

WATER RESOURCE PROBLEMS

AND

RESEARCH NEEDS

OF

NORTH CAROLINA

—
A

REASSESSMENT

June 1, 1974

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The undersigned accepts full responsibility for any remaining errors of fact, omission, and interpretation.

David H. Howells
Director

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PREFACE

This report was prepared as a source of orientation for the Institute's research program. The water resource problems and research needs discussed herein represent those areas in which the Institute is attempting to encourage a research response from potential investigators. The first report was published in 1967 and is now being revised and reissued biennially to assure continued validity. Comments are invited at any time.

Current and needed studies and research referred to in this report reflect the collective statewide effort of public agencies, industry, and the university community. All are involved, and there is no intent to imply that this is just an Institute or university program.



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WATER RESOURCE PLANNING



WATER RESOURCE PLANNING

Water is vital to North Carolina's future. The fixed supply must support more people, more industry, more agriculture, and more recreation in the face of increasing public expectations for a quality environment.

Water is a renewable resource which can meet mounting future needs if managed efficiently. Water resource management must be undergirded by imaginative public policy, responsive laws, and viable institutions. It must be implemented through modern planning techniques and management practices and supported by an informed citizenry and cooperative private enterprise.

Present water resource planning in North Carolina is a divided responsibility between several federal agencies, state agencies, regional councils of government, local government, and the private sector.

The planning process tends to be fragmented within as well as between agencies and appears to lack the desired degree of coordination. It is heavily dependent upon the findings and data of federal agencies. Continuing efforts are being made to improve coordination and organize water resources planning more effectively.

If the State is to be a fully effective participant in water resource planning, it should have sufficient independent planning capability to influence federal planning on the basis of its own objectives and initiatives.

State planning might well include short and long-term concepts of water and related land use which could serve to guide the location of industry, urban development, recreation, agriculture, and other uses on the one hand, and necessary conservation and protection of the natural environment on the other.

The Institute's research program should be geared to support this strategic level of State water resource planning.

Policy and Goals

Water resource planning objectives must have their roots in broad, underlying social and economic goals. Such goals have not yet been well defined and must be inferred from legislation and from administrative actions.

In water resource planning the full range of alternatives for specific objectives has seldom been revealed. Capital intensive public works have been at the forefront. Ground water utilization, industrial in-plant process

changes, land use controls, pricing schemes, and other non-structural alternatives to encourage more efficient use of water and pollution control have not received comparable visibility and attention and deserve continuing study.

Water resource policy is indivisible from and dependent upon land use policy. While land policy is receiving increased attention in the Congress and State legislature, progress is painfully slow.

The principal water policy statements are found in the preambles to recent State legislation, 1971 amendment to the State Constitution, the Land Policy and Coastal Area Management Acts of 1974, and pronouncements by the North Carolina Council on State Goals and Policy and the North Carolina Land Policy Council. Policy has also been markedly influenced by the 1972 amendments to the Federal Water Pollution Control Act (FWPCA), the National Environmental Policy Act (NEPA), and the Federal Water Resources Council (WRC) Principles and Standards for Planning Water and Related Land Resources. It is also likely to be affected by the recommendations of the National Water Commission (Appendices A and B).

Studies of alternative policy, planning, and management roles for State government could provide useful guidance. Socio-political studies to clarify viable goals and facilitate their attainment are badly needed.

Law and Institutions

The 1973 and 1974 General Assemblies enacted several laws affecting water and related land resources planning and management in North Carolina. These extended the State Environmental Policy Act, strengthened the State Water Pollution Control Program, and initiated new land use and control programs (Appendix B).

In the quasi-legislative area, the State Utilities Commission adopted rules regarding the planning, siting, and construction of electric generating facilities. The new legislation and rules offer substantial new authority to State and local government in water and related land resources planning and management. Continued review of existing law with respect to its effectiveness in light of present and emerging needs is to be encouraged. Perhaps, conferences and workshops scheduled within six months of the completion of each General Assembly could usefully implement the work of the Legislative Research Commission in preparation for the next General Assembly.

Responsibility for State water resource planning and management functions remain divided between the Office of Water and Air Resources (OWAR) and other agencies of the North Carolina Department of Natural and Economic Resources; State Planning Division, North Carolina Department of Administration; and the Division of Health Services, North Carolina Department of Human Resources. Water resource planning is also institutionally fragmented into surface water, groundwater, coastal water, inland water, water quantity, and water quality-- all in relative isolation from land use planning.

The need to integrate water resource planning and management functions and the increasing promise of regional planning and management through the Regional Councils of Government and other jurisdictions have initiated a number of steps by State and federal agencies. These include overtures to the State of Virginia for a NC-VA river basin commission under the Federal Water Resources Planning Act, a request to the U. S. Water Resources Council for a statewide level B (river basin) plan, initiation of the new EPA-sponsored areawide waste management planning project for the Research Triangle by the Region "J" Council of Governments under authority of the FWPCA, and the U. S. Army Corps of Engineers Urban Study Program also authorized for the Research Triangle area.

The State Water Plan Coordinating Committee represents a meaningful effort toward inter-agency coordination and action at the senior staff level. Whether the more difficult questions can be dealt with by agency staff remains to be demonstrated. A cabinet-level State Water Resources Council has also been proposed¹ as a policy-making, decision analysis, and coordinating group and deserves careful consideration. Perhaps both will be required.

An analysis of water resource planning and management institutions in North Carolina to clarify responsibilities; identify overlap, ambiguity and voids; develop approaches toward conjunctive water and land planning and management; and assess progress toward established goals and objectives would also be useful. This should include law, regulations, and guidelines; institutional arrangements for implementation; and operational effectiveness.

¹Moreau, David H., "Regional Water Resources Planning for Urban Needs," Vol. 1, Report No. 77, WRRRI-UNC, March 1973.

Public Participation

An informed and interested public is essential to the balanced formulation of water resource policy and goals and support of State water resource planning and management programs. Current research² indicates that public knowledge of issues, programs, and sources of reliable information involved in water resource management is rudimentary at best. It also discloses that participation in public hearings is often weighted heavily toward industrial and local government interests with a direct economic stake in the course of decision making.

Public participation can be meaningful only if there are open and effective institutional means for input. Federal and State laws concerning environmental impact statements are facilitating this process. Citizen access to the courts has recently been strengthened and also offers promise.

The U. S. Army Corps of Engineers Crabtree Creek project in Raleigh is a major innovative effort toward public involvement in the planning process. Much useful information will come from this experience to guide future activities.

Additional studies leading to improved institutional means for public participation in water resource planning and management together with preparatory educational programs and methodology are needed to create a more favorable environment for constructive public input.

State Water Plan

The State OWAR commenced the preparation of the North Carolina Water Plan in 1967. As originally conceived, this envisaged a series of detailed studies covering each river basin and needed background information such as forestry, recreation, and so on. This was recently modified to place priorities on framework reports highlighting present or anticipated problems, alternative solutions, beneficial and adverse effects, etc. to guide decision makers. A completion date of December 31, 1975, has been set for those elements on which decisions must be made by the State before January 1, 1977. Resources committed to the State Water Plan in the past have not been adequate to do the job within an acceptable time frame, and additional assistance is now being sought to support the new schedule.

²Davis, A. C., "Public Participation in Water Pollution Control Policy and Decision Making," WRR-UNC Report 88, Dec. 1973.

A plan--oriented toward the needs of decision makers--is imperative to orderly water resource development. It is a prerequisite to further federal planning services and is needed now! To the extent needed, the Institute should schedule research in support of this effort.

Basic Data Systems

Basic data on the available water supply, water demand, water-related land use, water quality, and associated socio-economic environmental factors are of fundamental importance to water resource planning and management in North Carolina (Appendix C).

Data available to water resource planning and management through existing data systems appear to be deficient with respect to groundwater supply, water demand, and effects of related land use.

While the revised water quality monitoring program is a marked advance over earlier programs, it needs additional attention with respect to:

1. the precise purposes to be covered by water quality monitoring,
2. degree of system reliability required for each purpose,
3. cost-effectiveness, and
4. overall strategy.

Considerable research is still needed to strengthen the strategies and techniques necessary for efficient and reliable basic data systems. There are also many questions about interfaces between existing hydrologic, water quality, and land use data systems; characteristics of water courses and waste discharges; environmental values; management of groundwater data; and other factors. Cooperative efforts between state agencies and the Institute are expected to continue in this important area.

Planning Techniques

The basic unit for water resource planning is the river basin. While this has a number of limitations as a single framework for comprehensive planning, it will continue to serve as the underlying system over which other systems can be structured.

The regional problems facing communities in the Piedmont, Appalachian, and Coastal regions impose added responsibility on the State and the Regional Councils of Government to encourage imaginative planning directed toward economically related regions of multiple-basin dimensions.¹ The development

and demonstration of improved planning techniques for these complex physio-graphic regions and the multi-county planning regions would do much to advance the State's role in water and related land resources planning.

Water resource planning cannot be carried on outside the broader framework of social, economic, and land use policies if all are to pull toward a common goal. Surface and groundwater are two interrelated and interdependent components of the total water resource and require conjunctive--not independent--planning. Water quality is not just a consideration in water pollution control but increasingly determines the availability of a water resource for beneficial use and is an essential component of broader water resource planning. Studies of conjunctive water and land resource planning leading to improved techniques for state planning are needed.

If the State is to have an influential role in water resource planning, it will need to have reliable data and techniques for at least broad-brush projections, the evaluation of alternatives, and penetrating review of federal agency proposals.

Water Supply and Demand

Fundamental to all water resource planning is information on water supply and demand. Understanding of both is dependent upon the previously mentioned basic data systems.

Water supply investigations have generally been community or federal project oriented. No statewide assessment has been made, and studies of supplies available to the principal growth centers are required.

Very little useful basic data for demand projections are readily available with respect to municipal, industrial, and agricultural water use in North Carolina. This information is badly needed.

The development of methodologies for projection of future water demand is one of the most pressing needs for water resource planning in North Carolina. Studies toward this end have been undertaken.³ They indicate that the dearth of water use data will be a limiting factor and that expanded data bases will be required to meet planning needs. Investigations of present water use, techniques for estimating water use where data are not available, price-demand relationships, potential for conservation and reuse, possible

³Sneed, R. E. and Sowell, R. S., "Agricultural Water Demand in North Carolina," Phases I & II, WRRI-UNC Report 83, Sept. 1973.

effects of technological change, and multiple projections of future demand based upon alternative futures would do much to strengthen planning by opening up new options for future choice rather than assuming rigid conformance to practices and water use patterns belonging to earlier eras.

Reservoir Siting

The steady encroachment of urbanization on available reservoir sites, land speculation, and rising public antipathy to large reservoir projects appear to be combining to prevent those actions necessary to identify and preserve remaining sites required to meet future water needs.

The escalation of land prices has become a major obstacle to the development of water and related land resources in North Carolina. Public land acquisition costs may well increase to such an extent as to make many worthwhile projects economically infeasible. Existing planning and regulatory tools are not adequate to cope with the widespread urban and vacation home sprawl, low-quality land development, and serious environmental degradation associated with recent and pending projects. A recent study^{4,5} of the problem has identified major policy areas through which the public can assert its interest in the character and outcome of land transitions in reservoir areas. Recommendations concerning policy initiatives have been made to the North Carolina Land Policy Council. Action should be promptly taken if the public interest is to be protected. The need for further investigation may become apparent as State response develops, but in no way should deter that response.

The intensity of land development is such that many of the State's remaining reservoir sites are threatened with pre-emption. Potential sites need to be identified and evaluated in terms of alternative uses and need for future storage. Studies should be undertaken to bring together present information from the federal construction agencies, public and private utilities, and other sources; develop supplemental information; assess the implications of land-use trends in each area; determine justification for retention as reservoir sites; and explore feasible means of holding these sites for future use.

⁴Burby, R. J., III, Donnelly, T. G., and Weiss, S. F., "A Model for Simulating Residential Development in Reservoir Recreation Areas," WRRI-UNC Report 52, May 1971.

⁵Burby, R. J., III, Donnelly, T. G., and Weiss, S. F., "The Effects of Authorization for Water Impoundments on Shoreland Transition," WRRI-UNC Report 78, June 1973.

Power

A matter of rapidly emerging importance is the need to consider the optimal location of thermal electric power plants throughout the State for the burgeoning electric utility industry. The effects of power plant siting are too important to the public at large for this to proceed outside a related planning effort by the State. State planning should be in a position of doing more than reacting to initiatives and proposals by the utilities. A firm step in this direction was taken by the North Carolina Water Plan Coordinating Committee in a recent resolution endorsing the urgent necessity for a statewide siting study.

The effects of power plant siting decisions include compatibility of land use, water and atmospheric pollution, consumptive use of water, economic and social impact, health and safety, and other considerations. The 1973 rules of the State Utility Commission should assist the site planning process. The utilities' response and commission follow-up need to be closely followed to determine whether additional steps should be taken. Studies of the consumptive use of water for power generation under alternative future siting configurations and its effect on the available supply and other demand projections will certainly be needed. Many questions related to economic and environmental tradeoffs in power plant siting, waste heat management, and the potential for reducing energy demand through conservation remain unanswered and need further investigation.

Flood Plain Management

Flood damages have continued to rise despite the construction of dams, levees, channels, and other control measures. Each new advance in flood control has been accompanied by increased occupation of flood-prone lands so that more human lives and property are exposed and damages mount despite large public investments.

National studies have long demonstrated the need for flood plain controls as alternatives or supplements to structural measures. The National Flood Insurance Program now requires the adoption of State and local control measures for land management and use in flood-prone areas. So if the occupants want subsidized flood insurance, they must first get their local governments to adopt acceptable controls. Simultaneous with the stronger Federal Flood

Disaster Protection Act of 1973 came an amended State act which greatly strengthened the State leadership posture with respect to local government controls.

Local initiatives are dependent upon information from federal flood information studies which are now backlogged about five years. Means must be derived to accelerate this much-needed work.

Studies directed toward improving the social and political acceptance of flood plain zoning are needed. Methodology and data for demarcation of floodway lines leave much to be desired. The use of environmental corridors to protect floodways deserves further exploration. Progressive land use changes in urban areas increase the frequency and characteristics of flooding and must be accounted for. These and other problems justify continued studies in support of the State's program.

Hurricane Flooding and Beach Erosion

Closely related problems are hurricane flooding and beach erosion. Intensive development of coastal islands and the Outer Banks will bring increasing damages with each succeeding storm. The need for land use controls to prevent, limit, or guide development in areas subject to flooding from hurricane tides is increasingly recognized. The Federal Flood Disaster Protection Act of 1973 will also be of value here.

There is considerable evidence that no steps taken to date under existing law have been effective. Development must recognize the natural forces at play and adjust accordingly. Since private interests have created the present situation in the absence of public planning and controls, it is self-evident that these must be provided. Recent action by the National Park Service and the North Carolina Department of Natural and Economic Resources have helped to sharpen the issues. A strong coastal zone management program is badly needed, and the 1974 Coastal Area Management Act is certainly a start in this direction.

Technical and scientific rationale for shoreline restoration, preservation, or abandonment to the forces of nature still appear to be inadequate and deserving of continued investigation.

Navigation

Transportation in coastal North Carolina has been heavily dependent upon the rivers, estuaries, and sounds since colonial days. Navigable channels now

extend inland as far as Fayetteville, Hamilton, and Murfreesboro. Responsibility for maintenance and improvements to the waterway system lies with the U. S. Army Corps of Engineers.

The National Water Commission has now recommended a reexamination of national policy with respect to federal non-reimbursable costs. Cost sharing by commercial and recreational users is a question under current debate. A decision to shift all or part of the costs to users could have substantial effect on the future of the system.

The State commissioned a navigation study in 1968.⁶ While this provided useful guidance with respect to individual projects, it did not attempt an areawide evaluation. What is missing is an overall regional assessment of water-borne transportation and navigational improvements within a regional transportation framework that includes alternative forms of transportation. The State Department of Transportation is aware of the need for such a study and is taking steps toward this end.

The environmental impact of channel dredging and maintenance--with associated spoil disposal--continues to be a matter of considerable interest. State and federal procedures for the review and issuance of permits for dredging in the marshes and navigable waters by private interests deserve to be examined. The review of individual applications on a project-by-project basis leaves unanswered the important question of cumulative effect. There appears to be a need for a study of procedures and aggregate impact on the coastal environment of permits issued since initiation of the State program. The objective should lead to conclusions and recommendations necessary to assure procedures and techniques that will sense cumulative effects and trigger response to prevent long-term impacts from developing.

Recreation

Recreation has become a very important objective in water resource planning. Yet, there is no clearly defined State policy concerning the specifics of recreation planning for existing and proposed reservoirs and other bodies of water.⁷ The recent debate over the Falls Reservoir highlighted the need

⁶ Commonwealth Transportation Consultants, Inc., "North Carolina Navigation Study," Oct. 1968.

⁷ Office of Recreation Resources, NCDNER, "Summary - Statewide Comprehensive Outdoor Recreation Plan for North Carolina," June 1973.

for extension of the State Recreation Plan to answer such detailed questions as how much, what type, and location of needed recreation lands and waters.

Public access to water bodies and the beaches of North Carolina is becoming increasingly difficult, and there is need for additional access areas before all available sites are pre-empted.

The State Park System is quite limited for a State as large and well-endowed in scenic natural resources as North Carolina. Extended delays in land acquisition once sites have been identified encourage exploitation and the loss of many of the values upon which the parks would depend. The State's new Conservancy Act is a constructive step to correct this problem.

While the 1971 General Assembly authorized a State Natural and Scenic Rivers System and studies of six river segments have been completed, the system has not yet been implemented.

Studies leading to improved techniques for the projection of recreation demands and resource carrying capacity need to be continued.

Fish and Wildlife

While the maintenance of viable fish and wildlife populations in State waters is recognized as an important objective in water resource planning and management, it appears to be largely accomplished through recreation, avoiding or ameliorating environmental impacts, and pollution abatement. The central criterion of water quality, dissolved oxygen, derives entirely from concern over fishlife. Both environmental impact and pollution are dealt with elsewhere in this presentation.

This indirect consideration of fish and wildlife seems to also be reflected in the response of fish and wildlife interests to water project planning--to avoid involvement until a complete plan is presented for review. This often results in conflicts which might be avoided if these interests had a more direct role in the planning process. More will be said about this under the heading of Environmental Impact Assessment.

There is strong argument in support of the position that fish and wildlife and other natural environmental values should be considered as objectives unto themselves. Indeed, this would be consistent with the recent elevation of environmental quality as a principal objective in federal water resource planning. This would seem to call for a more direct involvement of fish and

wildlife interests at the State as well as federal level in the planning process. Suitable techniques and procedures may have to be developed toward this end.

The nature, composition, and value of fish and wildlife populations affected by water resource development projects or serving as important objectives unto themselves need further investigation and elaboration in terms useful to project evaluation.

Forestry

The increasing demand for both timber and non-timber forest resources is stepping up the tempo of forest use and conflicts between uses. The effects of forest management practices on the quantity and quality of water arising from forested watersheds is a matter of concern to both forest and water resource managers. These include the effects of harvest practice on stream-flow, water temperature, erosion and sedimentation, and chemical quality; impact of recreational use on water quality; and effects of such practices as prescribed burning, fertilization, and pesticide treatments. Many studies have been conducted, and more will be needed before the full range of causal relationships can be established. Nevertheless, there is sufficient knowledge to improve present practices beyond their present levels. This is particularly true with respect to private holdings and those of local government in the rural sector. Careless harvest practices on smaller private holdings continue to fill stream channels with debris--which eventually leads to requests for public investment in channelization. On the urban scene, developer encroachment on forested municipal watersheds limits both source and storage capacity and adversely affects water quality. Both problems could be resolved through law and regulatory action.

Environmental Impact

The construction of water control structures, stream channelization, power plant siting, drainage of wetlands and marshes, rural land conversion, filling and dredging, forest management, private development, water development, and many other actions all have an impact on ecological systems and esthetic values.

Prior to passage of the National and State Environmental Policy Acts, there was little opportunity for review of the environmental impact of water resource projects. A study of environmental impact assessment in North Carolina

under these laws for State and federal projects is nearing completion and is expected to provide useful guidance as to both law and procedures. The central thrust of tentative findings is that environmental quality should be an important consideration throughout the planning process rather than a tag-on at the end after all of the decisions have been made.

This is being furthered by the new Federal Water Resources Council Principles and Standards for Water Resources Planning which now govern federal agency actions. The Principles and Standards establish environmental quality on an equal footing with economic development as one of the two principal objectives of water resource planning.

The effectiveness of assessments of ecological and broader environmental impact of proposed actions will depend upon the seriousness with which related acts are administered, the availability of requisite scientific personnel at both ends of the statement preparation and review process, and the necessary scientific information and criteria upon which to base and guide decisions. Neither scientific knowledge nor data are presently available for many questions of environmental impact and continuing investigations should be encouraged. A hazard to be avoided at all cost is the gradual degradation of environmental assessment into a pro-forma action to meet procedural requirements. It must have real substance. The substitution of paper for scientific, rational evaluation will inevitably bring revulsion against a system which can and should be an important part of the planning process.

There is some indication that State agencies might usefully pay more attention to the State Environmental Policy Act with respect to their own programs and in their review of projects involving federal as well as State funds. Clearing-house procedures do not seem to provide substantive input and local interests appear to have no recourse but to appeal to federal agencies for relief.

Because the federal and State Environmental Policy Acts are focused on federal and State actions, less attention has been given to local government and the private sector. While the State act authorizes local government to require the preparation of impact statements by developers, it does not require local government to do so, and there is little information as to how much the new authority is being utilized. Another act requires the Department of Natural and Economic Resources to investigate the environmental impact of new or expanding industry. The status of this is not clear.

An area of particular concern is the large-scale corporate agricultural development in the Coastal Region. This involves massive land conversion and drainage without sufficient State overview and control of the ultimate impact. Studies of this activity and its effect on surface and groundwater systems, soils, fish and wildlife, forest resources, social fabric, and the economy are urgently needed. These should lead to prompt recommendations for needed additional planning and management authority for State and local government.

Estuaries

The indiscriminate development of estuarine areas in North Carolina has given rise to wide apprehension and concern over the future of coastal water and related land resources. Marsh alteration and destruction; increased pollution; and hodge-podge development with loss of natural vegetation, erosion, and aesthetic disarray have encouraged a strong movement toward a comprehensive coastal zone management program for North Carolina.

Coastal mosquito control practices include both marsh ditching and impoundments. The ecological effects and effectiveness for mosquito control have been investigated and recommendations made to the regulatory agency to reduce adverse effects and increase effectiveness as mosquito control techniques.^{8,9,10}

The classification and inventory of coastal land-water resources will require guidelines and criteria based upon a thorough understanding of the values for alternative uses. Management actions on such matters as permits for dredging, mosquito control drainage and impoundment, and pollution discharges must be supported by a careful evaluation of the aggregative effects of otherwise isolated actions. A holistic approach on the regional scale is vital to any successful planning and management program. This will not be an easy task, and supportive studies will be required to strengthen the basis for planning and management decisions.

Wetlands

The concern over coastal estuaries and marshes has not extended to the fresh water wetlands where the same indiscriminate pattern of development prevails.

⁸ Kuenzler, E. J. and Marshall, H. L., "Effects of Mosquito Control Ditching on Estuarine Ecosystems," WRRI-UNC Report 81, Feb. 1973.

⁹ LaSalle, R. N., and Knight, K. L., "The Effects of Ditching on the Mosquito Populations in Some Sections of Juncus Salt Marsh in Carteret County, North Carolina," WRRI-UNC Report 82, June 1973.

¹⁰ LaSalle, R. N. and Knight, K. L., "Effects of Salt Marsh Impoundments on Mosquito Populations," WRRI-UNC Report 92, April 1974.

If North Carolina is to retain wetlands of value for fish and wildlife, parks, and hardwood production, it must proceed with a study leading to the preparation of a workable plan for wetland conservation, management and use. This should include the drawing together and updating of information already available and filling in missing data to provide a current inventory of the various types of wetlands encompassed within this broad generic classification together with assessment of their relative values for agriculture, forest production, fish and wildlife, and groundwater recharge. Questions as to which areas can most beneficially be drained, adapted to multiple purposes, or be preserved in their natural state must be answered. While preliminary studies^{11,12,13} have been completed and a State investigation is underway, there is a great deal yet to be done.

Regional Water Supply and Waste Management

As the demand for withdrawal uses of water multiplies and the need for advanced waste treatment of wastewaters increases, it becomes more and more imperative to look toward new institutional arrangements through which costs can be minimized and overall program effectiveness increased. Regional management offers the potential for systemwide perspective and decisions needed to bring greater efficiency to both water supply and wastewater disposal. Ways and means of accomplishing the objectives of regional management and facilitating the process through politically acceptable channels require continuing study.

Two matters of immediate concern are the perennial problem of septic tanks and wells and the proliferation of small water and sewer systems.

Septic Tank and Well Problem

Septic tanks and private wells continue to be used under unfavorable circumstances. The most obvious abuse appears to be in the Coastal Region in

¹¹Anon., "The Wetlands of North Carolina in Relation to their Wildlife Value," USDI-FWLS, Reg. IV, 1954.

¹²Wilson, K. A., "North Carolina Wetlands, Their Distribution and Management," NCWLRC, 1962.

¹³Hawley, A. J., "The Present and Future Status of Eastern North Carolina Wetlands," WRII-UNC Report 87, Jan. 1974.

areas of high water tables. While development plans have been subject to County Health Department approval, the misuse of private systems continues.

The problem appears to be multi-faceted. The requisite land use planning and controls are not sufficiently comprehensive to prevent developers from building in unsuitable areas and using septic tanks and private wells where surface and groundwater pollution are almost assured. By the time the plans are submitted to the health departments, the pressures are often severe and difficult to withstand. As a result, unsatisfactory private systems continue to be installed and the problem grows.

While new legislation was passed in 1973 forbidding the construction or relocation of dwellings without a county health department permit along with certain other restrictions, the problem doesn't seem to be under control. At least some of the difficulty seems to stem from variable performance by the health departments and too little authority at the State level. Thus, the problem may be more institutional than technical in nature, and studies and remedial actions should recognize this.

Areawide and Regional Systems

The proliferation of small community water and sewer systems throughout the State has handicapped efforts to optimize the utilization of available water resources for water supply and waste disposal and to benefit from economies of scale inherent in regional systems. 1971 legislation strengthened the regulation of new water systems and encourages regional water supply and sewerage systems. As originally conceived, this would have empowered the State to take action to reduce the rapid growth in number of small systems, but this power was not granted.

While revolving funds were authorized for comprehensive planning of regional water supply and sewerage systems, the funds appropriated have been small, and it is difficult to find much evidence of major progress.

The concept of regional systems is often interpreted to mean regionwide physical systems, which are not always desirable. It is regional management that is important--management with authority to finance, plan, and operate the configuration of regional facilities most appropriate for a given set of circumstances and conditions. Regional management can also provide the supervisory expertise and laboratory support necessary to maintain the level of services required. This avoids the problem of hundreds of isolated small plants without the financial or technical resources to assure proper performance and affords

the regional perspective and capability to provide for efficient and reliable services on a regional basis.

The greatest difficulty appears to be institutional in nature. Multiple or even limited purpose regional government has never had wide political support and is difficult to attain outside the gradual evolutionary process where evident need, economic and social conditions, and political climate provided the self-generating conditions. Where cities and counties are willing to assume this responsibility--and a number have--they should be encouraged to do so. Much of the difficulty lies outside the metropolitan areas where there is no critical mass around which to build the service function. It is here that county, multi-county, and State government would seem to have an increasing role to play. Additional attention needs to be given to ways and means for the encouragement of regional management of water and sewer services for these areas.

Two recently authorized studies are of particular interest with respect to regional water and sewer management systems. The Region "J" Council of Governments has just undertaken an areawide waste management study of the Research Triangle (Section 208 FWPCA) under sponsorship of the Environmental Protection Agency. The Congress has also authorized an Urban Study Program for the Raleigh-Durham-Chapel Hill area by the U. S. Army Corps of Engineers.

The use of a State commission to provide water, sewer, and solid waste services to areas not adequately served by existing governmental structures should also receive consideration. Studies of alternative institutional arrangements, relative advantages and disadvantages, costs, and other factors would serve a useful purpose.

Water Quality Planning

Comprehensive studies and water pollution control plans for each of the State's river basins were completed in the initial phase of the State's water pollution control program. Because of limited resources, these have not been kept up to date.

Water quality planning has been undergoing marked realignment and intensification as a result of new Environmental Protection Agency (EPA) guidelines implementing the expanded planning requirements of the 1972 FWPCA. These provide for two basic methods to achieve national water quality goals: (1) effluent limitations based on control technology, and (2) effluent limitations based on ambient water quality standards.

New State planning requirements imposed by the federal act are:

1. Statewide water quality planning as a management tool. The general approach is to classify all river segments as either effluent limited or water quality limited and develop and implement management plans.
2. Areawide waste treatment management planning under Section 208 of the FWPCA. To take place in metropolitan areas with substantial water quality limiting problems. The first area in North Carolina is Research Triangle Region "J".

A real threat in the implementation of the many planning requirements of the FWPCA with its tight deadlines is that the State will be compelled to give more form than substance in order to keep up. Good planning is certainly needed and must go forward if the massive public investment is to pay off, but sufficient time must be given to develop a sound program and carry it forward.

Authority for allocation of storage capacity in federal reservoirs for downstream water quality control was reaffirmed by the 1972 FWPCA. Despite this, there has been a tendency to discourage storage for this purpose on the premise that it is unnecessary if waste discharges are properly treated. This is a short-sighted view of the overall water quality management problem. The growing information on non-point sources of pollution indicates that while land runoff may be subject to some degree of control, the overall non-point source pollution is of sufficient magnitude to require dilution during critical periods if water quality standards are to be maintained. Thus, continued storage for this purpose appears to be necessary and should be dropped only after the most rigorous examination on a case-by-case basis.

Every authoritative group that has studied water resources on the national scale has concluded that comprehensive water pollution control planning should be carried out within the broader framework of water and related land resource planning. Section 209 of the FWPCA directs the WRC to prepare river basin plans for the entire country with priority to areawide waste treatment management areas. North Carolina has requested the WRC to approve such a study for the State as a whole. This would be a most meaningful step if approved.

There is often a considerable gap between legislative authorization for planning and performance at all levels of government. Earlier versions of the FWPCA--dating back to 1948--also required comprehensive planning and

conformity with broad regional plans. Except for a brief effort in the mid-1960's, the substance never materialized and token planning to comply with the technical legal requirements became the order of the day.

The new act can encourage and support a major advance in planning or it can produce more paper of little substantive value. Workshops designed to explore and evaluate present planning procedures as to approach, content, and scope would strengthen the process. Experimental and pilot projects to develop and demonstrate planning methodology in support of the efforts of multi-county regional and river basin planning would also be useful.



WATER POLLUTION CONTROL



WATER POLLUTION CONTROL

Water pollution control in North Carolina has made impressive gains since enactment of the Stream Sanitation Law in 1951. Prior to the 1972 FWPCA, considerable initiative still remained in State hands. However, the comprehensive requirements and tight time schedules imposed by the Federal Act have shifted the initiative to EPA. This extends from the broad federal goals through necessary changes in State legislation, identification of sources, permits, monitoring, reporting, planning and enforcement. Provision has been made for a rebalancing of initiatives through delegation of the permit system and certain other programs to the State.

While the Board of Water and Air Resources recently held a series of hearings and follow-up actions to upgrade the classification of State waters, this served to upgrade water quality objectives and does not speak to present water quality. As a matter of fact, it is very difficult to determine present quality from available data and information. It is known, however, that a considerable number of stream segments have not yet been brought into compliance with water quality standards, and much work remains to be done.

Earlier progress in water pollution control has been largely through the imposition of primary and secondary treatment requirements for municipal and industrial point sources. These steps made more visible such unresolved questions as to how to deal with agricultural wastes, urban and rural land runoff, sediment from urban and highway construction, oil, hazardous substances, and the varied problems of alternatives and choice where increasing numbers of cities and industries are faced with costly advanced waste treatment. Many of these pressing new problems cannot be dealt with on an individual basis and must be approached in a systems context on a regional basis.

Identification, Sources, and Fate of Pollutants

The identification of pollutants depends upon factual information on sources and timing of releases together with reliable and sensitive monitoring and analytical equipment and procedures. It is also dependent upon understanding of methods of transport, interaction with the physical and biological systems, and changing forms of pollutants.

The principal sources of water pollution in North Carolina are waste discharges from cities, industry, agriculture, and land runoff from urban and rural areas.

Municipal Wastes

Municipal wastes include domestic, commercial, institutional, and industrial discharges. Information on the important industrial component has not been generally available, but the situation should improve on January 1, 1975, when industries discharging to municipal sewer systems must start annual reporting to the cities servicing them. On July 1, 1973, cities were required to monitor waste discharges and to report monthly to the OWAR.

Variations of waste discharges over time, actual plant performance, and treatment plant by-pass are matters needing further investigation.

Industrial Wastes

Information concerning industrial wastes discharged directly to water courses has been very spotty. Despite earlier basinwide studies and a State permit system, little up-to-date information appears to be available. This is a serious deficiency which should be rectified by the same monthly reporting now required of cities in North Carolina. Follow-up studies of the effectiveness of the new reporting system would be useful.

The wide diversity of substances in industrial wastes and broad spectrum of effects can be difficulties in monitoring and reporting. These have encouraged oversimplifications like the expression of pollution loads with a single parameter like BOD when this is clearly not applicable to many wastes. Another example is the continued effort to detect the presence of pathogenic bacteria and virus through indicator organisms whose questionable applicability has been demonstrated.

The technology for waste characterization and measurement of pollutional effects is still relatively primitive and must be improved through continued research if there is to be a reliable basis for the rapidly increasing public and private investment in water pollution control.

Agricultural Wastes

Attention has only recently focused on agriculture as a major source of water pollution. Agricultural fertilizers have been widely alleged to be a major source of phosphorus and nitrogen reaching surface and ground waters, but this has not been well documented. Research to determine the extent of agriculture's contribution is underway. This has demonstrated¹⁴ that phosphorus

¹⁴Kilmer, V. J., Gilliam, J. W., Joyce, R. T., and Lutten, F., "Loss of Fertilizer Nutrients from Soils to Drainage Waters," WRR-UNC Report 55, Sept. 1972.

loss is associated with erosion and can be largely controlled through good soil conservation practice. Nitrogen leaching to ground and surface waters, however, does occur. Additional studies are necessary to determine the pathways and conditions associated with nitrogen losses and predictive relationships for estimating input from agriculture.

Pesticides are essential to the production of crops which are of major economic importance to North Carolina. They are also sources of pollution, and agricultural practices must provide the necessary protection to the aquatic environment. While fish kills and other extreme events have signaled the misuse of pesticides in North Carolina, they have generally resulted from careless and ignorant use. Increased knowledge of sources, transport systems, fate, and ecological effects of pesticides which are used in conformity with established practice and controls is required. Studies have been completed¹⁵ and others are underway. These need to be expanded to include all of the principal types of pesticides used in the State.

Probably the most important potential source of pollution from agricultural activities is animal wastes. The production of these wastes exceeds by many times that of human wastes; and yet, the problem has only recently been acknowledged. Numbers of animals in themselves can be very misleading. Topography, vegetative cover, animal access to water courses, soils, and availability of treatment all play a part. Reliable data on individual sources on a watershed-by-watershed basis are needed. Animal production units must be inventoried with due attention to local conditions--not the mere adding up of numbers of animals.

North Carolina studies on animal waste management have been underway for a number of years.^{16,17} Guidelines have been prepared for animal producers, and research is continuing to develop alternate waste treatment practices and refine design criteria.

¹⁵ Sheets, T. J., Bradley, J. R., Jr., and Jackson, M. D., "Contamination of Surface and Ground Water with Pesticides Applied to Cotton," WRRI-UNC Report 60, April 1972.

¹⁶ Robbins, J. W. D., Howells, D. H., and Kriz, G. J., "Role of Animal Wastes in Agricultural Land Runoff," EPA Report 13020 DGX 08/71, Aug. 1971.

¹⁷ Humenik, F. J., "Swine Waste Characterization and Evaluation of Animal Waste Treatment Alternatives," WRRI-UNC Report 61, June 1972.

Land Runoff

Pollution from land runoff has received only a fraction of the attention it deserves. This has been due to the higher priority associated with control of pollution from municipal and industrial wastes and the great difficulty of coping with diffuse sources of pollution. As treatment requirements for municipal and industrial wastes become increasingly severe and effluents more highly treated, the pollutants carried by runoff assume greater and greater importance. This is growing evidence^{17,18} that urban and rural land runoff is a major contributing factor to water pollution in North Carolina which can no longer be ignored in water quality management.

Actions to classify or reclassify waters should be taken in full knowledge of the use of contiguous lands and the effects of related land runoff on proposed uses and standards of quality. When land uses will interfere with proposed water uses, consideration should be given to necessary land use controls, the treatment of land runoff, or classification for less demanding uses. Studies of pollution contributed by land runoff need to be continued and expanded. They should include urban, recreational, agricultural, forest production, and natural areas; and encompass the relationship between water quality parameters and duration and intensity of rainfall, streamflow, and land use practices; control measures; and the development of techniques for the incorporation of land runoff into water quality management practice.

Sediment

Very little hard data have been developed on sediment pollution in North Carolina. The prevailing attitude concerning agricultural and forestry sources is that historical conservation programs are sufficient to keep erosion under control if applied in practice. Road construction and maintenance and urban construction have moved to the forefront of present concern for sediment pollution. Visible evidence of excessive erosion and sedimentation from highway and urban construction has been so plentiful and persuasive that public attention and interest culminated in passage of the Sedimentation Pollution Control Act of 1973. Additional information on sediment sources under varying conditions

¹⁷ Bryan, E. H., "Quality of Stormwater Drainage from Urban Land Areas in North Carolina," WRRRI-UNC Report 37, June 1970.

¹⁸ Colston, N. V., "Pollution from Urban Land Runoff," WRRRI-UNC Research Special, March 1974.

of topography, soil disturbance, and rainfall would be most useful for the refinement of objective standards needed for implementation of the Act.

Oil

While oil pollution is sufficiently serious to justify enactment of the Oil Pollution Control Act of 1973, it is difficult to describe in quantitative terms. Sources range from service stations, receiving and distribution facilities, and tank farms to tankers at sea. Stationary sources have not been inventoried, nor the overall problem well defined. Previous episodes of oil pollution, related federal legislation, and anticipated activity in oil shipping and refining appear to have made a convincing argument for State action.

Measurement of Pollution

Any strategy for water quality monitoring must be built upon a foundation of proven sampling and analytical techniques. The question of strategy was discussed under Water Resource Planning so attention here is limited to the ability to detect and measure pollutants once the basic strategy has been determined.

Effluent sampling of point sources of pollution is now required under State and federal law. Guidelines and standards need to be developed to assure uniformity and reliability of data.

Sampling of receiving waters has too long been a function of the availability of personnel, laboratory capacity, work day, and work week constraints. To be more meaningful, it should be adjusted to times and locations representative of changes in ambient water quality. Frequency of sampling has been too low in the past to provide meaningful data. Earlier discussion of monitoring strategy reflects the opinion that while frequency is being improved, fundamental questions still need further attention.

Analytical techniques are always in a state of change. EPA's Analytical Reference Service has been of great value in standardization and procedural improvements. Much remains to be done, however, with particular attention to remote sensing equipment whereby continuous records of changing water quality can be obtained.

The identification and measurement of toxic pollutants and tracing of their multiple pathways from source to ultimate fate is a complex undertaking. An understanding of the changing forms of such substances, their methods of transport, and movement through ecological systems is of great importance.

Sampling needs to be based upon this kind of information if these materials are to be effectively monitored.

The detection of toxic substances in water is difficult and expensive unless supported by intelligence on probable presence through use in the upstream watershed. The number of possible substances is simply too large for routine analysis without some screening process of this kind. Knowledge of the use of toxic materials in manufacturing processes, agriculture, and elsewhere would seem to be a necessary adjunct to routine reporting on waste discharges if monitoring is to be efficient and sensitive to change.

Sampling and analytical techniques are now being studied under a regional program in which the Institute is participating. This work needs to be continued.

Water Quality Standards

Water quality standards are now generally interpreted to include the classification of waters as to best usage; the physical, chemical, and bacteriological criteria necessary to define water quality for designated uses; and the plan for pollution abatement. The rapid rate of social and technological change underscores the importance of periodic reviews of water quality standards to assure continued relevance.

Classification of Water Courses

In 1973, the Board of Water and Air Resources undertook a statewide review of water use classifications in recognition of the changes that have taken place in water usage since the original classifications were assigned. The trend has been the upgrading of waters from Class D (agriculture, industrial, etc.) to Class C (fishing, boating, wading, etc.). Present classifications do not encompass all purposes and additional attention might be given to natural state preservation, broader recreational use, research, and education.

The relationships between stream classification and land use need to be thoroughly explored toward the end of identifying interdependencies and development of techniques to harmonize land and water use.

Water Quality Criteria

Water quality criteria are extremely difficult to define with precision. Most relate to biological systems, human health, or esthetic responses. All are approximations arrived at by specialists in the context of committee review and consensus. All are imperfect and can be improved through research

and further scientific review. The most recent federal criteria were developed for EPA by committees of the National Academy of Sciences last year. Federal criteria for such parameters as temperature and dissolved oxygen should provide for acceptable ranges within which due account can be given to geographical differences. Special attention needs to be given to improved criteria for nutrients, sediment, color and odor, toxic materials, bacteria, and viruses.

Plan Implementation

The final component of water quality standards--plan implementation--has so far avoided rigorous assessment. Experience indicates that acute pollution episodes involving fish kills or nuisance conditions have been the bases for most enforcement actions. But these represent states of deterioration in water quality far below levels at which contravention of standards first occurred. The question to be answered is: "What does the record show with respect to detection of contraventions of standards, identification of responsible polluters, and enforcement follow-up?" The record is vague and sheds little light on what has occurred. This is presumed to be due to the inherent weakness of reliance on stream standards as an enforcement tool where multiple sources of pollution are involved. It is simply too difficult to determine responsibility in many cases. Other factors are limitations in monitoring systems, inadequate resources to assure prompt analysis and reporting, and weaknesses in State law which have prevented decisive regulatory actions at the administrative level, and a policy emphasizing a cooperative rather than regulatory response toward polluters. Now that the law has been strengthened and monitoring procedures revised, the State should be in a position to take more affirmative action.

Studies dealing with all three phases of water quality standards would be very useful if they led to specific recommendations for the strengthening of the State program.

Effects of Pollution

The cause-effect relationships of many pollutants on water quality and water use are still inadequately understood. Some have been alluded to earlier in this report: rates of exertion of oxygen demand by the more refractory organic wastes, effects of sustained higher temperatures on aquatic biota, synergistic relationships involving toxic substances, water quality requirements for body-contact recreation, eutrophication, and drinking water quality. This

list is merely illustrative and in no sense is intended to be comprehensive. Some additional comment is warranted with respect to the latter two areas.

Eutrophication

The effects of nitrogen and phosphorus on reservoirs, streams, and estuaries have not been well defined. The juxtaposition of urban development in the Piedmont and the availability of reservoir sites along the fall line between the Piedmont and Coastal Regions places much of the urban, industrial, and domestic wastes and land runoff upstream from proposed and potential reservoir sites. Studies^{19,20} of nutrient levels in tributaries to the New Hope Reservoir over the past five years have provided much useful information in support of decisions which will have to be made with respect to water quality management. The trophic state of existing lakes and reservoirs is also a matter of concern and a related investigation is now underway.

Eutrophication studies were undertaken in the Pamlico estuary in 1966 as a result of phosphate mining and processing activities.^{21,22,23} While phosphorus levels have been quite high, nitrogen has been limiting and no eutrophication problems have developed. This work is now drawing to a close. Parallel studies have recently been undertaken in other major estuaries of the coastal region. A great deal of valuable data have now been accumulated which will be useful for water quality management decisions in these bodies of water. Work on one of these, the Chowan River estuary, will be greatly expanded during the coming few years through a joint North Carolina-Virginia-EPA-USGS-Institute study. Periodic algal blooms on the lower Chowan have occurred with increasing frequency. Public response has been vigorous and corrective action by regulatory agencies is expected. The objective of this comprehensive study is to determine the waste source or combination of sources

¹⁹Weiss, C. H., "Water Quality Characteristics of the New Hope and Lower Haw Rivers with Estimates of Probable Quality of New Hope Lake," WRRI-UNC Report 48, Jan. 1971.

²⁰Weiss, C. H., Yocum, T. W., and Minoque, J. E., "Further Characterization of the Water Quality of the New Hope and Lower Haw Rivers . . .," WRRI-UNC Report 73, Nov. 1972.

²¹Copeland, B. J., Hobbie, J. E., "Phosphorus and Eutrophication in the Pamlico River Estuary 1966-1969--A Summary," WRRI-UNC Report 65, March 1972.

²²Hobbie, J. E., Copeland, B. J., and Harrison, W. G., "Nutrients in the Pamlico River Estuary 1969-1971," WRRI-UNC Report 76, Dec. 1972.

²³Harrison, W. G., Hobbie, J. E., "Nitrogen Budget of a North Carolina Estuary," WRRI-UNC Report 86, Jan. 1974.

responsible for the blooms and develop predictive models to aid the public agencies in their management decisions.

Public Water Supply

The potential for movement of pollutants from raw water sources into treated public water supplies is a matter of increasing concern. The quality criteria in general use are the in-stream State and federal criteria and the EPA Drinking Water Standards. Routine safety of treated supplies is generally determined by bacteriological examination of water samples taken from distribution systems. Water treatment plants are not normally designed to remove the dissolved materials appearing in polluted streams, and there is considerable question as to the amounts of refractory organic chemicals and toxic metals which may be passing through treatment processes to the consumer. Because of the low concentrations, there may never be any recognition of toxicity and adverse effects in terms of the classical water-borne disease outbreaks. Research on the implications of prolonged exposure to trace-level contaminants has been accelerated by federal agencies. Concurrent studies at the State level of the presence of potentially harmful residual pollutants in raw water sources and the effectiveness of water treatment processes in their removal should continue. The detection of virus and removal in water treatment is very much an open question which deserves much more attention than it has received.

Aside from a general concern for the safety of public water supplies, attention needs to be given to the emerging water supply problems of the Outer Banks. Parallel problems associated with wastewater management are discussed under Ocean Disposal in this section. The rapid increase in demand and groundwater pollution are pressing the movement from local to areawide systems. Examination of available alternative courses and possible conflicts between a fixed supply and mounting demand is long overdue.

Waste Control and Treatment

As more stringent and costly waste treatment requirements are imposed to protect the quality of North Carolina waters under conditions of continuing population and economic growth, it is important that all possible means to reach objectives be investigated.

Municipal Wastes

Municipal treatment plant construction is now geared to the federal grant program, though State determination of project priorities leaves an important

element of decision making at the State level. General Assembly authorization of State aid through the North Carolina Clean Water Bond Act of 1971 increased the level of combined federal and State aid to 87-1/2 percent, thus reducing the local share of capital costs to 12-1/2 percent.

In a study²⁴ of the federal grant program a few years ago, the General Accounting Office of the Congress (GAO) noted the absence of comprehensive systemwide planning. While substantial remedial steps were authorized by the 1972 FWPCA amendments, these have not yet been implemented to any degree. (The Region "J" areawide waste management study is the first in the nation.) The 1971 Clean Water Bond Act and Regional Sewage Disposal Planning Act also give North Carolina leverage for systematic planning and construction of economically and technically efficient municipal wastewater management systems. Studies of present planning leading to recommendations for strengthened programs could be useful.

The GAO finding that EPA was not requiring industrial plants connected to municipal wastewater systems to bear their full share of the cost of new facilities through the imposition of appropriate user charges has been addressed by new requirements of the 1972 FWPCA. Such charges can now serve as an economic incentive for reduction of industrial waste discharges through in-plant controls and thus reduce the need for both capital investment and operating costs for waste treatment facilities. Incentives which promote the most efficient waste control procedures--not limited to waste treatment--are to be encouraged.²⁵

The GAO review of waste treatment plant operation included 69 plants in six states. Investigators found that 40 of the plants had operational, mechanical, or structural problems; 28 by-passed some sewage without treatment, and 59 did not meet the minimum provisions for personnel, laboratory controls, or records recommended by the Conference of State Sanitary Engineers. The situation with regard to municipal and industrial waste treatment plant operation and by-passing in North Carolina has not been reported, but the problem is known to exist. The 1972 FWPCA now requires annual surveys to determine

²⁴ Report to the Congress, "Examination into the Effectiveness of the Construction Grants Program for Abating, Controlling, and Preventing Water Pollution," GAO, Nov. 1969.

²⁵ Seagraves, J. A., "Surcharges for Industrial Wastes: Suggestions and Guidelines - A Packet of Information for Cities and Counties of North Carolina. . .," WRRRI-UNC, March 1972.

efficiency of operation and maintenance of grant-supported treatment works. This will be useful. A closely related problem is the shortage of qualified operators for waste treatment facilities in North Carolina despite special efforts by the State and EPA to increase training opportunities.²⁶

A current problem with respect to municipal pollution appears to be commitments for new or increased waste discharges which exceed existing treatment capabilities. Regulatory agency orders to a city do not appear to prevent local decisions leading to new commitments which overload existing facilities. This appears to occur with respect to both industrial and urban development sources. Much of this difficulty could be avoided if regulatory action were supported by a planning process that could point to emerging needs for regulatory action before a crisis developed. The regulatory agencies should possess sufficient information on projected new waste loads so that plant expansion and upgrading could be triggered with due consideration for lag times in planning, design, and construction. In other words, new treatment plant capacity would be available when needed. As it is, stream standards are often contravened and severe pollution experienced for many years before new plants can be put into service. The social cost of such avoidable pollution must be considerable.

Periodic by-passing of waste treatment facilities because of stormwater infiltration or overloading of municipal sewer systems has not received enough attention. Conventional engineering design has always provided for by-pass devices and very little effort has gone into seeking alternatives such as sewer system rehabilitation, temporary storage and pump-back for treatment, and limitations on connection of new or enlarged waste sources.

Where advanced waste treatment processes are installed, they should be accompanied by studies to determine actual performance, operational problems and possible design improvements. Resulting information could then be fed back into design and operation for subsequent installations.

Industrial Wastes

Waste effluent control requirements for industry are currently being promulgated by the Environmental Protection Agency. These include standards of performance for new plants--which represent the best available control

²⁶ Brown, J. C., "An Investigation of Curricula, Materials and Methodology for Training Operators for Wastewater Treatment Plants," WRRI-UNC Report 74, Dec. 1972.

technology; and effluent limitations for existing sources, best practicable control technology by 1977 and best available technology by 1983. Standards of performance and effluent limitations are being developed for each major industrial category and applied uniformly throughout the Nation. This procedure has both advantages and disadvantages and will bear close observation. Certainly, it represents the first comprehensive national effort to review the state-of-the-art of waste control--both in-plant and waste treatment--of all major industrial groups. In addition to serving its primary purpose, it should provide an improved basis for studies to lower the cost and increase effectiveness of control techniques. Such studies will be needed for many years to come.

The historical emphasis in water pollution control has been waste treatment. This has often led to unnecessary capital investment and inefficient solutions. The emphasis has been misplaced and needs to be redirected toward waste reduction through the most cost-effective means available. The new EPA guidelines recognize this to a much greater degree than heretofore. Studies^{27,28,29} of non-treatment alternatives need to be continued.

While the ultimate answer to waste heat may lie in more efficient methods of energy conversion, present technology is limited to heat dissipation by once-through and closed-cycle cooling systems. There are additional possibilities through beneficial use and reduced demand. Federal policy emphasizing the use of cooling towers to the exclusion of cooling lakes needs to be carefully scrutinized. It is entirely possible that the best solution for North Carolina will be a mix of heat management techniques designed to minimize the cost and environmental damage. Sole reliance on cooling towers--as with lakes--could prove to be a serious mistake over the long haul. Studies of alternative arrangements and respective costs and benefits could be useful.

Special attention might be given to temperature standards from the standpoint of regional differences and their effects on innovative solutions involving

²⁷ Kleppe, P. J. and Rogers, C. N., "Survey of Water Utilization and Waste Control Practices in the Southern Pulp and Paper Industry," WRI-UNC Report 35, June 1970.

²⁸ Proceedings "Workshop on Poultry Processing Plant Water Utilization and Waste Control," WRI-UNC Report 59, Sept. 1971.

²⁹ Carawan, R. E., Jones, V. A., and Hansen, A. P., "Water and Wastewater Management in Dairy Processing," WRI-UNC Report 79, Dec. 1972.

more efficient dispersion and heat dissipation. In view of the influence of consumer demand on power production, it might be useful to make a real commitment to investigate the potential for conservation through intensive education and pricing in contrast to earlier practices of encouraging increased consumption. With the present energy crisis, conservation has more official and public acceptance than heretofore.

Agricultural Wastes

Research on nutrient losses from agriculture fertilizer lends encouragement to the belief that much of the phosphorus losses can be controlled by sound soil conservation practices and nitrogen losses controlled by the design of drainage systems to maximize denitrification. Studies leading to design criteria for denitrification systems should be continued. Greater attention to the amounts and timing of fertilizer application could also be helpful.

Investigations of pesticide losses to surface waters also underscore the importance of sound soil conservation practices for control of pollution from this source. There also appears to be some possible gain from a more strict adherence to recommended application rates and timing. A large proportion of pesticide pollution occurs as a result of carelessness in application, cleaning equipment, and disposal of residuals and containers. The 1971 Pesticide Act is undoubtedly bringing gains in this area, but it is probable that more progress can be made. Biological controls and integrated pest management also offer considerable potential. In view of the apparent limited supply of food and fiber, sustained research is needed with respect to all alternative means for the control of pollution from pesticides.

Earlier design criteria for animal waste management had many recognized limitations. Studies have demonstrated that anaerobic lagoons are not satisfactory as sole treatment units. Land spreading is an acceptable procedure where appropriate land is available and recommended practices followed. When treatment facilities are required, economic constraints and desirability of recycling nutrients to the soil encourage facilities of simple design and operation with effluent irrigation as the terminal stage. Studies leading to improved design criteria for simple treatment systems and land disposal are underway. Interim guidelines³⁰ have been issued to North Carolina farmers by the Agricultural Extension Service. Investigations should continue.

³⁰ N. C. Extension Service, "Dairy, " "Swine," and "Poultry Waste Management Alternatives," Circulars 568, 569, and 570, Sept. 1973.

Land Runoff

Land runoff is a significant source of pollution and some form of treatment will increasingly have to be considered in areas of high impact. This could be as an alternative to or in conjunction with advanced methods for the treatment of point source wastes. Treatment of land runoff will be particularly applicable in urban areas involving small watersheds where best practicable treatment of municipal and industrial wastes will not be sufficient to protect water quality standards.

Research¹⁸ here has shown that treatment of land runoff by plain sedimentation can reduce organic wastes by 60 percent and suspended solids by nearly 80 percent. The addition of alum increases treatment efficiencies even further. This facilitates use of systems of ponds and lakes which can also be utilized for general urban landscaping. Further study of treatment configurations is warranted.

Sediment

A major step to control pollution from non-agricultural erosion and sedimentation was taken by the 1970 Legislature with enactment of the Sedimentation Pollution Control Act. The act created a Sedimentation Control Commission charged with developing and administering a sedimentation control program for North Carolina. Mandatory standards for land-disturbing activity are prescribed by the law. These are somewhat troublesome of implementation from the standpoint of both land disturbers and regulatory agencies. Study leading to second generation standards of greater ease of application would be welcome.

Authority for the administration of sediment control plans can be delegated to local government and State agencies upon submission of an appropriate and approvable plan. Full implementation of the program in an operational sense is not expected before FY 1975. However, a model ordinance has been drawn up, regulations are being finalized, education programs scheduled, and staff assembled.

Oil

The most effective control methodology for oil pollution would appear to be control at the source. Avoidance of spills, good housekeeping, and proper disposal of waste oils are to be preferred to the difficulties of cleaning up after a spill. This will require knowledge of sources and policing action, and vigorous enforcement to create the atmosphere favorable to prevention.

Land Disposal

Land disposal--or land treatment--appears to be an attractive alternative for the treatment of reclamation of municipal, industrial, and agricultural wastes under favorable circumstances. Soils vary in their suitability for this purpose, however, and additional studies are needed to determine long-term effects on the soil and recommended soil management practices.

Investigations of land disposal should consider forest floors as well as agricultural lands where the capacity to absorb wastewater and sludge without damage to the soil, groundwater, timber growth, and wildlife would be of paramount interest.

Another question currently being raised by regulatory agencies is the potential health threat from aerosol transport of pathogens from disposal sites. While there is no evidence to indicate this to be any more of a hazard than exists with respect to conventional waste treatment, the possibility of a hazard is sufficient for continued investigation.

Present research should be expanded to provide answers to questions on toxic metals and health effects and to develop reliable design and economic data to facilitate the full use of this technique as an alternative means for waste treatment and reclamation under suitable conditions. The Institute is participating in a regional study dealing with all aspects of land treatment. The Wilmington District of the Corps of Engineers land application waste treatment facility now under construction at the John H. Kerr Reservoir, Virginia, should be included in the regional study if at all possible.

Ocean Disposal

The accelerating development of Coastal North Carolina has brought increasingly serious waste disposal problems in its wake. Rapidly coalescing strands of beach cottages are being joined by population-intensive developments and the capacity of groundwater and nearby sounds to accept treated effluents is being exceeded. As land grows scarce and costs of waste treatment mount, the advantages of ocean disposal of treated effluents become more and more attractive.

State policy prohibiting ocean outfalls was born out of experience with a series of poorly designed systems along the Eastern Seaboard. Pollution of coastal waters from inadequately located outfalls has been sufficiently prevalent to discourage greater use. The probability of failure has been much higher than it need have been, however, if the necessary data had been available.

An adequate understanding of off-shore currents to assure proper depth and distance from shore has too often been lacking.

A comprehensive study of coastal waters for this purpose could serve the needs of all communities, identify alternative discharge configurations, and contribute a degree of reliability not otherwise available from less intensive investigations associated with point-by-point problems. Findings would need to be interpreted in both environmental and economic terms.

Groundwater Pollution

No comprehensive groundwater pollution control program now exists in North Carolina. This is equally true at the federal level. Attention continues to be focused almost entirely on surface waters where the effects of pollution first came to public attention. While groundwater pollution may be less obvious and of less immediate concern, it has one dimension at least which justifies far more attention than has been given so far. That dimension is time. Once a groundwater aquifer has become polluted, prolonged periods of time may be required for correction. In many cases this could represent a loss of the resource from the practical standpoint of normal planning and management periods.

The only deep-well injection permit issued in North Carolina involves a chemical plant near Wilmington. While the State continues to monitor this, the plant has been required to construct surface waste treatment facilities. New legislation prohibits future waste disposal by deep-well injection.

The State's only recognized problem from salt-water intrusion is associated with the Castle Hayne aquifer where heavy pumping carries the possibility of intrusion from the Pamlico estuary and from high salinity deposits located within the formation itself. This is under continuing observation by the State and additional studies will be needed.

The expected increase in phosphate mining and fertilizer manufacture anticipated in the near future will complicate the decisions which must be made with respect to increased withdrawals. See the following section on Groundwater Hydrology for further comment on the problem.

Groundwater pollution from septic tanks as a result of the rapid and accelerating rate of their installation under adverse conditions was recognized by the legislature through its enactment of the Ground Absorption Sewage Disposal System Act of 1973. This was discussed earlier under the section on

Water Resource Planning. On its face, the act appears to provide little more authority than existed earlier. Follow-up to determine effectiveness and necessary additional controls should be initiated.

The question of possible groundwater pollution from sanitary landfills is being examined by the State. This is expected to clarify the need for further information and control measures.



WATER QUANTITY MANAGEMENT



WATER QUANTITY MANAGEMENT

Problems associated with water quantity management in North Carolina arise from both water deficiencies and excesses. They include the damaging effects of droughts; heavy rains, hurricanes, and recurring floods; the effects of man's activities on surface and groundwater supplies; and water storage and availability to meet increasing needs.

Surface Water Hydrology

The hydrology of reservoirs, estuaries, and sounds is still inadequately understood, and considerably more information on circulation patterns in relation to applicable variables is needed. Hydrodynamic models of flow-through characteristics are highly desirable as a basis for predictive models for water quality management. This is of particular importance with respect to nutrient transport and eutrophication.

Additional information on rainfall variability³¹ and evapotranspiration rates would be useful for water balance studies, such as the one now being undertaken on the Chowan River estuary.

Changing land use patterns including species and density of vegetative cover are known to affect the yield, timing and rate of release, and quality of runoff from watersheds. Where watersheds are managed for water production, it is desirable that sufficient information be developed to optimize that function.

Shifting patterns of land use in urban areas with extension of impervious surfaces and alteration of stream channels and normal drainage bring far-reaching changes in hydrologic response. These must be monitored to develop the data necessary to predict effects and their implications for future planning and development. Floodway and sediment control at the local government level require information and techniques for the demarcation of floodway boundaries and prediction of runoff from variable frequency storms under different conditions of soil cover, topography, and soil type.

Groundwater Hydrology

The hydrogeology and effects of pumping from the Castle Hayne Aquifer System have been under study by the Office of Water and Air Resources, the

³¹Saucier, W. J., Weber, A. H., and Bayne, C. K., "Precipitation Variability Over North Carolina," WRR-UNC Report 84, Aug. 1973.

phosphate industry, and the Institute since 1965. An OWAR-industry report,³² published in September 1971, reported the effects of pumping to date and projections of the effects of possible future pumping. Because of the limited data on aquifer characteristics, the continued and expanded monitoring of piezometric and salinity levels is essential to aquifer management by the State.

Research³³ on the Castle Hayne aquifer has produced analog and digital computer models which will be useful in the testing of effects of alternative patterns of development. Simulation models of this sort can serve several objectives including: (1) aiding hydrologists to sharpen their concepts and understanding of how hydrologic systems function, and (2) aiding water managers in making decisions on water developments, and allocations. A cooperative study with OWAR using the digital computer for an investigation of development policy alternatives is being undertaken.

The Castle Hayne and other groundwater problems sure to arise in the future demand the best possible technical, legal, and administrative preparation for sound and equitable management plans. State and federal (USGS) resources directed toward these problems can be reinforced through cooperative studies with the university leading to the development of improved groundwater management techniques.

Flood Management

The principal difficulty associated with flooding is the progressive encroachment on flood plains and related increase in flood damage. Flood plain management problems were discussed under Water Resource Planning. The alleged environmental side effects of stream channelization and other flood control works were also covered in that section.

The U. S. Army Corps of Engineers is authorized to conduct hurricane studies to determine the best means of preventing loss of life and damage to property and to participate in the cost of building shore protection projects

³²OWAR, et al, "Summary of Conclusions of Report on Hydrogeology and Effects of Pumping from Castle Hayne Aquifer System, Beaufort County, N. C.," Sept. 1971.

³³Sherwani, J. K., "Computer Simulation of Ground Water Aquifers of the Coastal Plain of North Carolina," WRRI-UNC Report 75, April 1973.

with local and State government. North Carolina has appropriated funds for cost sharing in studies on beach protection and sand erosion control. Studies of coastal erosion and maintenance of inlets will be required for some time to come.

Irrigation

Although North Carolina has a relatively high annual rainfall, seasonal deficiencies are common, and supplemental irrigation is becoming increasingly important to agricultural production. The economics of irrigation need to be measured with respect to the variability of rainfall in the growing season. Little information is available on existing or potential irrigation. Research is underway on a methodology for the prediction of irrigation water demand. In addition, continued investigation of present irrigation practices, variances in rainfall, evaluation of shallow groundwater supplies, improved surface and subsurface irrigation criteria and techniques with and without land forming, and criteria for timing and amount of irrigation water required would all contribute to irrigated agriculture in North Carolina. This might start with a statewide irrigation inventory to identify points, frequency, and intensity of application; crops involved; equipment utilized; and other factors.

Drainage

Inadequate water control presently limits crop production in many areas of the Coastal Plain, and present drainage practice is oriented largely toward the needs of agriculture and pine pulpwood production with only limited consideration of the effects on hardwood production, fish and wildlife, and recreation. Some drainage systems are installed before considering the suitability for drainage, the adverse side effects, or the optimal water table depth for a given soil type. Under agricultural conditions, subsidence, oxidation, and difficulty in rewetting the organic soils can occur because of improper water management. Excess drainage reduces groundwater levels and is alleged to influence groundwater recharge. Drainage of recharge areas and tributary wetland could have a marked effect on the ultimate groundwater supply.

Studies of the beneficial and adverse effects of wetland drainage for agricultural use and pine production would contribute insight into the economic and social merits of drainage projects. Particular attention needs to be given to the prospective and actual effects of drainage associated with massive corporate-scale land conversions now taking place in the Coastal Region.

Research is also needed to assess alternative uses of wetlands and trade-offs involved in drainage decisions and to develop areawide management system concepts for integrating drainage, irrigation, fish and wildlife, wetland forest, and recreation.

PRIORITY RESEARCH NEEDS



PRIORITY RESEARCH NEEDS

Alternative Water Resource Policy, Planning, and Management Roles and Methods for State Government

Regional Water Supply and Wastewater Planning and Management Systems

- Water and Sewer Services
- Balancing Supply and Demand
- Water Quality Management
- Coastal Water Supply and Wastewater Problems

Conjunctive Water and Land Resource Planning

- Water and Land
- Surface and Ground Waters
- Quantity and Quality

Public Participation in Water Resource Planning and Decision-Making

- Identification of Publics
- Education of Publics
- Education of Planners and Managers
- Interaction Mechanisms
- Accountability of Public Agencies

Alternative Futures and Water Demand Projection Methodology

- Withdrawal Uses
- In-stream Uses

Predictive Models for Surface and Groundwater Management

- Water Quantity
- Water Quality
- Management Policy for Castle Hayne Aquifer

Urban Watershed Management

- Surface and Groundwater Hydrology
- Water Quality
- Landscape Enhancement

Effects of Rural Land Conversion Practices

- Surface and Groundwater Hydrology
- Water Quality
- Fish and Wildlife

Environmental and Social Effects of Water Resource Development

- Environmental Impact Assessment
- Techniques for Minimizing Adverse Effects
- Assessment of Ecologically Sensitive Land-Water Areas
- Effectiveness of Dredge and Fill Permit Program
- Value of Mitigation Measures

Information and Data Management Systems for Water and Related Land Management

Public Water Supplies

- Conservation and More Efficient Use
- Safety

Point Sources of Pollution

- Improved Characterization
- Temporal Variation

Non-Point Sources of Pollution

- Characterization
- Planning Methodology
- Control Technology

Pathways, Persistence, and Effects of Pollution

- Organic Chemicals
- Heavy Metals

Water Quality Monitoring

- Strategies
- Sampling and Analytical Techniques

Assimilative Capacity of Water Courses

- Time of Flow in Streams
- Reaeration Rates
- Circulation Patterns in Reservoirs, Lakes, and Estuaries

Septic Tank-Well Problem

- Effectiveness of Present Legislation
- Socio-Economic-Political Constraints

Eutrophication

- Cause and Effects
- Methods of Control

Non-Agricultural Erosion and Sedimentation

- Control Standards
- Control Technology
- Institutional Arrangements

Land Treatment of Municipal, Industrial, and Agricultural Wastes

- Beneficial and Adverse Effects
- Economics
- System Design

Municipal Waste Management

- Infiltration and By-passing of Treatment Plants
- Economic Incentives to Reduce Water Use and Waste Discharges
- System Regulation, Monitoring, and Pretreatment
- Least Cost Alternatives to Advanced Waste Treatment

Industrial Waste Management

- More Efficient Use of Water
- Process Changes
- Waste Recovery and Utilization

Agricultural Waste Management

- Animal Wastes
- Pesticides
- Fertilizer Nutrients

Water and Energy Production

- Consumptive Use of Water
- Waste Heat Management Alternatives
- Economic and Environmental Tradeoffs in Power Plant Siting

APPENDICES

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APPENDIX A

Declaration of Public Policy and Goals
for
Water and Related Land Resources

The principal policy statements related to water resources management are found in the preambles to State acts and the Constitutional amendment of 1973.

The declaration of purpose in the 1967 Water Use Act states:

"It is hereby declared that the general welfare and public interest require that the water resources of the State be put to beneficial use to the fullest extent to which they are capable, subject to reasonable regulation in order to conserve these resources and to provide and maintain conditions which are conducive to the development and use of water resources."

The language of the Act and implementing regulations authorizes the declaration and delineation of "capacity use areas" requiring State permits for withdrawals from surface and groundwaters in excess of 100,000 gallons per day. Prior approvals of surface drainage projects in excess of one acre and subsurface drainage projects adversely affecting groundwater supplies are required. The only such area designated to date is the multi-county region centering around phosphate mining and manufacturing activities near Aurora.

The declaration of public policy of the North Carolina Water and Air Resources Act of 1967 further states:

"It is hereby declared to be the public policy of this state to provide for the conservation of its water . . . resources, . . . to achieve and maintain . . . a total environment of superior quality. . . . affirm the State's ultimate responsibility for the preservation and development of these resources in the best interest of all its citizens and declares the prudent utilization of these resources to be essential to the general welfare . . . standards of water . . . purity shall be designed to protect human health, to prevent injury to plant and animal life, to prevent damage to public and private property, to encourage the expansion of employment opportunities, to provide a permanent foundation for healthy economic development and to secure for the people of North Carolina, now and in the future, the beneficial uses of these great natural resources."

The 1971 Constitutional amendment declares that the protection and conservation of natural resources is a proper public purpose and the policy of the State. This reads:

"It shall be the policy of this State to conserve and protect its lands and waters for the benefit of all its citizenry, and to this end it shall be a proper function of the State of North Carolina and its political subdivisions to acquire and preserve park, recreational, and scenic areas, to control and limit the pollution of our air and water, to control excessive noise, and in every other appropriate way to

preserve as a part of the common heritage of this State its forest, wetlands, estuaries, beaches, historical sites, openlands, and places of beauty."

The North Carolina Environmental Policy Act of 1971, amended in 1973, contains a declaration of state environmental policy as follows:

"The General Assembly of North Carolina, recognizing the profound influence of man's activity on the natural environment, and desiring, in its role as trustee for future generations, to assure that an environment of high quality will be maintained for the health and well-being of all, declares that it shall be the continuing policy of the State of North Carolina to conserve and protect its natural resources and to create and maintain conditions under which man and nature can exist in productive harmony. Further, it shall be the policy of this State to seek, for all of its citizens, safe, healthful, productive and aesthetically pleasing surroundings; to attain the widest range of beneficial uses of the environment without degradation, risk to health or safety; and to preserve the important historic and cultural elements of our common inheritance."

The statement of legislative findings and goals of the 1974 Coastal Area Management Act included the following:

"It is hereby determined and declared as a matter of legislative finding that among North Carolina's most valuable resources are its coastal lands and waters. The coastal area, and in particular the estuaries, are among the most biologically productive regions of this State and of the nation. Coastal and estuarine waters and marshlands provide almost 90 percent (90%) of the most productive sport fisheries on the East Coast of the United States. North Carolina's coastal area has an extremely high recreational and esthetic value which should be preserved and enhanced.

"In recent years the coastal area has been subjected to increasing pressures which are the result of the often conflicting needs of a society expanding in industrial development, in population, and in the recreational aspirations of its citizens. Unless these pressures are controlled by coordinated management, the very features of the coast which make it economically, esthetically, and ecologically rich will be destroyed. The General Assembly, therefore, finds that an immediate and pressing need exists to establish a comprehensive plan for the protection, preservation, orderly development, and management of the coastal area of North Carolina.

"In the implementation of the coastal area management plan, the public's opportunity to enjoy the physical, esthetic, cultural, and recreational qualities of the natural shorelines of the State shall be preserved to the greatest extent feasible; water resources shall be managed in order to preserve and enhance water quality and to provide optimum utilization of water resources; land resources shall be managed in order to guide growth and development and to minimize damage to the natural environment; and private property rights shall be preserved in accord with the Constitution of this State and of the United States."

The Land Policy Act of 1974 states that:

"The land of North Carolina is a resource basic to the welfare of her people.

"A lack of coordination of governmental action; a lack of clearly stated, sound, and widely understood guidelines for planning; and a lack of systematic collection, classification, and utilization of information regarding the land resource have led to inconsistencies in policy and inadequacies in planning for the present and future uses of the land resource.

"Governmental agencies responsible for controlling land use and private and public users of the land resource are often unable to independently develop guidelines for land use practices which provide adequate and meaningful provision for future demands on the land resource, while allowing current needs to be met.

"Systematic and sound decisions as to the location and nature of major public investments in key facilities cannot be made without a comprehensive State policy regarding the land resource.

"Those affected by State land use policy and decisions must be given an opportunity for full participation in the policy and decision-making process. Such a process must allow for the final implementation of policy by local governments. The State should take whatever steps necessary to encourage and assist local governments in meeting their obligation to control current uses and plan for future uses of the land resource."

North Carolina Council on State Goals and Policy

An act of the 1971 State Legislature established a North Carolina Council on State Goals and Policy to:

1. Express the needs and aspirations of North Carolina citizens and identify the kind of future they want for themselves and their families in the form of goals proposed for State action along with a suggested timetable within which these goals might reasonably be achieved;
2. Study the resources and means of action available to state government and recommended policies to guide the State in using these resources and means to achieve State goals and suggest short-run goals, consistent with the long-run goals, that should receive priority consideration within a three to-five-year time frame;
3. Evaluate the present structure and activities of State government and recommend improvements in management and communication to that the State may pursue its chosen goals in an efficient and well-coordinated manner;

4. Identify areas of public interest where needs are urgent or present policies inadequate and recommend appropriate study and analysis to provide a basis for evaluating alternative courses of action; and
5. Inform the general public of the main problems facing the State and involve the citizenry in the study and debate of State goals and policy.

The first annual report was presented to the Governor on November 30, 1972.

Recommendations pertaining to water and related land resources included:

1. Annunciation of a State Land Use Policy to encourage orderly and well-planned development with minimum damage to environmental quality;
2. Encouragement of regional water and sewer management systems;
3. High priority for the acquisition of land for public recreational use and improvement of existing park facilities; and
4. Preservation and enhancement of natural beauty.

The report of the North Carolina Council on State Goals and Policy to the Legislature in January 1974 recommended:

1. Environment

"The major environmental goal for North Carolina should be to preserve and enhance the State's precious natural resources and to ensure equal opportunity for all citizens to enjoy a total environment that is safe, healthy, free of pollution, and pleasant in which to live. This will require:

- a. Continuing and broadening the remedial measures now being undertaken to solve existing environmental problems;
- b. Initiating legislation, improved resource management policies and practices, and long-range planning to prevent future environmental problems; and
- c. Seeking to make our citizens aware of the nature of man's relationship to his environment, gain an appreciation of this relationship, and accept an environmental ethic to be practiced in decisions affecting man and his environment."

2. Land

Enactment of coastal and mountain area management, State land policy, and land conservancy bills;

Development of a comprehensive land use inventory and analysis system; and

Stronger State support for systematic land use planning at regional and local levels.

3. Water

Completion of the State Water Plan by December 31, 1975;

Alternatives to major impoundments for flood control and water supply;

Discouragement of location of wet industries in areas with water pollution problems and limited water supplies.

4. Recreation

Enactment of legislation establishing a State Land and Water Conservation Fund to place State park land acquisition on a sound and continuous basis;

Addition of a system of State recreation areas to present system of State and natural areas;

Annunciation of a State policy on recreation land acquisition and development at reservoirs;

Preparation of a comprehensive outdoor recreation plan;

Expansion of number and variety of State outdoor recreation opportunities;

Investigation of non-tax alternatives for the support of outdoor recreation, including user charges and fees;

Completion of the State natural area inventory by June 30, 1974.

North Carolina Land Policy Council

On August 17, 1973, the Governor issued an Executive order creating a North Carolina Land Policy Council to review and evaluate existing programs related to the management of State-owned lands; initiate steps to develop further components of an overall State land policy, alternate forms or models for a State land classification system, and a land resources information system; and compile and evaluate existing North Carolina law and regulations concerning land use management.

Federal Water Pollution Control Policy

No review of policy and goals would be complete without some reference to federal actions influencing decisions at the State level. The most profound of these has been the 1972 amendments to the Federal Water Pollution Control Act (FWPCA) which required many of the State legislative actions referred to in the section on State Law. The "Declaration of Goals and Policy" in this Act states that it is its objective to restore and maintain the chemical, physical, and biological integrity of the Nation's waters. In order to achieve this objective, the Act declares it is the national goal that:

1. The discharge of pollutants into the navigable waters be eliminated by 1985; and
2. Wherever attainable, an interim goal of water quality which provides for the protection and propagation of fish, shellfish, and wildlife and provides for recreation in and on the waters be achieved by July 1, 1983.

The Act further states it is national policy that:

1. The discharge of pollutants in toxic amounts be prohibited;
2. Federal financial assistance be provided to construct publicly owned waste treatment works;
3. Areawide waste treatment management planning processes be developed and implemented to assure adequate control of sources of pollutants in each state; and
4. A major research and demonstration effort be made to develop technology necessary to eliminate the discharge of pollutants into navigable waters, waters of the contiguous zone, and the oceans.

U. S. Council on Environmental Quality Revised Guidelines for the Preparation of Environmental Impact Statements

As early as possible and in all cases prior to agency decision concerning recommendations or favorable reports on proposals for: (1) Legislation significantly affecting the quality of the human environment, and (2) all other major Federal actions significantly affecting the quality of the human environment, federal agencies will, in consultation with other appropriate federal, State, and local agencies, assess in detail the potential environmental impact. Initial assessments of the environmental impacts of proposed action should be undertaken concurrently with initial technical and economic studies and, where

required, a draft environmental impact statement prepared and circulated for comment in time to accompany the proposal through the existing agency review processes for such action. In this process, Federal agencies shall: (1) Provide for circulation of draft environmental statements to other Federal, State, and local agencies and for their availability to the public in accordance with the provisions of these guidelines; (2) consider the comments of the agencies and the public; and (3) issue final environmental impact statements responsive to the comments received. The purpose of this assessment and consultation process is to provide agencies and other decision-makers as well as members of the public with an understanding of the potential environmental effects of proposed actions to avoid or minimize adverse effects wherever possible, and to restore or enhance environmental quality to the fullest extent practicable. In particular, agencies should use the environmental impact statement process to explore alternative actions that will avoid or minimize adverse impacts and to evaluate both the long and short-range implications of proposed actions to man, his physical and social surroundings, and to nature. Agencies should consider the results of their environmental assessments along with their assessments of the net economic, technical, and other benefits of proposed actions and use all practicable means, consistent with other essential considerations of national policy, to avoid or minimize undesirable consequences for the environment.

U. S. Water Resources Council Principles and Standards for Planning Water and Related Land Resources

The new Principles and Standards for Planning Water and Related Land Resources systematically relate the different aspects of water planning to economic, environmental, regional, and social well-being criteria. They will be used by all federal agencies in regional or river basin planning and in planning federal and federally assisted water related land resource programs and projects.

The "Principles and Standards" represent a marked departure from past resource planning which was based primarily on the economic impact of land and water resources. In the new system, planning for the use of the Nation's water and land resources will be carried out in the context of two broad national objectives relating to national economic development and environmental quality. Each objective will be given equal consideration in the conservation, development, and use of our Nation's water and land resources. Under this two-objective

approach beneficial and adverse effects on national economic development and environmental quality will be prepared and displayed for each alternative plan. In addition, an accounting of the effects on regional development and social well-being will also be prepared and displayed for each alternative plan. All positive or beneficial effects are to be evaluated as are all negative or adverse effects. Values will be expressed in appropriate monetary or quantitative units or in appropriate qualitative terms.

A planning discount rate to reflect the relative values of beneficial and adverse effects occurring in the future as compared with the present has been established by the Water Resources Council. This rate is consistent with the cost of Government borrowing concept which is based on the assumption that the Government's investment decisions are related to the cost of money to the Government. The rate has been established at 6-7/8 percent and will change up or down, as appropriate, not more than or less than 1/2 of 1 percent per year. The "Principles and Standards" will be applied to all currently authorized but unfunded projects on a selective basis to be determined by the head of the agency.

National Water Commission Report

The National Water Commission has now completed its monumental study of national water policy and programs and its recommendations are under active discussion and debate. These hold considerable significance to State as well as federal government. Policy implications are summarized in the following seven themes:

1. The level of future demands for water is not inevitable but derives in large part from policy decisions within the control of society;
2. National priorities should shift from water resources development to restoration and enhancement of water quality;
3. Water resources planning must be tied more closely to land use planning;
4. National policies should lead to the conservation of water--motivate better use of water and reduce water losses by improved efficiency;
5. Sound economic principles should be applied to decisions on whether to build water projects--consumer willingness to pay as well as benefit cost analysis;

6. Laws and legal institutions should be reexamined in the light of contemporary water problems; and
7. Development, management, and protection of water resources should be controlled by that level of government nearest the problem and most capable of effectively representing the vital interests involved.

Flood Disaster Protection Act of 1973

The Federal Flood Disaster Protection Act of 1973 amends the National Flood Insurance Act of 1968 to:

1. substantially increase the limits of coverage authorized under the national flood insurance program;
2. provide for the expeditious identification of, and the dissemination of information concerning, flood-prone areas;
3. require States or local communities, as a condition of future Federal financial assistance, to participate in the flood insurance program and to adopt adequate flood plain ordinances with effective enforcement provisions consistent with Federal standards to reduce or avoid future flood losses; and
4. require the purchase of flood insurance by property owners who are being assisted by Federal programs or by federally supervised, regulated, or insured agencies or institutions in the acquisition or improvement of land or facilities located or to be located in identified areas having special flood hazards.

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APPENDIX B

New State Legislation and Utility Commission Rules

Environmental Policy

Amendments to the Environmental Policy Act extended the expiration date to 1977 and require environmental impact statements for any project, or related policy and plan, financed in part by the State or approved by the State involving major changes in the environment. Prior to making statements, responsible officials are required to consult with and obtain the comments of any agency which has either jurisdiction or special expertise. State programs involving regulation or control through permits, licenses, or standards which in the aggregate have a significant environmental impact, must present in their annual work program a plan which delineates the rules and regulations and underlying guidelines on how they shall be administered.

Water Pollution Control

The North Carolina General Statutes relating to water pollution were amended to:

1. Limit membership on the Board of Water and Air Resources to persons who have not received any significant portion of their income from permit holders or applicants for permits;
2. Prohibit the discharge of any:
 - a. chemical or biological warfare agent or high-level radioactive wastes to waters of the State,
 - b. wastes to the subsurface or groundwaters of the State by means of wells, and
 - c. wastes, including thermal discharges, to the open waters of the Atlantic Ocean over which the State has jurisdiction, except where permitted by regulations of the Board;
3. Require State certification of laboratories performing analyses and monitoring required by the statutes;
4. Limit variances to conditions not endangering human health and safety and where best available technology economically achievable would produce serious hardship without equal or greater benefits to the public;

5. Authorize the designation of any employees of the Department of Natural and Economic Resources as hearing officers to conduct hearings;
6. Authorize the imposition of civil penalties not to exceed \$5,000 by the Board against persons in violation of standards, regulations, permits, and special orders, or who fail to submit documents and data, or refuse access for investigations required under the statutes;
7. Authorize criminal penalties up to \$25,000 per day of violation, imprisonment up to six months, or both;
8. Authorize injunctive relief to restrain violations or threatened violations;
9. Require the Board and Department to undertake a continuous planning process on a statewide or regional basis to assure implementation of statutory requirements and authorize the Governor to designate representative organizations for this purpose;
10. Authorize the Governor to consult and cooperate with governors of adjoining states in establishing interstate planning regions or areas and in designating representative organizations to develop interstate plans for water pollution control;
11. Authorize public hearings, whether or not a capacity use area has been declared, when it is believed that withdrawal of water from or the discharge of water pollutants to waters in an area is having or will likely have unreasonable adverse effects upon such waters to the extent that availability or fitness for existing and proposed uses has been impaired and that injury to the public health, safety, or welfare will result if increased withdrawals or discharges occur; and
12. Authorize the Board to issue orders prohibiting:
 - a. withdrawals in excess of 100,000 gallons per day,
 - b. any increase in rate of discharge of water pollutants in excess of rate established by order, and
 - c. any agency or political subdivision from issuing any permit for construction or operation of existing or new facilities for withdrawing water or discharging water pollutants in excess of rates established by order.

13. Regulate and control sources of oil pollution by:
 - a. prohibiting the discharge of oil into or upon any water, land or sewer without a permit from the Board;
 - b. establishing an Oil Pollution Protection Fund to defray expenses for the containment, collection, dispersal, or removal of oil discharged to water or lands of the State and for restoration necessitated by discharges, and
 - c. authorizing reimbursement to the Fund of costs and damages by persons responsible for discharges;
14. Develop, adopt, modify and revoke effluent standards and limitations for point sources of wastewater, toxic wastes, and pretreatment of wastewaters discharged to disposal systems;
15. Permit metropolitan sewerage districts to encompass land in more than one county;
16. Study of North Carolina small water and sewer systems to investigate and propose legislation to the General Assembly relating to the regulation of small water and sewer systems in North Carolina;
17. Regulate the installation of septic tanks and other ground absorption sewage disposal systems;
18. Establish an Advisory Committee on Animal Waste Pollution to assist and advise the Board in:
 - a. a survey and appraisal of animal waste disposal in North Carolina,
 - b. development of:
 - (1) criteria, standards, policies, rules and regulations concerning animal waste disposal, and
 - (2) proposals for legislation on animal waste disposal.

Erosion and Sediment Control

The Legislature also enacted a Sedimentation Control Act in 1973 to establish a statewide program for the control of erosion and sedimentation associated with non-agricultural activities. The Act established the North Carolina Sedimentation Control Commission which is charged with the duty of developing and administering the program within the Department of Natural and Economic Resources.

In implementing its program, the Commission is authorized and directed to:

1. Develop a model local erosion control ordinance and assist and encourage local governments in developing erosion and sediment

control programs, and to approve, modify, or disapprove such programs;

2. Assist and encourage other State agencies in developing erosion and sediment control programs to be administered within their jurisdiction, to approve, modify, disapprove, review, such programs; and to require at its discretion the submission of erosion control plans;
3. Develop recommended methods for the control of sedimentation, and prepare and make available related educational materials.

The Commission has jurisdiction to the exclusion of local government over land disturbing activities conducted by the State, United States, persons having power of eminent domain, local governments, or licensed by the United States. Authority to delegate jurisdiction to State agencies is provided. The Commission has concurrent jurisdiction with local government over all other land disturbing activities. Procedures for the approval of sediment control plans, mandatory standards, and enforcement authority with penalties for non-compliance are provided in the law.

Floodway Regulation

The authority of State government to regulate floodways was greatly strengthened by the Legislature in 1973. The State is now authorized to enter into contractual agreements with the federal government as previously vested in local government and to provide floodway regulation by the Board of Water and Air Resources.

The amended Floodway Regulation Law authorizes the Board to establish floodways on any stream when it has determined that floodways should be delineated, the use controlled, and local government has not taken action to do so. It continues to be the responsibility of local government to control uses within designated floodways.

The purpose of the law is to specify means for the regulation of artificial obstruction in floodways. It declares that the channel and a portion of the floodplain of all the State's streams will be designated as a floodway, in which artificial obstructions may not be placed except in accordance with provisions of the law. The purpose of designating these areas as a floodway is to help control and minimize the extent of floods by preventing obstructions which inhibit water flow and increase flood height and damage; to prevent and minimize

loss of life and damage in flood hazard areas; and to promote the public health, safety, and welfare of citizens in such areas.

Power Plant Siting

In 1973, the State Utility Commission adopted rules regarding the planning, siting, and construction of electric generating facilities and the periodic reporting of forecasts of loads and resources. Every electrical public utility must now report annually a ten-year forecast of loads and generating capability. The reports are to include:

1. Tabulation of peak loads, generating capability, and reserve margins for each year;
2. List of existing plants in service with capacity, location, and technological innovations to be back fitted to improve environmental quality;
3. List of generating units under construction planned at locations where property has been acquired and certification reviewed or application made with location, capability, plant type, and proposed date of operation;
4. List of proposed generating units at locations not known with general location, capacity, plant type, and date of operation.
5. List of units to be retired from service with location, capacity, and date of retirement;
6. List and description of transmission lines and associated facilities proposed or under construction;
7. List of generation and associated transmission facilities under construction which have delays of over six months and major causes of such delays; and
8. List of future probable sites giving general location and description, major advantages, and status of ownership.

The rules also require every electrical public utility to biennially report a twenty-year forecast of loads, generating capability, and reserve margins.

Coastal Area Management

The 1974 Legislature took an important step toward strengthening land use planning and regulation through enactment of the Coastal Area Management Act. This established a cooperative program of coastal area management between local and State governments. Local government is to have the initiative for planning.

State government will establish areas of environmental concern. With regard to planning, State government will act primarily in a supportive standard-setting and review capacity, except where local governments do not elect to exercise their initiative. Enforcement is to be a concurrent State-local responsibility.

The coastal area subject to the Act includes the counties bordering the Atlantic Ocean.

The program will be administered by a Coastal Resources Commission established within the Department of Natural and Economic Resources. Members are appointed by the Governor. All but three of the fifteen members must be appointed from a list of nominees prepared by the Boards of County Commissioners.

Planning responsibilities include the development and adoption of State guidelines for the coastal area and the development and adoption of a land use plan for each county within the coastal area. The guidelines are to consist of statements of objectives, policies, and standards to be followed in public and private use of land and water areas. They are to give particular attention to the nature of development appropriate to each type of area of environmental concern. All local land use plans adopted under the Act and State land policies must be consistent with the guidelines. If counties fail to adopt land use plans within specified times, the Commission will assume this responsibility. No permits can be issued which are inconsistent with plans approved by the Commission. The Coastal Resources Commission is to designate areas of environmental concern.

Land Policy

The purpose of the Land Policy Act of 1974 is to promote patterns of land use in accord with a state land use policy which encourages the wise and balanced use of the State's resources; to give local government guidance and assistance in the establishment and implementation of local land planning and management programs so as to effectively meet their responsibilities for economically and environmentally sound land use management; to provide essential public services equitably to all persons within the State and to assure that citizens shall have, consistent with sound principles of land resource use, maximum freedom and opportunity to live and conduct their activities in locations of their personal choice; to condition the distribution of certain federal and State funds on meeting reasonable and flexible State requirements for basic land planning; such conditions to include a clear statement of the State's authority and responsibility for review of planning and management by local governments; to

develop and maintain coordination of all State programs having a land use impact, including joint planning and management of State lands with adjacent non-State lands; and to promote the development of systematic methods for the exchange of land use, environmental, economic, and social information among all levels of government, and among agencies at all levels of government.

The Act establishes a North Carolina Land Policy Council within the Department of Administration to analyze applicable state laws, develop a land resource information system, consult with neighboring states and federal government as to interstate land use issues, prepare an inventory of relevant financial resources, establish a method for assessing regional impact of new developments, prepare principles and guidelines for systematic identification of areas of environmental concern, provide technical assistance and training programs, establish a method for coordination of land use programs, prepare a State Land Policy and State Land Classification System, and develop recommendations for the General Assembly concerning a system of property evaluation for tax purposes related to range of available public services.

The first part of the document discusses the importance of maintaining accurate records of all transactions. It emphasizes that proper record-keeping is essential for the success of any business or organization. The text outlines various methods for recording transactions, including the use of journals, ledgers, and spreadsheets. It also highlights the need for regular audits and reconciliations to ensure the accuracy of the financial data.

The second part of the document focuses on the role of management in overseeing the financial operations of the organization. It discusses the importance of setting clear financial goals and objectives, and the need for effective communication and coordination between different departments. The text also touches upon the importance of risk management and the need to identify and mitigate potential financial risks.

The final part of the document provides a summary of the key points discussed and offers some concluding thoughts on the importance of financial management. It encourages the reader to take the time to review the document and apply the principles discussed to their own organization.

APPENDIX C

Basic Data Systems

Basic data on the available water supply, water demand, water-related land use, water quality, and associated socio-economic-environmental factors are of fundamental importance to water resource planning and management in North Carolina.

North Carolina climatologic data reports are issued monthly by the Department of Commerce's National Climatic Center in Asheville. These list daily total precipitation for 200 stations. Data on maximum and minimum temperature are also provided for 125 of these stations. Detailed local climatological data are published monthly for Asheville, Charlotte, Greensboro, Hatteras, Raleigh, and Wilmington. The data include hourly observations of temperature, precipitation, general weather conditions, visibility, wind direction and speed, and barometric pressure.

Hydrologic data activities of the U. S. Geological Survey include 401 stream flow stations and 25 lake and reservoir stations. Continuous discharge records are maintained on 154 stream stations. Adequate records have been obtained for an additional 568 stream stations on which data collection has been discontinued. Other stations are operated by the Tennessee Valley Authority and U. S. Department of Agriculture. Chemical and physical data are collected by the Geological Survey at 136 surface water sites. USGS data are published periodically and are stored on magnetic tape in Washington, D. C., for computer use.

Prior to 1974, the State's surface water quality monitoring network included 102 primary and 1560 secondary stations. The former pertain to long-term changes in water quality of the major streams and their principal tributaries. The secondary network was designed to monitor water quality below all points of waste discharge to determine compliance with water quality standards. Sampling was generally by grab samples at about monthly intervals during warm weather seasons of the year.

The State's surface water quality monitoring program was redesigned last year to meet requirements of the 1972 FWPCA. Current objectives are:

"to develop and maintain an understanding of the quality of all waters in the State for the purpose of supporting water pollution control activities, including planning and enforcement."

The revised program includes intensive surveys of the 31 sub-basins designated as water quality limited,* a permanent primary in-stream monitoring network, a compliance network, and a sub-basin water quality network.

Initial effort with respect to the intensive surveys has been concentrated on the Cape Fear and Neuse River Basins. This is being done with the assistance of university faculty at North Carolina State University, University of North Carolina at Chapel Hill, and East Carolina University. The purpose of the surveys is to:

1. determine the extent and nature of water quality problems in each area;
2. facilitate the setting of priorities for pollution control; and
3. obtain basin data for updating water quality management plans, verification of stream classifications and waste discharges, and setting of effluent limitations.

The permanent primary in-stream network is to provide the data necessary "to establish baselines and water quality norms." Group 1 stations consist of 12 comprehensive water quality data stations on the Haw, Cape Fear, Pee Dee, French Broad, Tar, and Neuse Rivers and Sugar Creek downstream from Charlotte. Three additional stations are to be selected at unpolluted sites in the Mountain, Piedmont, and Coastal Plain regions of the State. Specific conductance and temperature will be measured daily and bacterial densities weekly. Other parameters will be measured on what is approximately a monthly basis.

Group 2 stations of the primary network include 34 sites for the measurement of chemical and physical quality "below clustered pollution sources, non-point sources of pollution and in water suspected of accumulating pollution." Samples will be taken twice monthly for the principal quality parameters and four times yearly for most of the remainder.

Group 3 stations have been selected to determine the trophic state of coastal waters. An Institute-sponsored study of the trophic state of North Carolina lakes is being conducted at UNC-Chapel Hill. The coastal and lake studies build on EPA's National Eutrophication Survey.

*Water quality limited segments are those where water quality will not meet applicable water quality standards even after application of best practicable control technology by industry and secondary treatment by municipalities.

Streamflow measurements will be determined at existing continuous record gages or by means of reference points and flow measurements.

New State Regulations for Monitoring and Reporting Wastewater Discharges and their Effect Upon Receiving Waters have been promulgated in response to requirements of the Federal Water Pollution Control Act and the N. C. 1971 State Reporting and Monitoring Act. They require all waste discharge permit holders to establish, operate, and maintain approved monitoring systems. This is collectively known as the compliance network.

All class 2, 3, and 4 dischargers are to install, operate, and maintain continuously measuring and recording devices or the methods approved by the State. Streamflow readings are to be reported at sampling times where gages or reference points are available. Sampling points are to be established in receiving waters upstream and downstream from waste discharges. Grab samples are acceptable in streams. Waste influent and effluent samples are to be 24-hour composites of proportional samples collected at intervals not to exceed 30 minutes. Monthly reports are required with telephone reporting of occurrences endangering public health, fish, and wildlife. All applications for permits must now be accompanied by a proposal for an approved monitoring and reporting system. The required testing and measuring frequency varies by class of waste source and parameter and is specifically prescribed by the State. Methods to maintain a check on the validity of data to be submitted are yet to be prescribed.

The sub-basin water quality network includes a system of monitoring stations to measure the quality of water at the lower and upper extremities of each of the State's 128 sub-basins. Monthly grab samples will be taken from March through October.

Monitoring of the State's 71 shellfish growing areas is conducted by the State Board of Health. Comprehensive studies are made on a two-year cycle in lieu of continuous monitoring. Total coliform densities have been measured in the past. Steps are currently underway to conduct parallel measurements of fecal coliform organisms.

While the revised water quality monitoring program is a marked advance over previous activities, it still lacks many of the concepts essential to a sound strategy. More attention needs to be given to such questions as:

1. What are the State's specific monitoring needs?
2. What degree of system reliability is required for each data need?

3. Will the proposed activities meet the specific needs within assigned reliability?
4. Is the proposed system the most cost-effective alternative?

Earlier monthly sampling frequencies have been demonstrated to be markedly inadequate for planning and management needs. The optimal frequency will not be determined by moving from the broad to a more narrow time spectrum. It must be derived from intensive studies designed to define stream response to varying conditions of flow and waste input. When the system is understood, necessary reliability for the various monitoring needs can be assigned and the minimum spatial and time frequencies determined.

Groundwater basic data systems include a State-USGS cooperative program to develop a statewide network of observation wells. This presently includes "about 400 wells." The Geological Survey reports that water levels are currently being measured in 94 wells--69 on a continuous basis. Adequate records have already been obtained on an additional 55 wells and measurements discontinued. Water quality data are obtained at 36 of the wells where water levels are being recorded and at 39 other wells where levels are not measured. The State is also installing "research stations" at strategic locations. These include a well into the principal aquifer equipped with recorders and a duplicate set of wells into related aquifers. Thirteen have been installed to date.

Comprehensive studies of groundwater supplies have been completed in eight counties and are underway in three more. Regional investigations have been undertaken in such problem areas as Northeastern North Carolina and the Pamlico River Ground Water Basin, where key wells are monitored monthly and the others quarterly. Additional data are collected from the examination of geophysical logs, well cuttings, and cores; well reports submitted by registered drillers; and well construction permits.

Steps are also underway to expand a groundwater quality monitoring program to include an inventory of groundwater pollution and associated monitoring wells. Initial emphasis is on effects of sanitary land fills and the State's only deep-well disposal site (which is still being monitored, though further waste disposal by this method has been prohibited).

Data on streamflow, rainfall, temperature, evaporation, and snowfall are stored in the Hydrologic Information Storage and Retrieval System (HISARS)³⁴

³⁴Wiser, E. H., "Hydrologic Information Storage and Retrieval System Reference Manual," WRRI-UNC Report 66, June 1972.

located at the Triangle University Computation Center. The U. S. Geological Survey data storage system and the Environmental Protection Agency's STORET System handle all surface water quality data. Storage and retrieval of ground-water data is not automated, though steps are being taken to implement electronic data processing. There would appear to be distinct advantages to utilization of HISARS for this purpose from the standpoint of conjunctive surface and ground-water resource planning.

The Division of Health Services, Department of Human Resources, maintains a Public Water Supplies Inventory which is accessed through the Administration Computer Center. The System contains information on source, capacity, treatment, laboratory analyses, etc. Water use data are limited to utilized plant capacity.

A computer-based Planning Land Use Management System (PLUM) is currently under development by the State Planning Division, Department of Administration. The system will accommodate land-related information such as soil type, geology, topography, vegetation, water bodies, land use, population densities, transportation networks, tax rates, and other data. When operational, it is anticipated that the system will provide for convenient entry and retrieval of land-oriented information and will allow flexibility in tabular and graphic output to permit spatial display and interpretative results. The State Planning Division also maintains a census analysis system, population projections to 1980 by county, and an input-output model of the North Carolina economy. The model divides the State economy into 58 producing sectors and permits the calculation of estimated economic impacts on the State's productive capacity of a variety of assumed conditions.

A Recreation Site Inventory is maintained by the Office of Recreation Resources, North Carolina Department of Natural and Economic Resources. The system includes a physical description and analysis of recreation resources by site, county, region, and state.

The Office of the Chief of Engineers recently completed an environmental inventory³⁵ for North Carolina which offers much useful information. Included are physiographic, biological, and cultural elements together with environmental use or management areas. The objectives of the inventory are to provide an environmental warning system and environmental information useful for public information and participation activities.

³⁵U. S. Army Corps of Engineers, "Environmental Reconnaissance Inventory of State of North Carolina," Dec. 1973.

The existing basic data systems are limited with respect to data on:

1. Available groundwater supply and aquifer characteristics;
2. In-stream water quality
 - a. for modeling and planning,
 - b. enforcement, and
 - c. measurement of trends;
3. Stream characteristics;
4. Waste sources
 - a. historic data on point sources,
 - b. non-point sources; and
5. Historic data on water use.

Considerable research is still required with respect to basic data systems to provide needed data not presently available and to interface the mounting number of specialized systems to encourage coordination and conjunctive planning rather than contribute to further fragmentation.