Oceanic and Atmospheric Administration and the Southern California Bight by Southern California Coastal Water Research Project should be initated immediately for all coastal areas where ocean waste disposal of municipal effluents is practiced. Although the information now available suggests that environmental impacts of marine discharge of adequately treated and adequately dispersed effluents receiving less than secondary treatment are minimal in the California Bight, the actual localized and universal short- and long-term effects of such practices cannot be understood fully until much more information is developed from other coastal areas. Discharge of any municipal or industrial wastewaters into coastal waters should not be allowed in any part of the nation until sufficient preliminary research has been completed locally to:

1) Determine the suitability of the area for waste disposal.

2) Determine the levels of wastewater treatment, types of outfalls and disposal methods necessary to minimize local environmental effects.

F. ENVIRONMENTAL FINDINGS, CONCLUSIONS, AND OBSERVATIONS

1. Study Design

• The Commission was unable to arrive at a precise definition of "physical, chemical, and biological integrity of the nation's waters." The Commission examined a number of opinions and philosophical approaches to defining the phrase, but was unable to determine which viewpoint most closely reflects the intent of Congress as stated in the Act. Since the

central efforts of the Commission's environmental assessment studies focused upon environmental studies at 41 sites, a practical approach using information about the sites was used to analyze progress toward a water quality better than that presently existing, and one that will provide for ". . . protection and propagation of fish, shellfish, and wildlife" and "recreation in and on the water." To evaluate achievement or non-achievement of the 1983 interim national goal, the Commission determined that any given water body should have (1) a dissolved oxygen level of at least 4 mg/liter during seasonal low flow conditions, (2) toxic materials present at levels not exceeding those recommended in Water Quality Criteria (NAS-NAE, 1972), and (3) total coliform or fecal coliform bacterial densities not exceeding those levels recommended in the Water Quality Criteria (NAS-NAE, 1972).

- Study sites were selected to provide geographic coverage that would permit the Commission to characterize regional and national environmental changes in fresh, estuarine, marine, standing waters, and related terrestrial environments. Criteria employed in site selection were (1) availability and applicability of a verified mathematical model for relating industrial and municipal point-source discharges to water quality, (2) existence of sufficient historical and baseline water quality and biological data to support impact assessments and projections of change, and (3) availability of professional expertise for relating water quality change to environmental change. In effect, meeting these criteria dictated the location of most of the study sites. By applying these criteria, the Commission's study sites are concentrated in those parts of the country presently experiencing moderate to severe water pollution problems. To balance the assessment, several sites also were chosen in areas having minimal water pollution problems, but where water pollution is expected to increase because of development. The Commission's environmental study methodology establishes a precedent, and provides a basis for future national environmental impact studies.

- At nearly all study sites, assessments of water quality conditions were based on more sophisticated analytical methods than were assessments of biological, ecological, and environmental changes. Methods employed to assess environmental impacts ranged from simplified regression techniques to mathematical simulations of ecosystem effects. At some sites, environmental assessments were limited to professional judgment when the supporting data were too limited to permit more sophisticated analysis. A uniform approach for projecting environmental change was not possible because the state-of-the-art is not sufficiently advanced.

- Biological and ecological data and supporting information were generally less abundant than information on physical and chemical factors. In many instances, biological information was limited to lists of names of commonly observed organisms. Detailed biological information

was available at some sites and was even extensive for a few. Nearly all studies lacked cause-and-effect data about specific pollutants and their effect under natural conditions. The Commission was able to extrapolate only in very general terms from published case histories to potential effects of pollutants at sites that had not been studied.

2. Water Quality and Quantity

• The following summarizes progress that might be expected towards achievement of the 1983 goal, based on conditions and projections from the Commission's 41 site studies. Where data permit, incremental improvements due to implementation of the Act's phased requirements are distinguished for each water quality variable assessed.

Oxygen Depletion

• Achievement of BPT by industrial discharges and secondary treatment by publicly owned treatment plants (as defined by EPA) will substantially increase dissolved oxygen levels in many of the nation's waters. These improvements vary, however, depending upon site-specific receiving water characteristics and pollutant loads from controlled and uncontrolled sources.

-- Approximately 60 percent of the Commission's study sites (based on 38 sites for which there were adequate data) could theoretically achieve the 4 mg/liter dissolved oxygen criterion for all seasons through implementation of secondary treatment and BPT. About 20 percent of the study sites currently reported levels of dissolved oxygen generally above 4 mg/liter. During seasonal low flow conditions, minor portions of most of the remaining 40 percent of the sites would not meet the minimum dissolved oxygen criterion.

-- Portions of about 40 percent of the study sites indicated that more stringent treatment than EPA limitations would be required to meet a dissolved oxygen standard of 4 mg/liter during seasonal low flow conditions. The majority of these sites contain segments which are presently designated as water qualtiy limited and would qualify for more stringent load allocation analyses under Section 301(b)(1)(c) of the Act.

-- Localized dissolved oxygen depletion problems in estuarine sites generally will be minimized by the achievement of BPT by industrial point-source dischargers and secondary treatment by municipal point-source dischargers or through relocation of outfalls.

-- Improvements in dissolved oxygen are anticipated to be the greatest in New England, the Upper Ohio region, the Middle Atlantic and South Gulf and in the Great Lakes region.

• Achievement of BAT by industrial point-source dischargers and BPWTT by municipal point-source dischargers (as defined by EPA) is expected to yield the following results:

-- Only marginal improvements in DO will result at those sites which currently achieve the 4 mg/liter criterion or which meet the criterion through application of BPT for industries and secondary treatment for municipalities during seasonal low flow conditions.

-- Application of more stringent state standards which apply to both industrial and municipal point sources and are based upon detailed load allocation analyses are required to meet in-stream dissolved oxygen standards for about 40 percent of the study sites which do not meet standards when industrial BPT and BAT requirements and municipal secondary treatment are utilized.

• A number of potential residual dissolved oxygen problems will persist following the achievement of BAT and BPWTT. These problems will be the result of urban storm runoff and combined sewer overflows, two important sources of oxygen-demanding materials at about half of the Commission's study sites. The extent to which these intermittently occurring DO problems are reduced or alleviated will depend in large part on the amount of progress made in controlling and treating these sources.

Bacteria

• More than three-fourths of the sites are expected to achieve the total and fecal coliform bacteria criteria levels during seasonal low flow conditions through uniform application of point-source disinfection practices associated with secondary treatment. These standards will, however, continue to be exceeded periodically at some of the sites due to (a) urban storm runoff, (b) combined sewer overflows, and (c) runoff from agricultral land. Based on the Commission's study sites, the relative importance of these three factors varies regionally, geographically and from urban to rural settings, with storm runoff and sewer overflows being important sources of bacterial contamination at nearly half of all sites studied, and agricultural runoff an important source in nearly one-fourth of the sites.

• At the individual sites there will be little improvement in fecal and total coliform bacterial problems that are not reduced or

eliminated through achieving secondary treatment and BPT. Some reduction in the overall coliform bacteria problem can be expected nationwide, depending on the amount of progress made in controlling and treating urban storm runoff and combined sewer overflows. A substantial problem will persist nationally, however, since a major source of coliform bacteria in the nation's water is attributed to nonpoint sources which will not be affected by achieving requirements beyond the EPA's secondary treatment standards.

Toxic Substances

- Achievement of the 1983 interim national water quality goal will depend in large part on progress made nationally to identify toxic problems, assess the impact of toxic substances on natural environmental systems, evaluate methods for their control and reduce or eliminate the amount of toxic materials presently entering the nation's waters.

- Environmental studies by the Commission's contractors illustrate the wide range of toxic problems and sources in the nation and the severe limitation of data availability. Based on a review of the Commission's 41 study sites, and considering that toxic levels exceeding those recognized, recommended or proposed in Water Quality Criteria (NAS-NAE, 1972) as "safe" levels would prevent the achievement of the 1983 interim national goal, the following pattern emerges:

1) Heavy metals concentrations commonly exceed "safe" levels in the water column or in fish tissue in portions of 37 percent of the Commission's assessment sites where adequate data were available. In portions of an additional 27 percent of the sites with data, heavy metals were found to sometimes exceed safe limits or are evident in high concentrations in the sediments. Minor problems were associated with heavy metals contamination at 23 percent of the assessment sites with data. Major sources of heavy metals include industrial discharges, urban storm runoff and mine drainage. Data on heavy metals were presented for 35 of the 41 sites (85 percent) although in many instances these data were of limited scope.

2) Pesticide concentrations commonly exceeded "safe" limits or were linked with fish kills at about 50 percent of the sites with available data. The presence of pesticides sometimes above safe limits was noted at about one-fourth of the sites. Minor pesticide contamination problems were reported at 23 percent of the study sites. Pesticide data were presented for only 26 of the 41 study sites (63 percent). Runoff from agricultural land was the most commonly cited as a major pesticide source. Urban storm runoff and runoff from forested land were noted as significant sources at a number of sites.

• Utilizing the three water quality criteria--dissolved oxygen, bacteria, and toxics--as a basis for assessing achievement of the 1983 interim water quality goal, the following conclusions can be drawn:

1) Two of the three water quality criteria will be met at about half of the 41 sites through achievement of BPT and secondary treatment.

2) Only marginal additional progress towards meeting the 1983 interim goal would be realized with the application of BAT and BPWTT as uniformly defined by EPA. Effective reduction or elimination of toxics may be a critical factor in full recovery of many water bodies. More stringent state treatment standards and control of combined sewer overflows and nonpoint sources of pollution are required on a site-specific basis to advance significantly beyond the BPT level.

• Other water quality criteria were used to round out the picture of the nation's water quality problems--both present and projected. These include the physical characteristics of water--e.g., temperature, turbidity and suspended solids--as well as nutrient-related eutrophication problems and salinity. Results of these assessments are summarized below.

Temperature

• The Commission's environmental studies evaluated the number of thermal power stations which could be directed by the Act to use alternative cooling methods instead of the traditional "once-through" system. The stations included both existing and planned through 1983. The Commission evaluated possible exemptions under Section 316(a) which requires that alternative cooling methods which protect a balanced, indigenous community of organisms at the site be used, and Section 316(b) which requires that technologies be used which protect aquatic life at the intake structures. Criteria evaluated in judging possible environmental impacts included:

1) Design and operating characteristics of power plants, particularly their cooling systems.

2) Physical characteristics of the water bodies which supply cooling water and receive the effluent.

3) Characteristics of the communities of aquatic biota believed to be indigenous to such waters, particularly their susceptibility to known power plant-induced changes.

- The conclusions reached in this study are:

1) Using criteria developed by the Commission, the need for alternative cooling systems is less for some categories of receiving waters, especially lakes, than had been estimated in previous analyses. A majority of steam electric power plants are likely to be found qualified for exception from thermal effluent limitations under Section 316(a). The percentage of plants which could use once-through cooling without damage to indigenous populations are estimated to be: Oceans - 80 percent; Estuaries - 38 percent; Rivers - 80 percent; Lakes - 90 percent; River/Impoundments - zero percent; Impoundments - 100 percent; and Man-made Lakes - 100 percent. By comparison, the EPA has estimated: Oceans - 100 percent; Estuaries - 50 percent; Rivers - 74 percent; and Lakes - 50 percent.

2) Detailed and extensive field studies which will result in a massive body of documented findings at each site will be required to support a successful application for exemption from alternative cooling.

3) Review of the extensive, detailed, site-specific body of information by the regulatory agencies charged with final determination will be a major undertaking requiring protracted effort and high scientific competence.

4) Implementation of Section 316(a) exemption procedures does not eliminate the need for further research on thermal and other effects of steam electric power plants. Any generalized scientific finding resulting from the individual case studies will be slow to emerge. However, continued efforts on such topics as the ecological effects associated with coastal siting can provide a valuable guide to consistency in findings and to eliminating unnecessary duplication.

5) For any meaningful evaluation of the effects of power plants on populations of aquatic organisms, the entire range of effects, including thermal (as highlighted in Section 316(a)), intake related entrainment and entrapment (as highlighted in Section 316(b)), and chemical (if present) must be considered together. Biological effects of entrainment and intake structures often constitute a greater impact on populations than may occur due to the discharge of heat. Independent enforcement of the separate provisions in Sections 316(a) and (b) could do a disservice to the goal of attaining overall minimum impacts.

Turbidity

- Turbidity and suspended solids problems resulting from point sources are most evident in the "clear water regions" of the country

(e.g., New England). In these locations, application of BPT for industries and secondary treatment for municipalities will bring substantial improvements. More stringent treatment required to meet DO standards at a number of sites will further reduce turbidity toward naturally occurring levels. Reduction of suspended solids levels in clean-water regions could increase light penetration into the water and increase the potential for excessive plant growth provided nutrient levels are sufficient.

- Natural and nonpoint sources of suspended solids obscure point sources in the Midwest Great Plains, and other regions of the western U.S. where agricultural land use practices add to naturally occurring suspended solids loads. Point-source controls will accomplish little towards reducing turbidity and suspended solids levels in these regions.

Eutrophication Potential

- Eutrophication problems were evident to some degree at most of the sites, but were most evident in the New England, Middle Atlantic and Southern Gulf, Great Lakes, Midwest, Great Plains and Great Basin regions. The extent of eutrophication at many sites, particularly in the West, was limited by high turbidity which limits light penetration required for plant growth.

Salinity

- High salinity, or total dissolved solids, levels are associated with inland regions of high natural background salinity, particularly in the West. Irrigation practices often add significantly to natural salinity levels. In other regions, normally low TDS levels are trending upwards with time through the influence of industrial and municipal point and nonpoint sources.

- Salinity levels are not projected to be greatly reduced by point-source controls. Improved irrigation practices would reduce salt loads, but loads from natural sources, as well as irrigation, would remain as problems for users, albeit at somewhat reduced intensity. Seasonal flow conditions can be altered by changed irrigation practices creating water allocation problems between established water users during low-flow periods.

- Salinity problems associated with saltwater intrusion into estuaries and coastal groundwaters, a threat to freshwater suppliers, will not be improved through point-source controls. Water conservation and flow regulation measures are required in these coastal situations.

3. Pollutant Loads

- A significant proportion of publicly owned municipal wastewater treatment plants within the Commission's 41 study sites will not be able

to meet the 1977 target year for achievement of secondary treatment because of delays in funding, planning, design and construction. Permitted effluent abatement levels reflect these delays, the consequence of which is that actual water quality improvements to be achieved by 1977 will bring the nation only marginally closer to the achievement of the 1983 interim national goal.

- A Commission comparison of waste loads from point and nonpoint sources suggests a number of water pollution problems will persist following elimination of point-source pollutants. One group of constituents is estimated to have at least 50 percent of the calculated BPT load left. This group includes suspended solids, nutrients (nitrogen and phosphorous), and fecal and total coliform bacteria. A second group of variables, including BOD and zinc, will have 20 and 50 percent of the total BPT load left after the end of point-source discharge. A third group, including oils, greases and cadmium, has a higher degree of controllability. These percentages indicate, therefore, the significance of the "non-controllable" loads.

- The analytical capability to assess sources, magnitudes, and impacts of nonpoint sources of pollution presently exist, with the exception of toxic substances. Basic information requirements must be satisfied, however, including detailed sampling programs for site-specific assessments.

- Rational assessment of water quality improvements associated with point-source control should be conducted with full recognition of uncontrolled source influences. Although uncontrolled sources contribute pollutants in a transient manner, their impacts can be long term and can obscure gains in water quality from point-source control.

- Evaluation of nonpoint source impacts will be aided by control of point sources, but this evaluation should not be delayed until point sources are controlled.

4. Residuals Disposal

- Generally it will be possible to dispose of virtually all residual materials generated by municipalities and industries responding to the Act's requirements in a safe and environmentally acceptable manner. The residuals will consist almost entirely of liquid effluents and semi-solid sludges generated by wastewater treatment technologies. Most of those materials will be suitable for either land disposal or economically beneficial use in land conditioning and agricultural practices. In many areas having insufficient land resources for residuals disposal, sludge incineration will provide environmentally safe options to land disposal. Residuals disposal will, however, pose a problem in highly populated areas with air quality problems prohibiting incineration, and

without adequate land resources suitable for environmentally safe land disposal methods. Insufficient data were obtained during the Commission studies to document adequately the amount of residuals that can be recycled or reclaimed nationally.

- Based on Commission studies, the national rate of generation of sludges, effluents and other residual materials will increase substantially for the 1977 and 1983 levels of wastewater treatment compared to present residuals generation rates. National residuals generation rates will not increase significantly for the EOD level of wastewater treatment compared to 1983 generation rates. Environmentally acceptable residuals disposal methods are available, however, for virtually all levels of wastewater treatment required by P.L. 92-500.

- The major problems resulting from residuals disposal will generally be institutional and economic rather than environmental in nature. In the vicinities of industrial complexes and densely populated sections of the nation, residual materials can be transported to safe disposal sites, but at a cost. Moreover, many sections of the country suitable for safe and often beneficial use as disposal areas will not be immediately available for such use for institutional reasons.

5. Environmental Impacts

- An overview of biological findings from the Commission's environmental sites selected to represent a range of water body type and water quality problems indicates the following with regard to fish, shellfish, and wildlife:

  1) Fish, of some species, are currently present and propagating in very nearly every water body in the country.

  2) Sport or game fish, most frequently considered "desirable" and often most indicative of underlying system conditions, are often more sensitive than rough or commercial species and have been virtually eliminated in about 40-50 percent of the total area studied by the Commission; half of this gross elimination is due primarily to nonpoint-source contributions.

  3) Although present in over half of the total area studied, fish species, numbers, and productivity have been to some degree altered by point- and nonpoint-source contributions, physical habitat changes and management practices. Some of these activities have benefited certain fish communities. Most have been detrimental.

- In those areas where the fishery essentially has been eliminated, BPT and secondary treatment potentially could restore 20-25 percent

nationally of that area not presently suitable for protection and propagation. The value of this improvement is enhanced in view of the fact that it occurs primarily in and downstream from large population centers. Fishing activity, and other recreation associated with cleaner water, potentially becomes available for more people.

- Achievement of BAT and BPWTT indicates the potential for another 10-15 percent improvement nationally in suitable area due primarily to additional dissolved oxygen improvements, and assumptions of projections at some of the sites of toxics and/or nutrient removal.

- Elimination of point-source discharge may add an additonal 5-10 percent improvement nationally in suitable areas.

- Available biological measures of the structure and function of most ecosystems, including those selected for Commission study, are inadequate to precisely characterize all facets of these systems or all potential reactions to point-source abatement levels.

- "Water quality which provides for the protection and propagation of fish, shellfish, and wildlife . . ." will not be attained nationally by 1983 or even with the national goal of elimination of point-source discharge. Nonpoint sources and physical alteration of water bodies and surrounding watersheds will continue to be primary deterrents in many areas.

- Impacts of point sources on biological communities are not uniform between water body types, between geographical regions or even between parts of the same water body. Consequently, reduction or elimination of those sources will not bring about uniform change.

- In some areas where water quality is sufficient to meet the stated goal, destruction of essential habitats will continue to influence plant and animal populations.

- The following findings generally apply to all effluent abatement levels:

  1) Problems associated with the presence of toxic materials (i.e., fish kills, bird population declines, potential contamination of food products) exist at nearly all sites where data were available. Documentation of existing concentrations and environmental effects of toxics is sufficient to justify major efforts toward limitation, and ultimate control, as well as additional research into specific effects.

  2) Nonpoint sources contribute heavily to the condition of the fisheries. Dominant forms and sources are (a) turbidity and

sedimentation, primarily from land runoff, (b) toxic materials from urban sources, and (c) excessive nutrients, especially in lakes, from land runoff.

3) The impacts of previous and planned physical changes, such as dams, channelization, and wetland drainage and fisheries management practices, such as stocking, exotic species introductions, are very important factors underlying all potential improvements in water quality and are unaffected by implementation of the Act.

- The following findings apply nationally to shellfish:

1) Shellfish resources have been lost at nearly all of the Commission's estuarine study sites due to (a) destruction of suitable habitat, and (b) contamination from bacteria and toxic chemicals. Point-source control will not affect the former category significantly since much of this loss is due to siltation of shellfish beds. Most areas with bacterial contamination problems will improve with achievement of secondary treatment requirements. If combined sewer contributions are controlled with 1983 requirements, additional beds will open, while smaller gains could be expected with the elimination of point-source discharges in those areas where effluents comprise a large percentage of the stream flow.

2) Portions of nearly all estuarine sites showed potential for continued contamination due to urban storm runoff and other nonpoint sources, especially with anticipated human population increases.

- The following findings apply nationally to wildlife:

1) Point-source abatement overall will have a small but beneficial impact on the wildlife resources of the nation. The greatest threats to wildlife stem from destruction of habitat. Point-source controls will contribute slightly to reducing the destruction and alteration of wildlife habitat, but control of activities, such as dredging and filling of wetlands, would do far more to halt the damage to wildlife.

2) Water-borne pollutants do have deleterious effects on water related wildlife. Their effect is two-fold: toxic substances, especially pesticides and heavy metals, interfere directly with reproduction and migration of wildlife; pollutants such as oil or excessive nutrients exhibit indirect effects by damaging or destroying wildlife habitat.

- Controlled ocean disposal of municipal effluents receiving treatment less stringent than secondary probably can be practiced without development of either short- or long-term adverse health and

ecological effects in some coastal sections of the nation. It appears to be generally unnecessary to go beyond secondary treatment of municipal wastewaters discharged to open coastal marine system through adequately designed outfalls to maintain local and regional marine ecosystems in a natural state. Little information exists about the environmental effects of dumping municipal wastewater sludges into the ocean. The data available suggest the practice to be locally damaging, but either insignificant or unmeasurable on a larger, regional basis. In some coastal areas, municipal effluents receiving only primary treatment can probably be released into nearshore coastal environments without measurable ecological effect. For those areas, implementation of P.L. 92-500 will have negligible environmental effects. Discharge of municipal and industrial wastes into coastal waters should not be permitted in any part of the nation, however, before sufficient preliminary research has been completed locally to: 1) determine whether or not the area is suitable for disposal, and 2) determine the levels of wastewater treatment necessary to minimize local environmental effects.

- The primary effect of point-source pollution of lakes and other standing water bodies in the nation has been an accelerated rate of eutrophication due to introduction of nutrients, primarily nitrogen and phosphorus. Significant removal of nutrients from effluents will require wastewater treatment technologies more stringent than secondary for municipal dischargers and at least the BAT level for industrial dischargers, but only in those areas where contributions of nutrients from nonpoint and uncontrolled point sources are relatively minor. Advanced rates of eutrophication in standing water bodies generally result in dramatic biological changes and development of obnoxious aesthetic situations. Application of wastewater treatment technologies that remove nutrients eventually will end those conditions in many lakes in the country, but will have little overall effects upon the lakes and other standing water bodies located in highly agricultural areas, and other areas where nutrient input comes mainly from nonpoint sources.

- The Commission's environmental studies were unable to address adequately the question of delayed implementation of the requirements and goals of the Act. The primary reason for this relates to the length of time over which there have been measurements made in any single environmental system across the country. Most ecosystems, for which there is considerable baseline or historical information, have only been studied for 5-10 years using modern ecological field techniques. There are far too few of these lengthy studies available to be able to predict in a general sense the effects of the delayed implementation of the Act, although data do exist to document the fact that continued pollution inputs eventually damage ecosystems <u>beyond</u> a point of recovery.

Secondly, there have been few studies conducted over a long enough time frame to where recovery from specific perturbations is well

documented. A few case histories, however, do document the importance of decisive action to control effluents. Where degradation has not proceeded for a number of decades, recovery appears to be rapid, often much more rapid than predicted initially. Since the threshold, that point in time when the perturbation has proceeded to where irreversible environmental effects have occurred, is not well documented, achievement of secondary treatment and BPT in those areas where point sources predominate and control of toxics will bring the most significant changes under this Act and the greatest amount of progress towards achieving the 1983 interim national goal.

Control of urban storm runoff and combined sewer overflows as soon as possible is expected to result in additional significant improvements in water quality. Achievement of the 1983 interim goal may be effectively delayed until more adequate measures can be taken to control pesticides and other materials entering the nation's waters from nonpoint sources and agricultural land. Achievement of the secondary treatment requirement nationally may not result in significant changes in coastal marine waters.

There is sufficient information available to question the merits of establishing secondary treatment for coastal municipalities as a high priority, although it should be stressed that few data are available and more information is required before policies can be established that are meaningful. Eventual growth in the coastal areas may result in pollutant loads that will require secondary treatment in every instance.

CHAPTER V.

PUBLIC LAW 92-500

AN ASSESSMENT OF INSTITUTIONAL STRUCTURE AND RESPONSE

PUBLIC LAW 92-500
AN ASSESSMENT OF INSTITUTIONAL STRUCTURE AND RESPONSE

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PUBLIC LAW 92-500
AN ASSESSMENT OF INSTITUTIONAL STRUCTURE AND RESPONSE

Introduction and Summary of Findings

Much of the progress toward national pollution control objectives depends upon the capacity and willingness of the institutional system to provide substance and momentum to implement the Federal law. The responses of the institutional participants -- persons in the Federal, state and local governments, and among the regulated municipal, industrial and agricultural dischargers -- greatly influence the facility and effectiveness with which the Act is given eventual shape in regulation, guidelines and compliance.

P.L. 92-500 established a set of rights, responsibilities and obligations comprising an intricate web of intergovernmental relationships, a categorical assistance grant program, a delegable regulatory scheme applicable to all levels of government, to industry and to agriculture, and a public participation mandate in both governmental decision-making and regulatory activities. This network is perhaps more complex than any other institutional arrangement used to pursue and accomplish a national goal. Although the Clean Air Act of 1970 relies upon effective coordination between the EPA and state air pollution control agencies, P.L. 92-500 calls for what may well be the most ambitious applications of Federal policy and program within the context and constraints of our system of federalism. The Water Pollution Control Act of 1972 attempts both to provide generous incentives and to wield heavy penalties through a delegable regulatory program, coupled with grant-in-aid assistance to publicly owned treatment works dischargers so that they may comply with prescribed effluent limits.

Initially, many of the institutional performers were less than enthusiastic at the prospect of implementing P.L. 92-500. EPA advised the Congress that the Act, as it was proposed and eventually passed, would place undue strain on the capacity and capability of that Agency to effectively execute the law(1). Most of the states resisted the essential structure of the Act, asserting -- as many of their spokesmen had in testimony before the House and Senate Public Works Committees -- that its strong focus on centralization and control at the Federal level constituted unwarranted infringement upon the basic sovereign authority of the states, and would result in an insensitive and unrealistic application of a Federal program to state and local problems. Local governments voiced concern about the rigidity of the Act, and what many considered to be unrealistic and unnecessary requirements for uniformity of compliance.

The application of uniform technologies, short-term compliance deadlines and the seemingly broad purview of the regulatory scheme were

also points of consternation and apprehension among industrial and agricultural dischargers. Thus, the Commission began its analysis of the institutional system and its response to the Act at a time when the predominant sentiments of the players ranged from apprehension to outright hostility. Unquestionably, this attitudinal posture by some of the major participants added to the uncertainty surrounding the Act's implementation, and contributed to delay.

These attitudes and delays in meeting some of the statute's early deadlines made formulation of its analysis more difficult. The study of the institutional system, of necessity, had to be conceived and conducted while the design and adjustment of the institutional framework were still being developed, tested and revised. Indeed, arrangements and responses by which the requirements and goals of the Act are to be met are still not universally, fully and smoothly operational. EPA has not issued final effluent limitations for all industrial categories and types of pollutants; a strategy for control of some agricultural point sources is still being formulated; EPA regional offices and NPDES state agencies have not completed the issuance of permits; and major revisions of the planning regulations were published after the Commission completed its studies.

Despite some formidable problems of interpretation and implementation, as well as some debilitating false starts, changed signals and delays, the institutional participants are moving toward full implementation of the Act. Moreover, many of the early apprehensions and hostilities have, or are being, overcome as the Act's processes become more clearly defined and well understood by persons in the institutional network. In fact, while the Commission's studies have been under way, there has been a perceptible change in attitudes toward the Act among the major participants. In a survey undertaken by the Commission, 94 percent of the Federal officials indicated their approval of the overall strategy of the Act; 63 percent of the state officials responded positively and the attitudes of those engineers, local officials and industrial representatives questioned were predominantly positive(2). This does not mean, of course, that many of those sampled, from every level of participation, still do not have major problems with some elements of the Act or wish for some change in the law or its administrative interpretations and application.

The Commission's institutional analysis examines the overall strategy of the Act and its dependence upon the interrelationships of the several levels of government and private wastewater dischargers to cooperatively put the Act into effect. To the extent possible, the analysis has tried to avoid the inclination to fix upon implemention of one part of the Act or the performance of one level of government or one group or segment of dischargers to the exclusion of others. Yet, since so much of the implementation requires the initiative of EPA, it is perhaps unavoidable

that much of the Commission's attention focuses upon that agency. As a result, EPA's performance in implementation may be the recipient not only of the most attention, but also of the most criticism.

The Commission recognizes that many of the delays associated with Federal decisions and actions were the unavoidable consequence of unrealistically short statutory deadlines. A recent House Subcommittee report put it this way, "P.L. 92-500 probably can be regarded as a classical example of two phenomena that have plagued governmental programs, and particular Federal programs, in the past decade. These are underestimation and overexpectation. . . The magnitude of the task set out in P.L. 92-500 has been drastically underestimated."(3)

To some degree, too, the delays resulted from the initial reluctance of the states and localities to accept the basic structure and early administrative interpretations of the Act. Also, the seeming rigidity and immediacy of the legislative changes embodied in P.L. 92-500 were there as a deliberate conclusion by the Congress that some states and localities, given too much latitude, could not or would not aggressively pursue the goals of national environmental legislation.

Another unavoidable limitation upon the Commission's analysis is heavy emphasis on the performance of functional elements of the program -- construction grants, permits, enforcement, compliance monitoring, planning, etc. These are the discrete components and, as such, provide some measure of the progress and problems of implementation. In the final analysis, the results contemplated by Congress in enacting the Federal Water Pollution Control Act Amendments of 1972 will be measured by the degree to which the quality of the Nation's waters improve. At this writing, an assessment based on actual water quality improvements resulting from the Act is not possible. Yet performance, thus far, must be measured against some standard, and one such standard is that established in the Act -- accomplishment of the statutory requirements within the specified schedules.

In examining the separate parts of the program, there is the risk that the full scope and form of the intended implementation structure designed by the Congress will be lost or obscured. The Act contains a discernible implementation strategy, predicated upon the proposition that substantial Federal financial assistance, coupled with strong centralized initiatives for regulation and enforcement defined within a comprehensive framework of state and local planning, will result in the most expeditious, effective and sensitive application of resources and manpower to accomplish the national objective of a better environment for the Nation's people.

So far, there is considerable difference between the blueprint and the actual result. Major delays in the outlay of Federal funds for construction grants, delays in issuing permits and variations in permit

conditions for municipal and industrial dischargers, and the fact that the mandated planning requirements are seriously out of synchronization with the construction grant and permit phases, all contribute to uncertainty about achievement. Experience, thus far, neither conclusively disputes nor sustains the legislative proposition. Examination can identify the points in the process where delays and difficulties have been most pronounced and yield observations, based on performance thus far, about the basic validity of the Act's structure and strategy and the institutional interdependence and cooperation upon which its implementation is founded.

Study Design

Public Law 92-500 interweaves two complex governmental activities through the fabric of the program -- a categorical grant-in-aid program coupled with a Federal regulatory scheme governing all wastewater dischargers. Each is interdependent upon the other and dependent, in turn, upon the interrelationships of the several levels of government to work cooperatively toward accepted common purposes. The Commission's studies, while focused primarily on the performance of the several functional elements of the program were conceived so as to examine the interrelationships of programs and jurisdictions. This meant, in effect, analyzing implementation of the program where it actually occurred -- in the states and with local governments. Because of limited time and resources, however, the Commission selected a limited number of representative states for detailed analysis. Using detailed criteria, eight states were chosen -- California, Georgia, Iowa, Maine, Maryland, Ohio, Texas and Utah -- for comprehensive analysis in seven of the eight institutional studies of permits, compliance monitoring, enforcement, construction grants, planning, public participation and attitudes. A summary description of these studies and some of the resulting findings follow.

Regulation

The National Pollutant Discharge Elimination System was designed to require relatively uniform state-by-state and industry-by-industry application of national effluent limitations promulgated by EPA and incorporated in permits for each wastewater discharger. Examination of NPDES implementation to date reveals that:

-- Problems with the development, publication and implementation of effluent limitations have slowed the entire regulatory process, and spawned more than 250 lawsuits by industries challenging the promulgated "effluent limitations guidelines."

-- There are significant variations between the industrial and municipal permits. While industrial permits are being written to require installation of appropriate technologies by 1977, many municipal permits are not. Roughly only 50 percent of the publicly owned treatment plants will meet secondary treatment or water quality effluent limitations by 1977.

-- Small municipalities, as well as small industries, have difficulty interpreting and applying the numerous and complex statutory and regulatory requirements.

-- Substantial duplication is indicated in some state and EPA regional offices in permit issuance.

-- Beyond 1977 requirements, the future application of NPDES is uncertain. Unsettled strategy for controlling toxics is a major contributing cause.

-- There is no currently functioning central information system designed to compare the nationwide application of effluent limitations in individual permits or to monitor permit compliance as a measure of pollutant discharge reduction.

-- Compliance monitoring activities, predicated primarily on a self-reporting system, may not provide meaningful permit enforcement information without committing substantial manpower to on-site verification of reported discharge data.

Construction Grant Financing

Congress anticipated that the construction grants program would assist in attaining the secondary treatment requirement for publicly owned wastewater treatment works by July 1, 1977. Delay in the program indicates that this requirement probably cannot be met until the middle of the next decade, at the earliest, as a result of:

-- Actual, as opposed to scheduled, funding of the Federal share of the construction grants program has compressed obligations of $11.3 of the $18 billion total available funds into Fiscal Years 1976 and 1977 if full commitment is to be realized by July 1, 1977.

-- An overly complex and often duplicate grant application, review and approval process.

-- A significant increase in the estimated funding level required to construct all eligible categories of publicly owned treatment works.

Planning

The Act contemplates a comprehensive approach to state, areawide and basin planning. The intended influence of planning activities has had, and for the next several years will continue having, only minimal nationwide impact because:

-- The key elements of the planning process -- facility planning and areawide waste treatment planning -- are seriously out of synchronization with construction grants for publicly owned treatment works and the permitting process.

-- The first areawide planning grant was not approved until nearly two years following passage of the Act, and the first such plan will not be completed until 1977, or later.

-- Use of continuing statewide plans generally has been limited to the determination of water quality standards.

-- Careful guidance and assistance are needed to optimize the eventual utility and acceptability of the areawide plans now being designed.

It is possible, however, that planning activities now under way will influence the second round of permits to be issued between 1978 and 1980, and future construction grants as well. Information was not available during the Commission's study to accurately assess this aspect and EPA has just revised its regulations to more fully coordinate the various planning activities with the other elements of the program.

Public Participation

The clear intent of the Act was to expand access and the potential for influence by the interested citizen on the institutional process for executing the water pollution control program. In practice, the pre-1972 pattern of public participation is largely unchanged. If anything, citizens may exert less influence upon the process than previously because:

-- Opportunities for participation prior to policy and administrative decisions are limited chiefly to public hearings.

-- The complex requirements of the Act and the frequent junctures for citizen input tend to dissipate the energies and limited resources of citizens, and reduce significant impact on the proceedings.

-- Effective, intelligible feed-back information management systems on progress of the implementation process and its relationship to water quality goals for specific bodies of water are lacking.

Legal Action

The courts have played, and will continue to play, a major role in shaping the implementation of P.L. 92-500. To date, at least 350 lawsuits have arisen under the Act, and more than 284 are still pending in

the courts. The suits consist principally of challenges by environmental groups, industry, states and local governments to EPA's implementation of the construction grants, planning and regulatory provisions of the Act. Most of the suits -- about 320 as of June 30, 1975 -- relate to some aspect of EPA's regulatory program. Of these, approximately 15 percent deal with issues concerning navigable waters, common law nuisance actions, civil and criminal penalties, dredge and fill, and oil spills, and were not analyzed in the Commission's studies. The remainder -- more than 25 percent -- reflect industry challenges to EPA regulations promulgating effluent limitations. Despite this extensive litigation, it is still too early to assess the court's role in implementing P.L. 92-500. Some of the most important legal issues are still pending before the courts. One thing is certain, however -- most, if not all, of the Act's major provisions will be subjected to challenges in court.

The Institutional Setting

Water pollution control became a topic of widespread national concern within the last 10 to 15 years. From a governmental function performed by state and local governments to a major national program the institutional system has undergone some radical organizational changes. Though changes have occurred at all levels of government, the impetus for change originated, and is most noticeable, at the Federal level. Between 1964 and 1970, the Federal administrative responsibility for water pollution control first emerged into a position of consequence in the Department of Health, Education and Welfare. From HEW, the program was moved by Executive Order as the Federal Water Pollution Control Administration to the Department of the Interior. In 1970 (pursuant to Presidential Reorganization Plan No. 3), it was combined with air pollution control, solid waste and pesticide control programs administered by five separate Federal agencies and shifted to the Environmental Protection Agency(4).

Just as the organizational pattern has undergone sometimes controversial evolution at the Federal level, changes have occurred in state patterns, too. Earlier state water pollution control functions were usually assigned to health departments. Sixteen states (Alabama, Arizona, Colorado, Hawaii, Idaho, Indiana, Kansas, Maryland, Montana, Nevada, North Dakota, Oklahoma, Rhode Island, South Carolina, Tennessee and Utah) still retain a health department type focus(5). Twelve states have adopted an arrangement similar to the Federal EPA (Arkansas, Florida, Illinois, Iowa, Maine, Minnesota, Nebraska, New Mexico, Ohio, Oregon, South Dakota and Wyoming). Fifteen states have "super agencies" responsible for more than just environmental programs (Alaska, Connecticut, Delaware, Georgia, Kentucky, Massachusetts, Michigan, Missouri, New Jersey, New York, North Carolina, Pennsylvania, Vermont, Washington and Wisconsin). Seven states have unique water pollution control administrative organizations, not readily classifiable in the three more common patterns -- California, Louisiana, Mississippi, New Hampshire, Texas, Virginia and West Virginia.

Organizations vary even more widely at the local level. Among them are incorporated municipalities, townships, counties, sanitary districts or special utility districts. Municipalities and townships may be governed by mayor-city council (with or without an administrator), city council-city manager or commission; counties may be governed by commissioner's court, county judge or by county manager. In some states, regional agencies may exercise major responsibilities. The local agency not only has a direct operating relationship with its respective state agency, but also the EPA region may contact the applicant directly. Any applicant for a construction grant may have an associated consulting engineering firm and a working relationship with a state governmental

organization providing funding of the non-Federal share of the construction cost. If industries discharge to the public collection and treatment system, the local agency must also work with them in the process of constructing the treatment works.

This intergovernmental structure and the affected wastewater dischargers have had to respond to major Federal water pollution control legislation in 1961, 1965, 1966 and the considerably more complex P.L. 92-500 in 1972. The evolving organizational structures have simultaneously had to adjust to an ever-changing legal and policy framework.

Environmental Protection Agency regional offices and their respective states are shown in Figure V-1. Manpower in the various states and regions to perform various water pollution control functions are shown in Table V-1.

Statutory requirements for technology-based effluent limitations to be applied to individual municipal, industrial and agricultural dischargers by July 1, 1977 and July 1, 1983 have already been discussed as have the 1983 interim and 1985 goals. These requirements and goals are to be achieved through the following institutional devices or tools:

I. Effluent Limitations

   A. Technology-based effluent limitations are prescribed for industrial categories by EPA for 1977 and 1983,

   B. Technology-based effluent limitations for publicly owned treatment systems comparable to secondary treatment for 1977, and best practicable treatment for the life of the works by 1983,

   C. More stringent limitations are defined to meet water quality standards, if required,

   D. New source performance standards are fixed by EPA for new plants,

   E. Toxic standards are determined by EPA, and

   F. The elimination of the discharge of pollutants is mandated wherever technologically feasible.

II. National Pollutant Discharge Elimination System

   A. A permit is required for any defined point source discharge into the Nation's waters by any entity, governmental or private,

FIGURE V-1

ENVIRONMENTAL PROTECTION AGENCY REGIONAL OFFICES

STANDARD FEDERAL REGIONS

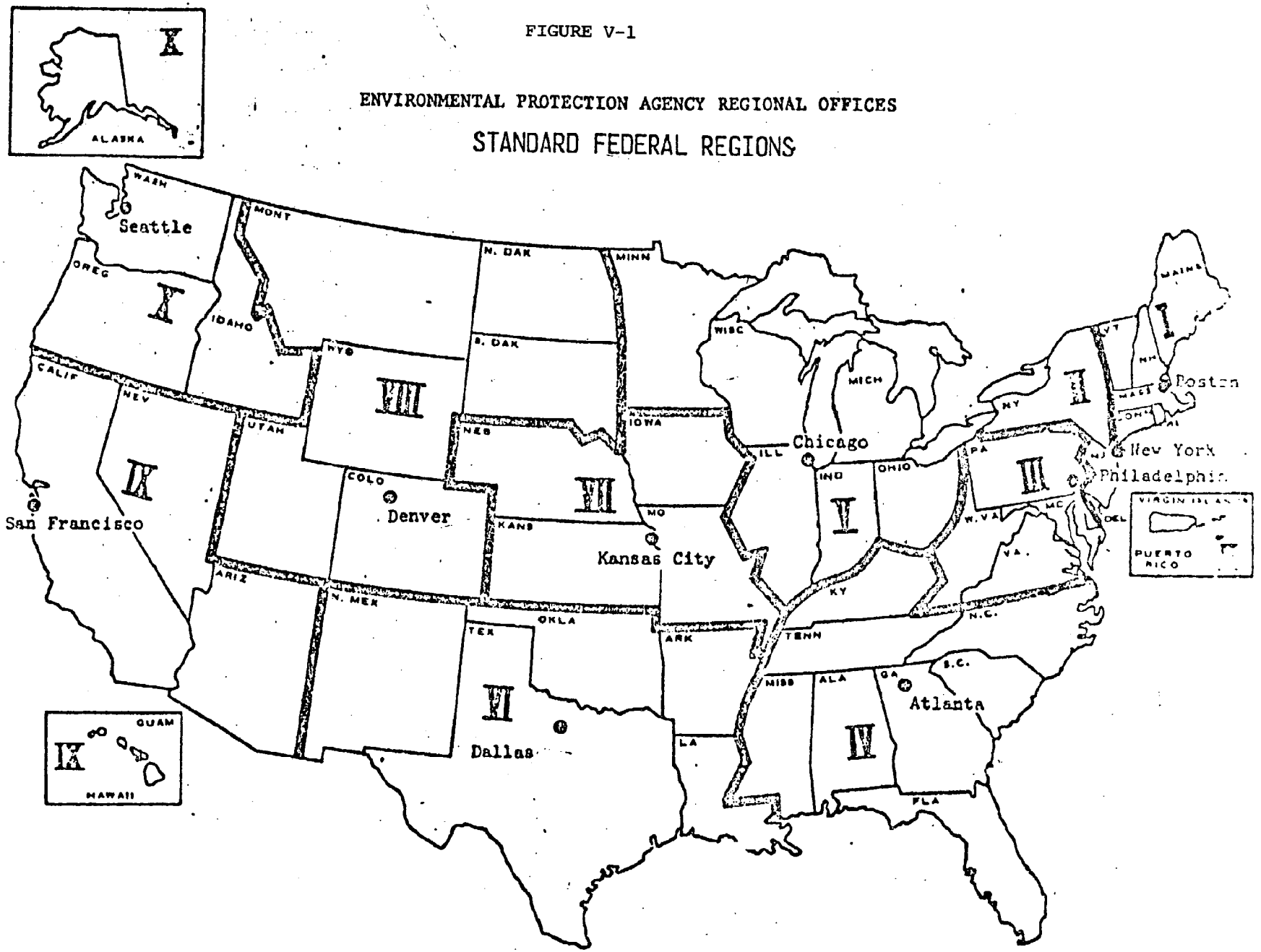


TABLE V-1

Approximate Program Manpower
EPA and State Agencies
Fiscal Year 1976

Region		Municipal Facilities	Permits	Planning	Monitoring	Enforcement	Training	Other*	Total
I	EPA	32	55	20	6	31	4	25	173
	State	86	54	45	111	32	7	137	472
II	EPA	48	66	16	29	37	5	48	249
	State	157	125	60	103	90	4	142	681
III	EPA	58	74	17	27	33	1	45	255
	State	151	142	166	171	113	22	260	1,025
IV	EPA	59	62	37	35	43	5	61	302
	State	141	185	145	292	60	33	210	1,066
V	EPA	72	81	33	29	81	3	58	357
	State	180	233	112	395	107	39	176	1,242
VI	EPA	44	63	11	14	30	4	35	201
	State	110	83	97	172	44	8	71	585
VII	EPA	39	37	21	14	26	6	24	167
	State	48	55	40	42	21	6	40	252
VIII	EPA	25	35	16	10	22	3	18	129
	State	35	30	20	36	6	6	26	159
IX	EPA	37	27	9	6	28	2	23	132
	State	98	105	77	110	33	15	108	546
X	EPA	28	29	6	24	15	0	35	137
	State	48	48	23	67	9	0	8	203
TOTAL	EPA	442	529	186	194	346	33	372	2,102
	State	1,054	1,060	785	1,499	515	140	1,178	6,231

* Often includes all State personnel in State regional offices who work all program areas.

SOURCE: EPA, Unpublished data; State data from State 106 Program Plans.

B. The discharge of any pollutant in violation or permitted conditions is proscribed,

C. Permit issuance can be approved for states which meet certain prerequisites,

D. The use of permit monitoring procedures, based upon a permittee self-reporting system, is authorized, and

E. Violation of permit conditions can lead to enforcement action.

III. Categorical Construction Grants for Publicly Owned Treatment Works

A. Grants are made to local government applicants for the construction of publicly owned wastewater treatment plants conforming to specific Federal criteria,

B. Federal grants support 75 percent of eligible construction costs with the balance provided by state or local matching (36 states have state-local grant or loan program), and

C. A three-tiered grant application process calls for EPA approval of Step 1 facility plans, Step 2 design and specifications and Step 3 construction(6).*

IV. Comprehensive Planning

A. Continuing state water quality planning processes are used to establish and update water quality standards,

B. Areawide wastewater control and treatment plans are required for those areas with substantial water quality control problems resulting from urban-industrial concentrations or other factors, and such plans are required to develop solutions to nonpoint source pollutant problems,

C. River basin planning, to be conducted by the Water Resources Council prior to 1980, emphasizes those basins which contain, or are located in, areas designated for areawide waste control or treatment planning, and

D. State program plan submissions articulate year-to-year goals.

---

* While the Act does not specify a three-step process, EPA requires three steps in response to what was interpreted to be Congressional intent.

V. Public Participation

A. An opportunity for citizens to participate in all phases of policy, program and administrative development is mandated,

B. EPA and NPDES state agencies must integrate participation into all on-going activities, and

C. Any person may commence a civil court action to enforce effluent limitations promulgated by the Administrator or to require the performance of any non-discretionary duty imposed by the Act on the Administrator.

National Pollutant Discharge Elimination System

The National Pollutant Discharge Elimination System may be viewed as a system-within-a-system. Effluent limitations, the NPDES, construction grants and planning comprise the basic components of P.L. 92-500, and discharge permits, compliance monitoring and enforcement comprise the programmatic activities of the NPDES. Permits are the heart of the NPDES -- and therefore the heart of the Act. Permits provide the institutional mechanism by which all point-source pollutant discharges are to be reduced and controlled, and are the yardstick against which compliance or violation is to be determined.

Federal permits for wastewater discharge had their antecedent in the Refuse Act of 1899. Administered as a navigation control law by the Corps of Army Engineers, it was never employed as a Federal pollution control device until its potential was "re-discovered" in 1970(7) by, among others, the House Subcommittee on Conservation and Natural Resources. In response to the creation of the Refuse Act Permit Program (RAPP) on December 23, 1970, by Executive Order, the Corps of Engineers issued appropriate guidelines in April, 1971.

The RAPP program was never fully implemented but was, in effect, superceded (though not repealed) by the passage of P.L. 92-500(8), by which time the Corps of Engineers had received approximately 20,000 RAPP permit applications, but had issued only 21 permits(9).

Section 402 of P.L. 92-500 established the NPDES process and provides authority to permit all point source (as opposed to nonpoint source) pollutant discharges. The principal pollutant discharge targets of the NPDES are discharges from municipal, commercial and industrial wastewater treatment works and from selected agricultural sources (Table V-2). In addition, P.L. 92-500 establishes several permit programs other than that established in the Section 402 National Pollutant Discharge Elimination System, as indicated in Table V-3, including a Corps of Engineers' administered program regulating dredge spoil.

Effluent Limitations

Public Law 92-500 changed the enforcement mechanism by shifting the focus from receiving water quality standards to effluent limitations. It provides in Section 301(a) that the discharge of any pollutant is unlawful unless it is in compliance with conditions (effluent limitations) contained in a permit issued under Section 402. Thus, individual permits may be enforced by measuring pollutants discharged in the wastewaters.

Section 301(b) states that there must be achieved effluent limitations for undefined "classes and categories of point sources." Section 304 requires EPA to publish regulations, providing guidelines for effluent

TABLE V-2

Coverage of Pollution Sources

P.L. 92-500

Direct Coverage by PL-92-500			Exclusions	
Direct Coverage by NPDES	Controlled by Other Public Law 92-500 Programs	Indirect Coverage by NPDES	Dischargers Excluded from NPDES Coverage [1/]	Uncontrolled by NPDES [1/ 2/]
--industrial dischargers	--ocean dumping (Sec. 403)	--industrial pretreatment (Sec. 307)	--storm sewer discharges	--urban runoff
--municipal treatment plants	--marine sanitation dischargers (Sec. 312)	--sludge disposal	--small feedlots	--rural runoff
--irrigation return flows	--aquaculture (Sec. 318)		--small pretreating industries	--groundwater pollutants
--large feedlots	--oil and hazardous materials (Sec. 311)		--landfill or other solid wastes disposal systems	--non-Federally funded land application projects
--combined sewers	--dredging spoils (Sec. 404)		--septic tanks, cesspools, & individual household systems	--acid mine drainage
	--Toxic substances (Sec. 307)			

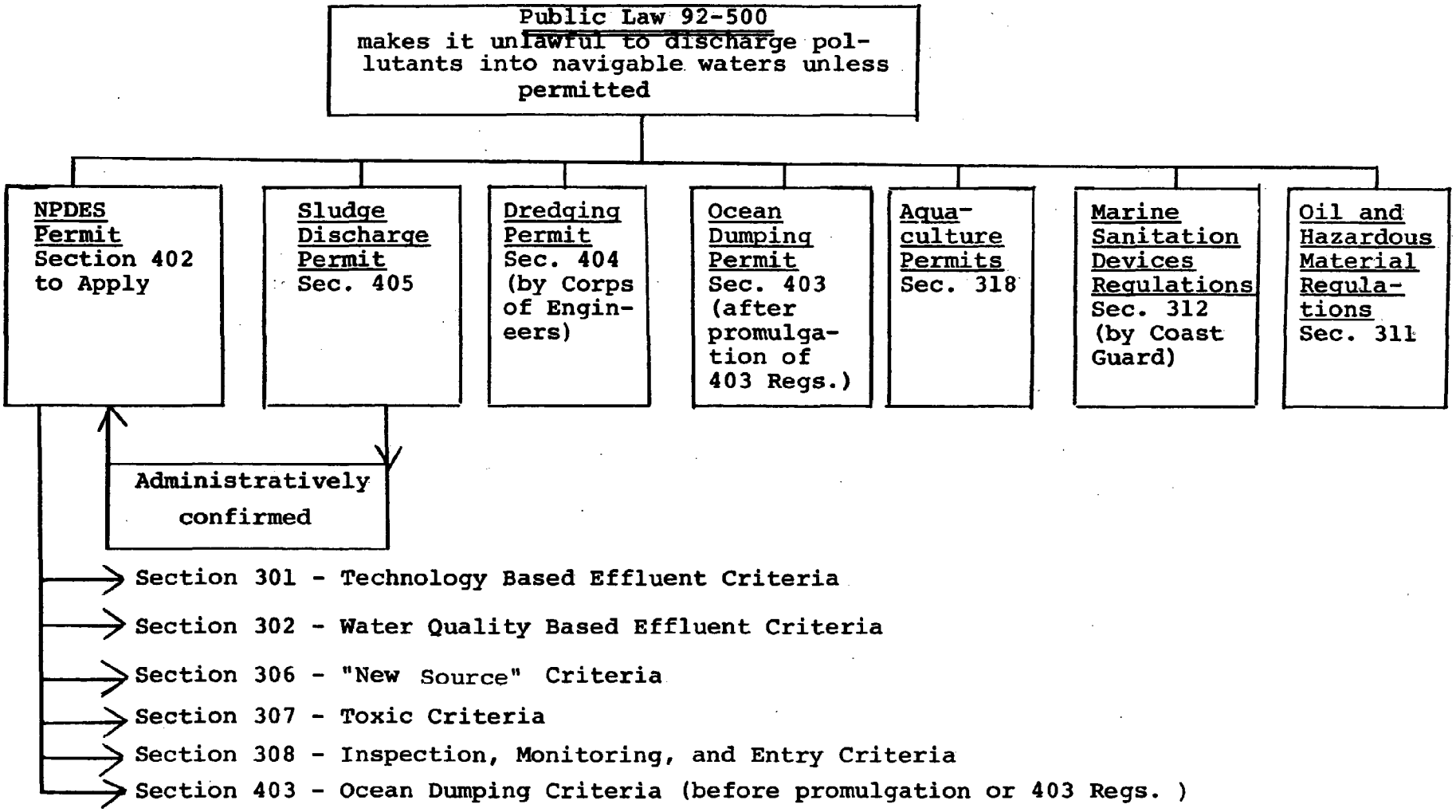
[1/] Excluded by EPA policy. Covered directly by Flannery decision currently under appeal.

[2/] May be covered by Sec. 208 management plans.

Source: The Water Pollution Control Act of 1972: Institutional Assessment, Permits, page 104.

TABLE V-3

PERMIT RELATED REQUIREMENTS OF P.L. 92-500



Source: The Water Pollution Control Act of 1972: Institutional Assessment, Permits, page 106.

limitations, that shall specify factors to be taken into account in determining the control measures and practices to be applicable to point sources (other than POTWs) within the categories or classes.

The Act recognizes that a meaningful categorization of industrial processes is essential for limitations to be applied nationwide. However, neither Section 301 nor Section 304 provides guidance as to what constitutes "classes or categories" of point sources. Section 306, on the other hand, does provide a list of categories of sources which the Administrator must use as a starting point in developing new source performance standards. These 27 categories named in Section 306 have also been used as the starting point by EPA in the issuance of its effluent limitations for existing sources.

EPA has designated the 27 categories in Section 306 as the Group I. Because within one category several different methods or processes may be used to produce the same product, EPA further subcategorized Group I into Phases I and II. Additional categories not specifically mentioned in Section 306 considered necessary by EPA were listed for purposes of issuance as Group II categories. The division of Group I-Phase I, Group I-Phase II, and Group II categories refers solely to the order in which EPA is promulgating the guidelines and is shown in Table V-4.

EPA's failure to publish all of the guidelines within one year of statute's enactment was the subject of a lawsuit(10). The court ruled that EPA failed to carry out this requirement and imposed a publication schedule of its own, assigning a publication date for each of the Group I and II categories.

In the guidelines published to date, EPA has identified more than 200 categories and subcategories of industrial processes (based on plant age and size, manufacturing process, raw material use, etc.) which will require discrete effluent limitations(11).*

Along with the technology-based limitations, the permit process also must incorporate "water quality", "toxic", and "new source performance" standards when applicable. State adopted and EPA approved water quality standards are translated into a format compatible with technology-based effluent limitations through the use of stream "load allocations."(12). When technology-based effluent limitations are inadequate to maintain the necessary quality of receiving waters (or to meet water quality standards established by the states and approved by the EPA Administrator for a particular stretch of water), more stringent effluent limitations to achieve the specified water quality must be applied. Through the use of modelling techniques, such loads may be allocated among dischargers situated on the same river or stream segment or water

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* Many of these guidelines have been challenged in the courts.

TABLE V-4

EPA CATEGORIES

Group I, Phase I

Insulation Fiberglass Manufacturing
Beet Sugar Processing
Cement Manufacturing
Feedlots
Phosphate Manufacturing
Rubber Processing
Ferroalloy Manufacturing
Electroplating
Asbestos Manufacturing
Inorganic Chemicals Manufacturing
Meat Product and Rendering Processing
Plastic and Synthetic Materials Manufacturing
Nonferrous Metals Manufacturing
Sugar Processing
Canned and Preserved Fruits and Vegetable Processing
Grain Mills
Soap and Detergent Manufacturing
Fertilizer Manufacturing
Petroleum Refining
Dairy Product Processing
Leather Tanning and Finishing
Pulp, Paper and Paperboard Mills
Organic Chemicals Manufacturing
Builders Paper and Board Mills
Canned and Preserved Seafood Processing
Timber Products Processing
Iron and Steel Manufacturing
Textile Mills
Steam Electric Power Plants

Group I, Phase II

Rubber Processing
Electroplating
Timber Products Processing
Inorganic Chemicals Manufacturing
Plastics and Synthetic Materials Manufacturing
Ferroalloy Manufacturing
Organic Chemicals Manufacturing
Nonferrous Metals Manufacturing

Phosphate Manufacturing
Fertilizer Manufacturing
Asbestos Manufacturing
Meat Products and Rendering Processing
Grain Mills
Canned and Preserved Seafood Processing
Glass Manufacturing
Sugar Processing
Iron and Steel Manufacturing
Pulp, Paper and Paperboard Mills
Builders Paper and Board Mills

Group II

Auto and Other Laundries
Paving and Roofing Materials (Tar and Asphalt)
Transportation Industries
Paint and Ink Formulation and Printing
Fish Hatcheries and Farms
Canned and Preserved Fruits and Vegetables Industry
Miscellaneous Chemicals
Miscellaneous Food and Beverages
Machinery and Mechanical Products Manufacturing
Coal Mining
Petroleum and Gas Extraction, Handling, Storage and Residues Disposal
Mineral Mining and Processing
Water Supply
Ore Mining and Dressing
Steam Supply
Structural Clay Products
Pottery and Related Products
Concrete, Gypsum and Plaster Products
Furniture and Fixtures Manufacturing

Residual Category

Point Source Discharge Categories Not Otherwise Covered

body to determine whether or not effluent limitations more stringent than those generally applicable are needed to achieve water quality standards.

While EPA has not yet established national standards for any toxic substances pursuant to Section 307, required within 90 days of October 18, 1972, some are limited on a permit-by-permit basis(13). On September 7, 1973, EPA published a list of nine toxic substances(14) including Aldrin, Benzidine, Cadmium, Cyanide, DDT compounds, Endrin, Mercury, Polychlorinated Biphenyls and Toxaphene. This action has been challenged (see discussion in legal issues) on the basis that the list is incomplete, and to date, EPA has not promulgated effluent limitations for any toxics.

In a few straightforward instances, discharge constituents will precisely match the constituent parameters contained in an applicable effluent limitation. But the more representative situations involve complex industrial processes with pollutant discharges which may not precisely match effluent limitations on a constituent-by-constituent basis because of the variety of products produced. The most complex permitting situations involve complicated plants, incomplete coverage of all production processes by promulgated effluent limitations, toxic substances and water quality limited waters.

As effluent limitations do not, and can not, cover every possible situation, permits frequently reflect a composite -- produced from the best information available to a particular permit writer including (in addition to interim guidance documents and interim and final effluent limitations) "best professional judgment" based on past training and experience and knowledge of research and technical studies.

State Designation

While the process is technically complex, it can also be administratively intricate. The Act provides that upon gubernatorial request, EPA may approve a state to exercise the NPDES authority, provided it determines the state possesses adequate authority and program support to implement the goals and requirements of the Act [Sec. 402(b)(1)]. After being designated, a state becomes responsible for administering the entire NPDES process -- issuing new permits, re-issuing expired permits, monitoring permit compliance and the first opportunity to enforce all permit violations. As of November 1, 1975, NPDES authority had been designated to 26 states. In time, perhaps 41 political subdivisions(15)* may operate the NPDES. While the NPDES is intended to provide uniform application of national effluent limitations, determination of whether they are being applied in that manner depends upon the development and

* Eleven states, the District of Columbia, and the Pacific Trust Territories have no present interest in NPDES delegation. Thirty-nine states, Puerto Rico and the Virgin Islands have a present interest.

installation of state information and management systems which can produce data compatible with a similar EPA central and regional system.

In EPA's judgment, nine states lack resources adequate to justify NPDES assumption, but three of those nine have no present interest in the program and four must overcome legal deficiencies. As a sole cause, inadequate state-level resource commitments bar NPDES designation to two states -- Maine and South Dakota. Of the 23 states which must overcome NPDES legal deficiencies, 10 are not presently interested. Thus, state laws incompatible with the Act bar delegation in only 13 states having an apparent present interest in assuming the NPDES. (Table V-5.)

Within the next several years, 39 states, Puerto Rico, and the Virgin Islands probably will be responsible for the operation of the NPDES. More than one-fifth of the states apparently are satisfied to let EPA administer the NPDES; one-half the states have requested and received NPDES, and the rest are attempting to remedy present legal deficiencies. A more meaningful assessment of NPDES designation must await the passage of time but statutory authority may not be the most important remaining constraint. A recent EPA Task Force on Decentralization concluded that "Progress toward decentralization in the form of formal program delegation (e.g., NPDES) has reached a point of diminishing returns, as there are few additional States which have the staff capacity to assume this type of large scale delegation." (16)

Permitting Process

The NPDES permit process contains 10 distinct steps -- beginning with a discharger request for a permit application and ending with issuance of the permit (See Table V-6). After a discharger files a permit application, it is reviewed by EPA or an NPDES state agency for completeness. During this review step, EPA solicits comments from a wide range of interested parties, including the Corps of Engineers and state and Federal water resource agencies. While such comments are generally advisory, in effect the Corps of Engineers can veto a permit when it concludes that the permit will damage navigation. Though not legally obligated to meet the review objections raised by agencies other than the Corps, negative comments are carefully considered by EPA which has established procedures for resolving interagency conflicts(17).

After review of the permit application, EPA (or an NPDES state agency) formulates permitted effluent limitations. If the discharger is unable to comply fully with permitted limitations within nine months of permit issuance, the two parties jointly formulate a compliance schedule for installation of the required pollution control plant and equipment. Some degree of permit formulation variation is apparent in every state and EPA regional permit writing process. Decisions regarding when to involve dischargers, how much data should be collected, by whom (the

TABLE V-5

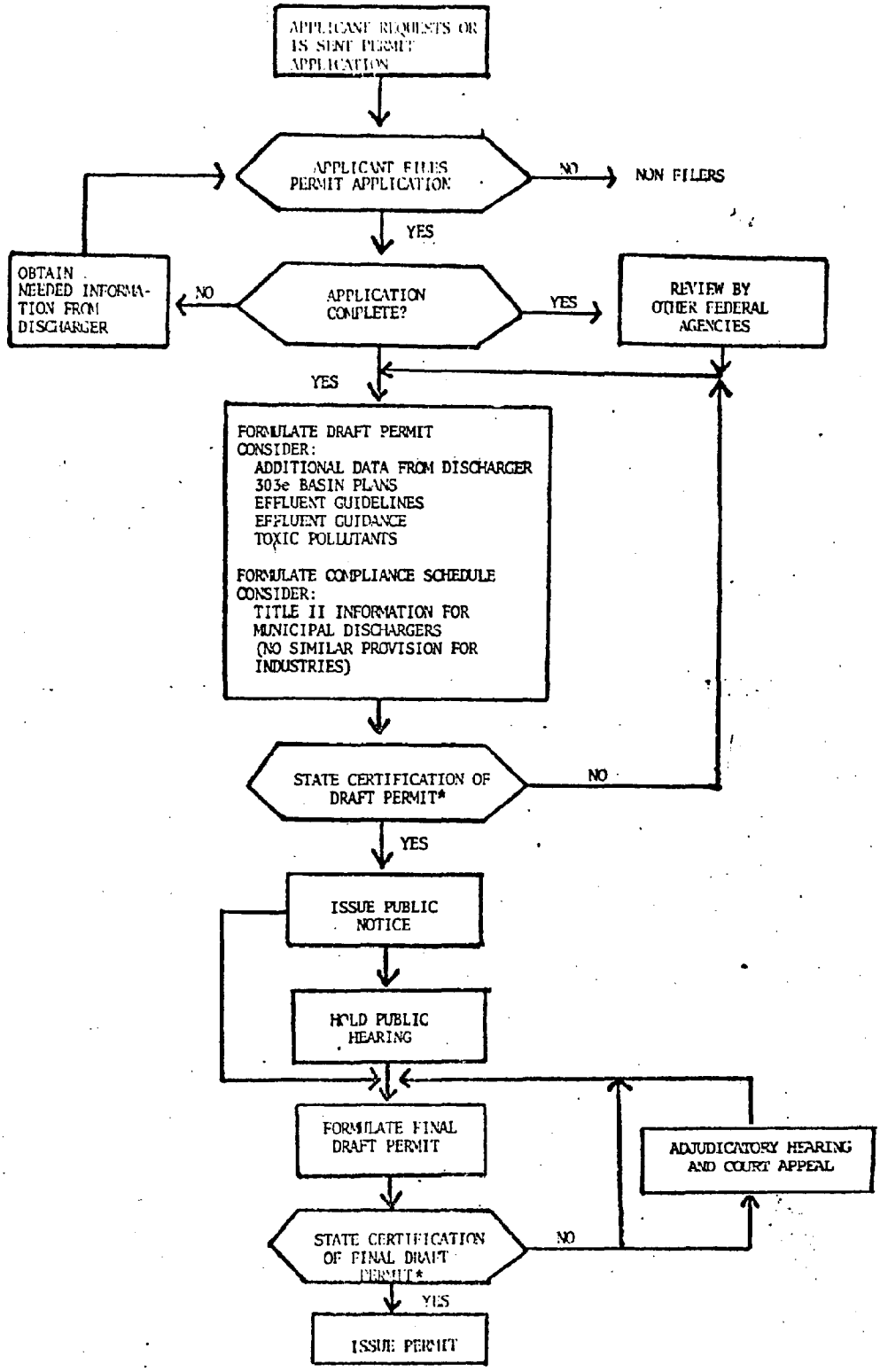
STATUS OF NPDES DELEGATION
(As of November 1, 1975)

	Delegation Date	Problem Hindering Delegation		
		Legal	Resources	Interest
Region I				
Connecticut	9-26-73			
Maine			x	
Massachusetts			x	x
New Hampshire			x	x
Rhode Island		x		x
Vermont	3-11-74			
Region II				
New Jersey		x	x	x
New York	10-29-75			
Puerto Rico		x	x	
Virgin Islands		x	x	
Region III				
Delaware	4-1-74			
Washington, D.C.		x		x
Maryland	9-5-74			
Pennsylvania		x		
Virginia	3-31-75			
West Virginia		x		
Region VI				
Alabama		x		x
Florida		x	x	
Georgia	6-28-74			
Kentucky		x		x
Mississippi	5-1-74			
North Carolina		x		
South Carolina	6-30-75			
Tennessee		x		x
Region V				
Illinois		x		
Indiana	1-1-75			
Michigan	10-10-73			
Minnesota	6-30-74			
Ohio	3-11-74			
Wisconsin	2-4-74			
Region VI				
Arkansas		x		
Louisiana		x		x
New Mexico		x		x
Oklahoma		x		x
Texas		x		
Region VII				
Iowa		x	x	
Kansas	6-28-74			
Missouri	10-30-74			
Nebraska	6-12-74			
Region VIII				
Colorado	3-27-75			
Montana	6-10-74			
North Dakota	6-13-75			
South Dakota			x	
Utah		x		
Wyoming	1-30-75			
Region IX				
Arizona		x		
California	5-14-73			
Hawaii	11-28-74			
Nevada	9-19-75			
Territories				x
Region X				
Alaska		x		x
Idaho		x		
Oregon	9-26-73			
Washington	11-14-73			
	26	23/13	9/2	13

Source: The Water Pollution Control Act of 1972: Institutional Assessment, Permits, page 65.

TABLE V-6

OUTLINE OF PERMIT ISSUANCE PROCESS
P.L. 92-500



Source: Federal Water Pollution Control Act of 1972: Institutional Assessment, Enforcement. page 144.

permittee, EPA or an NPDES state), and how load allocations are to be determined when water quality limited river segments or water basins are involved represent only a few of the discretionary subjects in the permit writing process.

The fifth step in the permit writing process relates to Federal-state certification (approval) of the draft (formulated) permit. If the permit is prepared prior to designation of the NPDES program to the state, the EPA prepared permit must be certified-approved by the state water pollution control agency. If the state has been designated, the NPDES state prepared permit must be certified-approved by the EPA Regional Administrator.

After certification-approval of the draft permit, public notice is given of the intent to issue a permit; at least a 30-day public comment period must follow such notice and when requested, a public hearing must be conducted if a significant public interest issue (as determined by the EPA Regional Administrator) is involved.

Following public notice, review of any comments and a public hearing when required, the final permit is drafted. Final Federal-state certification-approval is obtained, and the permit is issued unless the discharger-applicant resorts to administrative or judicial appeal of the permit conditions.

Permits -- A Short Deadline

Issuing permits to each industrial and municipal point source discharger has proved a mammoth administrative task. Initially, issuance of both industrial and municipal permit issuance were initially delayed pending development of national effluent limitations, review and upgrading of state water quality standards and completion of waste load allocations pursuant to the Section 303(e) state basin planning process.

EPA and nine NPDES states began issuing industrial permits in April 1973 and municipal permits late that year. They concentrated on major dischargers which represent approximately 12 percent of total estimated permittees and account for 60 percent to 80 percent of total point-source pollutant discharges. EPA regional offices identified major and minor dischargers/permittees on a subjective basis -- taking into account discharge volume, receiving water quality, discharge severity and discharger compliance history. By the December, 1974 deadline, EPA and the NPDES states had issued almost 28,000 of the estimated 47,000 permits required by the Act. The total included 94 percent of the major industrial, 91 percent of the major municipal, and 55 percent of all minor dischargers. To achieve even this level of performance, EPA and the NPDES states shifted significant manpower resources from other program areas to permit-writing activities.

TABLE V-7

NPDES Permits Issued Through 12-31-74

Issued By	Permits			Estimated
	Major	Minor	Total	Unissued
EPA	4,180	16,044	20,224	n/a
NPDES States	1,394	6,307	7,701	n/a
TOTAL	5,574	22,351	27,925	19,296

Source: EPA Draft of Clean Water Report to Congress 1975, page III-4.

The permit issuance date was an inflexible statutory requirement, and in retrospect, the Act established, and EPA and NPDES states were compelled to meet, an exceedingly tight permit issuance schedule which placed a heavy or even onerous burden on the Federal agency and the states.

As of June 30, 1975, all jurisdications had issued 20,091 industrial permits; 16,664 municipal permits, 1,548 agricultural permits and 1,988 Federal facility permits for a total of 40,291 permits issued. Of approximately 1,600 EPA issued permits challenged through the administrative hearing process, 400 have been resolved through discussions among the interested parties, e.g., government industry and public interest groups(18). With these totals, 98 percent of major and 59 percent of minor industrial permits have been issued and 93 percent of major and 83 percent of minor municipal permits. Ahead, however, are an indeterminate number of dischargers (EPA estimates anywhere from 50,000 to 100,000) such as small feedlots, stormwater sewers, irrigation return flows, etc., which presumably will have to be permitted and present enormous policy and management problems for EPA and the states.

Addressing this remaining task, a recent study by the General Accounting Office concludes that "EPA faces an almost impossible task if it has to issue permits to the estimated 1.8 million animal feedlots, 100,000 storm water discharge point sources and indeterminate number of agricultural and silvicultural activities."(19)

Permit Conditions

Permits for publicly owned treatment works are inextricably tied to the construction grants program which is geared to available resources and construction completion. Only an estimated 50 percent of all municipal permittees will meet secondary treatment required by July 1, 1977(20) Where funding was available, treatment requirements and compliance schedules were fixed in the permits. If a grant that would enable construction of the required treatment works by July 1, 1977 was not probable, "permits have required only the progress that can realistically be achieved by the deadline, with full compliance to be required at a reasonable future date."(21)

Thus, responding to physical and financial constraints, EPA made an understandable adjustment by establishing "double standard" municipal permits. While the administrative adjustment serves its purpose (to obviate the need to enforce permits which are clearly beyond the compliance capacity of municipal permittees), the adjustment is cosmetic, for unless the 1977 deadline is relaxed by Congress, or new permits are issued, some 50 percent of the nation's municipalities will be in violation of P.L. 92-500 on July 1, 1977.

For industrial categories, the first effluent limitation (sugar beet industry) was issued January 31, 1974. The process of identifying industrial subcategories for which effluent limitations must be promulgated, is not yet complete. At this writing, EPA is continuing to issue and revise effluent limitations. Neither EPA headquarters nor the Commission has undertaken a systematic, detailed analysis of the extent to which permit conditions for similar discharges actually match, exceed or fall short of effluent limitations.

The Commission's Attitudes Survey indicates differing opinions on whether or not discharge limitations have been applied uniformly on a nationwide, regionwide and statewide basis. EPA officials feel that the application of limitation guidance has been uniformly applied -- 71 percent agree that the application has been uniform on a nationwide basis, and 87 percent and 79 percent agree that regionwide and statewide application has been uniform. State and municipal officials express views opposite to those of EPA officials on the question of nationwide uniformity, but agree that the application of limitations guidances has been uniform on a statewide basis. Industry officials disagree with EPA officials on each count; with 74 percent believing permit conditions are not uniform on a nationwide basis. Industry officials are less sure of regionwide and statewide uniformity, as indicated in Table V-8.

TABLE V-8

Uniformity of Permit Requirements

Respondents	Nationwide		Regionwide		Statewide	
	Agree	Disagree	Agree	Disagree	Agree	Disagree
EPA Officials	71%	22%	87%	8%	79%	13%
State Officials	21%	61%	52%	31%	76%	19%
Municipal Officials	23%	60%	38%	42%	56%	38%
Industry Officials	13%	74%	32%	45%	43%	38%

Source: The Water Pollution Control Act of 1972: Institutional Assessment, Attitudes Survey, Questions 35(a-c). Permit totals do not equal 100 percent as neutral (don't know or no opinion) responses disregarded. "There is uniformity in the application of requirements for permits on a nation-wide, region-wide or state-wide basis."

Differences between effluent limitations for an industrial category or subcategory and a permit issued to a discharger within that group may be caused by any of the following circumstances: 1) the permit was issued before the current limitation; 2) the production process does not exactly fit any outstanding limitation; 3) state water quality standards require different conditions; 4) in its certification, the state requested additional conditions or parameters; 5) an additional parameter is required on a case-by-case basis; 6) the effluent limitation allows variances; and 7) the applicant requests that permit conditions conform to the provisions of Section 306(d) so that he may be assured of a longer term (up to 10 year) permit. The inability to easily compare permits with promulgated effluent limitations poses a major problem. Without such a comparison, an accurate analysis of the degree of reduction in pollutant loads -- by pollutant discharges, by volume, by river stretch and by population concentration -- is not possible. The measurement of progress is important in setting, or altering, program priorities and in coordinating program responses to the Act's requirements.

Permits -- Limited Utility As Management Tools

The NPDES is complex and requires constant and knowledgeable attention to a number of interrelated activities. The Act contemplates that discharges, into either effluent limited or water-quality limited river stretches, by industry, agriculture and municipalities will be regulated within the bounds of a nationally coordinated management-regulation scheme. To accomplish that goal, EPA and NPDES states must develop and use management information systems capable of comparing (on a state-by-state, and EPA region-by-region basis) permitted discharge limitations with intended statutory discharge requirements and, where appropriate, with the quality of the water into which they discharge. Just as important, EPA and NPDES states must be able to track progress toward meeting compliance schedule conditions.

EPA had begun, by 1974, to develop the basis for an effective management information system with its General Point Source File (GPSF). The GPSF system was described by EPA in the following manner:

> "With the GPSF, all data elements are standardized by title, by unit, and by description of data element or of the analyses involved to produce the data element. In the past, we were unable to keep multi-time records. For instance, in examining the efficiency of a municipal treatment plant, which is commonly indicated by percentage BOD removal, our old files allowed only a single value to be recorded. The GPSF allows a value to be recorded each time a plant is inspected, thereby producing a historical trend. Our separate files contained redundant data; since the files have been combined there is a minimum of redundancy. In the old files there was no formal responsibility for quality control or for keeping data current; in the GPSF every data element has an assigned responsibility. Previously, there was very little input editing; in the GPSF no data are admitted without a formal input edit. In addition, EPA has established a quality control group to check on the quality and currency of data. Because of the control and flexibility of the GPSF there is more incentive for users to contribute and to update data." (Emphasis added) (22)

The GPSF was not fully implemented, and its formal development was discontinued in December 1974. Pending the development of a comparable system, the utility of municipal and industrial permits as effective tools for managing and tracking the progress of the NPDES is limited. An effective national water pollution control program probably should produce (and EPA and NPDES states should analyze and use) meaningful information about the relationship of discharge limitations to the progress of abatement programs.

In the absence of a functioning information management system, some regions and NPDES states have developed, or are developing, their own systems. Many of these are relatively unsophisticated and employ "tickler" processes which "kick out" dates of monthly discharger reports. Manual checks are performed to determine whether reports are submitted. EPA does provide, through National Field Investigations Centers, technical experts who consult with the regions on particular types of permits. EPA also has established regional desks at headquarters to advise the regions on the use and applicability of effluent limitations. Quality control procedures, however, are at best informal in most states and regions(23).

Compliance Monitoring -- A Late Start

Compliance monitoring is the mechanism intended to alert EPA and NPDES states to permit violations, thus triggering corrective or enforcement action. It produces valuable information on progress toward the Act's goals -- information about where, how and at what pace the NPDES is operating. Performance data also are essential for the construction grants and planning processes. Such data should be useful in any periodic review and revision of effluent limitations as required every five years under Section 301(d) of the Act.

The Act structured compliance monitoring on a self-reporting basis with permittees having affirmative responsibilities to measure and report discharges. This, of course, depends on the reliability of the discharger to honestly and accurately report and suggests the necessity for periodic on-site compliance checks by the regulator. As an operating goal, EPA intends physically to inspect, or audit, each major permittee once a year. EPA will inspect minor discharge at least once during the 5-year life of their permits(24).

EPA developed, in March of 1972, a guidance document entitled "Water Compliance Monitoring" which purportedly represented the consensus of the EPA Offices of Enforcement and General Counsel, Air and Water Programs and Research and Development(25). According to the document, the keystone of an effective compliance monitoring program is the General Point Source File which has been terminated. Pending the development of a comparable system, substantive review of compliance schedule and discharge elimination reports on a permit-by-permit basis may not produce the kind of information needed to measure, nationwide, region-wide or state-wide, the progress of pollution abatement efforts.

Enforcement -- No Discernible Pattern

Most permits have been in effect for less than one and one-half years, and any judgment of the effectiveness of the enforcement process

is at best tentative. Prior to 1972, state enforcement of water pollution control laws was characterized more by negotiation and compromise than by resort to formal legal remedies(26). State agencies most often operated a regulatory system which required a balance among economic, environmental and public health interests. To obtain needed cooperation, state agencies often were reluctant to take strict and severe enforcement action. To do so might have created problems between the agencies and governors or legislators concerned about a particular industry's well being, or about the general well being of the state's economy. As a result, state agencies often preferred to obtain compliance through negotiations with dischargers rather than initiate formal action.

The enforcement provisions of P.L. 92-500 are mandatory -- not discretionary. They required the EPA, or NPDES state agencies, take specific enforcement actions which include administrative orders, injunctions and the recovery of civil and criminal penalties. EPA allows both NPDES states, and states that have not obtained NPDES status, the first opportunity to initiate enforcement actions(27). If a state does not act, EPA then exercises enforcement authority.

It is still too early to determine positively whether the provisions of the Act will cause a major shift from discretionary to mandatory enforcement. EPA only recently (July 1, 1975) began to shift manpower from permit issuance to compliance monitoring and enforcement. Many NPDES states are not expected to make such a transition until early in FY 1977(28). Most permits have been in effect little more than one year, and key compliance schedule deadlines have not yet been reached. If the experience with permit writing is any indication, both EPA and the states will rely first upon negotiation with the discharger before turning to legal proceedings. Federal and state government and industry officials who responded to the Commission's Attitudes Survey in eight states agree that a process of "bargaining, negotiation and compromise" is a significant feature of the relationship between the regulators and the regulated. While the question did not apply exclusively to enforcement, and might also apply to those elements of the permit process subject to negotiation (compliance schedules and reporting requirements), the responses are revealing.

TABLE V-9

How strongly would you agree or disagree with the statement that control of water pollution is largely a process of bargaining, negotiation and compromise between the regulated and regulator for enforcement of the law?

Respondents	Agree	Neutral	Disagree
State Water Pollution Control Agency	69%	7%	24%
Industry	73%	6%	21%
E.P.A.	62%	2%	38%

Source: The Water Pollution Control Act of 1972: Institutional Assessment, Attitudes Survey, Question 45.

The Commission's "Attitudes Survey," as well as the economic studies, indicate substantial uncertainty that industry will meet the July 1, 1977 requirement of best practicable control technology currently available by that date.

TABLE V-10

Congress has set 1977 requirements for water pollution control in the nation. In your opinion, how good is the chance that industry in your state will be able to meet the 1977 requirement of best practicable control technology by 1977?

Respondents	Good	About Even	Poor
State Water Pollution Control Agency	52%	19%	29%
Industry	41%	27%	32%
Consulting Engineers	24%	18%	58%
Municipalities	30%	19%	51%
E.P.A.	57%	13%	30%

Source: The Water Pollution Control Act of 1972: Institutional Assessment, Attitudes Survey, Question 26.

As indicated in the above Table (V-10), although a majority of EPA and state agency officials considered the chance of compliance "good", only 41 percent of the industrial respondents thought so -- and almost as many (32 percent) industry participants thought the chance "poor". The Commission's economic studies support the possibility that not all industry will achieve across-the-board compliance with '77 BPT requirements since industry does not appear to be investing capital in pollution control facilities at a rate that will meet the estimated cost of required treatment.

Given these uncertainties and the present status of compliance monitoring activities, as well as the inclinations by NPDES states (and to a lesser extent, EPA) to continue to use negotiation-compromise techniques, aggressive and reasonably uniform state-by-state enforcement will probably emerge very slowly.

Enforcement of municipal permits issued to those publicly owned treatment works which will not achieve required levels of treatment by July 1, 1977, raises critical questions about the application of nationally uniform treatment requirements to municipal dischargers. To date, these questions have been avoided by issuing permits containing conditions that can be met with treatment levels no more stringent than can be accomplished by facilities completed on July 1, 1977 with available construction grant assistance. The issue will be joined again, however, as the 1977 deadline approaches with the prospects that a sizable percentage -- as much as 50 percent -- of these plants will still not have achieved secondary treatment. As a result, the entire strategy for permitting, compliance and enforcement with the '77 requirements needs major adjustment or revision.

Administrative Variations

Notwithstanding national discharge requirements, some range of state-by-state variance is implicit in the administration of the regulatory scheme. Nearly every element of the system requires the application of varying degrees of professional judgment and administrative discretion. Permit issuance and permit modification are not routine, repetitive mechanical exercises. Achievement of compliance schedules will be influenced in some instances by discharger inertia, funding capability, material availability, construction delays, labor negotiations and even recalcitrance. One hundred twenty thousand compliance monitoring reports will receive differing levels of review. The outcome of enforcement actions will be determined by the same kind of negotiation and settlement decisions which characterize all legal proceedings.

The important issue here is not the element of variation in NPDES administration, but how wide and how detectable it will be. Without a management system designed to produce meaningful, comparable information (by states, by EPA regions, by industrial categories and subcategories, and by river stretches), neither EPA nor any state or other regional or local institution will be able to determine the adequacy of NPDES performance -- much less whether or not the range is acceptable. EPA has reported a study which showed that "the industrial portion of the permit program resulted in an estimated reduction of approximately 12 million pounds per day of BOD and 28 million pounds per day of suspended solids."(29)

Through all the controversy as to the validity of the effluent limitations, disagreements as to appropriate site specific permit conditions for each discharger and contention about the necessary monitoring times and parameters, the ultimate goal of improved receiving water quality can all too easily be obscured. In the final analysis, it is the quality of the water that matters.

Construction Grants for Publicly Owned Treatment Works

> It is the purpose of this Title to require and to assist the development and implementation of waste treatment management plans and practices which will achieve the goals of the Act.
>
> The Administrator is authorized to make grants to any state, municipality, or intermunicipal or interstate agency for the construction of publicly owned treatment works.
>
> Sec. 201
> Public Law 92-500

The Congress first adopted a construction aid program in 1948, with the passage of Public Law 80-845.* The Act provided for municipal waste treatment construction assistance loans, with annual authorizations of $22 million. Loans were available to a community for one-third the estimated cost of the construction works, but could not exceed $250,000. The loan program was extended in 1952 for an additional four years, at the same annual authorized level of authorization(30).

In 1956, the Congress moved from a loan program to a grant-in-aid program with an annual authorization of $50 million. In the period from 1956 to the enactment of P.L.92-500 in October of 1972, Congress authorized a total $9,670,000,000 for construction grant assistance.** With the passage of P.L.92-500, Congress provided a three-year authorization almost twice as large as all previous grant assistance, committing a total of $18 billion for waste treatment construction grants for Federal fiscal years 1973, 1974 and 1975.

The Federal Water Pollution Control Act of 1972 was a major departure from previous Federal program in other ways, too. The Act states that the grant program is intended to assist the achievement of the ". . . goals of this Act," thus specifically linking, for the first time, construction assistance with stated water pollution control goals.

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* Some Federal sewerage construction assistance was provided during the 1930s by the Works Progress Administration.

** Total includes P.L.92-500 authorizations of $2.75 billion to reimburse municipalities and states which had pre-financed P.L.84-660 projects (initiated construction in anticipation of an 84-660 grant), and total includes P.L.93-207 authorizations of additional reimbursement funds of $600 million. Thus, pre-1972 authorizations of $6.32 billion and P.L.92-500 and P.L.93-207 reimbursement authorizations total $9.7 billion.

Off Schedule

EPA's 1971 Survey of the estimated costs of planned wastewater treatment works led to a five-year $18 billion national construction grant authorization over a three-year period -- $5 billion for 1973, $6 billion for 1974 and $7 billion for 1975. Though the Congress recognized that the amount was probably inadequate to support full compliance with the 1977 requirement, the $18 billion authorization was adequate to produce construction worth $24 billion on a three to one matching basis.

The pace of grant obligations and outlays has proceeded at a rate which suggests that the full $18 billion may not be obligated by July 1, 1977, and that a large number of municipalities which might have met the July 1, 1977 secondary treatment requirement by July 1, 1977, will not , even though funds may be obligated by that date. As of June 30, 1975, only $1,034,389,957 had been actually expended and, based on EPA estimates, $2.3

TABLE V-11

Public Law 92-500 -- Construction Grant Program
(Federal share in billions)

Fiscal Year	1971 EPA Needs Survey	P.L. 92-500 Authorization	P.L. 92-500 Allotments	P.L. 92-500 Obligations	P.L. 92-500 Outlays
1972	$ 5.3	$ - 0 -	$ - 0 -	$ - 0 -	$ - 0 -
1973	6.2	5.0	2.0	1.6	- 0 -
1974	3.2	6.0	3.0	1.4	0.1
1975	(3.5)	7.0	4.0	3.6	0.9
1976		- 0 -	9.0[1]	6.4[2]	1.5[2]
1977	- 0 -	- 0 -	- 0 -	5.0[3]	n/a[4]
TOTAL	$18.2	$18.0	$18.0	$18.0	$ 2.5

1 Reflects amount originally withheld from allotment to states.
2 EPA Estimates, fiscal year includes three extra months.
3 No EPA Estimate available. Amount represents maximum available for 1977 obligation if 1976 estimate is achieved.
4 No EPA Estimate available.

Source: June, 1975 draft copy of EPA's Clean Water Report To Congress 1975, Table VI-1 adjusted with detailed information provided to the Commission staff by the EPA Office of Grants Management circa July 23, 1975.

billion will have been expended by the end of the 1976 fiscal year (September 30, 1976). The Administrator of EPA indicated, on July 14, 1975, that ". . . the estimate of (the) late 1980s for full compliance (of secondary treatment requirements) may be optimistic because compliance will be determined by the rate at which money is made available," and that only 40 to 50 percent of municipal waste treatment plants will meet secondary treatment requirements by July 1, 1977(31).*

New Requirements

P.L.92-500 imposes several planning, management and operating requirements which were not a part of the construction grant process prior to October 18, 1972. As a matter of reality, some laws do not lend themselves to obvious, straightforward implementation. On October 11, 1972, the then EPA Administrator indicated P.L.92-500 might be one such law. In recommending Presidential approval of P.L.92-500 to the Office of Management and Budget, Administrator Ruckleshaus stated:

> "The numerous conditions, limitations, and requirements with respect to treatment facility construction grants, which must be articulated in administrative regulations pursuant to the enrolled bill provides a broad range of controls. Through these administrative mechanisms, storm and combined sewer projects could largely be deferred, collection system projects could be minimized, and the phasing of commitments and funding outlays for all projects could be regulated through the rigorous application of stringent requirements." (Emphasis added)(32)

Section 203(a) requires that the "...Administrator shall (approve grants based) upon plans, specifications, and estimates" (emphasis added). After a review of the legislative history of the Act and of advice from the General Accounting Office, EPA established a grant process predicated on three distinct steps -- Step 1 facility plans, Step 2 designs and specifications and Step 3 construction. In outlining the advantages of this procedure, the Senate sponsor of P.L. 92-500 described the process as requiring "plans, specifications, and estimates (PS&E) for each stage (or project) of the construction of the waste treatment facility...For instance, the applicant may file a PS&E for a project to determine the feasibility of a treatment works, another PS&E for a project for engineering, architectural, legal, fiscal, or economic investigations, and another PS&E for actual building. This way the states and communities are assured an orderly flow of Federal payments. This should, in turn, result in substantial savings and efficiency." Subsequent to promulgation of the three-step grant process, EPA attempted to combine Steps 2 and 3 to accelerate the process, but the attempt was nullified by an adverse GAO opinion(34).

*Many such plants will, of course, have been constructed with assistance by P.L.84-660 grants.

Section 201(g)(3) of the Act requires that the approval of grants after July 1, 1973 for the construction of publicly owned treatment works be conditioned on a finding by the ". . . Administrator that each sewer collection system discharging into such treatment works is not subject to excessive infiltration" (emphasis added). By administrative interpretation reflecting the legislative history of this concept, EPA expanded the infiltration requirement to require an analysis of sewer inflow after determining that potential problems of inflow and infiltration should be considered in one analysis.

Section 204(b)(1) requires that all grant applicants ". . . adopt or will adopt a system of charges to assure that each recipient of waste treatment services within the applicant's jurisdiction, as determined by the Administrator, will pay its proportionate share of the costs of operation and maintenance (including replacement) of any waste treatment services provided by the applicant" (emphasis added). Similarly, grant approval is conditioned upon the applicant making "provision for the payment to such applicant by the industrial users of the treatment works, of that portion of the cost of construction of such treatment works (as determined by the Administrator) which is allocable to the treatment of such industrial wastes to the extent attributable to the Federal share of the cost of construction. . ." (Sec.204(b)(1)(B).)

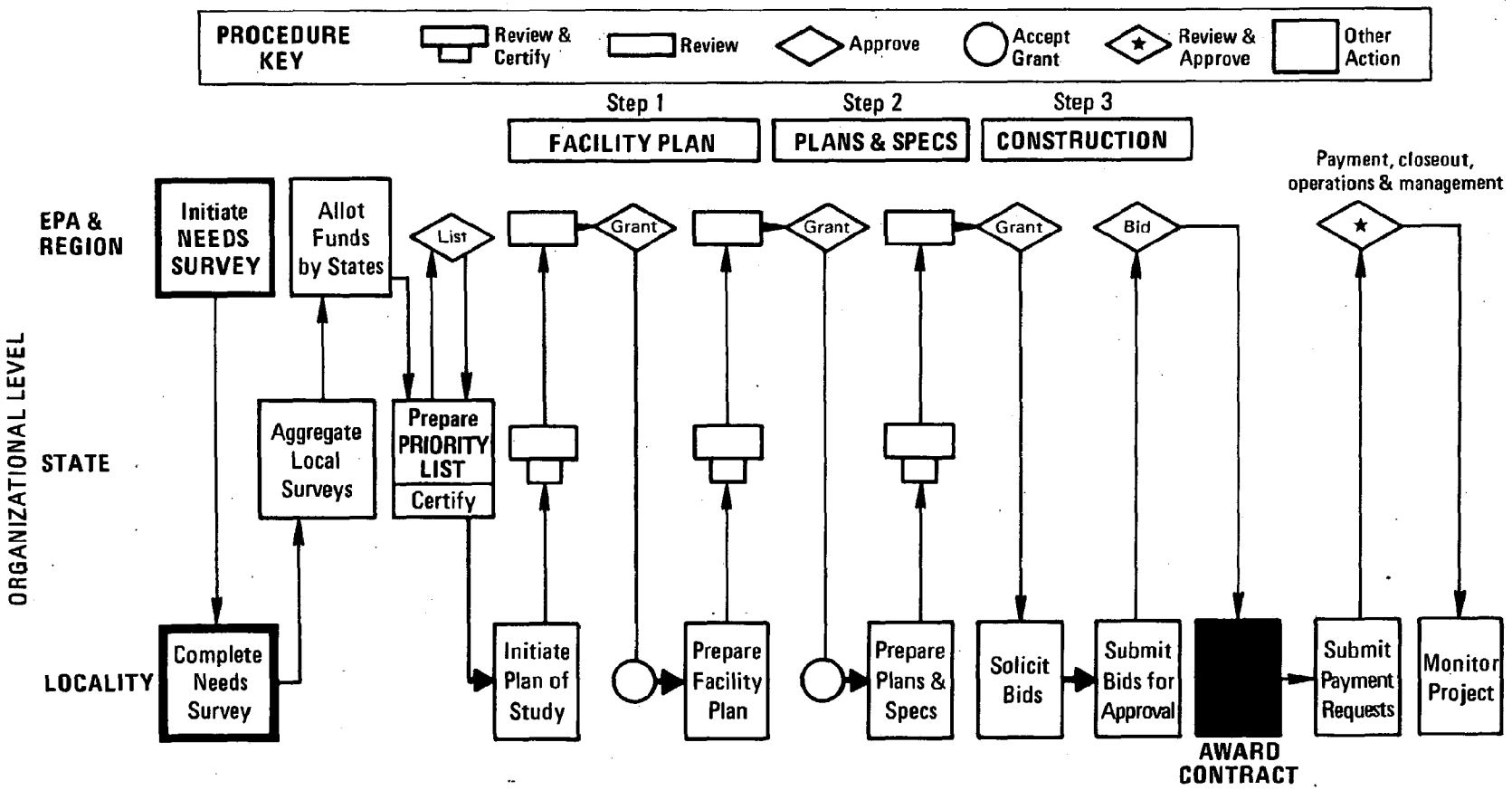
The Grant Process: How It Works

Regulations and administrative practice have elaborated these statutory provisions into 27 discrete decision points in the grant process (Figure V-2), which begin with a local determination to initiate a waste control or treatment project, move through the three-step grant process, and culminate in facility operation pursuant to the National Pollutant Discharge Elimination System(35). In moving through the process, applicants must comply with the requirements contained in some 30 separate EPA regulations interpreting the provisions of P.L.92-500 and coordinating the implementation of P.L.92-500 with requirements contained in an additional 27 Federal statutes or Executive Orders.

When a locality decides to initiate a wastewater control or treatment project (as a result of being placed on the state priority list or agreeing to an effluent limitation compliance schedule or other reason), it must prepare a plan of study consisting of four parts: 1) A definition of the proposed planning area; 2) An identification of the entity or entities conducting the planning; 3) A description of the nature and scope of the proposed Step 1 project, including a schedule for the completion of specific tasks; and 4) An itemized description of the estimated costs for the project. The Step 1 grant application is forwarded to the state, where it is reviewed and certified (if the application passes the review). The Step 1 application is then forwarded to the EPA region, where it is reviewed, approved (if

FIGURE V-2

REVIEW/APPROVAL CYCLE FOR CONSTRUCTION GRANTS



Source: Natl. Commission on Water Quality, from Touche, Ross & Co. contractor report "Institutional Assessment of the Implementation of the Construction Grants Program Under PL92-500", July 31, 1975, p.II-8.

March 1976

it passes the review), and a Step 1 grant is awarded to the locality. The locality now accepts the Step 1 grant and prepares the facility plan which must be compatible with basin plans prepared by the state pursuant to Section 303(e) of the Act, and must include 1) a description of the contemplated waste treatment system; 2) an analysis of infiltration and inflow problems; 3) a cost-effectiveness analysis; 4) an environmental impact assessment; 5) effluent discharge limitations; 6) certification of financial resources; 7) the relationship of Section 208 areawide waste treatment plans (when such plans exist) to the planned treatment works; and 8) an application for a Step 2 grant.

In the preparation of the Step 1 facility plan, the infiltration/inflow analysis, cost effectiveness study and the environmental assessment generally require the most time. The facility plan must also conform to Section 303(e) basin plans prepared by each state, under a continuing planning process approved by the EPA Administrator, and approved Section 208 areawide waste treatment management plans where they exist. Reformulation of projects to comply with these evolving areawide plans provide another possibility for delay.

The Step 2 grant application, including a facility plan, is forwarded to the state agency, where it is reviewed and certified (if it passes the review). At the same time, a copy of the application is circulated under established procedures to secure appropriate review by interested Federal, state and local agencies under Office of Management and Budget Circular A-95. The certified application then is forwarded to the EPA region where it is reviewed, approved (if it passes the review) and a Step 2 grant is awarded. The locality accepts the Step 2 grant and prepares the construction drawings and specifications, suitable for bidding. This step includes preparation of a Step 3 application and also must contain an assurance that adequate provision has been made for effective operation and maintenance of the treatment works. From the viewpoint of the municipalities, the requirements for Step 2 do not present any major difficulties, primarily because plans and specifications are part of the normal preparation work done for any capital building program.

The Step 3 grant application, which includes the engineering plans and specifications, is forwarded to the state agency, where it is reviewed and certified (if it passes the review). The certified Step 3 grant application is then forwarded to the EPA region where it is reviewed, approved (if it passes the review), and a Step 3 grant is awarded to the locality. Award of the Step 3 grant enables the locality to solicit bids for construction of the treatment plant. When bids are received, they are forwarded to the state and the EPA region for review. When the low bid has been approved by EPA, the locality awards the contract to the low bidder. "A typical and reasonable time lag between these (Step 3) obligations and the start of construction activity

(when the construction contractor moves on site) is about six months. Advertising for construction bids, letting contracts, and actually moving on site consume this time."(36) The step-by-step process and its relationship to other functions prescribed in P.L. 92-500 is shown in Figure V-3.

As the treatment facility is constructed, the locality disburses funds to the contractor building the plant and then submits payment requests to the state and EPA for reimbursement of the Federal share of eligible costs. When the payment request is approved by EPA, a payment check is sent to the locality. EPA and the state review requests for changes to the approved specifications, and EPA and the state also conduct interim construction inspections. Before the Administrator will authorize repayment of more than 50 percent of the grant amount, the applicant must show "adequate evidence of timely development of its system(s) of user charges and industrial cost recovery;" 20 percent of the project funds are retained by EPA until these systems are approved. In addition, EPA and the state also must approve an operations and maintenance manual prior to disbursement of all of the construction grants. Prior to the final payment of 10 percent of the construction grant, EPA and the state conduct a final close-out audit. Possible misapplication of funds has recently appeared to be a major concern of EPA; a recent report indicates that, even though "only a few cases involving fraud have come to light,...the potential for future irregularities is enormous, and cannot be ignored."(37)

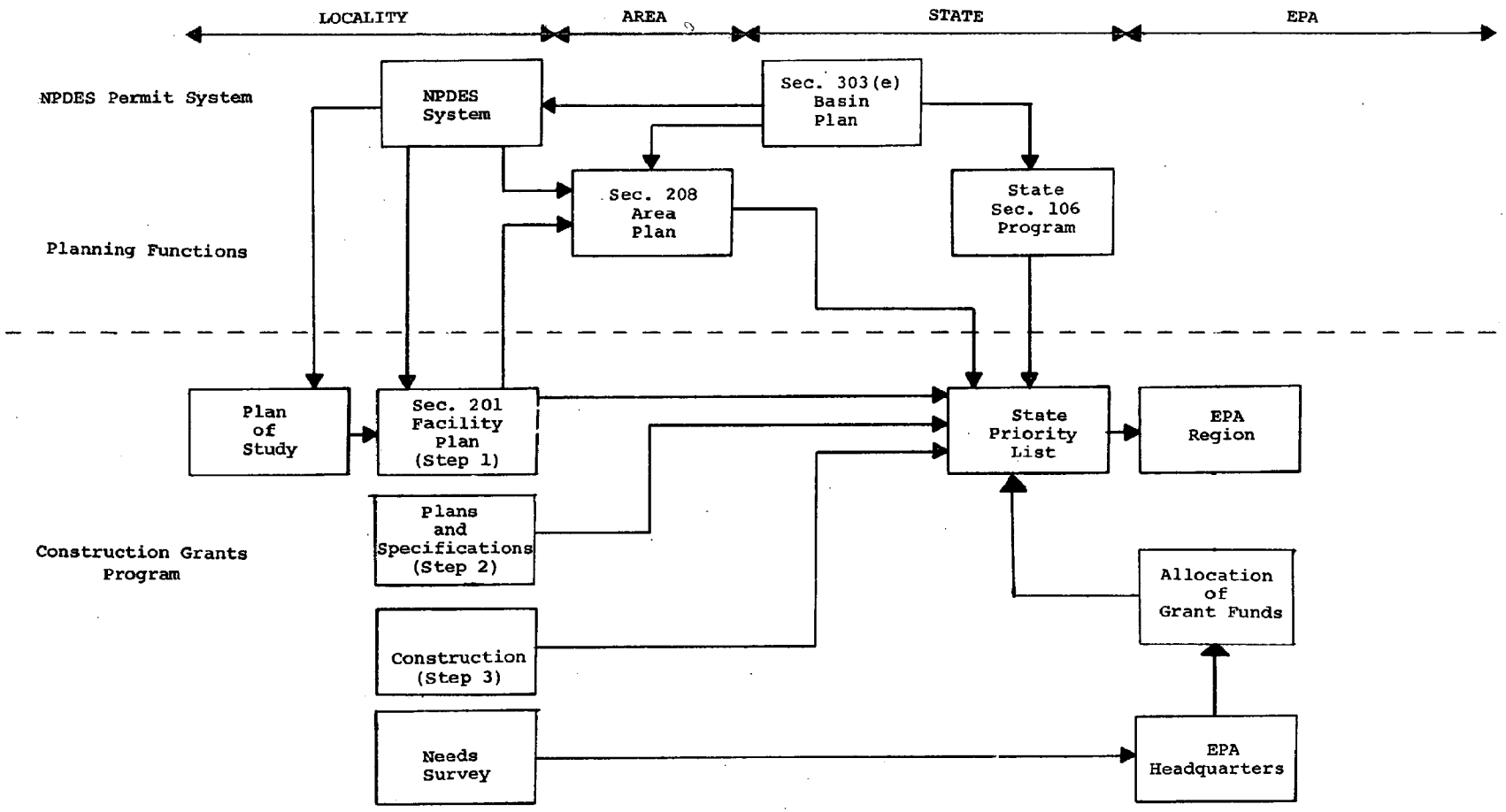
Considerably more complex requirements, a heavy administrative load for EPA, the states and applicants and very short deadlines made criticism of the Act and of its implementation almost inevitable. That criticism was sharpened by the then Administrator's indication that stringent requirements would be rigorously applied in the implementation of the Act(38). and by the 1972 and 1973 Presidential decision to withhold allotment of one-half the $18 billion authorization.

Causes of Delay

In a critique of the first two years of its own performance in the construction grants program, EPA concluded, "The shortcomings in EPA's current method of managing the construction grants program revolve around two points -- inadequate manpower in the regions and inadequate guidance from EPA headquarters."(39) The Review Group "concluded that EPA has not managed the construction grant program as a nationally consistent system" but rather has "10 separate programs managed by EPA's 10 regional offices."(40)

FIGURE V-3

OVERVIEW - PL 92-500 WATER POLLUTION CONTROL PROGRAM



Source: The Water Pollution Control Act of 1972: Institutional Assessment, Construction Grants, Exhibit II-1, p. II-3.

New statutory requirements were identified as lengthening the process. The Review Group concluded that ". . . considerably more time is required for facilities planning (Step 1) than has traditionally been consumed in preliminary engineering. The most time-consuming elements of the facility planning process are environmental assessments, infiltration/inflow analyses, public participation, and the cost-effectiveness analysis of major alternatives"(41). Regionalization was later identified as a "major factor . . . inhibiting application development"(42).

Environmental impact assessments have been singled out as one of the major causes of delay in grant development and approval. However, as EPA's review of its municipal assistance program pointed out, it is not necessarily true that the application of the requirements of the National Environmental Policy Act results in program delay(43). Only an estimated 10 percent of projects were expected to be subject to the NEPA procedure and, in actual practice, far less (about 4 percent) have required impact statements(48). In these cases, the added time was from four to 14 months, 60 days of which is mandatory waiting time(49).

Time to comply with the requirements of NEPA, infiltration/inflow and the cost effectiveness analysis were said to have added "from 2 to 12 months to project development"(46). The more detailed requirements also lengthened review time by state and EPA offices "an average of 12 man-days per Step 1 project" to "review plans of study and facilities plans"(47); "three to four months" is necessary for states and EPA to review and approve projects, except where an EIS is required(48). Citing "a perception widely held by consultants and states that the EPA review accomplishes little change" and that "treatment facilities are almost never changed and interceptors very seldom," EPA says they "were able to document instances where funding was refused or serious errors in the project were corrected"(49). Of course, if applicants or their consultants do not comply adequately with program requirements, weeks and even months can be added to project processing.

Taking the various times reported by EPA in 1974 as necessary for projects to move through all three steps suggests a two and one-half to an eight and one-half year progression.

Step 1	6-24 months
Step 2	6-12 months
State and EPA Review and Approval	6 months
Step 3	1 to 5 years
TOTAL	2-1/2 to 8-1/2 years

In a different analysis, the time range was shown as four and one-half to eight years, with the typical time being six years. (Figure V-4.)

Staff to a Congressional Committee concluded that "The three-step construction process mandated in the law ordinarily takes four or five years" (50). A later EPA examination indicated, perhaps optimistically, that "it takes about one year to complete the facility plan for an 'average' project and almost another year to prepare biddable plans and specifications;" ". . . the 'average' sized project will take about two years to plan and design. Very large regionalized projects can take up to 12-15 years, not counting actual construction time"(51).

Rules, Regulations and Guidance. Smooth functioning of the complex Federal-state-regional-local interagency machinery required to achieve the construction of publicly owned treatment works under P.L.92-500 requires understanding of the law and its interpretation by all levels of government, as well as those persons from the private sector who assist in achieving the program. How this understanding is being attempted has been characterized as utilizing several informational devices(52):

Law -- Define goals, general requirements, procedures and administrative responsibilities; authorize expenditures.

Regulations -- Interpret goals; specify requirements, procedures and responsibilities.

Guidance Memoranda -- Precede regulations in defining policy or clarifying specific operations.

Technical Bulletins -- Define procedures and practices for engineering or technical subjects.

Regional Guidance -- Clarify particular problems occurring in the regions.

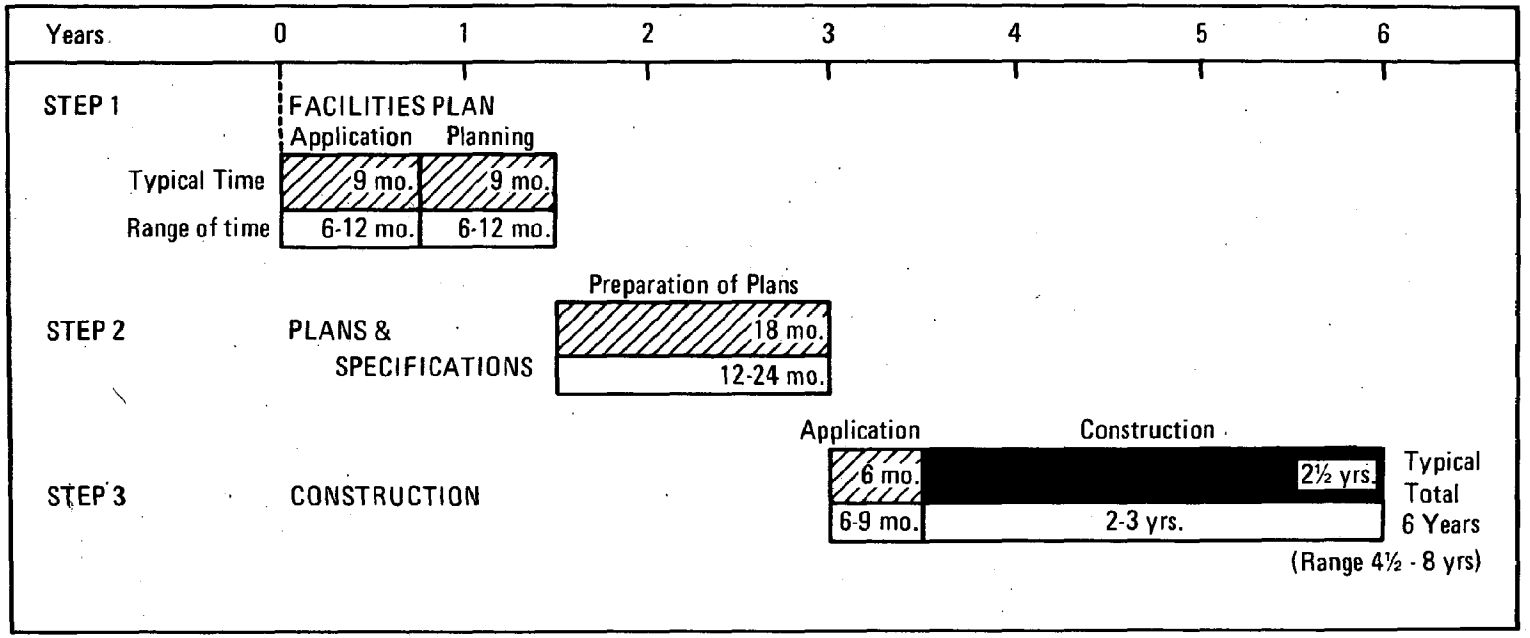
Strategy Paper -- Give long-range statement of EPA's policy in implementing P.L.92-500.

The construction grants program cannot operate independently of other provisions of the statute and, therefore, its governing regulations must be consistent with those issued pursuant to other requirements.

Perhaps the major initial delay in launching a new level of construction grants under P.L.92-500 was "virtual inactivity for 15 of the first 19 months" because of "the absence of final Title II regulations"(53). For the first three months, obligations were prohibited; during the next 15 months, prospective grantees apparently delayed formulating project

FIGURE V-4

TYPICAL TIME REQUIREMENTS
CONSTRUCTION GRANTS PROGRAM — PUBLICLY-OWNED TREATMENT WORKS



Source: Natl. Commission on Water Quality from "Fulfilling a Promise. An Analysis of the 1972 Clean Water Act's Construction Grants Program", Energy & Environmental Analysis, for the Natl. Utility Contractors Assn., 1975, Table 9, p. 67.

November 1975

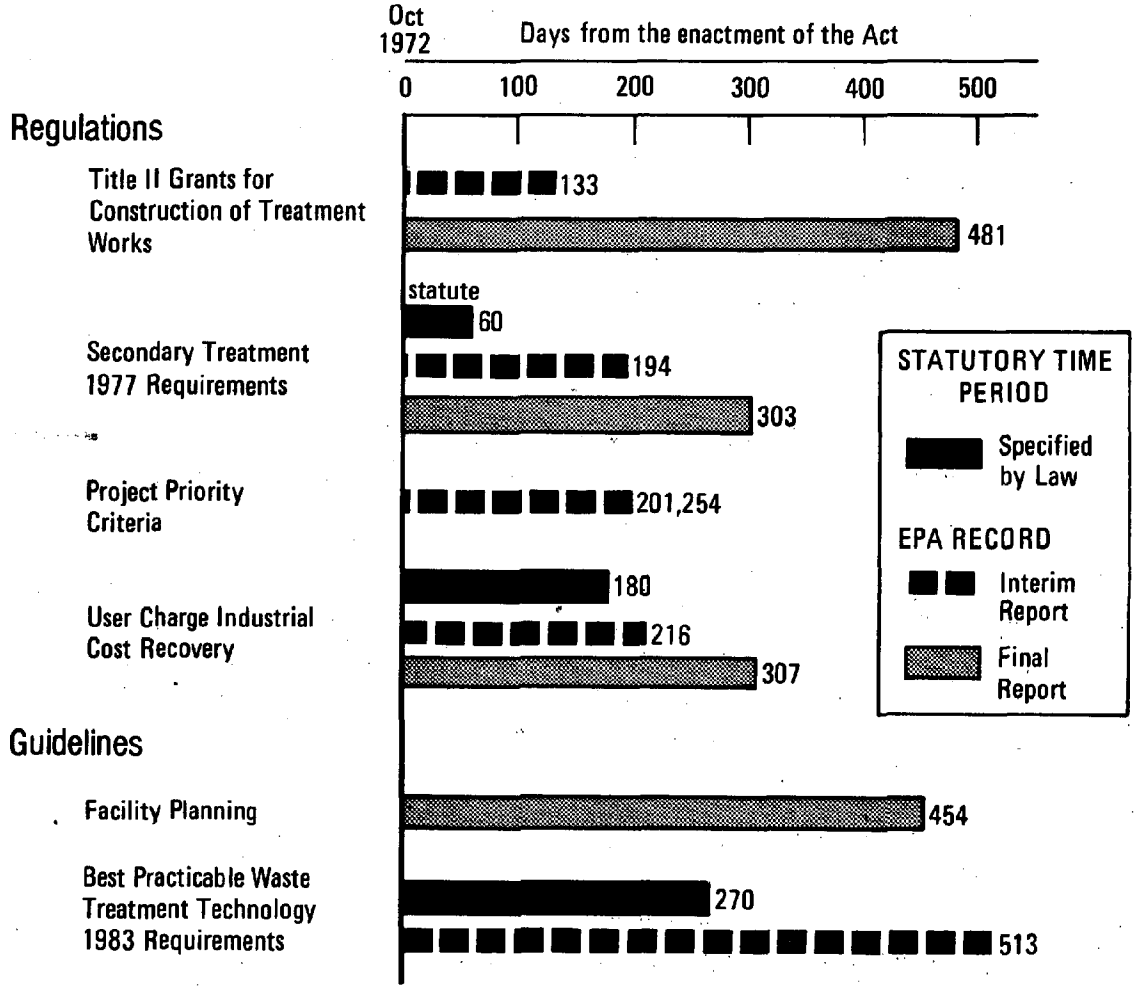
applications according to the new requirements until the final rules were known, while being assured the regulations were imminent. Some projects, proceeding under the requirements of P.L.84-660 (the prior statute), had to be redeveloped to comply with the new Act, and there was delay in preparing and approving priority criteria and annual state priority lists. The EPA Deputy Administrator has reportedly "admitted that the Agency made a great mistake in not honoring the 'in the pipeline' projects under the old ground rules;" to have let them proceed to completion under the prior law, however, might have precipitated a challenge in court(54). As late as 1975, EPA was stating that "some percentage (of projects) for which funding is now being sought was conceived and planned before various requirements of P.L.92-500 were applicable. In Region II, for example, upwards of 75 percent of the applications expected through September of 1977 will involve such projects"(55). The lapsed time before key regulations were issued is portrayed in Figure V-5. EPA has said, "issuance of regulations and guidance has been consistently tardy, thereby creating confusion and delay"(56).

Late issuance of regulations was not the only cause for delay. Sometimes, multiple revisions of regulations have occurred. Changes in program requirements have sometimes occurred so many times that EPA regional personnel are reluctant to ask applicants for new or additional information(62).

The sheer volume of the regulations probably also has caused delay. P.L. 92-500 states that "it is the national policy that to the maximum extent possible the procedures utilized for implementing this Act shall encourage the drastic minimization of paperwork. . .so as to prevent needless duplication and unnecessary delays at all levels." [Sec. 101(f)]. All the regulations governing construction grants have been estimated to make a stack several inches high and require two weeks to read(58). Twelve regulations or guidance documents specify just the basic requirements(59). Of 14 items sent to applicants for Step 1 grants in one EPA region, only five are regulations; the other nine items are applications and forms to be completed by the applicant. As the applicant progresses through the step process, other forms and applications are required(60). Because of the manner and chronology of formulating the regulations, they are not always organized so as to outline clearly the sequential process for securing approval of an application. EPA has said, "it is our judgment that the regulations as they exist cover little more than the basic legal requirements. To the extent that our regulations cause problems, the problems can really be attributed to two other factors: 1) a diminishing but persistent opposition to the legislation; and 2) the uncertainty and delay which have accompanied the preparation of regulations and procedures to implement the law."(61) EPA's current preparation of a construction grants manual should overcome many of the problems and much of the confusion that has probably delayed the preparation and processing of applications to date.

FIGURE V-5

LAPSE TIME FOR ISSUANCE OF REGULATIONS & GUIDELINES BY EPA* PUBLICLY-OWNED TREATMENT WORKS — CONSTRUCTION GRANTS PROGRAM



* Environmental Protection Agency

Source: Natl. Commission on Water Quality adapted from Touche Ross & Co. contractor report "Institutional Assessment of the Implementation of the Construction Grants Program under Public Law 92-500", July 31, 1975, p.111-F-3, constructed from Table VIII-1, p. 13, "Review of the Municipal Waste Water Treatment Program", EPA, November 30, 1974

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Requirements of Other Statutes. Besides P.L. 92-500 and EPA regulations and guidance documents prepared pursuant to that Act, applications must also conform to other requirements and their related regulations such as:

1. The Civil Rights Act of 1964 (particularly Title VI and excluding enforcement and compliance) (42 U.S.C. 2000e et seq.) and Executive Orders issued thereunder;

2. The Clean Air Act (42 U.S.C. 1857b-1 et seq.);

3. The Coastal Zone Management Act of 1972 (16 U.S.C. 1451 et seq.);

4. The Davis-Bacon Act (excluding enforcement and compliance) (40 U.S.C. 276a);

5. The Demonstration Cities and Metropolitan Development Act and Intergovernmental Cooperation Act of 1966 (42 U.S.C. 3311, 3374);

6. The Flood Disaster Protection Act of 1973 (12 U.S.C. 24.1709-1, 42 U.S.C. 4201 et seq.);

7. The Intergovernmental Cooperation Act of 1968 (40 U.S.C. 531 et seq., 42 U.S.C. 4201 et seq.);

8. The Marine Protection Research and Sanctuaries Act of 1972 (16 U.S.C. 1431 et seq., 33 U.S.C. 1401 et seq.);

9. The Safe Drinking Water Act of 1974 (42 U.S.C. 300f et seq.);

10. The Solid Waste Disposal Act (42 U.S.C. 3259);

11. The Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970 (42 U.S.C. 1415, 2473, 3307, 4601 et seq., 49 U.S.C. 1606);

12. The Wild and Scenic Rivers Act of 1968 (16 U.S.C. 1274 et seq.);

13. The Contract Work Hours and Safety Standards Act (40 U.S.C. 327 et seq.);

14. The Copeland (Anti-Kickback Act) (40 U.S.C. 276b, c, 41 U.S.C. 51 et seq.);

15. The Fish and Wildlife Coordination Act of 1958 (16 U.S.C. 661 et seq.);

16. The Noise Control Act of 1972 (42 U.S.C. 4901 et seq., 49 U.S.C. 1431);

17. The Water Resources Planning Act of 1965 (42 U.S.C. 1962d), all as amended;

18. The Rivers and Harbors Act of 1899 (33 U.S.C. 401 et seq.)(particularly 403 requiring Corps of Engineers permit for dredge and fill activity);

19. The Historic Preservation Act of 1966 (16 U.S.C. 460 et seq.) and Executive Order 11593;

20. The Archaeological and Historic Preservation Act of 1974 (16 U.S.C. 469a-1 et seq.);

21. The Endangered Species Act of 1973 (16 U.S.C. 1531 et seq.);

22. Federal Insecticide, Fungicide, and Rodenticide Act as amended (7 U.S.C. 136 et seq.);

23. The Federal Water Pollution Control Act, as amended (33 U.S.C. 1251 et seq.);

24. The Hatch Act (5 U.S.C. 1501 et seq.);

25. Executive Order 11246, with regard to equal employment opportunities;

26. Executive Order 11296, regarding evaluation of flood hazards;

27. Executive Order 11738, prohibiting utilization of facilities on EPA List of Violating Facilities.

Meeting these requirements can add more time to the grant process. For example, "where it is necessary to have a special area rate determination from the Department of Labor,. . .the opening of bids by a municipality. . .(can) be delayed up to three months."(62) These rate determinations "prior to opening of bids are effective for only 120 days and occasionally expire before a grant can be made. The bidding cycle then must be restarted."(63) "Equal employment opportunity requirements have delayed the award of contracts in areas where there are not many minorities to hire, such as Maine, or in other areas where minorities are still outside the regular construction work force."(64) While achieving the objectives of these various statutes and policies is undoubtedly worthwhile, fulfilling them does take time, and delay occasioned by coordinating compliance with them should not be justification for undue criticism of EPA.

Obligation and Expenditure of Grant Funds -- Slow grant obligations and outlays have been a focal point for expressed dissatisfaction with the requirements of the Act and the administration of the construction grants program.

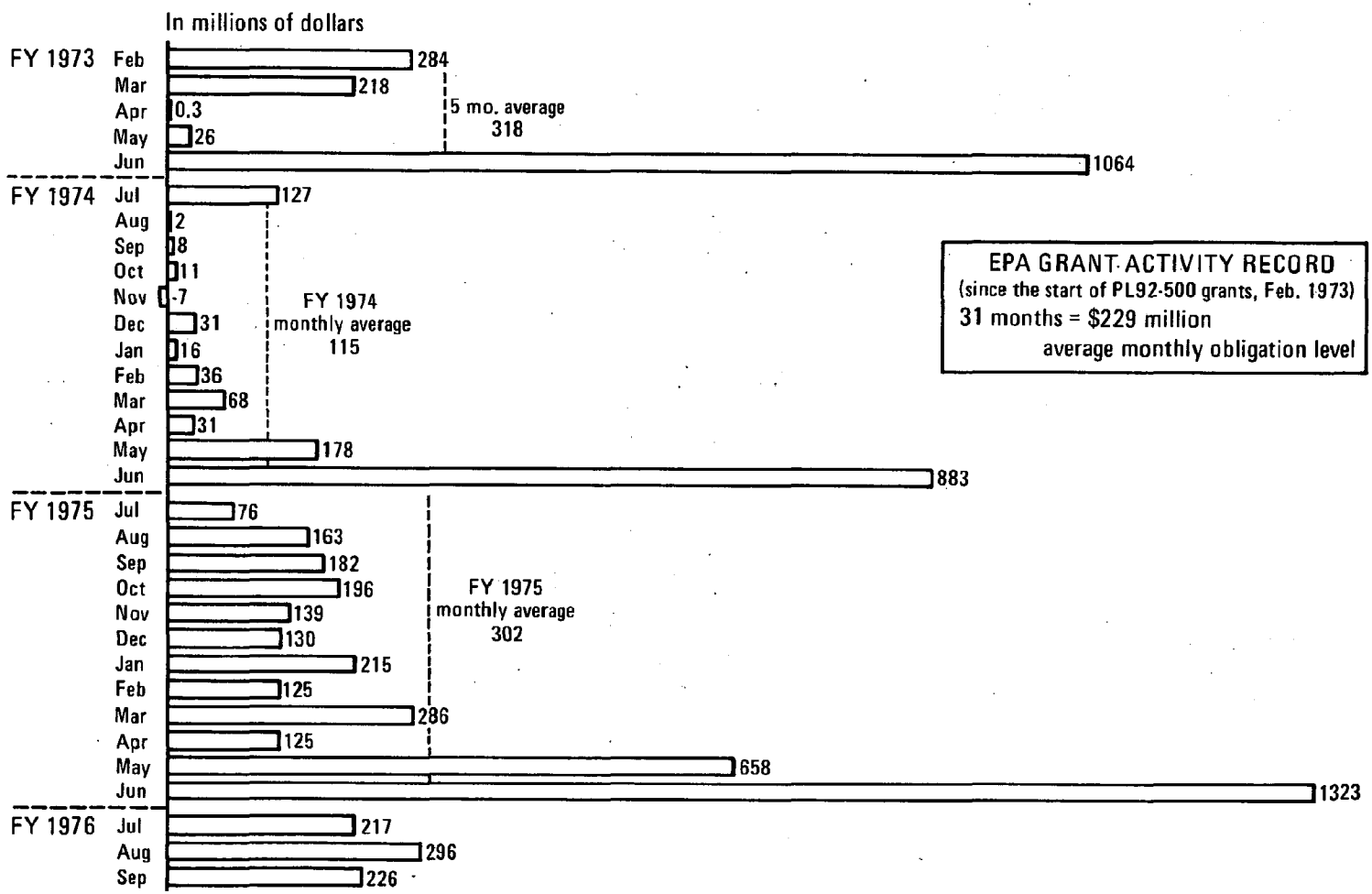
To have obligated the full $18 billion between October 18, 1972, and June 30, 1977, would have required an average obligation rate of $320 million monthly for 56 months. To date, EPA has exceeded this rate in only four of the 34 months ending with August 1975; the average monthly rate in the 1975 fiscal year was $164 million for the first ten months, $658 million for May, and $1.3 billion in June, producing a yearly average of about $300 million. As of July 1, 1975, about $11.4 billion remained to be obligated, making an average monthly rate of about $422 million necessary if the balance is to be committed by the end of the 1977 fiscal year (September 30, 1977).

Approaching deadlines have historically accelerated the rate of obligations. User charges and industrial cost recovery are required for all grants made after March 1, 1973 (Section 204(b)(1)); there was a rush "to beat the deadline," as illustrated in Figure V-5. Besides being the end of the Federal fiscal year, June 30, 1973, was the last date on which grant awards could be made without infiltration/inflow analyses; contract obligations of $890 million were made that month. Figure V-6 records the flood of grants made near the end of each fiscal year. The peaks have always been followed by a dramatic decline in the succeeding months. There is some indication that these surges to meet deadlines also cause submission of incomplete applications(70).

Another significant factor affecting the obligation rate is the value of construction grant applications received by EPA. As reflected in Figure V-7, applications averaged $236 million per month for the first ten months in fiscal year 1975, with $906 million received in May and $819 million in June, lending support to the observation that the pace of construction grant obligations is determined by the timing of local governmental unit's submissions or the rate at which they clear state review. Awards of large numbers of Step 3 grants in May and June "leads to the advertising for contracts on a large scale during the middle of the construction season. This, in turn, generates higher than average bid prices because contractors already have scheduled work. Finally, for a large portion of these last minute grants, the contracts are awarded in the late Fall which for many northern states means the postponement of construction until after the winter. This seasonal approach. . .adds delay and additional costs. . ."(66). Yearly obligations do not necessarily represent commitments to new projects. Of total 1975 fiscal year obligations, 32 percent consisted of cost overruns and added amounts for change orders; "some projects were bid at twice the estimated cost."(67)

FIGURE V-6

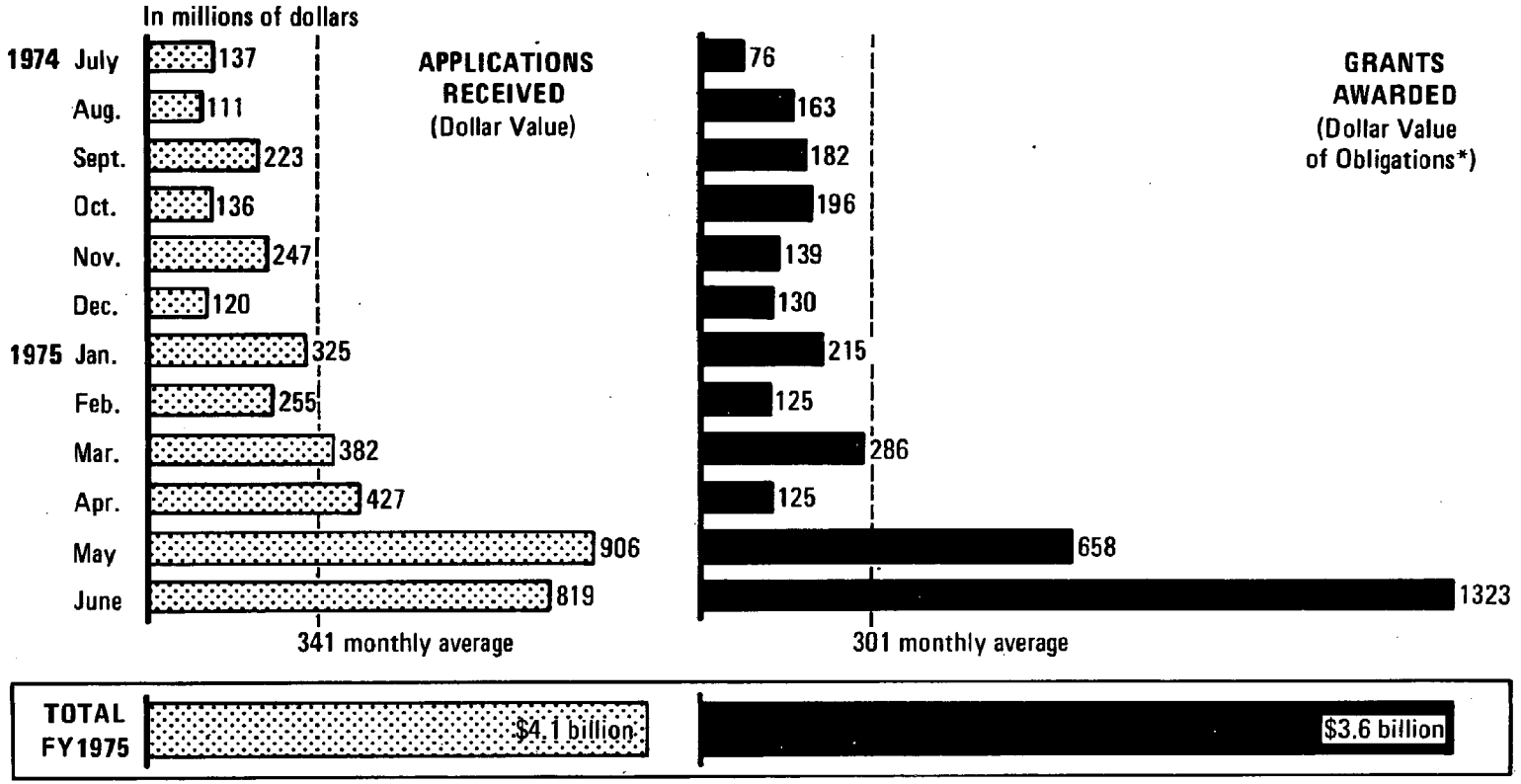
MONTHLY FEDERAL CONSTRUCTION GRANT ACTIVITY, 32 MONTHS, FY 73-76
CONTRACT AUTHORITY OBLIGATIONS FOR PUBLICLY-OWNED TREATMENT WORKS



Obligations = Funds committed for future spending under PL92-500. Excludes reimbursements to states for prior Act programs.
Source: Natl. Commission on Water Quality from EPA "Activities of Construction Grants Programs", Feb. 1973 - September 1975.
March 1976

FIGURE V-7

MONTHLY FEDERAL CONSTRUCTION GRANT ACTIVITY FOR PUBLICLY OWNED TREATMENT WORKS
APPLICATIONS RECEIVED & GRANTS AWARDED, FY 1975



* Obligations = Funds committed for future spending under PL92-500. Excludes reimbursements to states for prior act programs.

Source: Natl. Commission on Water Quality from EPA "Activities of the Grants Programs", June 1975 with figures from "Construction Grants Facts Sheets, Sept. 6, 1975.

March 1976

Actual payments lag behind the obligation. As a consequence, the actual construction and completion of treatment plants follows obligation of the funds by some years. A recent analysis for the House Public Works Subcommittee on Investigations and Review shows that of the $8.25 billion of Federal funds obligated as of June 30, 1975, $2.3 billion had been obligated to projects that were not yet under construction(68). This means that both the stimulative (or inflationary) impacts of the construction grants program, as well as the resultant water quality improvements, will occur some years after EPA first obligates the funds.

Lags in actual expenditures were understood by the Congress during its consideration of P.L.92-500. The House Committee Report contained the following anticipated pattern of expenditures(69):

Fiscal Year	Millions
1973	$ 20.0
1974	250.0
1975	2,450.0
1976	5,000.0
1977	5,955.0
1978	3,250.0
1979	1,050.0
1980	50.0
Total	$18,000.0

The EPA Administrator acknowledged this pattern of expenditures and stated "the major outlays produced by the contract grant authority will not occur until the fiscal years 1976-1981 time period."(70) He added that "traditional impoundment techniques pursuant to 31 U.S.C. 665 may properly be employed to limit the amount of obligations to be incurred under Title II of the enrolled bill."(71) Neither obligations nor outlays have occurred in the expected pattern. The degree to which actual obligations and outlays were influenced by the early Presidential refusal to allot $3 of the $5 billion for fiscal year 1973 and $3 of the $6 billion for fiscal year 1974 is debatable. EPA manpower was concentrated on other priorities and necessary regulations had not been completed. There is little doubt, however, that allotments created uncertainty as to the ultimate disposition of unallotted funds. In resolving the issue of allocation, on February 18, 1975, the Supreme Court said,

> As conceived and passed in both Houses, the legislation was intended to provide a firm commitment of substantial sums within a relatively limited period of time in an effort to achieve an early solution of what was deemed an urgent problem. We cannot

> believe that Congress at the last minute scuttled the entire effort by providing the executive with the seemingly limitless power to withhold funds from allotment and obligation.(72)

With regard to obligation, as contrasted with allocation, the Court indicated, ". . . as we view the legislative history, the indications are that the power to control, such as it was, was to be exercised at the point where funds were obligated and not in connection with the threshold function of allotting funds to the states"(73). Commenting on the contracting procedure, the Court said, "This mechanism considerably reduces whatever discretion Congress might have exercised in the course of making annual appropriations" (74). While this case was pending, Congress enacted the Congressional Budget and Impoundment Control Act of 1972 (P.L.93-344, 88 Stat.207). What impact this Act might have, if any, on the questions raised in the litigation over Presidential refusal to allot authorized amounts under contract provisions such as those in P.L.92-500 was not considered since it was effective subsequent to P.L.92-500.

Rates of obligation and expenditure are significant to an evaluation of progress toward achievement of the requirement for secondary treatment by publicly owned treatment works by July 1, 1977. Table V-12 indicates that as of July 1, 1975, only some 37 percent of the allotted $18 billion had been obligated and only 6.3 percent had been expended. State percentages obligated ranged between 21 percent for South Carolina to 74 percent for Arizona; percentages expended ranged from 1.3 percent for Hawaii to 27.4 percent for Oregon. Since Federal funds are paid as work is completed and bills are submitted, rates of outlay suggest that completion of projects -- or submission of bills for payment -- is proceeding very slowly. Higher yearly levels of Federal authorizations following commitment of existing authorizations will be effective only to the extent that rates of obligation and expenditure can be increased. The desired water quality improvement will come only with operation of completed treatment works.

Wide and erratic fluctuations in monthly obligations rising to high peaks just before deadlines and dropping to low levels immediately thereafter create severe administrative strains. A smooth flow of applications throughout the year at every level is administratively more efficient and certainly more effective in making progress toward the Act's requirements and goals. Municipalities could be informed of the flow of applications and encouraged or compelled to submit applications, using either state priority lists, administrative orders or permit conditions to fix construction schedules. State and EPA reviews could be streamlined to minimize duplication and provide a steadily rising volume of grant approvals to fulfill the Act's 1977 requirements for publicly owned treatment works as soon as possible. Earliest possible authorization of funds for fiscal years after September 30, 1977, is important so that there is no gap in the pipeline of projects. EPA

TABLE V-12

Publicly Owned Treatment Works
Status of Construction Grant Funds
Under P.L. 92-500, as of June 30, 1975
(Millions of $, Fiscal Years 1973-75)

		Allotment	Obligated*	Unobligated	Percent Obligated	Percent Expended
Region I	Connecticut	$ 308.7	$ 105.4	$ 203.3	34	9
	Maine	153.1	67.1	86.0	44	17.9
	Massachusetts	573.9	226.1	347.8	39	10.6
	New Hampshire	153.8	64.5	89.3	42	11.3
	Rhode Island	90.9	32.1	58.8	35	7.9
	Vermont	45.4	13.9	31.5	31	8.7
Region II	New Jersey	1,300.7	499.9	800.8	38	8.4
	New York	2,089.6	682.0	1,407.6	33	4.9
	Puerto Rico	170.0	49.5	120.5	29	--
	Virgin Islands	15.4	4.9	10.5	32	--
Region III	Delaware	111.0	46.2	64.8	41	3.6
	Maryland	564.7	244.4	320.3	43	6.3
	Virginia	496.2	219.0	277.2	44	12.7
	West Virginia	122.2	32.9	89.3	27	4.0
	Pennsylvania	992.8	327.5	665.3	33	4.9
	Dist. of Columbia	146.3	112.5	33.8	77	--
Region IV	Alabama	95.8	36.3	59.5	38	4.1
	Florida	691.7	316.0	375.7	46	2.6
	Georgia	242.6	58.2	184.4	24	3.7
	Kentucky	188.6	59.7	128.9	32	6.0
	Mississippi	80.8	28.0	52.8	35	4.3
	North Carolina	227.0	57.1	169.9	25	4.5
	South Carolina	170.5	35.0	135.5	21	4.5
	Tennessee	213.7	74.7	139.0	35	6.5
Region V	Illinois	1,136.4	412.5	723.9	36	6.6
	Indiana	483.6	170.5	313.1	35	4.4
	Michigan	1,213.7	486.9	726.8	40	4.8
	Minnesota	337.9	159.9	178.0	47	9.5
	Ohio	979.3	313.8	665.5	32	6.5
	Wisconsin	284.8	99.9	184.9	35	3.9
Region VI	Arkansas	81.4	23.5	57.9	29	9.2
	Louisiana	154.4	49.5	104.9	32	6.0
	New Mexico	36.3	11.3	25.0	31	6.0
	Texas	420.3	186.1	234.2	44	10.9
	Oklahoma	134.3	30.5	103.8	23	4.4
Region VII	Iowa	197.2	70.5	126.7	36	12.6
	Kansas	112.7	26.4	86.3	23	5.1
	Missouri	314.8	110.8	204.0	35	8.5
	Nebraska	78.0	33.0	45.0	42	9.4
Region VIII	Colorado	89.9	36.9	53.0	41	11.1
	Montana	28.2	14.5	13.7	52	20.1
	North Dakota	12.0	7.6	4.4	63	13.3
	South Dakota	17.7	6.7	11.0	38	17.1
	Utah	45.0	24.5	20.5	56	8.6
	Wyoming	8.3	4.2	4.1	50	7.1
Region IX	Arizona	43.3	31.9	11.4	74	5.6
	California	1,894.1	591.9	1,302.2	31	6.3
	Hawaii	109.6	58.1	51.5	53	1.3
	Nevada	64.9	15.7	49.2	24	10.8
	American Samoa	1.5	.2	1.3	15	--
	Guam	12.9	8.7	4.2	68	--
	Trust Territories	5.1	3.0	2.1	58	--
Region X	Alaska	51.6	26.9	24.7	52	19.7
	Idaho	38.0	18.3	19.7	48	25.6
	Oregon	154.2	66.1	88.1	43	27.4
	Washington	213.2	98.4	114.8	46	20.2
Total		$18,000.0	$6,591.6*	$11,408.4	37	6.3

* Includes FY 1976 Allowance (initially unallotted FY 1973, 1974 and 1975 funds).

SOURCE: Allotments, Obligations and Unobligated amounts from "Activities of the Grants Assistance Programs," EPA, June 1975, p. 17; Percent Obligated calculated; Percent Expended from "The Path to Clean Water," "Fulfilling a Promise," National Utility Contractors Association, Inc., p. 18.

projections indicate four states may exhaust presently available allotments in fiscal 1976 and another 24 states and territories will do the same in fiscal 1977 without new authorizations. Applicants receiving Step 1 and 2 grants must be reassured that Step 3 funds will be available when construction is to begin so that there is no excuse for delay. Another period of uncertainty about funding levels might have the same effect as deferral of allotments.

Distribution of Grants Among Steps 1, 2 and 3 -- Ideally, the states should maintain the optimum mix of Step 1, 2 and 3 projects to maximize the number of municipalities moving toward completion of collection and treatment facilities while maintaining an even flow of funds to projects ready to begin construction(75). Exactly what that optimum is cannot be exactly determined based on experience and data available to date. Table V-13 shows that, for the entire nation, as of August 31, 1975, there were 2,227 Step 1 projects ($147.1 million), 403 Step 2 projects ($171.3 million), and 1,573 Step 3 projects ($6,448.5 million). Of the Step 3 projects, 518 ($2,369.7 million) were awaiting construction, while 1,055 ($4,078.8 million) were under construction. If the assumptions that each $1 in planning will generate $20 in construction(76) are valid, then Step 1 grants in progress represent some $2.9 billion in construction, while Step 2 grants in progress represent some $1.7 billion in construction.

State-by-state distribution of grants among the steps as of June 30, 1975, is shown in Table V-14. The approximate values of pending construction for each can be calculated using the same multipliers. The largest number of projects, nearly 53 percent, are in Step 1, with nearly 10 percent in Step 2 and 37 percent in Step 3. This imbalance in distribution among the three steps suggests that the wide fluctuations in approval of grants is likely to continue unless Federal, state and local governments cooperatively undertake remedial measures now. In some instances, projects are not submitted to EPA until they are ready for Step 3. Thus the statistics here do not include those in Steps 1 and 2 of which EPA is unaware. To fully obligate the remainder of funds authorized in P.L. 92-500, EPA expects to make new grant awards through the fiscal years ending September 30, 1977 in the following pattern:

TABLE V-13

Publicly Owned Treatment Works
CONSTRUCTION GRANT ACTIVE PROJECTS
UNDER P.L. 92-500

August 31, 1975[1/]

($ in Millions)

Region	FY 73-75 Allotments	Total Active Projects		Step 1 Projects		Step 2 Projects		Step 3 Projects [2/]					
								Projects Awaiting Construction		Projects Under Construction		Total	
		No.	Amount	No.	Amount	No.	Amount	No.	Amount	No.	Amount	No.	Amount
I	$ 1,325.8	169	$ 526.5	38	$ 3.2	10	$ 2.3	34	$ 180.7	87	$ 340.3	121	$ 521.0
II	3,575.7	190	1,267.4	55	13.4	24	22.6	53	326.3	58	905.1	111	1,231.5
III	2,433.2	354	1,009.6	91	5.7	52	56.8	86	238.3	125	708.8	211	947.1
IV	1,910.7	786	648.8	585	38.7	58	18.4	47	200.4	96	391.4	143	591.8
V	4,435.7	799	1,717.6	487	28.5	37	30.4	103	892.2	172	766.5	275	1,658.7
VI	826.7	652	281.5	439	22.0	64	10.5	74	104.5	75	144.6	149	249.0
VII	702.7	367	218.5	125	2.2	76	11.2	44	17.3	122	187.8	166	205.1
VIII	201.2	354	96.1	240	4.7	25	1.7	21	15.8	68	73.8	89	89.6
IX	2,131.4	249	773.3	70	22.8	20	8.3	40	376.0	119	366.2	159	742.2
X	456.9	283	227.6	97	5.9	37	9.1	16	18.2	133	194.3	149	212.5
TOTALS	$18,000.0	4,203	$6,766.9	2,227	$ 147.1	403	$ 171.3	518	$2,369.7	1,055	$4,078.8	1,573	$6,448.5

1/ Preliminary figures.
2/ Includes Step 2 + 3 Projects awarded prior to July 1, 1974.

SOURCE: EPA, Unpublished data.

TABLE V-14

Publicly Owned Treatment Works
ACTIVE CONSTRUCTION GRANTS AWARDED UNDER P.L. 92-500 BY STATE
AS OF JUNE 30, 1975

State	Number of grants			No. as % of state total			Grant amounts awarded			Amount as % of state total		
	Step 1	Step 2	Step 3 (A)	Step 1	Step 2	Step 3	Step 1	Step 2	Step 3 (In thousands of dollars) (B)	Step 1	Step 2	Step 3
Alaska	10	1	9	50%	5%	45%	$ 670	$ 250	$ 25,750	3%	1%	96%
Alabama	89	12	9	81	11	8	6,270	1,310	14,140	29	6	65
Arkansas	45	2	10	79	4	17	1,000	80	19,000	5	-	95
Arizona	8	2	5	6	13	3	450	550	26,500	2	2	96
California	38	10	102	25	7	68	18,860	3,060	539,350	3	1	96
Colorado	18	4	8	60	13	27	1,050	450	32,380	3	1	96
Connecticut	2	-	17	11	-	89	270	-	105,120	-	-	100
District of Columbia	-	-	1	-	-	100	-	-	111,060	-	-	100
Delaware	3	2	10	20	13	67	80	790	45,300	-	2	98
Florida	22	4	22	46	8	46	1,790	2,000	294,040	1	1	98
Georgia	29	10	34	40	14	46	2,570	3,990	45,620	5	8	87
Guam	-	-	1	-	-	100	-	-	7,000	-	-	100
Hawaii	1	-	4	20	-	80	1,200	-	55,790	2	-	98
Iowa	27	7	28	44	11	45	830	1,550	63,510	1	2	97
Idaho	17	3	23	40	7	53	530	500	15,260	3	3	94
Illinois	97	8	88	50	4	46	4,360	18,860	387,600	1	5	94
Indiana	88	3	53	61	2	37	7,380	434	161,050	5	-	95
Kansas	23	12	17	44	23	33	440	770	23,710	2	3	95
Kentucky	81	4	4	92	4	4	3,490	3,800	40,310	7	8	85
Louisiana	34	4	27	52	6	42	4,150	210	40,700	9	1	90
Massachusetts	1	4	28	3	6	91	140	620	225,310	-	-	100
Maryland	2	-	27	7	-	93	380	-	242,430	-	-	100
Maine	-	-	21	-	-	100	-	-	66,060	-	-	100
Michigan	74	5	35	65	4	31	3,180	2,170	477,460	1	-	99
Minnesota	69	7	17	75	7	18	2,780	2,030	155,070	2	1	97
Missouri	22	35	69	17	28	55	300	7,870	76,250	-	10	90
Mississippi	103	13	8	83	10	7	4,480	3,290	5,440	34	25	41
Montana	32	1	7	80	2	18	420	200	13,330	3	1	96
Nebraska	37	18	22	48	23	29	430	610	29,500	1	2	97
North Carolina	88	1	17	83	1	16	3,840	630	37,770	9	1	90
North Dakota	68	8	24	68	8	24	530	60	6,090	8	1	91
New Hampshire	16	4	30	32	8	60	1,130	1,200	62,250	2	2	96
New Jersey	18	3	31	35	6	59	5,210	17,100	467,430	1	3	96
New Mexico	33	5	12	66	10	24	2,220	820	7,810	20	8	72
Nevada	1	1	16	6	6	88	1,690	20	8,970	16	-	84
New York	-	-	65	-	-	100	-	-	682,040	-	-	100
Ohio	33	3	42	42	4	54	1,660	750	292,310	1	-	99
Oklahoma	118	10	34	73	6	21	2,200	240	21,320	9	1	90
Oregon	-	2	52	-	4	96	-	580	64,570	-	1	99
Pennsylvania	2	-	114	2	-	98	190	-	278,960	-	-	100
Trust Territories	-	-	2	-	-	100	-	-	2,960	-	-	100
Puerto Rico	34	21	6	56	34	10	7,990	5,460	3,480	47	32	21
Rhode Island	3	-	8	27	-	73	760	-	31,350	2	-	98
South Carolina	53	8	19	66	10	24	3,440	1,710	25,550	11	6	83
South Dakota	95	3	17	83	3	14	1,980	90	3,950	33	1	66
Tennessee	79	6	22	74	6	20	9,050	820	67,540	12	1	87
Texas	207	29	53	72	10	18	11,450	7,230	144,860	7	4	89
Utah	15	5	9	52	17	31	280	870	23,140	1	4	95
Virginia	24	31	34	27	35	38	3,410	43,170	165,370	2	20	78
Virgin Islands	-	-	1	-	-	100	-	-	4,870	-	-	100
Vermont	7	-	11	39	-	61	370	-	13,580	3	-	97
Washington	62	24	57	43	17	40	3,720	5,510	85,870	4	6	90
Wisconsin	59	5	16	74	6	20	6,660	5,590	86,910	7	6	87
West Virginia	53	17	19	60	19	21	1,490	2,340	29,340	4	7	89
Wyoming	12	1	3	75	6	19	370	20	3,380	10	1	89

National total active grants: 3,831
Total active grant awards: $6.253 Billion

NOTES:
(A) Includes Step 2/3 Grants.
(B) All amounts rounded to nearest $10,000.

Source: Institutional Assessment of the Implementation of the Construction Grants Program Under Public Law 92-500, Touche Ross & Co., report to NCWQ, July 3, 1975, Exhibit III-A-6, p. III-A-17.

TABLE V-15

Steps	Numbers of Projects Fiscal Year 1975	Fiscal Year 1976	Fiscal Year 1977*
1	1,693	1,800	1,100
2	266	1,300	2,600
3	632	1,200	1,700
Totals	2,591	4,300	5,400
Active Projects	3,646	8,000	9,000

* Because of change in fiscal years, this year consists of 15 months.

Achieving a smooth, even, accelerating monthly flow of projects will be particularly important should the level of Federal financing be significantly increased for fiscal years ending after September 30, 1977. Early efforts to optimize the distribution among the steps could avoid complications in the event higher funding is provided. Responses of state and local units of government -- cities, counties and regional authorities -- and their consultants will be critical to the success of any deliberate program to equalize and accelerate the flow of grants since "the action is really with the potential grantee, his consultant, and the state."(77) While EPA has "little direct control over the process at the application development stage"(78), it can concentrate its efforts to assure that duplicate review is minimized and that funds are available for grant awards in a timely fashion. At a time when construction activity is slowed because of general economic conditions, and with the number of approved projects now in Step 1, rapid progression to Step 3, the construction stage, should be attractive to states and local communities to improve employment and general economic activity.

For its part, EPA can analyze its own procedures and those of states and municipalities to see whether there are ways to more rapidly move grants through the step process. While there may be adequate justification for the number of months approved projects remain in the various steps, the speed with which projects move through the pipeline is affected by the length of time projects remain in the various steps. Table V-16 shows how long various projects had been in the several steps as of June 30, 1975. Just moving the 518 projects representing $2.4 billion in construction shown in Table V-13 as already in Step 3, but "awaiting construction" to "under construction," would represent a substantial increase in construction activity. Distribution of 473 of these

projects by EPA regions with months held awaiting construction are shown in Table V-17. Unusual or significant delay between award of a Step 3 grant and taking of bids could result in higher bids because of inflation, requiring amendment of the grant and a consequent further delay.

TABLE V-16

Publicly Owned Treatment Works
Elapsed Time in Steps, Contruction Grants Active Projects
(As of June 30, 1975)

	Number of Grants by Elapsed Time Since Grant Award (in months)*					EPA estimate of time required
	0-6	6-12	12-18	18-24	Over 24	
Step 1	1,034	587	404	25	1	1 year
Step 2	192	67	50	15	34	1 year
Step 3**	419	225	302	120	403	2-4 years

* Does not include completed grants.
** Includes Step 2/3 grants.

Source: The Water Pollution Control Act of 1972: Institutional Assessment, Construction Grants, Exhibit III-1, p. III-4, data from Office of Water Programs, EPA.

Size of Projects -- Every application for a grant or project, regardless of size, presumably is subject to the same requirements; thus the smallest town filing a construction grant application for a treatment works must comply with the same statutes, rules and regulations as the largest city in the nation. The amount can be a few thousand dollars or hundreds of millions. While the current law makes no distinctions according to size, logic suggests that there are real differences based on size of project. EPA already provides abbreviated instructions for small communities in some areas.

Table V-18 shows that nearly 80 percent of the number of projects for cities and towns with populations under 25,000 account for slightly more than one-fourth of the contract dollars; two-thirds of the projects

TABLE V-17

Publicly Owned Treatment Works
Construction Grant Active Projects
Under P.L. 92-500
Months Held Awaiting Construction Approval
As of August 31, 1975

($ in Millions)

Region	(0 - 3) Amount	No.	(4 - 6) Amount	No.	(7 - 12) Amount	No.	(13 - 18) Amount	No.	(Over 18) Amount	No.	Total Amount	No.
I	$ 59.8	9	$ 92.0	13	$ 23.1	8	$ 2.6	3	$		$177.6	33
II	262.7	37	17.8	8	39.7	6	2.3	1	3.9	1	326.4	53
III	57.1	26	31.5	16	71.1	27	66.1	16	7.9	4	233.6	89
IV	150.6	30	35.1	12			13.3	2	.4	1	199.4	45
V	662.3	75	218.5	21	6.0	3	.9	1			887.7	100
VI	27.7	29	25.6	3	.5	1	1.2	1			55.0	34
VII	7.3	28	4.4	7			1.1	3	3.0	2	15.8	40
VIII	12.9	16	2.6	3	.3	2					15.8	21
IX	185.0	28	187.9	12	11.0	4					383.9	44
X	11.6	10	.3	1	6.2	2	.6	1			18.7	14
	$1,437.0	288	$615.7	96	$157.9	53	$ 88.1	28	$ 15.2	8	$2,313.9	473

Source: EPA unpublished data.

TABLE V-18

Publicly Owned Treatment Works
Construction Grant Contract Awards
By Population of Recipients
(As of August 31, 1975)

Community Size	Grant Awards				U.S. Population*	
	Number	% of Total	$ Millions	% of Total	Thousands	% of Total
Under 2,500	1,850	41	$ 420	6	11,235	7.7
2,500-5,000	613	14	228	3	8,038	5.6
5,001-10,000	510	11	370	6	12,924	8.9
10,001-25,000	570	13	829	12	21,415	14.8
Sub-Total Up to 25,000	3,543	79	$ 1,847	27	53,612	37.0
25,001-50,000	293	7	754	11	17,848	12.3
50,001-250,000	400	8	2,158	32	31,010	21.5
Sub-Total 25,001-250,000	693	15	$ 2,912	43	48,858	33.8
250,001-500,000	80	2	682	10	10,442	7.2
500,001 and over	168	4	1,401	20	31,736	22.0
Sub-Total 250,001 and over	248	6	$ 2,083	30	42,178	29.2
TOTAL	4,484	100%	$ 6,842	100%	144,648**	100%

* Per U.S. Census Bureau.

** Not including: (1) that portion of the population classified as "Other Rural" (farmers, ranchers and others not living in communities) (This = 43,379,000 people.) and (2) "Unincorporated Parts of Urbanized Areas." (This = 15,186,000 people.)

Source: EPA unpublished data, adjusted to format, and Statistical Abstract of the United States, 1974; U.S. Department of Commerce, Bureau of the Census, page 18.

are for places with populations under 10,000 and represent only 15 percent of the money. These data suggest that attention might be given to simplified procedures for smaller projects, while concentrating time and personnel on those which encompass larger populations and projects. Another suggested simplification of procedure would be to combine the Step 2 and Step 3 procedures into one step.

Manpower -- Manpower required to process a volume of construction grants adequate to meet the intended pace under P.L. 92-500 is a function of what has to be done initially, the depth to which original documentation is reviewed and the number of different reviews performed. The program is not, and perhaps cannot be, structured so as to achieve maximum efficiency. Projects are initiated by local units of government deciding to apply for construction grants or responding to regulatory or enforcement action by applying. Ultimately, the entire process depends upon local action, whether internally or externally stimulated; thus the volume of projects in process is whatever number local applicants, their engineers and consultants, governmental employees at other levels and the construction industry can generate, develop and shepherd through the approval procedure to completion under current statutory requirements and regulations.

Manpower at the Federal level has not grown in proportion to the obligation of funds as reflected in Table V-19. During the period from 1968 through the 1976 fiscal year, a nearly 25 fold increase in yearly obligations has been achieved with triple the number of Federal construction grants employees. Requirements also became considerably more complex during the same period. Conferees on P.L. 92-500 urged "the Administrator, the states, and local governments to draw from the experience of the highway program to improve the efficiency of the waste treatment grants program"(79). Comparing EPA staffing with that of the Federal Highway Program (390 employees per billion dollars obligated)(80), the construction grants program should now have nearly 2,000 employees to obligate the $5.1 billion projected for fiscal year 1976. In fact, EPA will have less than half that number. EPA has indicated that more than 200 employees, in addition to the 963 it will use in 1976, will be necessary to move to the fiscal 1977 level of $7 billion in obligations. Distribution of Federal construction grants staff within the ten regions is shown in Table V-20, with a comparison of the distribution of the number and dollar amount of applications among the regions. Two particular areas of activity were identified where lack of manpower is now "a definite impediment" -- "field inspections and audits," with only 35 man-years budgeted in fiscal year 1975 to audit the construction grants program(81); with "few personnel at the state or EPA levels . . . regularly involved in the inspection . . ., heavy reliance is placed . . . upon consulting engineering firms to manage and monitor the actual construction. . ."(82) The same shortage had been noted earlier by EPA(83), which is now exploring the possibility of interagency agreements with the General Services Administration and the Corps of Engineers to provide interim construction inspections.

TABLE V-19

ENVIRONMENTAL PROTECTION AGENCY
FEDERAL PERSONNEL AND OBLIGATIONS
CONSTRUCTION GRANTS PROGRAM*
1968-1976

Fiscal Year	Estimated Federal Personnel*	Fiscal Year Obligations (Billions of $)
1968	320	$ 0.2
1969	320	0.2
1970	360	0.4
1971	420	1.6
1972	402	0.9
1973	452	3.0
1974	595	2.6
1975	567	3.6
1976 (as of 10/30/75)	963	5.2 (Est.)

* Notes

1968-1974 personnel and obligations from Review of the Municipal Waste Water Treatment Works Program, November 30, 1974, U.S. EPA, Tables II-1 and II-2, p. 8.

1974-1976 personnel and obligations from "Construction Grants Fact Sheet," EPA, 9-6-75, and EPA unpublished data.

Estimated Federal Personnel for fiscal years 1968 through 1972 (October 18, 1972) do not include NPDES personnel as this program did not exist.

The figures for fiscal years 1968 through 1975 include post construction personnel. The figures for 1976 do not.

The figures for fiscal year 1975 do not include 107 positions which were new to the construction grants program. These were re-positioned people--constituting an internal shift. They are counted in 1976 figures, as the additions were made at the very end of fiscal year 1975.

The figures for fiscal year 1976 include 300 new positions. Of these, 250 were new; 50 were reallocations within the agency. The distribution is as follows:

New Positions:	225 to regions + 25 to HQ	= 250 total
Reallocated:	39 to regions + 11 to HQ	= 50 total
TOTAL	264 to regions + 36 to HQ	= 300 total

The 1976 figures do not include NPDES personnel as they were moved.

TABLE V-20

DISTRIBUTION OF EPA REGIONAL CONSTRUCTION GRANTS PERSONNEL VS. GRANT APPLICATIONS IN PROGRESS

(As of June 30, 1975)

EPA Region	Construction Grant Applications in Progress		Regional Personnel in Construction Grants Program	Portion of Total Regional Personnel in Program	Regional Applications As % of Total	Regional Grant Amounts As % of Total
	Number	Amount (Millions of $)				
I	41	$ 92.7	34	7%	6%	9%
II	43	330.2	56	12%	6%	31%
III	55	114.9	60	12%	7%	11%
IV	89	17.8	61	12%	12%	2%
V	204	304.4	91	20%	27%	28%
VI	82	16.2	45	9%	11%	1%
VII	151	48.6	40	8%	20%	4%
VIII	15	2.6	30	6%	2%	0
IX	51	155.9	39	8%	7%	14%
X	0	4.6	29	6%	2%	0
	745	$1,087.9	485	100%	100%	100%

Source: Municipal Construction Division
Office of Water Program Operations
EPA

As to general engineering manpower, in some places ". . . either there are too few consultants practicing in the state (West Virginia) or a few firms hold the bulk of the contracts (five firms handle 50 percent of all active P.L.92-500 projects in New York; 11 firms handle . . . [about] 90 percent in California) and do not have sufficient manpower to expedite all projects at once"(84).

Lack of adequate manpower at the state level has also been identified as a critical problem(85). States have been reported as "short an estimated 3,400 positions in their water pollution agencies," of which only a part would be for construction grants(86). "State performance in providing guidance consistent with P.L.92-500 (by the states), size of staff and an appropriate range of skills"(87).

Both state and EPA construction grants personnel appear to be vulnerable to high turnover "because of the exposure. . .(they) receive to consulting engineering firms and other parties,. . .the salary potential. . .with many private firms," and "the relatively low salary structure in. . .many state governments."(88) Local applicants have complained about the lack of continuity in project reviewers at the EPA regional offices which results from employee turnover or reassignment to accommodate widely fluctuating work loads.

Certification of Construction Grants Functions Performed by the States -- Recognizing that manpower limitations and duplicate reviews were complicating the construction grants approval process, EPA on January 23, 1974, announced a procedure for state "certification of adequacy of plans and specifications, operation and maintenance manuals, and certain documents involved in the bid and contract process," pursuant to written agreements between EPA regions and the states(94). Subsequently on February 4, 1974, EPA authorized certification of "any and all program functions" associated with such grants but made clear that the regulation "does not and cannot provide for transfer of authority to the states to actually approve grantee submittals."(90) As of September 2, 1975, certification was exercised by 28 states for plans and specifications, 33 for operations and maintenance manuals, 28 for change orders and three for bid tabulations (See Table V-21); EPA expects agreements to be executed during the fiscal year ending June 30, 1976, with 10 additional states for plans and specifications, six for O&M manuals, 11 for change orders and 10 for bid tabulations(91). In addition, agreements are expected with seven states for certification of the results of interim inspections.

The end result of these agreements has been differently characterized. In 1974, EPA felt that initial certification of three program functions by some states "were 1) working satisfactorily, 2) reducing duplication, 3) improving administration of the program, and 4) receiving the support of the state and regional staff involved."(92) The Commission

TABLE V-21

Publicly Owned Treatment Works
CERTIFICATON OF CONSTRUCTION GRANTS REVIEW BY STATES
(As of September 2, 1975)

State	Plans and Specifications	O & M Manual	Change Orders	Bid Tabulation
Region I				
Connecticut	X	X	X	
Maine				
Massachusetts				
New Hampshire				
Rhode Island				
Vermont	X	X	X	
Region II				
New Jersey				
New York	X	X	X	
Puerto Rico				
Virgin Islands				
Region III				
Delaware				
Washington, D.C.				
Maryland	X	X	X	
Pennsylvania				
Virginia	X	X	X	
West Virginia				
Region IV				
Alabama				
Florida	X	X	X	
Georgia	X	X	X	
Kentucky				
Mississippi				
North Carolina	X	X	X	
South Carolina	X	X	X	
Tennessee	X	X	X	
Region V				
Illinois		X		
Indiana		X		
Michigan		X		
Minnesota				
Ohio		X		
Wisconsin		X		
Region VI				
Arkansas	X	X	X	
Louisiana	X	X	X	
New Mexico	X	X	X	
Oklahoma	X	X	X	
Texas	X	X	X	
Region VII				
Iowa				
Kansas	X	X	X	
Missouri	X	X	X	
Nebraska		X		
Region VIII				
Colorado	X	X	X	
Montana	X	X	X	X
North Dakota	X	X	X	X
South Dakota	X	X	X	
Utah	X	X	X	
Wyoming	X	X	X	X
Region IX				
Arizona				
California	X	X	X	
Hawaii				
Nevada				
Territories				
Region X				
Alaska	X		X	
Idaho	X	X	X	
Oregon	X	X	X	
Washington	X	X	X	
TOTAL	28	33	28	3

Source: EPA 9-2-75. (unpublished data).

contractor, after noting that ". . . the states are limited to certification of technical and/or administrative accuracy in their review, (and) only EPA can approve a grant," reported that in its "field review in seven of eight regions, the EPA personnel still review every grant prior to approval despite state certification"(93). EPA, too, has commented that "state certification . . . tends to be unreliable . . . (One region), for example, finds that about half of the applications certified by one state are not approvable as received. About 10 percent are returned outright, another 10-20 percent have substantial problems, and another 20-30 percent have forms missing, signatures missing, etc."(94)

The Commission contractor concluded that the present certification process may not result in efficiency. Even if the state attains control over the administrative and technical requirements, "Key questions relating to growth or land use must be approved by EPA. . . The policy of decentralization is, therefore, restricted by both the law and regulations. One result of this policy is a series of duplicative reviews by state and EPA personnel"(95).

Actual and effective certification of various functions by more states should produce better utilization of available Federal, state, regional and local manpower. In describing its options for 1974, EPA indicated that its construction grants manpower should be increased by 455 persons, in addition to the 595 it then had -- 138 to improve the management of the program and 317 to process additional applications. State certification was listed as an alternative to this personnel increase(96). Currently, EPA indicates acceptance of state certification already made and expected through fiscal year 1976 would save the Agency some 49 man-years annually.

While certification can result in better manpower utilization, it is no substitute for adequate numbers of personnel. There is still evidence that effective and timely administration of the construction grants program requires more trained people at all levels. At the same time, "delegation of functions to the states would not reduce the basic processing time required. It merely transfers the processing from one agency to another, without necessarily saving time"(97). As the agreements are presently executed, too, "EPA expressly retains ultimate responsibility for final determination regarding other grant conditions listed in the regulations (40 CFR 35.935), including the facility plan, the state plan, priority certification, state allocation limitation, applicant's funding capability, permits, National Environmental Policy Act review, civil rights compliance, and the scope of project and grant amount"(98).

The State of California proposed a mechanism for providing performance of construction grant functions, such as review of plans and specifications, for which the state would charge the applicant or grantee a fee that would then be accepted by EPA as a project cost, 75 percent reimbursable under the eventual Federal grant. This procedure would enable the state to

recover its expenses for necessary review staff, while the applicant would pay only 25 percent of the added cost as part of the non-Federal share of the project. Subsequent EPA regulations permitted the use of this "California fee proposal" nationwide, but only California has thus far qualified. There is some indication that whatever manpower savings may have been realized by the EPA regional office have been more than offset by addition of new employees to the California pollution control agency payroll. The overall result is almost surely a total net increase in manpower in the program. Whether the "California" approach will be utilized more widely will probably depend upon the outcome of Congressional consideration of more direct statutory delegation.

Various methods for state certification can perhaps streamline the construction grants process. Substantial net time and manpower savings, however, may not be realized. Qualified personnel will still be necessary, whether employed at the state or EPA regional level; whether the procedure would represent an identifiable net saving in total Federal and state personnel cannot be determined easily. The functions required to be performed by P.L.92-500 must still be completed before final approval of the various steps in the process. Personnel needs of the states will be increased. States may still face difficulty in recruiting new employees because of salary levels, job locations, state revenue problems and personnel ceilings and the advisability of expanding staff for an activity with authorized funding only through fiscal 1977. Rather than net reductions in personnel, EPA would be better staffed to perform its responsibilities more effectively and efficiently since manpower availability will be a continuing influence on progress of the construction grants program. Adequate EPA staff would be required to assess state "authority, responsibility, and capability" to assume certification duties and audit state performance where certification has been approved to assure uniform, national compliance with the law.

The findings of a recent EPA task force on decentralization concluded that although decentralization was a highly commendable objective, they were not sanguine about the future prospects and detected a relative lack of commitment at both the Federal and state levels. Indeed, the task force concluded that "EPA and the states, collectively, have failed to establish the necessary program management systems to implement the water program in a decentralized fashion" (99). With appropriate and adequate EPA supervision and state commitment to the procedure, the grants approval process should be less cumbersome and time-consuming. The arrangement would, to be sure, add some substance to the declaration in P.L.92-500 that "it is the policy of the Congress to recognize, preserve, and protect the primary responsibilities and rights of states to prevent, reduce and eliminate pollution. . ." (Sec.101(b)).

EPA Definitions of Secondary Treatment and "Best Practicable Waste Treatment Technology over the Life of the Works"

EPA definitions of the treatment technologies and the effluent limitations required to be met by publicly owned treatment works by July 1, 1977, and July 1, 1983, have already been discussed. (See Chapter II.) Prescribed effluent limits for "secondary treatment" are permissible concentrations of BOD, suspended solids, fecal coliform and pH. Higher limits must be met for discharges to water-quality limited waters. For 1985, EPA has essentially fixed 1983 requirements equal to those for 1977; three alternatives are listed for meeting the 1983 limits -- treatment and discharge, land application and reuse.

Projections of technologies to be installed in treatment plants with needs reported in the 1974 EPA needs survey show the following treatment or disposal system:

Process	Number of Plants
Activated Sludge	5,700
Trickling Filters	4,600
Aerated Lagoons	1,000
Oxidation (or waste stabilization) Ponds	3,400
Land Application	900
Total	15,400

Of approximately 16,000 facilities in place in 1974, more than 80 percent provide some form of secondary treatment, 5 percent provide some type of treatment more advanced than secondary, and some 3,000 are untreated discharges. Those secondary treatment facilities in place do not always achieve the defined level of effluent limitations. The oxidation waste stabilization ponds generally cannot meet the suspended solids limit, and because a large number are already installed, a question has been raised as to a specific secondary treatment definition to cover such facilities. Most are for communities with populations below 10,000 persons. EPA is now considering a modification to its secondary treatment definition to accommodate these ponds. Similarly, only certain types of trickling filters will achieve the required results and then only when not overloaded and carefully operated.

Coastal cities accustomed to discharge through deep-ocean outfalls have argued that little adverse environmental effect has been demonstrated where wastewater receiving less treatment than necessary to meet the secondary treatment BOD limit has been discharged. They contend some level short of secondary treatment, as defined by EPA, is more cost-effective and will assure compliance with required water quality standards. Pending legislation in the House Committee on Public Works and Transportation would allow the EPA Administrator to extend the July 1, 1977, deadline for treatment

works discharging to ocean waters and "consider the cost of achieving secondary and alternative treatment and the effects such secondary and alternative treatment will have on public health and water quality, including effects on aquatic life, the propagation of fish, and recreation." No time modification "shall extend beyond July 1, 1982." (H.R.9560, Sec.9.) In addition, a recent report of the General Accounting Office to that Subcommittee recommends amendment of Sec. 402 of P.L.92-500, to provide the Administrator with authority to exempt certain categories and classes of dischargers with a minimal adverse impact on water quality.

A Panel on Secondary Treatment assembled under the auspices of the Committee on Water Quality Policy, Environmental Studies Board, National Academy of Sciences-National Academy of Engineering addressed some of these questions(100). The Panel concluded that the EPA definition of secondary treatment is appropriate except for inclusion of a fecal coliforms limitation and percentage removal limitations and 1) suggested that disinfection be required where necessary for water quality standards on a case-by-case basis; 2) indicated that the requirement that effluent BOD and suspended solids not exceed 15 percent of the influent levels is not operationally achievable even with the best of secondary treatment processes during certain times of the year when influent contains low concentrations; 3) concluded that waste stabilization ponds generally cannot meet the EPA secondary treatment limitations without additional facilities for removal of suspended solids; and 4) recommended that improvements to such ponds to meet the limitations receive low priority because of poor cost effectiveness unless the effluents are causing measurable harm to beneficial uses of the receiving waters. Regarding priorities, the Panel suggested that first priority be given to construction of municipal facilities to treat discharges which cause significant adverse effect on beneficial uses of receiving waters. Next should be facilities serving large populations because of greater cost effectiveness, with preference given to treatment of discharges to fresh or estuarine waters over discharges to the open ocean where dilution potential is greater. Lowest priority should be given to small communities with discharges of one million gallons per day or less (contributory populations of 10,000 or less).

The EPA Administrator commented on the Panel's report as follows:

> The 15 percent limitation on BOD and suspended solids is a complex subject. If we were to remove this limitation, then there will be a significant shift in the cost effectiveness analysis for infiltration/inflow or flow reduction. We would like to encourage removal of major sources of extraneous flow from the sewers. Moreover, if only the 30 mg/l limit applied, then it is probable that only primary sedimentation would achieve the standard on an influent value of 50 to 60 mg/l. On balance, we wanted to avoid dilution being used to meet the standard, while recognizing that combined sewers require special attention(101).

Recycling, Reuse and Reclamation of Wastewater and Land Application of Wastewater and Sludges*

The Act encourages reclaiming and recycling as part of the requirements covering construction grants. Section 201(d) states that:

> (d) The Administrator shall encourage waste treatment management which results in the construction of revenue producing facilities providing for --
>
> (1) the recycling of potential sewage pollutants through the production of agriculture, silviculture, or aquaculture products, or any combination thereof;
> (2) the confined and contained disposal of pollutants not recycled;
> (3) the reclamation of wastewater; and
> (4) the ultimate disposal of sludge in a manner that will not result in environmental hazards.

In addition, "The Administrator shall not make grants from funds authorized for any fiscal year beginning after June 30, 1974 . . . unless the grant applicant has satisfactorily demonstrated to the Administrator that --

> (B) as appropriate, the works proposed for grant assistance will take into account and allow to the extent practicable the application of technology at a later date which will provide for the reclaiming or recycling of water or otherwise eliminate the discharge of pollutants.

For land application of wastewater in the 54 states and territories, 22 (41 percent) have formal regulations (Table V-22); Washington has draft regulations. Thirty-eight states (70 percent) require a minimum of secondary or higher level of treatment before application. Application is prohibited in the District of Columbia, discouraged in Rhode Island, and not practiced in Nebraska, Ohio and Iowa, according to information compiled by the Commission or supplied by the various governmental jurisdictions.

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*For purposes of the ensuing discussion, the following words or phrases have these stated meanings: 1)reclamation -- groundwater recharge using effluent, effluent used for a substantial part of the water supply in lakes used for recreation or aesthetics and effluent used in man-made canals; 2) reuse -- municipal effluent used by industry or within the municipal treatment plant and effluent used in flushing toilets; 3) confined disposal -- confined effluent storage ponds and subsurface disposal areas; and 4) land application or recycling -- spray and other forms of irrigation and sludge disposal. These descriptions appear to best describe the Congressional intent of Sec. 201(d) and the stated practices on a nationwide basis. Land application or recycling has generated greater state activity via regulations, guidelines and projects than confined disposal, reuse and reclamation.

TABLE V-22

SUMMARY TABLE
LAND APPLICATION
OF WASTEWATER AND SLUDGE

STATE	WASTEWATER		SLUDGE	
	Regulations	Treatment and Other Restrictions	Regulations	Restrictions
Alabama	No	Secondary Treatment	No	-
Alaska	Yes	Secondary or Advanced	No	Permit Required
Arizona	Yes	" " "	No	-
Arkansas	No	Secondary	No	-
California	Yes	Primary to Advanced	No	Ad Hoc Basis
Colorado	No	Secondary & Disinfection	No	Allowed in Landfills
Connecticut	No	Ad Hoc Basis	No	-
Delaware	Yes	Secondary & Disinfection	No	Landfill - Ad Hoc
D. C.	Yes	Prohibited	No	-
Florida	Yes	Secondary to Advanced	No	Landfill - Ad Hoc
Georgia	Yes	Secondary & Disinfection	No	-
Guam	Yes	Ad Hoc Basis	-	-
Hawaii	Yes	Secondary & Disinfection	No	-
Idaho	Yes	Secondary or Sec. & Disin	Yes	Heat treatment
Illinois	Yes	Secondary	Yes	Ad Hoc Basis
Indiana	No	-	No	Stabilized
Iowa	No	Not Generally Practiced	No	Landfill if Dewatered
Kansas	No	Secondary	Yes	Ad Hoc Basis - Landfill
Kentucky	No	Secondary & Disinfection	No	Ad Hoc Basis
Louisiana	No	Secondary	No	Ad Hoc Basis
Maine	Yes	Secondary & Disinfection	-	-
Maryland	No	Secondary	-	-
Massachusetts	No	-	Yes	Landfill - Ad Hoc
Michigan	No	Prohibited; or secondary & Disinfection	Yes	Ad Hoc Basis
Minnesota	Yes	Secondary & Disinfection	No	Guidelines in Preparation
Mississippi	No	" " "	No	Stabilized - Ad Hoc
Missouri	Yes	Secondary & Disinfection	Yes	Landfill if Dewatered
Montana	No	-	Yes	Landfill if Dewatered
Nebraska	No	Not Currectly Practiced	No	-
Nevada	No	Ad Hoc by Permits	No	-
New Hampshire	Yes	Secondary & Disinfection	Yes	Permit - Ad Hoc Basis
New Jersey	Yes	Secondary - Toxics Prohib.	Yes	Landfill - mixed with refuse
New Mexico	No	-	No	-
New York	No	Secondary - Disinfection	No	Ad Hoc Basis
North Carolina	No	Advanced & Disinfection	No	Ad Hoc Basis
North Dakota	No	Secondary	Yes	Landfill
Ohio	No	If not cost effective - no disposal	Yes	Landfill - Ad Hoc
Oklahoma	No	Secondary	Yes	Landfill - Ad Hoc
Oregon	No	Secondary & Disinfection or more stringent	Yes	Landfill - Permit
Pennsylvania	Yes	Secondary & Disinfection	Yes	Landfill - Permit, if digested & Dewatered
Puerto Rico	No	-	No	-
Rhode Island	No	Discouraged	Yes	Landfill - Ad Hoc
South Carolina	No	Ad Hoc Basis	Yes	" " "
South Dakota	No	Secondary & Disinfection	No	Ad Hoc Basis
Tennessee	No	Secondary & Disinfection	Yes	Dewatering
Texas	Yes	Secondary or Secon. & Disin.	Yes	Landfill - Ad Hoc
Trust Territories	No	Ad Hoc Basis	-	-
Utah	Yes	Secondary	Yes	Digested or more Stringent
Vermont	Yes	Secondary & Disinfection to Prohibited	Yes	Landfill - Ad Hoc
Virginia	Yes	Secondary & Disinfection	No	Stabilized or more Stringent
Washington	Draft	Secondary & Disinfection	-	-
West Virginia	No	-	-	-
Wisconsin	Yes	Secondary & Disinfection	Yes	Digestion as a Minimum
Wyoming	No	Secondary	-	-

Source: Compiled by the National Commission on Water Quality.

For land disposal of sludge, 21 states (19 percent) have some formal regulations. Of the 35 states with policies regarding sludge disposal, 18 states (51 percent) allow or regulate disposal in landfills, 20 (57 percent) evaluate disposal on an ad hoc or case-by-case basis, five (14 percent) require dewatering, Mississippi and Indiana require some form of stabilization, Wisconsin requires digestion, Idaho, heat treatment and Pennsylvania requires digestion for landfill disposal.

In a 1973 survey(108) of 67 municipal and 20 industrial facilities, EPA and the American Public Works Association reached the following conclusions concerning land application (as opposed to "disposal") of effluents:

1. land application of wastewater is practiced successfully and extensively in the United States and in many foreign nations;
2. "various degrees of municipal sewage pretreatment are practiced prior to land application";
3. under proper conditions, land application is a workable alternative to advanced treatment;
4. "small communities and food processing industries will probably continue to be the principal users of land treatment of effluents for the future";
5. a large variety of potential opportunities for land application exists;
6. "sale of effluent for beneficial use has been generally unsuccessful";
7. there is a general improvement of the environment from land application at the site as opposed to an impairment of the indigenous ecology;
8. project monitoring has been generally minimal and inadequate;
9. "energy requirements for land application systems may be an important consideration";
10. "secondary treatment is generally provided by municipalities prior to land application"; and
11. "spray irrigation is the most frequently used (57 facilities) method of application."

A 1975 study of municipal wastewater "reuse" found continuing operations at 357 locations in the United States, exclusive of groundwater recharge(103). The bulk, or 94 percent of these reuse, recycling and reclamation activities were irrigation practices, 96 percent of which occurred in Texas, California, Arizona, New Mexico, Colorado and Nevada.

The 1971 total "reuse" volume was 132 billion gallons, 58 percent for irrigation, 41 percent for industrial reuse, 1.1 percent for recreational reclamation and 0.008 percent for nonpotable domestic reuse. For irrigation, approximately 75 percent of the national operations provided secondary treatment, the remainder being primary and some

advanced treatment. Proper irrigation management is needed for a successful operation. For industrial reuse, 82 percent of the national volume is used by Bethlehem Steel in Baltimore for cooling. Only 14 industrial plants are reusing municipal wastewater. The greatest potential identified for industrial reuse is cooling; both once-through and recirculating cooling systems using municipal effluent have proved successful. The primary motivation for industrial reuse is economics. For recreational reclamation or "reuse", three major projects exist in Santee, South Lake Tahoe and Lancaster, California. The single largest extra cost to the reuser was found to be transportation and storage facilities.

EPA regulations require that "land application systems shall be designed so that the permanent ground waters. . .which are in the zone of saturation. . .that result from the application of wastewater will not exceed the chemical or pestidices [arsenic, barium, chloride, chromium, copper, fluoride, foaming agents as methylene blue active substances, iron, lead, manganese, nitrate nitrogen, carbon absorbable organics-carbon; chloroform extractable (CCE), carbon absorbable organics-carbons; alcohol extractable (CAE), selenium, silver, sodium, sulfate, zinc, chlordane, heptachlor, heptachlor epoxide, heptachlor and heptachlor epoxide, lindane, hepthoxychlor, 2,4-D, 2,4,5-T, 2,4,5-TP, organophosphate and carbonate, and insecticides] levels for raw or untreated drinking water supply sources in the EPA Manual for Evaluating Public Drinking Water Supplies. . ." and "any public drinking water standards for raw water supplies hereafter issued by EPA which prescribe maximum allowable limits or permissible concentrations of chemicals or pesticides shall apply in lieu of those listed above."(110).

Those who expected widespread and more frequent resort to these waste treatment management methods have expressed their disappointment that traditional capital-intensive facilities continue to dominate the treatment of domestic wastes. The Commission contractor found "that project designs prepared by consulting engineers generally represent a uniform, standardized approach to the treatment of wastewater. The similarity of treatment facilities applies to all geographic areas, regardless of local wastewater, climatic, soil and receiving water characteristics."(105) Consulting engineers and municipal officials were found to be preoccupied with the facilities planning requirements of Step 1 and concerned about delays that might result in cost increases. The contractor concluded ". . .the inflexibility of secondary standards for dischargers and the constraints of the lengthy review process are causing consulting engineers and municipalities to submit standard designs for treatment facilities."(106) One other suggested "major reason for the lack of innovative alternatives is the number of projects designed prior to the enactment of P.L. 92-500. In these instances, alternatives have been developed only to meet the legal requirements."(107)

A Panel on Water Reuse assembled under the auspices of the Committee on Water Quality Policy, Environmental Studies Board, National Academy of Sciences-National Academy of Engineering, considered the regulatory and policy constraints and public health restrictions which may inhibit or reduce opportunities for reclaiming and recycling wastewater. The Panel's statement concluded:

> Although it is anticipated that water reuse projects will increase in number and scope due to the impetus of P.L.92-500, there are a number of regulatory, policy, public health, and technological constraints that will inhibit the development of such programs. Among the most important identified by the Panel are:
>
> (1) The requirements of P.L.92-500 that water reuse produce revenue for the treatment facilities.
>
> (2) Priority systems utilized in the administration of the Federal grant program.
>
> (3) Regulations related to control of groundwater or irrigation under-drain water quality.
>
> (4) The historic practice of utilizing the best quality of water available for any purpose.
>
> (5) Interference with existing water rights, particularly those associated with the western doctrine of appropriation.
>
> (6) Existing contractual commitments.
>
> (7) Limits on quality parameters based on scientifically established effects.
>
> (8) Public health prohibitions and established national policies against planned reuse of water for purposes for which potable water is required (until such time as public health factors and technological developments have been resolved through adequate research).
>
> (9) Political considerations involved in transporting treated waters across political boundaries from their area of origin to potential sites of reuse.
>
> In spite of the constraints enumerated above, the planned production of higher quality effluents over the next five to ten years should produce numerous opportunities for supplementing our natural water supplies with reclaimed water wherever the quality characteristics and the economics of its production and distribution permit(108).

The EPA Administrator commented on the Panel's report as follows:

> With regard to water reuse, we require that this be considered in the cost effectiveness analysis. It has been our judgment that if the analysis were based on the potential for reuse, the costs, to the Federal government and to state and local government, could be very high with no certainty of achieving a beneficial use. Additionally, it is likely that the construction without reuse will serve as an operable portion of a reuse system should the need for this water arise at some later time.
>
> . . . I know of no Federal regulations or interpretations of P.L.92-500 which require users of reclaimed water to pay for increased treatment to provide for reuse. Certainly such charges are appropriate, but they are not necessary in order for a reuse project to be cost-effective.*

"Needs," "Costs," State Allotments, Priorities, Federal Funding and Inflation

"Needs," "Costs" and State Allotments -- Beginning with the 1956 Water Pollution Control Act Amendments, Federal funds for construction grants were allocated to the states 50 percent on the basis of population and 50 percent on the basis of per capita personal income. A $250,000 maximum per project prescribed for the Federal loan program, initiated in 1948, was continued for grant projects from 1957 until 1961. At least half of the amount appropriated was required to be spent for grants to municipalities under 125,000 in population. Various limitations on the size of grants for a single project were in effect until the Clean Water Restoration Act of 1966, and the 50 percent population-50 percent per capita income formula was preserved for the first $100 million appropriated until 1972. Amounts in excess of $100 million appropriated for fiscal years after July 1, 1965, and until the fiscal year beginning July 1, 1972, were allocated to the states on the basis of "the ratio that the population of each state bears to the population of all the states." (P.L.84-660, as amended, Sec.8(c).)

Allotments for fiscal years beginning July 1, 1972, were to be based upon "the ratio that the estimated cost of constructing all needed publicly owned treatment works in each state bears to the estimated cost of construction of all needed publicly owned treatment works in all of the states. For the fiscal years ending June 30, 1973, and June 30, 1974, such ratio shall be determined on the basis of Table III of House Public Works Committee Print No.92-50." (P.L.92-500, Sec.205(a).) This table

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*Letter from Russell E. Train, Administrator, U.S.EPA, to Joe G. Moore, Jr., Program Director, National Commission on Water Quality, April 14, 1975.

contained a state-by-state list of the 1972-74 needs, as reported by EPA after its 1971 survey. Allotments thereafter were required to be embodied in Congressional Acts each two years, based on "a detailed estimate, biennially revised, of the cost of construction of all needed publicly owned treatment works in all of the states and of the cost of construction of all needed publicly works in each of the states . . . submitted no later than February 10 of each odd-numbered year (by the EPA Administrator)." (Sec.516(a).)

P.L. 92-500 contained authorizations of $5.0, $6.0 and $7.0 billion to be appropriated for fiscal years ending June 30, 1973, 1974 and 1975. [Section 207].

The Presidential decision to withhold allotment of $3.0 of the $5.0 billion authorized for fiscal year 1973, resulted in an allocation which probably precipitated an adverse Congressional reaction to the use of needs as a basis for alloting construction grant funds. Two billion dollars was allocated for fiscal 1972 under the prior law on the basis of each state's population as a percent of the total population; the same amount was allotted for the next fiscal year, 1973, under the new Act on the basis of a state's percentage of needs for 1972-1974 as shown in the 1971 EPA survey. Thirty-one of fifty-four states and territories received less in 1973 allotments than for 1972, and in some instances -- Alabama, Georgia, Kentucky, Mississippi, North Carolina, South Carolina, Arkansas, Louisiana, New Mexico, Texas, Oklahoma, Kansas, Colorado, Montana, North Dakota, South Dakota, Utah, Wyoming and Arizona, for example -- the reductions were substantial, i.e., 50 percent or more. (See Table V-26.) Considerable disruption faced these states. Had the full $5 billion been allotted, every state would have had an increase with, of course, some states getting much larger increases than others. Significant shifts in distribution of funds among the states might have been more readily accepted had every state received an increase over its allocation in the preceding fiscal year.

In its subsequent allotment statute (P.L.93-243), following the 1973 EPA needs survey, Congress prescribed that, for the fiscal year ending June 30, 1975, one-half of a state's allotment would be based on its proportionate share of costs for categories I through V, and one-half on its proportionate share of costs for categories I, II and IV-B, with a minimum equal to its 1972 allotment. The minimum had to be applied for Alabama, Arizona, Louisiana, Mississippi, Montana, New Mexico, North Dakota, Texas, Wyoming and Guam when EPA allotted $4 billion for fiscal 1975. When the Supreme Court later ruled invalid the President's refusal to allot each fiscal year's full authorization, the remaining $9 billion of the total $18 billion authorized in P.L.92-500 was allotted on the basis of the Congressional prescription for the fiscal year for which it had originally been authorized. In transmitting the 1974 needs survey results to Congress, EPA recommended "a new construction grant allocation formula . . . that

TABLE V-23

Publicly Owned Treatment Works
Construction Grants Allotment to Selected States
Comparison, Fiscal Year 1972 with Fiscal Year 1973
($2.0 billion in Federal Funds Each Year)
(Millions of Dollars)

State	Allotment FY 1972	Allotment FY 1973	State	Allotment FY 1972	Allotment FY 1973
Vermont	$ 5.1	$ 4.4	Kansas	$ 22.1	$ 7.5
Puerto Rico	27.0	17.7	Missouri	45.1	33.1
Alabama	33.8	7.2	Nebraska	14.9	11.1
Georgia	44.4	19.5	Colorado	21.8	6.3
Kentucky	31.5	13.2	Montana	7.5	3.3
Mississippi	22.3	7.9	North Dakota	6.9	.9
North Carolina	49.2	18.5	South Dakota	7.3	1.9
South Carolina	25.7	12.9	Utah	11.0	2.8
Tennessee	38.2	23.2	Wyoming	4.0	.5
Wisconsin	42.6	34.8	Arizona	17.7	2.7
Arkansas	19.4	7.1	Hawaii	8.1	6.6
Louisiana	35.6	18.9	Guam	2.2	1.7
New Mexico	10.7	4.2	Idaho	7.8	4.4
Texas	106.9	55.4	Oregon	20.6	17.0
Oklahoma	25.2	9.2	Washington	33.0	17.8
Iowa	27.6	23.1			

Source: Fiscal Year 1972 allotments, Table III, Committee Print (93-28), House Committee on Public Works, "Costs of Construction of Publicly Owned Wastewater Treatment Works;" fiscal year 1973 allotments from 38 FR 15760, May 6, 1974.

would be based on an equal 50 percent division between population and the Agency cost estimates for categories I, II and IV-B"(109).

In the same Act (P.L.93-243), Congress also required a special needs survey encompassing the eligible costs: a) of "best practicable waste treatment technology over the life of the works" [the 1983 requirement for publicly owned treatment works in Sec.201(g)(2)(A)]; b) to meet water quality standards established under Sec. 303; and c) "of constructing sewage collection systems and correcting excessive infiltration or inflow and . . . of correcting combined storm and sanitary sewer problems and treating storm water flows," i.e., all of categories I through VI to meet 1983 requirements and the 1983 interim goal.

The 1971 survey, stated in 1971 dollars, estimated "needs" in the sense that "needs" were considered the equivalent of then contemplated construction projects, i.e., costs of projects planned for the three-year period 1972-1974, most of which represented costs attributable to secondary or advanced treatment projects. Congress subsequently enlarged this estimate from $14.6 to $18 billion to cover fiscal 1975. The 1973 survey, stated in 1973 dollars and based on serving the population projected for 1990, estimated principally construction needs required for compliance with 1977 requirements for five waste collection and treatment categories -- secondary treatment, more stringent treatment required by water quality conditions, sewer rehabilitation to correct infiltration and inflow, new sewers and correction of overflows from combined sewers. Compiled from questionnaires addressed to municipalities, completed in some instances by consulting engineers and state officials and revised by EPA officials, the 1973 survey indicated a construction "needs" total of $60 billion.

The 1974 needs survey, for the first time(110), addressed costs associated with 1983 treatment requirements and produced a $342 billion estimate of "needs."* With three years' hindsight, the 1972 commitment of $18 billion for construction grants will provide three to one matching funds adequate to meet only a part of the collection and treatment requirements of P.L.92-500. While the $342 billion(111)estimate produced by the most recent (1974) Needs Survey may be an overstatement(112),** the approximately $320 billion gap between 1971 and 1974 estimates poses a vital question: To what extent did the 92nd Congress commit the Nation to a long-term, continuing municipal grant-in-aid program?

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*Revised by EPA to $444.3 billion, reflecting 1975 dollar value rather than 1973 dollar value used in original 1974 Needs Survey. See Table II-17 for a comparison of EPA estimates with Commission estimates.

**An examination of the validity of the 1974 Needs Survey was conducted by the Commission.

The latest survey precipated widespread discussion about the reliability of the cost estimates as a basis for allocation of grant funds to the states. Some states and municipalities apparently inflated their need estimates, hoping to maintain or improve their relative shares of annual Federal grant allocations. Moreover, some states and municipal survey participants did not support their estimates with detailed costs(113). EPA transmitted the survey to the Congress with the following disclaimer:

> The problem in using these estimates [for allocation of construction grants] is that they are based on implementation strategies that are in varying stages of development. Because of the inherent flexibility of abatement choices, the states could not be consistent or uniform in reporting their needs in situations where goals were not well defined or where there was no recognized "best method" for a solution. In those cases, when the range of choices available for abatement actions relating to a given pollution problem were wide, and when legal requirements for correction offered significant latitude, there was considerable unevenness in the impact of the diverse approaches taken by the states in determining what corrective abatement actions were necessary and in estimating the cost of such actions"(114).

During August, 1975, EPA concluded that the 1976 survey should be performed by two independent contractors -- in an attempt to develop a definitive estimate of construction needs based upon the uniform application of a consistent methodology. This survey will also fulfill the statutory directive for the next biennial estimate of needs due in 1977. The 1974 Needs Survey will be conducted by contractors for EPA with assistance from EPA regions, states and local agencies. Two separate contracts will be awarded. One, covering categories I-IV, will produce state and national costs and will use more detailed guidance to achieve standardized estimates. A major effort will be devoted to obtaining technical data on existing and needed facilities. The second contract will cover categories V and VI. State and national costs will be obtained by attempting to relate treatment needs to receiving water quality after developing uniform models. States and local governmental units will provide information and data, but final estimates will be produced by the contractors with close supervision by EPA.

A needs survey to be used as a basis for allocation must be reasonably accurate so as to produce an equitable distribution of funds. Several components of the present survey can be manipulated to produce high needs so as to enlarge a state's proportionate share of the available Federal funds. Only careful, documented state needs reports, prepared according to standard instructions and methodologies and adequately audited by EPA can assure equitable distribution. Among the variables subject to manipulation for the advantage of an individual state are population projections, percentage of the population estimated to be

sewered in future years, the expected life and capacity of collector and interceptor sewers, the miles of existing sewers subject to infiltration/inflow and requiring rehabilitation, the costs for correction of combined sanitary and storm sewer overflows, the costs of controlling or reducing pollution from storm sewers and effluent limitations more stringent than secondary to meet water quality standards and the 1983 goal.

States can increase their costs for treatment at publicly owned treatment works by designating waters at points of discharge as "water quality limited," i.e., they can adopt water quality standards that will require more stringent effluent limitations than secondary treatment. A letigimate policy question is raised: If a state, for its own water quality objectives, adopts standards stricter than those that would comply with Federal law and, in the process, increases the cost for publicly owned treatment works, should that additional cost be considered in allotting Federal funds to that state, and should that additional cost be entitled to 75 percent Federal funding? To prevent inequities in, or manipulation of, the allotment process, adequate comparisons should be made between adopted water quality standards and state-reported needs. At the same time, the extent to which state-adopted water quality standards are more stringent than required to meet the objectives and goals of the Federal Water Pollution Control Act should be examined to learn the possible effect of higher standards on allotments.

While costs for secondary treatment, and even for additional treatment processes that may be required for discharges to water quality limited waters, are well understood and generally uniform for various areas of the country, costs for some categories, particularly correction or treatment of combined sewer overflows and control or treatment of storm sewer flows, are less well identified, documented and defined. There is little agreement as to acceptable methods or solutions for control or treatment; a choice of the severity and duration of the storm event for which control or treatment is to be prescribed can substantially affect the resultant costs.

Meaningful comparisons between the three results of needs surveys conducted from 1971 through 1974 are impossible because each successive survey was based on its own definitions, interpretations and coverage. (See Table V-24). While EPA, in each instance, has attempted to revise or adjust the results of each one so as to make it more internally consistent, inherent differences in timing, instructions, interpretations and methodologies severely restrict their year-to-year comparability.

State-by-state comparisons of EPA estimates of total and 1990 per capita needs from the 1974 survey are shown separately for categories I through V and for categories I, II and IV-B in Table V-25. Wide variations exist between states and EPA regions. Comparison of per capita "needs" with per capita allotments in Table V-26 also reflects substantial differences. Identifying the fifteen highest per capita states in

TABLE V-24

Publicly Owned Treatment Works
EPA Needs Surveys -- Total Costs

Eligible Category	1971	1973	1974	
			1973$	1975$
I, II, IIIA and IVB Secondary and Advanced Treatment, Infiltration and Inflow Correction and Interceptor Sewers	$18.0	$35.2	$51.4	$67.1
IIIB Major Sewer Rehabilitation	n/a	n/a	7.3	9.2
IVA Collection Sewers	n/a	12.2	17.5	22.1
V Correction of Combined Sewer Overflows	n/a	12.7	31.1	40.4
VI Treatment and/or Control of Stormwater	n/a	n/a	235.0	305.5
TOTAL	$18.0	$60.1	$342.3	$444.3

n/a = not applicable.

Source: Commission Staff Compilation of EPA Needs Surveys. 1971 needs stated in 1971 dollars. 1973 needs stated in 1973 dollars. 1974 needs stated in 1973 and 1975 dollars.

TABLE V-25

Publicly Owned Treatment Works
EPA Estimate: State Needs and Per Capita Costs

	1990 Population*	Categories I, II, III IVA, IVB and V		Categories I, II, and IVB	
		Costs**	Costs Per Capita	Costs**	Costs Per Capita
Region I					
Connecticut	3,946	$ 1,594	$ 403	$ 484	$ 123
Maine	1,142	575	503	273	239
Massachusetts	7,052	2,964	420	1,325	188
New Hampshire	907	740	815	384	423
Rhode Island	1,134	447	384	187	165
Vermont	536	204	380	125	233
Region II					
New Jersey	8,822	4,894	554	2,602	295
New York	21,799	15,302	701	4,603	211
Puerto Rico	0	603		368	
Virgin Islands	0	44		31	
Region III					
Delaware	793	546	688	199	251
Maryland	5,318	3,642	684	2,324	437
Virginia	5,958	1,884	316	1,129	189
West Virginia	1,845	2,360	1,279	1,320	715
Pennsylvania	13,332	5,454	409	1,629	122
Dist. of Columbia	764	1,052	1,376	69	90
Region IV					
Alabama	3,850	778	202	472	123
Florida	11,728	2,704	230	1,874	160
Georgia	5,667	1,519	268	1,020	180
Kentucky	3,741	1,824	487	649	173
Mississippi	2,359	494	209	359	152
North Carolina	5,880	1,480	251	1,044	178
South Carolina	3,023	977	323	728	241
Tennessee	4,800	1,210	252	677	141
Region V					
Illinois	13,177	6,234	473	2,343	178
Indiana	6,433	2,903	451	837	130
Michigan	10,961	8,102	739	1,673	153
Minnesota	4,577	1,330	290	707	154
Ohio	13,202	7,773	588	2,367	179
Wisconsin	5,218	2,044	391	939	177
Region VI					
Arkansas	2,068	898	434	582	281
Louisiana	4,159	1,283	308	499	120
New Mexico	1,232	155	125	97	79
Texas	13,666	3,222	235	2,025	148
Oklahoma	2,942	1,484	504	662	225
Region VII					
Iowa	3,053	911	298	532	174
Kansas	2,509	1,783	710	524	209
Missouri	5,488	2,298	418	843	154
Nebraska	1,562	924	591	227	145
Region VIII					
Colorado	2,848	409	143	259	91
Montana	714	127	177	90	126
North Dakota	606	189	311	74	122
South Dakota	643	75	116	72	112
Utah	1,509	291	192	218	144
Wyoming	600	84	140	55	92
Region IX					
Arizona	3,384	500	147	266	79
California	26,601	6,208	233	4,104	154
Hawaii	1,010	523	517	439	435
Nevada	933	209	224	177	190
American Samoa	0	36	0	7	0
Guam	275	93	338	60	218
Trust Territories	205	195	951	133	649
Region X					
Alaska	408	405	992	319	782
Idaho	758	393	518	216	285
Oregon	2,943	1,081	367	308	105
Washington	4,194	1,836	437	675	161
TOTAL	252,274	$107,289	$425	$46,204	$183

* Thousands of People, 1990 population estimate
** Millions of 1973 dollars

Source: "Cost Estimates for Construction of Publicly Owned Wastewater Treatment Facilities, 1974 'Needs' Survey." EPA, February 10, 1975, Table SC-3, with per capita costs calculated and Table EPA-4.

TABLE V-26

Publicly Owned Treatment Works
Per Capita, EPA 1974 Estimates, Construction Grants "Needs" and 1973-77 Allotments

	Allotment FY 1973-77	Per Capita, 1990 Population Estimate "Needs" Categories I through V	"Needs" Categories I, II, and IV-B
Region I			
Connecticut	$ 78	$ 403	$ 123
Maine	134	503	239
Massachusetts	81	420	188
New Hampshire	170	815	423
Rhode Island	80	394	165
Vermont	85	380	233
Region I	$ 90	443	189
Region II			
New Jersey	147	554	295
New York	96	701	211
Puerto Rico			
Virgin Islands			
Region II	$ 117	681	248
Region III			
Delaware	140	688	251
Maryland	106	684	437
Virginia	83	316	189
West Virginia	64	1,279	715
Pennsylvania	74	409	122
District of Columbia	191	1,376	90
Region III	$ 87	533	238
Region IV			
Alabama	25	202	123
Florida	29	230	160
Georgia	43	268	180
Kentucky	50	487	173
Mississippi	34	209	152
North Carolina	37	251	178
South Carolina	56	323	241
Tennessee	45	252	141
Region IV	$ 46	268	166
Region V			
Illinois	86	473	178
Indiana	75	451	130
Michigan	111	739	153
Minnesota	74	290	154
Ohio	74	588	179
Wisconsin	55	391	177
Region V	$ 83	530	166
Region VI			
Arkansas	39	434	281
Louisiana	37	308	120
New Mexico	29	125	79
Texas	31	235	148
Oklahoma	46	504	225
Region VI	$ 34	293	161
Region VII			
Iowa	65	298	174
Kansas	45	710	209
Missouri	57	418	154
Nebraska	50	591	145
Region VII	$ 56	469	169
Region VIII			
Colorado	32	143	91
Montana	40	177	126
North Dakota	20	311	122
South Dakota	28	116	112
Utah	30	192	144
Wyoming	14	140	92
Region VIII	$ 29	170	111
Region IX			
Arizona	13	147	79
California	71	233	154
Hawaii	108	517	435
Nevada	70	224	190
American Samoa			
Guam	47	338	218
Trust Territories	25	951	649
Region IX	$ 66	240	160
Region X			
Alaska	126	992	782
Idaho	50	518	285
Oregon	52	367	105
Washington	51	437	161
Region X	$ 55	447	183
TOTAL National	$ 71	$425	$183

Source: National Commission on Water Quality

each of the three categories reveals that only five states appear on all three lists; another five states appear on one "needs' list and the allotment list, while four states appear on both "needs" lists but not the allotment list. There does appear to be some rough correlation between allotments and needs under P.L.92-500. (Table V-27.)

Priorities -- As states and localities proceed to complete more of the facilities required under the Act, detailed accuracy of the calculations and compilation of needs will be increasingly important. Totals of recent "needs" estimates, including the analyses by the Commission, raise the question of priorities. Because of the total cost estimates for all categories of "need" and the amount of Federal appropriations required with 75 percent Federal funding, should the categories I through VI be arranged in some priority sequence? Congress is faced with making the conscious decision whether it should fund all eligible categories or only some. Similarly, if the decision is not to fund all categories, should some eligible categories be funded in some states, based on an analysis of the potential benefits in relation to the costs? Decisions involving selective funding of projects in all eligible categories can lead to issues relating to priorities among the states. For example, should projects in categories I and II, relating to treatment, be funded in all states before funding projects in categories IV-A (collector sewers) and VI (storm sewer flows) in any state? Should states fix the priorities subject to EPA approval on a year-to-year basis?

On July 31, 1975, the Administrator of EPA transmitted to the Office of Management and Budget a proposal to alter project eligibility and to adopt a variable Federal matching share. The proposal stated the 1974 Needs Survey cost estimates in 1975 dollars -- $444.3 billion, rather than the original total of $342.3 billion. As indicated in Table V-29, EPA recommended that the Federal share of the $444.3 billion total be limited to $88.5 billion -- $57.0 billion* of which would be authorized by 1983. The proposal did not estimate when authorized funds would be obligated or expended, and did not recommend when or how the remaining federal share of $31.5 billion would be authorized or obligated. Based on the proposal, the cost of treatment and/or control of all stormwater would be borne by state and local governments. With respect to categories I-V, totaling $138.8 billion, the proposal suggests a federal/state-local cost sharing of $57.0 billion/$22.3 billion for those projects which would be eligible for grants from authorizations for fiscal years 1975 through 1982. The post-1982 cost-sharing suggestion calls for a Federal share of $31.5 billion and a state-local share of $28.0 billion.

*The $57.0 billion share includes $15 billion of the $18 billion authorized by P.L.92-500, but not obligated prior to July 1, 1974.

TABLE V-27

Publicly Owned Treatment Works
Fifteen Highest States
Per Capita EPA 1974 Estimates, Construction Grants "Needs"
And 1973-77 Allotments

State	Allotment FY 1973-77	State	"Needs" Categories I through V
**District of Columbia	$191	**District of Columbia	$1,376
*New Hampshire	170	***West Virginia	1,279
*New Jersey	147	***Alaska	992
*Delaware	140	***Trust Territories	951
**Maine	134	*New Hampshire	815
Alabama	126	**Michigan	739
**Michigan	111	Kansas	710
*Hawaii	108	**New York	701
*Maryland	106	*Delaware	688
**New York	96	*Maryland	684
Illinois	86	Nebraska	591
**Vermont	85	Ohio	588
Virginia	83	*New Jersey	554
Massachusetts	81	***Idaho	518
Rhode Island	80	*Hawaii	517

State	"Needs" Categories I, II and IV-B
***Alaska	$782
***West Virginia	715
***Trust Territories	649
*Maryland	437
*Hawaii	435
*New Hampshire	423
*New Jersey	295
***Idaho	285
Arkansas	281
*Delaware	251
South Carolina	241
**Maine	239
**Vermont	233
Oklahoma	225
Guam	218

* States on all three lists.
** States on one "Needs" list and the allotment list.
*** States on both "Needs" list but not on the allotment list.

TABLE V-28

Publicly Owned Treatment Works
EPA Construction Grant Proposal -- Scheduled Authorizations
(in billions)

Authorizations	Fiscal Years '75	'76	'77	'78	'79	'80	'81	'82	Total
P.L. 92-500	$3.6[1]	$5.5[2]	$5.9[2]	---	---	---	---	---	$15.0
Proposed 7-31-75	---	---	7.0	7.0	7.0	7.0	7.0	7.0	42.0
TOTAL	$3.6	$5.5	$12.9	$7.0	$7.0	$7.0	$7.0	$7.0	$57.0

1 Actual obligations.
2 Estimated obligations.

Source: EPA, "Proposal for a Long-term Funding Commitment Based on Variable Federal Share," transmitted to Office of Management and Budget, July 31, 1975.

Municipal compliance with P.L. 92-500 treatment requirements will be determined by both the magnitude and the scheduled outlay of Federal funds. Both the magnitude and the schedule will depend upon two determinations -- How much municipal construction incident to Public Law 92-500 will be eligible for Federal grant assistance and over what period of years will such eligible facilities be financed? The question of magnitude will not be easily answered, and once a schedule of Federal assistance is adopted, grant obligations and outlays must proceed without delay.

Determination of the magnitude and schedule of Federal grant assistance does not directly address the financial burden to be carried by state and local governments. Based on EPA's proposal for a "Long-term Funding Commitment," state-local costs could total $355.8 billion if present estimates of stormwater control or treatment costs of $305.5 billion were borne locally or by the states. Further study of the costs of alternative control or treatment methods compared with benefits to be derived from individual projects in this category could substantially reduce the cost by identifying the least cost solution to meet water quality goals or objectives.

TABLE V-29

Publicly Owned Treatment Works

EPA Construction Grant Proposal Based on Variable Federal Share
(in billions)

Eligible Category	Federal Share	Total 1974 "Needs"[1] By 1983	Total 1974 "Needs"[1] After 1983	Total 1974 "Needs"[1] Total	Federal Share By 1983	Federal Share After 1983	Federal Share Total	State/Local By 1983	State/Local After 1983	State/Local Total
I, II & IVB Secondary and Advanced Treatment and Interceptor Sewers	(75%)	$60.4	$ --	$60.4	$45.3	$ --	$45.3	$15.1	$ --	$15.1
IIIA Infiltration and Inflow Correction	(75%)	6.7	--	6.7	5.0	--	5.0	1.7	--	1.7
V Correction of Combined Sewer Overflows	(60%)	8.0	32.4	40.4	4.8	19.4	24.2	3.2	13.0	16.2
IVA Collection Sewers	(45%)	3.3	18.8	22.1	1.5	8.4	9.9	1.8	10.4	12.2
IIIB Major Sewer Rehabilitation	(45%)	.9	8.3	9.2	.4	3.7	4.1	.5	4.6	5.1
VI Treatment and/or Control of Stormwater	(-0-)	---	305.5[2]	305.5	---	---	---	---	305.5[2]	305.5
TOTAL		$79.3	$365.0	$444.3	$57.0	$31.5	$88.5	$22.3	$333.5	$355.8

1 1973 dollars used in 1974 Needs Survey adjusted by EPA to reflect 1975 dollar values.
2 Commission staff assumes that Category VI Construction would, as a matter of resource availability, be deferred until after 1983. That assumption may not hold in all localities.

Source: EPA "Proposal for a Long-Term Funding Committment Based on A Variable Federal Share" transmitted to Office of Management and Budget, July 31, 1975

Federal Funding and Inflation. The uncertainty of Federal funding for the construction grants program in recent years is reflected in Table V-30. In the eight years from 1963 through 1971, appropriations fell $1.2 billion short of the authorized $3.9 billion. The contract authority provisions, coupled with the yearly authorized level of allotments in P.L.92-500, were intended to provide some certainty and reliability to the flow of Federal construction grant funds. Once obligated under EPA's contracting authority, Congress is expected to provide appropriations in whatever total is necessary to meet actual yearly outlays under the contracts. Slow obligation of new funds in the fiscal years immediately following fiscal year 1972 will require accelerated obligation over the current and 1977 fiscal years to commit the $18 billion authorized in P.L.92-500.

While major Federal governmental effort is committed to retarding or halting inflation, experience over the last several years has indicated a severe increase in the cost of wastewater treatment plants and sewers. (Table V-31.)

In connection with delayed allotment of the full authorized $18 billion, the Commission contractor described the inflationary impacts.

> . . . Although virtually any fixed sum of money became progressively less effective in "buying power" during this time period due to increases in the standard cost of living index, the impounded grant funds were particularly affected by the rate of inflation unique to the construction industry. For example, during 1974, the construction cost index for municipal treatment plants rose 20% and the index for sewer construction rose 17.5%, while the cost of living index rose approximately 12% during the same time period. If only a 10% rate of construction price inflation is assumed to have existed during the fiscal 1973 through 1975 period, the "buying" value of the impounded $9 billion will have declined by $1.7 billion after the release of the impounded funds. However, this sum is meaningful only if it is assumed that the entire impounded amount of $9 billion could have been spent in fiscal 1973, 1974 and 1975. Thus, the only general conclusion that can be made is that a double penalty results from delays in construction grant projects, namely:
>
> a. Improvements in effluent quality are delayed; and
>
> b. The project will cost more to complete because of inflation, and thus will use more of available funds. (115).

TABLE V-30

Publicly Owned Treatment Works
FUNDING HISTORY OF CONSTRUCTION GRANTS PROGRAM

Fiscal Year	Authorized	Appropriated	Allotted Under P.L. 92-500
1957	$ 50,000,000	$ 50,000,000	$ --
1958	50,000,000	46,657,000	--
1959	50,000,000	46,816,000	--
1960	50,000,000	46,101,000	--
1961	50,000,000	45,645,000	--
1962	80,000,000	80,000,000	--
1963	90,000,000	90,000,000	--
1964	100,000,000	90,000,000	--
1965	100,000,000	90,000,000	--
1966	130,000,000	121,000,000	--
1967	150,000,000	150,000,000	--
1968	450,000,000	203,000,000	--
1969	700,000,000	214,000,000	--
1970	1,000,000,000	800,000,000	--
1971	1,250,000,000	1,000,000,000	--
1972	2,000,000,000	2,000,000,000	--
1973	7,750,000,000**	1,900,000,000**	2,000,000,000*
1974	6,600,000,000**	--	3,000,000,000*
1975	7,000,000,000	--	4,000,000,000*
1976	--	--	9,000,000,000*
1977	--	--	Remainder*

* Contract Authority; funds need not be appropriated prior to obligation.
** Includes $2.75 billion in 1973 and $600 million in 1974 authorized as part of P.L. 92-500 for treatment works constructed from fiscal 1957 to 1972; of these amounts, $1.9 billion was appropriated in 1973.

Source: 1974 GAO Report on Construction Grants for Municipal Waste Treatment Plants, printed in Institutional Assessment of the Construction Grants Program Under Public Law 92-500, Touche Ross & Co., contractor report for NCWQ, July 31, 1975, page III-H-2.

TABLE V-31

Publicly Owned Treatment Works
Inflation of Construction Costs for Treatment Plants and Sewers

	Treatment Plants	Sewers
Base (57-59)	100.0	100.0
1960	105.0	106.2
1961	105.9	108.2
1962	107.0	109.7
1963	108.5	113.1
1964	110.1	114.7
1965	112.0	116.6
1966	116.1	120.5
1967	119.4	124.5
1968	123.6	129.6
1969	132.7	138.7
1970	143.6	149.8
1971	159.8	167.2
1972	172.0	185.6
1973	182.6	199.6
1974	217.2	230.5
1975 (March)	247.4	253.0
1975 (June)	245.9	255.6
1975 (September)	251.3	261.3

Source: EPA Sewage Treatment Plant and Sewer Construction Cost Indices.

Using one possible pattern of Federal appropriations over an eleven-year period to meet a $158.1 billion construction grant program for categories I through V, with 75 percent Federal funding, provides an example of the inflationary effect:

Fiscal Year	Cummulative Inflation	Appropriations	
		Billions of 1975 Dollars	Billions of Inflated Dollars
1975	100.0%	$ 2.6	$ 2.6
1976	107.9	5.9	6.4
1977	113.4	7.5	8.5
1978	120.0	8.7	10.4
1979	132.4	9.9	13.2
1980	144.0	11.2	16.2
1981	153.3	12.5	19.1
1982	162.9	13.8	22.6
1983	173.3	15.2	26.2
1984	183.7	15.6	28.6
1985	194.7	15.6	30.2
TOTAL		$118.5	$184.4

If all sectors of the economy were to simultaneously experience the same rate of inflation, little adverse economic impact might result. When various sectors experience different rates, or some inflate while others deflate -- either of which is the more likely occurrence in the real world, then consequences for some sectors can be severe. Since government expenditures can be inflationary, a program of the magnitude outlined here could itself trigger or accelerate inflation. In shaping the construction grants program over the next decade, Congress will have to evaluate both the impact of general economic conditions on various alternative levels of expenditure and the economic impact of these levels on other sectors of the economy. The ideal rate of annual appropriations would be that which achieves Congress' selected objective with minimal contribution to, or loss of purchasing value from, inflation.

Pretreatment, Industrial Cost Recovery and User Charges

Pretreatment and industrial cost recovery are provisions designed for industrial or commercial sources discharging, or planning to discharge, into publicly owned treatment systems. The purpose is to insure that the discharged wastes are compatible with the public treatment facilities and that the discharger pays a share of the cost of construction proportionate to the use of the system. User charges relate to recovery by the municipality of the costs of operating and maintaining the facility from all users -- industrial, commercial and residential -- proportionate to the use of the facility.

Each of these provisions has provoked controversy, although none of them really has much of a record for analysis since they apply only to projects funded and completed under P.L.92-500, and few of those projects have been completed. The Commission's work, therefore, was limited to an analysis of the expected problems and success of these provisions and the contentions surrounding them.

Although these provisions contain potential problems for industrial compliance, there are also some very distinct advantages provided to industries that join up with publicly owned treatment works. EPA has identified the advantages to industries that choose to discharge into municipal systems as "economies of scale in public treatment, . . . avoiding the costs of obtaining their own permits, and (as long as they meet certain pretreatment requirements) . . .[and] avoidance of certain monitoring responsibilities. Firms participating in a municipal system also avoid the necessity to raise external capital themselves to purchase pollution control equipment, i.e., they do not have to go to the capital markets to borrow funds, thereby perhaps altering their debt-equity ratio." EPA adds, "Using an opportunity cost of capital of 10 percent, recovered over 30 years, and assuming that the industrial share of all local costs is recovered, from industry, it can be demonstrated that the implicit subsidy to industry on the Federal share is 69 percent. If one takes into account that many states provide supplementary grants that also do not require that interest be recovered, and that (in the Federal program) the 25 percent local share of industrial costs need not be recovered at all, the effective subsidy to industry will, in many cases, exceed the 75 percent subsidy to municipalities"(116).

Pretreatment

Probably no single aspect of the EPA's implementation of P.L.92-500 has caused more difficulty than the pretreatment regulation and guidelines issued pursuant to Sec. 307(b) of the statute. Regulations were proposed over two years ago and have yet to be promulgated.

Section 307(b)(1) of the statute requires the Administrator to promulgate pretreatment standards, "for introduction of pollutants into treatment works . . . which are publicly owned for those pollutants which are determined not to be susceptible to treatment by such treatment works or which would interfere with the operation of such treatment works." Original pretreatment regulations, pursuant to the law, were published in November, 1973, but subsequently withdrawn. Proposed new regulations which, to this date, are not yet final, were published in July, 1975 (40 CFR, Part 403). Under these proposed regulations, certain wastes which would interfere with the operation or performance of a treatment works are prohibited from entering the publicly owned system. All others would be regulated under limitations issued for each specific industry. As pointed out in the discussion of the economic impacts of the Act on certain industrial categories in Chapter III, the uncertain status of these pretreatment regulations is a major indeterminant as to the real economic impacts of the Act on many small industries.

The most serious issues with regard to the pretreatment question concern the definition of compatible and incompatible pollutants and the factors that are to be taken into account in the issuance of pretreatment standards. Tentatively, EPA has opted for including the variety of factors that constitute the best practicable technology from the best available technology guidelines, including macroeconomic impacts, ages, sizes, characteristics of particular plants and other factors directly related to the industry's production processes.

A second aspect of this problem concerns the relationship of volume to the pollutants, themselves. That is, in many instances, an industry is charged simply for the volume of water that accompanies its pollutants, not for the pollutants themselves because, as a practical matter, a primary cost factor with a municipal treatment plant is related to the sheer volume of liquid that it needs to treat. Also, compatible and incompatible constituents can be inextricably linked in chemical compounds, requiring an industry to apply the full treatment technology prescribed for BPT in order to remove the incompatible pollutant. The result of the treatment, however, is a level of reduction of BOD and suspended solids which would permit the discharger to discharge directly into a water course -- an option that, because of size or location, is probably not available.

An additional issue concerns the point of discharge. Does the regulation apply at the point of the municipal discharge or at the point of the industrial discharge into the municipal system? As a practical matter, it is difficult to determine or to regulate the actual industrial discharge because there is no permit on it if it is discharged into a municipal system. Yet, a large municipal system could have 4,000-5,000 industrial dischargers and it is extremely difficult to determine, from a sampling of that municipality's effluent, which contributions are being made by which industries.

In any event, the record of the implementation of Sec. 307(b) to date is not good. A possible reason is that the regulations have been geared directly to the industries, and not to the municipalities, and the municipalities have not been involved in their formulation. It has been suggested that if the municipalities were to set their own pretreatment requirements for their own industries, within perhaps somewhat broad Federal parameters, some of these problems might be solved.

Industrial Cost Recovery

For the first time in the construction grants program, P.L.92-500 required recovery of the Federal share from "the industrial users" of "that portion of the cost of construction of such treatment works (as determined by the Administrator) which is allocable to the treatment of such industrial wastes." [Sec.204(b)(1).] The grantee is allowed to retain an amount from the repayment of the Federal contribution to the industrial share of costs "equal to (A) the amount of the non-Federal cost of such project paid by the grantee plus (B) the amount . . . necessary for future expansion and reconstruction of the project, except that such retained amount shall not exceed 50 per centum of such revenues from such project." [Sec.204(b)(3).]

The concept of having users of wastewater treatment facilities bear their proportionate shares of both the capital and operation and maintenance costs was not new with P.L.92-500. Previously, EPA regulations required industrial cost recovery of the local share of grants and charges for the use of the system.

While the debate continues as to whether or not requiring recovery of the portion of the capital costs attributable to an industry's pollution either provides too much of a subsidy because it is, in effect, a long-term interest-free loan, or too much of a cost to industry which had, before the passage of P.L.92-500, been able to connect to municipal systems at no capital costs, it appears as though the actual implementation of the industrial cost recovery provision has not seriously held up the construction grants program. Of the 5,000-6,000 projects currently in some form of the construction grants pipeline, only 90 have been held up in some way in order to solve problems relating to industrial cost recovery.

One problem has occurred in large municipal systems where several grants are received every year for various portions of the system. For example, the City of Chicago could receive a grant to expand the size of an interceptor and that would be considered a separate grant. Then, the industrial cost recovery for the cost of that interceptor would have to be calculated and charged to each industrial user. This appears to be a significant problem in large cities, and not a problem to smaller communities which receive their grants in one piece.

Another series of problems concerns the definition of an industry to be considered under the industrial cost recovery provision. Commission studies showed that commercial establishments, such as hotels and office buildings whose waste is both compatible with the municipal treatment plant and largely domestic in character, were treated inconsistently, being exempted in some regions and included in others.

Another area relative to any discussion of industrial cost recovery concerns the facilities which are constructed primarily to serve a particular industry. There have been situations where a single industrial facility constituted a major proportion -- up to 95 percent -- of the waste discharged to a municipal facility. In effect, then, the municipality has constructed a sewage plant primarily to treat the waste of that particular industry and that industry has received an interest-free 30-year capital loan in order to solve its water pollution control problems. While this situation is somewhat isolated in its occurrence, it raises a serious question as to certain aspects of the industrial cost recovery program.

The enabling provision of the statute provides for the municipality to retain up to 50 percent of the money recovered under industrial cost recovery for the specific use of either future reconstruction of the facility or expansion of the facility. To date, EPA is still wrestling with the question of exactly what the 50 percent that the community keeps can be used for, and in what proportion.

The period of cost recovery is 30 years or the useful life of the treatment works, whichever is less. The general average, on an aggregated basis throughout the nation, of pay-back to the U.S. Treasury under the industrial cost recovery provision is $6 million per year for 30 years, for every $1 billion expended in construction grant funds. For the original $18 billion in construction grant money authorized by P.L.92-500, the total expected to be paid back to the Treasury under industrial cost recovery is $108 million per year for 30 years, or a total of $3.24 billion. A question has been raised as to why this money is paid back to the general fund in the Treasury and not reallocated to specific pollution control projects. In other words, while the first 50 percent of the industrial pay-back may be kept by the community for designated purposes of reconstruction and expansion of the facility, the other 50 percent goes into the general revenues of the Treasury.

In conclusion, the Commission, in its examination of the construction grant program, found that while there were certain philosophical differences and certain problems with actual implementation of the industrial cost recovery program, there was no evidence of overwhelming obstacles to its implementation.

User Charges

The user charge requirements established in P.L.92-500 were a major departure from previous legislation. Specifically, a "proportionality" procedure was included relating to local operations and maintenance funding. Payment by users must be proportional to use and revenues collected must be in excess of capital and O&M costs.

The concept of having users of wastewater treatment facilities bear their proportionate shares of both the capital and operation and maintenance costs was not new with P.L.92-500. Previously, EPA regulations required industrial cost recovery of the local share of grants and required user charges, although ad valorem taxes were considered an acceptable form of user charges. Many political subdivisions were already operating their systems as revenue producers. The major distinction produced by P.L.92-500 is the statutory and regulatory detail to which acceptable systems are described. Even the determination of the industrial share is not a simple, straightforward calculation because of the complexity of some industrial wastes and the difficulty of allocating treatment costs. Requirements of the new law and regulations also conflict with existing long-term contracts with industrial users.

EPA initially determined that the proportionality requirements of the law could be satisfied by a surcharge to the ad valorem taxes of a community. GAO stated that this method of payments was not consistent with the intent of the law for the following reason:

> Although the EPA proposal is to achieve proportionality between classes by imposing a surcharge for a class of users' proportionate share of operation and maintenance costs, the issue of proportionality within classes is not addressed. The only exception to this is the case of gross disproportionality. (117)

Because of this conflict, EPA rescinded its initial memorandum and developed user charge models which are totally independent of the tax structure. Specifically:

> The user charge system must result in the distribution of the cost of operation and maintenance of treatment works within the grantee's jurisdiction to each user (or user class) in proportion to such user's contribution to the total wastewater loading of the treatment works. (118)

To determine proportionate contributions, the charge is to be based on factors such as strength, volume and delivery flow rate. In addition, EPA regulations regarding requirements for municipal treatment facilities state that quantity discounts will not be acceptable.

The impact of this provision is that many municipalities which have incorporated waste treatment costs in the tax structure must reverse these procedures. It has been estimated by EPA that approximately 25 percent of all municipalities in the U.S. currently have an ad valorem structure. (See Table V-32.) This includes major urban centers such as Chicago and Orange County, California.

Of the municipalities with acceptable user charge systems interviewed during field visits, most were using a water usage charge for determining waste treatment charges. The advantages to cities already using this system are little increase in administrative costs and no costly additions of meters to the sewer system (assuming a meter is used to monitor usage).

The impact of user charge system requirements has not been fully determined since the system does not have to be approved by EPA until the 80 percent level of construction grant payments has been reached. As of completion of the Commission contractor's report on construction grants, only 199 step 3 projects out of a total of 1,465 active step 3s had reached or exceeded the 80 percent level(119).

User charge requirements necessitate that a nubmer of municipalities must change legislation to comply with requirements. The user charge requirements is a selective problem, insofar as EPA has estimated 70 percent of municipalities already have the legal and administrative structure to implement the provisions. This statement is qualified, however, in that little operational data exists as to the extent to which municipalities are affected by user charges. Larger municipalities have, in the past, used some type of charge system other than ad valorem taxes. Although these charge systems may not meet proportionality requirements, they do provide a basis for defining future cost systems. Smaller communities reflect greater instances of reliance on a tax basis, as well as being least prepared for the administrative requirements inherent in a relatively sophisticated cost assessment and collection system.

The regulations allow a water usage rate basis for administering the user charge system. In municipalities where this is the case, the water rate system reduces administrative costs and may be applied to both industrial and domestic users. As pointed out in the economics chapter, one advantage of this use-based system is that it definitely encourages industrial users to reduce water use and loadings, thereby freeing up capacity in the public treatment works.

Many municipalities have simply deferred the problem in anticipation of legislative action, citing as their reasons such matters as the delay in publishing regulations or pending legislation. This tendency to wait for a change in policy, rather than make the required changes in legislation and implement a new system, is indicated in the fact that, nationally,

TABLE V-32

Publicly Owned Treatment Works
User Charge and Industrial Cost Recovery System
(Population affected by ad valorem based systems)

STATE	1970 Urban Population	Est. % Pop. Served by ad valorem	Est. Pop. by ad valorem
Alaska	146,000	100%	146,000
Arizona	1,409,000	95%	1,338,000
California	18,136,000	90%	16,322,000
Connecticut	2,345,000	95%	2,227,000
Hawaii	639,000	100%	639,000
Indiana	3,372,000	50%	1,686,000
Illinois	9,230,000	90%	8,307,000
Kansas	1,485,000	50%	742,000
Louisiana	2,406,000	50%	1,203,000
Massachusetts	4,810,000	50%	2,405,000
Montana	371,000	50%	185,000
North Carolina	2,285,000	90%	2,056,000
South Carolina	1,232,000	50%	616,000
Utah	851,000	80%	680,000
Wisconsin	2,910,000	50%	1,455,000
		Total	40,007,000

Total U.S. Urban Population (1970) - 149,325,000

Total U.S. Metropolitan Population (1970 - 139,413,000

Source: Environmental Protection Agency, Construction Operations Branch, Office of Water Program Operations.

51 municipalities have completed more than 80 percent of construction, yet have been paid less than 80 percent of costs. This represents 25 percent of the grants which have reached the 80 percent level in construction. Of the rest, 148 have progressed beyond this point, indicating that either a user charge system acceptable to EPA was developed or that payments have been made without an acceptable system. Of these, 22 percent have reached the 100 percent payment level, indicating that there is definitely an acceptable user charge system(120).

A significant number of grants (several hundred) will probably reach the 80 percent level shortly. EPA expects that these grantes may create a substantial backlog of projects either delaying payment or, in some cases, slowing construction.

Unquestionably, user charge requirements have created administrative problems, but many of these problems occur because of inconsistent policy. The conflict of the original EPA position on ad valorem taxes and the GAO ruling has affected the credibility of the existing requirements, thereby creating the potential for future delays in the program.

The Environmental Financing Authority and Providing the Non-Federal Share

P.L.92-500, Section 12, provided for the creation of an Environmental Financing Authority to assist appropriate applicants in securing the local share of construction project costs. The Authority was authorized "to make commitments to purchase, and to purchase . . . any obligation or participation . . . issued by a State or local public body to finance the non-Federal share of the cost of any project . . ."(121). Before the Authority could make such a commitment, the EPA Administrator was required to certify: 1) "that the public body is unable to obtain on reasonable terms sufficient cridit to finance its actual needs;" 2) "has approved the project as eligible . . ."; and 3) "has agreed to guarantee timely payment of principal and interest on the obligation" (122). The Treasury was authorized to advance funds until they could become available from the $100 million authorization. The Authority's ability to make such commitments expired on June 30, 1975, it was not renewed, and only one application was made during its life(123).

The Commission contractor found little evidence that financing the local share caused major problems. They did indicate that "a more significant problem" might arise "as the cost of projects increase in the future" and that "at this time it appears to be a serious constraint only in very small, economically depressed communities and, in some cases, where bids received from the construction contractors are significantly higher than original project cost estimates"(124).

Subsequently, there have been indications of some communities having difficulty raising their matching share. Testifying before the House Subcommittee on Investigations and Review on February 24, 1976, EPA's Administrator advised the Congressmen that some places, like New York City, are experiencing real problems and singled out interest rates as high as 18 percent being bid on municipal treatment bonds as the explanation.

Program Management and Goal Achievement

Public Law 92-500 is generally characterized as a regulatory Act, but it is also a major resource allocation law -- particularly with respect to the Federal, state and local resources which must be allocated to the construction of publicly owned treatment works.

Construction grant assistance is inextricably related to the issuance of municipal discharge permits, for the quality of receiving waters should improve as more publicly owned treatment works meet the requirements of the Act. Analytical data generated by the construction grant management process is restricted almost exclusively to tracking construction grant projects, obligations and outlays. To date, the treatment requirements of the Act have not been translated into water quality objectives on a state-by-state basis, and the capability to relate POTW construction to permitted discharge conditions, to compliance monitoring and to enforcement activities has not been developed. While the management techniques used to administer a grant-in-aid program may differ from those employed in the administration of discharge permits, data regarding the elimination of pollutants as a result of the independent and interdependent actions of both programs is essential to an understanding of institutional response to P.L.92-500.

Summary and Future Prospects

EPA has undertaken two major internal examinations of the construction grant programs, one in 1974 and one in 1975. In both instances, major changes designed to improve and accelerate the procedures have resulted. Continued evaluation of the program nad its operations will result in other improvements which should serve to eliminate or minimize the causes of delay enumerated above. Some of the time-consuming requirements -- for example, the large number of laws and regulations outside P.L.92-500 with which applicants or grantees must comply -- probably cannot be changed quickly or easily, and may never be altered. Congress must realistically assess the time and resources necessary to manage and execute a program of the existing magnitude, particularly as it evaluates the rate at which it wishes to see the achievement of water quality improvements through completion of publicly owned treatment works providing secondary or advanced treatment to meet more stringent limitations and specified water quality goals.

Government Assistance to Impacted Industrial Dischargers

Congress made provision for minimizing any adverse economic impact on an individual discharger of meeting the 1983 requirements of the Act [Section 301(c)]. An industrial or agricultural point source discharger filing application for a permit after July 1, 1977, may ask for, and the EPA Administrator may grant, a modification of the applicable 1983 requirements "upon a showing by the owner or operator of such point source satisfactory to the Administrator that such modified requirements 1) will represent the maximum use of technology within the economic capability of the owner or operator; and 2) will result in reasonable further progress toward the elimination of the discharge of pollutants."

Among the Federal regulations and loan programs available to assist "impacted" individual dischargers are industrial revenue bonds, accelerated depreciation, an investment tax credit and loans and loan guarantees provided by the Small Business Administration.* Some states also allow property tax exemptions, sales and use tax exemptions and franchise and income tax deductions.

The first industrial revenue "pollution bond as such was brought out in 1971 to provide $5 million for a United States Steel installation in Pennsylvania. Since then more than $6 billion in sales have been reported and several hundred million dollars are estimated to have been spent but have not been reported. . ."(125). Acceleration of the use of these bonds occurred particularly after August 1972, when the Internal Revenue Service promulgated necessary regulations. By the end of 1974, all but two states -- Washington and North Carolina -- apparently had authorized this kind of bond, and sales have been reported over the last two years from 37 states(126). Two conditions must be met: 1) "the improvement would not have been made but for the purposes of pollution control" and 2) "it is not designed to significantly meet any purpose other than pollution control."(127) Some governmental entity must certify that the financed facility will meet current control standards, and at least 90 percent of the bond proceeds must be spent for pollution control.

Among the advantages of revenue bond financing are:

1. Savings in interest rates of 1.5 to 2.0 percentage points ("this can mean a gross savings of about $4 million in total interest expense on a 20-year $10 million issue.").

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* Unless otherwise indicated, this discussion is based upon Economic Report, Alternative Wastewater Treatment, Report of the Administrator of the Environmental Protection Agency, September, 1975, pp. IV-42 through IV-56, or information secured directly from the Small Business Administration.

2. Avoidance of "fees and related legal expenses" in connection with Securities and Exchange regulation since the bonds are not registered (these savings can be partially offset by municipal bond counsel fees, legal fees to local counsel and "the somewhat higher underwriters' spread usually found in the tax-exempt market.").

3. By utilizing a lease (or installment purchase) arrangement the treatment facility can be classified as owned property of the industry, eligible for depreciation deductions and investment tax credit with part of the lease payment deducted as though it were interest paid on a loan and with miscellaneous other expenses deducted as costs of securing the loan.

4. In some instances, the industry may receive favorable state and local tax treatment such as exemption from property taxes, sales taxes on construction costs (if done by a public body) and rental taxes (through use of an installment sale)."(128)

As noted in the Economics Chapter, these industrial revenue bonds are not without their adverse effects, especially upon state and local borrowing capacity since the tax exempt revenue bonds tend to drive up the cost of interest and to crowd out public tax exempt bonds.

Two characteristics of industrial revenue bonds tend to restrict their use to large firms -- underwriting costs are such that they are not feasible for projects costing less than approximately $2.3 million and, as with conventional financing, the bonds are supported by the firm's credit standing.

Accelerated depreciation, permitting a firm to depreciate in five years the first 15 years of the useful life of pollution control equipment, is available for such equipment installed between January 1, 1969, and January 1, 1975. This assistance provision is rarely used since the investment tax credit usually provides greater benefits.

Since 1971, a firm has been entitled to deduct 7 percent of its investment in pollution control equipment during the first year of installation. A firm may use either accelerated depreciation or the investment tax credit. "Analysis has shown" that, for equipment with a useful life between 12 and 22 years, accelerated depreciation is more advantageous, while for equipment for a life less than 13 or more than 22 years, the investment tax credit provides the most assistance.

Section 8 of P.L. 92-500 authorizes appropriations not to exceed $800 million to the Disaster Loan Fund of the Small Business Administration (SBA) to be loaned at low interest rates for long terms to small firms "substantially injured" by expenditures necessary to meet the requirements of the Act. Loan guarantees are also available. Firms

having financial difficulty prior to the imposition of pollution control regulations are ineligible, and applicants must demonstrate that they are unable to secure conventional financing. Loans are not available to large marginal firms.

Nineteen programs of disaster and other assistance are financed from the Disaster Loan Fund. The total current yearly appropriation of $160 million is divided into two parts, $60 million for physical disasters and $100 million for all other programs; no specific sum is earmarked for pollution control loans or guarantees. In the 12-month period between August 1974 and September 1975, SBA made 24 pollution control loans totalling $8.6 million.

The Economic Development Administration (EDA) also administers low interest loans available to impacted firms in designated areas of high unemployment.

All the programs currently available assist firms to finance capital costs of pollution control. EPA has stated, "The result is a bias in favor of capital-intensive pollution control programs, which may be costlier than more labor-intensive methods of control. The pollution control related costs of land, buildings, and process equipment changes are eligible for the SBA loan and loan guarantee programs and for IRB [industrial revenue bond] financing, but not for rapid tax amortization or the investment tax credit. Consequently, there is a bias in favor of end-of-pipe methods of treatment as opposed to process changes."

Planning

The Commission's examination of P.L. 92-500 planning activities has been complicated by two principal features of water pollution planning. First, water pollution planning covers a multitude of concerns -- from engineering determinations of sewer pipe needs to assumptions of metropolitan growth patterns. And secondly, the implementation of the Act's planning requirements has presented the Commission with a constantly moving target -- particularly with respect to areawide planning activities.

When the Commission began its analysis of planning in November of 1974, 11 areawide planning agencies had been designated by EPA. When the Commission's contractor submitted his final report on August 31, 1975, the number had grown to 149. Areawide funding during that 10-month period jumped from $13 million to $163 million. During the same period, EPA twice made major revisions in its planning guidelines, the pace of the construction grants program was accelerated and permits were issued to all major dischargers.

Congress intended that the permit and construction grants programs would be integrated through the planning process. The language of the two major planning sections -- areawide and statewide -- are directly keyed to permitting and construction grant activities. Areawide waste treatment management plans must include construction priorities [Section 208(d)], and all NPDES permits must conform to approved areawide plans [Section 208(e)].

Despite its intent, Congress did not incorporate planning provisions into any single section of the Act. Instead, planning provisions appear in various sections, are based on different planning assumptions and have led to different kinds of interpretations which have often produced different kinds of planning programs. Four major planning provisions are set forth in the first three titles of the Act.

-- Section 106 of Title I requires state program plans which define annual state water pollution control objectives and indicate state level resource commitments. Annual Federal grants to state pollution control agencies are conditioned upon submission of acceptable plans.

-- Section 201 of Title II contains the provisions which have been incorporated by EPA into the construction grant process as Step 1 facility planning.

-- Section 208 of Title II requires areawide waste treatment management plans which then lead to the designation of areawide waste treatment management agencies.

-- Section 303(e) of Title III requires continuous state planning, sometimes referred to as basin planning, which governs state establishment of water quality standards for each state river basin.

Given an uncoordinated legislative mandate, there is some justification for the fragmented implementation which has characterized planning efforts to date. But an uncoordinated legislative mandate -- difficult to interpret as it may be -- is not the sole explanation of the present disarray of planning efforts. EPA and the states have responded to fragmented planning provisions with fragmented implementation. The 1974 Water Quality Strategy Paper indicated that construction grants, permits, and nonpoint source controls should key off the relevant plans. But in practice, relevant plans key off grants and permits.

Apparently, EPA regards the planning process as only one of a number of program strategies -- set apart from other activities in a separate division, and competing for attention and resources with construction grants and permits. With few exceptions, the states follow the EPA pattern.

Out of Phase

According to the timetables of the Act, initial state basin planning should now be completed, and initial areawide plans would be close to completion by mid-1975. Yet, not one areawide plan has been completed and only one-third of 635 state river basin plans have been completed(129).

The data and management strategies developed in these two planning processes were intended to be used to determine controls necessary for implementing the Act's 1983 goals since:

-- The areawide planning process should be used to determine best practicable waste treatment systems for the designated areas and to develop strategies for control of nonpoint sources, and

-- The state basin planning process should be used to determine pollution control achievements and to identify additional point source control requirements.

As a practical matter, neither planning process is yet affecting decision-making.

Public Law 92-500 -- Four Major Planning Processes

State Program Plans (Section 106) Annual state program plans define program objectives, indicate resource allocations and report to

EPA progress toward current year objectives. Approved yearly by EPA, the plans are required as a condition precedent to Federal support of state programs.

The state plans parallel the Federal program planning effort (which now culminates in EPA's "Water Quality Strategy Paper"), but for the most part, are not employed effectively as management tools. Rather, state agencies parrot, as an expedient to EPA plan approval, the format supplied by EPA(130). Two notable exceptions are Virginia and California, where state program plans are used to manage the joint Federal/state program.

Facilities Planning (Section 201) Facilities planning is the first step of the three-step construction grants process. While facility planning is not specifically authorized by the Act, the 1973 EPA Water Quality Strategy Paper indicated that it regarded facility planning as a major program objective. Construction alternatives, including siting, size and number of facilities, are examined in Section 201 facility plans, and the most cost-effective solutions devised. Options considered include land treatment, water recycling, flow reduction, and operations and maintenance and are ranked in terms of the economic and environmental effort(131) in an effort to reduce construction and operation and maintenance costs and to ensure that facility size and location produce minimal environmental damage. Facility plans and the areawide management plans overlap significantly, and since facility plans play an integral role in the construction process, their impact on decision-making is great.

Areawide Planning (Section 208) Areawide planning is clearly the most complex, and potentially innovative, of the four major planning processes. It is the process with which implementing agencies have experienced the most difficulty. After a slow start, areawide planning is now EPA's top-priority planning activity for FY '76 and one of its eight major program priorities.

The Senate, which originated the areawide management concept that emerged in conference, made 208 (then 309) a clear and strong priority, as demonstrated in the Public Works Committee Ranking Majority Member's floor statement:

> A fifth major element in this bill is the mandate for regional planning. This is accompanied by a clear description of the planning requirements, which would incorporate all sources, to agricultural, mining, and urban runoff to the control of accumulated sources of pollution, such as deposits in harbors. Such broad planning is necessary to develop truly comprehensive and adequate waste management systems(132).

Areawide planning objectives include the development of a wastewater management strategy which designates methods for the control or treatment of all point and nonpoint pollution sources within an area. Once an areawide plan is approved -- at the state level by a Governor and at the Federal level by the EPA Administrator -- permits and construction grants must conform with its provisions. Specific outputs resulting from the Section 208 areawide planning process include:

-- treatment works necessary to meet anticipated municipal and industrial waste treatment needs for a 20 year period with provision for annual updating;

-- construction priorities for such treatment works with time schedules for initiation and completion;

-- a regulatory program to 1) control or treat all point and nonpoint pollution sources, including in place or accumulated pollution sources; 2) control the location, modification, and construction of any facilities within the area; and 3) assure that industrial or commercial waste discharges into any publicly owned treatment works meet applicable pretreatment requirements;

-- measures necessary to execute the plan (including financing), the time required, costs and its economic and environmental impact upon the residents of the area;

-- a process to identify agriculturally, silviculturally, mine and construction related nonpoint sources of pollution, and proposed procedures and methods (including land-use requirements) to control such sources;

-- a process to 1) identify salt water intrustion into rivers, lakes and estuaries, and 2) proposed procedures and methods to control such intrusion;

-- a process to control the disposition of all residual waste generated which could affect water quality; and

-- a process to control the disposal of pollutants on land or in subsurface excavations to protect ground and surface water quality.

State Basin Planning (Section 303(e)) EPA Guidelines indicate that:

> The basin plan is neither a broad water and related land resources plan nor a basinwide facilities plan. Simply stated, the basin plan is a management document that identifies the basin's water quality problems and sets forth a remedial program to alleviate those problems. A basin plan should be a dynamic management tool, rather than a rigid, static compilation of data and material(133).

State basin plans should identify problems, determine priorities for construction grants and discharge permits, and identify areawide needs and priorities.

Over 600 basin plans must be prepared nationally, and about 50 to 60 percent of the plans will have reached an intermediate level of development by the beginning of FY 1976(134). The 303(e) planning program is essentially a continuation of requirements established by EPA under its older 18 CFR regulations.

Basin plans have had their greatest impact to date in setting priorities for construction grants, in issuing permits based on the classification of stream segments (as either "water quality limited" or "effluent limited" segments), and in determining waste load allocations for particular river stretches. In most states, the water pollution control agency develops basin plans with the assistance of contractors. To date, the products have ranged from poor (purely descriptive, non-analytic, non-program oriented) to very good, program-directed studies(135).

EPA has promulgated revisions to its basin planning regulations (40 CFR, Parts 130-131). These revisions require nonpoint "Phase II" planning to follow approval of the "Phase I", point-source control plans. Plans will refine point-source controls developed during "Phase I", including necessary controls over stormwater runoff, develop control solutions for nonpoint sources for the period from July 1976 to July 1981 [categories are to be addressed throughout the period so that the requirements of Section 208(b)(2)(F-K) would be available by 1981], merge areawide wastewater management and facilities plans with state water quality management plans, develop regulatory programs and identify necessary implementing and operating agencies.

Planning -- Coordination, Management and Nonpoint Source Control

While EPA has attempted to coordinate the several planning processes, the attempts have, at best, been uneven. Proposed regulation revisions

will place all planning provisions of the Act within a single set of regulations -- an important step in the right direction. At the same time, the lack of coordination, first in the law and then in the course of implementation, has produced a confused planning scheme with unclear purpose and responsibilities.

The planning provisions have not yet influenced facility construction decisions and areawide wastewater management. Both Senate and House versions of the Act emphasized the areawide management planning process as central to its implementation: Areawide planning requirements are clearly linked to implementation and action in that construction grants and permits must conform to gubernatorially approved plans. The intent that planning was to guide and shape the action parts of the Act is quite clear.

Delay in implementing areawide planning requirements has foreclosed the prospect that construction and permits would reflect areawide planning efforts. Approved areawide plans will not impact construction and permit programs for another two to three years and then in only a relatively few areas in the country -- for only 149 areawide planning agencies will be operating by Fall of 1975 (Figure V-8). Thus, for five to six years after the enactment of the Act, construction grant and NPDES activities will have proceeded without the potential benefit of locally developed areawide wastewater strategies. Those plans which will be developed will accommodate existing permits and facility plans rather than influence their form, size and location.

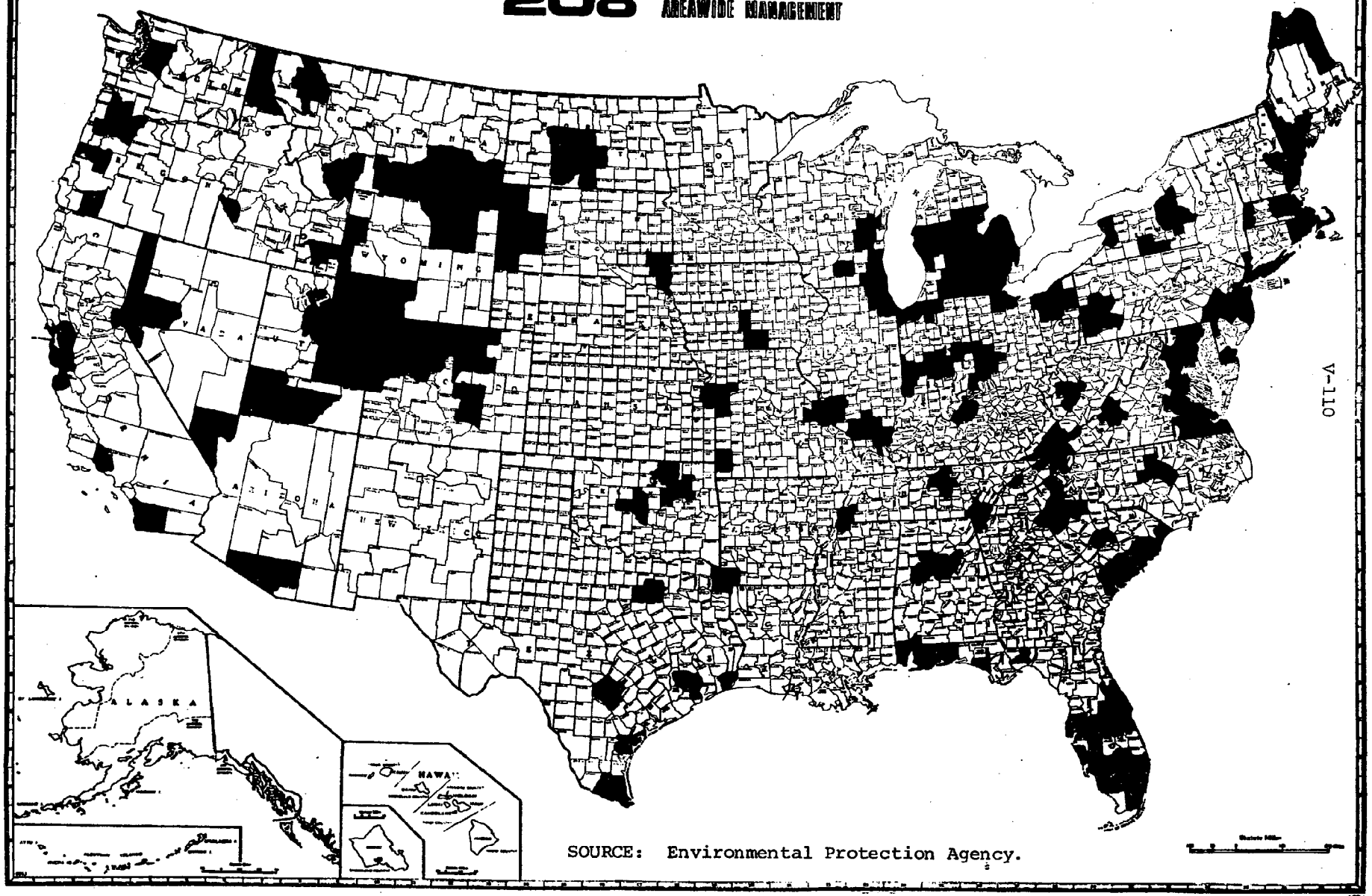
States are just now being informed of their responsibilities for water quality management planning in all areas of the state not served by designated areawide planning agencies. EPA has not yet clearly delineated what state responsibilities are in these cases -- particularly with regard to the relationship between state areawide planning responsibilities and construction, regulation, permits, financing and management.*

Section 208 areawide planning provisions contain the Act's only direct reference to nonpoint source control. As a result of areawide planning delay, the question of nonpoint source control has not been addressed in any substantial fashion. Despite concerned undertakings by several local planning agencies and states, the benefits promised by the nonpoint source control planning provisions in Section 208 have been jeopardized by the absence of specific EPA guidance. State and local misgivings about the propriety of using Section 208 as a land-use control device also have contributed to a slow development of nonpoint source

* In N.R.D.C. v. Train (decided June 5, 1975), the Court held that states must perform Section 208 areawide planning activities in those areas of the state not having a designated areawide planning agency.

FIGURE V-8

208 AREAWIDE MANAGEMENT



SOURCE: Environmental Protection Agency.

planning. The Act and its legislative history clearly indicate that Congress did not establish an absolute standard for solving nonpoint source pollutant problems. Nonpoint source pollution was, and still is, a problem area in that available regulatory and technological remedies were, and still are in most cases, untested. As a result, the Act calls for good faith effort by state and local governments to identify problems and to develop control plans.

Public Participation

Opening the water pollution control policy and decision-making process to the public is a major imperative of the Act. The Act contains the most comprehensive provisions for public participation ever written into Federal law.

It states that EPA and the states have affirmative responsibilities to develop procedures to ensure public participation in water pollution policy and decision-making processes:

> Public participation in the development, revision, and enforcement of any regulation, standard, effluent limitation, plan or program established by the Administrator or any state under this Act shall be provided for, encouraged, and assisted by the Administrator and the states. The Administrator, in cooperation with the states, shall develop and publish regulations specifying minimum guidelines for the public participation in such processes. (Emphasis added)(136)

EPA promulgated minimum guidelines(137) establishing a public participation program to provide for the timely distribution of information to, and for consultation with, the public prior to final decision-making. Additionally, the guidelines required that the public be provided technical assistance and opportunities for public hearings on proposed regulations, permits, and areawide, basin and facility plans.

EPA and the States: Partial Response

Neither state agencies nor EPA have completely met their responsibilities for providing for, encouraging and assisting public participation in the decision-making process. As established, the public participation program has been effectively isolated from the functional elements of the program. Rather than incorporating guidelines into regulations controlling categorical programs for permits, grants and planning, EPA promulgated discrete public participation regulations.* The Act intended citizen involvement to become an integral part of the categorical programs, but the intent has been fulfilled only insofar as program regulations provide for public hearings. As a consequence, public participation activities are centered around the public affairs offices, far removed from the decision-making process.

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* There are public participation directives incorporated into the planning, construction grant and NPDES regulations. These deal mostly with public hearings, with the exception of areawide planning which requires provision for a citizen advisory committee.

Public participation regulations -- developed apart from the categorical programs -- fail to define public roles, public participation purposes, and responsibilities of the implementing agency. Although the regulations contain provisions for sanctions if the agency fails to afford adequate participation opportunities, sanctions are seldom invoked. In fact, the EPA has seldom enforced the reporting requirements which provide the basis for determining the adequacy of public participation opportunities concerning a particular project(138).

As required by regulation, the information flow from agencies to the public appears to be sufficient in size. But the content is often either superficial or extremely technical and rarely seems to encourage active participation. Most public affairs offices disseminate voluminous informational booklets, newsletters and press releases which are informative in that they provide general descriptions of the Act, indicate ways to participate and explain agency functions.

With respect to the technical aspects of water pollution control, the flow of information takes the form of public notices tucked away in newspapers or in NPDES fact sheets mailed directly to the interested public. Agencies have responded to the criticism of excessive reliance on public notices by issuing press releases and by using radio, television and other media in order to reach more people(139). The technical information which does reach the public is usually neither translated from technical to non-technical terms nor summarized. More importantly, few attempts are made to help the public fully appreciate potential consequences of the decisions at hand and of underlying assumptions which shape decisions -- such as those related to priority list criteria and waste load allocations(140). As a consequence, the public is forced to rely on highly technical documents such as permit applications or basin planning materials.

EPA has sponsored a series of workshops in each of the ten EPA regions. Conducted by The Conservation Foundation, these Water Quality Training Institutes were an attempt to explain the complex legislation and to describe methods of participation that could be taken advantage of during implementation of the Act. A series of follow-up workshops were held in the states, but were felt to be less successful than the initial institutes(141). EPA is currently sponsoring a series of "Water Quality Awareness" workshops, which are focusing on "non-environmental" groups that traditionally are not concerned with water quality(142).

On the EPA regional level, efforts to educate the public are sparse. Region I has instituted a course in water pollution control for local officials. In Region V, the public affairs office has produced and distributed 1,500 cassettes that describe the industrial permit program in simplified language. Apparently, this technique has been popular with citizens in that particular region. Region IX has undertaken a series of seminars on facilities planning for major projects.

On the whole, EPA regulations emphasize public hearings as the principal technique for public access to decision-making. The hearing process is a carry-over mechanism from water pollution control efforts prior to 1972. The various agencies and publics continue to view the process critically. The almost exclusive use of hearings produces public input at the end of the line when essential decisions have, for all intents and purposes, been finalized. Generally, agency personnel and public interest groups agree that hearings are of limited use as a method of access and are a waste of resources(143).

Perhaps the most telling indicator of EPA's limited commitment to public participation is reflected by the amount of resources allocated to the program. While EPA acknowledges public participation resources are inadequate, the Agency does not actively seek additional monies from Congress(144). In most cases, public participation activities in the water division are handled part-time by public affairs offices in both Washington and the regions. At the regional level, no one having permit, grant or planning responsibilities is assigned, even on a part-time basis, to public involvement activities(145).

The EPA approach to allocating resources to public participation activities has given the states a fair indication of what is an acceptable level of public participation effort. As a result of state budget variations, absolute state level resource commitments are not available, but a relatively disproportionate amount of funds is being allocated to information distribution as opposed to those resources being allocated to participation activities(146). Too often, public information is erroneously equated with public participation.

Several states have taken the initiative in assisting the public. California has established a program for citizen participation in basin planning, including workshops throughout the process. Maryland and Pennsylvania have also set up citizen advisory committees for basin planning. In addition, most 208 planning agencies have created citizen committees.

Public Participation -- Resources and Commitment

Citizen group impact on the administration of the Act is hampered by levels of commitment, expertise and funds. Generally, members of the public are not program-oriented. Rather, they tend to involve themselves when they feel directly affected by a particular issue(147). There is a lack of continuing interest in permit and grant programs. There is some evidence of a general decline in interest, on the part of the public, in water pollution control. Issues, such as land-use control and energy use and development, seem to be much more predominant and perhaps more crucial in the public mind(148).

Time constraints also hinder public involvement on the local level. The task of sorting out and isolating critical technical issues is extremely difficult. The time demand is compounded by the relatively brief comment periods, usually 30 days, and the technical complexity of many of the documents.

Many previously active citizen groups have dissolved for lack of resources, while others are experiencing financial difficulty. Lacking adequate volunteer assistance, groups or individuals must pay technical experts, because water pollution control requires expertise which the public generally does not possess. In all probability, lack of resources and expertise have hastened the declining public interest in water pollution issues.

The general public, on the whole, only becomes interested in water pollution control when directly affected. Attempts at stimulating this public have failed. Again, expertise and the technical complexity of the Act is the barrier. When the general public does respond, organized groups have the task of picking out the issues and explaining the contemplated action. Seldom do they get assistance in this interpretive task from the state or Federal agency(149).

The Permit Program

The most structured public participation has occurred in connection with issuing permits(150). With few exceptions, the public participation regulations promulgated by EPA are being followed precisely; permits are drafted and notice is published, after which 30 days are allowed for comments and requests for a public hearing. Fact sheets and notices are also widely distributed. Overall, public interest has been slight even though permit conditions provide specific issues on which individuals may focus. Changes in permit terms have occurred as a result of citizen impact, but those changes have been relatively minor. The lack of participation is, in part, the result of the sheer number of permits being written (approximately 28,000), and the technically complex nature of permit conditions. A permit is essentially a contract written in technical and legally enforceable language. Agencies have been under such severe time pressure to issue permits that little assistance has been provided to help the public fully understand proposed permit terms and the related issues.

The Planning Process

It is always difficult to engender and sustain public interest and involvement in the planning process. As important as it is, it lacks the immediacy of impending action, even though it may be even more critical to the outcome of future events. Planning for water quality is no exception. The development of Section 106 state program plans has

attracted little public interest. As a consequence, EPA no longer requires that state agencies hold public hearings prior to adopting annual state programs. Some have attributed the lack of interest to the fact that annual state program plans do not involve specific issues with which the public can identify. In developing the construction grant priority list, state agencies are required to conduct hearings prior to final adoption. Those attending priority list hearings are normally representatives of municipalities and consulting engineering firms. To date, environmental groups and the general public have indicated relatively little interest. Although changes in the lists do occur, the underlying assumptions upon which the plans and changes are predicated are seldom discussed or questioned by those present(151).

Section 201 facility plans must be adopted after a public hearing. When specific and controversial issues are not involved, citizen interest has been low. Those who become involved in facility planning are normally concerned with three areas -- single project planning, land use and growth issues, and project costs(152).

Public involvement in approving Section 208 areawide plans has not developed, because no plans have been completed(153). Although it is too early to assess public involvement in this area, committees of local officials and the public will participate in the process from formulating the plans through to final adoption. Some feel that areawide planning holds the greatest promise for public involvement, while others feel the technical complexities will discourage full citizen participation(154). One thing is sure, however, areawide plans will have scant chance of being adopted and eventually implemented unless citizen groups and organizations are supportive of their general strategy. Thus, it behooves areawide planning agencies to develop a wide base of public involvement at the outset. Indications, thus far, are that most are not.

With respect to state river basin planning, EPA regulations require public hearings when there is a significant interest in a particular plan. The results of participation in these plans have been mixed -- ranging from public hearings to formation of public advisory committees. The most encouraging example is Pennsylvania's Comprehensive Water Quality Management Planning program. A series of citizen advisory committees has been formed and efforts are under way to explain to the public the technical nature of the program. Workshops and other informational devices are being used to brief the public. This effort is expected to consume about 25 percent of the $18 million budget(155).

Citizen Suits

Notwithstanding a clear congressional directive to incorporate public views prior to the development of policies and decisions, the most significant public impact on the implementation of the Act has been

made in the courts -- after agency decisions have become final. In N.R.D.C. v. Train(156), the Court held that EPA must establish effluent limitations for, and issue permits to, all point-source dischargers; EPA does not have the authority to exclude from the regulatory process insignificant point-source discharges. In N.R.D.C. v. Callaway(157), Section 404 of the Act was interpreted to require the Corps of Engineers to issue dredge and fill permits in all waters of the U.S., rather than just those which meet the traditional test of navigability. As a result of other litigation initiated by N.R.D.C., EPA was forced to accept a faster, judicially determined timetable for promulgating effluent limitations(158), and to establish regulations under which states would pursue areawide planning in non-designated areas(159). Public participation through judicial processes has advanced prospects for earlier, full implementation of the Act by speeding the pace of effluent limitations promulgation, by more clearly defining agency responsibilities and by expanding areawide planning activities. But public participation early in the administrative process has been infrequent.

Public Participation -- Basically Unchanged

Public Law 92-500 has not substantially expanded public participation. Generally, EPA and a majority of the states have not fully implemented the public participation provision. EPA regulations and guidelines for participation are inadequate in the sense that enough flexibility is provided to allow administering agencies to do as little, or as much, as they desire in assisting and encouraging public involvement(160).

The public continues to involve itself much the same way it did prior to 1972(161). Public hearings have and probably will continue to provide the major avenue for public involvement in administrative decision-making. With respect to planning activities, participation requires a level of expertise which most publics do not possess and cannot afford to purchase. In light of these impediments, actual public participation input to administrative and policy decisions is unlikely to meet the expectations of the framers of the Act.

P.L. 92-500 Litigation

Initial reaction by individuals and organizations affected by the requirements of P.L. 92-500 indicates that most, if not all, of its major provisions will be subjected to legal challenges. To date, at least 350 lawsuits have arisen under the Act.* More than 285 of those are still pending in the courts.

By and large, the suits represent challenges by environmental groups, industry, states and local governments to EPA's implementation of the Act's construction grants, planning and regulatory requirements. Most of the suits - about 320 as of June 30, 1975 -- relate to some aspect of EPA's regulatory program. The construction grants program has given rise to at least 25 suits, and the planning program has been the subject of one major suit.

Construction Grants Program

One of the first legal issues to arise under the 1972 Act, and the first to be settled by the U.S. Supreme Court, concerned the allotment of Federal funds for the construction of publicly owned treatment works. The controversy arose when President Nixon directed EPA to allot only one-half ($9 billion) the maximum amount authorized and appropriated by Section 207 of the Act for grants for the construction of POTWs. The impoundment of the construction grant funds was challenged in at least 24 separate actions filed by states, cities, counties, private citizens, congressmen, and organizations. The Supreme Court recently ruled that the impoundment was unlawful and that the Act required EPA to allocate "no less" than the full amount of construction grant funds. The Court indicated that EPA has discretion over the funds only at the point where the funds are obligated and not in connection with the threshold function of allocating funds to the states(162).

Another category of suits under the construction grants program includes those in which a state or local government has sought a court declaration that compliance with the secondary treatment requirement of the Act is not required unless such a requirement may be met with a Federal grant. One such case, Virginia State Water Control Board v. Train, is pending before the U.S. District Court for the Eastern District of Virginia(163). EPA and the Natural Resources Defense Council have taken the position that availability of Federal funding under Title II of the Act for the construction of publicly owned treatment works is not a precondition to the obligation of states and localities to comply with the secondary treatment requirement.

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* The Legal Issues study focused on lawsuits which could be identified as of June 30, 1975, based on case files maintained in the EPA Office of General Counsel. Cases being handled by EPA regional offices or by the states were not studied.

Planning Program

To date, one case has addressed the planning provisions of the Act(164). Environmental groups have challenged EPA's regulations implementing Section 208 areawide planning.

In its regulations EPA defined as Section 208 planning areas only those areas designated by governors or local officials as having substantial water quality control problems. EPA excluded from its Section 208 regulations those portions of the state which were "non-designated."

EPA's interpretation was challenged by Natural Resources Defense Council and other environmental groups. NRDC charged that under Section 208(a)(6)* the state must undertake the same planning in non-designated areas that is required in designated areas, and must do it within the same time constraints. The National Forest Products Association intervened in the lawsuit and took a contrary position. It asserted that a state need only engage in general, discretionary planning for the non-designated areas, and that it need not engage in extensive areawide planning for those areas.

The U.S. District Court for the District of Columbia accepted NRDC's arguments and ruled that the division among governor-designated and local-designated areas on the one hand and subsection (a)(6) areas on the other is intended to regulate which level of government is to develop a plan, not whether an area or portion of a state is to be covered by such a plan. EPA was ordered to revise its regulations so that the states can understand and fulfill their total planning responsibilities under Section 208. This decision has been appealed to the U.S. Court of Appeals by the National Forest Products Association.

Regulatory Program -- Introduction

To date, about 320 lawsuits have focused on EPA implementation of P.L. 92-500's regulatory requirements.** More than 250 of the suits reflect industry challenges to EPA regulations promulgating "effluent limitations guidelines" applicable to existing sources and standards of performance for new sources.*** These challenges have been consolidated in U.S. Courts of Appeals to 21 proceedings and include challenges brought by the following industries:

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* Section 208(a)(6) provides that "the state shall act as a planning agency for all portions of such state which are not designated. . ."

** About 15 percent of these suits deal with issues concerning "navigable waters", common law nuisance actions, civil and criminal penalties, dredge and fill, and oil spills and are not discussed in this summary. Digests of these cases can be found in the Legal Issues Report.

*** In most cases, EPA issued one set of regulations addressing Section 301 effluent limitations, Section 304 effluent limitations guidelines, and Section 306 new source performance standards.

Beet Sugar	Organic Chemicals
Cane Sugar	Petroleum Refining
Electroplating	Phosphates
Fertilizer	Plastics and Synthetics
Fruits and Vegetables	Pulp and Paper
Grain Milling	Rubber
Inorganic Chemicals	Seafood Processing
Iron and Steel	Steam Electric Power
Leather Tanning and Finishing	Textiles
Meat Processing	Timber Processing
Nonferrous Metals	

Only one case has been decided on its merits(165). Virtually all of the remaining suits have been pending in the courts for six to 18 months(166). In light of the time required for appeals, final resolution of all contested issues could extend two to four years beyond the date of promulgation of the regulations. Details of the challenges to the effluent limitations guidelines and the new source performance standards are discussed in the sections that follow, including a section on special issues raised by the steam electric power industry. Challenges to implementation of the permit program, toxic standards and pretreatment requirements also are discussed below.

Regulatory Program -- Effluent Limitations Guidelines

For existing sources, Section 301(b) of the Act, in part, provides:

> "There shall be achieved -- (1)(A) not later than July 1, 1977, effluent limitations...which shall require the application of the best practicable control technology currently available as defined by the Administrator pursuant to Section 304(b)(2)..., (and) (2)(A) not later than July 1, 1983, effluent limitations...which...shall require the best available control technology economically achievable. . . as determined in accordance with regulations issued by the Administrator pursuant to Section 304(b)(2). . ."

Section 304(b) of the Act, in part, provides:

> "For the purpose of adopting...effluent limitations. . . the Administrator shall...publish...regulations providing guidelines for effluent limitations. . . ."

Section 402(a)(1) of the Act, in part, provides:

> "...[T]he Administrator may...issue a permit for the discharge of any pollutant...upon condition that such discharge will meet...all applicable requirements under Section 301 . . ."

Implementation of Section 301 effluent limitations, Section 304 effluent limitations guidelines, and Section 402 permits has generated the most significant legal controversies under the Act.

The first dispute to arise concerned the date by which EPA would issue guidelines under Section 304. P.L. 92-500 called for guidelines to be published within one year of the statute's enactment, i.e., by October 18, 1973. EPA's failure to meet this deadline prompted a lawsuit by the Natural Resources Defense Council. The suit resulted in a District Court order requiring EPA to publish effluent limitations guidelines consistent with a court-established schedule(167).

After conducting extensive rulemaking proceedings, EPA issued one set of regulations to serve as both Section 304 effluent limitations guidelines and Section 301 effluent limitations. Industry has challenged these regulations for a variety of reasons. The legal questions involved can be divided into questions concerning the fundamental nature of the regulatory scheme, proper jurisdiction for challenges to the regulations, and the substance of the regulations.

The industry dispute with the fundamental nature of EPA's regulatory scheme centers around the proper interrelationship of Section 301 limitations, Section 304 guidelines, and Section 402 permits. The principal issue is whether P.L. 92-500 authorizes the EPA Administrator to promulgate nationally uniform effluent limitations regulations under Section 301, or whether effluent limitations must be set by a "permitting authority" for an individual source as a part of an NPDES permit under Section 402.

EPA contends that Congress intended Section 301 effluent limitations to be uniformly implemented by regulation. The agency also argues that since Section 304 guidelines are "inextricably related" to Section 301 limitations, EPA properly promulgated both together. Hence, EPA concludes that it has the statutory authority to issue a combined set of Section 301/304 regulations.

Industry argues that EPA does not have the authority to implement Section 301 limitations by regulation. Congress intended that effluent limitations be set in NPDES permits by the permitting authority using Section 304 guidelines, according to industry. Thus, EPA's published regulations must be viewed as Section 304 guidelines since EPA does not have the legal authority to issue Section 301 limitations by regulation.

This dispute gives rise to a problem of proper jurisdiction. Whether the case belongs in a Federal District Court or a Federal Court of Appeals may depend upon whether the promulgated regulations are combined Section 301 limitations/Section 304 guidelines or just Section 304 guidelines. Based on EPA's interpretation that 301/304

regulations are validly issued, jurisdiction clearly lies in the U.S. Court of Appeals since Section 509(b) of the Act provides for review of the Administrator's actions "in approving or promulgating any effluent limitation or other limitation under Sections 301, 302 or 306."

Industry argues that the regulations must be viewed as Section 304 guidelines; thus, since Section 509(b) does not expressly provide for review of Section 304 regulations, review must lie in U.S. District Courts pursuant to the Administrative Procedure Act. The general industry view of jurisdiction has not been adopted by the steam electric power industry, which contends that, although the regulations are merely guidelines, review should be in the U.S. Court of Appeals, pursuant to Section 509. Promulgation of Section 304 guidelines is an "action" which leads directly to the establishment of Section 301 effluent limitations by the issuance of NPDES permits, according to the steam electric power industry.

To date, no court has squarely ruled on the challenges relating to fundamental nature of the regulatory scheme. Four cases, however, have spoken to the question of jurisdiction. Three U.S. District Courts have ruled that they do not have jurisdiction to review EPA's 301/304 regulations, although the courts did not agree why jurisdiction did not lie in District Court. American Paper Institute v. Train(168) was the first case decided on the 301/304 jurisdictional issue. The U.S. District Court held that the regulations are effluent limitations issued under Section 301 and, hence, review must be in a U.S. Court of Appeals pursuant to Section 509.

In DuPont v. Train(169), the U.S. District Court for the Western District at Virginia held that the Act, "taken as a whole," supports EPA's construction that Section 301 effluent limitations are to be promulgated as regulations apart from the Section 402 permit proceedings. "It follows," the court ruled, "that plaintiff's substantive challenge to such limitations must be brought in the Court of Appeals pursuant to Section 509(b)(1)(E)." American Petroleum Institute v. Train(170) held that the District Court lacks jurisdiction, but the court specifically refused to decide whether EPA's procedure in issuing 301/304 regulations complied with the Act.

In CPC International v. Train(171), the U.S. Court of Appeals for the Eighth Circuit reached a different conclusion -- that the regulations are reviewable not by a U.S. Court of Appeals, but by a U.S. District Court. According to the Court, the regulations are reviewable in U.S. District Courts because Section 301 does not expressly provide that EPA must promulgate effluent limitations by regulation. The Court found that the omission of such a specific provision was not an oversight, since Congress provided unambiguously for the promulgation of national standards in other sections of the Act. Moreover, the Court recognized

that Section 304(b) sets a one-year deadline for promulgating effluent guidelines. The Court stated that if the guidelines were intended only for interim use in promulgating regulations under Section 301, then Congress would not have set a deadline for publishing the guidelines and have failed to provide a deadline for the promulgation of 301 regulations. On the basis of legislative history, the court held that Congress intended to enforce uniformity of conditions for existing plants, not by authorizing the promulgation of regulations under Section 301, but by granting EPA the power to issue permits and to veto state-issued permits which do not comply with the guidelines promulgated under Section 304(b). The court concluded that since the Act does not grant the Administrator separate authority to promulgate Section 301 effluent limitations, review of Section 304 regulations lies exclusively in the District Courts pursuant to the provisions of the Administrative Procedure Act.

Industry challenges to the substance, as opposed to the basic nature of the regulatory scheme and resulting jurisdictional issues of the Section 301/304 regulations, address six basic questions.

-- First, does the EPA categorization and subcategorization of industries, for purposes of establishing effluent guidelines, comply with the Act? Industry does not challenge the format of the EPA categorization and subcategorization scheme, although some specific classifications are attacked as based on insufficient evidence or as being overly broad. Rather, industry contends that the Act requires more than what EPA did -- that Section 304 regulations must specify factors such as age of plant, cost/benefit analysis and others which influence the establishment of the 1977 and 1983 effluent limitations.

EPA, on the other hand, asserts that its procedures fully comply with the requirements of Sections 301 and 304. It argues that the regulations do specify how the factors enumerated in Section 304(b) are to be applied in individual permit proceedings -- they have been found not to justify differential treatment, in general, since they do not significantly affect the ability of plants to achieve the specified limitations.

-- Second, does EPA's promulgation of single-number guidelines comply with the Act's requirements? Several industries argue that Section 304 guidelines must provide a range of effluent reductions which will then be applied to point-source discharges on a case-by-case basis in the permit process. Uniformity of permit requirements comes not from the mechanical application of a single number, according to industry, but through the administration of a permit system controlled by guideline regulations which ensure that similarly situated dischargers receive similar effluent limitation permits.

EPA argues that the Act permits several different approaches to handling a situation, and its decision as to which approach to take

should be deferred to by the court in accordance with the general principles of administrative law. According to EPA, the legislative history of the Act supports the agency's position that establishment of an effluent limitation range is neither precluded nor mandated -- that the specific scheme is left to the discretion of the Agency.

-- Third, does EPA have the authority to include a "variance provision" in its regulations promulgating 1977 effluent limitations based on best practicable control technology currently available? The "variance provision" allows the Regional Administrator or the state (subject to the approval of the Administrator) to adjust the effluent limitations for a plant when the discharger demonstrates that the factors relating to his plant are "fundamentally different" from the factors considered in establishing the guidelines. The inclusion of this provision in the regulations has been challenged by environmental groups as well as by industry. NRDC charges that major variations may be established only through the rule-making process used to determine subcategories(172). EPA asserts that the variance clause imparts needed flexibility to an otherwise uniform system of regulation. Industry argues that even the inclusions of the variance clause does not rescue EPA's regulations from inflexible rigidity.

-- Fourth, was EPA's use of "exemplary plants", as the basis for the guidelines, basically unfair because existing conditions in many industrial categories were not adequately reflected? Industry argues that EPA improperly relied on "exemplary plants" in identifying the degree of effluent reduction attainable by applying 1977 and 1983 technologies. In industry's view, the "starting point" for determining the range of numbers for each subcategory must always be a survey of at least a representative sample, if not all, of existing performance within the relevant subcategory, except where present practices throughout the industry are inadequate. Industry also argues that EPA's reliance on performance by a single exemplary plant, or by a theoretical model plant, is not in accord with the Act.

According to EPA, the Administrator correctly interpreted and applied the standard for specifying "best practicable" and "best available" technology. The agency emphasizes that the Act gives EPA a mandate to "press technology" -- that is, if effluent limitations are too closely tied to routine existing performance, necessary improvements in pollution control will not be obtained unless EPA prescribes the use of more sophisticated technologies.

-- Fifth, did EPA fail to balance adequately the costs of the regulations with anticipated environmental benefits? Many of the challenges to the Section 301/304 regulations argue that EPA did not consider adequately the economic, energy, and environmental costs of the technologies prescribed for 1977 and 1983. Industry argues that the Act requires EPA to balance

the costs of effluent limitations against pollutant reduction benefits. For example, the International Paper Company argues that EPA's economic, energy, and environmental analyses are deficient, garbled and inconsistent, thereby rendering the final regulations arbitrary and capricious(173).

EPA's response to these arguments has been a reiteration of the rationale set forth in the various Development Documents, and a defense of EPA performance as the best possible in light of environmental and economic data available for analysis.

-- Sixth, do EPA's Section 301/304 regulations actually create a criminal code for certain categories and subcategories of industries? Several industry petitioners contend that the establishment of effluent limitations by regulation would create by implication "a massive new criminal code." Several petitioners argue that any regulations establishing Section 301 effluent regulations would be criminally enforceable pursuant to Section 309(c) of the Act. They emphasize the uncertainties that could result:

> "Is there a new criminal offense created for violation of the Section 301 regulations, in addition to the Act's Section 301(a) absolute prohibition on dischargers without a permit, or is the absolute ban supplanted by the different prohibition under the regulations?
>
> "What is the status, as far as criminal liability is concerned, of those who obtained permits before Section 301 limitations were established, if the limits in the permit are different from those in the regulations?"(174)

These fears of a "massive new criminal code" are "illusory," according to EPA. EPA's brief assures the Court that it has no intention of enforcing the Section 301(b) effluent limitations without reference to either the discharge prohibition of Section 301(a) or the provisions of Section 402 permit system. EPA contends that compliance with the permit constitutes compliance with Section 301(b) effluent limitations pursuant to Section 402(k). Thus anyone with a permit could not violate Section 301(b) without violating Section 402 at the same time.

Regulatory Program -- Steam Electric Power Industry -- Special Issues

The regulations promulgating effluent limitations guidelines and new source performance standards for steam electric power plants have been challenged by 78 petitioners who own and operate over 50 percent of the country's electric generating capacity affected by the challenged regulations(175). The suits have been consolidated into one proceeding

which is pending before the U.S. Court of Appeals for the Fourth Circuit. The basic contention of the electric utility industry is that EPA promulgated inflexible regulations which when fully implemented will impose enormous costs, will waste valuable energy resources, and will result in little, if any, environmental benefits.

-- First, the steam electric power industry argues that EPA's implementation of the Act is too rigid -- that EPA must acknowledge that promulgated regulations for existing sources are guideline limitations which are "presumptively applicable," but not absolutely binding. That is, the guideline limitations should be applied in permits unless some party to the permit proceeding sustains the burden of showing that, on the facts of the particular case, the specific numbers are inappropriate. According to EPA, the regulations fulfill the legislative mandate for uniformity while retaining a sufficient amount of flexibility.

-- Second, the electric utilities claim that EPA's blanket requirement for backfitting closed-cycle cooling systems is arbitrary and capricious because 1) the regulations were promulgated prior to completion of the National Commission on Water Quality Report, 2) EPA's cost-benefit analysis is inadequate, 3) the regulations impose unreasonable costs, and 4) state-established water quality standards negate the value of the backfit regulations.

-- Third, the steam electric industry maintains that EPA should not require closed-cycle cooling on existing nuclear power plants when such cooling systems have been approved previously by the former Atomic Energy Commission (AEC) pursuant to National Environmental Policy Act (NEPA) review. According to industry, P.L. 92-500 allows EPA to respect the AEC's prior decisions and that, given the facts in the record, EPA's failure to adopt a special subcategory for nuclear plants was arbitrary and capricious. EPA, on the other hand, argues that although the AEC may exercise its full NEPA responsibilities prior to the promulgation of FWPCA regulations, EPA is not bound to follow AEC's policy decisions when it promulgates regulations pursuant to P.L. 92-500.

-- Fourth, the industry challenges regulations limiting the use of cooling lakes as a means of closed-cycle cooling. EPA argues that discharges into cooling lakes formed by the impoundment of navigable streams ignores the fact that these cooling lakes are navigable waters. As such, promulgation of regulations which would allow heat discharges to those bodies of water would violate the FWPCA order that additions of thermal pollution to navigable waters be reduced.

-- Fifth, the industry argues that the Section 316(a) variance provision is presumptively satisfied by compliance with Section 303 state thermal water quality standards approved by EPA. EPA argues that nothing in the Act requires EPA to use Section 303 as presumptive (prima facie) evidence

of satisfaction of 316(a), and, in fact, the Act may preclude such an interpretation. Section 316(a) is meant to provide an evaluation of site-specific characteristics to determine the stringency of an applicable regulations, and a state water quality standard may not be strict enough to protect a particular section of a river, although it may be adequate to protect the river as a whole.

-- Sixth, the electric utilities challenge EPA's regulations which prohibit open ocean discharges and require closed-cycle cooling at power plants located along the nation's coastlines. In most cases, coastal stations must use sea water cooling towers. EPA asserts that sea water cooling towers of the necessary size are "demonstrated" in the industry and appropriate for use since they will cause no unacceptably adverse side effects. Industry argues that EPA is wrong for the following reasons: 1) sea water cooling towers for a full size power plant are not now "currently available" -- they are not "demonstrated"; 2) sea water towers will cause unacceptable adverse environmental impacts; 3) the economic costs of sea water towers are excessive; and 4) the sea water cooling tower requirement violates sound land and water resource development policy.

Regulatory Program -- New Source Performance Standards

For many industrial categories, EPA issued one set of regulations promulgating both effluent limitations for existing sources and standards of performance for new sources. As a result, many of the issues being contested in litigation concerning effluent limitations are being contested in the new source litigation; in fact, in many cases the challenges of a particular industry to both the effluent limitations and the new source performance standards are set forth in the same brief.

As with the litigation involving effluent limitations, the sole decision to date on the merits of new source standards is the decision by the U.S. Court of Appeals for the Eighth Circuit in CPC International v. Train(176). At issue were new source standards for the corn wet milling subcategory of the grain mills point-source category. In that subcategory, the new source standards were predicated on the availability of the 1977 technology plus the use of deep-bed filtration. Deep-bed filtration is a technology which EPA conceded has not been "demonstrated" within the corn wet milling industry. But the agency has argued that the technology has been successfully used in other industries and is adaptable to the corn wet milling industry. The Court ruled that EPA had not carried its burden of proof and directed EPA to furnish additional support for the new source standards as promulgated, or to promulgate new regulations.

Nine cases concerning new source performance standards are pending in the U.S. Courts of Appeals. Generally, the significant issues include: 1) What consideration of costs is required by Section 306? 2) Can the

1977 "best practicable" control technology be used as a "floor" from which to project new source standards? 3) To what extent can new source standards be based on "technology transfer?" and 4) Is the system of categorization and subcategorization being employed by EPA adequate to comply with the purposes of P.L. 92-500?

A noteworthy argument is presented by the FMC Corporation in FMC Co. v. Train(177). In the sodium carbonate industry, soda ash is produced either by a "natural" process which generates no water pollution or by a synthetic process which generates significant water pollution. FMC argues that the "no-discharge" new source performance standard will effectively preclude the construction of new synthetic soda ash plants -- an effect which the Act does not authorize. EPA acknowledges that imposition of the no-discharge requirement may well preclude construction of new synthetic soda ash plants unless a radically new technology is developed, but the Agency does not believe that the requirement limits the future of the industry. According to EPA, it has recognized that economic and environmental considerations require that any increase in soda ash capacity be accomplished by building natural process plants.

Regulatory Program -- NPDES

At least 15 cases have arisen under the NPDES program. These cases touch on a variety of issues including exemption of point sources from the NPDES program, approval of state permit programs, and approval of NPDES permits.

In promulgating regulations setting up the NPDES program, EPA decided that certain point dischargers would not have to apply for (and be issued) a permit, although the exempted sources still would have to comply with applicable effluent limitations and other requirements under the Act. The exemptions included storm sewer discharges composed entirely of storm runoff uncontaminated by industrial or commercial activity; discharges from relatively small animal confinement facilities; discharges from silvicultural activities; and irrigation return flow from point sources where the flow is from less than 3,000 acres(178). The exemption of these categories from the NPDES program was challenged by NRDC in a suit filed in the U.S. District Court for the District of Columbia. NRDC charged that even if EPA developed effluent guidelines and limitations for the exempted categories and even if such limitations and guidelines could operate independently of the permit program, the permit system is still "indispensable" to the effective implementation and enforcement of the guidelines. EPA, on the other hand, argued that the exempted categories, although within the Act's definition of point source, nevertheless are "ill-suited" for inclusion in a permit program. Discharges from storm sewer, agricultural, and silvicultural point sources are best eliminated by process changes, which prevent pollutants from entering rainwater runoff, EPA asserted, rather than the end-of-pipe treatment method used by most point sources. EPA also contended that the tremendous

number of point sources in the exempted categories would make the permit system unworkable, and so it exercised its discretion to ensure that a manageable permit program was established. The Court was unsympathetic to EPA's argument and ruled that the Administrator could not lawfully exempt point sources discharging pollutants from regulation under NPDES(179). EPA has asked the Department of Justice to appeal this decision(180).

Another category of cases deals with EPA's approval of certain state applications to administer their own NPDES permit program. For example, California and Washington have challenged the Administrator's decision, in approving their permit programs, to exempt Federal facilities from complying with the state permit requirements. EPA takes the position that while Federal facilities must comply with substantive requirements imposed by states, such facilities are not subject to state procedural requirements such as obtaining discharge permits. The Ninth Circuit Court of Appeals upheld the states' position, and ruled that the provisions of P.L. 92-500 "clearly mandate a Federal agency duty of full compliance with all aspects of state permit programs."(181) This case is awaiting final resolution by the U.S. Supreme Court.

Pending litigation concerning the decision of the Administrator to approve a state application to administer the NPDES program also touches on (a) whether EPA followed correct procedures in acting on state applications and (b) whether EPA acted arbitrarily and capriciously in making its decision on a state application. Peabody Coal Company is challenging the approval of several state permit programs, and asserts that EPA's approval of a state permit program is a rule-making action and as such is subject to the procedural requirements of the Administrative Procedure Act(182). Peabody also challenges the substantive considerations on which the approval was given. For example, Peabody argues that EPA could not have determined that Montana had "adequate authority" to carry out its program (as required by Section 402) because EPA approval came before the requirements of Sections 301/304 were promulgated.

A third category of suits relates to the approval of individual permits. The administrative process is time-consuming and most of the challenges to permits are tied up in about 1,500 adjudicatory hearings. Once the administrative process is completed, a number of the 1,500 disputes may be appealed to the courts. While the Commission's legal issues study did not examine the adjudicatory hearings process, decisions issued by the EPA General Counsel during the course of adjudicatory hearings were reviewed. The issues of law addressed by the General Counsel may foreshadow those to be raised in court appeals. Some of the issues raised and the resulting answers of the General Counsel are summarized below:

-- May EPA issue NPDES permits prior to the promulgation of effluent limitations guidelines? Yes.

-- May a permit require achievement of effluent limitations more stringent than "best practicable" control technology? Yes.

-- Does EPA have the authority to issue NPDES permits based on effluent limitations which are being litigated? Yes, even if the permittee is a party to the litigation.

-- Does EPA have the authority to control, through conditions included in NPDES permits, the disposal of pollutants into wells? Yes.

-- Does EPA have the authority to issue a permit which includes a "force majeure" clause? Yes.

-- Does EPA have the authority to impose, as a condition of an NPDES permit, a compliance date prior to July 1, 1977? Yes.

-- Must the effluent limitation for a municipal waste treatment system which discharges into the ocean include the July 1, 1977 deadline for secondary treatment? Yes.

-- Does the EPA have the authority to issue permits containing provisions allowing for malfunctions of properly operated and maintained pollution control equipment? Yes, discretionary authority.

-- Will existing, effective permits be amended automatically to reflect any changes in the guidelines resulting from the resolution of the pending guideline litigation? No.

The suits which have reached the courts to date involve challenges to the permit procedures rather than actual permitted conditions. For example, EPA refused two permittees adjudicatory hearings on the merits of their respective permits and the refusals have been appealed to the Seventh Circuit Court of Appeals(183).

Regulatory Program -- Toxics Standards and Pretreatment Requirements

Environmental groups are challenging EPA's failure to promulgate toxics standards and pretreatment requirements. In EDF v. Train, the Environmental Defense Fund and NRDC are seeking to force promulgation of standards for the nine toxic pollutants listed by EPA(184). In NRDC v. Agee, NRDC is seeking a court order to establish a schedule for EPA promulgation of pretreatment standards for discharges into publicly owned treatment works(185). Both cases are still pending.

Summary

The courts have played, and will continue to play, an important role in shaping the implementation of P.L. 92-500. Litigation brought by environmental groups has directly impacted the implementation of the Act: for example, the Corps of Engineers must utilize the Act's expanded definition of "navigable waters" in issuing Section 404 dredge and fill permits; EPA had been required to publish effluent limitations guidelines consistent with a court-established schedule; EPA's exemption of certain categories of sources from NPDES permit requirements has been struck down; and states must carry out Section 208 planning in "non-designated areas". Environmental groups are alleging an EPA failure to adequately prescribe toxics standards, are challenging EPA's inclusion of a variance provision in the regulations for various industries, and are challenging EPA's failure, to date, to regulate discharges of all radioactive materials into navigable waters. States and local governments have challenged EPA's exemption of Federal agencies from state permit requirements and its impoundment of Federal funds for the construction of publicly owned treatment works. Industry suits concerning "effluent limitations guidelines" and new source performance standards represent the most significant challenges to date to P.L. 92-500's implementation.

Despite extensive litigation, it is too early to assess the court's role in the implementation of the Act. Most of the important legal issues are still pending before the courts. One thing is certain, however -- more litigation of P.L. 92-500 can be expected.

PEOPLE, PARTICIPANTS AND PRACTITIONERS

Reactions and Responses to P.L. 92-500

During the course of its studies, the Commission sought to obtain the views and opinions of the public in many ways. Technical meetings were held in Boston, Los Angeles, New Orleans, Portland (Oregon), Kansas City, Chicago and Atlanta. Representatives of industry, conservation and government were invited to Commission offices periodically for briefings. The program staff worked closely with contractors in field interviews and plant and city visits and participated in many conferences and meetings. The Commission also conducted a formal study of attitudes of selected groups, using accepted opinion survey techniques(186).

Much information was obtained by mail. On three occasions, the Chairman sent letters to interested publics -- local government leaders and members of civic and conservation groups. More than 1,000 persons -- some representing government agencies, industries and organizations -- replied. If all their comments were combined with the oral statements made at the technical meetings and with views received in unsolicited letters, the record would fill several thousand pages. Following are the general reactions and responses to P.L. 92-500, as expressed by representatives of the government, industry, agriculture, public interest and conservation communities and individual citizens.

Public Interest Communities

> I love to listen to my 75-year-old father and other people of his generation talk about life along the Mississippi before World War II -- How he swam along the side of the ferry to reach Natchez, Mississippi, without fear of ingesting industrial wastes -- How such a large proportion of the citizens made a satisfactory living from the fish they took from the waters each day. I do not suggest that we attempt to return 100% to the lifestyle of 1910; that is a ridiculous suggestion. We do have a right, however, to enjoy and reap the benefits of renewable natural resources, such as those derived from clean healthy waters, and not place all of our emphasis on an economic system which depletes and destroys for one use only, those natural resources.
>
> -- Individual from Baton Rouge, Louisiana

Of the more than 700 letters received by the Commission from environmentally concerned citizens and public interest organizations, the

vast majority believe that P.L. 92-500 represents a milestone in water pollution control efforts. They applaud the Act's goals and adamantly support its effluent limitations. They see application of uniform technology-based effluent limitations within firm deadlines as the best way to achieve clean water. This view was strongly confirmed by the Commission's Attitudes Survey which showed 79 percent of those surveyed as favorably inclined toward the Act, and highly supportive of its basic implementation strategy.

Experience, they point out, teaches that extending deadlines only discredits the force of control efforts. "An exception here, a postponement there, and the controls soon become virtually meaningless," observes an individual from Baintree, Maine.

They argue that water quality standards, as the sole basis for controlling discharges, have proven ineffective and do not encourage development of recycling methods or new technologies leading to elimination of discharges of pollutants. Frequently, they credit P.L. 92-500 with the water quality improvement they have begun to see in many areas of the country.

The most overwhelming reaction to the Act by environmentally aware citizens is the willingness to accept the costs of meeting its requirements. Clean water for themselves and for future generations is to them a basic right. Industry and government must accept the responsibility for reducing, and ultimately eliminating, their wastes as a cost of doing business. As an individual from North Amherst, Massachusetts, wrote: "Nobody has the right to dump chemicals and waste into our rivers, lakes and oceans. It is argued that elimination of such dumping will raise prices on many goods. My answer is that the purchase price of such goods does not reflect their true cost. The hidden cost is the degradation of our environment. If the purchase price included the expense of clean-up, then there might be more of a stimulus for inventing efficient, non-polluting ways of doing things."

Recycling is generally viewed as a vital element of the Act's strategy for water pollution control. They view it as the ultimate cost-effective treatment technology, turning wastes into useable products. While realizing that it is not a panacea, many support and want to strengthen the Act's encouragement of land application and disposal of wastewaters. They see it as an opportunity to turn polluting wastes into nutrients for food production.

Most of those commenting to the Commission see the Act's net impact on employment as positive rather than negative, creating jobs in the construction of waste treatment facilities.

Nearly all respondents mentioned some benefits accrued as a result of improved water quality -- safe drinking water, increased production of merchantable fish and shellfish, enlarged recreational opportunities, aesthetically improved environments and intangibles such as the satisfaction of protecting a vital natural resource for future generations. One individual from California observed that shellfish are returning to areas of San Francisco Bay for the first time since the turn of the century. "If current objectives are met in the Bay, it will be possible to harvest and consume these shellfish," he said.

In evaluating the economic impacts of the Act, many public interest organizations point out that the Commission has failed to calculate many of the benefits, particularly health benefits. Some benefits, of course, are not quantifiable. Even for those which the Commission quantified, they believe the benefits far outweigh the costs. They see the costs of achieving the Act's requirements as principally one-time-only costs, while the benefits continue to multiply.

The message that comes through over and over again is that the nation's citizens cannot afford not to clean up their waters. Many of the letters from environmentalists emphasize that if we do not meet the Act's requirements, water quality will be further degraded and the cost to restore the water later will be far greater than the cost of controlling discharges now.

The following comment from an individual in Arcata, California, illustrates what many have stated: "We must stop thinking and acting in ways that achieve only short-term economic gains. Past generations have done this and that's the reason our pollution costs are so high today. Tomorrow the price will be even higher."

Many individuals also expressed fear that failure to meet the Act's requirements will cause irreversible environmental damage.

In their comments, conservationists share a deep concern for protection of water quality for the future. They are particularly worried about the continued availability of safe drinking water. Many individuals, as well as public interest organizations, wrote to the Commission expressing shock that even with the Act, pollutants hazardous to our health are being discharged into drinking water supplies. As an individual from Madison, Wisconsin, said, "If we err, please let it be in the direction of being too safe."

Others have cautioned that the discharge of toxic chemicals and pollutants associated with various land uses are either not adequately addressed by the Act, or sections dealing with these issues have not been effectively implemented. Channelization and damming, draining and

dredging activities are viewed as a major pollution problem in many parts of the country. Land uses frequently mentioned as major causes of pollution by the Act are mining, agriculture, forestry and construction. Therefore, environmentalists want Sections 208 and 404 of the Act fully implemented and even strengthened.

Environmentalists want the Act strictly and expeditiously implemented with uniformity across the country. They are strong in insisting that the main authority for the program should remain with EPA and not be delegated to the states.

The Commission received many comments about funding for water pollution programs. Writers and speakers agree that more is needed -- more for EPA administration, monitoring and enforcement; more for states; more for construction grants; and more for research on new treatment technologies to reduce pollution more effectively and cheaply.

Several groups reported that the planning processes under the Act are cumbersome and time-consuming. However, they recognize that planning is an integral part of water quality improvement, and are particularly eager to insure the examination of secondary growth impacts of sewage treatment facilities.

While recognizing that many administrative problems have caused delays early in the program's implementation, most of the citizens commenting to the Commission believe the worst of those problems are resolved. Now, we face what some have called the "people problem" -- the attitudes of those who must act. "I believe hostility toward the many mandatory and new policies embodied in the Act is and will continue to be a major limiting factor to achieving the Act's laudable goals," writes an individual from Athens, Georgia.

Many of the individuals and organizations commenting to the Commission are frustrated by public participation as it is currently being conducted at all governmental levels. Even agencies that follow the letter of the law do not follow its spirit, they charge. Agencies are not encouraging and assisting public participation. Notices are distributed and hearings held as the regulations require, but there is no real program to assist and encourage participation in the control process. Some public interest groups suggested establishing an ombudsman in each EPA office and state agency to at least see that understandable information flows in a systematic way to interested persons.

Many believe that to "encourage and assist" public participation, agencies must fund public interest organizations. To provide the often technical information needed by agencies takes a great commitment of time and energy by volunteers in these groups. The only way for them to provide the quality of involvement necessary to be effective and

helpful is to be funded by the governmental agency. In this, too, attitudes are especially important. Agency staffs must view public participation as not just a chore and wasted effort, but as a useful part of their activities, environmentalists point out. Conservationists add that public education, teamed with public involvement in making decisions, fosters cooperation from the general public and the willingness of taxpayers to bear project and program costs.

In summary, conservationists and public interest groups generally support the Act. They believe initial implementation problems are being solved. They think the Act must be effectively implemented and strictly enforced. They strongly oppose any major changes in its requirements, goals, deadlines or administration.

Industry

The business and industrial community, concerned about the negative economic impact of the Act on their respective companies, has maintained a high level of interest in both the scope and detail of the Commission's study efforts. American Metal Climax, Inc., wrote the Commission: "It is our understanding that the Commission has broadened the inquiry to cover the 1985 goal of no discharge of pollutants as established in the Act. We fully endorse this broader investigation as the Commission's report to Congress will set the stage for possible amendments to the Act." The Procter and Gamble Company wrote, "The approach the Commission is taking of conducting studies on selected industries and regional assessments appears very sound."

The private sector has challenged the appropriateness of single number national effluent limitations for each industry and industry subcategory. Many spokesmen favored a matrix system, or at least provision in the law which would authorize EPA to negotiate compliance on a plant-by-plant basis. ASARCO wrote saying, "In evaluating standards, we think there should be consideration given to the ability of the receiving waters to cope with specific pollutants." Anheuser-Busch, Inc., wrote that "in order to meet the legislatively established deadlines, EPA has conceived guidelines in haste and has neglected such innovative approaches as the so-called matrix technique developed by the Effluent Standards and Water Quality Information Advisory Committee." Flexibility was mentioned in most of the correspondence as being extremely important, especially in cases of economic or social hardships.

As to meeting the legislatively stipulated 1977 and 1983 deadlines on time, there is a divergence of opinion. Most respondents said their companies intend to meet the 1977 BPT requirements; some reported that all, or most, of their industry category has already been issued permits and said that they expect the permit conditions will be met on time. The American Textile Manufacturers Association, for instance, wrote that,

"From the viewpoint of pollution abatement, a cooperative approach with EPA has resulted in a general acceptance by our industry of the 1977 limitations and has resulted in efforts toward compliance with them rather than litigation over their validity." However, Procter and Gamble commented, "It is our belief that the national goals of a quality of water that 'provides for the protection and propagation of fish, shellfish and wildlife, and provides for recreation in and on the water' will largely be met by imposition of the July 1, 1977, treatment limitations on industry and municipalities." Going further, United States Steel said that, "In effect, we will be required in many cases to achieve by July 1, 1977, what was contemplated by 1983 or 1985, if at all, without regard to the costs involved -- economic, social and environmental. Inasmuch as the 1977 deadline is unattainable in any event, by municipalities, it would make sense to wait until all of the first phase technology is in place so that existing water quality could be appraised before further significant expenditures are made." For the 1983 BAT requirements, industry was almost unanimous in asserting that they were too stringent, too costly, wasteful of manpower, energy and raw materials, and that they realized marginal improvements in water quality. Union Carbide Corporation indicated that, "It is particularly true for the 1977 to 1983 increment where a 50 percent increase in investment and operation costs will be needed to accomplish a five percent decrease in overall pollutant reduction."

Discussing the 1985 goal, Westvaco wrote, "We are unable to place a realistic price tag on the goal calling for complete elimination of the discharge of pollutants by 1985. However . . . it is not unreasonable to anticipate additional expenditures amounting to twice the total of all previous outlays to reach the pristine state anticipated by 1985. Whatever the actual cost, it is wasteful of both financial and natural resources to attempt to achieve this goal, which in our opinion is totally unnecessary." The Dow Chemical Company wrote, "The whole concept of 'zero discharge' for the electroplating industry can be seen to be nonsense spending of public and private resources -- and it will almost certainly put a substantial number of companies out of business -- without achieving any significant environmental improvement."

A number of companies expressed concern about the economic impact of P.L. 92-500, especially in relation to national economic uncertainties and other regulatory requirements which demand cost outlays from industry or affect productivity. The International Paper Company wrote, "An extension of time for implementation of Public Law 92-500 would do no significant damage to the environment, but would greatly diminish the inflationary impacts of these enormous expenditures by spreading them over a number of years. In short, the extension would help the Nation to recover both economically and environmentally." American Metal Climax wrote, "The Clean Air Act and the Federal Water Pollution Control Act have necessitated investment of large amounts of capital in unproductive

plant and equipment by AMAX and many other firms." The Joan of Arc Canning Company wrote, "The problem encountered is the tremendous capital investment. The four combined governmental agencies of EPA, Food and Drug, OSHA, and OEO will tend to bankrupt the smaller food processing companies. We have already closed two smaller operations within our own organization to transfer the production from these operations into larger facilities better able to spread the capital expense over a greater number of units of production."

Many companies commented on the problems of intermedia transfer, energy requirements and technology transfer. The Medford Corporation wrote, "Not everything taken out of waste waters can be incorporated into a saleable product, recycled back into the manufacturing process or harmlessly discharged back to the sources. These unusable pollutants must be put somewhere on air, water, or land, causing problems of concentration. This concentration would soon become a new environmental hazard." The Hoerner-Waldorf Corporation wrote, "Our real concern in the promulgation of the standards is the seemingly total lack of concern of the energy costs to achieve a limit for the sake of a limit." American Metal Climax, Inc., wrote, "In several cases, EPA has required levels of effluent treatment at our plants based on technology used in other industries. Treatment technology used in one industry is not necessarily transferrable for application in another industry. Individual plants and plant processes are often unique and cannot be economically modified or retrofitted with pollution control equipment in a manner that may be feasible for a particular industry."

A number of business concerns also expressed dissatisfaction with the industrial cost recovery and the user-charge provisions of P.L. 92-500. Some asserted that municipalities were using the provision as a new revenue source. Others objected to it as inequitable. Anheuser-Busch wrote, "In practice, an industry using a federally funded facility must pay back 75 percent of the cost of that portion of the plant allocated for the use of the particular industry. This cost recovery burden is unique in that it falls only on one user class -- industry. Industry must in effect pay twice for pollution abatement: once for the treatment of its own wastes through industrial grant recovery and again for the treatment of wastes produced by others not subject to grant recovery through industry's payments of federal income taxes."

A number of letters received by the Commission indicated that extensive administrative problems were being encountered. For instance, United States Steel wrote, "We continue to have problems with the overlapping jurisdiction of local, state and Federal agencies. In some cases, their objectives are inconsistent. In others, state or local agencies arbitrarily insist on standards more stringent than Federal standards which in themselves may be unattainable or at best represent the limits of technology. Conflicts of this nature, which are actually retardants

to progress, must be eliminated." Bethlehem Steel wrote, "We have experienced difficulty with conflicting state and federal regulations. Whereas the EPA wants standards based on pounds per day, some states insist on low concentrations. These two standards are often incompatible."

Yet, in spite of the serious criticisms expressed by industry toward the Act, the Commission's attitudes survey revealed that a majority of industry spokesmen surveyed were generally favorable toward the Act, believing, however that major adjustments were needed in the goals, requirements and guidelines. Based upon this survey and the other responses, industry's views toward the appropriate course for "mid-course corrections" could be summarized as follows:

1. The 1977 compliance date for BPT should not be enforced against industries that make a good-faith showing that they have been seeking to achieve permit compliance in a timely manner or where litigation has been initiated challenging the effluent limitations or the permit requirements. An appropriate period of time after final judicial appeal must be allowed to plan, design and construct the facilities.

2. The 1983 compliance date for BAT should be temporarily delayed or perhaps permanently discarded if the 1983 interim goal is achieved by less restrictive requirements, (i.e., BPT). Much of the industry testimony given at the NCWQ technical meetings indicated that an evaluation of water quality should be undertaken after (a) industry has installed BPT (or technologies to meet more stringent limitations in the case of water-quality limited rivers and water bodies); (b) the public sector has had sufficient time to achieve secondary treatment; and (c) abatement programs have been implemented for nonpoint sources of pollution.

3. The 1985 goal of EOD should be eliminated entirely as being unrealistic.

4. The assimilative capacity of the receiving waters should not be ignored, nor should an inordinate percentage of a state's rivers, lakes, streams or estuaries be designated to be restored and maintained at a quality adequate to meet the 1983 interim goal. Some spokesmen have maintained that the highest and best use of at least some American waters should be for industrial production, with the attendant social benefits realized from area employment.

Flexibility in methods for resolving these and other issues was a common concern voiced by the industrial community. P.L. 92-500 is characterized as an unusual piece of legislation in that it stipulates mandatory compliance deadlines and other requirements, and yet provides little direct administrative flexibility for EPA and little language that the courts have been able to interpret as allowing EPA much flexi-

bility. The industrial sector consistently expressed a genuine desire to work cooperatively with EPA to develop and fix limitations, guidelines, standards and appropriate schedules for compliance. They hope this might occur not only on an industrywide basis initially, but that it might also occur during the permit negotiations relating to a specific process or plant. To the extent that P.L. 92-500, as interpreted by the courts, does not now allow this flexibility, industry feels that it must be amended.

Agriculture

Agricultural interests see themselves in a unique and perplexing situation regarding P.L. 92-500. There is an acceptance of the fact that agriculture can and does have a marked impact on water quality and the environment. However, there is also almost unanimous feeling that the provisions of P.L. 92-500 are unsuited to agriculture.

In referring to one of the water quality problems associated with irrigated agriculture, the Colorado River Board of California commented, "(We) concur with the statement that in the Colorado River Basin 'the overriding water quality problem is salinity.'" The Johnson County, Kansas, Soil Conservation District commented, "erosion and the resulting sediment is the greatest pollutant of water by volume," and agreed that erosion was the priority water pollution challenge.

However, most representatives of agricultural communities felt that the Act's reliance upon waste treatment technologies applied to point source discharges is completely unsuited to addressing agriculture's impact on water quality. If progress is to be made in improving water quality, it will only come as new agricultural practices are adopted. There is widespread feeling that EPA does not understand the nature of agricultural problems and would be overzealous and irrational if it attempted to bring about improved practices.

The governmental structure needed to implement an agricultural permit and enforcement program is almost totally nonexistent. There is no consistent policy defining which public or private organization could be required to obtain and comply with discharge permits. Governor Daniel J. Evans, of Washington, commented, "This is the issue of the apparent institutional inadequacies of local levels of government to enforce NPDES conditions for managing irrigation return flows. When such flows emanate from Federally constructed projects, the respective roles and responsibilities of the Federal government and operating irrigation districts are even more controversial."

Many commenters broached the subject of possible conflicts between the appropriative water rights doctrine of the western states and the provisions of P.L. 92-500. Western water law is based upon the right to "beneficial use" of a water resource. As summarized in a Colorado

River Basin report, "Water quality limitations on the definition of beneficial use are almost always opposed by western water users. Some even go so far as to claim that rights to the beneficial consumptive use of water implies a right to pollute and that water quality limitations constitute a 'taking' in violation of due process."

Another common opinion expressed is that the water quality problems associated with agriculture, particularly salinity and sediments, are natural or nonpoint pollutants. Although these problems may be exacerbated by agriculture, they should not and cannot be controlled by uniformly applied treatment technologies. Other agricultural pollutants, including fertilizers and pesticides, are best controlled by regulating their application, rather than through the treatment of runoff or drainage water.

Two more concerns of the agricultural community are the economic consequences of abatement and the status of agricultural dischargers as public or private entities. Many farmers, irrigators and ranchers commented that the individual operator would not be able to afford the cost of abatement control measures. A Nebraska feedlot operator stated that the costs for pollution control would be five to six dollars per head and that this cost could not be passed on to the consumer. Several commenters pointed out that farm subsidies are available from the Farmers Home Administration, the Soil Conservation Service and the U.S. Forest Service, all in the Department of Agriculture. However, none of the programs is large enough to cover the costs of abatement measures and many agricultural operations would be unable to meet these costs.

Many people also commented on the ambiguity concerning the status of agricultural operations as public or private concerns. While the irrigator, farmer or rancher is certainly a private individual, irrigation, drainage or soil conservation districts are public organizations. Many commenters suggested that an effective way to influence agriculture is through public agencies such as soil conservation services, agricultural extension services, etc. Several commenters from the Bureau of Reclamation and the states in the Colorado River Basin pointed out the program of the Colorado Salinity Control Act (P.L. 93-320) is jointly funded on a 75-25 percent federal-local basis, as are publicly owned waste treatment plants under P.L. 92-500. In addition, state pollution control programs for agriculture always involved planning by either state or areawide organizations.

Government

The response to P.L. 92-500 by Federal, state and local governmental agencies* has been both diverse and numerous. The institutional com-

*Unpublished Digests of Letters, National Commission on Water Quality.

plexities, combined with individual attitudes, continue to affect implementation of this Act. Generally, the attitude of the state and local officials, as characterized in the Commission's survey, was supportive of the Act and many of its essential concepts, especially financial incentives and revenue producing devices, but negative about the advisability and likelihood of achieving the major goals of the Act.

The responses from various government officials at all levels are grouped into four general program aspects or characteristics: 1) fiscal, 2) administrative, 3) constraints, and 4) priorities.

Fiscal Factors -- Both state and local government officials express concern about availability of adequate funding in a highly competitive governmental fiscal situation. At the state level, there have been frequent statements that inadequate funds have been provided to achieve the Act's requirements. This concern is illustrated by comments from the State of Alabama: ". . . it would appear that it is not feasible to place all, or substantial amounts of available construction grant funds in one or two areas . . . at the expense of other areas . . ." and from the State of Ohio: ". . . I assume that the study will address the effect of the impoundment of construction grants. . . (T)his has (been) . . . and is . . . a deterrent to the program."

Local or municipal governments expressed equal concern. Communities as small as Hanover, New Hampshire, and as large as Oakland, California, expressed concern about both the availability and commitment of Federal monies. For example, Nashville, Tennessee, commented that ". . . communities will not move without assurance of Federal funds and Federal funds are not enough to stretch to every potential recipient in the appropriate amounts. . ." Poweskirk County, Iowa, commented: "It is not easy to say to a small community that you are going to have to meet this Act's requirements when it is almost certain it cannot even get on a priority list (for federal funds)."

In addition to concern about the availability of funds for capital construction, state and local governments voiced strong feelings about operation and maintenance costs. Winchester, Virginia, says, "One of the main problems that we face . . . is a shortage of personnel . . . I think the salaries and public image of these workers must be improved," and Brockton, Massachusetts, echoes, "I could never understand why we spend millions of dollars to build sewage plants and give so little thought to the staffing of these plants."

The ultimate effect of national economic trends, very tangible at the local level, is evidenced by this statement from Petersburg, Virginia: "Energy requirements for increased capacity and treatment levels are expensive. Labor costs . . . have risen sharply. Costs for replacement

parts and dates for delivery are becoming unreasonable. Chemicals are more costly and harder to obtain. All of these costs must be passed on to the user and are slowing down our national goals."

Responses to two of the Act's key provisions, "user charges" and "industrial cost recovery," were numerous. Responses indicated a general acceptance of the user charge concept, but disagreement with the court decision that ad valorem taxes are unacceptable. States and many municipalities feel that increased flexibility allowing local entities to determine the methods for assessing and collecting user charges would make the implementation of this requirement much simpler and easier.

The industrial cost recovery requirement generated complaints from the public sector. Opposition was not directed so much to the purpose of the requirement, which was intended to ensure that some industries did not get a free ride at the expense of the Federal taxpayer, as to the procedure by which the purpose is to be realized. The general feeling is reflected in a comment from Wichita, Kansas: "The engineering required as well as the bookkeeping necessary to administer the industrial cost recovery provision . . . is not a practicable approach to the problem."

Administration -- A major concern of state and local governments is administrative deficiencies in implementing the Act -- chief among them, the effects of "excessive paper work," "duplication" and "red tape." The intensity and number of responses on this subject are impressive. Other concerns -- such as delay, duplication, lack of delegation of authority and responsibility, rigidity, erratic policy guidance and lack of continuity in the program -- were identified not only as administrative problems, but also as major factors contributing to or, in some cases, causing duplication and excessive paper work.

This problem is described well by comments of San Antonio, Texas: "Our second most pressing problem is the tremendous amount of paper work . . . the requirements are repetitive and absurd; others are frightening . . . (T)he most important steps which could be taken to improve the Federal-State-local partnership would be to study all means of cutting red tape." Another good example is the statement of an official from Palo Alto, California: "It is extremely frustrating to those in the wastewater field to spend a million dollars and four years on reports which are repetitive and redundant without ending up with plans and specifications from which to solicit bids or a single element of construction."

States also voiced strong opinions about administrative demands, insisting that administrative and regulatory provisions of the Act have imposed enormous workloads on their staffs. Even with increased staffs,

they asserted that the requirements of the Act adversely affected their ability to carry out other responsibilities under state law. From Wisconsin: "I am concerned that over the long haul the State legislatures will not continue to support the State contributions to the overall program. . . Duplication of regulations and jumping back and forth from State to Federal regulatory procedures will result in a serious loss of confidence by the public as well as those who are regulated."

Technological Constraints -- While a few responses specifically indicate purely technical constraints to implementing the program, a few technological and "environmental" factors were characterized as being counterproductive to achieving the Act's requirements. Many officials questioned the need, in all cases, to provide "secondary" treatment as rigidly defined by EPA. Many argued that it would be more effective to allow the use of several different types of conventionally defined wastewater treatment processes such as waste stabilization lagoons or ponds. Although these processes may not meet the strict EPA criteria, some felt they would fulfill local environmental needs, and lessen the fiscal and administrative impact.

States and municipalities in coastal areas have argued against the need for "full secondary treatment." In northern or wet climates, the imposition of the "infiltration/inflow requirements" posed a seasonal constraint wherever actual field analysis was required. This problem occurs primarily during spring runoff; consequently, nature -- not the Act -- dictates when a reliable technological assessment can be made.

These responses generally indicated that the rigid imposition of "requirements" strongly influenced state and local administrative personnel and elected officials' attitudes toward the acceptability of the Act.

Priorities -- One subject receiving a large number of responses, particularly from the states, was planning. Many government officials voiced concern over numerous and often ambiguous planning requirements, uncoordinated and overlapping planning programs and priorities, unrealistic deadlines, and the uncertainties and inevitable shortages of funds. Some questioned the need and utility of the new extensive planning levels initiated by the Act. They argue that construction of wastewater treatment facilities will abate pollution, but studying the problem will not. A few others argue that these studies essentially have already been performed. Thus, the new requirements only generate more paperwork and waste the taxpayers' money.

There appears to be a general acceptance of the need for planning, but a major concern about the most beneficial kind of planning. For example, the State of Washington states that, "Facility planning is a

study area . . . that could use a closer look. Over-planning of alternatives for rural areas, unrealistic projections of growth, and duplication of effort need to be adequately addressed." The State of South Carolina adds that ". . . comprehensive water resource planning should not be allowed to evolve into a series of separate efforts with only token coordination."

Another subject posed as a question of priorities is the control of pollution from nonpoint sources. While reactions to the program addressing this problem under the Act have been mixed, responses tend to show that the most significant question is, "Who will have ultimate responsibilty for this planning?" State, local and regional groups have all demonstrated a desire to "control" the nature of this planning, primarily because of its land use implications. An indication of the level of this concern is illustrated by comments from the State of New Mexico: ". . . many of the western states either do not understand, or do not agree that 'non-designation' under section 208 (of the Act) has the effect of requiring the establishment of state land use control sufficient to regulate the location, modification and construction of any facilities which may result in any discharge."

Other problems, such as research and development, manpower training and public participation have also been listed as concerns in the establishment of priorities by government officials.

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VI. THE REGIONAL ASSESSMENT STUDIES

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VI. THE REGIONAL ASSESSMENT STUDIES

A. SUMMARY FINDINGS AND CONCLUSIONS

America is rich in diversity -- of its lands, its climate, work force and levels of government. Because of this diversity, the impacts of water pollution abatement programs upon the environment, the economy and people are likely to vary substantially from place to place.

Reasons for the variations are many. One area may be growing; another declining. One stream may be polluted; another clean. One stream may be easily accessible to bathers or boaters while another may be lined with factories.

The eleven regional studies undertaken by the Commission to analyze the local impacts of the Federal Water Pollution Control Act Amendments of 1972 clearly confirm this diversity. The studies show, for example, that in some regions projected growth could virtually negate the progress made by abatement programs within a few years. In other regions, however, the law's requirements would provide long-term protection to water quality if extensive growth does occur. Industry will bear the brunt of the cleanup costs in some regions, while municipalities will pay a larger share in others. In some places, the law's requirements would bring only marginal improvement in a stream while in others the improvements would be substantial.

The eleven regions represent a wide range of economic and environmental setting and incorporate a great diversity of water pollution problems. Each assessment has been a case study of the environmental, economic, social and institutional aspects of point source abatement programs in a particular region. Each has focused on key water quality-related issues in specific local areas within the basin.

o With few exceptions, achieving the 1977 effluent limitations for industries and municipalities is a rational first step in overcoming local water pollution problems.

In highly industrialized areas, the Act's point-source provisions are most effective. Industrial pollution loadings dominate in such areas. Effluent limitations applied to these dischargers in most cases will result in marked water quality improvement. In other cases, the sources controlled by effluent limitations contribute a smaller portion of the total pollutant loading.

Urban runoff and the discharge of stormwater from separate sewers or combined sanitary and storm sewer overflows can intermittently degrade water quality near large metropolitan areas. In

the regions studied, programs to control urban stormwater generally have not been developed or implemented. Lack of stormwater discharge control may markedly restrict the environmental improvement achieved by point-source abatement programs. Metropolitan areas near coastal waters argue that the secondary treatment requirement for publicly owned treatment works discharging into marine waters is unnecessarily stringent and ineffective. In Seattle, for example, the 1977 technology-based effluent limitations are questioned for discharges to Puget Sound. Economically, it is argued that they are more stringent and therefore more costly than required; and environmentally that, by focusing on oxygen demanding materials, they ignore the more important toxic materials and nutrients.

In regions where irrigation drainage discharges poor quality water into streams and rivers, the effectiveness of regulating point source return flows is highly problematic. The institutional, economic and hydrological characteristics of irrigated agriculture in the three regions studied suggest that the utility and overall impacts of measures to reduce point-source discharges should be reviewed as part of basinwide plans for water quality and use.

Other problems will remain. Under EPA's interpretation of the Act's technology-based point-source provisions, neither eutrophication nor salinity will be effectively reduced. Control of these problems will have to come as a result of applying the Act's more stringent provisions related to water quality standards or the state pollution control programs.

o The stringency of the effluent limitations and abatement measures required to achieve and maintain water quality standards exceeded those of the 1977 technology-based requirements for industrial dischargers and publicly owned waste treatment plants in nine of the eleven regions studied.

In many areas with sizable urban-industrial concentrations, effluent limitations are based upon the allocation of pollutant loadings compatible with maintaining water quality. In these locations, major publicly owned treatment works are generally required to achieve pollutant reductions significantly more stringent than EPA's definition of secondary treatment. The effluent limitations required of industrial dischargers generally are more stringent than BPT, but less stringent than BAT.

o Economic and population growth implies a need to achieve increasingly stringent abatement or to accept increased total pollutant discharge and degraded water quality.

In undeveloped areas, vigorous pollution control programs, including eliminating the discharge from new steam electric generating and coal conversion plants and achievement of at least secondary

treatment for municipal wastewater, must be implemented to assure water quality maintenance if growth occurs and energy resources are developed. In the Yellowstone basin, for example, if the dischargers in the population centers can meet the required effluent limitations, water quality standards generally will be maintained and water quality degradation circumscribed. A major effort will be required in the basin, however, to assure control of pollution from present and potential surface mining activities and to identify localities where new growth will occur so that they can plan for adequate waste treatment.

In many urban-industrial areas, economic growth will require increasingly stringent abatement measures to control industrial and municipal point sources and urban stormwater. Effluent limitations more stringent than the technology-based requirements of 1983 may be necessary in such areas to assure the maintenance of water quality standards.

o In many regions requiring industrial and agricultural discharges to achieve by 1983 limitations more stringent than those for 1977, without similarly requiring a more stringent level for publicly owned facilities, is both environmentally and economically questionable.

The relative portion of the pollutant load contributed by public and private dischargers varies markedly from region to region as does the relative cost to achieve compliance with the 1977 and 1983 effluent limitations. Generally, abatement requirements are more stringent for industrial dischargers. As the 1977 requirements are met, the relative portion of the discharge of nontoxic pollutants, such as BOD, nutrients and suspended solids, contributed by municipal sources increases. Similarly, the public sector's portion of the regional cost is usually smaller than its contribution to the total pollutant load. The 1983 technology-based requirements continue the trend of increased stringency in the private sector over that in the public.

o The benefits of pollution abatement are determined not only by changes in water quality, but also by local and regional factors including the public's perceptions of the water's suitability for recreational pursuits and its desire to use or preserve the uses of the specific water courses.

The willingness to open and use recreational areas or allow commercial or recreational fin and shellfishing is determined by many features, including the historic perceptions and the availability of alternative recreation or fishing areas. Often the policies of such state and local institutions as recreation departments, boards of health, and fish and game departments are central in determining the degree of recreational participation or the allowed level of fin and shellfishing.

o Many of the institutional concerns associated with P.L. 92-500 are related to the prior status of pollution control programs in the regions.

Each of the Act's major programs -- pollution control planning, enforcement and publicly owned waste treatment facility construction -- has a prior history and institutional embodiment. The institutional impacts depend upon the similarities and differences between these programs and the Act's requirements. In states such as California where discharge permits have been in effect prior to the enactment of P.L. 92-500, the Act's program requirements can be duplicative and inhibiting, in cases even slowing down the state program. More frequently, however, the Act has required major alterations in state laws and programs.

o One of the major impediments to effective implementation may be the difficulty in designing workable strategies that the various levels of local, state and interstate governmental entities will accept.

Section 208, "Areawide Waste Treatment", provides a mechanism for designing management schemes for waste treatment programs where more than one local authority or municipality is affected. It is premature to judge the impact Section 208 grants will have in helping to improve institutional structures. In multistate basins, there is a need to coordinate the priorities for constructing waste treatment plants and waste load allocations among several states. EPA's review authority can be used to assure this coordination in cooperation with interstate agencies or advisory groups.

o The Act does not effectively recognize the water quality provisions of agreements with Canada and Mexico.

It is likely that timely fulfillment of the U.S. obligations to Canada can only be successful if separate appropriations are specified for abatement measures on the Great Lakes. The obligations to Mexico will be fulfilled by programs separately authorized by the Colorado River Salinity Control Act (P.L. 93-320).

o Hydrological changes caused by dams, channels or diversions are important water quality considerations in many basins.

Pollution discharge abatement measures alone cannot assure the ability to control water quality degradation. P.L. 92-500 specifies that alterations in flows or hydrological patterns are to be considered for their effects on water qualty. Both the institutional and physical problems in evaluating hydrological changes are extremely complex. However, the Act's basinwide planning and water quality standards provisions potentially can be used to assure the compatibility of proposed water resource projects and water quality concerns.

B. THE REGIONS

Four criteria were important in selecting the regions and study topics. The regions were to cover a range of environmental settings, including small and large rivers, lakes, coastal bays and estuaries. They were to represent a range of demographic settings, from rural, through small and medium-sized towns, to urban complexes. They were to include major classes of pollution problems -- municipal, industrial or agricultural point sources, storm runoff and nonpoint sources. Finally, they were to include a range of severity of water quality problems and a range of past programs for water pollution control.

The purpose of this chapter is to highlight some of the variations found among the regions in relation to the Act and to discuss why these variations occur. The results presented here were chosen to illustrate certain topics; where possible, the chapter will draw comparisons between regions. A comprehensive treatment of all the regional studies is in a supplementary volume.

The Merrimack & Nashua Rivers

The Merrimack River Basin drains an area of 5,010 square miles in New Hampshire and Massachusetts. Formed by the confluence of two headwater tributaries at Franklin, N.H., the main stem extends 118 miles. Twenty-two of these are tidal estuary. The Nashua flows northerly from Lancaster, Mass., to the confluence with the Merrimack at Nashua, N.H.

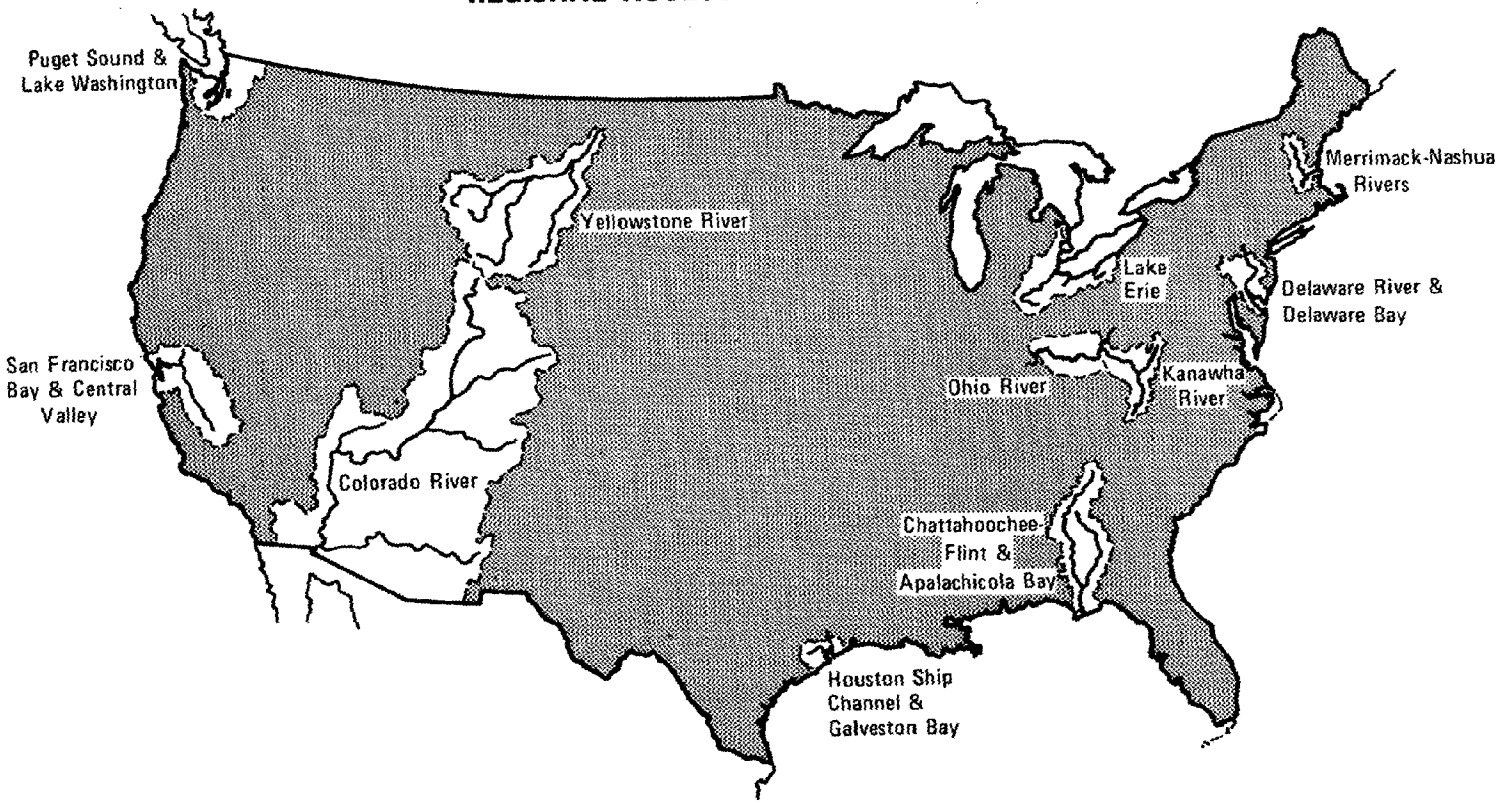
While three-fourths of the basin's land area lies in New Hampshire, three-fourths of the population is in Massachusetts. The basin's population in 1970 was one million, about 45 percent of the population of New Hampshire and 19 percent of the population of Massachusetts. Although the western and northern fringes of suburban Boston lie within the basin, much of the population lives in medium-sized towns.

At present, the Merrimack and Nashua Rivers are severely polluted by municipalities and industries. Important industrial dischargers are food processing, textiles, paper, chemicals, metal fabricating and leather plants. Many of the firms are small and concentrated in the older part of the industry.

Until recently, pollution abatement programs in the basin were considered weak. This can be attributed in part to the historical perception of the Merrimack as an industrial river and to the difficulty in taking effective action with diverse and independent local governments. An extensive abatement program for the construction of publicly owned treatment plants was initiated prior to 1973, however.

Figure VI-1

REGIONAL ASSESSMENT STUDY SITES



Natl. Commission on Water Quality
February 1976

The Delaware River

The Delaware River extends from southern New York State about 250 miles to the Atlantic Ocean. Below Trenton, N.J., the river is tidal. Salinity in the estuary increases downriver to a point near Wilmington, Del. There the estuary widens to form Delaware Bay.

The southern portions of the basin are highly urbanized. More than seven million people live in the basin. The largest concentration of people occurs along the estuary from Trenton to Wilmington and includes the Greater Philadelphia-Camden area. The other important population center is located on the Lehigh River, a Delaware tributary and includes the industrial area of Allentown, Bethlehem and Easton.

Many of the urban areas are associated with large industrial complexes. The Delaware estuary receives wastes from population centers and petrochemical industries. The Lehigh River receives wastes from energy and metals industries.

Before 1950 the Delaware and its tributaries were extremely polluted. An interstate agency, formed in 1936, eventually evolved into the Delaware River Basin Commission. Under the aegis of the Commission a program designed to achieve water quality standards was initiated in 1968. Standards have not been met. During the summer, dissolved oxygen concentrations may go to zero downstream of Philadelphia. Many municipal discharges do not presently receive secondary treatment, but facilities to upgrade treatment are being built.

The Kanawha River

The Kanawha River basin drains an area of 12,300 square miles in the States of North Carolina, Virginia and West Virginia. Formed by the New and Gauley Rivers at Gauley Bridge, West Virginia, the Kanawha flows 97 miles northward to the Ohio River.

The major population center in the basin is Charleston, W. Va. The Charleston SMSA has about 256,000 people, slightly more than 30 percent of the basin's population. The primary industry in the Charleston area is chemical manufacturing, which provides 9,800 of the total 15,700 manufacturing jobs in Kanawha County. The plants are large and well-established. Industrial pollution continues to be a major factor in the degradation of the Kanawha. Municipal sewage and acid mine drainage also are problems.

The Kanawha has experienced a severe decline in water quality since World War I. In 1958 the West Virginia Division of Water Resources began a three-phased approach to cleanup. With the cooperation of industry, the program has been successful in raising levels of dissolved oxygen and lowering levels of many pollutants. By 1972, the BOD level

had been reduced by 85 percent and minimum dissolved oxygen concentrations were 3 mg/l. At that time, the state set a more stringent standard of 4 mg/l.

Lake Erie

Lake Erie is the smallest and shallowest of the five Great Lakes. The shallow western third of the lake -- with an average depth of 25 feet -- is particularly susceptible to degradation.

The largest concentration of population and industry is located on the south shore of the western and central basins. The 1970 population of the western half of the basin was about 10 million. The three major urban-industrial centers are Detroit, Cleveland and Toledo. The Maumee River basin southwest of Toledo is heavily farmed.

The water quality in the western basin is severely degraded. Nearshore problems exist from municipal and industrial discharges. A critical lakewide problem is accelerated eutrophication induced by large phosphorus loadings. Principal phosphorus sources are municipal treatment plants, urban stormwater from separate and combined sanitary and storm sewer overflows and agricultural runoff. The lake has been an important recreation and commercial fishing area. The catch of desirable fish has been declining, however. In past years many beaches were closed because of high bacterial levels. Recently, beaches in some areas have improved.

In the past decade the lake has served as a national symbol of environmental pollution. Publicity, enforcement conferences and legal actions have helped force major polluters into abatement programs. A U.S.-Canadian agreement now sets limits for the discharge of phosphorus.

The Ohio River

The Ohio main stem is formed at Pittsburgh, Penna., by the Allegheny and Monongahela Rivers. The Ohio flows 981 miles to its confluence with the Mississippi at Cairo, Ill. The basin drains 163,000 square miles in eleven states.

Major population centers include Pittsburgh, Steubenville-Weirton, Wheeling, Huntington-Ashland-Portsmouth, Cincinnati and Louisville. Recently, development and population growth have been more rapid in the Cincinnati region than in the eastern portions of the basin.

The Ohio is an important transportation corridor for heavy industry in the East. The river is controlled by a series of locks and dams to assure minimum depths required for barge traffic. Manufacturing industries, including chemicals, metals and energy, are located along the river. The enormous concentrations of heavy industries and large population centers, combined with low summer flow, result in serious water quality degradation.

During the early 1900's the river became increasingly polluted. Water quality problems on the river have been particularly difficult to control because of the large number of jurisdictions involved. A basin-wide authority, the Ohio River Valley Water Sanitation Commission (ORSANCO), has been the center of pollution control activities. In the early 1950's very little of the waste load from municipalities and industries was treated. By 1973 all dischargers were using some form of treatment.

The Yellowstone River

The Yellowstone River flows west about 450 miles from Yellowstone National Park in northwest Wyoming to the Missouri River in western North Dakota. Four of the main tributaries are the Powder, Tongue, Bighorn and Clark's Fork Rivers.

The basin has a population of about 280,000. Billings, Mont., with a 1970 population of 61,500, is the only community with more than 15,000 people. There are three Indian reservations in the basin -- the Crow and Northern Cheyenne in Montana and the Wind River in Wyoming.

Water pollution problems of the basin are not severe compared with many other rivers in the U.S. Water quality varies widely and seasonally. In the upper mountainous regions, streams are generally cold, clear and low in suspended and dissolved solids. Erosion occurs throughout the lower elevations where limited precipitation supports only sparse vegetative cover. Agriculture is the largest water user. Nearly one-third of the total 3.3 million acres of cropland is irrigated. The Middle Yellowstone region receives the largest municipal and industrial point source discharges. These include the discharges from the Billings sewage treatment plant, two petroleum refineries and a sugar beet processing plant.

In recent years, concern about water quality has increased because of proposed development of the basin's vast coal resources.

Puget Sound

Puget Sound is an inland extension of the sea. The Sound drains an area of about 2,340 square miles. The region contains four distinct types of water environment -- rivers, lakes, estuaries and the marine waters of the Sound itself. Lake Washington, the largest lake in the region, is located in the heart of the Seattle area.

Sixty-five percent of the population of the State of Washington resides in the region. More than 80 percent of the region's total population of 2.2 million live in the metropolitan Seattle and Tacoma areas.

Waters are generally of high quality and are extensively used for recreation and commercial fishing. Sources of pollution include industrial and municipal discharges and disposal of dredged materials. Major discharging industries are lumber products, pulp and paper and food processing.

Initially, anti-pollution efforts focused on public education and voluntary cooperation of municipalities and industries. An industrial permit program was established in 1955 and by 1963, 93 percent of all industrial discharges were under permit. In general, municipalities discharging to the Sound have been required to have primary treatment, while those discharging to freshwaters have been required to employ secondary treatment. The most dramatic pollution control results occurred in the Lake Washington cleanup in the 1960's when municipal effluents were diverted from the lake to the Sound. The Municipality of Metropolitan Seattle (METRO), a regional sewage agency, gained a national reputation for its role in this cleanup.

San Francisco Bay/Central Valley

Central California is a large valley drained in the north by the Sacramento River and in the south by the San Joaquin. The rivers meet and discharge through the Carquinez Strait to San Francisco Bay and the Pacific Ocean. Much of the Bay itself extends to the south and is not continuously flushed by freshwater inflows. Salinity levels in the south Bay at times exceed those of seawater.

The population of the region is more than 7.5 million. About 4.8 million people live in the San Francisco area. The industrial centers follow the northern Bay and the Carquinez Strait. Agriculture and food processing are important in the area. The area's small rainfall means that much of the agriculture is irrigated.

The region has had three different types of water pollution problems. In the south Bay, sewage discharges have resulted in coliform and low dissolved oxygen problems. Fish kills in the north Bay and Carquinez Strait have raised questions about the toxicity of industrial and municipal effluent. Pollution problems in the Central Valley have been related to drainage from irrigated agriculture.

California has had an aggressive water pollution control program which has effectively addressed the municipal problems in south Bay and the potential toxicity problems in the Carquinez. Many industrial plants are using advanced treatment technologies. The system of State Boards has enormous power to control pollution problems on an areawide and comprehensive basis.

The Colorado River

The Colorado River, more than 1,400 miles long, drains one-twelfth the area of the contiguous 48 states. The land at lower elevations is desert, averaging less than 10 inches of rain each year. Averaged over the entire basin, the yearly runoff is about one inch.

One aspect of the Colorado distinguishes it from nearly all other rivers -- its flow does not reach the ocean. Almost all of the water in the Colorado is diverted directly or is stored in reservoirs to meet current and future consumptive uses.

The basin's total population is 2.5 million. There are three urban centers -- Tucson, Phoenix and Las Vegas. Much of the population lives in small towns or on farms. The basin is nonindustrial and sparsely populated. Agriculture and, to a lesser extent, mining are the most important activities affecting water quality.

The overriding water quality problem is salinity. About 65 percent of the salt comes from natural leaching. Irrigation adds additional salts to the river. A more important aspect of irrigated agriculture's impact, however, is that it selectively evaporates water, increasing the concentration of dissolved salts. Salinity has a greater impact on man's use of the river, particularly irrigation, than it does on fish and wildlife.

The salinity control program in the Colorado has two aspects. The water below Imperial Dam in California flows to Mexico. Its quality is to be maintained through the use of desalting technology. The quality in the river above Imperial Dam must be maintained through a complex set of measures applied to irrigation and energy uses.

Houston Ship Channel-Galveston Bay

The Houston Ship Channel is a man-made navigation route connecting the City of Houston with the Gulf of Mexico. Twenty-two miles of the channel are inland, while the remaining 29 miles extend through Galveston Bay. The Bay itself is an important Gulf Coast estuary receiving the flows of the Trinity and San Jacinto Rivers.

Three major cities are located in the vicinity of the Bay -- Houston, Texas City and Galveston. The region, particularly the Houston area, has experienced extremely rapid growth. The 1970 population for the greater Houston area was 2 million.

Houston is a major port. The shipping carries the products of the area's petrochemical industry. The large concentration of industry in the Houston area, particularly along the Ship Channel, includes chemicals, pulp and paper and metals. These industries contribute to the waste discharges to the Channel and the Bay.

The low dry weather flows and large municipal and industrial waste discharges to the Ship Channel significantly degrade water quality. Water from the Channel is flushed into the Bay during storms. In 1965, the Texas Water Quality Board began a program to control pollution to the Channel and ultimately the Bay. By 1972 the discharges of pollutants had been reduced considerably. Existing permits, valid through 1979, are very stringent. Major industries are being required to achieve effluent limitations which are very nearly the same as the Act's limitations for 1983. Major municipal dischargers will reduce their effluent to one-third of the secondary treatment levels defined by EPA.

Chattahoochee-Flint-Apalachicola

The Chattahoochee River rises in the Blue Ridge Mountains of northern Georgia and flows south for 436 miles where it meets the Flint River to form the Apalachicola. The Flint rises just south of Atlanta and flows about 350 miles southward. The Apalachicola, the main stem of the river system, is 133 miles long. The river system drains 19,500 square miles in Alabama, Florida and Georgia. The Chattahoochee recently has been dammed about 160 miles south of Atlanta near West Point, Ga., mainly for flood control.

The major population centers on the upper portion of the Chattahoochee are Atlanta and West Point, Ga.-Lanett, Ala. Total population of the two areas is about 2.8 million, primarily in the Atlanta region. Population in the Atlanta area has been growing rapidly and growth is expected to continue. The Atlanta area has little heavy industry. Textile and food processing plants are located in the West Point-Lanett area.

Water quality in the Chattahoochee south of Atlanta has been poor. Municipal sewage discharge and urban storm runoff are the major sources of pollution. Sewage treatment plants in the Atlanta area are being upgraded and are expected to achieve secondary treatment in 1975.

Because of the poor quality water south of Atlanta and the newly built reservoir at West Point, a stringent abatement program has begun. The municipal plants are scheduled to employ advanced waste treatment technology by 1979.

C. THE EFFLUENT LIMITATIONS AND WATER QUALITY PROBLEMS

How effective are the technology-based point-source effluent limitations for solving local water pollution problems?

Each of the regional studies has assessed alternative abatement programs to determine their costs and environmental impacts. The findings indicate there are important differences between regions regarding

the water quality and environmental changes which can be expected from achieving the presently defined point-source effluent limitations. Two factors were found to be important in determining the effectiveness of the technology-based effluent limitations for controlling pollution discharges. These are the relative contribution of unregulated sources to the total discharge of pollutants and the relative importance of nutrients or other materials not covered by the technology-based effluent limitations.

Technology-based effluent limitations have not yet been defined for two important categories of point sources. These sources are the confined return flows from irrigated agricultural lands and urban stormwater* from storm sewers or from combined sanitary and storm sewer overflows.

In addition to mandating effluent limitations for point sources, the Act provides for programs to assist planning for the control of nonpoint sources. The Act defines nonpoint sources to include activities such as agriculture, silviculture, mining and construction, associated with actual increases in pollutant discharge. In addition, the definition is extended to include modifications of ground or surface water hydrology leading to water quality degradation or salt water intrusion.

A discussion of the situations where effective pollution control programs must incorporate additional or more stringent measures may give an incorrect impression of the relevance of the technology-based effluent limitations to pollution problems. The Act specifically recognized that more comprehensive and more stringent programs would be necessary in certain areas. In many instances the technology-based effluent limitations are a necessary first step in a pollution control program. The regional studies identified only two cases where serious questions were raised as to the environmental rationality of imposing uniform effluent limitations. The first concerned deep-ocean disposal of effluents. In this instance, secondary treatment removes oxygen demanding materials from the effluent. The case was presented that a more reasonable strategy would concentrate effort on removing toxic materials or nutrients and decrease the priority for BOD removal. The second instance was salinity and sediment control for irrigated agricultural sources. Here it was argued that a comprehensive water management plan designed to assure water quality should be used as the frame of reference for deciding the utility of requiring specific changes in irrigation practices.

*The term "urban stormwater" is used in this chapter to note the discharge from sewers. The term "urban runoff" is used to mean the discharge both from sewers and diffuse sources.

1. Unregulated Sources

More information exists on the types and quantities of pollutants discharged from point sources than from nonpoint sources or urban runoff. Many of the regional assessments were unable to address nonpoint problems and others used only generalized information to determine the possible magnitude of nonpoint problems. However, a few of the studies did report specific information on mine drainage, agricultural runoff and urban stormwater discharged from storm or combined sanitary and storm sewers.

The findings of the regional studies provide information on two topics -- the extent to which urban stormwater or nonpoint sources limit the water quality enhancement achieved by industrial and municipal point-source abatement and the importance of natural and nonpoint source discharges in limiting the efficacy of abatement programs for irrigated agriculture.

a. Urban-Industrial Areas

At least two different types of situations are apparent in the urban-industrial areas studied. The Kanawha River near Charleston, W. Va., and the northern portions of Puget Sound illustrate situations where urban stormwater or nonpoint sources are not now particularly important. In these areas, the urban centers are not large. Industrial wastes are, by far, the most important portion of the pollutant discharge. The industrial component dominates the municipal, not only in terms of BOD and suspended solids, but also in its potential for having a toxic effect on the environment. The Houston Ship Channel and the reach of the Chattahoochee River south of Atlanta, on the other hand, are areas where urban stormwater may limit the ability of effluent limitations to achieve clean water.* Urban populations in both areas are very large and sewage treatment plants contribute a significant fraction of the total point-source discharge.

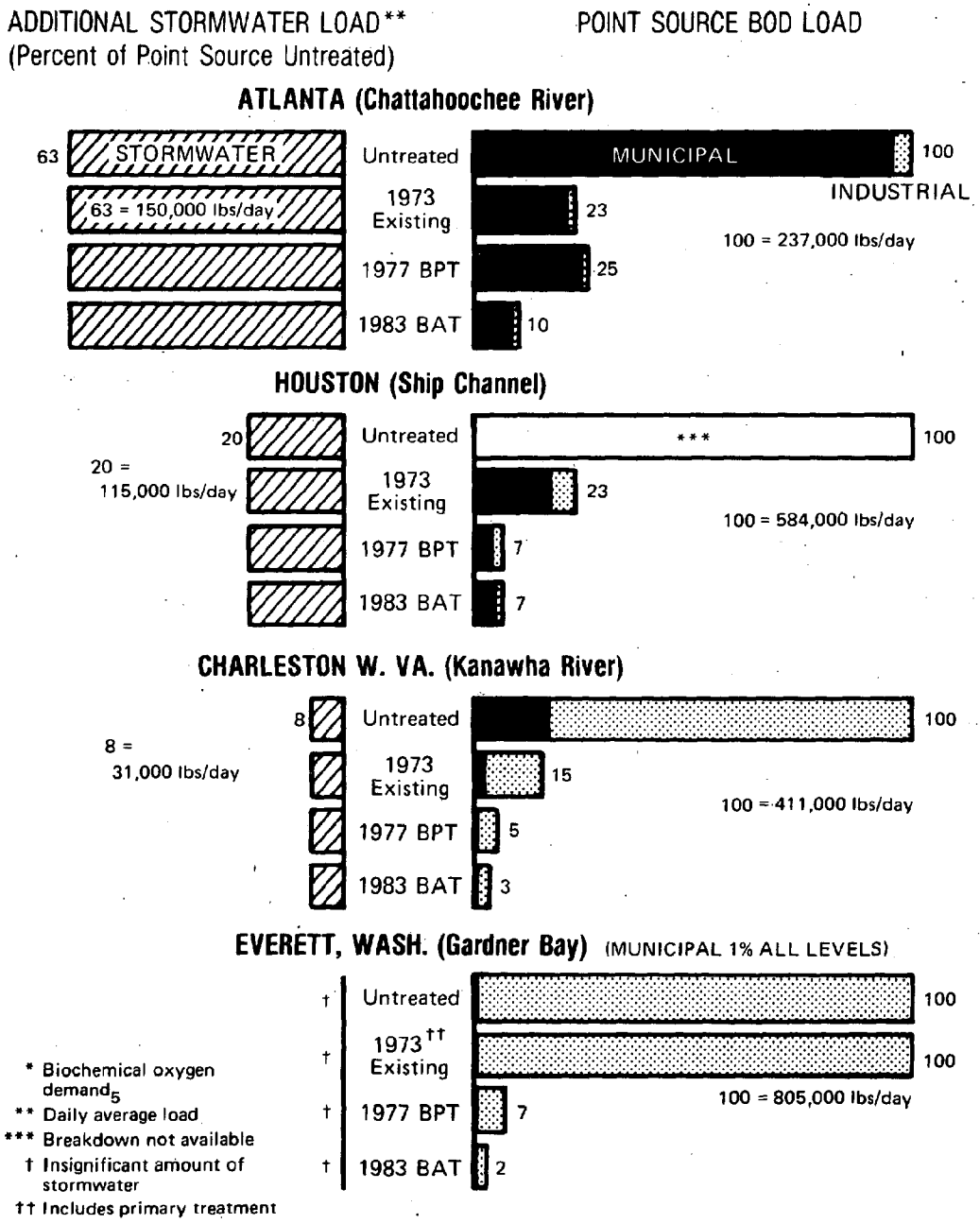
The Kanawha River and Puget Sound differ significantly in their water quality. The present and historical water quality in Puget Sound is relatively good while that in the Kanawha River has been poor. The history of pollution abatement programs on the Kanawha River illustrates the impact of point-source effluent limitations for a water quality-limited river. The impact of abatement on Puget Sound illustrates the impact of technology-based effluent limitations.

*In this chapter the average discharge of BOD in stormwater is presented as a daily average for comparison with municipal and industrial sources. The environmental effects of stormwater, of course, depend on characteristics other than annually averaged BOD loading.

Figure VI-2

IMPORTANCE OF STORMWATER AS A POLLUTANT

BOD* PROJECTIONS FOR 4 CITIES



Source: NCWQ (Hammer & Siler - Atlanta; Dames & Moore - Cincinnati; Texas Water Quality Board - Houston) February 1976

Kanawha(1)

The history of water pollution control in the Kanawha River begins well before World War II. However, at the end of the war, water quality in the river just below Charleston was poor. Municipal and industrial load reduction was achieved by June 30, 1968. Phase III was initiated in 1970 and was designed to achieve an 85 percent reduction of the discharge of oxygen demanding material. Phase III was completed on schedule in 1972 and a water quality standard of 3 mg/l dissolved oxygen was achieved.

In 1973 the average total oxygen demand load of organic and nitrogenous material for the river in the Charleston area was about 185,000 pounds per day. Of this, 65 percent was discharged by industry, 9 percent by municipalities, and 26 percent by storm sewer and combined sanitary and storm sewer overflows. When the 1977 technology-based point source effluent limitations are achieved, the total BOD* load will be reduced to about 101,000 pounds per day -- 41 percent from industry, 9 percent from municipalities, and 50 percent from stormwater. Achievement of the 1983 effluent limitations for industries would further reduce the load to about 78,000 pounds per day.

For extreme low-flow conditions, the present discharges will result in a minimum dissolved oxygen concentration of 1.8 mg/l.** Achievement of the 1977 effluent limitations would produce minimum dissolved oxygen concentrations in excess of 4 mg/l and achievement of the 1983 limitations would raise the minimum to greater than 5 mg/l.

The Kanawha River study briefly assessed the additional nonpoint problem of acid mine drainage. Acid mine drainage has a detrimental effect on many of the tributaries to the Kanawha. The degradation is intermittent in the lower main stem, however.

Puget Sound(2)

Gardner Bay lies off Possession Sound, one of the two major arms of the complex system of marine channels of the Puget Sound area. Five rivers discharge into the Bay and together account for one-third of the freshwater inflow to Puget Sound. The dominant waste discharges are effluents from pulp and paper plants. The other significant point

*The term BOD is used consistently in this chapter to mean five-day biochemical oxygen demand.

**The Kanawha regional study did not incorporate nitrogenous biochemical oxygen demand into water quality projections. If nitrification is an important process on the Kanawha, the actual dissolved oxygen levels will be lower than those projected in the study.

sources are sewage treatment plants. One-third of the basin's population of 156,000 reside in the town of Everett, Wash. The principal nonpoint sources are runoff from pasture land and large log rafts stored on the Bay. While the study was not able to accurately assess the quantity of pollutants from these sources, they are considered to be inconsequential.

The history of water pollution control in Gardner Bay began with various surveys during the 1940's. At that time, all industrial and municipal wastes were discharged directly to the Bay's surface waters. The quality of the water suffered and the concentration of dissolved oxygen decreased significantly. The pulp and paper wastes include sulfite solutions, termed "waste liquors", used in processing the wood to pulp. This material is known to be toxic to fish and wildlife. Fish kills occurred in Gardner Bay in the late 1940's. Although the salmon were not among the species of dead fish recovered and there was little evidence of altered salmon populations, the fish kills and the large area of degraded surface water quality raised the question of a blockage in the salmon migratory route from the marine waters to the region's rivers. In 1951, two paper companies responded to this concern and began discharging wastes through a deep-water outfall. Water quality at the surface improved markedly. In theory, migrating salmon will avoid the outfall's effluent plume.

The deep-water outfall is designed to discharge up to 22 million gallons per day of the concentrated digester wastes from the two sulfite mills. The remaining municipal and industrial wastes of 130 million gallons per day are discharged to the Bay's surface waters. Currently, the biochemical oxygen demand of the effluents is 805,000 pounds per day. Of this, the municipal contribution is less than 1 percent. If the 1977 abatement requirements are achieved, the BOD loading would be reduced to 57,600 pounds per day, of which 8 percent would be municipal contribution. Achievement of the 1983 effluent limitations would further reduce the industrial loading and result in a net discharge of 15,600 pounds per day.

Under present conditions, a plume of water extending from the discharger has high concentrations of sulfite waste liquor and low dissolved oxygen. The plume extends a few miles, and typically shows sulfite waste liquor concentrations of 40 mg/l. When the 1977 effluent limitations are achieved, this plume will effectively disappear. Sulfite waste liquor concentrations will not exceed 10 mg/l and dissolved oxygen values will exceed 5 mg/l, except quite near the discharger point. Achievement of the 1983 technology-based effluent limitations will not effect much change in water quality.

In contrast to the situation in the Kanawha River and northern Puget Sound, the water quality in certain areas may be affected by urban runoff and other nonpoint sources. Two of the regional assessments -- the Chattahoochee River and the Houston Ship Channel -- represent situations where urban runoff, storm sewer discharge or combined sanitary and storm sewer overflows may well be a significant factor in limiting the efficacy of point source abatement programs. Both of these urban areas are large and both receive considerable rainfall during certain seasons.

The water quality in the Chattahoochee below Atlanta and in the Houston Ship Channel is poor. Both areas are currently implementing a program of stringent control of point source discharges. However, the ultimate degree of improvement in water quality will be limited by the effects of urban stormwater.

Chattahoochee(3)

The pollution control program for the Chattahoochee River has been fairly aggressive in achieving abatement. In 1973, about 77 percent of the total BOD load of 237,000 pounds per day was being removed. The remaining discharge of 54,000 pounds per day degraded water quality downstream from Atlanta. In addition, a dam has recently been completed in the West Point-Lanett area, and its reservoir is now being filled. The future water quality in the reservoir would be seriously affected by the present BOD and nutrient loadings from upstream discharges. The sewage treatment plants in the Atlanta area will begin using advance waste treatment technology by 1979. This technology will reduce the discharge of nutrients, as well as organic materials.

Atlanta's combined sanitary and storm sewers overflow during wet weather. Based on the findings of a 1971 study, the BOD loading from urban stormwater is estimated to be 150,000 pounds per day, averaged over the year. The discharge of suspended solids may be from 100,000 to 500,000 pounds per day.

The true environmental impacts of the urban runoff and combined sanitary and storm sewer overflows are difficult to determine. Storm events will result in water of very low dissolved oxygen traveling down river. It is unlikely that significant populations of pollution-sensitive species can exist. In addition, the preliminary information indicates that the nutrient discharge from stormwater alone may be sufficient to produce undesirable algal growths in the new West Point reservoir.

Houston Ship Channel(4)

The land along the Houston Ship Channel is almost solely devoted to industries which discharge their wastes into the Channel. The Channel

also receives the wastewater discharge from municipal sewage plants, storm sewers and runoff from the urban area. The industrial discharge of BOD amounts to 35,000 pounds per day, while the municipal contribution is about 98,000 pounds per day. The BOD loading from urban runoff has been estimated to be of the same magnitude as the combined total of industries and municipalities, roughly 115,000 pounds per day on average. Ten percent of the annual figure may be discharged during a single large storm.

One of the contributing factors to the pollution problem in the Houston Ship Channel is the lack of dry-weather flow. Waste discharges in the Channel are not continually diluted. The accumulated wastewater, often essentially depleted of dissolved oxygen, is flushed into Galveston Bay during storms. This poor quality water may have marked impacts on the biology of the upper portion of the Bay. The historic fish kills may have occurred as surges of poor quality water reached the Bay.

b. Irrigated Agriculture

The Colorado River, the San Francisco Bay/Central Valley and the Yellowstone River regional studies addressed the pollution problems associated with irrigated agriculture. Canals, ditches or pipes carrying the drainage or runoff from irrigated lands constitute point source discharges of pollutants. The quality of these waters is often significantly degraded from the quality at intake. No limitations or technologies have as yet been designated by EPA as applicable abatement measures. However, each of the studies did address the impacts of two strategies for controlling the discharge of pollutants from these sources. The first included various measures to increase the efficiency of water use in agriculture. The second included various schemes to treat and remove pollutants from the return flows. The practice of irrigated agriculture may increase the concentration of several pollutant parameters, including salinity, sediment, fertilizer and pesticides. The regional studies did not specifically examine fertilizer or pesticide control.

Although irrigation practices and their associated pollutant discharges are not the same for all regions and crops, the problems of salinity concentration and sediment transport are typical of most areas of large scale farming. Point, nonpoint and natural sources contribute to these problems.

Sediments

In furrow or flood irrigation, water is applied to the land by diverting it from a stream and letting it flow onto the soil. The degree of control in the application of this water varies in different geographic settings. However, it is impossible to apply precisely the correct amount and the excess will run off the bottom of the field.

Surface runoff, or "tailwater", carries sediment with it and this material returns to the stream. Control practices for sediments in tailwater include collecting the water and pumping it back to the irrigation distribution system for reapplication or more careful control of the applied water. Controlled application can also be achieved by using sprinkler, bubbler or drip irrigation systems.

The Clarks Fork valley is an area of extensive irrigation in the Yellowstone basin (5). The natural sediment load in the river is large, particularly during spring and summer, and far exceeds the contribution from irrigated lands.

Since there are no storage reservoirs, as much of the spring runoff as possible is diverted to the land, where it percolates into the soils. Delivery canals and farmland temporarily store the diverted water and filter out much of the sediment. Excess water eventually returns to the river in surface and subsurface flows and becomes a major part of the streamflow later in the season.

Data on sediment loads and irrigation return flows are tenuous for the Clarks Fork region. Based upon a single year's data in the lower river, an estimated 489,000 tons of sediment are discharged yearly from the region. About 23 percent, or 112,000 tons come from agricultural return flows. About 150,000 tons of sediment are withdrawn along with water diverted from the river. With present practice, the difference between sediment diverted from the river and that returned results in a net sediment removal of about 38,000 tons a year.

Net removal occurs during spring and summer when flows and sediment concentrations are highest. During other times of the year when the sediment load in diversions is smaller, surface irrigation return flow is a net contributor to suspended solids in the Clarks Fork. The detailed balance in sediment removal and addition by irrigation will depend upon the specific characteristics of a basin's soils and hydrology.

Increased efficiency of irrigation practices could slightly reduce sediment load in the Clarks Fork. For the same acreage, increased efficiency would mean less water diverted and much less surface water returned. Improved irrigation practices could reduce the sediment load in the river by as much as 15,000 tons annually by the year 2000. However, this is only a 3 percent decrease in the total load.

Salinity

The other irrigation pollution problem addressed in the regional studies is increased salinity. Two mechanisms are important in causing high salt concentrations. Crops absorb and transpire irrigation water, selectively rejecting the dissolved salts. These salts must be removed

from the soil near the plant's roots if agriculture is to continue. Extra water is used to leach and drain the salt from the fields. The drainage water would normally return the salts to the rivers and streams. The net effect is the same as evaporation. Water is removed but the salt load remains unchanged and hence concentration increases. In addition, soils may contain soluble salts. When irrigation water is applied to the soil, some of these salts are dissolved and are added to the return flows. As long as leaching processes continue, new salt loads are added to the river. In some areas salt balance in the soils can be achieved after a few years and no new salt will be added. In other areas, the soil is so saline that leaching may continue indefinitely.

Two types of control measures could be used to reduce the polluting effects of irrigation. Increased efficiency in using diverted water could reduce drainage flows and hence the rate of salt weathering in areas where it is occurring. Technological means can be used to remove salt from the return flows. These technologies are expensive and their practicality depends upon the salt concentration in the incoming water. Desalting technologies decrease both the concentration and total salt loads in irrigation return flows. Increased irrigation efficiency on the other hand will actually increase the salt concentration of the return flows while reducing their volume and total salt load.

Most of the salt in the water is initially derived from natural sources. To the extent that these sources could be eliminated, the concentration buildup could be prevented. The Colorado River study examined a variety of measures for controlling salt concentrations in the river. Two types of measures were examined for their ability to reduce salt loads in the river above the Mexican border. These were improved irrigation practices and eliminating three highly saline ground or surface water inflows. Of the total 9.0 million tons of salt presently carried each year in the river, 2.2 million would be eliminated by a strict program to control irrigation efficiency(6). An additional 320,000 tons would be eliminated by the three projects*(7). Irrigation return flows could rejoin the Colorado River below the Imperial Dam. If the quality of the water flowing to Mexico is to be sufficiently high and if these return flows are to comprise part of that flow, their salt content must be lowered. A large desalinization plant has been proposed to treat the return flows from the Wellton-Mohawk irrigation project.

There is an important relation between the concepts of point and nonpoint sources for irrigated agriculture. When the water is applied

*The three salinity control projects at Paradox Vallay, Crystal Geyser and Las Vegas Wash isolate a flow of very saline water. This flow is evaporated and the salt stored.

to the fields, it percolates through the soils until it joins the general pattern of groundwater flow. Groundwater may discharge into drains or directly to natural water courses. That portion collected in drains becomes a point-source discharge. The groundwater discharging into the rivers constitutes a nonpoint source. The relative fraction of the water returning in drainage ditches and that moving with the pattern of groundwater flow is usually not well established. However, it is likely that the dominant return is groundwater discharge. In both the San Joaquin and Colorado Basins, groundwater makes up a very significant portion of the return flows. In these basins only about 5 percent of the land is drained (6,8). A salinity program focused on uniform measures for drained lands may well miss the most significant portion of the problem.

Hydrology

In many basins, most of the annual runoff is diverted for irrigated agriculture. In such basins, the practice of irrigation can significantly alter the ground and surface water hydrology. Methods for controlling water quality degradation resulting from irrigated agriculture include changing practices to increase the efficiency of water use, i.e., to reduce the amount of water applied to the land to that minimally necessary. In basins where irrigated farming has changed the natural patterns of ground and surface water flow, abatement measures modifying irrigation practices can, in turn, affect the overall hydrological patterns of the basin. Such changes have both economic and environmental implications. The regional studies documented situations where the requirements for increased efficiency would, in fact, alter downstream flow.

Several factors in the regional hydrology and in the irrigation practices themselves are important in determining the effect of increased irrigation efficiency. Generally, irrigation will tend to decrease the total annual basinwide runoff and to extend the period of stream flow into the dry season. In basins such as the Colorado and the San Joaquin Valley, where dams impound water, spring runoff is stored and released at a later time. In areas like the Clarks Fork, there are no storage reservoirs and runoff is diverted directly to the fields. As much water as possible is applied and allowed to percolate into the ground. The movement of this water through the ground to surface discharge later in the summer extends stream flow well into the dry season. If the spring irrigation were more efficient and less water were applied to the land, less water would be available to downstream users later in the year.

In some basins, the natural water supply is augmented by importing water from out of the basin. Generally, these water imports are contracted by irrigators. The return flows from irrigated farms may provide much of the downstream flow. If practices achieving increased efficiency are required, the amount of water imported may decrease. This, in turn,

would decrease downstream flow and would probably lower downstream water quality. If the level of water imports were to be maintained and less water were to be applied by contracting irrigators, a way would have to be found to pay for the imported water which was not utilized. The regional study of California's Central Valley documented a situation where requiring increased efficiency would probably reduce water imports. This, in turn, would have detrimental effects on downstream water uses, water quality and wildlife areas. As in all cases where water is moved from one basin to another, impacts related to changes in water quantity occur both in the supplying and receiving basin.

One final aspect of changing irrigation practices may involve the relationship of groundwater quantity and quality to surface water supplies. In many basins, both groundwater and surface water are used for irrigation. The excess water applied to the land percolates down and joins the groundwater table. If the groundwater recharge rate is decreased by decreasing the application of irrigation water diverted from surface streams and if the groundwater pumping rate is maintained, a groundwater overdraft will occur and the water table will fall. Cases where groundwater overdrafts would result from more efficient irrigation practices require careful evaluation of the water supply and water quality implications of proposed requirements for modified irrigation practices.

2. Controlled and Uncontrolled Pollutants

Effluent limitations have been established for various categories of municipal, industrial and agricultural point sources. The limitations specify allowable discharges of particular pollutant parameters. Two important parameters -- nutrients and salts -- are not generally included. Additional abatement measures may be required if water quality is to improve. Effluent limitations would be imposed under the state authority or under the Federal authority on the basis of water quality considerations.

In the Colorado River basin, the important water quality parameter is salinity. Current and future levels of development of the energy industry in the basin can significantly affect the salinity concentrations. The technology-based effluent limitations for the steam electric power industry regulate the discharge of heat, but in the Colorado basin the energy industry, or any water-consuming industry, must limit the discharge of salt. Because major water losses through evaporation would aggravate the downstream problems, all of the Colorado basin states are considering special requirements for salt discharges. Steam electric generating plants or any new energy development would have no salt discharge. Wastewaters can be evaporated and the salts or brines can be disposed of so that they do not return to the river.

While the problem of salinity is localized to a few western areas, the problems of nutrient discharge and eutrophication are widespread.

More than half of the regions studied -- the Merrimack, the Ohio, Lake Erie, Puget Sound, San Francisco and the Chattahoochee -- show the importance of nutrients in contributing to water quality degradation. The two most important classes of nutrient materials are phosphates and nitrates. Concentrations of these materials, while not particularly significant themselves, may induce the growth of algae. Generally, lakes or other slow-moving waters are more likely to show excessive algal growth than are rivers or streams.

Algae growths will give water bodies an unpleasant appearance and can also severely degrade water quality by consuming dissolved oxygen. After the algae die, the process of decay consumes oxygen. In addition, the metabolism of the living algae consumes oxygen. The net effect is that waters supporting large algae concentrations may show marked oxygen deficiencies, particularly during the night or early morning hours.

Perhaps the most important eutrophication problem occurs in Lake Erie. However, specific nutrient abatement measures have been proposed for at least three other regions -- the Merrimack River, the Seattle area of Puget Sound and the Chattahoochee River near Atlanta.

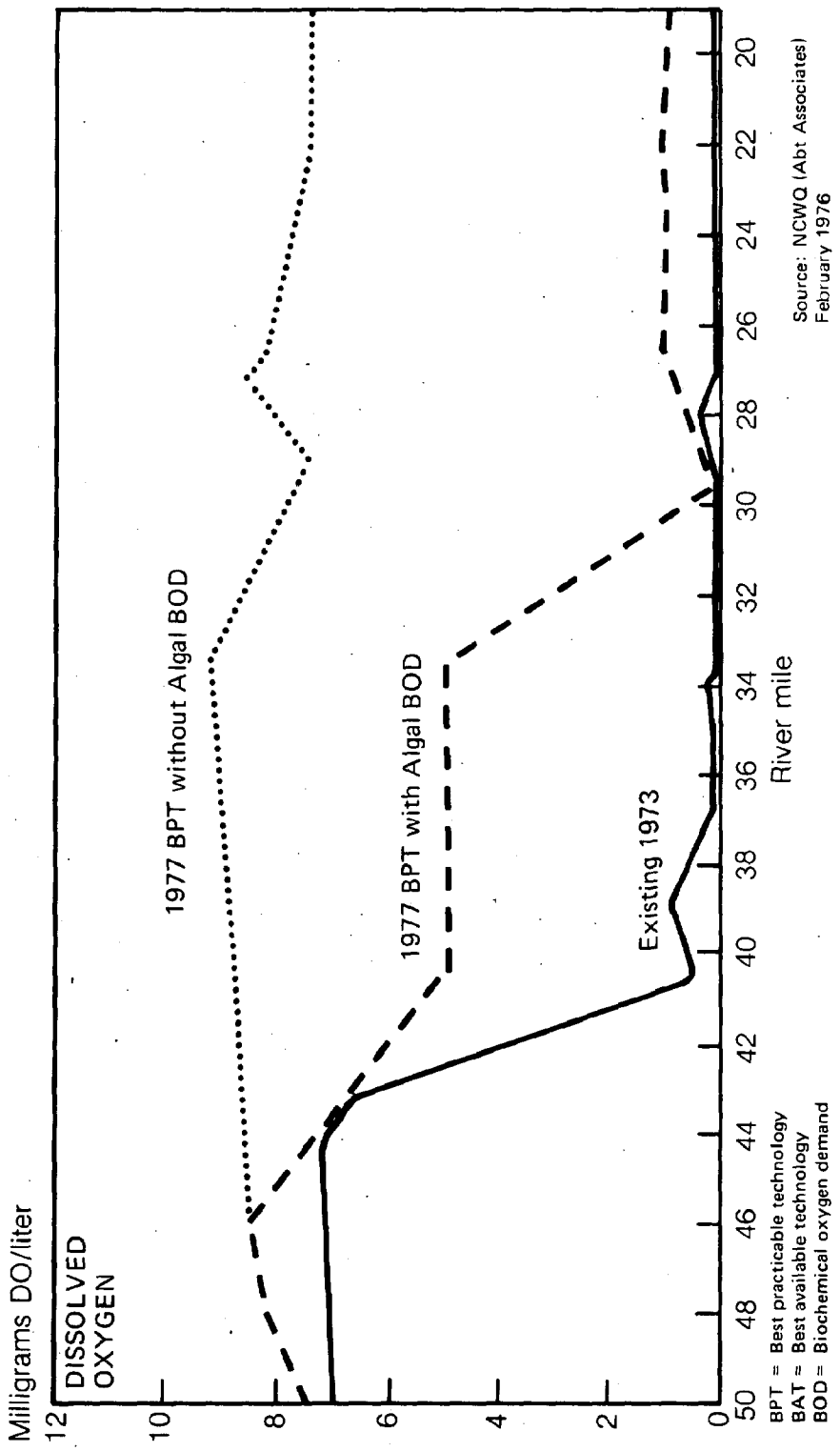
Most of the pollutant discharge to the Merrimack River is from publicly owned treatment works. These works are designed to meet the requirements of secondary treatment, i.e., BOD and suspended solids removal, but are not designed to control nutrients. The findings of the Merrimack study indicate that the nutrient load may have an important effect and ultimately limit the degree to which water quality will be improved(9). Nutrient concentrations in the slow-moving pools behind dams on the Merrimack may well induce algae growths. The study documented the present levels of dissolved oxygen in the river and projected future levels once the treatment plants become operational. Implementation of secondary treatment will markedly improve the water quality in the river. However, restricted stretches of the river may have poor water quality if algal growths do, in fact, develop.

The situation on the Chattahoochee River south of Atlanta is similar to that on the Merrimack. Most, if not all, of the point-source discharge is from publicly owned treatment works. The Chattahoochee has been dammed recently near West Point, Ga., and the reservoir is now being filled. The nutrient concentrations in the Atlanta effluents would possibly cause serious eutrophication problems for the reservoir. A program has begun to remove nutrients from the municipal point sources with a goal of 90 percent reduction in nitrogen to be achieved by 1979(3).

By far the most important pollution problem on Lake Erie is accelerated eutrophication induced by phosphorus. The United States and Canada have entered an agreement which includes the control of phosphorus

Figure VI-3

EFFECT OF NUTRIENTS ON WATER QUALITY
31 MILE SEGMENT OF MERRIMACK RIVER



discharges to the Lake. The agreement specifies that the phosphorus discharge be limited to 23 million pounds per year -- a 56 percent reduction from the present levels(10). The Lake Erie study focused on the western half of the basin, particularly the cities of Detroit, Toledo and Cleveland, and the agriculture in the Maumee River valley. The important sources of phosphorus are municipal point sources (39 percent), urban runoff from storm and combined sewers (12 percent), and agricultural runoff (46 percent). Various programs have been initiated to limit the discharge of phosphorus. The effluent from municipal treatment plants must contain no more than 1 mg/l phosphorus. Several jurisdictions -- including all of Canada, Indiana, Akron and Euclid in Ohio, and Buffalo in New York -- have controlled the use of phosphate in detergents. These limitations will help abate the water quality problems in Lake Erie. However, they fall short of achieving the level of reduction required by the Canadian agreement. To achieve these reductions, a program to control agricultural and urban runoff will be required.

D. GROWTH AND ENVIRONMENTAL QUALITY

What is the effect of future economic growth on water pollution control requirements?

The three decades since World War II have marked a period of rapid economic growth. Population increased while per capita productivity, income and consumption rose even faster. These increases multiplied pollutant discharges and water quality problems. Many regions experienced serious pollution problems for the first time, while in established urban-industrial centers, existing problems became more severe. P.L. 92-500 aims to reverse this trend toward greater pollution loads and deteriorating water quality. As long as effluent limitations do not change, increases in industrial production, in per capita consumption or in total population would cause increases in pollutant discharges.

The Act contains four provisions which would increase the stringency of effluent limitations over time. First, the 1983 technology-based effluent limitations require a large fractional decrease from 1977 levels in the allowed discharge of pollutants. Second, the technology-based effluent limitations are periodically reviewed and modified if improved treatment technologies are available. Third, the Act requires that more stringent effluent limitations be set if they are necessary to assure instream water quality. Finally, all new facilities must meet new source performance standards and be reviewed for their environmental impact under the National Environmental Policy Act of 1969.

In areas not grossly polluted, the technology-based effluent limitations effectively assure water quality maintenance well into the future. In urban-industrial areas, economic growth implies a continuing need to

implement increasingly stringent water-quality-based effluent limitations or to accept water quality degradation.

The regional assessments used a simple method for projecting pollution discharge. The method assumes abatement requirements remain static and equates the growth rates for population or industrial production with the growth rates for pollution loads. For example, if a regional growth rate of 5 percent is projected for the organic chemical industry, then that industry's discharge would grow at 5 percent per year. Increases in sewage treatment effluents are assumed proportional to population increases.

This analysis is applicable only if abatement requirements do not, in fact, change. In areas where a fixed maximum load must be maintained to assure water quality, effluent limitations would become more stringent. Since the method assumes static abatement requirements, it will project future loads above the allowed maximum.

The Act specifically recognized the difficulties of dealing with the implications of economic growth for water quality in individual localities. Section 208, "Areawide Waste Treatment Management", and Section 303(d), "Water Quality Standards and Implementation Plans", provide for the identification of organizations in areas with urban-industrial concentrations or other substantial water quality problems. Such local agencies will have to develop detailed and comprehensive management schemes to assure the compatibility of waste loads and proposed treatment facilities for a 20-year period.

In water-short areas, the question of growth cannot be separated from the question of water supply. Two regional studies -- the Colorado and the Yellowstone -- include a more complete treatment of the relationship between future economic and water-use patterns and water quality. Each of these studies examines several projections of future water use and the effect of alternative pollution abatement programs.

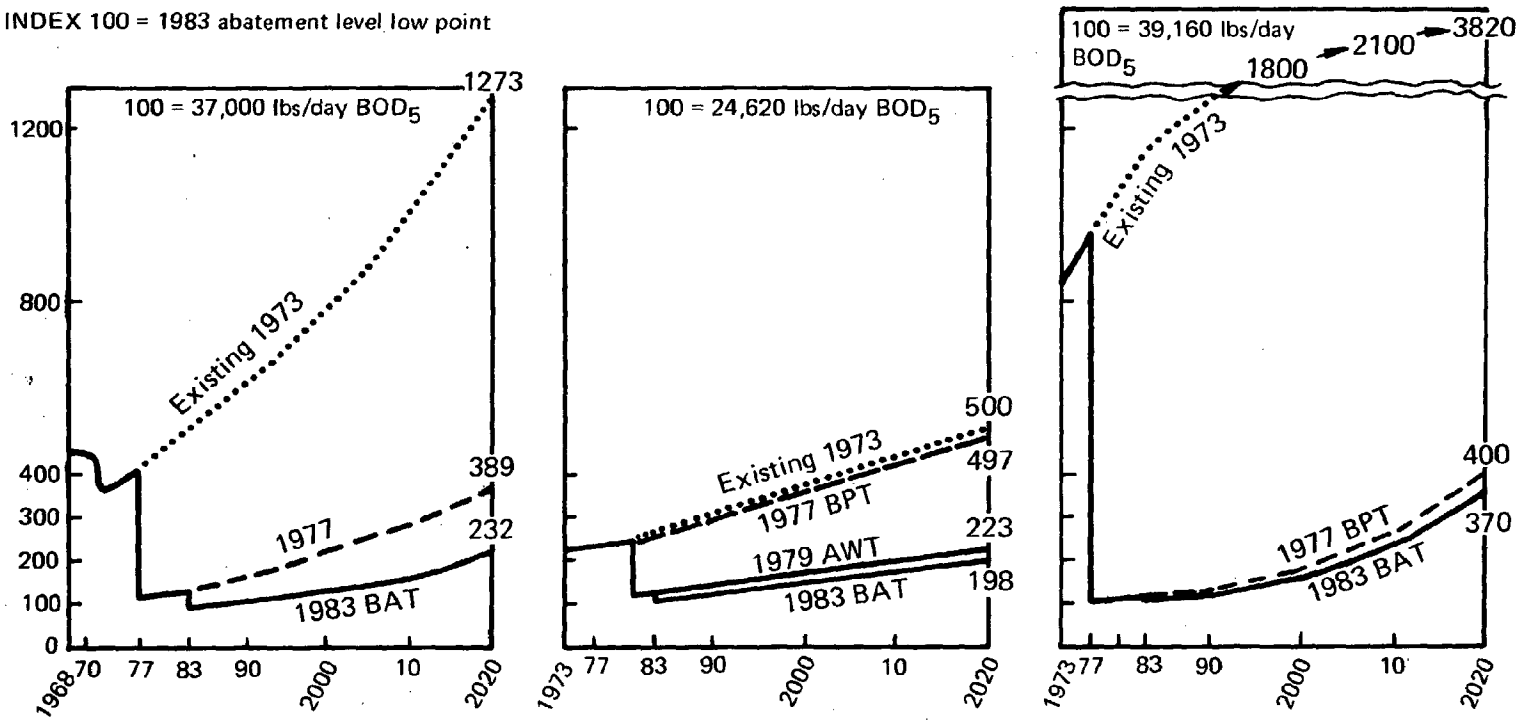
1. Urban Areas

Houston, Atlanta and Cincinnati are located on seriously polluted water bodies. These bodies have been designated as water-quality-limited, and discharge permits are written on the basis of discharge load allocations, rather than 1977 technology-based requirements. Pollutant loadings have been projected for a period extending from the 1960's through the year 2020. The figures in this section should not be interpreted as predictions of future loads. Rather, they are projections of loads assuming effluent allocations based upon static formulas for the allowed discharge per unit of economic activity, and upon future

Figure VI-4

BOD DISCHARGES BY ABATEMENT LEVELS

HOUSTON, ATLANTA, CINCINNATI



Projections based on Ober's growth rates
Source: NCWQ (Hammer & Siler – Atlanta; Dames & Moore – Cincinnati; Texas Water Quality Board – Houston)
February 1976

BPT = Best practicable technology
BAT = Best available technology
BOD = Biochemical oxygen demand
AWT = Advanced waste treatment

projections of economic activity*(11). The 1977 loadings of biochemical oxygen demand are the total allowable discharge under the existing permits in each area.** The 1983 loadings shown assume compliance with technology-based effluent limitations.

In Houston, the 1977 permits are based on achieving water quality standards in the Houston Ship Channel, and for major dischargers they are much more stringent than 1977 best practicable technology (BPT) requirements(4). Large industrial dischargers will have almost achieved the 1983 guidelines for "best available technology" by 1977, while major municipal dischargers will have reduced BOD concentrations to one-third of 1977 requirements for secondary treatment. Abatement measures will also reduce discharges of oxygen-demanding material such as ammonia.

The Houston graph shows three projections for the future -- continuation of the fractional abatement achieved in 1973; continuation of the fractional abatement required by current permits; and continuation of the fractional abatement required to be achieved in 1983.

To assure that permitted loads do not violate water quality standards, the Texas Water Quality Board specifically included a 5 percent growth rate when it developed permits in 1974. When these permits expire in 1979, EPA and the Board will reevaluate the ability of 1983 limitations to maintain water quality(12).

Atlanta, unlike Houston, has few industrial point sources. Publicly owned treatment plants discharge most of the pollutant load(3). These plants currently meet the requirements for secondary treatment, but will institute advanced wastewater treatment in 1979 to meet water quality standards. Effluent BOD concentrations will be about two-thirds of the 1977 secondary treatment requirement of 30 ppm. The municipal load will increase if Atlanta's population continues to grow at a rate comparable to the past annual rate of 2.7 percent. Municipal dischargers will have to improve effluent quality further and begin addressing the problem of stormwater if population growth by the year 2000 is to avoid degrading the water.

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*The U.S. Water Resources Council publishes the OBERS growth projections for regions of the country. Series E projections were used in all regional studies.

**BOD is used as an example in this chapter. Similar projections were developed in each region for other pollutant parameters, e.g., suspended solids, coliform bacteria and nutrients.

In Cincinnati, as in Atlanta and Houston, most of the present point source discharge is from publicly owned treatment works(13). However, most of the industrial load is discharged to the municipal system. Industries contribute 25-30 percent of municipal inflows and an estimated 43-48 percent of the BOD. Municipal plants presently discharge poor quality effluent. Many provide only primary treatment for influent sanitary and highly concentrated industrial wastes. Achieving effluent limitations based on water quality standards will cause a ninefold decline in BOD loads. Imposition of 1983 BAT does not further reduce the pollution load very much. Most area industries discharge to a municipal system and are not, therefore, subject to the 1983 BAT requirements.

Cincinnati has an annual population growth rate of 0.8 percent, and an industrial growth rate of about 4.4 percent. If these growth rates continue, more stringent measures will be required to assure the water quality behind Markland Dam on the Ohio River.

Seattle differs from these three cities in that BOD discharges do not presently degrade water quality or cause violations in state dissolved oxygen standards(2). When 1977 BPT requirements are achieved, BOD levels will drop 70 percent. However, nitrogen loads, which contribute to algae growth, will increase sharply by century's end. In 1983, nitrogen concentrations may cause algal blooms, lowering dissolved oxygen concentrations below standards. Increased nitrogen loads would result from a 1.7 percent population growth rate and an expansion of the service area of treatment plants.

Seattle METRO has proposed nitrogen removal for its plant on the Duwamish Estuary in Seattle. The proposed technology would achieve an 87 percent reduction in ammonia, the major nitrogen component in sewage, and keep algae at acceptable levels beyond the end of the century.

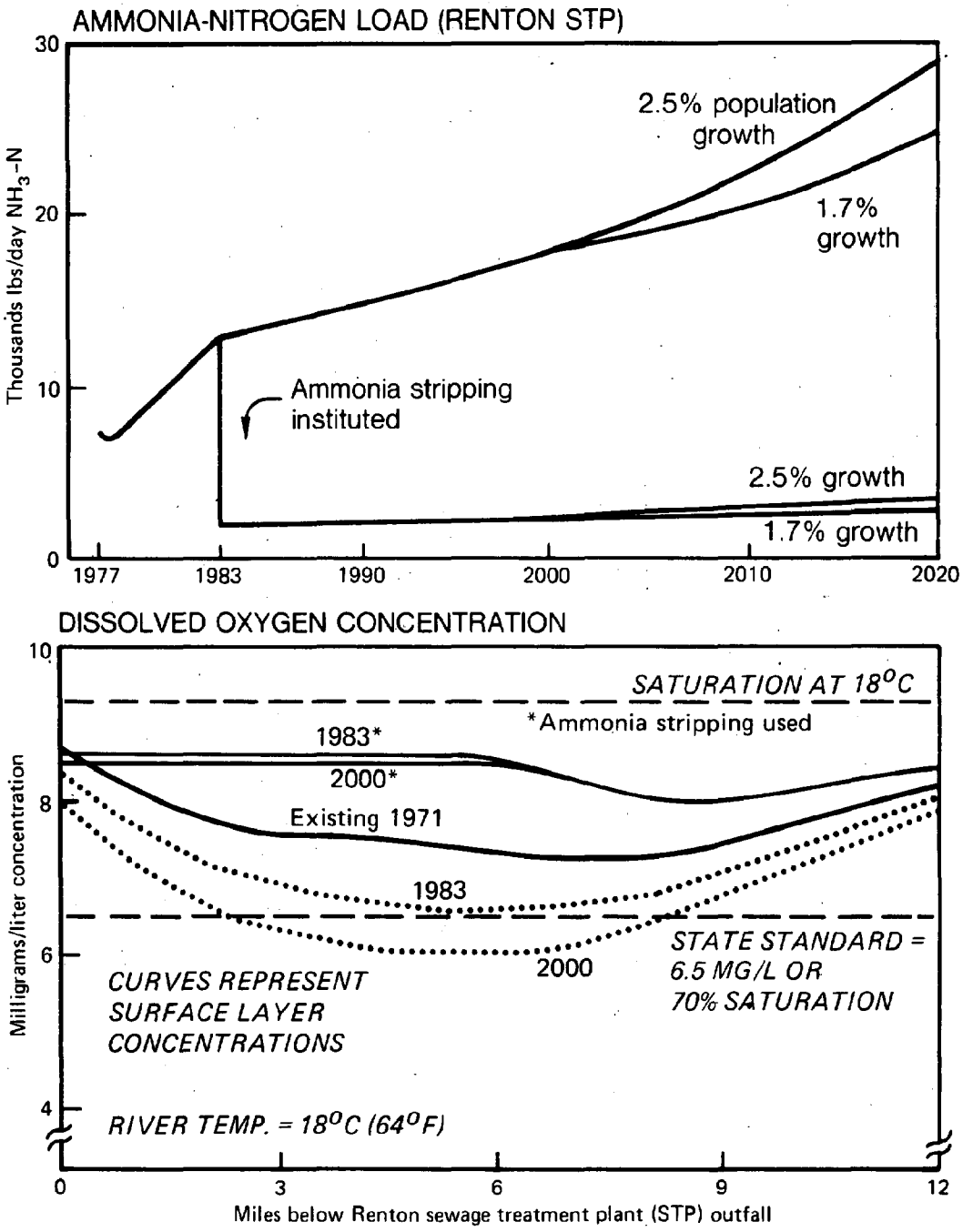
Seattle, like Cincinnati, Houston and Atlanta, must provide treatment beyond secondary treatment in order to maintain water quality standards -- in this case, nutrient removal.

In areas which are not water-quality-limited, publicly owned treatment plants are required to achieve secondary treatment in 1977, and best practicable waste treatment technology over the life of the works in 1983. EPA has defined these requirements to be identical in most cases. Typically, this corresponds to an 85 percent reduction in BOD discharge. Because of EPA's interpretation of the 1983 technology-based effluent limitations for publicly owned treatment works, only industrial discharges are reduced. In areas where municipal discharges constitute a sizable portion of the pollutant load, the discharge decrease achieved in 1983 may not be large.

Figure VI-5

EFFECT OF AMMONIA-NITROGEN REMOVAL

Seattle (Duwamish Estuary)



Source: NCWQ (Stevens, Thompson, & Runyan)
February 1976

The Delaware Estuary receives pollutants from many industrial point sources, mostly petrochemical plants, and from municipal point sources, mainly Philadelphia's primary treatment plants(14). Industry contributes about one-third of the total oxygen demand. Total BOD loads will drop more than 60 percent when 1977 requirements are imposed -- from 930,000 pounds per day to 320,000 pounds per day. When 1983 requirements are imposed, total BOD loads drop about 10 percent -- from 368,000 pounds per day to 344,000 pounds per day. Growth will negate any gain over 1977 totals of 320,000 pounds per day.

2. Water-Short Areas

The prospect of economic development in the western states has implications for water use. Two regional studies, the Yellowstone and the Colorado, address the questions associated with development in water-short areas. Questions of the level of development, the availability of water resources, and maintenance of quality are interrelated in these regions.

The undepleted natural flow of the Colorado River at Lee Ferry, the division point between the Upper and Lower Basin,* is conservatively estimated to be about 14 million acre-feet per year. Currently 11.3 million acre-feet are depleted by out-of-basin transfers or consumptive use from the Colorado River and its tributaries in the Upper Basin and from the main stem of the Colorado River in the Lower Basin. In addition, 1.5 million acre-feet are delivered to Mexico each year. The Upper Basin use amounts to about 3.7 million acre-feet each year, including reservoir evaporation. The Bureau of Reclamation has recently estimated that the demand could grow to 5.9 million acre-feet annually by the year 2000(15).

The salt concentrations in the Upper Basin water are generally much lower than those in the Lower Basin. The consumptive use or out-of-basin transfer of high quality water in the Upper Basin will result in increases in salt concentration in the lower reaches of the river. The degree to which increased use in the Upper Basin will affect the Lower Basin salinity problem will depend to some extent on the type of development which occurs. Currently, the salt concentration at Imperial Dam is about 850 mg/l. Upper division development could raise the concentrations to 1,250 mg/l if no abatement measures were implemented.

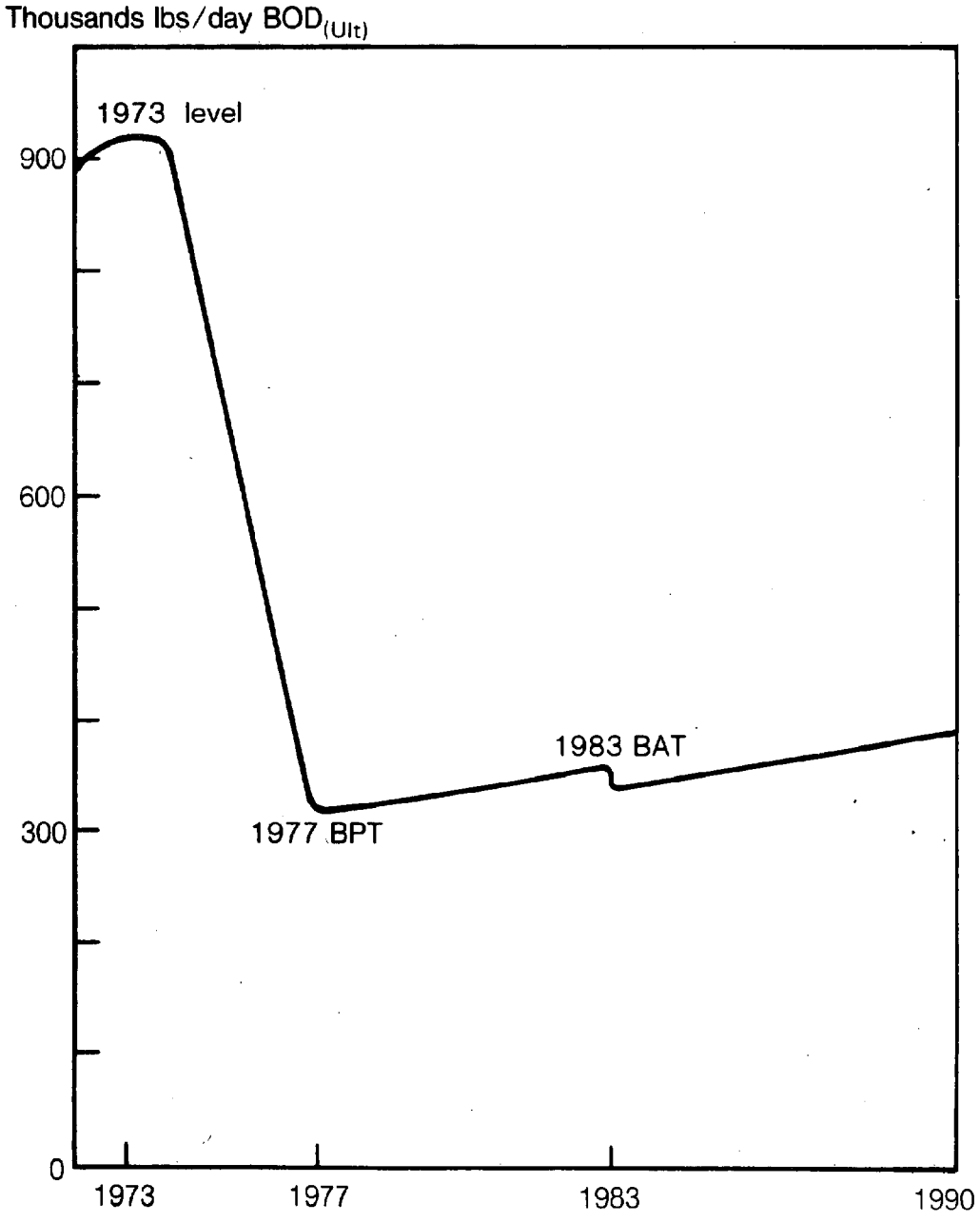
Uniform abatement measures potentially applicable to all irrigated agriculture include measures for increasing the efficiency of water use. Additionally, the Bureau of Reclamation program for salinity control in

*By Congressionally approved compact, the Upper Basin includes all areas the drainage for which enters the river above Lee Ferry, Arizona; the Lower Basin includes all areas the drainage for which enters below Lee Ferry.

Figure VI-6

BOD DISCHARGES BY ABATEMENT LEVELS

PHILADELPHIA (Delaware Estuary)



BPT = Best practicable technology
BAT = Best available technology

Source: NCWQ (Betz Environmental Engineers) February 1976

the Colorado River Basin includes diverting and evaporating highly saline inflows. These measures could reduce the salt concentration by as much as 400 mg/l(6). Most of the reduction would be achieved by controlling irrigation practices.

The seven states of the Colorado River Basin have cooperated to develop water quality standards(16). Their proposal includes among its provisions sixteen specific agricultural and natural source control projects. These projects are those authorized for planning or construction by Title II of the Colorado Salinity Control Act.

Water pollution problems in the semi-arid Yellowstone Basin presently are not considered severe compared with many other rivers of the nation. Pollution from municipal and industrial sources is minor throughout the basin. Of more concern are the large volumes of sediment from natural and agricultural point and nonpoint sources. With the advent of widespread energy production in this coal-rich region, the situation could change(5).

Forecasts include increases in coal production in Montana and Wyoming from the present levels of about 15 million tons yearly to as much as 728 million tons by the year 2000. The construction of coal-fired electric generating plants and coal conversion plants in the basin is expected as the nation pushes for energy self-sufficiency. The energy plants and mining operations would use large quantities of water. Surface mining would disturb groundwater and might cause large amounts of sediment, containing metals and other wastes, to wash into the streams.

Energy development would bring rapid population growth. Some towns may double in population in a few years, producing severe sewage pollution problems unless local officials can plan adequately for growth. With extensive energy development, the basin's population could increase from the present 280,000 to as high as 380,000 by the year 2000. Much of that increase could come within the next decade.

Sheridan and Buffalo, Wyo., and Billings, Mont., are examples of communities that may be affected by intensified energy development. Sheridan, located in the Tongue River basin in northeast Wyoming, presently has a population of about 11,000 which could increase to more than 23,000 by the year 2000. Buffalo, located in the Powder River basin about 40 miles south of Sheridan, could increase from today's 3,400 population to 7,400 by the turn of the century. The Billings SMSA, located more than 100 miles northwest of the coal-rich Tongue and Powder areas, could feel the indirect effects of coal development through expansion as a regional trade center. Its present population of 87,400 would increase to more than 114,000 persons by the year 2000.

Sheridan presently has a 1.5 million gallons per day trickling filter facility which provides secondary treatment for most of the community's two mgd in wastes. The remainder receives primary treatment. A doubling of population without upgrading these facilities could cause severe degradation to Goose Creek, a tributary of the Tongue. Dissolved oxygen levels during low-flow conditions in Goose Creek below Sheridan could fall below 4.0 mg/l. The Wyoming standard for that stream is 6.0 mg/l. Even with secondary treatment for the expected population, DO levels may fall below this standard during low-flow. Only with advanced waste treatment would the standard consistently be met and fish populations protected.

Buffalo, located along Clear Creek, presently has an overloaded evaporation lagoon to treat its 1 mgd in wastes. The town is conducting studies for improved treatment facilities. Under average flows secondary treatment would provide moderate fish protection in Clear Creek below Buffalo for all projected growth levels. However, during critical low-flow periods DO probably would not be adequate to support fish life. Advanced waste treatment would provide minimal protection for fish during the three-month low-flow period and high to moderate fish protection the other nine months. If high growth occurs, Buffalo may need wastewater storage during low-flow periods to provide adequate fish protection year-round.

In Billings, there are several major sources of pollution including the Billings sewage treatment plant, presently being upgraded from primary to secondary, two oil refineries and a sugar beet refinery. With projected growth, BOD loadings into the Yellowstone would increase from a maximum of 32,200 pounds per day to more than 52,000 pounds per day by the year 2000 in the absence of secondary treatment and BPT. If these requirements are met, BOD loadings would be reduced to a maximum of 8,700 pounds per day by the year 2000. This would permit DO levels to be at or near saturation.

Without secondary and BPT requirements, projected additional loads could degrade the Yellowstone downstream of Billings. During low-flow conditions, the DO could drop to 4 mg/l on occasion. The Montana standard for this stretch is 5 mg/l.

E. CAPITAL EXPENDITURES AND WATER POLLUTION ABATEMENT

What capital expenditures for wastewater treatment facilities are required of the public and private sectors to meet abatement requirements and what levels of abatement are achieved?

The abatement measures of the Act will require capital expenditures by a variety of public and private point-source dischargers. Each of

the eleven regional assessments attempted to calculate the total cost of compliance in the public and private sectors. In addition, each study evaluated the discharge abatement achieved.*

The range of variations among the regions with respect to the absolute cost of compliance and the relative division of the cost between public and private sectors was very large. Similarly, the size of pollution loads and the relative contribution of industry and municipalities varied markedly from one region to another.

The status of abatement programs in 1973 was also different in the regions. Some areas had made considerable progress in using treatment technologies; others had not. Additionally, some of the regions' abatement programs will require stringent effluent limitations based on water quality considerations; others require the technology-based limitations for 1977.

Despite the differences in the nature of the inventories of dischargers, the degree of progress prior to 1973 and the demands of water quality considerations, the patterns of the relative distribution of costs and abatement for public and private dischargers are similar in many of the regions. Generally, the abatement programs are more stringent for the private sector. The relative portion of the total pollutant load discharged by publicly owned treatment plants increases as more stringent requirements are met. **In addition, the relative cost for the private sector is generally higher than its contribution to the total discharge.

Ultimately, the costs of pollution abatement must be paid by the public -- either in increased charges for sewage treatment, or indirectly as increased prices for consumer products. The Act requires that publicly owned treatment plants receiving federal grants institute a proportional system of charges to cover operation and maintenance costs. An industrial discharger to a publicly owned plant must meet any pretreatment costs and a proportional share of the capital investment, but is not required to achieve BPT in 1977 or BAT in 1983.

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*The regional studies attempted to establish compliance costs by determining the individual costs for each discharger and adding them. This proved to be very difficult and it is likely that cost figures may be in error by as much as 50 percent.

**EPA has not required more stringent technology-based measures for publicly owned waste treatment plants in 1983. Unless these measures are required on the basis of water quality considerations, the additional costs of the 1983 requirements fall in the private sector.

The relative amounts of industrial and sewage wastes received by publicly owned works and the relative numbers of local industries discharging to public plants vary greatly among the regions. In areas such as Cincinnati and the Merrimack Valley, most of the industries discharge to publicly owned plants and their wastes are the major portions of the total influent load. In other areas, such as Seattle or Houston, almost none of the industries discharge to municipal systems and industrial wastes are an insignificant portion of the load to municipal plants.

Three examples -- Atlanta, the Huntington (W. Va.)/Ashland (Ky.)/ Portsmouth (Ohio) urban area and Charleston -- illustrate the cost burdens and degree of abatement achieved in situations typical of the regions studied. In Atlanta, the vast majority of discharge is from publicly owned treatment works. In the HAP area, the relative discharge from the public and private sector is approximately equal and in Charleston, the industrial discharge dominates.*

The Atlanta area of the Chattahoochee River presently experiences low DO concentrations resulting from municipal point sources(3). Although many of the municipal sources are currently or soon will be operating at EPA's defined secondary treatment level, the DO concentration in the Chattahoochee does not meet water quality standards. During periods of heavy rainfall, Atlanta's combined sewers overflow increasing pollution discharges. The present point-source BOD load in the Atlanta area averages 54,305 pounds per day. The municipal sector contributes about 52,179 pounds per day or 96 percent of the load.

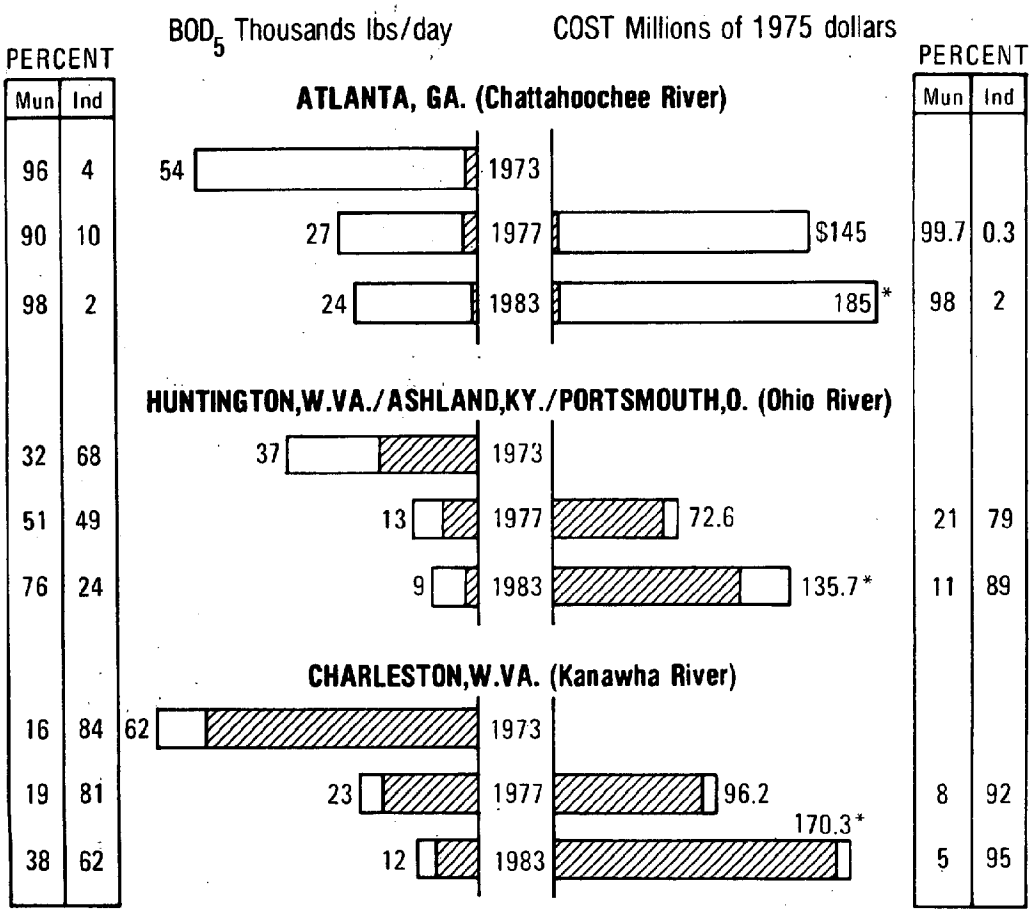
Compliance with the waste load allocations based on water quality standards requires major municipal dischargers to achieve a level of treatment considerably more stringent than the 1977 secondary treatment effluent limitations. At this level of treatment, the BOD load will be reduced to 27,300 pounds per day. Municipal discharges will still dominate, contributing 24,916 pounds per day or 90 percent. Total cost to the public and private sectors to attain this level will be about $145 million. The municipal share will be $144.4 million or more than 99 percent of the total.

Compliance with the 1983 abatement level will require the industrial dischargers to meet BAT, and the medium-sized municipal dischargers to meet the advanced waste treatment levels assigned on the basis of water quality. Achievement of this treatment will reduce the BOD load to 24,300 pounds per day, an 11 percent reduction from the estimated 1977 load and a 55 percent reduction from the present load. The cost of meeting this level is about $40 million. The municipal sector cost for

*BOD is used as a surrogate for total pollution loadings in this chapter. Detailed information on other pollutant parameters is available in each regional assessment study.

Figure VI.7

MUNICIPAL & INDUSTRIAL WASTEWATER LOAD REDUCTIONS & COSTS



1977 & 1983 are abatement levels. 1973 existing.
1983 costs are cumulative from 1973.

Municipal - Mun Industrial - Ind

* Includes the cost for achieving both 1977 & 1983 requirements.

Source: NCWQ (Hamer, Siler, & George) Chattahoochee
(Dames & Moore) Ohio, Kanawha

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advanced waste treatment is $36.7 million or about 92 percent of the total. The $40 million is in addition to the $145 million necessary to meet the 1977 requirements. The total cost to go from the present level of treatment to 1983 is about $185 million. The municipal share is about $181 million or 98 percent.

The urban-industrial region, including Huntington, W. Va.; Ashland, Ky.; and Portsmouth, Ohio, is representative of an area with major pollution problems, a high out-migration rate and an economic dependence on a few industries that will have to meet abatement costs(13). The pollution abatement program in the Ohio River basin has been a multi-state effort since 1948. Because of the severe water quality problems resulting from economic growth and industrialization during World War II, a program designed to achieve primary treatment was instigated during the 1950's. Under the aegis of the Ohio River Valley Water Sanitation Commission (ORSANCO), most industries and municipalities achieved a degree of treatment by the early 1960's.

The present total BOD load in the HAP area from municipal and industrial point sources is 37,150 pounds per day, with industry contributing 25,410 pounds per day or about 68 percent. Compliance with the 1977 effluent limitations will reduce the BOD load to 12,630 pounds per day at a capital cost of $72 million. Both the abatement and cost requirements for the private sector exceed those of the public sector. Once the 1977 requirements are met, industrial BOD loads will be approximately equal to those from publicly owned treatment works.

Compliance with the 1983 requirements will reduce the BOD load from the 1977 levels to 8,520 pounds per day; a reduction of 30 percent. At this abatement level, the municipal loads will exceed the industrial, with municipalities discharging about 6,500 pounds per day or 76 percent of the total. The incremental cost to reach the 1983 level from 1977 is about $63.1 million.

The total cost of achieving the 1977 and 1983 abatement levels is $135.7 million. Industry's requirement is about 89 percent or about $120.6 million. Industrial dischargers account for 80 percent of the total BOD reduction of 28,630 pounds per day. In addition, industrial compliance will remove other types of pollutants. Some of the costs are met by industries such as iron and steel manufacturing. For these industries, other pollutants are more significant than BOD.

The Charleston area of the Kanawha River is a situation where the industrial loads far outweigh the municipal loads and the water quality needs dictate a more stringent level of treatment to meet the 1983 goals of the Act(1). Industry is not far from achieving BPT, but is being required to provide more stringent treatment to meet water quality standards and, therefore, will incur increased costs.

In 1958 a major three-phase cleanup program was begun on the Kanawha. By 1972 the industrial and municipal BOD discharge had been reduced by 85 percent, and a dissolved oxygen concentration of 3 mg/l was achieved. In 1972 the minimum DO standard of 3 mg/l was upgraded to 4 mg/l. This necessitated still further reduction in the organic waste loads.

Industry presently contributes 84 percent of the BOD load to the Kanawha River. Almost all of the industrial load is from the chemical industry. EPA and the West Virginia Department of Natural Resources have determined that the technology-based effluent limitations for 1977 will not achieve the water quality standard of 4 mg/l for DO. Municipal dischargers have not been required to provide more control than secondary treatment. The major industries, however, are expected to reduce their discharges.*

Upon compliance with these 1977 effluent limitations, the present BOD load of 61,730 pounds per day would be reduced to 22,490 pounds per day, a drop of about 64 percent. At this 1977 abatement level, industry still dominates, contributing about 81 percent of the BOD load. The total cost to reach this level is about $96.2 million. Industry's share is about $88.4 million or about 92 percent. It is estimated that 1977 reductions will produce a DO concentration above the desired 4 mg/l.

Compliance with the 1983 effluent limitations requires industrial dischargers to meet best available technology and municipalities to continue to meet secondary treatment in the basin. Achieving this level of treatment will reduce the BOD load to 11,680 pounds per day, a 48 percent reduction from 1977 and an 81 percent reduction from the present load.

The total cost is about $74.1 million, of which the industrial share is about $72.8 million or more than 98 percent. The $74.1 million is in addition to the $96.2 million necessary to meet the 1977 abatement level.

Total cost in going from the present to the 1983 level is about $170.3 million. The industrial share is $161.2 million or 95 percent. Achieving the 1983 abatement level would raise the DO concentration to almost 5 mg/l.

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*The effluent limitation assumed for the Kanawha industries corresponds to 74 percent of the "best practicable technology" waste load. Actual industrial permits issued subsequent to the completion of this study are somewhat less stringent.

F. BENEFITS

What changes in water use or other benefits can be expected from improved water quality?

The eleven regional studies examined changing patterns of water use resulting from improved quality. These changes in water-related activities may be broadly defined as the "benefit" of pollution abatement. More specifically, each study examined three categories -- changing industrial and municipal water uses, recreational uses and commercial fishing.

Ideally, one would like to identify all the types of activities that may result from cleaner water, assess the magnitude of the changed levels of use and assign a monetary value to the projected changes. Given the state-of-the-art and the limited data base available, this is, at best, an arduous undertaking. The regional assessments were at least partially successful in the first step -- identifying the types of uses to be made of cleaner water. More importantly, perhaps, the studies were also able to identify regional concerns regarding the availability of better water and factors which influence the demand for water use -- particularly recreational use. Three concerns are apparent in the collected findings.

First, factors such as perceptions, access and availability of recreational facilities will greatly influence the level of participation in water-based recreation where water quality does improve. The studies indicated that the importance of these factors varies from region to region and, in many cases, is not necessarily related to water quality. The public's perception of the "appropriate" uses of a water body can influence its willingness to use it for recreation. For many rivers which are viewed as industrial waterways, recreational access has become restricted and water quality allowed to deteriorate. If these rivers are cleaned, their recreational value may not be realized until the river's "image" improves.

Second, commercial fishing is often regulated to assure protection of public health or to prevent depleting fish populations through overfishing. Local regulations and institutional arrangements may affect the ability of commercial fisheries to benefit from pollution abatement. The regional studies documented the variability in the criteria used in determining whether or not to allow commercial shellfishing. In some regions, the local policies tend to be more restrictive than national criteria and shellfish areas will possibly not be reopened even if water quality improves.

Third, in many areas, public concern is not focused on the direct benefits of cleaner water, but on expenses which could have been avoided if water quality had not been allowed to deteriorate. Several regional

studies documented increased costs for developing alternative municipal water supplies where local supplies have become polluted and been abandoned. In a similar way, the capital value of fishing fleets is allowed to depreciate in areas where commercial fishing is adversely affected by pollution. In a real sense, water quality preservation has a benefit in that certain expenses are not incurred. It would be extremely difficult to quantify this type of benefit. However, the costs of developing distant water supplies or the decay of fishing fleets are often emotional subjects in localities where they occur.

1. Recreational Opportunity

The Merrimack regional study provides an example of the effect that perceptions can and will have on the degree to which cleaner water may be exploited as a recreational resource(9). The Merrimack and Nashua Rivers have long been too dirty to be considered for extensive recreational uses. Since the early years of the industrial revolution in New England, the Merrimack-Nashua system has been used for disposal of industrial and municipal wastes. Access to the river has been restricted by land use and development practices. In general, for the past 50 to 75 years, the people of the Merrimack basin have not looked to the Merrimack and Nashua Rivers to satisfy their recreational demands. Instead, they have traveled to the more rural recreational sites nearby.

With rising population, increased demand for recreational sites has grown in the communities along the Merrimack. Yet, there are striking differences in the perceptions of the river by local residents.

In Nashua, N.H., for example, there is only limited access and no water-based recreation of any consequence on or near the Merrimack. What recreation that does occur consists mostly of activities such as picnicking and hiking. Even these are limited near the shoreline because a railroad restricts the right-of-way, creating a psychological barrier to the river.

Planning for recreation parks and development has not progressed to the drawing board stage in Nashua. Priorities have been established, but include only a dock, a fishing pier and areas for picnicking and hiking. The city planning board has stated that water-contact recreation is not even a "long-range dream", and "no one of sound mind would develop water-oriented recreation plans here . . . the water is too bad." At this stage, the perception of the Merrimack is such that the prospect of cleaner water means very little to planners concerned with future recreation sites.

In the same basin, but in a neighboring community, there are similar water quality problems, but remarkably different attitudes toward the future use of the Merrimack as a recreation area. Lowell, Mass., is the

major urban center in the northern Middlesex area of the Merrimack basin. It is the population center for the Massachusetts portion of the basin, yet the available land suitable for recreation is limited.

Since the 1930's, increasing pollution of the Merrimack and connecting canals have impaired recreational opportunity in the Lowell area. Recreation today does include limited boating, fishing and shoreline activities, but as in the Nashua area, most people turn to rural areas for recreational activities.

Unlike in the Nashua area, however, the perception of the river is rapidly changing in Lowell. The development of the Lowell Urban National Cultural Park is indicative of a new enthusiasm toward the river. This park is being specifically planned to take advantage of the river and canal system.

As upstream point sources are controlled and water quality improves, people are beginning to think of increased uses for the river. Boating on the river and canals will become an important feature of the Cultural Park. The numbers of fish should increase. This, and a more attractive waterway, will provide local sport fishing opportunity to Lowell's urban residents.

The situation on the Merrimack may be similar to that on the Kanawha near Charleston, W. Va. Until the early 1960's, the Kanawha River, in the 40-mile stretch surrounding Charleston, was one of the dirtiest rivers in the country. For the past ten years, there has been a vigorous and on-going program, sponsored by the State of West Virginia in cooperation with the major industries.

The result of this program has been a marked abatement of pollution. Ten years ago, recreation on the Kanawha River was almost nonexistent. Although the water is not yet entirely suitable for contact uses, the citizens of the Kanawha Valley have begun to realize that the Kanawha can provide an area for family recreation(1). Over the past ten years, there has been an increase in boating activities, including water skiing. Today, there is a need for 3.9 million recreation days per year. By 1990, this need is projected to be approximately 5 million.

The Houston Ship Channel is a striking example of a waterway where access is severely limited by industrial development(4). On the upper portions particularly, all the land is devoted to heavy industry. It is a unique body of water, designed by man to be a transportation corridor. It has been used as a depository for industrial and municipal wastes and for drainage of urban runoff. These uses have traditionally overshadowed its recreation potential.

Understandably, a survey conducted as part of the regional analysis indicated that only six percent of the people had used the lower portion

of the Ship Channel for recreation during the past year. Surprisingly, 57 percent indicated that they would use the lower portions for recreational activities, such as fishing and boating, if it were not polluted.

2. Shellfish Bed Openings

Benefits in the form of reopened shellfish beds will vary as a function of water quality and state public health regulations. Improvements in water quality sufficient to allow reopening in one state will not permit renewed harvesting in another.

There are few point sources discharging to the Apalachicola Estuary and Bay, but shellfish beds are often closed during the prime collecting season. The State of Florida bases bed closings on total coliform counts which can come from natural or nonpoint sources, rather than fecal coliforms, a more accurate indicator of sewage contamination. In the Apalachicola, high coliform counts occur during periods of high flow, suggesting that the counts may not be associated with municipal point-source discharges. Unless state standards and monitoring programs are based upon fecal coliform counts, point-source abatement programs may not lead to increases in the oyster harvests.

San Francisco Bay and the Merrimack River estuary, both of which could support commercial and recreational shellfishing, have their shellfish beds totally closed because of bacterial contamination. Projected improvements in water quality could allow reopening of commercial shellfishing under present state standards. Facilities were, at one time, provided on the lower Merrimack for decontaminating shellfish. However, as coliform counts continued to increase, all harvesting was abandoned. It is likely that the Merrimack's beds will be harvested again if bacterial counts are diminished by abatement measures.

No shellfish beds are projected to reopen in Puget Sound since the present practice of state authorities seems to prohibit shellfishing near sewage treatment plant outfalls, regardless of effluent quality. Until state policies change, beds will remain closed if they are located near a sewage treatment plant outfall.

3. Costs of Degradation

The "benefits" associated with the preservation of clean water are not easily defined or assessed. The regional studies included many instances illustrating costs which would have been avoided if water quality had been maintained. The studies documented two cases where the cost of delivering municipal water supplies was significantly increased when nearby resources were abandoned because of pollution.

Communities along the Chattahoochee, south of Atlanta, must obtain their water supplies from other sources(3). Many communities rely on

limited groundwater resources. The more abundant supply of water in the Chattahoochee River is badly polluted by Atlanta's sewage and waste discharges. The limited supply of groundwater, combined with the costs of providing adequate storage and pressure, has been a major concern and may have restricted industrial and residential expansion. Areas that have realized growth have been obligated to incur large costs to insure adequate water. For example, the towns of Newnan and Shenandoah are jointly constructing a 29-mile water line to the Flint River near Gay, Ga., because the nearby Chattahoochee is too polluted to use.

Nonpoint sources and urban runoff also contribute to the problem of maintaining an adequate water supply for the basin's growing population. Residential development north of Atlanta is increasing runoff and pollution in the area's principal storage reservoir. Urban runoff from Atlanta itself is endangering the water supplies for the urban counties of Cobb, DeKalb and Gwinett.

In Charleston, the West Virginia Water Company is the primary supplier of drinking water(1). The firm serves a population of 180,000 about 79 percent of the total population in Kanawha County. Other communities along the Kanawha, including Belle, Nitro and Dunbar, have joined the service area. The communities had previously drawn their public water supplies from the Kanawha; however, because of taste and odor problems, they abandoned the Kanawha in favor of the West Virginia Water Company, which obtains its supply from the Elk River.

Capital expenditures could have been avoided if the Kanawha were less polluted. It is unlikely that the Kanawha would replace the Elk as a cheaper source of water for communities along the Kanawha main stem even if the requirements of the Act were implemented. However, the costs for drinkable water are currently higher because the river is used to carry industrial and municipal wastes and has not been preserved for public water supplies.

An important "benefit" of maintaining water quality will be the preservation of fishing commerce. The regional studies documented a wide range of situations regarding the viability of commercial fisheries. Although several economic factors can be important, water pollution has severely limited or eliminated fishing in many areas.

The decline of the U.S. commercial fishing industry on Lake Erie in the past two decades has been caused, in part, by pollution problems. As water quality worsened and, simultaneously, spawning grounds were dredged or otherwise impaired, populations of desirable species decreased. Bordering states, particularly Ohio, began a program to control the catch of desirable species by restricting the types of fish that could be caught by commercial and sports fishermen, and by regulating the types of fishing equipment that could be used.

Canada views Lake Erie's pollution problems as arising mainly from the U.S. side, and therefore has not been as active in restricting fishing in her waters.

Between 1950 and 1970, the U.S. fish catch in Lake Erie dropped from 24 million pounds to 10 million pounds per year, and decreased in value from $4.5 million to $1.3 million*(17).

The Canadian fish catch, on the other hand, has been increasing. In 1960, 1965 and 1970, the reported catches were 30, 35 and 50 million pounds per year. The values of these catches were $2.0, $3.3 and $3.0 million dollars respectively*(17). Even with the large increase in weight of catch between 1965 and 1970, the total selling price remained relatively constant. The trend of decreasing value per pound of fish caught reflects the historic decrease in populations of high-quality fish. The catch of high-quality species has decreased and has been replaced by lower value fish despite efforts, particularly on the U.S. side, to regulate the pressure on the remaining resources.

The Lake Erie fishing commerce clearly contrasts with that of Puget Sound where the fish catch has remained relatively constant. The selling price of the 1970 catch exceeded that of 1955, although its true value may be less because of inflation.

The control of pollution in Puget Sound may have been relatively easier than in Lake Erie. Nevertheless, fish kills began to occur in the Sound during the 1950's and 1960's. Although it is difficult to associate fish kills unambiquously with pollution discharges, the State of Washington instituted a pollution abatement program. The program emphasized controlling potentially toxic industrial discharges, eliminating sewage discharges to freshwaters and assuring pollution-free corridors for migrating fish species. Improved water quality in the region has been instrumental in preserving the fishing industry.

If no additional pollution control measures were taken by cities and industries along Lake Erie, historical trends in water quality degradation would accelerate because of population and industrial growth(10). Although the assumption that no further steps would be taken is highly unlikely, it does provide a "worst case" to show what could happen if water quality is not preserved. By 2020 there would be no swimming beaches open on the south shore and lake water would seldom meet bacterial standards. Drinking water would have to be heavily chlorinated, raising the cost of treatment.

In the long term there would be a total collapse of the fishery in nearly all areas. Important species of fish would decline dramatically or disappear, while several "trash" types would continue to increase.

*Dollar values are not corrected for inflation.

Seasonal oxygen depletion in the bottom waters would spread from the central basin to the western and eastern basins. The eastern basin, which is presently relatively clean, would become more like the rest of the lake.

Implementation of the 1977 and 1983 requirements would produce significant improvements in the lake's water quality, particularly near the shore. However, the lake would never return to its earlier pristine condition. With improved water quality, several species of valuable sport and commercial fish would increase in number.

G. OVERLAPPING JURISDICTIONS

What overlapping authorities or responsibilities exist for public organizations charged with implementing the programs of the Act?

The provisions of P.L. 92-500 place specific responsibilities on Federal, state and local governmental organizations. Progress in achieving the goals and fulfilling the requirements of the Act will depend upon the relationship of the organizations to each other. An aspect of this relationship is the ability of organizations at the same level to cooperate in pursuing their responsibilities and tasks. By focusing on problems at the basin level, the regional studies identified instances where interstate or intermunicipal cooperation could play a role in furthering the progress of the Act's programs. Additionally, treaties with Canada and Mexico have affected pollution control programs on the Great Lakes and the waters of the Colorado River delivered to Mexico.

1. International Commitments

Imperial Dam, on the Colorado River, lies just above the Mexican border. A part of the waters arriving at Imperial Dam, the last major point of diversion in the U.S., as well as return flows from some of the lands in the U.S. irrigated by water diverted at Imperial Dam are delivered to Mexico in accordance with the 1944 Treaty. To implement a recent agreement (Minute No. 242), executed by the Commissioners for the United States and Mexican Sections of the International Boundary and Water Commission and approved by the two governments, a portion of the return flows will be treated to control the salinity. Minute 242 stipulates that salt concentrations in the Mexican flow would not exceed those of the waters behind Imperial Dam by more than 115 ppm (plus or minus 30 ppm). Title I of the Colorado Salinity Control Act (P.L. 93-320) authorizes the construction of desalting works for the drainage waters of the Wellton-Mohawk project. When completed, these works will enable the U.S. to fulfill its obligations.

Title II of P.L. 93-320 charges the Secretary of the Interior with implementing a salinity control policy for the Colorado River. The

policy is to be in conformity with the conclusions and recommendations of the Colorado River Pollution Abatement Conference, held in 1972 under the authority of the 1965 Federal Water Pollution Control Act. Four salinity control projects are authorized. Three of these are designed to stop specific highly saline inflows to the river. The fourth project is designed to improve water use efficiency in the Grand Valley irrigation project. The Secretary is also charged with completing plans for an additional twelve projects.

The seven basin states have supported the Salinity Control Act, particularly the provisions of Title II. The desalting works of Title I will be federally funded. The salinity projects of Title II are funded on a cost-sharing basis: 75 percent of the cost is Federal and 25 percent is derived from the Upper and Lower Colorado River Basin Development Funds. P.L. 93-320 authorizes over $280 million for the Title I and Title II projects.

Under the authority of the Boundary Waters Treaty, the U.S. signed a broad agreement with Canada in 1972(18) regarding water quality in the Great Lakes. Measures for pollution control include discharge from ships, as well as from shore facilities. One of the important provisions of the agreement calls for the abatement of the discharge of phosphorus to Lake Erie and Lake Ontario. Municipal waste treatment plants and the discharge of storm sewers or combined sanitary and storm sewer overflows are important sources of phosphorus. The municipal permit provisions include limitations on phosphorus, and the major cities are developing plans to control discharges from combined and storm sewers.

Although the Federal authorities have agreed to a schedule for phosphorus abatement, all the Lake Erie basin states do not necessarily view Lake Erie and Lake Ontario as their most important pollution problems. The states participate in advisory panels to the International Joint Commission established by the Boundary Waters Treaty and have endorsed the requisite stringency of phosphorus abatement measures. However, the Federal Water Pollution Control Act was amended in 1974 by P.L. 93-243 to clarify the point that no state must consider international agreements in establishing its priority system for waste treatment construction grants.

2. Interstate Jurisdiction

When a drainage basin contains portions of more than one state, effective progress toward water pollution control may require cooperation between the states. For two of the Act's functions -- the issuing of discharge permits designed to assure achievement of water quality standards and the development of state priorities for the construction of publicly owned treatment works -- this may be particularly important. In the Delaware, Ohio and Merrimack basins, interstate agencies have water quality-related authority and responsibilities.

The Delaware River Basin Commission (DRBC) and the Ohio River Valley Water Sanitation Commission were organized for different purposes. ORSANCO is primarily a pollution control agency; the DRBC, on the other hand, was organized to manage the water resources of the Delaware basin. The New England Interstate Water Pollution Control Commission (NEIWPCC) is primarily a water pollution control agency and is involved in all the interstate streams in New England.

Although ORSANCO and NEIWPCC were organized for water pollution control and DRBC for a broader purpose, their attitudes and approaches to their roles have been similar -- they have all assumed roles which emphasize coordination rather than operation or enforcement. All three agencies set water quality standards and have active programs in monitoring and surveillance. Load allocations were set by the DRBC for the Delaware, and by the individual states for the Ohio using ORSANCO water quality models. NEIWPCC was instrumental in deciding the designation of water quality limited stream segments.

All three agencies left priorities for construction grants, NPDES permit issuance and enforcement to the states. Although the agencies have not functioned directly in these programs, they have used their influence to try to insure compatibility between the states.

An early requirement of states was that they establish a system for setting priorities for Federal construction grants. The priority system guidelines approved by EPA for use throughout the nation were based upon a numerical system which assigned weights to such considerations as: population served, water use affected, geographic locations, and severity of pollution.

Although Ohio and West Virginia are across the Ohio River from each other, they have different priority setting systems. West Virginia heavily weights factors which assign high priorities to projects on the Ohio River. Ohio's priority setting system assigns highest priorities to projects in the Lake Erie area. Portions of New Jersey, Pennsylvania and Delaware lie in the lower Delaware River basin. Each of the states views the Delaware differently and these differences are reflected in the priorities they have assigned to constructing treatment plants. Delaware and Pennsylvania have been moving ahead with abatement programs on the Delaware. In the past, New Jersey had tended to give higher priority to the rivers in the northern portion of the state.

The general opinion of the interstate agencies, themselves, has been that the priority system is not presently the reason for delay in meeting the objectives of P.L. 92-500. The agencies believe they can achieve an appropriate degree of compatibility of priority systems within their respective basins.

3. Intercommunity Jurisdiction

If neighboring communities participate in regional waste systems, they may realize a cost savings and advantageous financing arrangements. P.L. 92-500 encourages regional systems by requiring that federally subsidized treatment projects be cost-effective. In addition, the Act stresses the need for areawide waste treatment planning and management. Most states provide a number of legislative mechanisms which enable communities to join efforts for a joint purpose. However, it is common for individual communities to resist regional systems and to favor local control. Much of this feeling probably stems from fear of losing local identity or control of local development.

Much of the controversy surrounding Section 208, "Areawide Waste Treatment Management", is related to these fears. This portion of the Act calls for planning to solve the administrative, managerial and operational aspects of areawide waste treatment. In doing so, the Act raises questions relating to the relative roles of state, areawide and local authorities in providing an essential public utility -- waste treatment. Many local organizations are acutely aware that the power to provide or withhold utilities, including waste treatment, ultimately may be used to control growth and development.

The regional studies included representative cases where localities have encountered and solved the problem of regionalization. Regional systems such as the Gulf Coast Waste Disposal Authority, the Metropolitan Municipality of Seattle, and the Metropolitan Sewer District of Cincinnati are examples of organizations which are now dealing with areawide waste treatment problems.

Metropolitan Sewer District of Greater Cincinnati (MSD) (19)

The district was formed in 1968 by resolution of the City and Hamilton County and is operated by the Cincinnati Department of Sewers. Stimulus for the formation of the district came when Ohio threatened to prohibit further development in the County because of inadequate sewage collection facilities. The District now handles the waste from most of the municipalities and townships in Hamilton County. A significant portion of the waste is industrial.

Expansion policies are set by the Hamilton Board of Commissioners. Decisions to expand sewer service areas are presumably based upon economic considerations. The district probably will expand into other counties and perform more extensive waste management functions in its authorized area.

The incentive for communities to join is monetary. The district has no legislative limit on its capacity to issue revenue bonds. As the

need for additional treatment arises, the economics of scale and availability of financing will induce communities to join the MSD system. However, a few communities are resisting these inducements for matters of local preference. MSD can only offer to provide service; reluctant communities cannot be forced to join.

Gulf Coast Waste Disposal Authority (GCWDA) (4)

The Gulf Coast Waste Disposal Authority is a unique organization. It is a state agency authorized by an act of the Texas legislature, but it operates as a quasi-public utility.

Its main business is waste treatment. It will contract with any industry or community desiring the service and able to pay for it. Until recently, it had the authority to force municipalities to accept its services.*

Funds are derived entirely from user charges to the industries and public agencies served. Although GCWDA has broad authority in matters of water quality management, it has chosen not to exercise it. At present, the agency views its chief responsibility as providing services and tends to avoid using its enforcement powers.

GCWDA will build, purchase or operate waste treatment works. However, the agency will assume responsibility for an existing plant only if the plant is considered adequate to meet the abatement requirements set for it.

GCWDA can sell public agency tax-free bonds backed by revenue contracts with the community or industry. If industries contract for such bonds, the contracts are irrevocable. GCWDA can, but does not, levy taxes and it receives no funds from the state government. It can refuse to accept a waste into its treatment plants if it deems that the waste is incompatible with its treatment objectives. Dischargers whose wastes are refused treatment then come under enforcement jurisdiction of agencies other than the GCWDA.

The agency simultaneously holds NPDES discharge permits from EPA and state permits from the Texas Water Quality Board. The NPDES permit includes specific effluent limitations for each influent waste stream. GCWDA has protested this arrangement and feels that EPA has illegally exercised its authority.

*The Gulf Coast Waste Disposal Authority has been delegated powers similar to those of River Basin Authorities under the Texas Constitution and state laws. Since 1967 the authorities have been empowered to acquire, construct and operate waste treatment facilities.

Although the agency is eligible for EPA funds, it has no EPA grants at this time but is presently in the process of filing.

Metropolitan Municipality of Seattle (METRO)(2)

METRO Seattle represents an instance where a number of communities were able to submerge their differences and join forces to solve a common recognizable problem -- the cleanup of Lake Washington.

Wastes from the City of Seattle and other communities were causing algae blooms in Lake Washington. With the support of local citizen groups, METRO was formed with the goal of saving the lake. There were fears of a regional government, the loss of local identity and takeover of small communities by larger communities. However, the need to save the lake transcended local fears and the district was formed.

Within ten years, METRO developed and constructed a system where all sewage formerly discharged to Lake Washington was collected, treated, and discharged to Puget Sound.

METRO completed the difficult task of acquiring locally owned interceptors, pumping stations and treatment plants. These were either incorporated into the system or abandoned.

METRO's reputation during this period was good, and little opposition was generated toward its formation or financing of the project. There was a general feeling in the affected communities that METRO was doing a job at reasonable cost.

Now that METRO has matured as a governmental organization, attitudinal changes are taking place in some member communities. There appears to be a resurfacing of the fears of losing local control. For instance, there is a difference of opinion between the City of Seattle and METRO as to which entity should solve the problems of combined sanitary and storm sewer overflows. Some member communities now object to subsidizing construction in other areas and of possibly stimulating movement of families from one community to another.

METRO has entered the controversy concerning the suitability of the secondary treatment requirements for plants discharging into the ocean. METRO feels that secondary treatment is not needed. The conflict is particularly important to METRO since its primary attraction to prospective member communities is its ability to provide treatment more efficiently than the communities could on their own.

H. OVERLAPPING PROGRAMS

What is the relation between the water pollution control programs of the Act and programs in water resource management?

The implementation of a water pollution control program inevitably involves concerns and interests other than pollutant discharge abatement. There are situations throughout the nation where abatement measures cannot assure the ability to control the degradation of water quality. The Act recognizes the situations and specifies that alterations in flows or hydrological patterns are to be considered for their effects on water quality. In the regional studies there were two important cases where an effective water pollution control program must include more comprehensive measures than control of point and nonpoint discharges through applicable technologies.

1. Navigation

The first of these situations is encountered on the Ohio River. In order to improve the waterway as a transportation corridor, a series of dams have been built. These dams slow the flow of the river and establish standing water pools or reservoirs and thereby tend to aggravate pollution problems. Currently, the dam system on the Ohio is being changed to increase the height of the major dams and the depth of these pools. A similar dam-building program is proposed for the Chattahoochee. Permits for point-source discharges into these waterways have been developed from a consideration of the hydrologic conditions as they now exist. Projected dams or navigation changes are only begun after environmental impact statements have been prepared. However, there is no formal mechanism which assures that dams, channels or other new hydrological modifications will be compatible with permitted and nonpoint pollutant discharges. The Ohio regional study extensively documents the water quality degradation which resulted from the construction of the Markland Dam and the failure of dischargers to implement abatement measures simultaneously. This project would have required 40 percent decrease in the discharge of organic pollutants if the dissolved oxygen concentration were to be maintained.

The planning provisions of the Act, particularly those pertaining to state functions, are extensive. The lead times required for planning navigation projects and the requirements of an environmental impact statement suggest that the Act's water quality planning processes could and should include review of proposed changes in waterways as they may affect concentrations of pollutants.

2. Water Resources

In many basins, questions of water quality, quantity and use are inexorably related. Water users divert water, consume a portion and return the remainder, carrying wastes. In basins where the demand for water is large, discharged effluent comprises a major fraction of the downstream flow and water resources are repeatedly reused. As demands increase, instream water quality will degrade and approach that of the effluent discharges.

Where the demand for all uses is large but the demand for consumptive use (including consumption required by pollutant discharge abatement) is small, sufficiently stringent abatement requirements theoretically can assure instream water quality. If the requisite levels of abatement are not technologically or economically achievable, satisfying all the demands for polluting uses may degrade water quality below acceptable levels. Section 302 of the Act, "Water Quality Related Effluent Limitations", specifically recognized this situation and established a procedure to determine the relationship between the economic and social costs and benefits of implementing the requisite abatement measures.

In basins where the demand for consumptive water uses is an appreciable fraction of the available flow, and where the consumptive uses or other uses add pollutants, water quality is determined by a delicate balance between pollutant discharge and water consumption. In water-short areas, i.e., those areas where potential consumptive demand equals or exceeds available supplies, pollution may become critical. Since consumptive demand reduces the volume of water, pollutants tend to become increasingly concentrated. Allowed to run to extremes, the demand for water consumption may lower water quality to the point where further use is not possible.

Water quality management in water-short areas or those approaching shortage is physically and institutionally complex. Water quality depends upon the levels of achievable pollutant discharge abatement and on the consumptive requirements of various water uses. Water use, on the other hand, may be limited by poor water quality. The technology and water quality-based effluent limitations of the Act and various state laws deal with pollution abatement. Water resource utilization, particularly in water-short areas, is determined by a system of "rights" to beneficial use, a system established under state water law. In theory, the concepts of appropriative or riparian doctrines and the requirements for pollution discharge abatement are broad enough to accommodate one another. However, as water rights and pollution abatement laws were originally conceived and as they may be actually practiced in some jurisdictions, they are yet to be made completely compatible.

The concept of ambient, or "instream", water quality standards allows for the complexity of water quality management in regions of high demand. In theory, all proposed changes in a basin are assessed for their impact on water quality and are initiated only after these impacts are compared to established standards. The analysis must include a careful assessment of changes in pollution loadings, matched with anticipated hydrological patterns. Inevitably, the analysis and assessment process leads to institutional questions. Issues arise as to the legal status of water quantity and water quality concerns in determining the acceptability of a proposed hydrological modification or in selecting between alternative proposals.

Although problems of limited available water supply occur throughout the nation, the Colorado River Basin and San Francisco Bay/Central Valley regional studies clearly illustrate the nature of the issues involved.

The Colorado Basin

Apportionment of water resources of the Colorado River basin is complex. Institutionally, water is apportioned among seven states and Mexico by various treaties, compacts, Federal laws and court decisions. Within each state, water is apportioned among individuals and public or private organizations according to state law. Physically, it is divided among a variety of uses; including out of basin transfers, water for cooling or other requirements in the energy industry and irrigated agriculture. (Municipal and industrial use within the basin requires smaller quantities of water and has a lesser effect on salinity than either energy or irrigation use.)

Salt is discharged to the river by natural processes and in irrigation return flows. Diversions for out-of-basin use and for new energy uses will not return salt or water.* At the present time, the salinity concentration in the lower reaches of the river is high enough to impair some water uses. Consumption in the upper basin will increase in the future as upstream states commit to use the quantities to which they are entitled. When this occurs remedial actions to control the salinity concentrations will be required.

Colorado River water is managed by the Secretary of the Interior through the Bureau of Reclamation. Most of the major dams and diversion projects are operated by the Bureau. Generally, it has the responsibility and capability of assuring the proper water deliveries.

The seven basin states are in the process of developing water quality standards. Standards include numerical criteria for salt concentrations at various points and measures which will assure achievement or maintenance of the criteria. EPA must approve both the numerical concentrations, the number of locations where they are applicable and the abatement or control measures for their achievement. Among the many issues and controversies associated with this process is the institutional one of which organizations will be required to implement remedial measures to achieve finally accepted salinity standards. Meanwhile, the Colorado River Basin Salinity Control Act charges the Secretary of the Interior

*Newly constructed coal-fired steam electric power plants and plans for coal gasification plants follow the "no-salt return" policy. The Water Quality Standards proposed by the Colorado River Basin Salinity Control Forum include the statement, ". . . the objective for industrial dischargers shall be a no-salt return policy wherever practicable."

with completing four projects which will remove salt inflows to the River. Twelve additional projects are being planned for controlling salt from irrigation and natural point or diffuse sources. Other organizations which theoretically might be required to take additional measures are the states, irrigation districts, drainage districts, individual irrigators as well as any of a wide variety of legally recognized public or private organizations.

There are many institutional and attitudinal problems in identifying organizations which have the necessary authority and interest in water pollution control. Most interests in the region historically have been concerned primarily with water resource development projects and concern about salinity control is relatively new. Although concern over salinity is widespread, interest in development projects still dominates water resource attitudes, and the institutional structure reflects this dominance. For example, while irrigation districts can recover the costs of delivering water, it is questionable whether they have the authority to assess charges for pollution control measures or to place requirements on irrigation practices.

EPA has not yet applied the NPDES permit program to irrigated agriculture. EPA's original policy defining who should hold permits was successfully challenged in court. As yet no formal policy has been established. Currently the sole provision of the effluent limitations for irrigated agriculture is monitoring the quantity and quality of diversions and return flows. The permitting provisions of the Act are flexible enough so that EPA theoretically could require specific abatement measures or effluent limitations of individual permit holders. This flexibility potentially allows consistency between the measures required to achieve and maintain salinity standards and the NPDES permit program.

The San Joaquin River

Many of the water quality/water quantity questions or concerns are similar in the San Joaquin River Basin to those in the Colorado. However, there are important differences in both the physical system and in the institutional structure for its management.

The San Joaquin Valley contains large areas of irrigated agriculture. The San Joaquin River collects all drainage waters and carries them to the Delta. Water for irrigation is obtained from the river and storage reservoirs in its tributaries. Additional water is pumped from the Delta and imported into the Valley. Since the waters of the Sacramento and San Joaquin Rivers mix in the Delta, a portion of this supply is actually from the San Joaquin. To the extent that San Joaquin water is recycled, its salt content will remain in the valley and, in the long-term, salt concentrations will increase. Nitrates are an important constituent of the salt load.

The San Joaquin and Sacramento Rivers connect through the Delta and discharge to San Francisco Bay. Unless adequate freshwater flows are maintained, salt water will intrude upstream past existing water diversions. The ecology of the Bay-Delta-River system depends to some degree on seasonal variations in the outflow and the position of the salt water transition zone.

The central problem in the region is the management of the entire water resource to assure that the proper salt loads are removed from the San Joaquin Valley, that the proper outflows occur through the Delta and that nitrate concentrations do not produce eutrophication problems.*

Some of the drainage waters from the San Luis irrigation project will be collected and carried out of the basin. This measure will assure that salts, particularly nitrates, are not added to the pollution load in the San Joaquin. However, the absence of this water will reduce the net outflow and will therefore not be available to buffer salt water intrusion. New drainage projects would help eliminate the discharge of pollutants to the San Joaquin, but would further complicate the problem of salt water intrusion.

The California Water Resources Control Board both issues water rights and administers discharge permits. California's discharge permit program predates P.L. 92-500 and the NPDES program has been delegated to the state. The Board is issuing discharge permits for irrigation. The present permits require only that the quantity and quality of return flows be monitored. However, if abatement measures which changed water use or consumption, were to be required, the changes would affect the projects supplying water to the valley. The Department of Water Resources plans and develops water resource projects. These projects must receive water rights permits from the Water Resources Control Board. Unlike most other states, California separates the agency interested in future water resource projects from the agency responsible for water quality and water quantity regulation(20).

*Various management plans for the Delta are now being discussed in California. Debate centers upon a proposed "peripheral" canal to allow controlled water transfers from the Sacramento River.

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APPENDIX A: CONTRACTOR AND STAFF REPORTS

I. CONTRACT REPORTS PUBLISHED (as of April 27, 1976)*

Water Pollution Abatement Technology, Capabilities and Costs.

- Organic Chemicals Industry - Catalytic, Inc., PB 244 544. $19.25.
- Inorganic Chemicals Industry - Catalytic, Inc., PB 244 800. $12.50.
- Publicly Owned Treatment Works - Metcalf and Eddy, PB 250 690. $46.25.
- Irrigated Agriculture - Toups Corporation, PB 250 016. $9.00.
- Iron and Steel Industry - Arthur G. McKee and Co., PB 249 661. $16.25.
- Urban Runoff - Black, Crow and Eidsness/Jordan, Jones and Goulding, PB 247 391. $10.75.
- Control of Water Pollution from Selected Nonpoint Sources - Midwest Research Institute, PB 248 806. $10.00.
- Metal Finishing Industry - Lancy Laboratories, PB 248 808. $16.25.
- Pulp and Paper Industry - Hazen and Sawyer, PB 242 376. $11.50.
- Textile Industry - Lockwood Greene Engineers, PB 244 802. $12.50.
- Canned and Preserved Fruits and Vegetables - Environmental Associates, PB 244 801. $19.25.
- Petroleum Refining Industry - Engineering Science, Inc., PB 243 830. $15.25.
- Selected Industries - Battelle Memorial Institute, PB 251 437. $95.75.

Water Pollution Control Act of 1972, Economic Impacts.

- Leather Tanning Industry - Development, Planning and Research Assoc., PB 250 019. $6.00.
- Iron and Steel Industry - National Bureau of Economic Research, PB 248 802. $6.00.
- Nonferrous Metals Industry - National Bureau of Economic Research. PB 248 804. $7.75.
- Metal Finishing Industry - National Bureau of Economic Research, PB 248 803. $6.75.
- Pulp and Paper Industry - National Bureau of Economic Research, PB 248 801. $10.00.
- Textile Industry - National Bureau of Economic Research, PB 249 948. $7.50.
- Petroleum Refining Industry - National Bureau of Economic Research, PB 248 800. $9.00.
- Plant Closures - National Bureau of Economic Research, PB 250 015. $4.50.
- Fertilizer Industry - Development, Planning and Research Assoc., PB 250 017. $6.75.
- Direct and Cumulative Industry Impacts - Development, Planning and Research Assoc., PB 251 224. $6.75.
- Meat Products - Development, Planning and Research Assoc., PB 251 215. $16.25.

*Available from National Technical Information Service, Springfield, Va., 22161. Specify PB number when ordering. All reports are available in microfiche at the cost of $2.25 per volume.

Canned Fruits and Vegetables - Development, Planning and Research Assoc., PB 251 216. $10.75.
Dairy Products - Development, Planning and Research Assoc., PB 251 217. $8.00.
Grain Milling - Development, Planning and Research Assoc., PB 251 223. $7.75.
Pilot Study, Five Industries - The Conference Board, PB 251 628. $18.75.
Irrigated and Non-Irrigated Agriculture - Center for Agricultural and Rural Development, Iowa State University, PB 248 807. $6.75.
State and Local Revenues and Expenditures - Data Resources, Inc, PB 250 018. $18.75.
Foreign Trade - Public Research Institute, PB 249 949, $10.50.

Water Pollution Control Act of 1972, Technologies and Economic Impacts.
The Feedlot Industry - Development, Planning and Research Assoc., PB 251 214. $10.75.
Steam Electric Power Industry - Teknekron, PB 251 372. $32.75.

Water Pollution Control Act of 1972,
Demographic and Quantitative Analysis - Human Resources Planning Institute, PB 251 321. $5.50.
Municipal Options - Meta Systems, PB 249 947. $13.50.
Social Impacts, Eight Case Studies - Abt Assoc., PB 250 106. $13.00.

Benefits from Water Pollution Abatement.
Beach Closings and Reopenings - Battelle Memorial Institute, PB 251 221. $16.25.
Property Values - David Dornbusch and Assoc., PB 248 805. $9.75.

Annualized Costs of Pollution Control, State Tax Incentives - National Bureau of Economic Research, PB 251 436. $4.50.

An Analysis of the U.S. Environmental Protection Agency's Needs Survey- American Public Works Assoc., PB 244 803. $9.50.

Innovative Technologies for Water Pollution Abatement - Water Purification Assoc., PB 247 390. $13.00.

Water Pollution Control Act of 1972, Institutional Assessment.
Digest of Legal Issues - Environment and Safety Research Service, PB 250 975. $12.50.
Construction Grants - Touche Ross & Co., PB 244 804. $10.00.
Attitudes of Participants - Oregon Research Institute, PB 247 392. $10.00.
Planning - Harold Wise & Assoc., PB 244 907. $7.50.
The Permit Program - Energy and Environmental Analysis, Inc., PB 244 805. $10.50.
Public Participation - James Ragan and Assoc., PB 245 410, $8.75.
Enforcement - Environmental Law Institute, Two Volumes. Volume I, PB 246 321, $12.50. Volume II, PB 246 322, $18.75. Set, PB 246 320, $30.00.

Water Pollution Control Act of 1972, Regional Impacts.
- Delaware River Basin - Betz Environmental Engineers, PB 249 910. $41.75.
- San Francisco Bay/Central Valley - Arthur D. Little, Inc., PB 249 730. $21.25.
- Ohio River Basin - Dames & Moore, Inc., PB 249 680. $55.25.
- Colorado River Basin - Utah State University, PB 249 660. $46.25.
- Merrimack Nashua River Basin - Abt Assoc., PB 250 060. $41.75.
- Kanawha River - Dames & Moore, Inc., PB 250 105. $23.75.
- Lake Erie - Dalton, Dalton, Little, Newport, PB 251 009. $28.25.
- Yellowstone River Basin - Stevens, Thompson and Runyan, PB 251 072. $7.75.
- Puget Sound/Lake Washington - Stevens, Thompson and Runyan, PB 251 319. $7.75.

Environmental Impact Assessment, Water Quality Analysis.
- Puerto Rico - Tetra Tech, PB 251 323. $8.00.
- Gulf of Alaska - Tetra Tech, PB 251 322. $9.00.
- Hawaii - Tetra Tech, PB 251 320. $9.00.
- St. John River (Florida) - Atlantis Scientific, PB 251 225. $9.00.
- S. California Bight - Tetra Tech, PB 251 435. $12.75.
- South Platte - Tetra Tech, PB 251 446. $12.00.
- Escambia River and Bay - Atlantis Scientific, PB 251 447. $9.00.
- Hudson River - Lawler, Matusky and Skelly, PB 251 099. $13.00.
- J. Percy Priest Reservoir - Vanderbilt University, PB 251 098. $9.25.
- St. John River (Maine) - Meta Systems, PB 250 942. $10.50.
- Yadkin Peedee River Basin - TRW, Inc., PB 250 933. $8.00.
- Connecticut River - The Center for the Environment and Man, PB 250 924. $9.00.
- Susquehanna - Lawler, Matusky and Skelly, PB 250 925. $9.75.
- Housatonic River - Lawler, Matusky and Skelly, PB 250 926. $11.00.
- Missouri River Basin - Midwest Research Institute, PB 250 930. $7.75.

Water Quality Analysis.
- Upper Mississippi River Basin - Water Resource Engineers, PB 250 982. $5.50.
- Snake River - Tetra Tech, PB 250 929. $5.50.
- Columbia River - Tetra Tech, PB 250 927. $5.50.
- Santee River Basin - Water Resource Engineers, PB 250 928. $6.00.
- Upper Rio Grande - Water Resource Engineers, PB 250 981. $4.50.
- Iowa-Cedar River Basin - Water Resource Engineers, PB 250 931. $6.75.

Water Pollution Control Act of 1972, Environmental Impact Assessment.
- Potomac River - Academy of Natural Sciences, PB 250 934. $7.75.
- Iowa-Cedar River Basin - Midwest Research Institute, PB 251 227. $12.00.
- Snake River - Parametrix, PB 251 226. $7.50.
- Upper Mississippi River Basin - Midwest Research Institute, PB 251 222. $10.00.
- Santee River Basin - Academy of Natural Sciences, PB 251 354. $9.25.
- Upper Rio Grande - Academy of Natural Sciences, PB 251 228. $6.00.
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- Recreation - National Planning Association

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- Biscayne Bay - Water Resource Engineers
- Trinity River - Water Resource Engineers
- Charles River/Boston Harbor - Process Research
- Guadalupe/San Antonio River Basin - Water Resource Engineers
- Chesapeake Bay - Virginia Institute of Marine Sciences

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- Chattahoochee-Flint-Apalachicola - Hammer, Siler, George Associates

APPENDIX B

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