

WATER RESOURCES RESEARCH INSTITUTE

OF THE UNIVERSITY OF NORTH CAROLINA

NORTH CAROLINA STATE UNIVERSITY AT RALEIGH

UNIVERSITY OF NORTH CAROLINA AT CHAPEL HILL

Number 54

July, 1970

NEW INSTITUTE REPORTS

✓ Report No. 34. The Relative Significance of Phosphorus and Nitrogen as Algal Nutrients, by Dr. Charles M. Weiss, Department of Environmental Sciences and Engineering, University of North Carolina at Chapel Hill

By the examination of the interaction between nitrogen and phosphorus species relative to algal growth in several fresh water environments of differing trophic state, it has been possible to establish the relative significance of these elements as algal nutrients. The algal assay was carried out using membrane filtered samples derived from a series of oxidation ponds receiving secondary effluent from a trickling filter plant and from samples derived from sampling points on the New Hope and Haw Rivers. The latter represented a series of changing river qualities with particular respect to the oxidation states of nitrogen and phosphorus. The algal assay used pure cultures of five species: Euglena rostrifera, Chlamydomonas reinhardtii, Pandorina morum, Scenedesmus quadricauda, and Chlorella ellipsoidea. Each of these species has been described as normally associated with polluted waters.

The results of both chemical and biological assay examined through multiple regression analysis of the independent variable involved in the algal assay as well as a quadratic analysis of covariance of $\text{NH}_3\text{-N}$, $\text{NO}_3\text{-N}$ and $\text{PO}_4\text{-P}$ established the relative significance of the nitrogen and phosphorus species in water containing high concentrations of these elements, concentrations normally found in discharges from biological waste treatment plants and following dilution in receiving streams. Under these circumstances it has been shown that the quantity of nitrogen rather than that of phosphorus determines the biomass of algae that might be expected to grow. This response holds true for the several species of algae that were used. It would thus appear that the question of algal nutrients takes on a somewhat more formidable dimension due to the considerably greater difficulty in removing in significant amounts the nitrogen that is normally found in municipal wastewaters.

Research Program 1970-1971 Water Resources Research Institute

An updating of a brochure which briefly describes the Institute's mission and research program for FY 1971. It also carries a list of Institute publications.

Note: Copies of the above reports are available from the Institute upon request.

HEARING ON REGIONAL WATER SUPPLIES

The Mills Subcommittee of the Legislative Research Commission met in Raleigh on July 15 to hear those who wished to comment upon its study of local and regional water supplies in North Carolina. Commenting from the University were Dr. Daniel A. Okun, Department of Environmental Sciences and Engineering, UNC at Chapel Hill, and David H. Howells, Institute Director.

Dr. Okun emphasized the disparity in water services between large and small communities. A national survey by the Public Health Service, he reported, disclosed that 24 percent of the communities under 500 people were providing water supplies that exceeded mandatory limits for trace chemicals while none of the water supplies for communities over 100,000 persons exceeded these limits. The state can do much, Okun said, to improve water supply service and the potential that water supply has for economic development:

1. More funds should be invested in planning,
2. Financial incentives for joint water supply systems should be provided for some or all of the engineering costs for planning and design,
3. The state might participate in the cost of constructing joint water supply systems,
4. Legal barriers to regional enterprises need to be eliminated,
5. Private separate water supply systems should not be authorized until a neighboring city or the county have indicated they are not prepared to serve the community, and
6. If the legislature indicates its support for regionalization, the State Board of Health might use its statutory authority to press for more rigorous standards for design and operation, thereby imposing higher costs on small systems and thus encouraging regional supplies.

In his remarks, Howells attributed local government water problems to inadequate investment and fragmentation of responsibility resulting in public health hazards, inefficient development of small systems, and failures to achieve economics of scale in utility development. The Advisory Commission on Intergovernmental Relations has expressed the belief, he said, that effective service areas properly related to state, regional, and federal planning are essential to the provision of public water supplies and sewerage services. The performance of these responsibilities requires comprehensive planning including the incorporation of water supply and sewage system plans into over-all regional plans. Among the findings of a 1968 statewide symposium on the problem in North Carolina were the need for:

1. A clearly established responsibility for comprehensive planning of water and sewerage services,
2. Responsibility for risk taking and development investment,
3. Procedures to assure coordination of actions at local level, and
4. A statewide water plan.

The state is in a strategic position to assert its influence in this vital area, Howells said. It can provide a framework for comprehensive planning of water and sewerage services and for the orderly coordination of local actions, so as to make the most efficient use of available water resources and economies of scale for system construction, operation, and supervision. Responsibility for general statewide planning and coordination needs to be centered in a single state agency. Regional service agencies within this framework should then be established for the more detailed planning, construction, and operation of areawide water and sewer systems. State financial incentives would be very useful, particularly with respect to the problem of "risk taking" in areas where development is insufficient to support systems compatible with regional plans.

Howells reviewed new legislation in Maryland, New York, Ohio and Pennsylvania dealing with similar problems which provide for statewide and regional water and sewer system planning, construction and operation. Copies of existing and proposed laws were given to the Committee for its consideration.

SENATE HEARINGS ON WATER RESOURCES RESEARCH

The Subcommittee on Water and Power Resources of the Senate Committee on Interior and Insular Affairs held hearings on S. 3553 and related legislation to amend the Water Resources Research Act on July 20, 1970. The proposed amendments would:

1. Increase the authorized annual allotments for state water resources research institutes from \$100,000 to \$250,000, and
2. Authorize scientific information dissemination activities, including identifying, assembling, and interpreting the results of scientific and engineering research deemed potentially significant for solution of water resource problems, providing means for improved communication regarding such research results, including prototype operations, ascertaining the existing and potential effectiveness of such for aiding in the solution of practical problems, and for training qualified persons in the performance of such scientific information dissemination.

The measure has the support of President William Friday, Senators Jordan and Ervin, and Governor Scott. A letter from Governor Scott endorsing the legislation was introduced into the hearing record by Senator Jordan. Institute Director David H. Howells testified for the Senate Bill on behalf of the Universities Council on Water Resources and the Consolidated University of North Carolina.

Early passage of the legislation is expected in the Senate, but questions still remain as to progress in the House.

WATER RESOURCES COUNCIL SETS NEW PLANNING POLICY

The Water Resources Council has approved conceptually a new planning policy. The concept involves standardization of planning into three levels. National and regional assessments would be the first level and would be a continuing process reported at five-year intervals. They would update projections, type 1 framework studies, assess needs for water and related land resources, and identify problem areas.

The second level would be regional and river basin plans. These would be reconnaissance-type multiple-purpose plans. They would be initiated in problem areas designated by the national and regional assessments or by other means and would be completed within three years. The third level would be implementation studies. If they result from the assessments and regional plans, they should be completed within two years.

The study direction of the multi-agency efforts on the assessment and regional plans would be furnished or designated by the River Basin Commissions or the Water Resources Council. The implementation studies would proceed under the direction of the principal federal, state, or local agency involved.

EDUCATIONAL SYSTEMS FOR OPERATORS OF WATER POLLUTION CONTROL FACILITIES

The proceedings of a workshop on Educational Systems for Operators of Water Pollution Control Facilities sponsored by the Southeast Region - Federal Water Pollution Control Administration and Clemson University and conducted in Atlanta, Georgia, November 3-5, 1969, are now available.

These proceedings contain papers from academic, governmental, industrial and other organizations who are concerned with educational methods for the training of operators of water pollution control facilities. Of particular interest are the discussions of the potential use of new methods such as programmed learning, educational television and computer based instruction.

Copies of the proceedings may be obtained for \$3 from:

Professor Robert A. Banister, Coordinator
Office of Industrial & Municipal Relations
College of Engineering, 112 Riggs Hall
Clemson University
Clemson, South Carolina 29631

Checks payable to CLEMSON UNIVERSITY should accompany order.

NATION'S WATER POLLUTION CONTROL NEEDS SET AT \$33-\$37 BILLION

Senator Edmund S. Muskie, Chairman of the Senate Subcommittee on Air and Water Pollution, has released a report estimating the nation's water pollution control needs for the next six years at \$33-\$37 billion.

The report strongly urged approval of a federal funding program of at least \$2.5 billion a year for the construction of municipal facilities. It added that "a \$3 to \$4 billion a year federal program can be easily justified in light of present needs."

The report was prepared by the National League of Cities and the United States Conference of Mayors at Senator Muskie's request. He had asked for hard figures during water pollution hearings held last May.

The Maine Democrat is chief sponsor of S. 3687, pending before the Subcommittee, to authorize a federal program of \$2.5 billion a year for five years. The funds would become the federal share of \$25 billion worth of municipal facilities.

WHITE HOUSE ANNOUNCES NEW REORGANIZATIONAL PLANS FOR ENVIRONMENTAL PROGRAMS

The President has submitted to the Congress Reorganization Plans Nos. 3 and 4 of 1970, establishing the Environmental Protection Agency (EPA) as a new, independent agency within the Executive Branch, and the National Oceanic and Atmospheric Administration (NOAA) in the Department of Commerce.

Environmental Protection Agency. The EPA brings together in a single organization the major federal pollution control programs now existing in four separate agencies and one interagency council. The creation of the EPA, the White House press release said, fulfills the President's pledge of February 10, 1970, to recommend improved administrative machinery to meet the current pollution crisis.

The mission of the EPA will be to organize the fight against environmental pollution on an integrated basis which acknowledges the critical relationships between pollutants, forms of pollution, and control techniques. Under the present organization, pollution control activities are conducted by many departments and agencies. Each is typically concerned with a single pollutant or source (radiation,

pesticides), a single environmental medium (air, water, food), or a limited aspect of the total problem (health or economic effects, aesthetics). This fragmentation of effort has resulted in confusion and overlap, some delay in the recognition of new problems, and the continuance of inefficient management techniques. It has effectively inhibited any comprehensive examination of the total effects of pollutants by man, plants, animals, and ecological systems.

The creation of EPA will have the following advantages:

- It will upgrade the effectiveness of the Federal Government's major pollution control programs.
- It will provide a central focus for an evaluation of all pollution-related activities of the Federal Government.
- It will serve to upgrade the importance of environmental considerations and pollution programs within the Federal Government, and over a period of time tend to have a similar effect on program priorities within state and local governments.
- It will clarify industry responsibility by providing consistent standards and a single enforcement agency.
- State and local pollution control agencies will be able to look to one federal agency for all their financial support and technical assistance.
- It will insulate pollution abatement standard-setting from the promotional interests of other departments.

The EPA will have an estimated FY 1971 budget of \$1.4 billion and 5650 personnel, and consist of the following:

- The Federal Water Quality Administration (FWQA), now in the Department of the Interior;
- the National Air Pollution Control Administration (NAPCA), now in the Department of Health, Education, and Welfare;
- parts of the Environmental Control Administration (Bureaus of Solid Waste Management, Water Hygiene and a portion of the Bureau of Radiological Health), also from HEW;
- the pesticides research and standard-setting program of the Food and Drug Administration, HEW;
- the pesticides registration authority of the Department of Agriculture;
- authority to perform general ecological research, from the Council on Environmental Quality (CEQ);
- certain pesticide research authorities of the Department of Interior;

- the environmental radiation protection standard-setting function of the Atomic Energy Commission;
- the functions of the Federal Radiation Council (FRC).

National Oceanic and Atmospheric Administration. NOAA brings together in a single administration the major federal programs dealing with the seas and atmosphere. These programs presently exist in four departments and one agency. The creation of NOAA will improve the overall management of programs dealing with the three-fourths of the earth covered by the oceans.

The mission of NOAA is to organize a unified approach to the problems of the ocean and the atmosphere and to create a center of strength within the civilian sector of the Federal Government for this purpose. Although each of the units which will comprise NOAA presently carries out oceanic functions according to its particular mission, the lack of overall planning and systems approach has resulted in an impetus towards oceanic affairs which has been much less than it should be.

The NOAA will have an estimated 1971 budget of about \$270 million and over 12,000 personnel and will consist of the following:

- The Environmental Science Services Administration, already a part of the Department of Commerce;
- most of the Bureau of Commercial Fisheries, now in the Department of the Interior;
- the Marine Minerals Technology Program of the Bureau of Mines in the Department of the Interior;
- the marine sports fishing program of the Bureau of Sports Fisheries and Wildlife in the Department of the Interior;
- the Office of Sea Grant Programs of the National Science Foundation;
- elements of the United States Lake Survey of the Department of the Army.

Upon the establishment of NOAA, the following programs will be transferred to it by executive action. (No legislative authority is required to effect these transfers):

- The National Oceanographic Data and Instrumentation Centers of the Department of the Navy;
- the National Data Buoy Program of the Department of Transportation.

The President will request, upon approval of the plan, that the Secretary of Commerce establish a National Advisory Committee for the Oceans and Atmosphere to advise him on the progress of governmental and private programs in achieving the nation's oceanic and atmospheric objectives.

ACTION ON MERCURY POLLUTION

Interior Secretary Walter J. Hickel has announced that his department is "moving aggressively to identify and eliminate industrial discharges of mercury pollutants into the nation's waterways."

"To insure immediate action," the Secretary said, "I have designated a special investigating team of water quality and minerals experts from the Federal Water Quality Administration, and the U.S. Geological Survey, to pinpoint areas of mercury contamination and to provide the basic data needed for effective control."

In telegrams to the governors of seventeen states (includes North Carolina) in which mercury pollution is suspected, Secretary Hickel pledged full support of the department's water quality monitoring expertise and legislative authority. He urged the governors to act vigorously in eliminating known discharges of the metal.

In his statement the Secretary said, "The Administration is developing hard evidence and will seek court action in any confirmed case of mercury pollution if corrective measures are not taken swiftly on local levels."

He said the Interior Department will notify all industries across the nation which are shown by Interior investigations and data to be responsible for mercury pollution.

The Secretary's declaration follows reports from the Federal Water Quality Administration which reveal that abnormal mercury concentrations have been found in waste water in major waterways in the South, Southwest, Northeast and Midwest areas of the nation.

\$280,000 FWQA GRANT AWARDED MARYLAND TO DEMONSTRATE NEW STORM WATER EROSION CONTROL METHODS DURING CONSTRUCTION

The State of Maryland has just been awarded a \$280,000 grant by the Federal Water Quality Administration to demonstrate new methods for controlling storm water erosion during development of new suburban areas.

The Maryland project will involve a 200-acre watershed in a section of the Village of Long Reach in the "new city" of Columbia. By using new erosion control practices, retaining storm water in a pond, and disposing of sediment, the state and the developers hope to curtail the pollution of the Little Patuxent River.

Normally, during a construction project many acres of land are graded and left exposed to the weather. When it rains or snow melts, the water washes many tons of soil into the nearest stream, polluting the water.

Some of the new erosion control practices planned in the project include the preparation of the site in stages to reduce the land area exposed at one time to erosion, the grading of slopes so that water runs off slower and doesn't concentrate in one deeply gouged streambed, temporary seeding and sodding to hold soil during construction and placing of mulch on slopes to discourage erosion.

ZILLGITT RETIRES AS DIRECTOR OF SOUTHEASTERN FOREST EXPERIMENT STATION

Walter M. Zillgitt has retired as Director of the Forest Service's Southeastern Experiment Station of Asheville after thirty-seven years in research with the Forest Service. He has been a valued member of the Water Resources Research Institute's Advisory Committee and will be sorely missed.

Zillgitt has been succeeded by Dr. Stephen G. Boyce, presently Assistant to Dr. Keith Arnold, Deputy Chief for Forestry Research in Washington, D. C.

UNDERWATER POWER PLANTS STUDIED TO PROVIDE MORE POWER, BUT LESS THERMAL POLLUTION

A grant has been awarded to General Dynamics, Inc., by the Interior Department to study the feasibility of underwater power plants in the oceans as a means of supplying more electricity for America with less water pollution.

Secretary Hickel said, "We must immediately plan for the placement of generating plants so that the impact of waste heat discharge is beneficial rather than detrimental.

"I think bold, innovative ideas such as placing power plants beneath the oceans may possibly ensure the protection of the environment and at the same time allow a safe and orderly expansion of our power-producing capacity."

"Particular emphasis will be placed on identifying the possible effects that power plant waste heat and other wastes might have on the marine ecology of the area," Secretary Hickel said. "Our Fish and Wildlife Service advises that an upwelling created by waste heat discharges can be beneficial if properly located. The concept is to make technology our servant, rather than our master."

The concept behind this proposal is based on the fact that the cold ocean waters can more readily absorb the large quantities of waste heat from power plants than inland bodies of water.

Under the FWQA grant, General Dynamics will determine the feasibility of placing a 1000 megawatt, nuclear-powered generating station on the sea floor at depths to 250 feet. They could be placed as far as twenty-five miles from the shore.

PRESERVATION OF WILD AND SCENIC RIVERS IS SUBJECT OF SEPTEMBER NATIONAL SYMPOSIUM

America's remaining wild and scenic rivers will be the subject of a three-day nationwide symposium September 10-12 at St. Paul, Minnesota, Secretary of the Interior Walter J. Hickel has announced.

The Wild and Scenic Rivers Act designated eight rivers for immediate inclusion within the national system, provided for in-depth studies of twenty-seven other rivers named in the Act to determine their potential as possible additions to the system, and directed the Secretaries of Agriculture and the Interior to list other rivers for possible inclusion in the system.

The Act also provides that State wild and scenic rivers may be designated as part of the national system, with management and ownership remaining with state governments. Secretary Hickel said that a major part of the September symposium will be devoted to working with state officials on ways to evaluate and develop state wild and scenic rivers.

The conference is expected to draw some 400 persons who will consider management of wild, scenic and recreation rivers; guidelines for adding new streams to the national system; ways in which state and local programs can mesh with the national effort; and related policies and programs which affect the environment of many river basin areas.

MRS. NIXON TO BE CHAIRMAN OF SUMMER YOUTH PROGRAM AIMED AT CLEANING UP WATERWAYS

Secretary of the Interior Walter J. Hickel has announced that Mrs. Richard M. Nixon will serve as honorary chairman of the Operation Clean Waters Program, which involves some 1200 unemployed youth who will be cleaning up waterways in eleven locations this summer.

Secretary Hickel said that the youth, members of the Department of Labor's Neighborhood Youth Corps, will also work in area waste treatment plants as part of the program to expose them to job opportunities in pollution control.

He said, "This nationwide ten-week program is an interagency effort involving Interior's Federal Water Quality Administration, the Department of Labor, and the President's Council on Youth Opportunity. Not only will the youth involved perform a valuable service to their communities by cleaning up the banks and beaches along our waterways, but they will also receive work experience and be exposed to new opportunities for employment.

The Department of Labor is providing \$600,000 for the program, which started in June in the following cities: Kansas City, Missouri; San Juan, Puerto Rico;

El Paso, Texas; New York City; Cleveland; Seattle; the Virgin Islands; San Francisco; Washington, D. C.; Salisbury, Maryland, and Chicago. There will be work forces numbering up to 100 young men in each of these locations.

FEDERAL AID FOR WATER PROJECTS

<u>Agency</u>	<u>Community</u>	<u>Amount</u>	<u>Project</u>
HUD	Shelby	\$500,000	Additions and improvements to water treatment facilities

STATUS OF WATER RESOURCES IN NORTH CAROLINA

The June report of the U.S. Geological Survey on Water Resource Conditions in North Carolina reported that stream flow during the month was slightly above normal in the Mountains, and below normal in the Piedmont and Coastal Plains. Cumulative runoff for the period October 1, 1969, through June 30, 1970, expressed as percent of median, shows that runoff through the central part of the state was below normal or deficient during this period.

Ground water levels in selected observations wells fell in most sections throughout the state but rose in the eastern Piedmont.

WATER RESOURCES LEGISLATION IN THE CONGRESS

Bills Passed

- S. 3617 To extend for one year the National Council on Marine Resources and Engineering Development, w/o amendment.
- H.R. 11833 To amend the Solid Waste Disposal Act in order to provide financial assistance for construction of solid waste disposal facilities, to improve research programs pursuant to such act, and for other purposes.

Bills Introduced

- S. 3935 To amend the Federal Water Pollution Control Act, as amended, to provide financial assistance for river basin programs.
- H.R. 18015 To amend the Internal Revenue Code of 1954 to allow an incentive tax credit for a part of the cost of constructing or otherwise providing facilities or equipment for the control of water or air pollution or for processing of solid waste, and to permit the amortization of such cost within a period of from 1 to 5 years.
- H.R. 18043 To amend the Fish and Wildlife Coordination Act to provide additional protection to marine and wildlife ecology by requiring the designation of certain water and submerged lands areas where the depositing of certain waste materials will be permitted, to authorize the establishment of standards with respect to such deposits, and for other purposes.

- H.R. 18191 To amend the Small Business Act to encourage the development and utilization of new and improved methods of waste disposal and pollution control; to assist small business concerns to effect conversions required to meet Federal or State pollution control standards; and for other purposes.
- H.R. 18333 To amend the Land and Water Conservation Fund Act of 1965, as amended, and for other purposes.
- H.R. 18334 To amend the Solid Waste Disposal Act in order to establish economic incentives for return, reuse, and recycling of packaging, to reduce the public costs of packaging and other solid waste disposal, to require national standards for controlling the amount and environmental quality of packaging, and for other purposes.
- H.R. 18336 To amend the Federal Water Pollution Control Act by ban poly-phosphates in detergents and to establish standards and programs to abate and control water pollution by synthetic detergents.
- H.R. 18337 To amend Federal Water Pollution Control Act to protect the navigable waters of the U.S. further pollution by requiring that pesticides manufactured for use in the U.S. or imported for use in the U.S. comply with certain standards of biodegradability and toxicity.
- H.R. 18342 To preserve, protect, develop, restore, and make accessible the lake areas of the nation by establishing a National Lake Areas System and authorizing programs of lake and lake areas research, and for other purposes.

NEW PUBLICATIONS RECEIVED BY THE INSTITUTE

(These may be borrowed from the Institute for a two-week period or may be ordered from the organization issuing the publication.)

Water Resources Planning

- "A Critical Analysis of Employment Projection Methods: A Test Case of New Jersey," Part two of a three-part study on "Urbanization and Its Effect on Water Resources," by D. Hellman, et al, N. J. Water Res. Inst., Rutgers - The State Univ., Brunswick, N. J., 08903, May 1970.
- "Forest Land Use and Streamflow in Central Oregon," by H. W. Brent, et al, Pacific Northwest Forest and Range Exp. Sta., P. O. Box 3141, Portland, Oregon 97208, 1970
- "A Study of Institutional Factors Affecting Water Resources Development in the Lower Rio Grande Valley, Texas," by T. J. Casbeer, et al, Water Res. Inst., Texas A & M Univ., College Station, Texas 77843, Sept. 1969.
- "Negotiation and Land Conversion," by G. A. McBride, et al, Resources for the Future, Inc., 1755 Mass. Ave., N.W., Washington, D. C. 20036, Jan. 1970.
- "Water-Resources Manpower Supply and Demand Patterns to 1980," by J. E. Lewis, La. Water Res. Res. Inst., La. State Univ., Baton Rouge, La. 70803, May 1970, Bull. 4.
- "Conference on the Future of the Marshlands and Sea Islands of Georgia," Edit. by D. S. Maney, et al, Coastal Area Planning and Dev. Comm., P. O. Box 1316, Brunswick, Ga. 31520, June 1970.

- "A New Policy Direction for American Agriculture," by M. Clawson, Resources for the Future, Inc., 1755 Mass. Ave., N.W., Washington, D. C. 20036, April 1970.
- "General Criteria Used in Establishing Recreation Land Requirements for Reservoir Areas," by E. A. Pesonen, Reservoir Mngt. and Wildlife Conser. Br., Bu. of Reclamation, Reg. 2, Sacramento, Cal., Aug. 1966.
- "Factors Affecting Relocation in Response to Reservoir Development," by R. J. Burdge, et al, U. of Ky., Water Res. Inst., Lexington, Ky. 40506, 1970, Report No. 29.
- "Evaluation of the Social Impact of Reservoir Construction on the Residential Plans of Displaced Persons in Kentucky and Ohio," by R. L. Ludtke, et al, Res. Report No. 26, U. of Ky., Water Res. Inst., Lexington, Ky. 40506, 1970.
- "Use of Taxes, Subsidies, and Regulations for Pollution Abatement," by H. H. Macaulay, Rept. No. 16, Water Res. Res. Inst., Clemson U., Clemson, S. C. 29631, June 1970.
- "Relative Importance of Variables in Water Resources Planning," by I. C. James II, et al, Resources for the Future, Inc., 1755 Mass. Ave., N.W., Wash., D. C. 20036 April 1970.
- "Water and Air Resources Program," N. C. Dept. of Water & Air Res., Bd. of Water & Air Res., Raleigh, N. C. 27603, June 1970.
- "North Carolina Watershed Progress Report," by USDA, Soil Conservation Serv., P. O. Box 27307, Raleigh, N. C. 27611, July 1, 1970.

Water Quality Management

- "Intermediate Products in the Bacterial Decomposition of Hexadecanol and Octadecanol," by W. D. Langley, Water Res. Inst., Texas A & M Univ., College Station, Texas. 77843, June 1970.
- "The Effects of Copper Sulfate on Certain Algae and Zooplankters in Winnisquam Lake, New Hampshire," by P. J. Sawyer, Water Res. Res. Center, U. of N. H., James Hall, Durham, N. H., 03824, May 1970.
- "Studies of Marine Estuarine Ecosystems Developing with Treated Sewage Wastes," by H. T. Odum, et al, Inst. of Marine Scs., Univ. of N. C., Chapel Hill, Annual Rept., 1969-1970 27514
- "SPARKS IN THE GRASS ROOTS - Municipal Distribution of TVA Electricity in Tennessee," by V. C. Hobday, Univ. of Tennessee Press at Knoxville.
- "Physical, Meteorological, and Hydrologic Aspects of Evapotranspiration," by J. R. Lambert, Rept. No. 14, Water Res. Res. Inst., Clemson U., Clemson, S. A. 29631, March 1970.
- "Evaluation of Soil-Applied Herbicides for Vegetation Control," Res. Rept. No. 22, by N. E. Otto, Bur. of Reclamation, USDI, 1970, Washington, D. C. 20240.
- "Hydraulic Resistance in Alluvial Channels," by B. C. Yen, et al, Dept. of Civil Engr., Univ. of Ill., Urbana, Ill., Water Res. Center, 61801, July 1969.

- "Chemical and Physical Character of Municipal Water Supplies in N. C.," by E. J. Phibbs, Jr., Bull. 3, N. C. Dept. of WAR, Water Pollution Control Div., P. O. Box 9392, Raleigh, N. C. 27602, 1969.
- "Env. Review No. 2, Nitrates, Nitrites and Methemoglobinemia," by Nat'l. Inst. of Env. Health Sciences, Dept. of HEW, Research Triangle Park, N. C. 27709, May 1970.
- "Oceanic Overwash and Its Ecological Implications on the Outer Banks of N. C.," by P. J. Godfrey, Office of Nat. Scs. Studies, Nat'l. Park Serv., USDI, Washington, D. C. 20240, April 8, 1970.
- "Benthal Decomposition of Adsorbed Oil Pollutants," by J. V. Hunter, et al, N. J. Water Res. Res. Inst., Rutgers - The State Univ., Brunswick, N. J. 08903, May 1970.
- "Environmental and Technical Factors for Open Drainage Channels in Milwaukee," by Ted B. Prawdzik, ASCE, N. Y., N. Y., 10017, Feb. 1970.
- "Responses of Some Anadromous Fishes to Varies Oxygen Concentrations and Increased Temperatures," by D. Dorfman, et al, N. J. Water Res. Res. Inst., Rutgers - The State Univ., New Brunswick, N. J. 08903, June 1970.
- "Influence of Salinity and Temperature on the Accumulation of Cesium-137 by an Estuarine Clam Under Laboratory Conditions," by D. A. Wolfe, et al, Bur. of Comm. Fisheries, Radiobiological Lab., Beaufort, N. C. 28516, Aug. 1969.
- "Sedimentation," Annotated Bibliography of Foreign Literature, Pub. by USDA and NSF, Washington, D. C., 1967-1968 Survey No. 5.
- "Digest of Sewerage Enabling Acts of the State of California," State Water Res. Control Bd., Rm. 1140, 1416 Ninth Street, Sacramento, Cal. 95814, Pub. No. 28, 1964.
- "Virus Removal by Chemical Coagulation," by R. S. Engelbrecht, et al, Dept. of Civil Engr., Water Res. Center, U. of Ill., Urbana-Champaign Campus, Ill., 61801, Nov. 1969.
- "A Battery Powered Proportioned Stream Water Sampler," by R. L. Fredriksen, USDA Pacific Northwest Forest and Range Exp. Sta., Corvallis, Oregon 97330, Dec. 1969.

Water Quantity Management

- "Coastal Regime Recent U.S. Experience," by T. Saville, J.r, et al, U.S. Army, Corps of Engrs., Washington, D. C. 20016, June 1969.
- "Floods on Richland Creek and Tributary Streams in Vicinity of Waynesville and Hazelwood, N. C.," by TVA, Div. of Water Control Plan., Knoxville, Tenn. 37902.
- "Part A: Guidelines for Establishing Economic and Engineering Flood Criteria," by P. W. Barkley, et al, Water Research Centr. Univ., of Wash., Wash. State Univ. Pullman, Wash., Rept. No. 4, June 1970.
- "An Activity Analysis of Nonstructural Floodplain Management Alternatives," by J. C. Day, Water Res. Center, Univ. of Wis., Dept. of Ag. Ec., Madison, Wis. 53706, 1969.
- "Hydrologic Effects from Urbanization of Forested Watersheds in the Northeast," by H. W. Lull, et al, Northeastern Forest Exp. Sta., Upper Darby, Pa. 19082, 1969.

- "Meteorological Tables for Determination of Precipitable Water, Temperatures, and Pressures Aloft for a Saturated Pseudoadiabatic Atmosphere - in the Metric System," by W. O. Eihle, et al, Water Res. Inst., Texas A & M Univ., College Station, Texas 77843, June 1970.
- "Availability of Rainfall-Runoff Data for Partly Sewered Urban Drainage Catchments," by L. S. Tucker, ASCE, 345 East 47th St., N. Y., N. Y. 10017, March 1970.
- "Storm Runoff from Forested Catchments by Subsurface Routes," by R. Z. Whipkey, Northeastern Forest Exp. Sta., Forest Serv., USDA, Columbus, Ohio, Aug. 1967.
- "Influence of Transpiration Suppressants, Sprinkler Irrigation and Moisture Levels on Transpiration and Evapotranspiration," by C. J. Gerard, Water Res. Inst., Texas A & M, Univ., College Station, Texas 77843, May 1970.
- "Measuring Directional Velocity in Water Waves with an Acoustic Flowmeter," by R. H. Multer, Tech. Memo. No. 31, Dept. of the Army, Corps of Engrs., Coastal Engr. Res. Cntr., 5201 Little Falls Rd., N.W., Washington, D. C. 20016, April 1970.

Miscellaneous

- "Fifth Annual Report, Program Activities," Water Res. Res. Center, Univ. of Md., College Park, Md., July 1, 1968 - June 30, 1969.
- "Report on Fifth Annual Water Resources Research Conference," Sponsored by OWRR, Washington, D. C. 20240, Feb. 3-4, 1970.
- "A Bibliography of Publications Relating to Water Resources in Connecticut," by Inst. of Water Res., The Univ. of Conn., Storrs, Conn., 06268, Rept. No. 10, May 1970.
- "North Carolina's Work in Environmental Protection," by Gov. R. W. Scott, Presented before Carolina Symposium 1970 at Chapel Hill, N. C., March 17, 1970.
- "Oceanographic Ship Operating Schedules," July 1970-Dec. 1970, Pub. by Marine Scs. Affairs Staff of the Office of the Oceanographer of the Navy for the Nat'l. Council on Marine Res. & Engr. Dev., Pamphlet #39, June 1970, Wash., D. C. 20390.
- "Proceedings Mississippi Water Resources Conference, 1970," Mississippi State Univ., State College, Miss. 39762.
- "Report of Water Resources Research - July 1, 1968 - June 30, 1969," by USDI, Geological Survey, Water Res. Div., Washington, D. C. 20240, Jan. 1970.
- "Report of Progress on Engr. Research," 1968-69, Res. Rept. No. 21, USDI, Bu. of Reclamation, Wash., D. C. 20240.

Water Resources Research Institute
of the University of North Carolina
124 Riddick Building
North Carolina State University
Raleigh, North Carolina 27607

PRINTED MATTER