THE ROLE OF THE U. S. ARMY CORPS OF ENGINEERS IN WATER QUALITY MANAGEMENT

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13. ABSTRACT

This report examines the water quality management problem in the U. S. and alternative institutional arrangements aimed toward solution of the problem. Emphasis is placed upon the need for Federal regional-scope multiple objective planning. Under the institutional arrangements discussed in the report, benefits derive from:

a. Integration of planning for separate functional water needs; e.g., water supply and water quality management.

b. Regionalization of waste water systems for groups of communities and large metropolitan areas.

c. Institutional and financial arrangements that foster regional solutions.

d. A flexible Federal role to match the diversity of conditions across the nation

e. Cost-effectiveness allocation of funds.

The role of the Corps of Engineers within the context of various institutional arrangements is visualized largely from its broad planning capability, nationwide organization and strong decentralized field staff, and well-established congressional authorization and budgetary review procedures. The special capabilities of the Corps of Engineers are related to filling gaps in the existing Federal role and overcoming institutional barriers. The report recommends several currently urgent problem situations where Corps' assistance could be applied for early demonstration of its special capabilities.

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FOREWORD

This report examines the federal role in water quality management principally as it applies to waste water treatment. It identifies problems at both federal and non-federal levels which are deterrents to program progress. Emphasis is directed at identifying institutional barriers at the non-federal level and gaps in the federal role which, if corrected, would accelerate progress toward water quality improvement and improve the cost-effectiveness of both federal and non-federal investments. Under an overall need to fully integrate waste treatment into the planning and management of all water uses, consideration is given to federal planning for regional solutions.

The special capabilities of the Corps of Engineers for contributing to the solutions of such problems are discussed. These would be principally in planning for regional solutions as integral parts of overall comprehensive water resource development and achieving regional consensus for implementation.

The report finally identifies some currently urgent situations that offer opportunities for early action under these concepts.

DEPARTMENT OF THE ARMY
CORPS OF ENGINEERS - CIVIL WORKS

THE ROLE OF THE U. S. ARMY CORPS OF ENGINEERS IN WATER QUALITY MANAGEMENT

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This document was written by the authors as a report to the Secretary of the Army and should only be construed as to represent their views.

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PART I

SUMMARY AND RECOMMENDATIONS

SUMMARY

The Problem.

Water pollution control has historically been considered, and probably will continue to be considered, primarily the responsibility of state and local governments. However, there has been a collective lag in perception of the degradation of the nation's waters--and action has lagged behind even further. Recognizing the need of local governments for external incentives and support, the federal government has been seriously involved in the problem over the last two decades and major federal funds increasingly have been applied in the last few years. Nevertheless, a consensus has formed that as a nation we are not doing enough about halting and reversing the degradation of our waters. The President, the Congress, the states, the cities, and the people all agree that the overall level of effort must increase in relation to past efforts and to other activities.

While the nation needs more effective regulations and enforcement, more exhortation to do the right thing, it also needs to put more emphasis on the kind of planning that leads to wise investment, to improve and develop new institutional arrangements, and to change the mix of efforts.

Fragmentation of governmental responsibility and action is much involved in the explanation of unsatisfactory progress. The image of the polluter--whether a municipality or a private firm--of passing the problem downstream as a cost to be borne by others, is certainly not invalid. The ability to shift the cost to others merely by inaction makes understandable why the growing suburban community or declining central city finds pollution control investments difficult to make in the face of other pressing needs whose effects remain at home.

Fragmentation of responsibility has also resulted in too much single purpose, single means, single objective thinking in our water resources program. This has been recognized and largely overcome in overall planning for water resources development. The most obvious remaining exception, and one that can be tolerated least in the future, is in the area of water quality. Too many other water resource activities affect or could affect the restoration of our waters. Too many other uses of water are influenced by their degradation. Failure to relate water quality considerations to our other water resource activities will simply create costs we should not have to bear. A major example is in the area of water supply. By not integrating the functions of supply development and quality enhancement, too much will be spent on distant sources, more upland environments will be disrupted than necessary, and fewer nearby waters will be restored for wider use.

There are several keys to unlocking the problems of accelerating the reduction of municipal and industrial waste water pollution. One is cost-effective allocation of presently available funds. But the master key is the concept of regionalization of waste water systems for groups of communities and large metropolitan areas. That this latter course has not generally been adopted is testimony to the difficulties involved. Regionalization requires institutional arrangements and incentives to surmount local and interstate jurisdictional barriers, it requires commonality of investment funds, it requires commitment and adherence to preplanned and priority-phased investment, and it requires equitable means for sharing the burdens both as to funds as well as plant and effluent discharge locations. On the other hand, given the means to overcome those obstacles, the advantages can be overriding.

As the size of the jurisdiction increase , its emphasis on environmental control also increases. The incidence of degradation becomes more internal to the decision making unit since both the cause and effect are more likely to be within its jurisdiction. Investment funds for environmental control should thus become more competitive with other demands on local resources.

Regionalization offers outstanding economies in investment which, according to some estimates, could amount to as much as a 50 percent reduction in cost over localized, fragmented, non-systems. It also makes feasible the application of higher levels of operating skills resulting in economies of operation and higher effluent

quality, greater flexibility in minimizing the effects of component breakdowns, greater capacity for treatment of difficult waste products, and finally it simplifies the monitoring of effluent quality.

It is in regionalization of waste water treatment facilities that an important aspect of the federal contribution lies, in that it has the ability to foster or create the kinds of institutional and financial arrangements that will permit state and local governments to overcome the obstacles of regionalization and gain its benefits.

The Elements of Solution.

The opportunity to improve the national response to the water quality challenge can be discussed in several ways. An important aspect is to improve the cost-effectiveness of our efforts. Industrial waste integration, urban regionalization of waste collection and treatment, and basin related management--in about that order--offer fairly well understood opportunities for increased effectiveness.

Industrial wastes represent some three times the volume of domestic wastes presently collected--in terms of an oxygen demand index--and yet the costs of collection and treatment appear to total about a third as much. From a national efficiency point of view this suggests a high priority for industrial waste management. Increasingly industrial firms are turning to municipal systems to at least complete the job of treating their wastes beyond the elimination of exotic constituents that are best handled before discharge. From simply a technical point of view this is more effective in managing the wastes of a region, but it also has real economies. Both the real economies and fiscal advantages can be used to induce this integration, but the value of planning and enforcement should not be overlooked. It is probably true that a tradition of providing public services when needed through good planning is as important to industrial location and development as service capacity in place. The need for enforcement should need no elaboration.

The economies and greater effectiveness of system development on an urban regional basis together with basin related management

could produce as much as a doubling in the overall effectiveness of our management of water quality. Not all of this, or even most of it, will be realized in out-of-pocket cost savings. Much will be measured in a better aquatic environment for the money. This is not to preach the gospel of bigness for its own sake, but simply to point out that as long as the many jurisdictions within a basin, and more to the point, within an urban area, plan, request grants for, and operate their own systems with only token relationship to each other, the nation simply will not save its degraded streams. The change in incentives needed will not take place.

Economies of operation of larger treatment plants can provide some incentives for consolidation, but often not enough to overcome the mis-match in needs and point of view of the many local jurisdictions involved. Other inducements must be provided to overcome these, including the development of regional institutional arrangements that can achieve regionalization, yet provide the local jurisdictions with some of the control and side conditions they seek.

But the water quality problem doesn't end with collection systems and treatment plants. The state of the art has barely begun to relate the quality of water to all of the causes of degradation. Urban storm run-off, agricultural run-off, the nutrients and pesticides which accompany both, and sediment from many sources, are but a few of the other problem areas. These suggest the need for a basin-wide and problem-wide management point of view, but even more to the point, they suggest the need for a balanced possibility or practicability of implementation of the means to correct pollution. Several aspects of this will be very difficult to solve. For example, variable levels of treatment among polluters, which may be efficient, are difficult to match with equitable shares of the cost burden. Other aspects should be easier. For example, the design, construction, and operation of in-stream reaeration devices show promise for some situations, but who is to be responsible for their implementation if included in a basin plan? If the Federal Government can provide low flow augmentation for water quality improvement, it should be equally able to provide for instream reaeration devices or any other appropriate solution.

Responsibility for achieving the integration of different functional interests, such as water quality with water supply, is related to the need for balanced practicability or possibility of implementation of the means to correct pollution. Both would seem to support the view that the Federal interest is to create the incentives needed for optimum and effective solution of a water quality problem.

Much of the academic literature on these subjects concludes with the vision of the utopian basin authority which promises to solve everything, but since it can't be implemented really solves nothing. The built-in resistance on the part of local, state and Federal governments to share automony with any basin agency is clear. Less than utopian means must be sought to achieve regional institutional arrangements. If Federal planning, investment and regulatory powers were directed toward encouraging fiscally viable waste collection and treatment systems for whole metropolitan areas, a substantial part of the problem could be overcome. The full potential of these regional systems would not be realized, however, unless they were made responsive to the interrelationships with the river basins in which they found themselves.

An equally important prescription for the Federal role is flexibility to match the diversity of conditions across the nation. In some states a very effective system of control and investment stimulation is developing. In some regions there has been a much higher level of past investment in collection and treatment capacity. Some areas have unique natural values of national significance that call for higher levels of protection. Some regions face unusual construction cost problems. In others, the willingness and ability to respond to such problems differs. And all of these distinctions are changing and at different rates.

Our national approach to water resources planning needs to be modified to meet the challenges of water quality more effectively. This can be viewed as particularly critical at two levels--the comprehensive, regional and basin planning level and the feasibility or "hardware" planning level.

Comprehensive planning which by its very nature is multi-agency and multi-government in nature, must be made to produce a better basis for repeatedly answering the question "what next?" An immediate need is to provide an objective basis for decisions in the allocation of grant funds for municipal treatment facilities. Competition for these funds is increasing and effectiveness, not simply

readiness to proceed, should loom larger in the criteria. Comprehensive planning must be made more useful in identifying where better alternatives to meet water quality objectives should be cast up for decision, i.e., where hardware planning should go next.

The hardware level of planning is where commitments are sought, support is developed and action can follow. Feasibility is evaluated. Cost-sharing can be developed to produce not only equity but a commitment to carry out activities that would not otherwise come about. Interrelationships can be identified and exploited. Joint costs can be spread by multiple-purpose features. The goals for this level of planning must include industrial waste management, urban regionalization and basin related management. It is through this kind of planning that the actual building of regional institutions will be realized.

We have identified two concepts that hardware planning in particular should include. First, there must be established new client-planner relationships. Obviously if the initiative for implementation is left to the smallest service areas, the plans and proposals that result will largely reflect only the local motivations of those decision units. New relationships that reflect broader interests are vital to achieving effectiveness. State and federal levels of government, and state or quasi-state and federal agencies, are the most promising. Secondly, a second generation concept must be applied to existing investments and other actions to achieve water quality changes. Planning cannot overlook what has gone on before. It must seek to develop systems that build upon existing plant and equipment, and to build new institutional arrangements out of old.

It is important to provide federal backstopping for local and state efforts in such a way as to insure that such support does not lead to unreasonable reliance on federal action. The evidence tends to support the opposite conclusion. Some have concluded that even under existing programs local governments have held back too much waiting for federal funds. However, with improved enforcement programs now generating, including the much expanded role of the Corps of Engineers under the 1899 Refuse Act authority, greater emphasis and assistance in achieving regional solutions and commitments to their implementation, and a range of federal options designed to fit a wide diversity of local

situations, the basis for local delay could be reduced materially from present levels rather than increased. The pending development of evaluation and budgeting procedures that cut across functional and program areas should further improve control and minimize any such problems.

New Roles for the Corps of Engineers.

The Corps of Engineers has been active in the water quality field, especially in recent years. It is equipped, and uniquely so, to carry out a much wider role--indeed to provide the balance required in the federal approach to water quality management.

Currently the Corps has revised its permit procedures for discharges into the navigable waters of the nation--both inter and intra-state--to insure their effectiveness in controlling pollution. This promises to be of particular importance in stimulating the reduction of waste discharges of industrial origin. For a number of areas--notably San Francisco Bay, the Gulf Estuaries, Galveston Bay and Chesapeake Bay--the Corps has special planning authority to consider water quality problems. Under the Northeast Water Supply Study it is necessarily relating water quality to water supply for metropolitan areas such as Boston, New York and Washington, D. C. In the planning of reservoirs it is authorized to include storage for the augmentation of low flows to improve water quality over and above what will be achieved by treatment at the pollution source.

Many of its functions and activities have water quality improvement potentials that could be exploited further. Protection of the quality of existing and future reservoirs should be explored. Dredging, debris removal, and channel improvement should be modified to produce more environmental gains; urban flooding and storm runoff should be viewed from not only its flood control aspects, but its water quality aspects as well.

The Corps of Engineers, due to its strength as a planning agency, as well as its construction and operating capabilities, should be given more responsibility in at least two areas. First, it should be looked to as having the residual responsibility to act when no one else can or will. Second, it should be held responsible for integration across functional areas such as relating water supply to quality.

Neither of these roles is done well now by anyone. They are badly needed, and the Corps has unique advantages in performing them because of its broad planning capability, nation-wide organization, and its well established procedure of proposing individual projects for Executive and Congressional approval.

With the widest set of functional activities of any water agency, the Corps is closest to the point of being able to perform that portion of a plan that all agree is needed but which no one else can take on. With its strong decentralized field staff it is able to respond to the unique character of local needs with tailormade emphasis and project mix and without setting strong precedents for like federal action over the whole nation.

In this approach of comprehensive planning for water quality, closer cooperation between the Corps and the Federal Water Quality Administration is prerequisite to achieving the needed reforms.

In the management of large and complex ventures, from planning through construction, the Corps has preeminent skills. These go far beyond those available in private firms or state governments. Its planning capability is assurance for consideration of a wide variety of alternative means and integration across purposes and objectives, out of which come proposals that balance efficiency with effective support. The best engineering talent is applied to design and construction, and Corps' projects tend to perform as expected. In-house capacity has long and successfully been augmented by private consulting engineers, architects and construction contractors, as it would be for undertaking waste treatment programs.

RECOMMENDATIONS

General.

The overall findings and conclusions of this study are that the wide-spectrum water resources mission of the Corps of Engineers be extended to incorporate consideration of water quality control and improvement in all its aspects with a view to:

a. Achieving integration and proper balance between water quality improvement and all other water resources uses.

b. Providing a needed channel for direct federal action.

c. Providing a mechanism for the achievement of regional solutions.

Specific.

It is further recommended:

a. That a range of options[1/] for action be established capable of responding to the diversity of situations existing throughout the nation.

b. That all existing and proposed Corps' projects and programs be reviewed with a view toward identifying opportunities for contributing to water quality goals.[2/]

c. That subject to budgetary approval and funding, the following specific problems be adopted for immediate and short-range action by the Corps within the existing authorities. Listed are funds required to carry present studies to the specific detail adequate for approval and initiation of waste treatment construction:

1/ See "Providing a Range of Options," pp. 72-75, Part II.

2/ See "Extending the Multiple Purpose Concept Under P. L. 91-190 and Other Authorities," pp. 57, Part II.

Project	Funds Required FY 71	FY 72	Balance to Complete	Complete in FY
San Francisco Bay 3/	-	10,000	-	1971
Codorus Creek, Pa. 4/	175,000	75,000	-	1972
Potomac River - Wash, D. C. / Metro. Area 5/	-	500,000	500,000	1973
Merrimack River, Conn. 6/	-	500,000	1,000,000	1974

d. That pending completion of recommendation in subparagraph b., the following specific problems be considered for action by the Corps subsequent to those listed in subparagraph c. above:

Susquehanna River Basin	7/
Connecticut River Basin	8/
Kanawha River Basin	9/
Cuyohoga River	10/
Willamette River Basin	11/
Rogue River	12/
Trinity River	13/

e. That existing and proposed sewage treatment plants and designs for Army and Air Force installations be coordinated with, and made available as practicable to, the Federal Water Quality Administration (FWQA) for prototype testing of new advanced treatment processes. 14/

3/ See pp. 145-147, Part III
4/ See Appendix I to Part II
5/ See pp. 116-118, Part III
6/ See pp. 129-132, Part III
7/ See pp. 120-125, Part III
8/ See pp. 127-129, Part III
9/ See pp. 132-136, Part III
10/ See pp. 136-140, Part III
11/ See pp. 141-142, Part III
12/ See pp. 143-144, Part III
13/ See pp. 144-145, Part III
14/ See p. 81, Part II

PART II
PLANNING FOR BUILDING FACILITIES AND INSTITUTIONS - THE NEXT EMPHASIS IN THE EVOLVING FEDERAL ROLE IN WATER QUALITY

INTRODUCTION

Where does the nation stand in water quality management? The basis for a shared approach to enforcement has been established. States have adopted standards subject to Federal review and local enforcement is backed up by expanding State and Federal capability. A wave of construction activity has been launched essentially matching the existing pattern of municipal jurisdictions. While industrial pollutants are clearly the largest threat and progress has been made toward their control, we still have some ambivalence about providing industrial capacity in municipal facilities. Waterborne diseases are now rare, but the recent mercury episode leaves no room for complacency. Indeed for all our efforts we seem to face more degraded aquatic environments, not less, then we had a few years ago. The number of recognized improved situations can be counted on one hand. The parallel to flood control losses is strong, and for very similar reasons--imbalance in our national approach to the problem.

Major opportunities lie ahead. One is the efficiency and improved control possible with greater municipal-industrial integration. Another is the opportunity afforded by urban regional management to balance costs of transmission with net gains from the scale of treatment to achieve greater overall servicing effectiveness. Also there is the long run need to make the watershed or river basin more effective management units to allow the interrelation of separate water quality actions to each other and to other water development decisions. Sewers and treatment plants may turn out to be the first but not the largest of our water quality needs--silt, heat, exotic chemicals, storm runoff, oil spills, habitat improvement and the like require other measures. In any case the challenge is quite as much institutional design and development as it is facility design and construction.

The Corps of Engineers is a Federal engineering organization. Its strengths lie in managing large complex construction projects and in managing large and even more complex public planning programs. Developing this capacity has meant creating large competent field organizations that understand local problems and have close ties with the regions in which they work. Also, unique arrangements for Congressional authorization, funding and review have been developed. It is our conclusion after a review of the history and present status of water quality management in the nation that this resource of expertise and institutional arrangements can and should be used to produce a more effective response to the national challenge of waste management.

Since the Corps primarily has built up an expertise in the area of water resources, and water pollution is now the largest part of the challenge in water resources, the emphasis for the Corps should be obvious. Since the Corps is expert at planning and construction it seems reasonable that it should plan and build for water quality needs, but in context with all other water needs. Unless the justification goes deeper than that it is, of course, hardly adequate.

Subsequent sections of this part of the report will go from a review of the current state of water quality and investment needs to an identification of objectives for a fully developed Federal investment and planning program pointing out the need for 1) a continuous municipal grant-in-aid program, 2) incentives beyond grants to achieve higher overall effectiveness through regional integration at both the metropolitan and basin level, and 3) solving the immediate questions of regulation and enforcement and laying the institutional and planning basis for the next generation of operating systems. In combating flood losses we are wisely adding a variety of incentives and controls in the use of the flood plains to an initial emphasis on investment. In water quality we have begun instead with an emphasis on regulation, and now is the time to balance the mix with greater emphasis on planned investments and related incentives.

HISTORICAL PERSPECTIVE AND SCENARIO FOR CHANGE

Regulation Came First, Thus Planning Has Developed to Support It.

In almost every session for the last 90 years, Congress has considered bills relating to the control of water pollution. Early emphasis was on regulation, first with refuse that might impede navigation, enacted in 1886 for New York Harbor, and expanded to cover the nation in 1899. By both interpretation and amendment, this statute, administered by the Corps of Engineers, has been expanded to consider more than navigation. To obtain a permit for a discharge, now, there must be assurances that standards for water quality will be met. Between this recent strengthening of the regulatory approach and the enactment of the original act, much has evolved in response to the growth of public support, although little use has been made of the talents of the Corps in that interval.

Some technical assistance and planning were added as early as the 1920's and 1930's in support of a regulatory approach which was seen as solely a responsibility of local government. Human health was the emphasis and the virtual irradication of waterborne diseases played a major part in the nation's transition to an industrial state. But note that now industrial processes are producing exotic byproducts with major health implications. In 1948 and 1953 research and the development of treatment technology and more direct Federal participation in local regulation were authorized. In 1956, the Congress authorized grant-in-aid to municipalities (increased to significant size in 1970). Earlier, capacity in Federal reservoirs, largely built by the Corps, was authorized for low flow augmentation to meet water quality goals above the usual achievement level of treatment at the source of the wastes. With the authorization of stream flow regulation for water quality and particularly with the Water Resource Planning Act of 1965, comprehensive planning gave more detailed attention to water quality but to date only reservoir capacity for water quality has been substantially influenced by such planning. Planning has not been used to rationalize other forms of public investment for water quality to any significant degree, and has only made a modest contribution to enforcement.

Essentially water supply management has developed one set of institutions; water quality management, another. The degree of overlap is limited and limits the extent of coordination and integration. There are challenges here that are not being met. Not the

least of these is the need to link planning and construction to achieve greater efficiency and effectiveness. How we got where we are has a lesson for us. Where we may go--greater levels of water reuse--reenforces that lesson.

A starting point can be the first major effort of the Public Health Service and the Corps of Engineers for the development of a basin-wide water quality plan which resulted in the report Ohio River Pollution Control, (House Document No. 266, 78th Congress). That report summed up the research and field experience of the Public Health Service until that time and provided the outline of the planning process that is still used today. The key planning elements included: 1) knowledge about the sources and characteristics of pollution; 2) the determination of water uses; 3) establishing of quality criteria necessary to allow water uses to be achieved; and 4) a remedial program to control pollution. But such planning was then and still is viewed primarily as an input to the regulatory process.

The 1948 Water Pollution Control Act (P. L. 80-845) provided for a continuation of planning typified by the Ohio River Report. The Act included an option which allowed the Surgeon General to "adopt" state plans as well as authorizing him to "prepare" such plans. During the 1955 Hearings to amend the Water Pollution Control Act, Senator Kerr and others raised questions about the "adoption" process. The questions implied a concern about the effect of a Federal Office "adopting" state water pollution control programs on other Federal water resource programs where direct Federal financial commitments were involved. Partly as a result of this exchange, the Amendments approved in 1956 authorized the Surgeon General to "prepare or develop" comprehensive programs. Under these new provisions and an improved appropriation base, the Public Health Service embarked upon an extensive program of basin-wide comprehensive planning. Later, these programs were linked by scheduling through the Water Resources Council the appropriations to the national multi-purpose comprehensive water and related land resources planning program authorized by President Kennedy soon after he assumed office.

The Water Quality Act of 1965 added several new components to the "comprehensive planning" program. First, it provided a guide to the formulation of such programs by stating that national policy was aimed at "enhancing the quality and value of the Nation's waters." Second, it formalized the planning process by requiring states to participate under the penalty that if they did not act, the Federal Government

would establish a program. Third, it provided, for a return to the idea of the Surgeon General "preparing or adopting" comprehensive programs since the Secretary's approval of a State program is, in effect, a formalized form of adoption. (Under the "adoption" idea contained in the 1948 Act, the Surgeon General "adopted" only those programs of which he approved under written guidelines provided in the Water Pollution Control Programs manual of operations.)

Standard Setting and Enforcement Have Not Been Related to Investment.

What was apparent at the time of enactment of the Water Quality Act of 1965, and what should be clear to everybody today, is that the use of the word "standard" in water quality standards was a misuse of the term. What was, in fact, called for was a comprehensive water quality plan. The "standards" which have been approved by the Secretary include the elements of the planning process that we have traced back to the Ohio River Report. The "standards" include identification of sources of pollution; the water uses that are to be protected; the "criteria" or numbers indicating the characteristics of the quality of the body of water (lakes, rivers, estuaries, coastal waters) after receiving the managed discharges of cities, industries and other pollution sources; a program of remedial works; and a time schedule for accomplishing the needed works. Thus, while we have used many words, and taken nearly three decades, our achievements have not been substantial from a planning technology point of view. The substantial achievement has been to institutionalize one planning process, giving both the States and the Federal Government roles to play in accomplishing this planning task, and linking this planning process to the enforcement program.

In the interim, the Federal Government has spent somewhere in the neighborhood of $80 million for comprehensive planning since 1957. With an investment of this kind it ought to follow that plans useful in the guidance of public investment for substantial areas of the country should be available. Unfortunately, this is not the case.

According to the public statements of responsible officials, enforcement and grants for planning and construction have not been related in a program coordination sense. A review of the water quality

plans shows that they provide only a listing of the facilities for each existing jurisdiction that would meet the ultimate standard. There is neither a sense of the relative timing of the investments that would be desirable nor the relative costs and returns from alternative configurations of investment, control or standards of water quality. There is no thorough examination of the institutional arrangements to facilitate particular objectives. Usually there is no explicit consideration of action measures other than domestic and industrial waste collection and treatment and low flow augmentation. Now some regionalization of waste treatment has been studied under special grants and as a part of urban planning programs but these have had no noticeable effect on the water oriented planning much less the investment programs that, unlike Federal water quality grants, do follow from them. Certainly little of the multiple-use approach to the search for agreement and compliance to plans has been related to achieving water quality objectives.

Why is this the case? The reason lies partly with the policy guidance and coordination provided in this field, partly with the state of our understanding and partly with the concepts underlying this particular part of the planning process. The planners have provided that was expected of them.

The idea of formulating comprehensive plans has been included in water pollution control legislation since its initial modern formulation in the mid-1930's. At that time it was clearly in the minds of persons like Dr. Abel Wolman that comprehensive water pollution control plans would result in projects; that these projects should be tied together with other public works efforts relating to water resources; that a coordinated program would be placed before Congress with an annual budget; and that priorities would be established in order to take care of the most important pollution control needs.

Somewhere along the line we have either forgotten these early ideas or have preferred to move away from them. Our own estimate is that we have both forgotten and have found "highway type allocations" more useful politically. For example, during the first eight years of the Water Pollution Control Act (1948-56) comprehensive planning was an important activity of the program. Yet Congress provided no funds to carry out the plans. From 1957 to 1965 Congress provided money to aid cities but new or updated comprehensive plans were not developed in any effective degree to guide the expenditure of these funds; and even if they had been developed the

Congress had made no provision for their use. By way of further example, Congress had neither established, nor requested the Public Health Service to establish, a procedure for transmitting Comprehensive Plans for their information, review or use; the Act provided no procedure for Congress to grant its approval to a plan. The only provision of the Act that related comprehensive planning to the Federal financing of municipal waste treatment works was the provision that projects be included in a comprehensive plan developed under the Act. In actual operation, the guide to the use of Federal funds merely has been the "need for a project" as determined by the State agency. In addition, the priority for project approval has been that provided by each state based on its own set of projects (with little or no relationship to other projects on interstate waters). Local initiative usually must be relied upon to make a project available at all and most frequently the priority has been established on the basis of the "willingness or ability" of a city to proceed with the financing and construction of a waste treatment plant.

In its report "The Economics of Clean Water" dated March 1970 the FWQA presents an analysis of regionalization, priority setting and planning that although developed independently, parallels many of our findings. It is their perceptive evaluation of the organizational problem that we would like to cite here. Obviously if we could plan with the assumption that Federal and local funding was assured, the niceties of effectiveness might be ignored. With budget constraints there is pressure to only put Federal grants where the most abatement can be gotten for the dollar. But a very similar restriction on funds causes local government to resist expenses whose benefits seem so much to fall elsewhere. Thus the applicants are said to be only those who could not resist the persuasion of the state enforcement officers, not necessarily those whose action might be most cost-effective. But with the recent increase in interest in the environment this lack of competition for Federal grants is not likely to persist. And in any case it would seem useful in both the "persuasion" process and in the budget allocation process to have some knowledge of the relative opportunities. Indeed it seems quite likely that the bargaining process that goes on in multiple-purpose comprehensive river basin planning in order to achieve coalitions to support the final plan might be put to real advantage in the water quality "persuasion" process. We shall examine later the possibility of providing a link between enforcement and construction, now separated, through a restructured planning process.

Plans to Guide Investment Needed and Should Lead to Institution Building.

It is our view that the planning program implicit in the development of "Water Quality Standards" under the Water Quality Act of 1965 and the general goals expressed in the Clean Waters Restoration Act of 1966 provides an opportunity for a hard reappraisal of the comprehensive planning process as it applies to water quality.

We suggest that the comprehensive planning concept, typified by the Ohio River Report approach of the 1940's and carried forward in recent Susquehanna River, Lake Erie, Lake Ontario and Snake River and other planning documents could be extended by:

a) Selecting a number of demonstration areas comprising an entire river basin, manageable sub-basins, or an appropriate problem region and that offer a variety of problem situations.

b) Develop an engineering plan for the regional management of water pollution control using all available technology, and based on modern and innovative financing procedures. (An engineering plan is defined as a "hardware and related processes" control plan including regional and related treatment works, waste water transmission facilities, flow regional works, and other processes practical or amenable to a regional design scheme.)

c) Using the "hardware" plan for water quality and a general multiple-purpose approach as a basis for negotiating and establishing an appropriate regional management institution to finance, construct, operate and maintain the project and to plan for future needs.

It should be noted that this suggested approach has been discussed for some years and has most recently found expression in the first annual report of the Environmental Quality Council. Bases for this suggestion rest on the notion that it is highly difficult to achieve regional arrangements for regional management schemes because of the extensive cooperation that is required of many agencies of local government. Additional difficulties are posed by the absence of a client-planner relationship to initiate and outline a planning program that can handle an entire basin or a substantial part of one.

The client-planner relationship is fundamental to the character of the output from the planning process. The objectives and capabilities of the client to act condition the kind of response the planner or engineer can and will provide in the form of technical solutions. And political "designing" is even more constrained. As long as the primary initiative to act as client for water quality remains with the smallest service district it is doubtful that effective solutions can result. Too little of the benefit is internal to the decision system. Obviously the trend is away from this toward a role shared in a variety of ways with larger units of government. The image of the state or Federal government taking action when there is obvious failure on the part of local government--the vacuum idea--is helpful here but not enough. One should also remember that one function of a higher level of government is to provide a mixture of incentives to encourage action that local governments would not take on their own.

We believe that improved client-planner relationship can be provided in a number of ways. State government can become an effective client by contracting for regional plans for an appropriate part of the state. New York State, under its Pure Waters Authority Program, could act as a client to support engineering works studies. Maryland has a similar arrangement. The State of Ohio has already acted as a contractor for a multi-basin area works program including pollution control in Northwestern Ohio using consulting engineers. On interstate waters, two or more states could act as a client to initiate a planning and engineering study for quality control purposes on a broad basin area, but such arrangements would be difficult to achieve.

We would suggest, as an additional procedure, that the Federal Government use its authority to act as a client and authorize an appropriate Federal agency adequately skilled, or made skilled, in engineering works, namely the Corps of Engineers, to outline "hardware" type projects for selected demonstration areas. There is precedent for such action in the flood control, navigation, irrigation and other Federal water programs and, specifically, in the recently authorized Northeast Water Supply Study by the Corps of Engineers. Indeed the plans found in some Corps survey reports on Type III studies under the Water Resources Council system is the level of detail we envision when we refer to a "hardware plan." It is adequate for inter-governmental commitments.

The Corps of Engineers under the Northeast Water Supply Study is authorized to consider reservoirs, pipelines and water purification facilities to meet growing water supply development needs of the region. We suggest that an appropriate arrangement of this nature applied to pollution control would stimulate the development of basin-wide arrangements along the lines Congress intended to move in the proposals that led to the 1966 water pollution control amendments but that were unclear in the Clean Waters Restoration Act as passed. If a demonstration program of this nature were initiated, detailed conversations could be initiated with states, localities, industries and others as to organization and administration, Federal cost-sharing, and for operation, maintenance and future updating of the regional program.

CURRENT STATE OF WATER QUALITY MANAGEMENT CALLS FOR INTEGRATION IN SEVERAL DIRECTIONS

No one today would disagree that most of the aquatic environments of our nation are degraded but some might argue about how much of it is worth preventing. Fish kills from pollution are reported across the nation, some 15 million in 1968. Rivers in the arid West carry more and more salts. Lakes in the humid East become greener and soupier as they are enriched with nutrients from many sources. When extended droughts occur--as one recently did in the Northeast--we are reminded again that polluted water close to home has driven our supply systems to stretch further and further to meet our growing demands. This last phenomenon is being precisely delineated in the NEWS Study.

In the 1970 FWQA report, "Economics of Clean Water," almost 70 percent of the nation's population, less than the total urban population, is listed as sewered as of 1968. Of those sewered, 92 percent had their wastes at least pass nominally through a waste treatment plant, and 60 percent through a plant whose design <u>when built</u> was rated as at least secondary treatment. On the unlikely assumption that these plants are operated and loaded as designed, this would mean that at least some four out of every ten Americans had at least 75 to 85 percent of the solids and short-term oxygen demand removed from his domestic wastes.

While only about 8 percent of the sewered population of 131 million discharges its wastes directly to our waterways without benefit of any treatment, most of these "straight pipes" are in the Northeast. This may partly explain the greater interest in this region in securing municipal water supplies from carefully controlled mountain watersheds.

Municipal and Industrial Waste Treatment Facility Integration Can Have a Large Payoff Now.

Although raw or only partly treated sewage flows into our streams from millions of people, industrial wastes are now about three times the volume of domestic wastes in terms of oxygen demand. And they are growing at about three times the rate of population increase. Yet it will require a lower level of investment to catch up, partly because industrial wastes are more concentrated geographically and chemically and thus cheaper to treat. For 85 percent removal of oxygen demand and solids from existing and immediate industrial discharges, an investment of from $2.6 to $4.6 billion is said to be required. Comparable treatment of all domestic wastes according to FWQA will require an investment of some $8.5 to $120 billion. 1/

1/ This is based upon a standard of secondary treatment which implies a biological breakdown process, disinfecting and aeration as well as substantial settling out of solids. However it is becoming increasingly clear that this is a crude standard at best. In a few cases a lower level of treatment would not increase the degradation of the receiving environment. In many cases such treatment does not sufficiently reduce the flow of nitrogen, phosphorous and other chemicals in forms available to plant life. And it is this plant nutrient aspect of human and industrial wastes that sometimes has greater long-run impact than the effect of oxygen depletion. But the point is that nutrient reduction will add substantially to the costs now experienced in achieving only solids removal and oxygen control.

Obviously estimates of this kind are most difficult. Costs differ greatly and change at different rates around the nation. Both perceptions of need and conditions change in addition to a rising standard of expectation. FWQA models estimate $8.5 to $12.0 billion, and state intentions are reported at $10.2 billion, and further a National League of Cities survey gave estimates of $8.7 billion for primary

The 1969 dollar value of municipal works which primarily treat domestic wastes in place is estimated by FWQA at some $12.4 billion. This is less than the sum of past investment due to the effect of wear and tear. Between 1952 and 1968 municipal waste handling system investments have totaled over $14.7 billion. Over the same period industrial treatment plant investment has totaled about $4.2 billion. No estimate of present dollar value is available. The average dollar invested today in industrial waste treatment removed substantially more waste from the aquatic environment than the average dollar invested in municipal works. In very crude terms we apparently face an overall investment, combining plant in place and needed, of $21 to $27 billion to treat about 25 percent of the domestic-industrial portion of the overall pollution problem, and some $7 to $9 billion to treat the remaining 75 percent of the domestic-industrial portion of the problem. This suggests that on the average the efficiency of the dollar is some nine times greater invested in industrial treatment since the volume of industrial waste is three times larger than domestic.

The uncertainties of industrial waste management cast doubt on the effectiveness of municipal investments if there is not substantially more integration with municipal systems. With three times the waste load, three times the growth rate of domestic sources and some nine times the investment effectiveness, integration of municipal and industrial investment programs is an obvious and attractive opportunity. Based upon two approaches to estimation

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1/ (cont'd)
and secondary treatment, $3.9 billion for tertiary treatment plus $7.3 billion for interceptor and storm sewer improvement, all for a city population of 89.4 million. Adjusting for the 50 to 60 million people not included they estimated a total need of $30 to $33 billion today (July 1970). It is likely that if industrial plant managers were asked to estimate their needs as the basis for Federal cost-sharing similar differences from official estimates would be reported. The only thing you can be sure about is that history will probably prove all of these estimates to be wrong. For the analysis made here only the relative proportions need to be firm.

(industry profiles and design data or census projection) the backlog for industrial treatment is put at $1.1 to $2.6 billion. To include growth ($0.7 to $1.0 billion) and replacement of existing plant ($0.8 to $1.0 billion) the 1969 to 1973 needs are put at $2.6 to $4.6 billion. A solid estimate of the potential extent of integration with municipal systems has not been found by this review. More and more industrial capacity is being built into municipal systems. More and more of this capacity is being aided by Federal grants. GAO has written a review of this integration suggesting that Congress make an explicit policy determination. We have been backing into what seems to be a very efficient policy.

In 1968, the available FWQA data suggests that the volume of industrial wastes handled by municipal treatment plants may have been about equal to the volume of domestic wastes. Some 1235 plants had double the loading that would be expected from just the population they served. Indeed 40 percent of the nation's 11,000 municipal plants treated more wastes than simply their service population would have produced. And the trend to scaling plants with such "extra" capacity is accelerating. In 1962 the median capacity was between 1.2 to 1.4 times that required by population. This is not an unreasonable level even without industrial connections in view of the need for capacity to handle peak loads, infiltration, combined sewers and the like. But by 1968 the median size had shifted to between 1.4 to 1.6 times the population requirement. One plant in 13 was scaled to handle four times or more of the domestic loading.

Overall unit costs are reduced, on the average, by including industrial treatment capacity in domestic systems. Unforeseen changes in the composition of wastes in a municipal system can raise operation and maintenance costs and can produce more operating problems. Such opposition to joint systems as remain may be the result of this fact. But the fact remains that in many instances a municipal system can treat an industry's wastes more cheaply than it can do it by itself. The wastes from industry are more concentrated both in composition and geographically and often actually help in the process of treating domestic wastes because they often contain heat and biologically complementary constituents for the removal of nutrients. And larger systems enjoy substantial economies of scale, not the least of which result from the ability to employ more skilled operators. Lack of skills in operator personnel is probably the major reason for many plants operating far below their designed effectiveness. GAO in another study of waste management effectiveness is reviewing operation and maintenance. This can be expected

to detail the operating effectiveness gaps and causes such as operator skill levels.

Lack of Planning Has Allowed Industrial Wastes to Overwhelm Effect of Federal Grants.

A recent review of the Federal Water Quality Administration by the General Accounting Office has called for the use of an effectiveness analysis on a river basin basis as an underpinning attention to the potential gains from public investments in water pollution control. They noted that in the past "...the benefits obtained from construction of the projects have not been as great as they could have been, because many waste treatment facilities have been constructed on waterways, where major polluters located nearby--industrial or municipal--continued to discharge untreated or inadequately treated wastes into the waterways."

While decrying a "first come-readiness to proceed" criterion for grants, the GAO did not really answer Interior's response of "however obvious the situation, the way to implementation of the most cost effective investments first has not been so obvious." GAO urges that we should at least try adding effectiveness to other criterion.

GAO based its analysis in part on a review of a number of field situations, eight of which were summarized in the report. In one case an upstream city had the bulk of the industry on the stream, and industrial wastes accounted for 80 percent of the BOD being discharged into the river. Treatment was planned for completion some years away and some doubt seemed to exist that they would be able to meet this schedule unless substantial Federal funding occurred. Two downstream cities had received grants, installed plants and incurred operating costs for some years with no hope of enjoying a healthy stream until the upstream city and industries took action.

In another case a regional plan had been prepared some years ago and showed that a regional solution was necessary to avoid nuisance conditions. Individual plants could

not provide adequate protection and would be investments that if made would need to be replaced. Inability to organize and finance a regional system resulted in expanded and new individual plants (29 in all). A new regional plan has confirmed the prediction of the first plan (at least 3 recently built plants should be abandoned), as has the grossly polluted stream that receives the wastes of the region.

Another case involved two communities that with grants constructed facilities to treat the major part of their wastes. Yet two industrial firms discharge, untreated, over forty times the waste removed by the municipal plants.

Elsewhere two industrial plants discharged one hundred times the waste taken out by four municipal plants. In both of these cases corrective action is planned, although the conditions have persisted for some years.

Again, substantial grants stimulated five communities in a basin to treat their wastes while a sixth did not, and some 80 industrial establishments with state discharge permits more than tripled their untreated discharges. The waste removed by the five communities is less than one-third that being discharged by the sixth and one-thirtieth of that discharged by the 80 firms.

In another case early grants helped reduce BOD by a tenth--with most of the untreated waste being discharged by one industrial firm. It is now proposed in new grant requests that new municipal facilities include the industrial wastes but this will mean abandoning one of the plants built earlier.

In another case study slightly less than half of the BOD being discharged into a grossly polluted stream by two municipalities was cut by almost nine-tenths with grant aided facilities. But of 37 industrial discharges identified in a 1965 enforcement conference,

six had taken effective action, eight had begun construction, 22 had not, and one was not accounted for.

A final case study involved two industrial plants that had some 400 times the waste discharge of a downstream municipality which was given a grant. One of the industrial plants was put in after the grant but the first was enough to swamp the stream. While some abatement measures had been attempted and even 90 percent removal would not be enough to restore the stream, it appears that no further abatement is contemplated.

It is worth noting that in the only case where a systematic regional plan was available it was not implemented and there was no attempt to follow it in the allocation of grants. Also in almost every case the expansion in industrial waste discharges greatly exceeded the removal by municipal plants. Where abatement looked most hopeful it was where municipal facilities were being provided to treat industrial wastes. GAO's conclusion: "the construction of municipal waste treatment facilities appears to have been administered without sufficient regard to what was being planned or done by other municipalities and industries."

Public Reaction, Enforcement of Water Quality Standards and Permit Authorities May Solve Part of the Industrial Waste Problem.

Recently the question was raised why sections 10 and 13 of the Rivers and Harbors Act of 1899 (the Refuse Act) had not been more extensively involved. That Act prohibits the discharge of matter of any kind, whether from ship or from shore, into both the inter and intra-state navigable waters of the United States, unless flowing from streets or sewers in a liquid state, and also regulates the construction of works that would discharge even liquid wastes. The candid reply was that until now there

had not been the public support for such enforcement. The result is a complete overhaul of the regulations and procedures, even the form for such permits. See the material inserted into the Congressional Record by Mr. Reuss, June 17, 1970, pp. H5731 to H5736.

In recent testimony before the Senate Commerce Committee on July 29, 1970, Robert E. Jordan, III, Special Assistant to the Secretary of the Army for Civil Functions, pointed out that the Army has clear jurisdiction for discharges that affect navigation, or are isolated or occasional, and impact on the environment or involve a navigable but intrastate waterway. In each case FWQA is limited in its jurisdiction. He went on to point out, "The type of case which presents the greatest difficulty for the Army, both because it involves overlapping jurisdiction with the FWQA and because its detection and investigation involve expertise which is not readily available within the Department of the Army and the Corps of Engineers, involves interstate discharges or deposits of a frequent or continuous nature resulting from the ordinary operations of an industrial or other permanent facility. Discharges of this type, although violative of the Refuse Act, may not be inconsistent with FWQA approved pollution abatement proceedings, or may, in the judgment of the FWQA, present a case that should be subjected to the remedies afforded under the Federal Water Pollution Control Act.

An interagency memorandum of understanding is being developed to identify cases in which the Refuse Act can best supplement FWQA. One preliminary estimate is that adequate enforcement of the Refuse Act will require some 400 new personnel in addition to assistance from FWQA. But note that under this Act and the Environmental Policy Act of 1969 applicants for permits are now required to identify the character of the effluent, and to furnish data on chemical content, water temperature differentials, toxins, sewage amount and frequency of discharge and

type and quantity of solids. Permits will be reviewed every three years and polluters will need to admit their failure to meet standards or be open to charges of false reporting. Now only will this procedure allow clearer identification of discharges that jeopardize the standards for receiving waters, but it will provide for the first time a reasonable beginning on a national industrial wastes inventory.

It should be clear that this newly energized permit system has the capability of strongly complementing the enforcement role of FWQA and the states. Indeed it would seem that carefully developed cooperation between the two Federal agencies could lead to a substantial enhancement of the environment, greater realization of the economies of municipal-industrial waste treatment integration, and the like, through this program alone.

Economies of Scale and Urban Regionalization May be Achieved Through a Multiple-Purpose Construction Planning Approach.

The gains from industrial-municipal integration are but one aspect of the potential in capturing the economies of scale in waste treatment. A second is the trend toward metropolitan regional systems. Chicago is an acknowledged pioneer. Others include Washington, Seattle, Los Angeles County, St. Louis, Pittsburgh, Cincinnati and recently, Detroit. In each case there is a twin problem--the development of a lower cost treatment and receiving system, but also the development of an administrative arrangement to bring the many municipal governments together. It is probably the administrative problem that is the more difficult of the two. Balanced against the gains from lower cost were effective treatment in the distribution of those gains in the form of cost-sharing, control over the decision as to timing and level of service. Municipal governments sometimes seem quite willing to forego the advantages of metropolitan systems if they perceive a loss of control over land use changes, revenue, tax levels, etc.

But as FWQA points out in its 1969 Cost of Clean Waters report, "The concept has many advantages. It eliminates overlapping

jurisdiction, centralizes operational responsibilities, allows orderly and programmed system development, provides a higher measure of control over effluent quality, offers more advantageous access to financial markets, and eliminates many of the problems of staffing and operator training encountered in smaller treatment systems."

Some large municipalities have excess capacity available to serve nearby areas. In 109 municipalities over 100,000 population, for which there were data, FWQA estimates that one-third have installed plant capacity of over 1.6 times average loadings. But about one-third have capacity equal to present loadings or less. The result has been that there is a trend on the part of suburban communities to invest in interceptor sewers to connect with nearby central plants rather than build or add to their own plants. But where a small municipality would have to abandon an investment in a plant to enter a larger system there is less enthusiasm for the change. While it is probably a fairly common situation, the extent of such abandonment that would be involved in consolidation has not been estimated. Indeed it appears that there has never been a systematic nationwide survey of the potentialities for system consolidation. However as of July 1, 1969, FWQA had made ten grants totaling $1,122,000 for basin or partial basin plans to regional planning agencies that presumably would produce evaluations of such opportunities.

FWQA is currently conducting a review of the coverage of metropolitan regions by either multi-municipal, river basin or other regional operating authorities. This would include presumably comprehensive state management programs that can serve the same function such as those being developed in Ohio, Maryland, New Jersey and New York. State officials, among others, have identified such comprehensive management units as essential not only to capture the economies of scale but also to obtain agreements from municipalities to construct needed facilities. It was ranked second only to lack of funds in a recent GAO survey. Surely lack of funds is not independent of other considerations. Indeed it is not unlikely that a major source of pressure for regional consolidation will come from the financial community. Well-managed, large regional agencies with recourse to the property tax as well as user charges are more attractive risks than small over-extended municipalities.

The distinction between regional integration and basin coordination should be kept in mind. Economies of scale in treatment plants are offset by the diseconomies of interceptor sewer costs as the potential users of a system become more scattered and the geographic density of waste production goes down. Much of the benefits of regionalization may still be available from coordinated central management of multi-unit systems. As the GAO review and the studies of many others, including the recent FWQA report, "Economics of Clean Waters," so dramatically indicate, the efficacy of a basin approach is clear. The record shows that distribution of investment which is based too much upon a nearly arbitrary level of treatment and a willingness to proceed, that may be worse than randomly distributed, can leave the job undone.

Neither the metropolitan region nor the river basin are natural political units. It is the exception not the rule to find political boundaries, representation and organizations even vaguely following the hydrologic unit. And urban regions have a way of sprawling out across many old political jurisdictions and creating many new ones. The result is a natural resistance to the creation of new governmental jurisdictions, even though functionally limited, that take political power away from the "natural" political units. The metropolitan unit is more firmly established for waste treatment than the river basin unit. Indeed while at least one river basin agency--the Delaware River Basin Commission--has the power to build and construct treatment works, none have been constructed by them.

The role for the river basin unit seems to be restricted to planning and control. However, effective control or regulatory organizations on a basin unit are not common. Clearly state and Federal agencies have the momentum and initiative. While they may collect data and do analysis on a basin basis, they have not been aggressive in helping basin agencies with whom to share their power and responsibilities, however reasonable this may seem to students of the problem.

The history of the Federal role in pollution control is instructive on these points. S. William Hines puts it as "the dilemma of Federal power." First is the oft repeated policy that pollution control is primarily a state and local responsibility. And second

is the response to a clear need for a "national policy for the prevention, control, and abatement of water pollution." More than a "vestigial respect for the concept of federalism," he sees this as an expression of a "judgment that, on balance, some form of local control appears the most efficient means of dealing with the problem. Over time, as the pollution problem has steadily worsened, the wisdom of this judgment increasingly has been called in question." As Congress has moved the Federal role towards greater and greater involvement, the pattern has been for a proposal to be turned down at least several times before its need is seen so clearly that it is finally adopted. In the "Clean Rivers Restoration Act" proposed by President Johnson in February 1966, and based upon a report of the Environmental Pollution Panel of the President's Science Advisory Committee, river basin pollution control agencies were a major element. While grants were to be keyed to the plans of those agencies, they were not envisioned as operating and construction agencies. And note that recent grant formulas provide a bonus for compliance with a metropolitan plan not a river basin plan. No such agency was authorized nor has it been since, although proposals are pending in the Congress. FWQA has striven to make the state standards compatible on an interstate basin basis and has sought similar consistency through its enforcement conferences. But these programs remain to be integrated with investment decisions.

While this history has had a focus on regulation not construction and operation, it seems that initiatives to establish separate operating agencies on a basin basis face greater resistance than integration of standards and enforcement as a nationwide policy. Operating agencies on a metropolitan basis, on the other hand, may find less resistance. This does not mean that in a particular case, perhaps where establishment of a metropolitan agency has been blocked, that a basin agency could not be created. While organized on basin lines, it would still have to construct and operate facilities in response to the realities of the interaction between interceptor costs and economies of treatment plant scale.

We have noted that the basin and comprehensive planning process for water quality, unlike that for other investment activities, has not produced plans which form the basis for the commitment of local and Federal funds. We suggest that a shift in the client-engineer relationship is in order. We have noted the gains to be had from industrial municipal integration and have hinted that the Corps permit

authority may be useful here. Obviously planning that took this into account would also help. Next, integration by municipal region has a major potential but would be resisted at this time if tied too closely to a river basin unit of administration, but comprehensive water quality planning has almost always had a basin orientation. Also it should be noted that the multiple-purpose concept of basin planning has been most useful in both increasing the effectiveness of investments and in forging coalitions in support of projects. It would seem that one modification in the water resources planning process worthy of experimentation would be the development of multiple-purpose plans that draw upon the work of a basin planning effort but focus on the needs of an urban region and specifically relate the development of a water quality plan to the variety of other water related but urban investments that are needed. At very least plans should be developed for the urban region that identify the gains to be had from a regional system over and above what would exist without regionalization.

The Facility Backlog.

Much has been made recently of the gap between Federal authorization and Federal appropriation.[1/] This assumes, implicitly, that the amounts authorized for existing programs have some necessary

1/ Actually this funding gap is relatively recent. From 1957 to 1967 inclusive $900 million was authorized and the accumulative gap in appropriations was some $45 million. For 1968 and 1969, $1.15 billion was authorized and $417 million appropriated. In 1970, $214 million was requested against $1 billion authorized and Congress appropriated $800 million. The gap will then amount of almost $1 billion or one-third of the authorization. But to what extent has this been the result of the pressure of other programs and inflation? To what extent has it been uncertainty over the need, or uncertainty with regard to the effectiveness of the investments that would be made?

relationship to the magnitude of the solution. Indeed it seems to be assumed also that after some finite backlog of municipal needs has been gotten out of the way, Federal support can be withdrawn and we can relax back into the myth that waste management and pollution are by nature local problems. Considering the record of past performance, our rising expectations and the rate of growth in waste production, the extent of inter-state problems and the obvious disjuncture between upstream and downstream interests, it is hard to see that this myth can be allowed to persist. Furthermore, while the tangible benefits of clean streams may fall heavily to the nearby downstream residents, the interest is more and more pervasively national in character. Certainly recreational uses--which are directly involved--both attract people from a wider area and also have a tradition of national and federal concern. But to the extent that we are motivated by ethical considerations to maintain the quality of aquatic environments it would seem that these benefits are national in character much like defense, safety, health, education, or welfare. Thus, the backlog concept itself, while useful, is so incomplete in justifying a federal role. Investment needs to meet growing population and economic output, investment needs to replace and upgrade old plant and equipment are too great to leave to local resources. The needs won't be met for the same reasons they aren't met now, i.e., the result of costs met by a local government when the benefits are reaped downstream.

Effect of Federal Grant Money Is Not Clear.

And how much leverage do existing Federal grant programs have in stimulating the investment required? Repeatedly state officials explain that the shortfall in municipal investments is due to the low level of funding by the Federal government. Local investments, it is alleged, are geared to the availability of the Federal share. Why should the

local people invest 100 percent of the cost now when if they wait they can avoid around half of the investment cost, or at least so goes the argument?

Up to June 30, 1969, Federal grants from all sources totaled $1.345 billion in 9,445 projects whose total cost was $5.352 billion, but total investment in all waste treatment facilities approached $22 billion. It is difficult to see whether there was much affect one way or the other. Cost-sharing rates reenforce this impression. Under FWQA funding since 1957 a 30 percent grant has been available for municipal treatment works, interceptor sewers (a somewhat flexible concept) and outfall sewers but not collector sewers and connections to individual properties nor independent, industrial treatment. Around half of the municipal-industrial waste handling investment is not directly eligible for Federal cost-sharing. But since 1968 if a state agrees to meet 30 percent of the eligible cost, the Federal share from the FWQA program may be increased to 40 percent, to 50 percent if the state pays at least one-fourth of the cost of all federally aided projects in that state, and a 10 percent bonus was awarded if the project conformed to a metropolitan area plan. Recently this bonus was withdrawn in favor of requiring all proposals to meet requirements of metropolitan and basin plans, such as they are. Prior to June 30, 1967, limits were placed on individual projects that favored the smaller cities. Grants from Agriculture, HUD and Commerce have accounted for only some $73 million but have allowed the Federal share to be quite high on individual projects.

Other rigidities in the programs have mitigated against cost-effective performance. In 1968, after the limits on size were removed in the FWQA program, seven states did not fully utilize their formula allocation of funds and these were released to other states. This indicates either an overstatement of needs in the original allocation formula contained in the program or a lack of interest in solving the problem. Most of these states rank fairly high in the proportion of sewered population with secondary treatment and fairly

low in sewered population with no treatment. This suggests needs were overstated relative to interest.

On the other hand seven states have "prefinanced" almost $300 million of the Federal share, with one state (New York) accounting for half of this and most of the rest in two others. Again one might expect that the needs were either understated in the allocation formula or there was particularly intense interest. These states tended to have higher than average incidence of untreated sewered population and relatively lower incidence of secondary treatment.

In mid-1969 there was a backlog of 4,648 applications for construction grants. In the entire period 1957 through June 1969, 9400 projects were funded.

The evidence is mixed. While it is clear that many local facilities were built without Federal grants, it is also clear that there is a high probability that many more would have been put in, at least sooner than otherwise, if Federal participation were greater. If investments had been strictly limited to the availability of Federal funds (at an average rate of 30 percent Federal cost-sharing for half of the total expenditure) less than $10 billion would have been invested. Based on the GAO review it seems reasonable to suspect that the backlog needs are more critical and would do more to improve the quality of our aquatic environment than the investments we have already made. This suggests that we should explore other approaches to improve local performance with Federal initiatives. A new initiative in planning and a new initiative in construction oriented toward regional integration will be explored.

Examples of Cost-Effectiveness in Urban Regionalization.

When is an urban region not an urban region but a watershed? This apparently irreverent statement is made to point out that even when the focus is on the development of a waste treatment system for an urban region instead of a water quality plan for a river basin,

the drainage pattern of the region is still critical to the optimization decisions to be made. The number and location of treatment plants and outfall points is a function of the trade-offs of transmission costs (in which gravity plays an important role), the returns from the flow and quality of the receiving stream, economies of scale in treatment plus the distribution of waste production over both time and space and dilution. An informal canvas of several eminent environmental and systems engineers has produced the target that reasonable management of all of these variables on a basin-wide basis could be expected to double the effectiveness of investments that would be made by our existing pattern of independent municipal and industrial decision making units. In other words, the realistic potential is roughly to either obtain as much environmental enhancement for half the expenditure or twice the enhancement for the same investment in facilities and program. FWQA reports and others indicate that much of this gain is to be had in the integration of urban regions.

As an appendix to this report we have extracted the key portion of a feasibility study of a regional system. It was suspected that five separated but rapidly growing sewage service areas, both in a single watershed and a single county, might be effectively linked. Several restrictive characteristics should be noted. First, it was assumed that treatment levels would all be at least at the secondary level and raised to a point necessary to meet a dissolved oxygen level of 5.0 ppm (lower than existing levels) with piping to the stream where flow might also be managed. Greater flexibility here might have made an individual plant system more competitive but probably at considerable cost in stream quality with present technology. Second, an interest rate of 4.875 percent was used throughout. Had the same 8 percent faced by municipalities been used the schemes involving more transmission investments would have been favored due to their longer life. Also no attention was given to the natural complementarity in the timing of flows or what could be done in managing flows to obtain fuller utilization of investments or other possibilities for savings. Nonetheless the full regional system was found to save some $500,000 annually over individual systems. This would capture about one-fifth of the potential judged to be typically available. And it would seem that as the region grows, and the spaces between the communities fill in, the

regional system would increase in relative effectiveness, approaching both the typical urban area configuration and the theoretical level of effectiveness. This study area was neither the most favorable nor the least favorable for such a system and suggests to us that the potential is real and worthy of further effort.

It must be remembered that not all the potential gains from regional systems can be quantified in such a study. Plant investment and operating costs can be estimated. For example, the following figures were prepared by FWQA to indicate the advantages of handling 10 million gallons per day (a service area of about 100,000) in one or two plants as opposed to 10 plants, using 1957-59 dollars:

	Construction Cost	Interest Charges	25 Years O&M Cost	Total
	$	$	$	$
10 plants	4,200,000	2,600,000	7,800,000	14,600,000
2 plants	3,200,000	2,000,000	6,000,000	11,300,000
1 plant	2,500,000	1,500,000	4,300,000	8,300,000

But which configuration is apt to hire the best people, operate to design standards, be able to obtain funds for operation and maintenance and for timely expansion, be most responsive to needs for upgrading and the like? We have solicited professional judgment on these points and believe that although the potential for big systems to make mistakes is well recognized the advantage is clearly in favor of the larger organizations. Indeed we would judge that if you can demonstrate by computation that a larger integrated system is superior to fragmented action--the realized gains will be at least twice the computed differential.

It should also be pointed out that the realized units of investment by size of place that can be graphed from FWQA data do not show a smooth decline in unit costs as size increases. At about a population equivalent of 10,000 there is a noticeable increase from about $100 invested per person added to over $250 per person when costs again decline to $150 per person added. It is pointed out that this is about the point where lagooning stops being feasible as a treatment

approach. But we would also make the point that cross sectional experience may not fully indicate the opportunity costs of consolidation in given situations over time. Indeed we have yet to find any studies that adequately treat the problem and would look forward to a planning program that would generate such information. The typical approach, for such regional planning studies as there are, appears to be heuristic and vague as to the benefits and their distribution. With the result that if a serious regionalization is being proposed, the managers of each existing service area call in their familiar consultants and ask them to evaluate their self-interest. Since consolidation may jeopardize the income, prestige and influence of both the managers and consultants, the results are open to some question.

Also, it would be a mistake to conclude that we advocate size for its own sake or fail to recognize the values of autonomy for each community. The point is to achieve a management unit that can take a regional view and that can respond to multiple-purpose, multiple-means, multiple-objective opportunities and at the same time provide for local control. Administrative devices can be designed to achieve these objectives. The Northeast Water Supply Study by the Corps is making solid strides in this direction on the parallel problem of urban water supply. Various representational and local response arrangements look promising. The ability of a Federal bargaining agent, to achieve the "multi-multi-multi" approach with local single-purpose agencies, while not perfect, is encouraging.

OTHER SOURCES OF POLLUTANTS POINT TO THE NEED FOR BASIN INSTITUTIONS, MONITORING AND BROADER ENFORCEMENT

Catching Up On Treatment Plant Construction is Important But So Are Other Needs.

As important as is our backlog of needs in conventional municipal-industrial waste treatment, future requirements and other unmet needs may be even more important to consider. With a $9.9 billion in capital outlays estimated by FWQA to be needed over 1970-74, $2.5 billion is identified for additional construction needed for the increase in urban population. About 1,000 communities outgrow their treatment facilities each year. Another $2.5 billion is earmarked as an allowance for recapitalization and depreciation--essentially to replace worn out and obsolete facilities. The remaining

$4.9 billion is required to provide adequate service to the some 32 million urban people who have partial service now and to an equal number not served by any treatment.

It is interesting to note in an FWQA review of the intentions and expectations of state programs that the states are found to be projecting a level of expenditure of about the same magnitude as that in the last six years. This is disturbing to anyone who would hope that an accelerated state effort will make up for a Federal effort that might lag behind the needs. Even if the Congress does provide $800 million annually in grant funds for several years it is not clear that the performance picture will be changed enough. Pressures for new sewer construction in suburban areas, and replacement in older areas, rising operation and maintenance costs and the like will put pressure on local resources.

Among several opportunities for future action to correct pollution problems, two particular aspects that relate to public works must be pointed out here. First, we can expect increasing attention to storm drainage and to the overflow from combined sewers. Second we can expect a continuation of the resistance to low flow augmentation arising out of the increasing feasibility of advanced waste treatment and lowering public acceptance of new reservoirs. But a corollary may be greater use of instream manipulation techniques with particular emphasis on achieving a visual impact on water quality.

The cost of digging up city streets to lay down two sewers where there had been one is recognized as prohibitive. As urbanization continues with its effect on runoff--particularly with the typical lack of adequate controls and public investment--storm drainage accelerates as a problem. Locally it is viewed as a flood control problem, but regionally it is increasingly seen as also a major water quality problem. Our myopia with dissolved oxygen in the water quality field has tended to cause oxygen rich storm runoffs to be given lower priorities. But, with a shift to more emphasis on urban street wastes, plant nutrients, eutrophication, habitat values and visual quality values, the organic, silt and debris loads of storm runoff will receive more attention. Combined sewers and storm runoff even when free from domestic wastes come together on a policy level because it would appear that the solution will be technologically similar. A good example is the current pilot project of deep tunnels under Chicago. These act as holding

ponds from which peak flows can be evenly fed to treatment plants and provide some treatment themselves. The flood control gains make such investments attractive locally but the pollution aspect clearly calls for even more federally provided incentive than domestic wastes. It is one thing to ask your neighbor not to pour his excrement into your stream and another to get him to pay for removing nutrients, silt and debris. The above estimates do not include the storm and combined sewer problems of the nation that will require at least $15 billion to correct and perhaps as much as $49 billion or even more. Some 36 million persons are so served that storm waters in passing through the sanitary sewers overload sanitary treatment facilities and pass untreated wastes through to the receiving waters. Even where separated, storm waters wash great amounts of waste from our cities and are a significant source of degradation.

Cooling water discharges can raise the temperature of receiving water causing damage directly and by changing the physical and chemical properties can have far-reaching effects on aquatic ecology. One estimate suggests $2.1 billion needed to correct this. Considering our history in making such estimates, this is more apt to be understated than overstated.

Erosion and sedimentation causes damage directly and is also a source of nutrient enrichment in the receiving waters. Urban and highway construction, stream bank erosion and some cultivated land present avoidable sources of silt. Investment need estimates range from $300 million to $10 billion, and annual recurring costs from $140 million to $1.4 billion.

Acid drained from operating and abandoned mines has effectively sterilized the waterways of parts of the nation. Oil field brine, oil spills, animal wastes, salinity caused by irrigation return flows, pesticides, radioactive wastes and trace metals such as mercury also must be added to the list. These are less well understood sources of degradation, but may be no less important than the others.

Basin Related Management Must Continue to be Our Goal.

Virtually every study of water pollution policy and administration, just as in almost any other aspect of water resources, concludes

that the logical management unit is the drainage basin. The hydrologic system is so pervasive in transmitting the effects of human actions across political boundaries that control of these effects always implies a decision unit that matches that system. But as every student of both quality and quantity problems laments, the work of government is so strongly rooted to non-hydrologic boundaries that in fact little control can be visibly related to the basin.

In water quality management the gains to be had from investing first in the most cost-effective approaches to water quality have been seen as related to the basin decision unit. This implies differential levels of treatment but at least cost, and maximum control overall. It suggests the ability to tax all--perhaps in proportion to benefit from water quality and/or in proportion to ability to pay--and spend where and ho it will do the most good. As is pointed out so well in the FWQA report, "The Economics of Clean Water," there are no examples of this approach in the United States. And such arrangements will not be easily achieved in spite of some discernible trend in that direction. We find also that the gains from industrial-municipal integration and metropolitan regional systems are more attainable and feel they will go a long way toward capturing some of the technical gains possible in the ideal river basin system. But we refuse to be pessimistic about the long-run realization of integration on the river basin basis. Efficient differential municipal treatment levels can be stimulated by more flexible cost-sharing policies that can grow out of sound planning. And in any case differential municipal treatment levels are perhaps less important in basin related management than the gains from interrelating other sources of pollution to municipal sources and in particular from relating other water related public activities to the attainment of water quality objectives.

It is not clear that a basin management authority needs to immediately come into being and that its initial function should be water quality. And there is every reason to argue that to be concerned solely with water quality would be a mistake. The opportunity costs of single purpose developments in many aspects of water are too high. First, the opportunity to spread fixed costs over a range of outputs is lost and, perhaps more important, the ability to forge multiple interest coalitions to back plans and

projects is reduced. If our planning is made more comprehensive to effectively link water quality to other purposes, if monitoring and enforcement focus on the basin as a unit, and if basin related management is recognized as a long-run objective to be achieved by careful evolution, we may have most of the gains from the basin decision unit even where there is no visible, fully empowered political entity on basin lines.

The problem is to correct those deficiencies in incentive, authority and responsibility, including public awareness and support, that prevent decisions that are not efficient and responsive to basin oriented technical interrelationships. It would seem that the place to start is by seeing to it that a continuous planning and monitoring process is created. And it would seem that the mechanism to begin with and reject only upon demonstrated deficiency is the River Basin Planning Commission related to the Water Resources Council. But for this vehicle to succeed it will be necessary for the residual Federal responsibility to be complete and for the water quality function to be given full status in Council and Commission work. As long as the Federal planning processes for water quality are seen as only in support of an enforcement role and not construction, and as long as Basin Commissions feel they are restricted to planning for traditional channel and reservoir construction, the deficiency of the approach is demonstrable.

To put it another way, one or more agencies at the Federal level must be in a position to not only identify the technical opportunities that follow from basin interrelatedness in water quality but must also be able to realistically take, and/or otherwise facilitate the taking, of efficient actions, if the state and local institutions fail to seize the opportunities. A variety of bribes are possible through cost-sharing, financing, and simultaneous carrying out of related activities such as flood control, recreation facilities, habitat and other environmental improvements, urban interior drainage, enforcement conferences and the like. But the possibility of direct Federal construction and even operation if no suitable regional entity is formed, should be a real and possible alternative.

Visualize a river basin with a well developed multi-interest planning and monitoring program with participation of a variety of state and Federal agencies. The New England River Basins Commission and its program for the Connecticut River closely approximate this today. Visualize a water quality hardware planning

effort that focused on each of the urban clusters in the basin, and was able to produce multiple purpose plans with regional waste treatment systems as a primary objective but with anything from municipal water supply and storm drainage to water based recreation as possible related outputs. Some flexibility for one-time cost-sharing might be provided to induce either initial mergers of satellite communities or industrial integration, to overcome unique construction problems, to protect unique natural values of material significance and the like. Also presume that one or more Federal agencies had the flexibility to construct and/or operate or to induce others to carry out any plan element that no other unit of government could or would carry out such as in stream aeration or low flow augmentation, or land use controls. What aspects of the opportunities of basin interrelatedness need be overlooked that would not also be overlooked by a basin authority? We believe very little. Metropolitan or state programs may be settling today for the more limited goals of simply disposing of urban wastes and not managing a basin water quality plan. Indeed they will have their hands full to meet the limited goal and perhaps we should not ask for more. But there is no reason for the whole water resources apparatus to settle for limited goals.

EXPANDING THE FEDERAL INITIATIVES TOWARD ACHIEVING A PARTNERSHIP APPROACH TO TOTAL WATER MANAGEMENT

What has been the character of the growth of the Federal role in water quality management? It has been one of incremental steps to reenforce a local responsibility. We have attempted to identify the current state of affairs and draw from its internal logic where and how gains in effectiveness might be found. In this section we shall attempt to draw out more specifically what we feel should be the next several incremental shifts in the Federal role and match these to the capabilities of the several agencies who might carry them out.

In the light of pollution control history the "Federal interest" and similar terms can be taken to mean those Federal actions that will cause state and local governments to act and either meet some acceptable standard of performance or allow for the Federal agencies to act directly. Solving interstate effects is only part of the problem. Given the great variety of situations faced by the states and the very unequal distribution of means to accomplish things, a highly

variable Federal role is clearly called for. Also the very diffuse nature of the gains from some activities such as pollution control call for substantial power at the Federal level. The following quotation from N. William Hines' landmark work, "Nor any drop to drink - public regulation of water quality," is to the point of the evolution of the Federal role.

"In retrospect, the growth of the federal program in water pollution is seen as a process whereby increasing recognition of the gravity of the pollution menace gradually has eroded the force of local primacy shibboleth.

"Notwithstanding the continued assertion that expansion of the federal activities causes a reduction in local pollution control efforts, an objective analysis of the current state of local programs reveals that this claim is without substance. Far from displacing local pollution control efforts, the federal involvement has multiplied their effectiveness by making available additional funds, manpower, and technology. It is true that federal leadership in such areas as the creation of water quality standards has caused some state control programs to move in directions and at speeds they might not have otherwise chosen. Nevertheless, such mild coercion seems easily warranted by the present nationwide crisis in water quality.

"The growth of federal antipollution activities largely has been a process of filling the gaps in pollution control, to which local efforts either could not or would not respond effectively. Thus, when it became obvious that local agencies could not support the level of research required by the increasing volume and variety of pollutants, the federal government made available substantial amounts of research money. The federal grants to help support programs of state and interstate control agencies were a recognition that these agencies have traditionally suffered from a lack of adequate financing. Federal enforcement powers were created to provide a supplemental means for state pollution control agencies to handle pollution conditions that originate outside the bounds of their abatement jurisdiction. The problem small cities experienced in assigning realistic priorities to pollution control construction led to the institution of the federal construction grant program to stimulate needed waste treatment plant construction; the success of the program led to subsequent extension of the incentive to all municipal areas. The bonus for state assistance to municipal

sewage plant construction is a more recent example of the federal government's concern that lack of adequate local revenues will retard the needed acceleration in sewage plant construction.

"The federal commitment to the proposition that water quality is most efficiently regulated by local machinery seems immutable, but the concept of local control is undergoing redefinition." 1/

We view our discussion, both to this point and what will follow, as consistent with the redefinition of the concept of local and state control. Indeed it is the view of many that the next decade will see the accendency of the state water resources programs into positions of responsibility and effectiveness. We can only applaud such a possibility -- "Many hands make light work."

The Second Generation Concept Should be Linked to New "Client-Planner" Relationships.

A new goal we have identified for the Federal response to water pollution is the organization of waste management systems by metropolitan region with investments rationalized over the long term by river basin and integrated to overall resource development. And we believe this goal statement has substance and is achievable. But by the very pluralistic nature of our government and the widely varying institutional and physical situation across the nation, it is less likely to come about from direct creation than by evolution. We believe that through new initiatives in Federal planning and construction this evolution can be achieved most effectively.

But both strategically and realistically such planning and construction initiatives should be concerned with the pattern of development some fifteen to thirty years hence. Between now and then many of our present facilities will have to be replaced, but more to the point, it is doubtful that institutional arrangements for some regional systems can be developed more rapidly. Of course, in some cases regionalization is almost immediately achievable with perhaps only a single dramatic step required.

1/ Iowa Law Review, Vol. 52, 1966-67, p. 860.

At the present time one or two state programs and the "701" regional planning grant programs of the Department of Housing and Urban Development are producing general metropolitan regional plans. These grants are to fund work done by, or directly for, a locally sponsored planning program. They provide a basis for approving and reviewing local municipal grant-in-aid applications to FWQA but do not provide the basis for significant incentives to create meaningful regional systems, nor any sort of basin-oriented, cost-effectiveness based approach to investments. It is difficult to see that this will produce the accelerated progress that we feel is called for.

How might such an accelerated effort come about? The Northeast Water Supply Study provides a format that we feel has promise. It provides the mix of organizational as well as technological evaluation and the basis for meaningful negotiation between the Federal Government and state and local governments. And the NEWS Study approach allows a concentrated effort tailored to the differing problems and priorities between regions. It is discussed in greater detail elsewhere in this report.

Thus the second generation concept is a strategy of encouraging the evolution of more sophisticated and more completely articulated regional management of water quality. It should be recognized that this will be successful only if the partnership approach, as exemplified by recent water resource development planning, is used. This becomes clear if the reader considers first the variety by region that must be faced; second, the critical roles of other agencies; and finally the likely pattern of response to other water quality management opportunities.

New England and the Delaware, the Susquehanna and the Potomac, the Great Lakes and the Missouri, upper and lower Mississippi, Puget Sound or San Francisco Bay; just to list these is enough to bring to mind great diversity in problems and institutional development. On both the Delaware and the Ohio there exist potentially strong basin management commissions. Planning groups have been formed in a number of ways. Some states, New York and Wisconsin for example have innovative and aggressive programs and provide major financing. Others have done very little. The level of Federal

interest from region to region is also variable--not simply because the magnitude of pollution differs, but because the barriers to effective action differ. The amount of interstate involvement differs as does the extent to which unique natural areas are threatened. In some regions industries and communities face the task of correcting a pattern of development laid down over one hundred years ago, in others only a few decades ago. The costs, burdens, rewards and approaches called for will be substantially different. The result is that regional agency forms will evolve differently and Federal participation should differ. Thus while some programs can emphasize nationwide approaches, others should be free, indeed encouraged, to respond to the internal logic of each situation. Accelerated achievement of the goal of the second generation concept will not come about from the efforts of one agency alone.

For example, FWQA has in the past and must in the future provide help to achieve the second generation goal. Research on advanced waste treatment processes, industrial demonstration grants and the like are crucial. Standard setting and enforcement activity at the Federal level have probably done more than any other single action to strengthen the hand of local officials. And clearly the nation's cities must have fiscal assistance and sewage treatment grants are an important way to provide it. Without the extensive data collection and analysis program, already well underway, it is doubtful that any rationalization of investments would be feasible. But we believe a good case exists for using the staff and experience in large project planning and management built up by the Corps in civil works to achieve this goal.

A broad multi-agency total water management program of water quality control appears inevitable. Simply the change from a dissolved oxygen proxy for water quality to a multi-parameter measure demonstrates this point. It symbolizes the fact that we have only come part way in developing effective programs to bring public management to bear on the full range of pollutants of our streams. Secondary treatment for all municipal and industrial wastes is a target that itself represents a broadening of former targets yet is a small part of the pollution problem of some streams. Urban storm water runoff is a carrier of many wastes, but it is rich in oxygen, lacks the aesthetic aversion of human wastes although it contains animal feces and is awkward and expensive to treat. Various forms and causes of land erosion, for example

stream bank cutting due to the accelerated flows of urbanized land, have long been recognized as a source of materials that pollute. Feed lots have recently gotten more notice. Eutrophication of our lakes and sludge filled rivers and estuaries are being recognized as problems which can be and perhaps should be managed beyond simply limiting existing inputs of waste. Continued increase in reuse rates will, indeed is already, producing troublesome salt concentrations in our waters. In essence it will become increasingly important to determine on a basin basis what should be done next to enhance the quality of the water in that basin. And programs limited to particular technical approaches such as reservoir storage for low flow augmentation will not be enough. Total water management will involve some of every kind or approach somewhere, and the identical mix no where. The challenge is to build institutions that can choose the best combination in response to the internal logic of each region.

Planning for Water Quality--An Unexploited Opportunity.

Actually, as we have noted, the whole approach to water quality enforcement and regulation can be called a planning process. In setting standards the future uses of the water are projected and the water quality requirements of these uses fix the standard. Present and projected needs for waste treatment and other action are spelled out to meet those standards and a schedule is developed. The emphasis in the past has been on enforcement, not public investment, and the actors visualized have been existing municipalities and industries on the one hand and the state and Federal enforcement agencies on the other hand. Cost-effective investment planning and institution building have been left out. Unexploited opportunities would seem to exist in greater integration with construction oriented planning and the creation of regional management units. The process in the past has not been able to work with a full understanding of the range of needs for quality management because criteria, particularly for ecological values, have not been particularly discriminating. There has been little interaction between the evaluation of investment and control alternatives, particularly their costs, and the evaluation of the values to be created or protected. Specification of cost sharing, interest accommodation, commitment of participation, the necessary application of inter-governmental coercion and similarly covert if not overt parts of the decision

process have been only partly included in the process. And what has been labeled planning among the pollution agencies has only in recent years been much more than data collection. It is not impossible that this has come about in part from the successful efforts of those who have yet to be convinced of the need for pollution control.

Water quality agencies have participated in our so-called comprehensive planning efforts largely to point out the quality effects of construction others were promoting. Little resembling regional water quality investment plans have developed save the justification of low flow augmentation storage in reservoirs.

The GAO review is able to point to five reports emerging from some $33 million of the total expended on comprehensive water quality planning. Of course these funds have provided many other outputs. These reports have covered the Willamette and Snake Rivers plus Lake Michigan, Erie and Ontario and the St. Lawrence. The drafts of reports for Lake Huron and the Susquehanna River were in review at the time of the GAO study. Some 25 reports are promised in 1970 and 36 basins will be under study in FY 71. There are some 210 basins or comparable areas in the nation. It was not until 1968 that the present program was reoriented to place more emphasis on "...developing pollution control action plans...."

Of the five reports released under this new emphasis, the one for the Lake Ontario, St. Lawrence River Region is perhaps the best. It provides at least some sense of seeking an optimum. But the output of the plan is fixed by the standard setting that is carried out as part of the regulatory process. This leaves only a cost-effectiveness approach open to the planner, but if such was carried out the results are presented in such a way as to lose whatever insights it might have provided. Secondary treatment of all wastes is a policy dicta that takes away some of the possible flexibility that might have been left. Cost-effectiveness could still have given a ranking or grouping of projects that would indicate their priority. The report does note that "there is considerable variation in relative urgency of..." treatment needs by the various municipalities and industries listed (p 62). But no measures of such relative urgency are given. There is no indication that an evaluation of such "relative urgency" would be a desirable feature of a plan. The way in which scheduling is discussed

suggests that this is seen from a regulatory rather than an investment or construction point of view. A schedule for phosphorus removal is presented and clearly given as a regulatory target (p 120). Otherwise immediate measures are defined as all of those things that involve the application of known technology and can be done by 1972. Long-range needs are those "which generally need more research and time to accomplish" (p 119). In general, the report can be characterized as a useful listing in one document of program elements of the several agencies involved, a listing of standard policy positions and a listing of treatment elements needed by point of existing discharge to meet stream standards, plus an estimate of the overall investment cost. A stab is taken at benefit identification. While some population projections and background information are presented, these are not tied to future investments nor are the questions of industrial-municipal integration and municipal system consolidation more than mentioned. These omissions may reflect judgments as to political realities as much as anything else, since the pollution control agencies lack the policy tools to bring about such regionalization.

It is interesting to note again that perhaps the first and in many respects still the best basin planning study emphasizing water quality was conducted by the Public Health Service and the Corps on the Ohio River. The basin-wide water quality plan included in the report Ohio River Pollution Control (House Document No. 266, 78th Congress) set the pattern still in use today but not recognized as a planning process--uses of water, quality criteria of the uses, sources of pollutants and remedial action. The challenge is to move beyond this to construction and operation planning with more emphasis on both engineering and organizational aspects.

What might be called a "hardware" plan could be used as a much more effective basis for negotiating and establishing an appropriate regional management institution to finance, construct, operate and maintain the projects and plan for future needs. While this could be done on the initiative of the states, interstate agencies, metropolitan councils and the like, it is probably reasonable that the Federal Government and particularly the Congress provide for establishing for itself the client-planner relationship needed to carry this out. This could be used in those limited cases where it was a more expeditious approach

than relying on state or regionally developed client-planner relationships. The precedent for this is well established in flood control, navigation, irrigation and most recently has been extended to water supply in the NEWS Study.

But the long run solution may lie in developing a two-way client-planner relationship to the Congress and the Executive on the one hand, and to the state and regional operating, planning and enforcement agencies on the other hand. With its existing leadership role in traditional basin planning and major construction, the Corps of Engineers would have many advantages in providing such a service. Not the least of its advantages are its large competent field organizations and well developed contacts with local officials and community leaders. To the Congress it could provide a series of proposals that represented the needed complements to the programs of other local, state and Federal efforts. These proposals would spell out Federal financial and construction participation that would be required to meet the goals of regional integration of waste treatment systems. It could provide additional authoritative inputs as to the overall and marginal costs of achieving various levels of water quality in the setting of standards by FWQA, state and regional agencies. In enforcement conferences it could offer the alternative of direct Federal action for those elements of an overall plan where a direct Federal construction and operation role is or becomes more accepted practice. More important perhaps, would be the latent threat and opportunity that if existing arrangements didn't succeed, here was a Federal agency that could and would construct and even operate on a regional basis.

But more to the point, the Federal client-planner relationship could be essentially that of helping to create a new regional client for hardware plans, cost-sharing analysis and bargaining, phased and supervised construction, and the specification and delivery of extraordinary Federal participation. A regional agency to construct and operate waste treatment systems and to be generally responsible for achieving water quality goals, however they are set and enforced, is much more likely to come about if its organizers can expect this kind of support.

Federal Construction Should be a Separate Initiative to Stimulate Action.

In virtually every other part of water resources development we

have found it expeditious to not only provide the possibility of Federally developed "hardware" plans but also direct Federal construction. But increasingly we are doing this in two steps; first, a general planning process, then a separate implementation stage. Sometimes this implies Federal operation and management but certainly not in every case. It is intriguing to consider what the effect would be on the control of water pollution if this approach was added to the kit of public policy tools. It is out of the question to consider this as a substitute for the other approaches except insofar as they have proven inadequate to the solution to particular regional and local problems. Thus the real test is whether or not there are situations where the consideration of direct Federal construction would assist in reaching a solution during the implementation stage at least enough to offset whatever potential misuse of such a program there might be.

Clearly, if they would, state and local governments could find ways to construct everything that was needed to treat untreated wastes, to integrate municipal and industrial treatment, to solve the combined sewer and storm runoff problems, to rationalize regional systems, etc. If they would, and perhaps most will, but such statemanship is not traditional in waste disposal. Federally stimulated planning, federal grants with incentives for state grants, federally stimulated regulation and enforcement, and perhaps eventually federally stimulated regional operating authorities will go a long way toward moving the nation towards protecting its aquatic environment. Direct federal construction is one additional step. This would imply the development of engineering expertise for design and construction scheduling in the federal establishment. However, just as in other federal construction, private firms would have to be used. Such expertise exists now for most other water functions and indeed does to an important degree for waste treatment systems. Federal office buildings and particularly military installations pose waste disposal problems not unlike those of municipalities. Some of this talent could be redirected. Indeed it has been suggested to us by Dan Okun--Environment Engineer at the University of North Carolina--that military installations should be considered for siting controlled field calibration of advanced waste treatment technology. There is no question that lower cost technology for advanced waste treatment, including storm runoff, is still a real need. Reliable performance data is rarely sufficient for any new process.

An argument for developing a Federal role in construction, in addition to 1) the opportunity to fill out the range of alternatives open to public decision-makers and 2) the coercive effect that this would have on local and state governments, is the yardstick principle. This is a familiar concept in the justification of public development of power and it may be applicable here. Most of the construction, and for that matter planning and design, of waste treatment facilities is done by private firms. There are only a few very large firms that compete on a national level. Then there are many small firms, but they are scattered so that in any given locale there is apt to be only one or two that do most of the local work. Most of these firms are competent and most of them provide a sound balance between cost and performance. Nonetheless an "in-house" construction agency with whom to compare would be valuable to well operated grant making, planning and enforcement activities.

FWQA has noted that the average cost of production capacity to service a unit of pollution in the Northeast costs 4.5 times as much as the national average. They speculate in their "Economics of Clean Water" on the causes. A direct construction program would bring this imbalance under some control.

An aspect of federal construction that cannot be overlooked is the opportunity it provides for further adjusting the cost-sharing to reflect unique situations with respect to the federal interest. While it is often difficult to distinguish a federal interest from any other aspect of the public interest, it is a question that is often at issue in any change of federal activities. This is part of the process of matching our actions to a rationale that legitimizes them and provides a basis for assigning responsibility, and so on. It would seem that one way to consider the federal role in cost sharing is to recognize the need to balance incentives for investment and action. This goes back to the basic explanation for why pollution takes place at all--the sub-optimization of decision-making. Thus it can be argued that one way to define the federal role is to adjust the incentives on decision makers at lower levels of government and in the private sector so that waste management meets society's needs.

Obviously cost-sharing is one way, along with regulation and information to change incentives. Existing grant programs offer much in this respect. The full federal coverage of the cost of

low flow augmentation for water quality has been justified on the basis that benefits are so diffused that in the minds of the recipients they are not fully perceived. In a similar manner the flood control beneficiary who benefits from 100% federal cost-sharing is visualized as discounting these benefits because they are so problematical and in the future. These characteristics are in addition to the indivisibility and public nature of the benefits, i.e., they can t be unit priced nor denied to anyone once they are provided at all. This makes it a public process to begin with. But it is the incentive question that makes it a federal interest. The questions are, first, would the other levels of government meet the need without the federal incentive and, second, how much federal incentive is required?

Consider a city in one state upstream from another in a second state. It could be argued that the downstream city and state should offer a bribe to the upstream city and state to clean up its wastes. While this is a good way to think of the problem in trying to decide how much should be spent upstream to benefit persons downstream, it is politically unrealistic to expect the system to really collect and pay the bribe in that way. The approach is to offer that bribe from the federal coffers. The weight of precedent is too great to change this pattern just for pollution, as rational as that might be.

Therefore it may be desirable to offer direct federal construction in general at the same cost-sharing relationships as currently exist for grants, but t provide the possibility that a higher level of federal cost-sharing should be proposed when there is an unusual degree of federal interest. Besides the interstate problems, there are situations where the environmental values at stake have such uniqueness that their protection has special national standing. Naturally this raises the question that if they are values worthy of special federal protection from pollution they should be within some kind of recognized system that will protect them from other threats and that makes them available to the public.

But direct cost-sharing is not the only way that federal construction offers an opportunity to increase the fiscal incentives for action. It is instructive to note that if a municipality were to contract for storage space in a federal reservoir for its future water supply needs (which would seem to have less federal interest than pollution control) it is held for the repayment of the

proportional share of that space. But terms on which that repayment is made are quite favorable, especially relative to alternative financing available to municipalities. Under the Water Supply Act of 1958 such supply is considered the prime responsibility of state and local interests but it should be fully considered in federal multiple purpose projects. Certainly considering the municipal share in a multiple objective, multiple interest pollution control facility is analogous. Also there is a parallel between space in the reservoir plus facilities for withdrawal and conveyance on the one hand, and treatment plants plus interceptor and outfall sewers on the other hand. Also note that water supply space may be provided both for immediate use and future use, although the latter is usually limited to 30 percent of the reservoir (computed on a cost basis).

Repayment may be extended over the physical life of the project up to 50 years with payment for future supplies delayed until use begins, and up to 10 years when interest shall not accrue if use is not made. Thus the fiscal advantage of federal financing is passed on to the local municipality in two important aspects, i.e., use of federal interest rates and long term annual reimbursement arrangements. Used judiciously this should bring more than one reluctant municipality into an otherwise unobtainable regional plan.

But Federal construction suggests one other consideration--how are such projects to be initiated and selected? The natural thing would be to use the same pattern for this type of project as for others in the water field. The pattern for direct federal construction of reservoirs, and the like, is sometimes criticized for its close relationship to the Congress and the log rolling, etc. that results. This is also one of the strengths of the process. If this pattern is followed it will mean that when a local problem cannot be solved with the other devices at hand it will be possible to use the federal construction device provided the local Congressional delegation gives its support. Two kinds of risk are that local interests will use this avenue to seek higher levels of federal participation than may be fair and justified and/or to delay taking effective action. Effective constraints such as requiring a clean cut gain from a regional system over the alternative individual systems and careful review and interagency coordination would reduce these risks. In particular an emphasis on the "second-generation concept" should limit such abuse. In the broader

context this risk is offset by providing a higher yielding form of public works to be used in the bargaining to secure consent on other issues and matters that have little or nothing to do with water resources. Some of the most uneconomic projects are perpetrated today because the system cannot produce socially higher yielding opportunities to be used as rewards in the political process.

Extending the Multiple Purpose Concept Under P. L. 91-190 and Other Authorities.

One can visualize a river basin with existing and potential water quality degradation facing a range of opportunities to do something about it. Which ones to choose? Assuming a decision mechanism that could implement any and all of them, the best objective approach to choice is some kind of cost-effectiveness analysis based upon the behavior of the water quality system. But all means are not equally available. The utopian basin authority solves everything and nothing. In the real world of fragmented authority and responsibility, of uneven access to alternative means, it is often expeditious to link the attainment of one objective with another. If there are economies from joint costs, then it is particularly advantageous and often easier to organize and have accepted. Indeed in basins that lack of anything approaching the utopian water quality authority, it may be necessary to extract from a series of other water related programs the maximum in water quality effects rather than the set of actions that would provide a least cost single purpose solution. In the use of scarce political capital this may be the least-cost attainable plan. Silt may be more of a problem due to erosion at construction sites, but it may be more expedient to get farmers to reduce silt from their cropland. Effluent charges might have the potential to induce industrial process changes that would reduce the volume of waste, but be more difficult to achieve than industrial connections to municipal plants.

This argues for some flexibility in the evaluation of means. And of course the fact that the ideal and the attainable may differ is no argument for full license to promote the inefficient But probably the social cost of abuse or in settling for second

best is less than the opportunity cost of not exploiting the multiple purpose potentials of other activities. The potential to be seized here is to consider water quality enhancement opportunities whenever any other activity is considered. And there are unexploited opportunities to modify the approach of some existing Corps programs so that water quality effects become a joint product with other functions.

Unlike other opportunities, low flow augmentation storage is a well established case in point. It is an approach to achieving standards that is often competitive with existing and projected advanced waste treatment technology on a cost-effectiveness basis for many water quality parameters other than dissolved oxygen and in many cases even for that parameter. Much of the criticism it has received should be directed at the standards used as objectives and the failure to provide equally realistic and available alternatives. But it illustrates the point here, in that it takes advantage of the support for expenditure and action from the other objectives of the storage facility as well as the sharing of the joint costs of the project. This section reports on some of the opportunities of this kind in other aspects of the existing programs of the Corps of Engineers and recommends their further development.

Both the further development of the opportunities identified in this report and the identification and development of others to enhance the environment and achieving other values is in the spirit and under the letter of P. L. 91-190, the National Environmental Policy Act of 1969. It is as clear as these things ever are that where old authorities to study plan and design for construction have included language such as "...recreation, flood control and related purposes," the phrase "related purposes" can now be interpreted to include any reasonable actions and investments to mitigate consequential environmental damages, to create positive environmental values that are made more feasible by the other purposes, and to protect positive values created or maintained. Of course the results of such an interpretation would still be subject to the usual reviews of the Executive Agencies, including those added by P. L. 91-190 and by the Committees of Congress.

Review of Dredging, Drift Removal and Waterway Renewal Opportunities.

In recent months substantial study and effort has been put to the problem of pollution from spoil disposal. Silt and sludge that are the products of pollution make up a goodly part of the material dredged out of some waterways. Disposed of in desirable aquatic habitats it can add to our pollution problems; disposed of in other sites it can add to the solution of those problems, although to what degree is little understood. Also there has been a review of the problem of floating debris in our waterways, especially where derelict and abandoned structures are crumbling into the waters of our harbors and waterways.

It is suggested that both of these areas of effort offer opportunities that should be explored to widen the contribution to environmental enhancement. But we must recognize that this can be viewed from either the narrow aspect of water quality standards or expanded to a consideration of the whole environment of the waterway. The latter would seem the proper perspective.

From the point of view of solids and precipitates in the water, it is clear that action at the sources of pollutants is more cost-effective than action at the level of the affected habitat. Therefore, for illustration sake, we can assume that the silt and sludge being deposited by polluting activities will eventually be stopped at the source. But the question remains as to the ability of the affected waterway to return to a more desirable state of ecological health. It is probable that eventually the "self-purifying" process of the waterway will take effect. But it is not clear how quickly this will come about. In slow moving water--arms of estuaries, lakes, canalized streams and the like--the bottom muds could continue to release pollutants to the water for years. The removal by dredging and/or the deposition of unpolluted material on top of them could speed up the process of rejuvenation. This suggests a line of further study that should be pursued. While some

basic research has been done on the nutrient balance effects of bottom muds, little is known about the value of man's efforts to restore a waterway.

Waterways play a wider role in our environment than provision of a habitat for various aquatic organisms--some in desirable ecological balance and some not. A waterway is also a visual focal point, particularly in an urban setting, to add or detract from our enjoyment of the world around us. Debris removal can be justified on these grounds alone. This point of view suggests that we ask if in carrying out the Corps of Engineers' primary functional responsibilities for navigation, flood control, water supply and recreation it could not influence broader accomplishments. Beautification of bank areas goes well beyond the debris problem. For example, many waterfront areas have been, and more should be, the sites for urban renewal projects, including parks and open spaces. Should the Corps play a broader role in the water related improvements to insure environmental change? How can the Corps respond under existing authorities and policies? Again an opportunity for some imaginative thinking presents itself. A review of existing harbor and canal projects would be in order to explore these opportunities further.

The Cuyahoga River, famous for its tendency to catch fire due to the industrial wastes it carries, offers an interesting specific example for further study. Based on the premise that existing programs of enforcement and cost sharing will in fact halt the inflow of wastes, it is clear that the residual of many years still presents a challenge. Some 50 miles of stream generally situated between Akron, Ohio and where the stream joins Lake Erie near Cleveland, offers an opportunity for change. Bars, shoals and banks contain an accumulation of pollution residue that could be cleaned up in conjunction with navigation, flood control, and drift

removal projects already being planned for the lower river and in coordination with treatment plants now underway. Federal funds have already been used to construct and maintain a 5.8 mile navigation channel. A report nearing completion urges local improvement for flood control for some 9 miles. A settling basin is already in the plans for flood control and would have water quality advantages. Clearing and snagging to remove bars, shoals and debris, and bank improvement for environmental enhancement, plus dredging settled sludge and silt for the some 43 miles, in addition to that which would normally be given such treatment, might cost as much as $10,000,000. However, this figure is not the result of a careful study of the problem area and much could be accomplished with less. The unexplored challenge is to consider what this stream could eventually mean to the environment of this densely populated, highly industrialized area.

The Kerr-McClellan Waterway on the Arkansas River provides an example of a very different kind. Here the Corps of Engineers has recently planned and largely completed the construction of a major waterway. It has recently been asked by the Ozarks Regional Commission to study the operational needs for the comprehensive and rapid economic development of the region affected by that waterway. The Commission staff has said that it "intends for the Corps to assume appropriate and new responsibilities for the region's economic development. The Corps is the major agency now operating in the region. Its capabilities must be applied quickly and effectively." In particular the Commission staff is concerned with management of second and third order consequences of its major initial work, specifically including "...moving to not only get the water cleaned up, but to make sure that it does not become more polluted." This is presented here less to point out that others see similar opportunities, than to raise the question as to where our responsibility for a major investment program ends. If we plan and construct a major facility should we not at least assist in the planning of those steps that will optimize the related public investments? If we attract the industry

and its pollution to the Arkansas should we also assist in solving the pollution problem? At least to the extent that management and design of the waterway and related facilities is involved, the answer seems obvious.

Review of Urban Drainage for Flood Control and Water Quality Effects.

In connection with a current policy consideration in the Office of the Chief of Engineers concerning urban flood control, there is recognition that federal participation in planning andproviding improved outlets for urban storm water run-off should consider the highly polluted characteristics of such water, and should include such treatment as required to meet established Federal or State standards for water quality control.

It should be noted that this embodies a principle being explored in this report--namely the application of multiple-purpose, multiple-means planning. There is little doubt that runoff from urban areas can be both a flooding problem (a traditional Corps concern) and a water quality problem. In cases where such waters are a significant contributor to the degradation of the receiving body of water, where jointly developed measures will be cheaper than separate measures, and the separable costs for quality control are more cost effective than other investments that are truly alternatives to achieve the same results, namely meeting stream standards, such joint approaches should be encouraged. Of course this implies that regional water quality plans are available in such detail that such judgments can be made.

Specific examples of the potential application of joint flood-quality facilities should be explored further. Also needing further study are the opportunity, only one or two steps removed from this case, of treatment of storm waters where there is no flooding problem, both where they are carried

in combined sewers and otherwise. Sewers that are used for both domestic wastes and storm water force many municipal systems to bypass treatment facilities during storms sending into the receiving streams the mixture of street runoff, fresh domestic wastes and the solids built up in the sewers between storms. In these cases where the storm water should be treated in any case, and this may be most cases, there is a substantial potential saving to be had in avoiding the cost of separating combined sewers. We would urge such a follow-up study of the potential Corps role be started immediately.

Review of Water Quality Control in Multiple Purpose Reservoirs.

A reservoir can become a sink for pollutants entering a stream above it. While to some degree reservoirs may act as purifying agents, existing regulatory and cost-sharing programs should prevent any degradation that interferes with intended uses of the reservoir waters. In fact they have not. And the question should be asked what is the proper course of action in the future to complement existing programs and protect the Federal investment in the impoundment. This divides into two somewhat different problem situations. The first is the case of the existing reservoirs where public investments to produce water supply, fish, wildlife, and recreation benefits may be threatened. In some cases management of flows, instream aeration and other measures short of action at the source of the pollution are possibilities and may even be competitive in a cost-effective sense with advanced waste treatment when that would be required. Indeed even for natural lakes or reservoirs not otherwise subject to Corps of Engineers' management, such efforts may be called for. In other cases, direct action to correct upstream pollution at the source should be reviewed. A detailed survey of existing situations should be begun by all Districts to identify where additional Federal action should be taken, including the actual construction of abatement works, instream aeration

and the like. Cost-sharing should follow existing FWQA rates or recommendations for deviations be substantiated as discussed elsewhere in this report.

The second situation concerns the problem faced where a new project is being planned. An interesting example is posed by the Honey Hill project in New Hampshire. Here an experimental program in design research is being conducted for the Corps of Engineers. A variety of imaginative approaches to recreational development combined with flood control are being explored. But these possibilities are threatened by the discharges of a woolen mill upstream. It is possible, but not yet confirmed, that in its natural flowing state a substantial amount of this pollution would be assimilated by the stream. Part of the discharge is probably over that which strict enforcement of the standards would allow. But the proposed reservoir may pose new dimensions to the problem. What should be the approach of the planners? Ignore it? Include treatment agreements in the project, and on what terms? In all current and future survey reports this problem should be examined carefully and the alternatives to protect the quality of any proposed impoundment be explored. Direct Federal construction of abatement works, instream aeration facilities and the like should be recommended where necessary to protect the quality of the environment of the new facility. Cost sharing, following the existing FWQA rates again, should be the standard from which deviations should be justified in terms of special Federal interest as discussed elsewhere in this report.

Review of Water Supply and Reuse.

It has been estimated that 60 percent of the population reuses water that has been used at least once before. The issue on reuse is not "if" but under what terms--to what degree, for what, and after what natural and man-induced renovation?

All future uses could be met from the reuse of existing supplies; indeed most of them will be. The problems are of relative cost, attitudes and organization. The water supply problem is the water quality problem, and we will not become efficient in the solution of either until the supply agencies see themselves as having equal responsibility for the quality problem. This does not mean simply merging the city water department with the city sewer department so that they better coordinate tearing up the streets with the repaving program of the highway department. The challenge is more like trying to induce behavior that ought to follow from the upstream city recognizing its responsibility for the water supply of the downstream city.

Enough is known about the potentials for waste water reclamation that planning for its use should be made more widespread in the future. A general review has recently been carried out by the Planning Division of the Office of the Chief of Engineers. While not conclusive, it is suggestive of the factors that are involved, including the attitudes of users and managers. The extract of that staff study is attached as an appendix to this portion of the report. That study found communities in the arid southwest using renovated waste water for such purposes as lawn irrigation, industrial uses, recreational lakes including swimming, and indirect supply through aquifer recharge--all uses, particularly the last, that can be expected to be developed before significant direct reuse. While certainly less common now, it was expected that in the future such reuse in the Great Plains and the Midwest would grow as it became more competitive with other sources. Directed piping of renovated waste water to industrial users was seen as a low-cost means of freeing capacity in existing municipal systems in some Northeastern situations. Those sites examined for a general test of feasibility, Tucson, Indianapolis and Philadelphia, all gave preliminary indication that some type of scheme of waste water reuse was competitive with other sources of water.

Until the advent of the Northeast Water Supply Study, the Corps of Engineers had not had a mandate to develop

regional municipal water supply plans. Up to that time and today for the rest of the nation its posture was to offer to a municipality storage space in a reservoir primarily being built for other purposes. It is instructive that in the NEWS Study some of the most attractive alternatives being pursued involve indirect reuse--specifically the use of streams with little or no further flow augmentation where upstream waste water renovation is needed to make the source suitable.

Thus we conclude that in all planning of future municipal and industrial water supply by the Corps of Engineers, all reuse alternatives should be given careful and explicit consideration. Institutional arrangements as well as physical facilities for linking upstream treatment with downstream use and the like, even as a Federal construction project, should be reviewed for feasibility. Even where these kinds of arrangements are not feasible or politically acceptable at this time, the educational effect for the future would be worth the effort. Even where traditional storage solutions are clearly superior on economic grounds, examination of reuse possibilities would be of considerable significance in considering the environmental effects of alternatives.

A Multiple Agency Federal Strategy for Effective Water Quality Management.

We propose a new multiple-agency strategy in the Federal program to achieve enhancement of the aquatic portion of the environment. Essentially all of its elements would complement and strengthen existing elements and would add several new initiatives that would close existing gaps. The Federal Water Quality Administration would continue its emphasis on standards and enforcement, research and construction grants. It would continue to establish the framework for water quality planning and participate vigorously in it, including its provisions to strengthen state participation.

Added to this would be a new mission for the construction agencies, particularly the Corps. This would focus on planning in support of the FWQA activities, and in support of actually carrying out and achieving regional and basin pollution control measures and organization. Integration of water quality measures with other development would be stressed. In the case of the Corps it would bring to the effort a new emphasis on water quality effects in its multiple purpose permit authorities under the Refuse Act and others.

The Corps is a national engineering resource with capacity to plan and construct, creating a partnership of real mutual commitment between state and local governments on the one hand and the Congress and the Executive on the other hand. We believe that the need is so strong in the water quality field for this kind of effort that the Corps should be given an opportunity to prove what can be done. In the past it has provided leadership and organizational focus in comprehensive multi-agency, multi-objective and multi-disciplinary planning. Except for Framework Planning (Type I), the level of detail is sufficient to form the basis for authorization, fiscal commitments in support of projects, and engendering confidence in the efficacy of the proposals. It provides a firm basis for future review of project performance and monitoring local commitment and ensuing local performance.

We suggest that it would be a needless duplication of effort to ask another agency to create the kind of planning capacity needed to produce such plans for water quality investments. These are the hardware plans referred to in other discussions, and they should inherently involve a cost-effectiveness, regional and multiple means approach to achieving water quality goals as expressed in the stream standards now blanketing the nation. Such activity normally involves planning, designing, developing cost-sharing agreements including any special Executive or Congressional oversight, authorization and funding required, managing the construction if required and follow-up on performance of the engineering works. Of course here the organizational problem to achieve regionalization looms large enough to be added to this list of required activities.

Essential to effectiveness at this hardware level of planning is the balancing off of all approaches to water quality achievement one against the other and balancing this set of activities

against other water resource development investments, all within approved stream standards. To do this implies an agency skilled in the management of complex multiple-purpose projects and already involved in other water resource investments. The Corps is such an agency.

Would this mean the withdrawal or reduction in effort by FWQA or the states in the planning field? We think not. In terms of effective results their input is needed even more, not less. At the framework and comprehensive level and in connection with standards and enforcement they must participate effectively. The Corps must make its present survey program more responsive to water quality opportunities. But by no means can we envision all hardware or project planning being a Federal activity--only where there is a need to achieve regionalization and other Federal objectives.

We would envision survey reports that were generated at the request of local interests acting through the Congress, and from other Executive agencies to prepare a construction and investment plan for a metropolitan region probably acting with a council of governments. If an enforcement conference were called or in existence for the region, the planning would be in cooperation with that activity too. It would work also within the guidelines laid down by any existing comprehensive basin planning activity. We would doubt that every region would want or need this sort of intensive effort.

One class of result could be a plan which clearly could be accomplished within the framework of existing grant programs and authorities for low flow augmentation, flood control, dredging, government facility plans, etc. The region might simply gain a plan to which it could relate near-term activities and which it might be able to keep up-to-date with its own activities. This might be the exception since it would indicate that the region chosen for survey scope level of study faced no unusual obstacles in meeting water quality goals. The more likely result would be identification of action needed over and above what is likely to be accomplished under existing "business-as-usual" arrangements. Where special Federal-local partnership action was required, the specifics would be detailed and authorization and funding would be sought from Congress for approval to proceed. Justification for a Federal interest other than "business-as-usual" would

be developed and proposals defended on the merits of the internal logic of the problems found. If we are serious in our commitment to action to save the environment, this is a process to allow everyone involved to "put his money where his mouth is."

This envisions a strengthened role for comprehensive basin planning with an increased input at that level from the Federal Water Quality Administration. We are moving into a new era of multiple-objective, multiple-means, multiple-agency planning. Our review of recent comprehensive plans indicates a substantial lack of the kind of hardware planning envisioned here as only possible with the kind of capability represented by the Corps in other areas of investment. We also discovered that there is a potential for a more sophisticated input in the identification of needs and priorities in the water quality portion of comprehensive plans. The development of more sophisticated models by FWQA has allowed more recent plans (e.g., the Susquehanna and Connecticut) to be more useful. But much remains to be done. We urge that FWQA be encouraged to continue to develop greater capacity for this. Standard-setting is a vital element of such planning, and should only be done by FWQA in cooperation with the states. Basin planning must be flexible and use the talents of every agency.

Indeed we would envision the comprehensive planning process as the proper point in the overall set of activities to build the factual basis for systematic review of standards. It is removed from the actual standard setting procedure and from the enforcement process. But it is the place where costs, monetary and non-monetary, of achieving different standards can be reviewed dispassionately and matched against the level of benefits which that standard represents. The results can then be fed by FWQA into the standard setting process with its eventual feedback effect on hardware planning and enforcement. Obviously the results of previous hardware planning and enforcement would be an input to the review of standards in the comprehensive planning process.

But perhaps the key characteristic of the Corps that should be exploited here and which is probably not compatible with the mission of a basically environmental protection agency is its capacity to bargain. It is tempting in the niceties of bureaucratic rhetoric to overlook this kind of tough reality. This is not and should not be bargaining with respect to standards and enforcement

of compliance in the sense associated with water quality. Rather it is the bargaining needed to achieve political acceptance of financial commitments between the Executive and the Congress on the one hand and local governments on the other hand to achieve such standards.

The Corps' critics are always quick to point to its effectiveness in this arena. Should it be denied to this pressing area of need? And the objectives of such bargaining must be the creation of effective regional administrative units and effective waste management plant capacity and other water quality measures. The Corps very process of project development lends itself to this. Its large, well-established and competent field staff and wide range of other public works activities are essential. They have proven delivery capability to get things done.

Finally, it has been suggested that the option of direct Federal construction should be developed to be used selectively and added where other means have faltered. If this is to be pursued, we can identify no convincing argument why any other agency should be asked to duplicate what would have to be a weak version of this agency's existing capability. It must be recognized that the Corps has probably built more waste treatment plants than any other entity in the world and under a wider variety of climatic conditions if not for as wide a variety of wastes as called for in many municipal systems. Indeed, as we have mentioned elsewhere in this report, the treatment plants at the many hundreds of Army and Air Force bases across the nation offer an untapped opportunity to test and develop advanced waste treatment processes.

The following table demonstrates the performance level of Army installations (Air Force data could be collected for those installations which are Corps responsibility but are not listed here).

(FY '69 CONUS, Alaska and Hawaii Performance

Level of Treatment	CONUS	Alaska	Hawaii
Secondary (million gals)	27,000	--	615
Primary (million gals)	7,700	601	--
Untreated * (million gals)	53	--	51
	34,753	601	666
Effective Population **	1,095,000	24,000	25,000

* Consists largely of cooling water (AMC) in CONUS and one complex in Hawaii where Congress has refused to appropriate requested funds until local municipal wastes are treated, and several other problem installations.

** Effective population is defined as all residents plus 1/3 of non-residents.

Note that of our total U. S. population (205,000,000) only 131 million are serviced by sewers, and eight percent of these (11 million) are without treatment. Some 44 million are served by only primary treatment and 76 million are served with secondary treatment. Thus only comparing the sewered population to Army installations, and ignoring the many people who need sewer services, some 78 percent of the Army wastes receive secondary treatment (around 85 percent BOD removal) compared to 58 percent of the civilian sewered population.

The vigorous and full development of FWQA's present roles are seen as vital to the success of any mission that might be given to the Corps of Engineers. We believe that the hardware planning role and the construction role that we foresee as potentials for the Corps are complementary to the setting of standards and enforcement which have been developed by FWQA in a partnership role with the states. The municipal grant-in-aid program and the vital research program of FWQA should probably be coordinated quite closely with the role we see for the Corps. We have already pointed out how important we see a strong input by FWQA in basin planning.

Standard-setting is indeed a kind of planning process in its own right. It is important to the enforcement and construction program but it probably should be kept separated. Indeed we might differ, in principle, with last October's shift of the water quality standards program from the Office of Operations to the Office of Enforcement in what was then FWPCA. While we agree with the Commissioner that "all enforcement and regulatory activity in the future should be tied and related to the Water Quality Standards Program," there is always the problem of back pressure from the enforcement effort simplifying achievement by encouraging the relaxation of standards. Obviously we are not in a good position to really judge the merits of this change, but want to make the point that on principle the too close merger of operating and regulatory arms can lead to problems and certainly invites criticism. The Corps is not free of this problem in other programs, but is better able to deal with it because of the applicability of objective criteria and effective intergovernmental and interagency reviews. Such processes do not lend themselves so well to water quality standards.

A not dissimilar problem is faced by FWQA today with regard to the coordination of its grant and enforcement program. Note the statement by Assistant Secretary of FWQA (Carl Klein) that "whether the money comes along or not, we are going to get along with the program. There is no correlation between the Water Quality Act that requires meeting standards and the Clean Water Restoration Act that promises money." This is not a view shared universally by all professionals, particularly those in the states. They saw the justification of one at the Federal level tied to the provision of the other. They also may want control of both the carrot and the stick. In the minds of many, this is the moral dilemma FWQA now faces.

We believe that the bargaining position of the hardware planners--whether they went on to construct or not--would be weakened if they were within the agency charged with enforcement. They should be insulated from any incentive to lower standards as a substitute for raising investment and operating expenditure levels. Yet with responsibility for hardware plans, the Corps would be in a position to be more helpful in its participation in enforcement conferences--a role now sometimes limited to a discussion of waterway debris removal. Some of the scheduling responsibility would be on its shoulders if it went on to the construction role. Enforcement processes would still be free to judge whether or not standards had been met. This is a freedom that would be more difficult to exercise if all functions were in one agency.

In this day of the urban crisis, no overall reduction in any city grant-in-aid program can be envisioned. This program was begun at the urging of city officials and is thus more of a city-aid program than a pollution control program. State formulae allocations, with state-set priority machinery--such as it is, or can be--were built in. Initial preference to small cities has relaxed as the fiscal plight of the big cities became more apparent. Now in the current program the Secretary has been given discretion to use up to 20 percent of the funds as he sees fit. This first year much of that will go to repay states that "prefinanced" the Federal share of past projects. We would envision that in any Federal construction the current FWQA cost-sharing approach would be a basis from which to start and that funds appropriated for that purpose would reduce the demand for FWQA grants. But most of the task of getting plants built to meet enforcement requirements will certainly have to depend upon the FWQA program for assistance even though they may use Corps-developed plans for decision making.

Reshaping the grant program to achieve the regionalization objective must be considered as an alternative to what we are proposing. But our conclusion is that it would be an inherently unrewarding task. Regionalization will not come easily as experience with the former 10 percent bonus shows. The required flexibility in grant awards will not be won easily from the states who now greatly influence the grant distribution. Any measure to achieve the essential project review and commitment by the Congress would be cumbersome at best. Tampering with this program to this extent would surely be resisted by the city interests that backed its initiation and by the concerned state agencies. Since it is needed in its present form we see no reason to attempt that route. As we see the need, grants are really no substitute for the Federal construction approach in the situations where that is called for. And if special cost-sharing is found desirable, the pressure to extend those levels to all in the program would be irresistible. By operating through a separate program at the project level this may be abused, on occasion, but can be controlled effectively overall.

Providing A Range of Options.

A summary overview of the problem involved in achieving clean waters for the entire nation has pointed to two central facts that must be carefully considered in the formulation of an effective program.

First, the problem is not susceptible to single and simple solutions. The circumstances surrounding these problems around the nation are essentially unique and differ for each locality. These differences stem from a variety of regional and local attitudes toward environmental and pollution problems, from the degree of development or non-development, Federal-state relationships, tax and revenue problems, rural, urban or industrial emphasis, social problems, political jurisdictions and juxtapositions, even the amount of natural rainfall and many other factors which occur in a myriad of combinations and proportions unique to each locality.

Consequently, any program focused on achieving direct and early action, particularly to achieve uniformly applied standards within a context of evenhanded enforcement, will require a

spectrum of optional, alternative arrangements that will provide at least one procedure appropriate to each set of circumstances encountered.

Second, this variety of circumstances points to many procedural gaps that would need to be filled in order to eliminate any opportunity for non-action. It is suggested that the capabilities of the Corps of Engineers are such as to fill that need.

Figure 1 is an attempt to illustrate how both of the above concerns might be functionally arranged to display both the extent of options that are needed as well as proposed Corps of Engineers' assistance to close the gaps and existing Corps' activities in water pollution. An explanation of figure 1 follows.

Indicated at the top are the three principal Federal agencies that would be involved. The U. S. Department of Agriculture is omitted to simplify the already complex table.

Listed below that are the nine principal elements of the program, ranging from water quality research and standard setting to organization. It must be recognized that "planning," the third element listed, could be further divided into "framework" and "hardware" levels of detail.

Listed in the left-hand column are alternative options A through F with an indication of whether the action marked by "X" is by one or more of the Federal agencies, by non-Federal entities, or shared by both.

The following notes relate to each of the options shown.

Option A. This would apply in a situation where a large regional system (probably inter-state) was undertaken as a Federal enterprise with the integration of existing local works into such a system under Federal operation. In such a situation, the Federal Government would serve the function of a regional management organization. With respect to the Corps of Engineers, such a function would not be unlike that now provided in many river basin multi-unit water resources project systems.

Option B. This would provide for a Federally constructed system integrated into existing non-Federal systems and operated

Figure I. Alternative Options Needed to Respond to the Wide Variety of Regional Water Quality Management Conditions in the United States in the 1970's

Federal Agencies Involved H - HUD F - FWQA C - CofE		Research	Standards	Planning	Design	Finance[1]	Construct	Operate	Enforcement	Organization	Points of Emphasis:
		F C	F	F C	C	H F C	C	C	F C[3]	C	
A	Fed.	x	x	x	x	x	x	x	x	x	Large regional system, existing works integrated into Federal system.
	Non-Fed.	x	x			x			x		
B	Fed.	x	x	x	x	x	x		x	x	As above but Federal system integrated into existing non-Federal system.
	Non-Fed.	x	x			x		x	x	x	
C	Fed.	x	x	x	x	x			x	x	Federal technical assistance to regions and localities.
	Non-Fed.	x	x			x	x	x	x	x	
D	Fed.	x	x	x		x			x	x	Federal regional coordination.
	Non-Fed.	x	x		x	x	x	x	x	x	
E	Fed.	x	x	x	x	x	x		x		Small local projects.
	Non-Fed.	x	x	x	x	x	x	x	x		
F	Fed.	x	x	x	x		x		x		Private industry with no opportunity to tie into public system.
	Non-Fed.	x	x			x[2]	x	x	x		

(1) HUD - Community facilities program
FWQA- Grant program
CofE- Normal project authorization and funding procedure for water resource projects

(2) Facility investment reimbursed to the states on a long-term basis.

(3) With respect to permits for waste disposal in navigable waters

by a regional organization, entirely non-Federal, or Federal and non-Federal such as the Delaware River Basin Commission. A Corps' "turn-key" construction role would be possible under this option.

Option C. This would provide for Corps' technical assistance in planning and design for implementation by a regional organization or by a locality. Cost-sharing comparable to FWQA grant levels would be the rule but special cost-sharing might be provided in cases where a special Federal interest is justified in the plans developed.

Option D. This would provide Corps' assistance for planning as a means for developing a regional organization to assume subsequent implementation.

Option E. This would provide alternatives for the implementation responsibility at the local level, such as quick response by the Corps of Engineers for planning assistance on request or in some cases extension to a "turn-key" operation.

Option F. This would provide for the important problem of industrial pollution situations where the industry has no opportunity to tie into any public system. Where desired, Corps' assistance could also extend to a "turn-key" operation.

Financing. For Options A through E, financing would be on a cost-sharing basis generally in accordance with present arrangements under the grant programs of HUD and FWQA, or through the normal Corps of Engineers' Civil Works authorization and budgeting process on a project-by-project basis and annual appropriations. Need for special financing for communities with debt limitations may be explored. With respect to Option F, the cost for planning, design and construction could be funded by the state government under an agreement for repayment on an interest and amortization basis over a period of years by the industry concerned, perhaps under terms similar to those applicable to Federal water supply storage in reservoirs now administered by the Corps of Engineers. Massachusetts, for one, is developing such an arrangement. This is included here for completeness and, as is true of all these options, needs further study.

First and Second Generation Investments. It must be recognized that the above not only would apply to a wide variety of situations over the nation but that variation over time is involved. Major increases in cost-effectiveness of waste treatment are available and are needed to meet the standards being developed for our waters. If they are to be realized we must begin now to build the organizations needed to bring them about. Therefore, we envision the Corps of Engineers' making a major contribution to the design and evolution of regional waste treatment systems that will provide the "second generation" of investment as well as near term investments. Not only field-based engineering, project and planning management skills are required for this effort, but also the ability to act as intermediary to produce binding commitments between particular local governments and the Federal Congress and the Executive.

Cooperative Development of Improved Water Quality Planning.

It should be obvious from our review to this point that a great deal of planning effort has been done in the name of water quality. We wish the results were better and feel we have identified the goals to be sought for improvement. But this would be incomplete if we did not spell out the cooperation that will be required between the FWQA and at least the Corps to achieve an efficient realization of these goals. The essence of this is essentially a joint planning, programming and budgeting approach applied to the development of improved water quality planning.

The first step involves developing an immediate response on the part of the Corps of Engineers' survey and comprehensive planning program to the need for water quality plans upon which to have FWQA grant approvals. This is a need for a level of planning detail that falls short of the hardware level and corresponds to the comprehensive planning level. The second is to identify regional allocation for hardware planning. The third is to develop a procedure for control and programming of a federal construction initiative.

Planning for More Effective Grant Awards.

On July 2, 1970, the FWQA listed in the Federal Register (Vol. 35, No. 178) new regulations for grants

for the construction of treatment works. In essence this is a step to ensure greater cost-effectiveness by requiring that such grants will be made only if they conform to a basin water quality plan and to a regional and metropolitan utility system plan. The states are directed to submit such plans for approval. Grants are to be given only if they are for included projects or if on other grounds they are found to be effective. Future use of the water, integration of systems, future development, relationship of other investments and the like are to be considered.

The states need the full assistance of all Federal agencies in developing these plans. FWQA has used its knowledge of some 1300 sub-basins to develop priority groupings to indicate where this assistance would be most fruitful. It is proposed that the Corps match its on-going survey program to these priority groupings. Those survey authorities which are found to provide the basis for such assistance would be identified and funds immediately sought to provide it. In every case we anticipate that these existing planning efforts will have available some of the information needed and for a lesser cost than states or their consultant staffs could provide. The Corps would assist FWQA regional staffs in applying this data to the needs at hand.

For the coming year this effort could provide Corps' field personnel an opportunity to provide assistance and become more familiar with the opportunities for water quality planning. We would propose that a memorandum of understanding be drawn up between the agencies as a basis for their initial assistance and future cooperation in support of the new grant regulations.

Program Development for Hardware Planning.

The Corps of Engineers' now provides low flow augmentation for water quality in many of its reservoirs. Existing PPBS procedures require the

development of physical needs estimates--reported by region in terms of million gallons per day flows required to meet water quality standards. This is over and above the results of secondary treatment and over and above flows that will be provided for other purposes. It is recognized that such needs estimates are "soft" and need to be strengthened. A task force to accomplish this is being formed at this time. It is suggested that it must concern itself with the appropriate means to identify a more meaningful and useful estimate of the need for waste treatment and water quality investments. The residual over secondary treatment should be partitioned into a fraction that can and will probably be met with advanced waste treatment and that which should be met with low flow augmentation. This is probably a judgment that must be specific to the particular stream reaches involved since there is not a simple one to one tradeoff. Advanced waste treatment is usually specific to particular waste constituents--BOD, nitrogen or phosphorus, suspended solids, Ph, color, etc. Low flow augmentation affects all or most constituents to some degree but not uniformly nor in the same manner in every case. It also has effects on other values such as recreation, fish and wildlife, estuary habitat and the like. It may be preferable to develop a simple national model of needs based on BOD loadings for all projected population and industry and the existing FWQA facilities model whose results would be sent to the field for modification following specified guidelines. But the main point is that FWQA and the Corps should cooperate more closely both at the Washington and field levels in the development of needs estimates so that they are consistent between programs as well as within. This should be pursued whether or not the Water Resources Council becomes more active in relating PPB systems in the agencies to the water resources planning effort, as has recently been suggested by the Special Assistant for Civil Functions of the Secretary of the Army.

Improving the needs estimates in the PPB System is one step which is necessary for rational choice within a set of opportunities for planning or construction. But it does not solve the problem of how the set is generated initially within which the choice is to be made. The existing procedure within the Corps' survey program depends heavily upon local initiative suggesting through the Congress that a resolution of one of the Public Works Committees be sought for a study of a problem, or a study be authorized by specific legislation. Comprehensive planning is usually initiated through the Water Resources Council. These arrangements can be taken as given and the question is do they need to be supplemented.

Whether as a means to stimulate a resolution, separate authorizing legislation, WRC comprehensive planning or direct action under any general legislation that may be forthcoming, it is suggested that the Corps of Engineers and FWQA proceed jointly and immediately to identify a more complete list of study areas than could be done by either alone. A "worst-first" criterion should be applied as well as the opportunity to achieve Federal objectives more effectively and expeditiously. FWQA obviously has data and expertise here and in the field to provide much of the technical guidance needed. From its experience in enforcement, grant awards and planning it should be able to help identify where hardware plans and related water resources development could make the most effective contribution.

This effort should be carried out to identify at least three kinds of situations which appear to require different degrees of involvement. First, would be situations where a general overall plan formulation is required which would feature water quality, but where limited comprehensive planning has gone on in the recent past. Such a situation is just getting underway in the Southeast New England Study under the leadership of the New England River Basins Commission. Here the inventory of both current

water quality hardware plans and other water development plans with quality relationships needs to be built up as well as consideration of organizational problems.

Second would be situations where there is no shortage of other water development plans but hardware and organizational work for water quality is needed. For example, in the Susquehanna where a better than average Type II study has been completed--the problem is to get the project mix formulated to bring into being the most effective water quality systems.

Third would be situations where both kinds of planning have been done in a technical sense but operationally they have not been formulated together, and agreements have not been made on roles and responsibilities that insure organization and action. San Francisco Bay has in hand a regional hardware plan that at least seems to clearly indicate what should be done in the first phase of construction of a regional waste water treatment system. Phase I leaves a number of options open for Phase II, some of which involve close interrelatedness to water supply for industrial, irrigation and possibly municipal use. Some other water projects are in hand that could be quickly related to the overall problem of enhancing the aquatic environment of the Bay region. Washington, D. C. and the Potomac, Dallas-Ft. Worth and the Trinity, and the Merrimack River may all fall into this category where study of alternatives and data collection are not the problem so much as the formulation of plans which can get agreement and action.

Using Military Bases to Confirm Technology.

The many military bases of this nation provide an opportunity for the development of technology that should be explored further. The obvious advantage is the degree of control of inputs that is available--not so much ability to manipulate, as to identify the

real magnitude of background variables. It should be possible to design a sample of military bases knowing exactly the composition of the wastes available, present treatment, and the climatic and related considerations. Advanced waste treatment facilities needed to meet water quality standards might then be designed to provide calibration testing of the results. The point is that so little of this technology is in place, so little information is available on operating results, that designers are forced to use laboratory results for the processes with little assurance that these can in fact be obtained in practice. Several of the experts in the field with whom we have consulted point to this as a concept that should be explored.

We recommend that this be approached in three steps. First, a qualified consultant be asked to review the merits of the concept and, with the assistance of a panel of experts including officials of the Federal Water Quality Administration, make recommendations to the Chief of Engineers. This report would identify the need for this kind of calibration information and the limitations of military bases particularly from the point of view of the mix of industrial wastes that would be found in municipal systems but not on military posts. It would also indicate the factors to be considered in designing such a program of advanced waste treatment testing and the justification for such investments on military bases irrespective of research considerations.

The second and third steps would depend upon the results of the first. A program design would need to be prepared, authorized and funded within guidelines agreed to as a result of the consultants' report. Then the actual construction, operation, data analysis and interpretation step would require careful review of organizational relationships within the Corps and coordination with FWQA.

APPENDIX I TO PART II
A REGIONAL WASTE TREATMENT SYSTEM FOR CODORUS CREEK, PENNSYLVANIA*

INTRODUCTION

The objective of this pilot study was to analyze the feasibility of regional treatment of the five sewage service areas of a sizable county. All likely combinations of treatment and collection facilities which transport wastes by gravity are considered, including a combined system consisting of all five service areas.

BACKGROUND

The Susquehanna Study[1/] assumed, as the water quality standard, that every stream reach should have a dissolved oxygen (DO) concentration of at least 5.0 parts per million (ppm). This standard governed all designs for water quality control projects, except for one overriding constraint: the recommendation that all sewage receive secondary treatment (85 percent BOD removal).

If it was determined that a particular sewage flow, after receiving secondary treatment, would result in a DO concentration less than 5.0 ppm in the receiving stream, then one of the following measures was recommended:

1. The service area should provide "advanced waste treatment," which means more than 85 percent BOD removal and, in some cases, includes induced aeration.

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* This is extracted from a larger staff report prepared by John J. Broaddus, Baltimore District, Corps of Engineers.

1/ Susquehanna River Basin Study Coordinating Committee, Susquehanna River Basin Study--Appendix F, (Washington, D. C.: Government Printing Office, 1970).

2. The sewage should be piped to a point where the assimilative capacity of the receiving stream would be large enough to insure a DO concentration of at least 5.0 ppm.

3. Reservoir storage should be provided for low flow augmentation.

In general, each decision as to the best method of satisfying water quality criteria was made considering only the flow and BOD concentration of one sewer service area. A preliminary draft[2/] of the report on the Susquehanna Study, however, contained a recommendation that "feasibility studies be conducted on broad regional bases to determine the most efficient and effective combination of collection, treatment, and operation." The report further recommended that "such studies should be undertaken at an early date...to determine whether economies of scale in construction or operation merit combining systems of sewage service areas."

This is a report of a preliminary study, such as suggested in the preceding statement, of the economics of regionalizing the sewage treatment facilities of one of the regions surveyed in the Susquehanna Study. The region is York County, Pennsylvania, and it includes the sewer service areas of York, Spring Grove, Hanover-Penn Township, Dallastown-Yoe, and Red Lion (see Figure 1). These service areas could be combined into one sewer service area, with one treatment plant, simply by connecting them with a series of relatively straight gravity pipelines. An advantage of such a system would be a possible saving in waste treatment costs. A disadvantage would be the added cost of transporting all of the sewage by pipeline to a single plant, which would probably be located at York. The question to be answered is: Does the reduction in treatment cost resulting from regionalization outweigh the increase in collection cost?

2/ Susquehanna River Basin Study Coordinating Committee, Susquehanna River Basin Study--Supplement B, (Washington, D. C.: Government Printing Office, 1970).

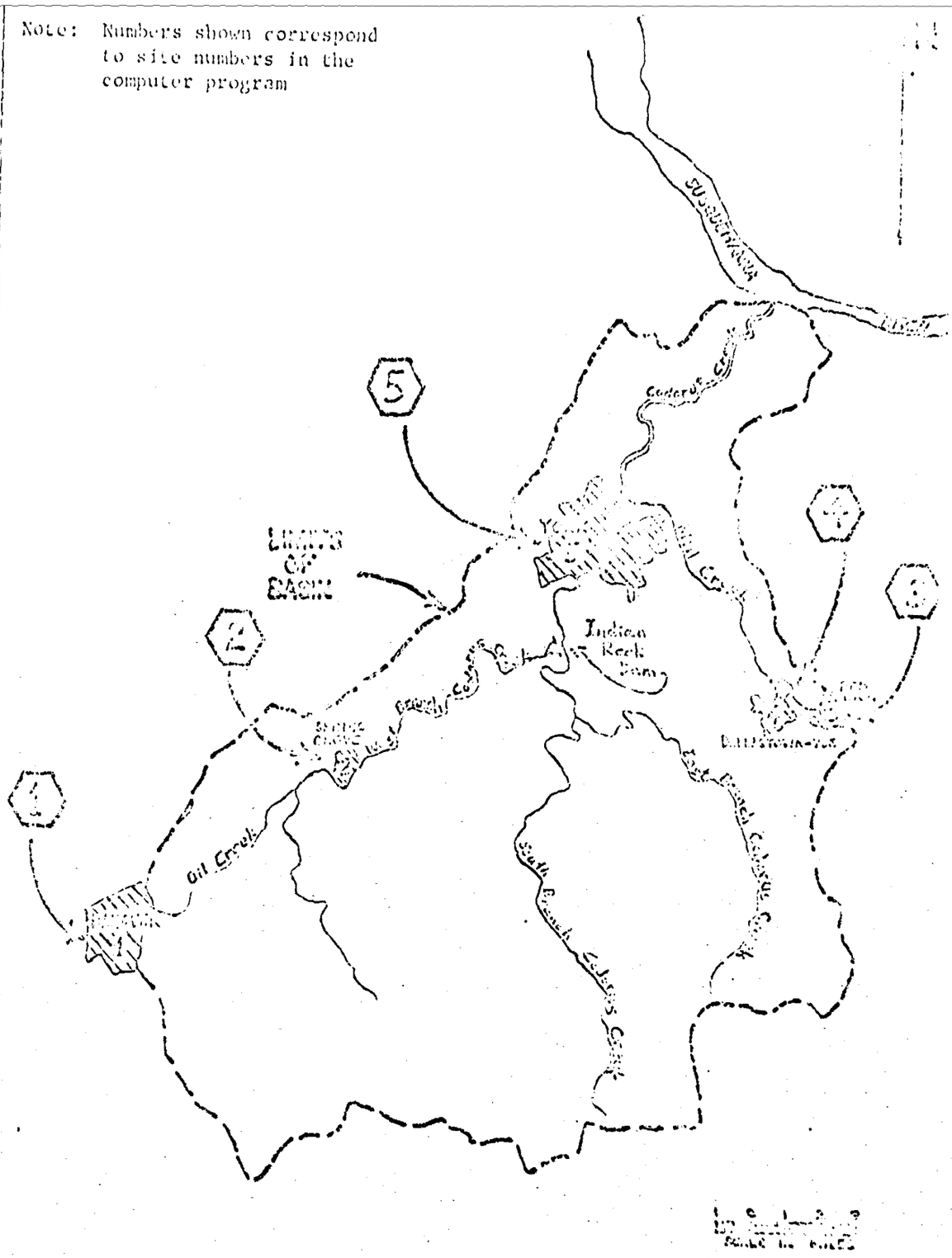

Fig. 1. Location of study area

TABLE I
SEWAGE SERVICE AREA PROJECTIONS, YEAR 2000 3/

Sewage Service Area	Population	Sewage Flow, mgd	BOD, mg/l
Hanover-Penn Township	62,200	8.9	825
Spring Grove	11,200	30.4	372
Red Lion	12,900	1.6	320
Dallastown-Yoe	10,500	1.8	175
York	236,500	53.2	248

3/ Susquehanna River Basin Study Coordinating Committee, Susquehanna River Basin Study--Appendix F (Washington, D. C.: Government Printing Office, 1970).

There are 36 possible combinations of treatment and collection facilities for the five service areas, based on the following assumptions:

1. A planned, low-level, recreation impoundment on the Susquehanna River, which will create a pool at the mouth of Codorus Creek, rules out the technical and political feasibility of discharging waste treatment plant effluent directly into the river.

2. Cost effective pipeline schemes involve only gravity flow, rather than pressure.

3. Economies of scale exist in the construction and operation of treatment and collection facilities which rule out the feasibility of treating a portion of a service area's sewage while piping the remainder of the sewage to another plant. Economies of scale also rule out partial treatment (treatment less than adequate for the service area's usual receiving stream) and piping of sewage. All of a community's sewage is either treated within the service area or transported to another plant.

OPTIMIZATION

This study determines the least expensive combination of treatment facilities and by-pass pipelines, and thereby optimized the sewage treatment plan of the York County study area, based on economic efficiency.

The average annual costs of the 36 systems are approximately equal, but the cost of System 16 was somewhat less than the costs of the others. System 16 includes transmission pipelines from Hanover to Spring Grove, Spring Grove to York, Red Lion to Dallastown, and Dallastown to York, and a treatment plant at York which treats the sewage from all five service areas. The inside diameters of the pipelines are 30, 60, 12, and 18 inches, respectively. The treatment plant would be capable of removing 98 percent of the BOD from the region's 95.9 mgd of sewage. Although the construction cost of System 16 ($68,020,000) exceeds those of 19 of the other systems, its average annual cost ($6,108,000) is the lowest of all 36 systems.

DISCUSSION OF RESULTS

Regionalization of the major sewage treatment facilities of York County is marginally superior to the continued development of individual service area plants, based on economic efficiency. It is impossible, however, to make a very positive statement regarding the economic feasibility of regionalization because of (1) the small difference between the estimated average annual costs of the most efficient and the least efficient systems, and (2) the preliminary nature of the data.

The sensitivity of the results to variations in the economic assumptions is illustrated by considering the choice of interest rate. This thesis assumes an interest rate of 4.875 percent, which is the rate currently (fiscal year 1970) being used by federal agencies in computing the costs of water resources projects. An interest rate of 8.0 percent, however, is more realistic when considering a project to be financed by the sale of municipal bonds. If cost estimates in this report had been prepared based on an interest rate of 8.0 percent, it seems reasonable that the

systems with the highest ratio of pipeline costs to total construction cost would have the smallest increase in average annual cost over the average annual cost computed using 4.875 percent. This is because of the 30 year life assumed for treatment plants and the 60 year life assumed for pipelines. The result obtained from the analysis using 4.875 percent, therefore, would probably be reinforced if the analysis was repeated using a higher interest rate.

Another factor which might reduce the relative cost of a regional system is the time lag between the arrival of peak sewage loads from two or more service areas which are using one treatment plant. The cost estimating procedure used in this thesis assumes the design capacity of a multi-service-area waste treatment plant is determined by adding the design flows of all contributing service areas. It is conceivable that, due to the nature of individual service area sewage flow patterns, a regional treatment plant at York would not require the capacity which the procedure used in this thesis indicates.

In spite of all the qualifications, it is significant that the economic analysis indicates the superiority of regionalization in York County. All non-monetary considerations seem to favor regionalization. Consider the effects of a system which would provide adequate treatment at each of the five sewage sources and discharge effluent into the nearest receiving streams. Below each discharge point (two on Codorus Creek, two on Mill Creek, and one on Oil Creek), there would be a substantial decrease in the DO concentration in the stream. As a result, the minimum DO concentration in each of the five stream reaches would be 5.0 ppm. A DO concentration of 5.0, although generally considered adequate for the support of aquatic life, does not represent the ultimate in stream quality control. Moreover, if <u>no</u> sewage is discharged into a particular stream reach, the stream would maintain its upstream DO concentration which, for a stream in the study area, would be approximately 7.2 ppm. This 2.2 ppm difference in DO concentration is an important physical inequity between regionalization and single-service-area waste treatment which is not considered when comparing only relative economic merits.

Another factor not evaluated in the economic analysis is the increase in weed and algal growth which usually results from sewage discharges, especially in the Northeastern United States. Unless nutrient removal is included in the waste treatment process, algal blooms may dominate stream reaches below sewage outfalls, even if the sewage receives high-level biological treatment. However, if upstream sewage is transported by pipeline all the way to the most downstream service area for treatment, the upstream reaches should be entirely free of algal growth, leaving the lower reach as the only one with any algae (this lower reach, of course, would have experienced algal blooms anyway, even without regionalization).

Sewage effluent from the Spring Grove service area causes severe discoloration of the West Branch of Codorus Creek below Spring Grove and upstream from York. There is a flood control dam on the West Branch of Codorus Creek, three miles upstream from York. This structure, Indian Rock Dam, is a component of the protective works for York, which consist of the dam and channel improvements on Codorus Creek in the city itself, and which provide a high level of protection at York. The possibility exists that, if the pollution problems caused by the Spring Grove effluent (discoloration, DO deficit, algae) are eliminated, a trade-off between flood control and water conservation could be realized at the Indian Rock Dam. In other words, perhaps some of the flood control storage in the project could be used to create a conservation pool, which would partially satisfy the area's ever-increasing demands for water supply or water-oriented recreation, or both.

High-level waste treatment at Spring Grove would probably not prevent all stream discoloration, nor would it prevent the growth of algae unless the treatment process includes nutrient removal. Transporting Spring Grove's sewage to the York treatment plant would not eliminate "color pollution" from the Codorus Creek Basin but it would remove it from the West Branch, thereby eliminating the water quality constraint from the multiple-purpose use of Indian Rock Dam.

In summary, there are three specific beneficial effects of waste treatment regionalization which are not evaluated when comparing system costs. These effects are:

1. The increase in upstream DO.

2. The elimination of upstream algal growth.

3. The elimination of stream discoloration in the West Branch of Codorus Creek and the subsequent enhancement of multiple-purpose use of Indian Rock Dam.

The sum of these effects would result in both tangible and intangible benefits. By maintaining DO levels at 6.0 or 7.0 ppm, instead of 5.0 ppm, the upstream reaches of the Codorus Creek Basin could conceivably support trout fishing. The increase in DO level, the prevention of algae, and all other effects of the complete elimination of pollutants would also enhance all water-oriented recreation activity, especially if they permitted Indian Rock Dam to be used for recreation. The value of this enhancement could be partially determined by assigning a monetary value to a visitor-day, estimating the recreational potential in terms of expected annual visitation, and computing average annual dollar benefits. Moreover, the creation of an opportunity for such a high-quality recreational experience would be considered enhancement of the social, as well as physical, environment.

The use of Indian Rock Dam for water supply would mean the creation of a new water source for the expanding York water service area, whose municipal and industrial water needs are projected to increase by 100 percent by the year 2000. A tangible benefit could be attributed to this use based on the cost of the most likely alternate water source which York would develop in lieu of the Indian Rock Dam.

CONCLUSIONS

There are two conclusions regarding the feasibility of regionalizing York County's major waste treatment facilities:

1. The estimated average annual cost of a completely regional system is $6,100,000. The estimated average annual cost of a system without regionalization is $6,600,000. Waste treatment regionalization in York County, therefore, is economically feasible.

2. Several technical, economic, aesthetic, and social considerations, not evaluated in the engineering-economic analysis, seem to favor regionalization. Without regionalization, upstream pollution is only reduced; but if treatment facilities are combined at York, upstream pollution would be eliminated.

SURVEY OF RELATED WORK

There are several recent studies which, with respect to the problems considered or the techniques employed, are similar to this thesis.

One of these studies[4/] optimizes the waste treatment of several service areas along the lower 70 miles of the Kanawha River. Treatment levels are determined such that the total cost to all service areas is minimized, subject to the constraint that the water quality standard is maintained throughout the reach.

Another study[5/] develops an analytical model which considers by-pass piping as a tool for regional water quality management. Efficient solutions to a large scape problem are sought using linear programming and data based on the Delaware estuary.

The most recent paper[6/] is a water supply study for the James River (Virginia) region. The study uses nonlinear programming to find the most cost effective mix of alternatives (reservoirs, weather modifications, wells, desalination, and waste water reuse) to satisfy future water demands within the region.

4/ W. N. Fitch, P. H. King, and G. K. Young, "The Optimization of the Operation of a Multiple-Purpose Water Resource System" (paper resented at a meeting of the American Water Resources Association, San Antonio, Texas, October 1969).

5/ G. W. Graves, G. B. Hatfield, and A. Whinston, "Water Pollution Control Using By-pass Piping," Water Resources Research, February, 1969, pp. 13-47.

6/ G. K. Young and M. A. Pisano, "Nonlinear Programming Applied to Regional Water Resource Planning," Water Resources Research, February, 1970, pp. 32-42.

APPENDIX II TO PART II

RENOVATED WASTE WATER--AN ALTERNATIVE SOURCE OF MUNICIPAL WATER SUPPLY IN THE UNITED STATES[1/]

The optimal solution to increasing municipal water demands and water quality deterioration may rest with waste water renovation. This would allow for purification of sewage effluent through advanced waste treatment, and would make this high quality water available on-site for municipal use. The idea of reusing water is not new, nor is it unique. The seemingly radical element is attributed to the degree and proximity of reuse. It is estimated that 60 percent of the U. S. population reuses water that has been used upstream.[2/] In some instances where the water supply intake of one city lies immediately downstream of the sewage outfall of another, or where tidal influence returns the flow of a city's effluent to its water supply, water systems currently do use waste water.

Numerous factors may affect the practicality of using renovated waste water for municipal water supply. Among the most important of these factors are: a) the availability of high quality effluent, b) a demand for some purified product of this effluent, and c) the availability of proper technological and organizational capabilities to allow for such usage.

1/ This section is extracted from a draft report of this same title by James F. Johnson, Economic Evaluation Branch, Planning Division, Office of the Chief of Engineers.

2/ Ernest F. Gloyna, "Major Problems in Water Quality," Water Research, (eds.) Allen V. Kneese and Stephen C. Smith (Baltimore: The Johns Hopkins Press, 1966), 11. 479-494.

Incremental Cost and Utility of Treated Sewage Effluent.

The various purposes for which renovated waste water can be used impose substantially different demands for water quality. In order to use renovated waste water for certain "higher order" purposes, effluent will have to be treated to a high degree. As communities are required to provide additional treatment for their sewage effluent, the resulting product will be of high quality. This high quality effluent will support a large number of different uses without additional treatment; and with slight additional treatment it would enable even the highest quality-demanding uses. For instance, the quality provided by coagulation and sedimentation, and rapid sand filtration processes (Table 1) would enable use through directed-piping for low quality industrial supply, non-contact recreation ponds, and indirect municipal use through limited aquifer recharge. Effluent of this quality would be produced in locations where these processes are used for phosphorus removal. Where carbon adsorption is needed to provide very high removal efficiencies for organic materials, a higher quality effluent will be produced. This effluent would be suitable for such purposes as industrial process water, body-contact recreation, and long-term aquifer recharge. The small cost increment of 4 cents per 1000 gallons in larger systems beyond clarification and filtration would make this effluent competitive with alternative sources even where such high quality is not required of waste treatment facilities. On this basis, some municipalities that are required to bring removals of BOD and phosphorus to about 95 percent would be within about 5 cents per 1000 gallons of producing a potable supply (based on 100 mgd), and those requiring higher removals of 96-97 percent BOD removals may need only to increase the depth of carbon columns and disinfect to produce a potable product for less than a few additional cents.

Build-up of Inorganic Materials.

Unfortunately, many of the areas in which scarcity of water supply is great also are those in which the concentration of inorganics, or dissolved solids, is large. Because 300 to 400 ppm of these inorganic materials are added through each municipal use, the recycling of waste water would tend to build up concentrations beyond limits acceptable for domestic or industrial use. The concentration of inorganics is determined by a combination of factors,

TABLE I

INCREMENTAL COST AND UTILITY OF TREATED SEWAGE EFFLUENT

Treatment	Cost/Dollars per 1000 Gallons[1] 1MGD Plant	10MGD Plant	100MGD Plant	Application[2]
Secondary				Non-food Crop Irrigation
Coagulation-Sedimentation & Rapid Sand Filtration	.042	.038	.034	General Irrigation Supply Low Quality Industrial Supply Recreational Water Supply Short-term Water Recharge
	.080	.035	.016	
Carbon Adsorption	.165	.080	.039	High Quality Irrigation Supply Good Quality Industrial Supply Body-contact Recreation Long-term Ground Water Recharge
Electrodialysis	.220	.140	.090	High Quality Industrial Supply Indefinite Ground Water Recharge
Disinfection	.012	.009	.006	Potable Water Supply

[1]Robert Smith, "A Compilation of Cost Information for Conventional and Advanced Wastewater Treatment Plants and Processes," (Unpublished Report, December 1967).

[2]David G. Stephan and Leon W. Weinberger, "Wastewater Reuse - Has it Arrived?" Journal of the Water Pollution Control Federation, XL (April, 1968), pp. 529-539.

most notably the nature of rock materials, and the climatic conditions which affect the hydrology of an area. For the most part, hydrologic conditions account for the greatest variation in dissolved solids content in surface streams of the United States. Areas of greatest precipitation and runoff such as the Pacific Northwest, the Southeast, and the Northeast by and large have the lowest concentration of dissolved solids. Likewise, the Great Plains and Southwest have the lowest precipitation and highest concentration of dissolved solids.

Although 500 mg/l has been recommended by the Public Health Service as a limit for dissolved solids in drinking water, no record has been found of the basis for establishing this standard. In fact, concentrations greater than 500 mg/l are found in the treated supplies of several cities in the West. Industrial use for boiler feed and certain types of processing probably are more limiting factors than drinking water standards. Boiler feed water has low tolerance limits for dissolved solids at high temperatures and pressures; limits on inorganics are 500 mg/l at operating pressures above 2000 psi. Certain types of process water require even lower levels of dissolved solids. For instance, dye operations require less than 300 mg/l.[1/]

Several methods are available for the removal of inorganics from waste water. These are distillation, freezing, reverse osmosis, electrodialysis, and ion exchange. These processes also are used to purify saline or brackish waters. Distillation, freezing, and reverse osmosis separate the purified water out of the waste water, and are most practical where concentrations of inorganics are great. Ion exchange and electrodialysis remove the inorganics from the waste water and are more practical where concentrations of inorganics are low. At present, the most economic process for the removal of dissolved solids from waste water is electrodialysis.[2/]

1/ Durfor and Becker, op. cit., pp. 18-19.

2/ In this technique, ions are caused to migrate to positive and negative electrodes by an electric potential. With cation (positive charges) and anion (negative charged) permeable membranes placed alternately between these electrodes, alternative compartments become diluted. This presently is limited to removal efficiencies of about 50 percent on inorganics.

The increase of 300 to 400 ppm of inorganics with each municipal use would preclude the operation of a closed system without treatment for solids because concentrations soon would exceed tolerance limits. Three options are available in recycling to deal with this problem: (1) renovated waste water could be diluted with fresh water of lower dissolved solids content; (2) partial removal of dissolved solids could be achieved through advance waste treatment; or (3) there could be some combination of these. Water supply systems with high concentrations would be limited to the latter two options, because dilution alone would not offset the buildup from municipal reuse. Therefore, systems with high inorganic concentrations would have to include the additional costs of electrodialysis or some other process as a part of complete renovation of waste water for certain industrial uses and for domestic potable use. This cost would be substantial, amounting to about 9 cents per 1000 gallons even in larger systems.

Practicality of Municipal Usage

Alternative Water Supply Situations.

The costs for reservoir storage and transmission from distant sources are largely for construction although transmission power costs may be significant in some situations. Because of continually increasing costs for construction, it is likely that the distances over which water can be transported in competition with renovated waste water will decrease considerably. Nevertheless, extensive water transmission projects such as the Feather River and Central Arizona proposals have been authorized, and these appear to be just the beginning. Other current proposals include the transport of Mississippi River water to West Texas, and the more distant hope of transporting Columbia River water to the Southwest. By way of comparison, one study has indicated that reclamation of secondary effluent through groundwater recharge could produce water at a cost of 10-15 cents per 1000 gallons (based on 400 gpm plant), whereas the cost would be on the order of 17 cents per 1000 gallons for Cannonsville water and 22 cents per 1000 gallons for Feather River water. 1/

1/ John H. Peters and John L. Rose, "Renovation and Reuse of Sewage Plant Effluent in Nassau County, Long Island, New York," Proceedings, International Conference on Water for Peace (Washington, D. C., 1967), Vol. 2, pp. 516-523.

Regional Variation in Practicality

The practicality of using renovated waste water for municipal supply in terms of comparative cost advantage will be affected by two major conditions: (a) scarcity of alternatives to meet these demands, and (b) the high quality of waste water that may make it too valuable to discharge. The manner in which waste water is used may depend on which of these two conditions provides the dominant incentive for reuse, and this would vary considerably among the different regions of the country. The way in which renovated waste water use is expected to vary among the regions of the United States is discussed in terms of these two major conditions.

Southwest.

The scarcity of alternative water sources for various municipal uses already has provided the incentive for certain communities to use renovated waste water for such purposes as lawn irrigation, industry, recreational lakes, swimming, and indirect supply through aquifer recharge. At some point in the near future, communities in this region may be expected to turn to direct use of renovated waste water for at least part of their municipal supplies. Preceding this, however, there ought to be a general increase in the number of communities with directed-piping of renovated waste water to certain municipal users. Indirect use of renovated waste water also may be expected to precede direct reuse where physically possible.

The Great Plains and the Midwest.

The threat of water scarcity is not quite as serious as that of the arid Southwest, although the region can expect increasingly critical periods of water shortage. Direct municipal use of renovated waste water can be expected in this region, although this should not be as widespread as in the Southwest. Such direct municipal use is most likely to occur in the Missouri Basin, and those areas in the south and west of this region. Directed-piping, on the other hand, is imminent through the region in the not too distant future. The increasing waste treatment standards

and growing scarcity of alternative supplies in larger industrial communities of the Ohio, Upper Mississippi, and Missouri Basins should signal the need for this course of action in the next two decades.

The Great Lakes and the Northeast.

The scarcity of water supply may not be so critical as to warrant the direct municipal use of renovated waste water in the near future, although the increasing waste treatment requirements and future industrial water demands enhance the prospective directed-piping of renovated waste water. Such directed-piping to concentrated industrial users would enable communities to use presently available fresh water supplies for domestic potable purposes, while supporting increasing industrial demands with renovated waste water.

The Pacific Northwest and the Southeast.

On the whole, use of renovated waste water is not expected to be widespread because of the availability of alternative sources. In some instances, localized water scarcity and high waste treatment standards may result in isolated directed-piping of renovated waste water for various uses by communities, but it is unlikely that direct municipal use will be necessary in the near future.

Factors Inhibiting the Use of Renovated Waste Water

The municipal use of renovated waste water may be inhibited by certain other factors, aside from its economic practicality in any given situation. These are (a) the hygienic risk associated with use of renovated waste waters, and (b) the nature of institutions dealing with community water supply and sewage disposal.

Associated Hygienic Risk.

In spite of the small percentage of municipal water supply used for drinking purposes, the decision by a community on whether or not to use renovated waste water for direct municipal supply may

well be determined by the hygienic risk involved in human consumption. The element of risk remains in spite of the fact that the quality of renovated waste water compares with that of fresh water sources. Although there is an element of risk involved in using polluted water sources, the situation is much more acute with renovated waste water because of the shortened reuse cycle.

The most serious hygienic problem involves viral infection, particularly polio virus and infectious hepatitis virus. Essentially, the problem involves the ability of chlorination to remove virus, the ability to detect virus, and the risks involved in the presence of virus in a water supply. Advanced waste treatment processes including high levels of chlorination are able to remove virus from water supplies; although critics maintain that however effective, this removal is not complete. For instance, Chang states that some virus will necessarily remain in the water supply, and the numbers remaining will depend on the numbers originally present in the waste water.[1/]

If there is doubt as to the ability to remove virus from water supplies, the burden would then fall on the detection of virus in order to isolate such supplies. However, the detection of virus is difficult to accomplish on a large scale. The process involves the concentration of virus, and their innoculation into tissue cultures for determination of densities. Because the number of virus in treated water supplies are necessarily low, the entire process is both cumbersome and costly. In place of actual detection, the presence of virus is determined by fecal coliform bacteria which act as indicators. It is generally accepted that bacteria such as Escherichia coli are more resistant to chlorination than virus, and that the removal of coliform indicate removal of virus. However, some critics maintain that coliform bacteria are less resistant than virus to chlorination, and therefore cannot be justified for use as indicators.

The possible presence of virus in water supplies gives rise to still another difference of opinion. This involves the determination of what levels of virus presence are acceptable in water

1/ Shih L. Chang and Leland J. McCabe, "Health Aspects of Wastewater Reuse," (to be published).

supplies. Some maintain that presence of low levels of virus and bacteria are advantageous for the purpose of general immunity. Others feel that if low level transmission of virus is accepted as a means of immunization, it should have the same safety factor as dispensation of vaccines. 1/

It is unlikely that an issue involving such deep-rooted philosophical views will be resolved in the near future. It is more likely that communities will be required to evaluate each argument according to their own needs, and under the guidance of state and federal health authorities. On this basis, one can assume that such hygienic risk constraints would limit the operation of direct municipal use of renovated waste water beyond circumstances dictated by economic practicality.

Nature of Institutions Managing Water.

The nature of the institutions dealing with community water supply and sewage disposal also may inhibit the municipal use of renovated waste water. Increased separation in the management of water supply and sewage disposal operations tends to impede the prospect of coordination. Communities vary in the manner in which these operations are organized, according to whether they function as unified or separate and diverse agencies. Municipal water and sewage services can operate (1) under one agency, such as a department of public works; (2) as part of the same government agencies, such as city water supply and county sewage treatment; and (3) as completely separate in structure, such as a private water company and public sewage authority.

Agencies are not anxious to explore alternatives beyond their assigned roles; water companies distribute water and sewage authorities dispose of sewage. The greater the separation of supply and disposal management, the less is the likelihood for coordination involving the use of renovated waste water. Public works authorities handling both water and sewage responsibilities will look to reuse more readily because it is compatible with their role. On the other hand, an autonomous sewage authority

1/ Shih L. Chang, "Waterborne Viral Infections and Their Prevention," Bulletin of the World Health Organization, XXXVIII (1968), pp. 401-414.

may hesitate to consider the possibility of waste water distribution, and a water company may not take this initiative until scarcity is at hand. If use of renovated waste water is to be developed efficiently, water supply and sewage authorities should establish dialogue at the earliest opportunity, in order that the potential value of reuse be realized from the outset.

The profit-oriented nature of private water supply companies also can have considerable influence upon the prospective uses of renovated waste water. Private water companies may be more concerned with the marketing of water rather than the conservation of it. It is difficult to foresee that private companies would take the initiative to use renovated waste water or to encourage reuse if it would affect the marketability of the product in a negative manner. Municipalities concerned with taxation or bonds are more likely to consider the cost savings of renovation than are the private companies which seek to market a highly attractive product with attendant higher production costs passed on to the consumer. Where private companies market their product aggressively, there may be a more immediate need for alternatives such as renovated waste water. In spite of cost savings, however, it appears unlikely that private companies would extend beyond the directed-piping of renovated waste water to direct reuse.

Comparative Cost Analysis at Three Sites

It has been suggested that under certain environmental conditions, renovated waste water might be economically more practical than other alternatives for municipal water supply. This study next provides a cost analysis of selected alternative sources at three sites, Tucson, Indianapolis, and Philadelphia, without attempting to arrive at an optimal solution. At each site, renovated waste water is compared with the most likely source of future water supply, as designated by responsible water management officials. It is recognized that without considering the range of alternatives at each site, one cannot gain a truly accurate evaluation of the practicality of using renovated waste water. Instead, the purpose here is to understand the general practicality of renovated waste water with respect to what water management officials perceive to be the most practical alternative.

Summary

The three case study sites vary markedly in their resource situations, and yet the use of renovated waste water has been demonstrated as a possible practical alternative at each location. The use of renovated waste water can be incorporated into various schemes, depending upon particular resource situations. The factors affecting the future practicality of these schemes may be the more obvious regional variables such as climate, and associated availability of water for supply and waste assimilation; or such local variables as urban land use patterns, and associated distribution networks and concentration of industrial demands.

It has been demonstrated that Tucson may be able to use renovated waste water either directly or through aquifer recharge at a cost differential of about 6 cents per 1000 gallons over Central Arizona Project water. Tucson and other communities which seek to transport future supplies over long distances should consider more carefully the use of renovated waste water for potable supply, either directly or through aquifer recharge.

Indianapolis may be able to use renovated waste water directly at a cost advantage of 1 1/2 - 4 cents per 1000 gallons over water from the proposed Big Walnut Reservoir. The difference would be of similar magnitude if water was piped directly to concentrated industrial users; and under these circumstances, present sources could supply potable water demands. Indianapolis and other communities that face increased waste treatment requirements and inadequate local water supplies should consider the possibility of direct municipal use of renovated waste water for concentrated non-domestic usage.

The cost to Philadelphia of producing renovated waste water may be about 2 cents per 1000 gallons more than Torresdale water, but there actually may be cost savings on the basis of delivery of this water to the southeast or southwest areas of the city. Philadelphia and other communities in which no "shortage" is anticipated should consider the directed-piping of renovated waste water where industrial demands are suitably concentrated, possibly realizing the real but less obvious impact on the cost of distribution within the system.

Consideration of alternative sources of municipal supply should not be hindered by their relative practicality as available at present community distribution points. Production and transfer costs alone may favor a fresh water alternative in particular situations, but renovated waste water may be the most practical choice with respect to ultimate distribution to the consumer. In view of this, water demands and supplies should be examined with respect to particular localized sub-regions within the service area, with greater emphasis on possible savings on water as delivered to these "demand sub-regions" rather than as available at purification plants.

Although much is made of the value of non-conventional alternatives where broad climatic effects point up the need for them, the value of these alternatives seems to be passed over by water management officials in more subtle situations such as where the associated cost of local distribution could be improved. Perhaps categorical thinking regarding production and distribution functions has led to this. What is needed is a greater awareness of the impact of water production alternatives on the ultimate cost savings in satisfying localized demands.

Consumer Attitudes Toward Renovated Waste Water

Although the possible practicality of using renovated waste water for municipal supply may be demonstrated, there is little assurance that it would be used even where more economical than other alternatives. One barrier appears to be the hygienic risk perceived by water management officials. Even if hygienic risk was reduced, it is likely that many managers would forego the consideration of renovated waste water based on their perception of negative consumer attitudes toward this alternative.

But water managers know very little of consumer responses concerning renovated waste water, yet generally consider that the public would not accept it. Ten management officials were interviewed at the Philadelphia Water Department.[1/] Their educational backgrounds ranged from engineering and chemistry

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1/ These interviews were conducted over a period from September-November, 1968, concurrently with consumer interviews in this city.

to general business, and their managerial responsibilities ranged from water planning to waste treatment. Of the ten interviewed, all thought that the consensus of consumer reaction to community consideration of renovated waste water would be disapproval. Discussions with management officials at various other sites throughout the country revealed that the feeling that consumers would not approve of renovated waste water was widespread. This was particularly true in humid environments where managers had given little thought to the possible practicality of using renovated waste water.

Interviewing was conducted at five sites. The sites were Philadelphia, Pennsylvania; Camden, New Jersey; Cincinnati, Ohio; Portland, Oregon; and Tucson, Arizona. Sites were sought where consumers would perceive extremely high or low quality of present supplies, and others where consumers would perceive extreme scarcity or abundance of supplies.

Although cities often go through elaborate means to produce a highly potable water, the delivered product may be viewed by the consumer as of quite different quality. Water suppliers generally attempt either to draw their water supplies from the purest source available, or to purify a polluted source to where its quality is worth boasting about. In fact, the emphasis given by managers to the production of pure water may run contrary to serious consideration of renovated waste water, because of the associated risk of contamination. However, it is unlikely that hygienic risk or aesthetic quality of delivered supplies would be seriously risked through the use of renovated waste water on the basis of present tap water quality as perceived by consumers. Respondents were asked to describe their tap water according to a wide range of characteristics, among which turbidity (suspended material) and odor are most relevant to this discussion.

Turbid tap water was perceived at all sites, in spite of the fact that finished water supplies before treatment were virtually free of turbidity, according to information published by the cities.

It is likely that turbidity is largely the result of seepage through cracked distribution pipes, and such a situation could well introduce the type of hygienic risk that managers associate with renovated waste water. This problem can be more serious than one might suspect. Collingwood has indicated that the presence of animals

in water distribution systems gives rise to strong objections from consumers, and "instances are also known where complaints of dirty water were due to the accumulation in the mains of hard parts of the animals or their waste products." 1/ The implications of such contamination may be far reaching. For instance, a recent sample survey by the U. S. Department of Health, Education and Welfare indicated substantial bacterial and other contamination of drinking water supplies of several cities in the United States. 2/ While these incidents are not meant to imply a situation of hygienic risk at the five sites where perceptions were measured, they do provide a lesson for overall water management policy. Hygienic risk may be increased with the use of renovated waste water, but this may be no greater than the existing risks from other sources.

The odor from tap water presents another interesting difference between published descriptions and consumer perceptions. Although published data indicate no significant odor problems with water leaving the treatment plants, this does not appear to be the case with reference to tap water odor perceived by consumers.

Interestingly enough, it is likely that renovated waste water would be more palatable and less odorous than water supplied at sites where heavy chlorination is applied, on the basis of the purifying characteristics of the activated carbon adsorption treatment. On the other hand, at least part of the odor problem is caused by the same factors as those affecting turbidity, namely seepage into the distribution pipes. This would result in foul and musty odors from decayed matter.

1/ R. W. Collingwood, "Animals in Distribution Systems," Proceedings of the International Conference on Water for Peace (Washington, D. C., 1967), Vol. 3, p. 702.

2/ U. S. Department of Health, Education, and Welfare, Bureau of Water Hygiene, Community Water Supply Study (Washington, D. C.: In press as of this writing).

It would appear that an individual's lack of need to consider alternatives blocks the perception of peripheral alternatives such as desalination. That is, respondents in environments where several alternatives are available are not as aware of peripheral alternatives, even though these alternatives may be less expensive to develop than in arid environments where they may be perceived as practical alternatives.

Recycling and reuse were perceived by only 5 respondents out of the total 221. It is interesting that so few respondents perceived these as practical alternatives, while 117 later indicated some knowledge of renovated waste water. Perhaps the same factor that blocked perception of desalinized water also blocked perception of reuse. Namely, the respondents perceived sufficient alternatives to "preclude" consideration of reuse.

Perception of future adequacy of water resources was a significant factor relating to the respondents' attitudes toward renovated waste water. Relative approval is much higher among consumers who do not perceive their water resources as adequate for peak demands in 20 years. On the other hand, disapproval is greater among those who consider their resources as adequate. It would appear that conditions of environmental stress would favor the acceptance of such innovations as part of a broader range of alternatives. This appears to be born out by the communities which have chosen to use renovated waste water.

From these associations, it can be generalized that arid environments and those experiencing situations of water shortage are more likely to provide the setting for consumer acceptance of community consideration of renovated waste water as a source of supply. Conversely, the humid environments and those which experience situations of adequate water supply or possibly where there is uncertainty about adequacy are more likely to provide the setting for lesser consumer acceptance. In general, different regions of the country will exhibit quite different water supply and demand characteristics. Insofar as the public becomes aware of these water supply situations, we can assume that there will be a concomitant variance in their willingness to accept the community consideration of renovated waste water. Although conditions may vary considerably within any region, it is possible to assign certain characteristic on a regional basis to the United States. In general, it is likely that conditions favoring community consideration of renovated waste

water will be found in the Southwest, Great Plains and Midwest; conditions associated with lower acceptance will be found in the Pacific Northwest and the Southeast. Conditions in the Great Lakes and the Northeast probably would be more moderately associated with lower acceptance of community consideration. Respondents who perceived their present source as polluted were more willing to accept renovated waste water than those who perceived their source as not polluted. This seems natural enough because the polluted source is of a quality more similar to waste water.

From these associations, it can be generalized that the environments where water supply sources are most polluted would provide the setting for greater consumer acceptance of using renovated waste water. Conversely, environments where water supplies are least polluted, other factors being similar, would provide the setting for lesser consumer acceptance of using renovated waste water. As with adequacy of water supplies, different regions of the country will exhibit quite different water quality characteristics in terms of organic pollution. Although particular communities would exhibit quite different water quality characteristics depending upon the particular source of supply, it is possible to assign certain generalized characteristics on a regional basis to the United States based on organic quality of surface waters. Insofar as the public becomes aware of their water supply quality, we can assume a concomitant variance in their willingness to use renovated waste water. In general, it is likely that conditions favoring willingness to use renovated waste water will be found in the Northeast, the Ohio Valley and Midwest, and the lower Great Plains; conditions unfavorable to willingness to use renovated waste water would be found in the Pacific Northwest, New England, and the Southeast. Conditions in the Great Lakes, the Missouri Basin, the lower Mississippi Basin, and the Southwest would be more moderately associated with willingness to use renovated waste water.

One other point of interest relates to the problem of waste water renovation and its relevance to municipal water supply. This concerns the attitude of the public toward the community treatment of waste water, which was measured by the question, "Should communities be held responsible for treating their waste water so that it is no more polluted than when they withdrew it?"

Response was decidedly in favor of communities treating their waste water. Almost 91 percent of the respondents indicated that communities should be held responsible for this. Several of the interview sites such as Camden, Philadelphia, and Cincinnati discharge sewage which now deteriorates water quality and affects downstream users. In many instances, water management officials react negatively to the prospect of additional treatment because of the costs involved, without taking into account whether the public would or would not favor such additional treatment. In discussions with management officials and consumers in Philadelphia, it was apparent that the public is much more favorable toward increased treatment than the management of the water utility. Perhaps in waste disposal as well as in water supply, managers are not wholly cognizant of public attitudes and their significance to management goals and objectives.

Practicality of Using Renovated Waste Water

The practicality of using renovated waste water for municipal water supply varies according to particular environmental conditions. In particular, practicality is tied closely to the quality of effluent discharged by the community and the availability of suitable alternative sources of supply. Increasing waste treatment requirements that limit the discharge of organic wastes and nutrients will result in the availability of a high quality product effluent for many communities throughout the United States. In many instances, both in humid and arid environments, this effluent may be less expensive for satisfying particular urban demands than alternative sources of supply. This should become more obvious in the near future in view of the growing scarcity of good reservoir sites, the increasing costs of construction-oriented alternatives, and the growing competition for state and federal funds necessary for the construction of many of the larger projects. The use of renovated waste water, on the other hand, should become relatively less expensive in time, owing to the refinement in purification technology and the increasing sewage treatment requirements. The nature of this use could vary considerably, depending upon the different water supply conditions throughout the United States. In water-scarce areas such as the Southwest and Great Plains, it may be more practical for communities to consider the direct use of aquifer

recharge of renovated waste water for municipal supply. On the other hand, advanced waste treatment requirements in the Midwest and Northeast may make it more practical for many communities in these regions to consider at least directed-piping of renovated waste water to satisfy concentrated high-volume demands, such as for industrial usage.

Greater emphasis is needed at the national level to assure a coordinated management of water quality control and water supply. At present, various agencies are charged with specific tasks within each of these two problem areas. In particular, more effort is needed to classify, describe, and analyze the resource situations most amenable to advanced waste treatment. Present efforts are piecemeal; apparently being limited to the funding of separate operations in particular communities, apart from any ordering by regions or conditions of environmental stress. The water resource agencies concerned with this problem first need to improve the methods of classifying environmental situations in the United States according to the nature of resource deterioration, the alternatives available to improve the quality of these resources, and the immediacy with which these programs should be put into action. From this, it would be possible to describe more accurately the regions where high quality effluent may be available for meeting future municipal and other water demands.

Technical and Institutional Factors Affecting Reuse

The use of renovated waste water appears to be considered by many water managers as a desperation alternative, one more appropriate for consideration in arid environments. A reversal of thinking is required if renovated waste water is to be considered when it is the most economical alternative rather than when it is the "only" economical alternative. Planners and managers should recognize that several alternative methods are available by which to use renovated waste water, namely: direct reuse; aquifer recharge; directed-piping to high-volume users such as industry; and, possibly, systems combining the distribution of bottled water for potable usage. This study has indicated that while the use of renovated waste water at Tucson may be of more apparent practicality, it also is likely to be of practical value to communities in more humid regions of the country, such as Indianapolis and Philadelphia.

Consideration of renovated waste water as a practical alternative may be constrained by the organization of water agencies in a community or region. In order to incorporate the use of renovated waste water into municipal water planning in an efficient manner, administration of supply and disposal should be effectively coordinated. In communities where separate agencies are responsible for water supply and waste disposal, an effort should be made to establish liaison between them in order to make efficient use of renovated waste water. The situation is most critical where agencies are wholly segregated, such as a private water utility and a public sewage disposal agency.

This may be asking too much of most communities. Nevertheless, renovated waste water is going to be an integral part of municipal water management in the relatively near future, and we should be concerned that communities use this source wisely at the most opportune time. Because of the constraints created by the lack of administrative linkages and inadequate information flows, water management officials may not consider the use of renovated waste water in spite of its possible value. Federal agencies involved in this area, namely the Federal Water Quality Administration, the Corps of Engineers, and the Department of Housing and Urban Development, should consider creation of information services which could take an active role in both disseminating information and providing technical expertise.

Consumer Attitudes Toward Renovated Waste Water

The issues of whether or not the municipal use of renovated waste water is technically feasible or economically practical lose relevance if officials responsible for water management preclude the consideration of such alternatives. Both water analysts and community water management officials have expressed concern that consumers would not accept the use of renovated waste water because of certain aesthetic and hygienic constraints. In fact, however, consumer attitudes are found to vary considerably according to differential perceptions of their resource situations, and certain personal factors. Perhaps the most significant finding is that some of the factors which may affect the economic practicality of using renovated waste water, namely the adequacy and quality of water supply sources, also are associated with individual attitudes toward renovated waste water.

The perceived adequacy of water supply sources to meet anticipated future demands showed a significant association with consumer acceptance of possible community consideration of renovated waste water. Because the scarcity of alternative sources, or the cost of developing them, may signal the need for communities to consider renovated waste water, it is important for managers to be aware that the perception of these conditions also may be reflected in more favorable public support. There also is a significant association between consumer perception of the quality of the present water supply source and attitude toward use of renovated waste water as reflected in willingness to pay. Where communities consider it economically practical to supplement a source of low organic quality with renovated waste water, it is important again for managers to be aware that perception of these conditions by the public may be reflected in more favorable support.

PART III
POTENTIAL PLANNING AND CONSTRUCTION STARTS AVAILABLE FOR IMMEDIATE ACTION

When we began this study it was suggested that we should touch base with a number of field situations to insure a measure of realism and relevancy to our comprehensive analysis. As we became more and more convinced that certainly an immediate "hardware" planning role and in some cases a construction role for the Corps of Engineers was called for we expanded the case study portion of the effort. This is by no means a complete canvass of the opportunities for immediate action and this canvass should be continued. But we feel it represents the kind of varied foundation that is essential to the sound development of a new mission area for the agency. The other parts of the study represent more the application of the synoptic model of policy analysis. This part is more the application of the incrementalistic model of policy analysis.

AN ALTERNATIVE MODEL FOR POLICY ANALYSIS

In other parts of our study we have assumed that by identifying the general areas where there were unexploited and relatively attractive returns to new program initiatives we would be demonstrating how we might move the nation to a higher point on the social welfare function. If the social return from industrial-municipal integration, urban-region systems, basin related management, and extension of the multiple purpose principle would produce more cost-effective results in the attainment of our goals for our aquatic environment, then the means for achieving these should be explored. If the means available through the Corps of Engineers seem to provide the potential for a higher social return they should be recommended. Targets such as treatment works, higher dissolved oxygen, improved natural

habitats, and other action to protect environmental values reflect social goals with respect to the environment. Our analysis was directed at a comprehensive identification of alternatives--all the ways to improve water quality and their means for implementation. To be fully satisfying this approach requires data that at our level of analysis was essentially unattainable in a precise form. Ideally we should have estimated the marginal efficiency of each alternative approach to improve the Federal water quality program. We had to rely on informal judgments gleaned from a broad sample of involved professionals. The test for policy determination was the expectation of improved effectiveness.

This part of the study applies a different kind of test, namely a test that measures the prospect of acceptance. The assumption is that an agency is more efficient in developing new programs that are more closely related to existing programs. Limited alternatives are considered and this allows the full use of limited knowledge of possible outcomes. A variety of ventures are sought; successful ventures are expanded. Success is measured in terms of increased support and facilitation of new alternatives to be considered. The basis of decision is acceptance by other decision makers and the various groups at interest. This approach can also be viewed as an implementation model to be used within the limits imposed by application of the synoptic approach to policy analysis.

First we review some opportunities in a number of river basins to move ahead with the development and implementation of a basin-wide approach to regional municipal waste treatment systems, and the achievement of water quality targets. Then we identify a few metropolitan situations that so dominate their basins and that have considerable planning in hand that the most effective approach is to move almost directly toward a construction role.

THE NEWS STUDY - A FORMAT FOR A REGIONAL APPROACH

The Northeast Water Supply Study offers an approach to program development that must be considered for its relevance to the issues at hand. In response to the crisis of the extended drought of the

1960's the Congress directed the Corps of Engineers to study "...a situation that requires collective action at a still higher level--the level of the Federal Government." Metropolitan water districts and cities acting independently were recognized as inadequate to meet the water supply needs of the future megalopolis that would extend from south of the nation's Capitol to north of Boston. Joint action by cities to meet their waste management needs is far less common than for water supply and may present even greater advantages in terms of economy and effectiveness in the even greater crisis posed by the assault upon the quality of our aquatic environment. It is our conclusion that just as we then crossed "another threshold in the progressive development of national policy," to quote from the analysis of that legislation, it may be time to do so again. And the regional approach advocated then applies now even more strongly.

The NEWS Study has proceeded by first marshalling the engineering alternatives for regional systems. Unlike many prior single purpose studies, it has not stopped there. Concurrently it has launched a thorough review of the organizational alternatives and politico-legal obstacles to regional organization and operation. Also it is reviewing the multiple purpose and environmental opportunities of the engineering alternatives. Indeed it is in the achievement of multiple purposes, multiple means and multiple objectives that a federal role is justified for urban water supply. Existing single purpose agencies will find the water they need but at too high a cost in foregone opportunities as well as in out-of-pocket costs. Armed with an array of alternatives and information, NEWS can begin to develop local governmental and local community leadership assistance in narrowing down the choices and negotiating out the best and most likely to be supported arrangements. Careful development of the roles and obligations of the several participants is showing itself as the essence of creating successful multi-purpose regional systems.

A significant question being explored is the appropriate level of federal intervention, in functional as well as fiscal terms, necessary to launch a regional system. Not only are they asking what costs should the federal government bear but what action should it take directly. Cost-sharing to create a regional system is probably different from that needed to insure the protection of the

federal interest once the regional system is successfully underway. Not only has the study taken two essential levels of approach to planning analysis, engineering and organizational, it has also given primary focus to the integration of the urban region as such, but in the context of the full range of resource development needs and opportunities in each of the river basins involved.

It should be noted that this study embodies the principle that you cannot plan for people, but only with people if the result is to be more than an addition to our library shelves. Plan acceptance depends upon such participation. As this is being written, before the alternatives and principles are fully developed, this participation process has begun. It should be expected that once a beginning has been made on organizational implementation, replanning of engineering alternatives in greater detail, more detailed environmental analysis and specification of multiple use opportunities will be pursued with the close cooperation of local governments and community leaders. The results of this would then be reviewed by the Executive and Congressional Branches of the federal government. Assurances of local cooperation, costs and preliminary designs, justification including the meeting of standards and tests of cost-effectiveness, specification of cost-effectiveness, reasons for the recommendation of the agreed upon investments and reasons for the rejection of other feasible alternatives would all be detailed. Upon acceptance by the federal government, a firm partnership, hopefully, will have been consummated and, subject to appropriations, work can begin. The result should be far different than what would have resulted without strong federal participation.

While the NEWS region is large, the task has been made more manageable by early selection of those urban regions with the most pressing problems--Washington, New York and Boston. Need, not readiness to proceed, is the guide. It is of particular interest here to note that in each of these cases the alternative most politically feasible and still competitive cost-wise may be one that combines early action flow regulation sufficient to provide time to clean up a now polluted nearby source. The Merrimack for Boston, the Hudson for New York and the Potomac for Washington, once rid of pollution, have a chance to be accepted as water supply sources. But this may depend

on a firm joint responsibility for supply and environmental quality protection at the source that is now missing and not likely to result without strong federal incentives. How should the federal government provide them?

A Proposal for a NEWMAN Study.

We would urge that a very similar program should be sought for a waste management study in the Northeast. Indeed the NEWS Study should transition to become a NEWMAN (Northeast Water Management) Study. Water supply is an important aspect of pollution control but by no means the only objective and to many not even the most important. But the approach of the NEWS Study is just that needed in water quality--regional hardware plans and regional organizational forms planned for together. And under any scheme of regional allocation of study effort and construction funds the Northeast must rank at the top.

Not only does the Northeast represent the largest concentration of unmet water quality needs in the nation, it also faces the greatest obstacles in achieving them. More people need sewers, more people with sewers need treatment, more with treatment need better treatment. It is our judgment, based on the fragmentary evidence available, that a higher proportion of the waterways are more completely degraded in the Northeast than elsewhere. But just as relevant are the obstacles. Northeast urban areas are more fragmented by jurisdictions and it is our impression that consolidation has not progressed as far as elsewhere. More of the urban development is older, making new facilities more expensive to construct due to street layouts, lack of space and the like. And for a variety of additional reasons, the construction costs per unit of pollution removed are some 4.5 times the national average based on experience with current jurisdictions. We would anticipate that a vigorous federal program of planning, and where necessary of construction, could substantially reduce the real cost of achieving pollution control in this major section of the nation. The following are particular situations we have explored in the NEWMAN region that show promise for immediate action.

THE WASTES OF METROPOLITAN WASHINGTON, D. C.

Washington Has Made a Start Toward a Regional System.

Since 1957 an enforcement conference under the Federal Water Pollution Control Act has been meeting to resolve the problems of waste management for the Potomac River Basin. Much of the discussion has been on how to expand the D. C. Blue Plains plant without filling in some 50 acres of mud flats apparently considered by the Department of the Interior to be vital to the ecology of the region's natural environment. This overloaded plant now provides service for much of the District and its Maryland suburbs and could be the beginning of a true regional system. The application of a new physical chemical treatment process being tested at the plant under an Interior grant may temporarily ease the pollution which has caused Maryland legislators to investigate the process of sueing the District. At the same time the Washington Suburban Sanitary Commission which serves two Maryland counties faces problems expanding its plant on Piscataway Bay due to assimilative capacity and the need to cross Park Service land. Also it would like to put a large interceptor sewer into the D. C. facility to facilitate further development of the other of its two counties. An alternative facility has been suggested at another location. Meanwhile it has announced that for the Seneca Basin further applications for service could not be received until facilities were expanded.

On the Virginia side of the river, some county supervisors have suggested a moratorium on all building and zoning permits until alternative plans for their overloaded sewer systems are developed. A State board is considering similar action. But a local board indicated it continued to approve land development plans so long as they did not exceed the capacity to which local treatment plants could be expanded someday. Meanwhile the Occaquan water supply reservoir serving three Northern Virginia counties is being polluted for lack of an upstream waste treatment plant. And a supervisor pointed out that a proposed new plant in another area would mean that the citizens of that Virginia county would be carrying the expense of diluting the pollution of the Potomac.

In April and May of 1969 it had been agreed by the conferees of the Enforcement Conference for the region that perhaps a "Future Needs Study" might be wise. At the November 1969 review the representative of the Interstate Commission on Potomac River Basin said "... This is the first time that the FWPCA had indicated that this recommendation was being actively pursued," and took exception to the proposed plan to plan. This consisted of a most ambitious and comprehensive multiple systems analysis of total water management in the metropolitan area to be conducted by the Metropolitan Washington Council of Governments (COG). The COG proposal was being considered for funding partly by FWPCA and partly by the Office for Water Resources Research and would substantially duplicate part of the NEWS Study underway by the Corps. The problem seemed to be that even when completed it would not produce the kind of hardware plans upon which action, i.e. commitment of funds, could be based. The result was to go back to more planning to plan.

The point is that one has to search hard in the welter of detail that surrounds current metropolitan problem situations to find any effect of long range planning. As in several hundred other areas, the many governments in the region attempt to coordinate their many joint interests through a Council of Governments. The Washington COG has a small staff, has technical and policy committees concerned with sewerage services, and has applied to several federal agencies for funds to carry out studies of these problems. Meanwhile efforts have been continuing to establish an interstate compact on the Delaware model for the Potomac. Were such a commission to be created, it would have as a basis for its administration the several plans prepared by the Corps for upstream flow control, a pioneering model of water quality parameters developed by FWPCA, and recent additional studies on water supply and its relationship to water quality in the estuary by the Corps, but little in the way of a staged hardware plan for water quality management.

Washington is one of the few major metropolitan areas that is using water at rates equal to or above the safe yield of its water supply system. There is no lack of aqueduct capacity - operated by the Corps of Engineers. But there is a shortage of dependable flow in the Potomac where water is withdrawn - slightly upstream from the polluted upper estuary. Reservoirs for flow regulation have been proposed and vigorously opposed. It appears now that

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a plan combining several dams with emergency use of the estuary may proceed. Some advocate extensive use of the estuary. But this raises the question of pollution control on the estuary in a new light. The obvious questions about disease transmission, especially viruses, come to mind. Also the aesthetics of the river and its banks would seem to take on new meaning. Will acceptance of the use of the estuary as a water supply be affected by the obviously slow progress on pollution control?

Visual pollution is probably as much a part of the aesthetics of water supply as the more usual concerns about disease. Storm runoff produces huge amounts of silt and floating debris, overflows from combined sewers, as well as plant nutrients and other wastes less obvious in the short run. One small facility for storm water treatment is under study. Some of the counties in the area have regulations to limit silt produced from construction sites--a major source. The Corps has a quite successful program of floating debris removal, but as noted in recent newspaper articles, many shore areas are strewn with litter.

The Pohick Demonstrates the Problems of Fragmentation and Lagged Response.

The interesting case of the Pohick Creek provides an opportunity to explore somewhat more deeply into the process by which planning, funding and construction of pollution investments take place. Fairfax County voters approved a bond issue in 1965 to finance a plant that would be located between Accotink and Pohick Creeks, quite near the mouths of both, but discharging treated waste into the Pohick. Sewers from other bond issues would collect the wastes from both these drainage areas and deliver them to the plant.

As now designed the effluent would pass a Boy Scout reservation, a water recreation area, an historic home, a national wildlife refuge, a bald eagle rookery, a migratory stop for swans, a large military installation, and numerous homes. The original proposal was reviewed by the Planning Commission for that part of Virginia in 1966 and received conditional approval necessary for federal cost sharing. Special outfall arrangements and tertiary treatment were conditions posed to avoid damage to the above uses and to conform to a regional plan prepared in 1962. It appears that the

conditions were not incorporated. Also changes were apparently made in the plan without consultation with the reviewing group. Citizen groups are also raising objections to the inclusion of an emergency by-pass that would put untreated sewage into the Pohick and note that, in addition to the usual reasons for a plant to be forced to shut down, this one has a power source that comes on poles adjacent to a heavily used highway. Holding ponds and emergency power are being considered.

It appears that none of this puts the cost sharing in jeopardy or indeed that it is even under review. The former Executive Director of the Regional Planning Commission in question points out in correspondence on the case "The U. S. Corps of Engineers has vast experience in assuring that local obligations are met when projects financed jointly are undertaken. This experience should be utilized more frequently." But are there other lessons to be learned from the Pohick, other than that there is a difference between the obligations in a grant program and those that attend to direct federal construction? The comment of the supervisor who pointed out that the citizens of this county would just be diluting the pollution of the Potomac went on to say that other jurisdictions must solve their sewage problems also before there would be any benefit to the Potomac River. But if we all wait until someone else goes first.... Clearly we need a planning process that produces solid commitments on the part of the governments involved, as well as effective oversight of implementation. This implies the strengthening of intergovernmental organizational arrangements. Review and specification of cost sharing, and the like, as specific planning objectives may be even more important than planning of facilities, location and phasing.

Should We Try a New Approach?

It is our conclusion that a focus wider than that provided by the enforcement conference, yet one that is primarily concerned with the urban region is worth trying. The Washington COG may provide the beginnings of an answer. It has some experience now in bringing together the various governments of the region. Currently COG is studying the solid waste disposal problem--probably a more pressing problem in the day-to-day affairs of the local officials than the quality of the Potomac downstream from the water supply intakes. It has taken steps to create the Metropolitan

Washington Waste Management Agency which has the power to develop plans and manage facilities for a regional system for both solid and liquid wastes. But what facilities should be built and how should they be paid for? One local Congressman has called for TVA-like federal authority without much apparent positive response. Corps' construction and COG operation is about the only combination not publicly suggested to date.

Would a long, drawnout study be required? It would appear that with the current NEWS effort, and other ongoing hardware planning work, most of the technical alternatives for the large elements in a system are fairly well understood. Also we have reasonably current plans for other water development features that could be related to quality. At least some feel that plan formulation at the major commitment level could be carried out with little further technical effort. However at the neighborhood level, systems planning may not be as well in hand and certainly there are many elements of a several-basin water quality plan that would be left out--storm water runoff, erosion, habitat protection are examples.

We recommend that the Corps of Engineers in coordination with other federal agencies enter into discussions with the Washington Council of Government with the view toward developing the specific arrangements under which the COG would request assistance for plan formulation. This plan should at least develop organizational arrangements and investment commitments for a phased approach water quality and related water resource development for presentation to the Congress for authorization and funding. Under the NEWS authority, funds should be sought for hardware planning for the Washington Metropolitan area.

REGIONAL WASTE TREATMENT IN THE SUSQUEHANNA BASIN

The following is taken in part from the review draft of the Susquehanna River Basin.

Inadequate Facilities Now.

"The present 'stock' of water quality treatment facilities is grossly inadequate. ...Organic wastes are discharged into the Basin's streams from 130 sewage service areas totaling a population equivalence of more than 3.5 million. Altogether 310 miles of tributaries and 120 miles of principal rivers are degraded by organic wastes. About 1.8 million people are served by sanitary sewers; 360,000 (32 service areas) are served by systems that discharge untreated wastes into streams; systems serving about 870,000 people (46 service areas) discharge waste into streams after primary treatment; and 542,000 people (52 service areas) are served by systems that discharge after secondary treatment. Forty-two sewage service areas representing 54 percent of the Basin's population have systems that mix storm runoff with municipal wastes. There are some mine drainage pollution abatement projects that reduce acid in streams.... In addition, land treatment measures, such as those described previously, as well as other voluntary measures taken in the course of good farm practices, help reduce sediment loads in streams, although 3 million tons are still carried down the Susquehanna's waters annually. Other problems that are inadequately dealt with presently in the Basin are algal formations that result from inadequate organic waste treatment and runoff from agricultural areas where phosphate use is heavy, thermal pollution resulting from heated discharges usually from electrical power plants, and pesticides that are also found chiefly in heavily farmed areas."

High Costs to Meet Growth.

"By 2020 a greater proportion of the Basin's population, which is projected at over 9 million for that year, will be on municipal collection and treatment systems. The wastes of a population equivalent of 16.2 million people will then be dumped into the Susquehanna. The need for treatment will be more than proportionately greater than this increase, because higher levels of treatment will be needed in more places."

Costs are estimated from past experience in the construction of comparable facilities. The federal and non-federal shares are based on federal grant financing of 50 percent of the project

costs by the Federal Water Pollution Control Administration as well as 50-50 cost sharing of the construction costs of waste collection systems as authorized under P. L. 98-117, the Housing and Urban Development Act of 1965, administered by the Department of Housing and Urban Development.

The Coordinating Committee realizes that this recommendation calls for about a 20-fold increase over the next decade in the level of funding to HUD over the current (FY 1970) funding level. They are of the opinion that this increase is essential for the well-being of the Basin's residents. These treatment costs are based on a reduction in biochemical oxygen demand (BOD), but do not include an incremental cost for nitrogenous oxygen demand (NOD) reduction and amonia reduction. The Water Quality Subcommittee of the Coordinating Committee did not specifically include NOD and amonia reduction in its standards on which these costs are based. These figures do not reflect facilities planned to be in place by 1972.

Table I summarizes the potential cost sharing for the waste collection and treatment facilities in the early action recommended plan.

TABLE I
EARLY ACTION FUNDING BASINWIDE FOR WASTE COLLECTION AND TREATMENT FACILITIES
(Assuming 50% Federal Financing on All Facilities)

Fund Source	Collection $ millions	Treatment $ millions	Total $ millions
Dept. of Housing & Urban Development	341.46	-	341.46
Federal Water Pol. Control Admin.	-	145.45	145.45
Pennsylvania (State and local)	241.79	117.35	359.14
New York (State and local)	99.67	28.10	127.77
TOTALS	682.92	290.90	973.82

Treatment costs are estimated for sewage service areas, which in many cases extend beyond a city or borough. The effects of concentrated loads of treated wastes from these areas were evaluated for oxygen levels in the receiving streams. On the basis of these evaluations, treatment levels were recommended as though treated wastes were discharged at one location.

Regional Systems Offer Savings and Greater Effectiveness.

The Committee urges early implementation on the basis of broad regional collection and treatment wherever feasible, from engineering, economic, and aesthetic viewpoints. It appears that this approach to pollution control may be applicable at the locations listed below. This recommendation does not imply that large regional systems would be mandatory or necessarily desirable, but rather that feasibility studies be conducted on broad regional bases to determine the most efficient and effective combination of collection, treatment, and operation. Such studies should be undertaken at an early date for the regions listed below to determine whether economies of scale in construction or operation merit combining systems of sewage service areas.

Binghamton Area: Binghamton, North Binghamton, Port Dickinson, Vestal, Endicott, Johnson City, Endwell.

Elmira Area: Chemung County, Elmira, Horseheads, Big Flats, Corning.

Lackawanna River: Carbondale, Jermyn, Dickson City, Scranton, Dunmore, Clarks Summit, Old Forge, Duryea.

Williamsport Area: Williamsport, South Williamsport, Montoursville.

Spring Creek: Greater State College Area, Bellefonte.

Milton-Lewisburg Area: Milton, Lewisburg.

Altoona Area: Altoona, Bellwood, Hollidaysburg, Duncansville, Tyrone.

Conodoguinet Creek: Greater Carlisle, Mechanicsburg, Hamden Township.

Harrisburg West Shore: Fairview Township, Lower Allen Township, Upper Allen Township, Camp Hill, New Cumberland, Lemoyne, Wormleysburg.

Swatara Creek: Harrisburg East, Hummelstown, Swatara Township, Hershey.

Codorus Creek: Greater York Area, Red Lion, Dallastown, York, Spring Grove, Hanover.

Lancaster Area: Lancaster, Lititz, E. Petersburg, Willow Street, Millersville.

Shamokin Creek: Shamokin, Kulpmont, Mt. Carmel, mine drainage problem areas.

From the above opportunities Codorus Creek was selected as the focus for a more detailed review. Alternative systems were studied to meet the water quality standards of the watershed treating the wastes of the rapidly growing communities which happen to fall in a single county. Savings from a regional system are significant. Initial investment costs may be only some 10 percent lower, but other economies accrue from management of peak loads and other operating economies. Also the system size is then such that more skilled operation is possible. Effectiveness of the system would be substantially greater as a result than with a number of individual systems.

The results of this reconnaissance study are sufficient in the view of the Director of the Sanitary Engineering Board of the Pennsylvania Department of Health and he has suggested that the Corps of Engineers proceed to survey scope studies on the ten potential regional systems in the state. He feels that other approaches to the achievement of this planning--waiting for local initiative, state grants or federal grants from either HUD or FWPCA--will not produce results in time to insure the sound investment of the programmed state and federal construction aid. And, in any case, phased designs that look beyond short-range needs are required.

Planning funds required to develop expeditiously, but fully, regional plans that explore not only the hardware problems but also the

organizational problems at a level of detail sufficient to allow federal, state and local commitments would be required for the twelve opportunities. Priorities for both the sequencing of the planning and for construction could be developed to meet national water quality goals.

We suggest that the Chief of Engineers' and Secretary of the Army's comments on the Susquehanna Study to the Water Resources Council urge that the above studies be carried out in conjunction with the "Authorization and Investigation" report by the Corps of Engineers. As a Type II study, no recommendation for authorization and construction follows from the Coordinating Committee Report to the Water Resources Council. The individual agency is expected to followup with feasibility investigations within the framework laid down by the comprehensive report and seek authorization following its normal procedures. In order to make a meaningful recommendation in the authorization report and under the original study authority, it is recommended that a full hardware plan be developed for Codorus Creek as a first effort.

NEW ENGLAND -- CONCENTRATED DIVERSITY

New England discharges to its waters a higher proportion of its wastes with little or no treatment and has done so longer than any other region of the country. Its basic pattern of economic development was established long ago on the premise of no treatment. The long overdue change in "the rules of the game" for pollution control probably has a unique level of impact on this region, only now on the road to recovering from the flight of many of its old industries. Fortunately this shift in industrial composition is probably closing down some high polluters and the new plants coming in to use some of the released labor supply produce less pollution per unit of employment. Nonetheless, the provision of waste treatment for the pulp and paper, textile, food, leather and metal processing plants that will remain is made substantially more expensive than for corresponding plants that enjoy the advantages of modern site conditions.

In addition, the age of urban and other development pose special problems of combined sewer overflows and storm water

runoff treatment, re-regulation of streams for water quality optimization, control of nutrients and associated lake management problems, control of land use affecting water quality protection and rejuvenation of streams and estuaries, particularly those with special national significance.

In old cities the separation of combined sewers in order to divert storm waters and prevent overloading and hence the bypassing of treatment plants is particularly vexing. Costs are high both in an out-of-pocket sense and in terms of disruption and as a result almost no progress has been made. And if, as is quite clearly indicated, it would be very advantageous to provide some treatment to urban storm water in any case, other solutions look quite attractive. But these will put an added requirement on existing already slowly moving treatment investment programs.

New England developed first with water power and since the earliest days small stream regulating structures have been put at almost every conceivable point. During dry periods, many release flows only when their plants are operating. The effect of weekend shutdowns on water quality and the aquatic habitat can be disastrous. On many streams progress on water quality can only be fully meaningful if it is combined with re-regulation of the flow.

Particularly in southern New England, lakes are ringed with residences and very heavily used for recreation. Industries and communities discharge wastes. Urbanization increases runoff and adds to streambank cutting which provides more silt to the loads coming from construction sites. The resulting eutrophication poses special problems of lake management. Elsewhere, land cover has shifted to trees so completely that little nutrient laden silt comes from farms.

Many of the areas that could be threatened by further pollution have a unique standing among the natural areas of this nation. The estuary of the Merrimack, Long Island Sound, the Kennebec, Narragansett Bay, Plymouth Bay, the Connecticut and Cape Cod are among those for whose protection extra federal effort might be justified.

The Chicopee and Ashuelot Rivers provide interesting cases of conditions faced in New England. The Chicopee represents

a well-studied stream with great diversity in its own right. Some 25 small dams--too small to be licensed by the FPC--play havoc with stream flow. Interest exists for removing many of them and replacing the power and water supply they provide by other means. The Quabin Reservoir has further closed off part of the natural flow and adds to the need for a flow management scheme. The State of Massachusetts has encouraged a large treatment system for the urban area of Springfield, Chicopee and Ludlow, but this does not exhaust the possibilities for regionalization. Indeed the need for an integrated water quality management plan is to tie the several opportunities together.

The Ashuelot in New Hampshire presents the case where a number of industrial users are lined up along the streams as well as the towns of Keene, Hinsdale, Winchester and Swansee. It appears that if each industry were to deliver its wastes to a single treatment plant there would not be much flow left in the stream. The challenge is to combine water supply investments, in-plant water use changes, and waste treatment facilities to have both the industry and the stream.

THE CONNECTICUT RIVER

The following is extracted from information presented at public hearings for the Connecticut Comprehensive Study. This represents, in large part, the FWQA input to the study. A secondary level of treatment and then observation of the results is the recommended plan for a region with little treatment now.

> The estimated capital cost of providing secondary water pollution control facilities sized to meet the 1980 projected waste load is estimated at $171 million with $321 million estimated for the projected 2020 loads. In practice treatment facilities constructed before 1980 will be designed to accommodate 1995 to 2000 year projected waste loads to allow for a 20 to 25 year economic life of the plants. This means that total actual expenditures for secondary treatment under the "Early Action Plan"

would amount to approximately $240 million. This does not include operation and maintenance costs nor those expenditures necessary for the construction of interceptors, pumping stations, and collection systems.

Under the burgeoning pressure of future population and industrial expansion, abatement of pollution and the control of its effects must receive continuing evaluation. Under these pressures, planned facilities will be enlarged and controls above basic secondary treatment levels must be considered.

The basin study recognizes the need for increased measures of pollution abatement which will emerge in future years and that future expenditures will be necessary. These expenditures may be for increased levels of treatment, flow augmentation, modifications of industrial plant processes, other controls or combinations of these. Inasmuch as pollution abatement is a continuing and dynamic process involving changing needs and technology, the final selection of the alternative or combination of alternatives in some cases must await the construction of planned treatment facilities and an evaluation of their performance.

The Basin Plan includes provisions for storage of water for flow augmentation and recommends prior to final project design and where appropriate specialized studies of the role of low flow augmentation be undertaken after the implementation of planned treatment facilities; analysis of their performance; and evaluation of new waste treatment technologies.

The problem of combined sewers and storm water overflows also required further investigation.

In separated sanitary and stormwater drainage systems, the domestic and industrial wastewater remains effectively treated during these periods of intense rainfall. However, normal storm drainage

containing diffused pollution loads from urban and suburban runoff can enter the receiving watercourse untreated and cause, periodically, water quality deterioration. Although the separation of sanitary and stormwater systems or the temporary holding of these waters have, in the past, been considered as possible solutions, continuing research indicates combinations of these and other methods such as microscreening, air flotation and biological treatment may provide adequate and more economical solutions.

It is probable that the long term discharge of untreated wastes to the waters of the basin has resulted in accumulation of bottom deposits. Research is needed to identify these areas, the extent of the deposits, possible long range effects of such deposits and control measures.

It would seem that the costs could be reduced and the level of effectiveness greatly increased from the development of regional treatment systems and with implementation carefully related to other water resource development investments. Therefore it is suggested in the comments of the Chief of Engineers and Secretary of the Army to the Water Resources Council it be urged that such followup investigations be a part of the Corps of Engineers' preparation for its authorization report. It should also include further study of the urban runoff problem, both as it relates to flooding, drainage and water quality, and other elements needing further investigation for recommendation to the Congress. Coordination should be through the Connecticut River Program of the New England River Basins Commission.

THE MERRIMACK RIVER

Under the NEWS study, investigations are progressing to identify the investment and organizational needs to clean up this river as a potential water supply source for the greater Boston region. Water supply for the foreseeable future would be

possible through joint use with the Quabin Reservoir. Virtually no further upstream regulation would be required-a major consideration in New England. The following is extracted from a staff report on the Merrimack prepared by FWQA:

> Historical evidence suggests that the Merrimack River mainstream has been polluted since the mid-nineteenth century. Studies of its pollution and recommendations that the towns and industries along its banks treat their wastes have been made since the turn of the century. As of mid-1969, the results of these recommendations are two primary treatment facilities--one in Nashua, New Hampshire, and the other one in Newburyport, Massachusetts. The rest of the towns and industries along the Merrimack continue to discharge raw sewage and waste directly to the river.
>
> In the Nashua River Basin, a tributary, the situation is no better. There are secondary treatment facilities at Clinton, Leominster and Ayer, and an inadequate facility at Fitchburg; however, the major pollution sources, those in the Fitchburg area, continue to reduce the Nashua to one of New England's most polluted rivers.
>
> The Merrimack and Nashua Rivers do not need more studies. Studies cannot return game fishing, swimming beaches or clear, fresh water to these rivers. But the implementation of the water quality standards and the actual construction of the required treatment facilities can.
>
> Throughout the basin interest in improving the water quality is on the increase. One definite result is seen in the New England Regional Commission's five-year Regional Development Plan, which the New England Governors approved in July 1969. Funds for the Commission's Plan have been requested in the President's Budget for fiscal year 1971. Part of the plan will make available $2 million to launch the Nashua River Basin Water Quality

Demonstration Program. The Federal, State and interstate agencies concerned with the Nashua River Basin have agreed to establish a Policy Committee to manage the program. Local governments and community groups, such as the Nashua River Watershed Association, would be involved through an Advisory Committee.

Efforts to determine the effect on the receiving waters of combined sewer discharges have not been successful. Estimates by consulting engineers have been based primarily on studies conducted in 1947 on the frequency and volume of overflows in the Merrimack Basin and in studies in 1960-1961 on overflows in Northampton, England. These estimates indicate that combined sewers in these areas overflow about five to six times per month from June to November, and that two to three percent of all sewage produced during this period overflows. In addition, about 30 percent of the total annual load of suspended solids and coliform bacteria and 10 percent of the total annual load of BOD from Lowell, Lawrence and Haverhill is estimated to be discharged to the river from these overflows.

It will be noted that while the need for more studies is not evident for the Nashua and the Merrimack, the need for the kind of planning that leads to institutional arrangements and commitments is evident. Also note that while the NEWS study will review water quality solutions so far as they can be related to water supply needs, many of the elements identified above will be left out.

We recommend that the Corps of Engineers work through the New England River Basins Commission to:

a. Act as the planning and construction agency for the New England Regional Commission's Nashua River Basin Water Quality Demonstration Program.

b. Move as rapidly as possible to a plan formulation effort for the remainder of the Merrimack River Basin

with the view to providing recommendations to the Congress and the Executive Branches of the Federal Government and the several states on organizational arrangements and phased investments needed to restore the aquatic environment of this historic region.

To this end, under the existing Northeast Water Supply Study authority, funds should be sought to prepare a comprehensive hardware level water quality plan for the Merrimack.

THE KANAWHA RIVER AND A REGIONAL SYSTEM FOR CHARLESTON, W. VIRGINIA

The following prospectus for the study of a regional sewage collection and treatment system is based on material prepared by the Huntington District of the Corps of Engineers:

> The Kanawha River Valley of West Virginia contains one of the oldest and largest chemical industrial complexes in the mid-continental United States. A sizable number of chemical and allied industries are located along approximately 30 miles of river valley, above, at and below, Charleston, West Virginia. This chemical and alloy industry had its beginning in 1797 when the first commercial salt operation was initiated. From that time on, steady industrial development has occurred. Currently the chemical complex employs about 15,500 with an annual payroll of about $130,000,000. The chemical complex has attracted a complement of satellite and service industries. Approximately 300,000 people reside in the valley and contribute to the serious industrial-urban congestion.
>
> The pollution problems which exist in the valley today have resulted in large measure from national priorities during World War II. The nation called upon the valley to produce vital war materials and this was of necessity done with little concern for stream and air pollution. The war ended but chemical production continued to grow. Pollution problems

are complicated by the unending stream of new wastes resulting from the continuous development of new products. The waste materials are both carbonaceous and nitrogenous in nature, resulting in both first and second stage biochemical oxygen demand. Studies made during the current Kanawha Basin Comprehensive Study indicate that, for base year 1965 conditions, the raw industrial waste load before treatment equals a population equivalent of approximately 8,200,000.

A vigorous cleanup program is being conducted by the State of West Virginia and the valley's industries and municipalities. This program began in 1958, following a cooperative survey by the State and industry. Phase I called for a 40 percent reduction in 1958 BOD-5 wasteloads. An additional objective was to bring visible forms of pollution under control. A second phase of the cleanup program has been developed and substantially completed. This phase provides for an additional 50 percent reduction in wasteloads and will result in a total industrial wasteload reduction of approximately 70 percent from 1958 levels. Special attention was also directed to reduction of taste and odor-bearing substances. As of July 1967 the industries and municipalities had spent or committed over $50 million dollars on construction of facilities with an annual operating cost amounting to $10 million.

During Phase II of the cleanup program, water quality standards for the valley have been developed by the State and generally adopted by the Department of Interior. Standards are two-stage, with the second and more stringent requirement becoming effective in 1972. Compliance with the 1972 standards will require achievement of significant reduction in second stage BOD-20. Currently such a reduction of waste is said to be technically infeasible and reduction must be met either by process change or shutdown of facilities.

While the adopted water quality standards for the lower valley are quite extensive and provide for

alleviation of taste and odor problems inherent to the chemical industry, the most demanding component requires maintenance of at least four milligrams per liter of dissolved oxygen content at the point of maximum sag in the Kanawha, and minimum of five milligrams per liter for water entering the Ohio River at the mouth. The need for, and means of, achieving water pollution abatement in the valley have been subjected to detailed consideration by the Federal Water Quality Administration, with the conclusion that the standards cannot be met and maintained by at-source treatment alone under natural flow conditions. FWQA has concluded that the only practical supplement to at the source treatment is low flow augmentation for water quality control. Projected requirements for minimum stream flows would require actual reservoir storage in the order of 2 - 1/2 million acre-feet by year 2000. While studies and projections of FWQA reflect anticipated improvement in waste treatment technology, they approach low flow regulation levels which exceed the practical hydrologic yield of the Kanawha Basin above Charleston by about year 2000. In addition, there is a great public dissatisfaction with potential reservoir development, primarily for augmentation of low stream flows in the summer and fall.

FWQA alleges to have conducted detailed studies of various methods of improving water quality. These conditions include revision of production processes, waste disposal by deep well injection, inter-basin transfer of treated wastes, short term storage of wastes during low flow periods and in-stream reaeration. A recent detailed review draft report by FWQA indicates that all of the foregoing measures were considered separately at the many sources of waste generation. Little, if any, study was made of the feasibility of combining two or more of the aforementioned measures such as transfer of waste to a point on the lower Kanawha where an efficient treatment complex, short term storage of waste and regulated releases of effluent in conjunction with in-stream reaeration might be practical. Preliminary appraisal of such a regional

approach to waste collection and treatment indicates that it may afford the only practical means of accomplishing long range water quality control in the valley. Development of such regional waste collection and treatment systems would be compatible with a practical rate of development of reservoir storage for low flow regulation.

Informal discussions between representatives of the Huntington District and the West Virginia Department of Natural Resources, which is the agency responsible for water quality control planning and enforcement, indicate that the state would support and collaborate in a detailed study of a regional waste treatment system. State representatives are particularly concerned over the substantial number of small to moderate size treatment works that are being developed in the Valley. These concerns result in part from the difficulties municipalities encounter in retaining qualified plant operators and financing modernization and expansion programs.

Current projections of economic growth in the Valley reflect the limited availability of flood free plant sites and the comparatively high plant development costs. Anticipated growth in output will result primarily from increased productivity at existing plants rather than through new plant development. Generally, the Valley is at a competitive disadvantage to many other areas of the country with regard to attracting and retaining industry. The additional burdens of process limitation and shutdown could increase the existing competitive disadvantage to the point where the costs of plant development and modernization would exceed profit realization potential. Since the Kanawha Valley encompasses a sizable component of the State of West Virginia's industrial output and tax base, a decline in the Valley would adversely affect the State's marginal capability to provide essential services and provide a tax structure attractive to industry.[1/] In this

1/ Preliminary 1970 census data indicates a current state population of 1,700,000, a decline of about 10 percent since 1960.

context, a regional sewage collection and treatment system in the valley may be of paramount importance for the economic and social well-being of the entire state.

We recommend that the Kanawha River Basin Coordinating Committee consider recommendations that would provide for the further study of regional waste collection and treatment in conjunction with reservoir storage for low flow regulation, including improving the efficiency of in-plant water use, instream aeration, collection of wastes for centralized treatment, and diffusion of the effluent from treatment plants. It is further suggested that the Corps of Engineers and the Secretary of the Army in their comments on the Kanawha Report indicate that such studies would be made a part of the "Authorization and Investigation" report so that the full range of alternatives are equally available for implementation within the framework plan developed by the Coordinating Committee.

SPEEDING UP THE RENEWAL OF THE CUYAHOGA RIVER, OHIO

The following description of the problem setting is taken from material prepared by the Buffalo District of the U. S. Army Corps of Engineers:

> The Cuyahoga River rises about ten miles northeast of Burton, Geauga County, and flows to the confluence with the Little Cuyahoga River at Akron, then to Lake Erie at Cleveland. The Cuyahoga River Basin comprises an area of about 810 square miles in northeastern Ohio.
>
> The industry of the Cuyahoga Basin is concentrated in the vicinities of these two cities. Akron obtains water for its municipal and some of its industrial uses from the upper reaches of the Cuyahoga, and discharges practically all of its liquid wastes to the river after some treatment. Lake Erie water supplied to Cleveland is returned through waste discharges to the Cuyahoga River and to streams and creeks in

adjacent watersheds. The huge industrial complex of the lower Cuyahoga Valley also makes extensive use of the river as a source of cooling water, and for the disposal of its wastewaters. In addition, the lower 5.8 miles of the Cuyahoga River have been improved for commercial navigation as a part of the existing Federal project for Cleveland Harbor, Ohio. Private interests have constructed wharves and bulkheads along the project channel for most of the improved length.

From Lake Rockwell to Akron wastewater treatment plant, major deteriorations of water quality are only observed downstream of the Little Cuyahoga and in the pools in Munroe Falls and Cuyahoga Falls. From the Akron wastewater treatment plant to Furnace Run, the river is grossly polluted. In this reach there are excessive concentrations of suspended solids, dissolved solids, coliform bacteria, and nutrients in the water. Some of the industrial wastes discharged to Akron wastewater treatment plant are not amenable to good biological treatment. From Furnace Run the river exhibits some degree of recovery. The effectiveness of recovery is reduced by the pool above a diversion dam which becomes nearly devoid of oxygen during low flow in the summer months. In Lake Erie the water quality becomes seriously degraded. Large quantities of domestic and industrial wastewaters are discharged into this reach. Oil and floating debris are also present. For the entire length of the main stem downstream of Lake Rockwell the existing bars, shoals, and banks contain polluted material deposited over several years.

Previous studies include Corps reports concerning flood control measures submitted to Congress 13 November 1942 and 21 May 1946. The first report was an unfavorable preliminary examination concerned with flood control for Cuyahoga River and tributaries. The report submitted 21 May 1946 was printed as House Document No. 629, 79th Congress, 2nd Session, and recommended against

construction of a settling basin at that time. A report on sedimentation, in the Cuyahoga River Basin, prepared by the Soil Conservation Service, Department of Agriculture, in 1952, discusses sediment sources along, and loads in, tributaries and the main stream. A Corps' report concerning the collection and removal of drift in the Cleveland Harbor was submitted to the Board of Engineers for Rivers and Harbors, 24 January 1967. This report recommended that the existing project for Cleveland Harbor, Ohio be modified to provide for the collection, removal and disposal of drift in the Cleveland Harbor channels and tributary waters. A special Buffalo District report dated March 1969 on "Dredging and Water Quality problems in the Great Lakes" presented the most feasible alternative means for disposing of materials dredged from the Cleveland Harbor navigation channels during maintenance, as opposed to the historical practice of dumping them in deep water in Lake Erie.

A current favorable Corps' report concerned with flood control recommends local improvements on the Cuyahoga River for a distance of about nine miles, beginning about a mile above the head of navigation in Cuyahoga County, Ohio. The report also recommends that the existing project for Cleveland Harbor be modified to provide for construction of a settling basin on the Cuyahoga River about two miles above the downstream limit of the proposed flood control improvements.

Existing projects and programs include the 5.8 mile navigation channel near the mouth of the Cuyahoga River in the City of Cleveland. Water supply reservoirs in the upper portion of the basin have been partially financed with federal funds. Pollution below Kent has been alleviated by enlargement of the treatment plant at Kent and diversion of sewage from Stow to the Akron plant farther downstream. Water is diverted from Lake Rockwell into the Akron system and storage is provided there and at

two upstream reservoirs for this purpose. Present and projected storage and diversion needs for Akron preempt storage sites and flows which might otherwise be used to improve water quality there.

Based on information received from FWQA, pollution prevention measures on the Cuyahoga River would be in effect by 1974. These measures would include improvements to the Akron treatment plant by 1973 and the Cleveland Southerly plant by 1974.

The 1968 Flood Control Act authorized the Corps of Engineers to make a survey of the Cuyahoga River from Upper Kent to Portage Trail in Cuyahoga Falls, Ohio in the interest of flood control, pollution abatement, low flow regulation, and other allied water purposes. This study was sponsored by the Cuyahoga River Reclamation Commission, an agency of the City of Cuyahoga Falls. Another group is understood to be interested in the development of recreational open space and both instream and bank regeneration. To date, no work has been done on this study due to the lack of funds (April 1970).

Considering the reaches covered by the present navigation project at Cleveland Harbor and the proposed flood protection measures, and assuming that adequate pollution measures would be in effect, approximately 43 miles of the Cuyahoga River would need improvement after 1974. This reach would extend from the upstream limit of the proposed flood control project to Lake Rockwell. The work required by the existing navigation project and the proposed flood control project would take care of the channel cleanup for these reaches. The work left undone would consist essentially of clearing and snagging to remove bars, shoals and debris. Existing dams would be left in place in the interest of recreation. Channel and bank improvements would mainly be in the interest of environmental quality.

The Cuyahoga is an example of the ultimate in a degraded stream. The many millions of dollars involved in treating the waste flows that now reach it will not alone restore the environment. The stream, loaded with sludge, will respond much more quickly with a few dollars spent to renovate it. The banks, littered and neglected, will not complement the improved water quality without further investment and control.

Authority should be sought in the next Rivers and Harbors Act to modify the authority in the 1968 Act to study the stream renewal problem over the whole of the lower 43 miles of the stream and recommend to the Congress a plan of investments and controls with full identification of the roles to be played by the several governments involved. As a pilot project, and with both the current case and others like it in mind, emphasis should be given to the careful exploration of:

a. The relationship of dredging and other physical works and modifications to the rate of stream regeneration, including aesthetic values and habitat creation. There is an obvious relationship between debris and sludge removal, flow through pools and the like to environmental enhancement, but the design relationships are not firm.

b. The relationships that could and should exist between shoreline renewal and beautification and urban redevelopment and related aspects of the urban environment.

c. Evaluation procedures that net out the effects of natural regeneration of the aquatic environment from man-made regenerative efforts and that develop cost-effectiveness tests for beautification and other environmental measures.

d. Appropriate cost-sharing principles giving due attention to the incidence of benefits, precedent in other programs and unique federal interest.

THE WILLAMETTE RIVER BASIN--SOME PROGRESS AND MORE OPPORTUNITY

Two-thirds of Oregon's population live in the eighth of the state in the Willamette Basin. By 2020 the population is expected to grow from 1.5 million to 4 million, and farm output along with food processing is expected to triple. In 1961 this river had the distinction of being one of, if not the, dirtiest streams in the Columbia Basin. It is actually cleaner now than then. A too rare event. Portland and its growing environs--the Salem region, the Corvallis-Albany area, and the Eugene-Springfield urban cluster--represent four opportunities to develop urban region waste systems. Such systems might reduce the cost and/or increase the effectiveness of the $346 million, in 1965 prices, estimated to be needed for the capital costs for treatment of municipal and industrial organic wastes for the 1985-2020 period. This estimate was prepared for the water pollution control section of a comprehensive study by a Task Force of the Pacific-Northwest River Basins Commission, soon to be completed. The estimate is based upon the costs of providing effective waste treatment with the methods and fragmented organizational structure that presently prevail in the Willamette Basin.

This $346 million is composed of $308 million for municipal facilities that include capacity for industrial wastes felt to be reasonable to expect to be included. The remainder is for separate industrial facilities. Since the region has an unusual degree of such integration now further economies in programs designed to seek them might be limited. While treatment has reduced their impact to some extent, it was not long ago that 80 percent of the waste load of the basin came from industrial sources. It seems possible, based upon very crude guesswork from this study, that capital costs could be reduced and effectiveness increased substantially from urban regionalization of systems and closer integration with the basin development system proposed in the plan.

The river has been viewed as a potential tree-lined greenway through the state, to be developed as a park. But a clean river is at least as vital as the pleasant banks to the value of the river environment. Portland Harbor and above is the scene of more potential cleanup. Besides the usual visual problems, the dissolved oxygen levels in the harbor drop every year just in time

to threaten the important Chinook salmon runs. Meeting the standards here will require management of treatment and flows over the whole basin. An opportunity on which the Task Force could not make a recommendation was the possibility of artificial reaeration as a supplemental measure to meet at least the severest drop in oxygen in years of particularly low flows. Who would do it if it were recommended?

The Basin has made significant strides. Treatment capacity already installed has had a noticeable effect on quality conditions. More investments are planned. State agencies are well organized and at least in the Portland region the several counties have agreed to approach their facilities problems jointly. An authority with bonding, taxing and control powers has been established. However, the county that includes Portland dominates the others and a neutral third party might be useful in their programs. In 1946 only nine basin communities had any treatment plants. By 1966 the number had grown to 118--in almost every case, each community provided its own system.

Urban run-off and combined sewer inflows are flagged as problems to be dealt with in the not very distant future. Some storm water flooding occurs now and more is expected as growth continues. Pollution from these sources, as well as fertilizers and toxicants, erosion on construction sites, and the like, are awaiting suitable technical solutions. To date, joint solutions that relate flooding, water supply and recreation to water quality have not been fully explored.

It is suggested that the Chief of Engineers and the Secretary of the Army, in their recommendation for implementation and authorization studies to follow up on the Willamette Plan, make provision for the development of hardware plans for regional waste treatment systems for the four urban regions of the Basin. With the background of the Plan it will be possible to relate these to the other quality related features. Measures beyond treatment facilities, such as monitoring systems to complement hydrologic data and to provide for day-to-day management, should be considered.

THE ROGUE RIVER BASIN--POLLUTION OF A WILD RIVER

The Rogue River Basin includes a substantial portion that has been designated a wild river area under the Wild and Scenic Rivers Act. It is only accessible by trail or float trip, and the latter means of viewing it attract more and more people each year. But the nationally known wild river reach lies downstream of several growing urban areas, such as Grants Pass and Medford, which are creating pollution and already have significantly and visibly degraded the wild river section. This is a situation which clearly illustrates a Federal interest in preserving a national environmental treasure. Existing basin planning has considered temperature and other effects from low flow augmentation from proposed reservoirs.

The Medford region is growing more rapidly than the rest of the basin and has considered some waste treatment integration. Efforts to date fall far short of full regionalization of the obvious potential urban service area and have little effective relationship to the potentials for interrelations with other actions that might be taken in the hydrologic region. An example that deserves reflection involves a tributary on which repeated rediversions for irrigation produce a degrading flow into the main stem. One almost joking comment was that in dry years you had to push the stream to get it to flow. Informed speculation suggests that a treatment plant for the entire flow of the tributary, which would operate only during low flows, might be economically competitive with new upstream storage. No realistic mechanism now exists for the planning and construction of such a plant. We suggest that the Corps should explore the possibility of a Federal facilitating role for such a possibility within the context of a comprehensive water quality hardware plan for this not so unique basin.

It is suggested that either the existing survey authorities for the Rogue River be interpreted broadly through the "related purposes" clauses and the Environmental Quality Act of 1969, or that additional study authorization be explored and additional funding requested to develop water quality hardware plans. Special attention should be given to:

a. The regionalization of the urban waste treatment system in the region.

b. Any special technical features, investment evaluation, and general cost-sharing implications of the protection of the Rogue wild river area should be considered from the point of view of the special federal interest that this may represent. Recommendations which recognize the implications for similar situations in other parts of the nation should be carefully developed.

c. Likewise, treatment of irrigation return flows should be studied. The organizational, cost-sharing and technical problems should be explored and recommendations for action developed.

THE TRINITY RIVER AND THE FORT WORTH-DALLAS REGION

Under FWQA and State funds, something approaching a hardware plan for the regionalization of 25 communities into six sub-regional systems has been worked out. Only one of these sub-regional systems has been successfully organized and pursued to the construction stage. The Trinity River Authority has been instrumental in this process and has good working relationships with the Corps of Engineers in other matters. Under existing programs and authorities, it doesn't appear to have occurred to anyone to involve the Corps in the problem of regionalization of waste treatment. Yet water quality is a consideration in the Trinity River plan which has led to the authorization of a major waterway scheme with related flood control, recreation, and water supply features. As in the case of the Arkansas River, the Corps has the opportunity to participate in the follow-up planning needed to cope with the problems and exploit the opportunities provided by that multi-million dollar investment. Water quality problems and other aspects of the environment are by no means the least of these.

In the Fort Worth-Dallas ten-county region, a vigorous Council of Governments program has pursued opportunities for water supply and waste disposal planning. There are real unexplored and unexploited opportunities to relate waste

water reclamation to industrial and even perhaps domestic water supply needs. While the COG effort has not proceeded at the survey scope or hardware level of planning for this larger region, interest in such a venture seems to exist. A related question is the need to protect the level of water quality in existing federally financed reservoirs. Some are now used for water supply. Treatment prior to distribution as well as upstream abatement of wastes should be explored.

It should be noted that in Texas as in a number of other states, the water supply planning and development has not been effectively related to the water quality programming. The Texas Water Plan, like others in the Southwest, has resisted all but temporary storage for water quality in fear that such purposes would become a preemptive claim on that flow. Water quality planning has proceeded with some concern for reclamation and reuse, but this has hardly been a major effort in spite of the generally water short conditions. This may reflect a mix of attitudes toward reuse and Western water law that raises some difficult questions as to who owns reclaimed waste water. The considerable potential for effectively bringing together quantity and quality aspects of water resources planning and development would seem to offer a strong functional as well as bureaucratic justification for federal and Corps involvement.

We recommend that the Dallas-Fort Worth Council of Governments and the Trinity River Authority be asked to discuss, with a view to seeking appropriate study authority, the possibilities in the areas of waste treatment regionalization, including assistance in the construction of such systems and the integration of waste water renovation with supply. This should be a part of a broader program to perform followup planning on the Trinity River project and indeed might be most expeditiously made a part of the post-authorization planning and design work for that project.

SAN FRANCISCO BAY - A SYSTEM WAITING FOR A BUILDER?

Kaiser Industries, supported by both State and FWQA funds, has prepared for a regional water quality board and council of governments a single purpose waste water facilities plan. While comprehensive as to region, it fails to be comprehensive as to

all of the environmental and water use interrelationships that loom rather large in this setting. Even in the more humid north of California, water is not in such great supply that it can be wasted. The volume of waste water is substantial--about 1.5 billion gallons per day is being considered. This is half again the New York City current rate of use. In the plan it is proposed to take this water that has only passed through a single use after being collected in the mountains and send it out to sea through an ocean outfall. At this point the environmental impact of this, combined with proposed changes in the fresh water flows to the Bay from the Sacramento-San Joaquin Delta, are not fully appraised. Nor has the relationship of changes in the hydraulics and hydrology of the Bay due to filling, urbanization and the like been carefully related to waste water alternatives. Yet the need for treatment capacity is made more and more evident as time passes. Some counties in the Bay area have had to prohibit further residential construction due to overloaded plants. Much waste now receives no treatment.

It is interesting to note that the Kaiser Plan begins with an examination of the sub-systems that would economically collect the wastes of the region. Then it examines full treatment and release to the Bay but finds minimal treatment, disinfection and transmission to the deep waters of the ocean somewhat cheaper, and this is recommended. But a Phase I--the construction of the sub-regional collection system, along with interim treatment to the secondary level and release to the Bay, has been suggested. The ocean outfall then becomes deferred for some years. The point is that Phase I would seem to be called for, whatever the final system may look like. Advanced waste treatment at the several central sites or at a smaller number of points with release to the Bay would be about equally feasible. Directed piping of the partially reclaimed waste water into a separate industrial use system to reduce the pressure on the municipal supply systems would seem to be little affected by the Phase I plan. The feasibility of collecting and pumping a reclaimed product back up to the Delta to be mixed with the substantial fresh water flows there for reuse again, would appear to be little affected.

The Corps is well equipped to consider these and other alternatives. It has authority to participate in the water quality

studies of the Bay and the physical model of the Bay has been put to good use. Its greatest asset is in its experience to manage a complex situation of this sort and work through to a solution that results in concrete and steel being put in place. This is not to say that the State of California lacks the capacity to solve such problems. The California Water Plan is evidence to the contrary. But we would suggest--as has the Regional Director for the Federal Water Quality Administration--that something effective is more likely to be done sooner if the Federal Government could approach the problem with its own construction agency. It is our understanding that he has agreement from his superiors to pursue at the staff level how the Corps might act as a construction agent. We would suggest that the need to effectively relate quality problems to supply problems calls for the Corps to also consider the remaining planning tasks either now or later.

We recommend that:

a. Within its current planning authority for San Francisco Bay and using a small allotment from available funds, the Corps develop a working agreement with FWQA and the State. The purpose of such agreement being to develop an early action federal construction role for the sub-regional collection and treatment system.

And subsequently investigate:

b. The relationships between water quality measures for the expected waste water flows of some 1.5 billion gallons per day and the water supply needs for the region, with particular attention to the water flows in the Sacramento-San Joaquin Delta and in the Bay and their impacts on the environment.

c. The considerable national as well as regional significance of the environmental values of the region and relate these to the recommended programs and projects, cost-sharing arrangements and the like.