NEWS
WATER RESOURCES RESEARCH INSTITUTE
OF THE UNIVERSITY OF NORTH CAROLINA

Number 82 November 1972

TABLE OF CONTENTS

NATIONAL SYMPOSIUM SCHEDULED FOR DURHAM

A National Symposium on Ultimate Disposal of Wastewaters and Their Residuals will be held in Durham, North Carolina, on April 26 and 27, 1973. Sponsored by the Research Triangle Universities and several national organizations, the program will include sessions on land disposal, marine disposal, sludge handling, design practice, recovery, and recycling.

For further information, please contact:

F. E. McJunkin
Associate Director
Water Resources Research Institute
of The University of North Carolina
North Carolina State University
124 Riddick Building
Raleigh, North Carolina 27607

WHAT'S NEW IN ENVIRONMENTAL INFORMATION

Readers are reminded of the Environmental Information Workshop at North Carolina A & T University in Greensboro on December 14 (see p. 3, October News).

Attendance by pre-registration only. Contact WRRI Associate Director F. E. McJunkin for further details--755-2815.

NATION HAS SPLIT ATTITUDE ABOUT WATER RESOURCE DEVELOPMENT

The time is now ripe for the nation to re-examine its attitude about water resources development, according to a U.S. Geological Survey, Department of the Interior, scientist.

Dr. Raymond L. Nace, research hydrologist of the Survey's Raleigh, N. C., office, said that traditional practices tend toward separate development of surface and ground water resources. "These practices," Nace said, "have hampered the proper management of the resource, particularly ground water, vast amounts of which are stored naturally in subsurface, water-bearing rocks (aquifers)."

In a paper presented at an American Water Resources Conference, sponsored by the American Water Resources Association, October 30-November 2, 1972, St. Louis, Mo., Dr. Nace cited two phenomena now leading to a turning point in the management of water in the United States: (1) a narrowing of the margin between surface water supplies and water demand, and (2) growing recognition of the role of ground water in the water cycle and its potential role in total water supply.

One of the major reasons for the existence of "hydroschizophrenia"--a term coined by a Survey colleague to describe a split attitude towards surface and ground water--is that while our surficial flow resources, chiefly surface waters, are visible and fairly well known, our ground water is invisible, and its role in the total water system is obscure, even to most water managers, Nace pointed out.

"In humid areas of the world," Nace said, "knowledge about ground water lagged for millenia, and development was applied chiefly to natural springs. Indeed, the very origin of ground water was controversial until late in the 18th century. However, while many aquifers are not well understood, data on many others are adequate for long-range broad-scale planning."

"The need for joint management and development of surface and ground water is apparent," Nace said, "when we consider just a few hydrologic factors. For example, owing to the interrelations between ground water and surface water systems, water cannot be withdrawn from one system without affecting the other. Water pumped from the ground causes changes in the total system. Where the ground water is not replaced, but is progressively depleted, water levels decline, total storage in the system declines, and base flow of streams may diminish."

"It is interesting to note," he said, "that withdrawal uses of water in the United States currently amount to about 370 bgd (billion gallons per day). Yet, only about 20 percent of this (70 bgd) is ground water."

"On the other hand," Nace said, "planners and developers should not become bemused by the sheer volume of ground water, because volume alone is not the most

important factor. The reservoir itself is at least equally important, and may be of paramount concern from the managerial standpoint. Aquifers are natural multiple-purpose reservoirs which offer new opportunities for manipulation and use of the total water supply, affording many benefits that go beyond their use as sources to alleviate shortages of water."

"For example," he said, "surface water reservoirs in the U. S. currently have an aggregate capacity of 120 cubic miles, and in order to provide water supply and waste dilution needs during the next 30 years, about 5 to 9 times that amount of surface storage would be necessary. Thus, it is wholly unreasonable to assume that so much surface capacity could be provided; the vastly greater capacity of natural underground reservoirs can and must be used."

WATER RESOURCES DIRECTORY CONTRACT AWARDED BY CORPS

A contract for compiling an environmental expertise resources directory has been awarded to Institute of Ecology of Madison, Wisconsin, by the U. S. Army Corps of Engineers.

The directory, scheduled for completion by February, 1973, will provide the Corps with a cross-indexed listing of qualified individuals and institutions who are willing to evaluate Corps water resources activities for their environmental consequences.

The directory will include a listing of individuals and organizations who have the skills and interest to advise the Corps, indications of their availability for long and short-term program assessments, identifications of their fields of expertise, their geographical region, and their familiarity with engineering problems. The directory will also contain a glossary to define precisely the environmental terminology used.

The Institute of Ecology, a federation of 65 universities and research centers in North and South America, was organized in 1971 to conduct large-scale ecological knowledge into social decision-making processes.

The directory is one of several steps the Corps of Engineers has taken to correlate its water resources development programs with environmental ramifications of current public and governmental concern.

MOVEMENT OF POLLUTANTS IN N.E. CAPE FEAR ESTUARY

The U. S. Geological Survey recently released Water-Supply Paper 1873-E, Movement and Dispersion of Soluble Pollutants in the Northeast Cape Fear Estuary, North Carolina." The report presents results of a fluorescent dye tracing study to determine the concentrations of a pollutant that would be present in the Estuary at various rates

of continuous waste injection and fresh water inflow. Data were used to predict the maximum buildup in concentration of a soluble contaminant introduced into the Northeast Cape Fear Estuary at any given rate.

The study was conducted under conditions of below-average fresh-water inflow and above-normal high tides. The concentrations measured would be lower during normal conditions. On the other hand, since much lower inflow rates do occur, correspondingly higher concentrations of contaminants can be expected. Since inflow rates to the estuary vary widely, the results are expanded to provide a basis for estimating the buildup for different inflow conditions. Curves are presented to give the reader a concept of the average flushing time of the estuary as related to fresh-water inflow, the probability of occurrence of low flows, and the probability of occurrence of flushing times of various durations.

Discharge measurements during the tidal cycle measured showed upstream flow exceeded downstream flow. A pollutant released on the high-slack tide preceding the measurements would make no net downstream progress during the cycle. This phenomenon was observed during a period of only moderately low fresh-water inflow. During periods of extremely low fresh-water inflow, furthermore, the net movement of water in the estuary could be upstream for several days, particularly if higher-than-normal tidal levels prevailed.

The Northeast Cape Fear quickly disperses a solute both vertically and horizontally. The high velocities and resulting turbulence of water associated with the tidal movement cause this rapid dispersion.

Pollutants released into the Northeast Cape Fear Estuary do not tend to remain in a discrete, highly concentrated mass, but rather quickly disperse into a tremendous volume of water. For this reason during moderate flow conditions, tidal flow will not immediately carry a solute injected in the vicinity of the gaging station out of the Northeast Cape Fear. It will instead be dispersed to form a cloud several miles long which will gradually decrease in concentration as the forces of dispersion and the effects of fresh-water inflow remove it from the estuary.

OWAR STAFF BRIEFED ON AGRICULTURAL WASTES RESEARCH

On November 10 a meeting was held in the Board Room of OWAR to review three research projects containing specific information on the movement of pesticides, fertilizer nutrients, and animal wastes to water sources.

Research findings on the loss of fertilizer nutrients from soils to drainage waters were presented by Dr. J. W. Gilliam, Department of Soil Science. Dr. Gilliam specifically discussed the movement of nitrogen and phosphorus during specific periods and the quantity of nutrients that entered drainage waters.

Dr. Frank Humenik, Department of Biological and Agricultural Engineering, reviewed the research which has been directed to improve the techniques for characterization and handling of animal wastes.

Dr. J. R. Bradley, Jr., Department of Entomology, presented research findings on the contamination of surface and ground water with pesticides applied to cotton.

These research projects were sponsored by the Institute in cooperation with the Agricultural Experiment Station. All of the researchers are members of the School of Agriculture and Life Science at North Carolina State University. Copies of the research reports on these three projects can be obtained from the Institute.

THE SUTTON EFFECT

The October issue of OR/SA Today carries the first of a set of articles on Principles of Operations Research which is not without some application to water resources research at large. Entitled "The Sutton Effect," it is reproduced for reader good humor and enlightenment as follows:

"The Sutton Effect was named for the distinguished scholar Willie Sutton, who became famous because he was outstanding in his chosen profession; namely, that of robbing banks. He became available for an interview when his career was eventually brought to a close, and he was then asked, 'Why do you rob banks?' And his immortal answer was: 'Because that's where the money is.'

"The relevance of the Sutton Effect to OR is that it constitutes a directive to examine the possible pay-off before undertaking an extensive effort on a problem. That is why an OR analysis of a one-shot problem must be approached with so much more caution than a recurring decision; and even with the recurring problem, one must worry that the environment is changing so fast that new analysis may be required before one's investment has been recouped. If somebody asks, 'Why are you working on the inventory problem?' the response 'Because that's where the money is' is entirely appropriate.

"We can find an historical antecedent for this principle in what Morse and Kimball called 'Hemibel Thinking.' They adjured the OR worker only to undertake those projects where improvement by a hemibel (factor of three) seemed probable. Such luxury is rarely available today, but the novitiate is still well advised not to waste his time if nothing very good can eventuate.

"Of course, the pay-off need not be in money. A few years ago, when pollution became a cause celebre, a number of self-appointed wardens of the public weal, who had heard that the dyes in colored toilet paper were not biodegradable, began visiting their neighbors' bathrooms in an effort to enforce the use of white toilet paper. This is, of course, a violation of the Sutton Effect, which is more honored in the breach than the observance."

—— Robert E. Machol

DR. WARREN A. HALL APPOINTED ASSOCIATE DIRECTOR OF THE OFFICE OF WATER RESOURCES RESEARCH

The Department of the Interior has announced the appointment of Dr. Warren A. Hall as Associate Director of the Office of Water Resources Research (OWRR). With the recent resignation of Director Hershey, Dr. Hall has also assumed responsibility as Acting Director.

Born in Hot Springs, South Dakota, in 1919, Dr. Hall attended high school in Crawford, Nebraska, and obtained degrees in engineering from the California Institute of Technology and the University of California.

He joins the OWRR staff from the position of Professor of Engineering at the University of California, Riverside. While at the University, he occupied various professorial positions and served for several years in the posts of Director of the Drylands Research Institute and Director of the University's Water Research Center.

Dr. Hall spent the period from September 1969 to December 1970 in Washington, D. C., as Technical Assistant to the Director, Office of Science and Technology, Office of the President, and, at the same time, served as Chairman of the Committee on Water Resources Research of the Federal Council for Science and Technology with responsibility for the broad coordination and review of all federal water resources research programs.

WATER CONSERVATION

Even a "water rich" state like North Carolina has problems with water shortages where the supply is out of phase with demand--or when it simply doesn't rain on schedule. More efficient water use is one way of extending supplies and avoiding unnecessary capital investment. Higher water rates, for example, don't necessarily mean higher water bills. It has been adequately demonstrated that they act as an economic incentive toward less waste. Thus, higher rates could just as easily mean a lower water bill if adjustments were judiciously made with water conservation in mind.

The Colorado River Association Newsletter for Sept./Oct., 1972, describes a campaign in Oakland, California, with this objective in mind:

"East Bay Municipal Utility District in Oakland, California, is planning all-out campaign to cut use of water in its two-county service area, Engineering News-Record reports. EBMUD is selling more than 200 million gallons of water a day at present. Proposed is educational effort to persuade its one million customers to cut back voluntarily on water use. Said official of district: 'We want to discourage banana plants and lily ponds by introducing gardeners and homeowners to beautiful California plants that don't need water in the summer. We want to show developers and contractor that toilets don't need six-gallon tanks--a three-gallon tank is sufficient. Smaller shower heads can save a lot of water and still provide a good shower, too.' Other

targets of program will be dripping faucets and too frequent use of dish washers and garbage disposals. Higher water rates are also being considered. EBMUD staff emphasizes that with increasing demands for water there is also pressure from conservationist groups to halt new water development projects.

ENVIRONMENTAL IMPACT STATEMENTS

Department of Defense

Corps of Engineers

Neuse River (Craven County) - Dredging of a commercial navigation channel 12 feet deep and 120 feet wide for 9 miles. Aquatic life will be disturbed by dredging and 47 acres of wildlife habitat will be lost to spoil deposit. (DRAFT)

Department of Transportation

Federal Aviation Agency

Plymouth municipal airport - construction of a new general aviation airport. Approximately 225 acres of land would be committed. (FINAL)

Federal Highway Administration

N.C. 24 in Cumberland, Sampson, and Duplin Counties - Construction of approximately 50 miles of new highway. 2500 acres of farmland and woodland committed. Some siltation and erosion of streams. (DRAFT)

Cain Road, Ireland Drive, Cumberland County - Three-mile segment of thoroughfare. Siltation anticipated. (DRAFT)

N.C. 110 from Canton to US 276. 5 miles of reconstruction and a 150-foot bridge across E. Fork of Pigeon River. (FINAL)

US 264 in Wake, Nash, and Wilson Counties - 15.7 miles of reconstruction. Siltation may occur. (FINAL)

STATUS OF WATER IN NORTH CAROLINA

Streamflow was above normal throughout the State and excessive in the eastern Piedmont and portions of the Coastal Plain during October. Although rainfall was also above normal, no flooding was reported.

Storage decreased in the major lakes and reservoirs in the State. Drawdown of the lakes in the Tennessee Valley Authority system to flood season levels is continuing.

Ground-water levels continued the seasonal decline in most wells throughout the State. However, some wells recorded rising water levels because of locally heavy rains. Water levels in artesion wells located in areas of heavy withdrawals also declined with the exception of the observation well at Murfreesboro which recorded the highest north-end water level since 1968.

THE NEW FEDERAL WATER POLLUTION CONTROL ACT

The 1972 amendments to the Federal Water Pollution Control Act are profound in their implications and wide sweeping in their coverage. Everyone concerned with water quality research and management needs to become familiar with the Act if he is to be relevant to current national policy and goals. To facilitate this, the News will carry a summary review of the Act in this and subsequent issues. The review will start with Title I below:

FEDERAL WATER POLLUTION CONTROL ACT AMENDMENTS

OF 1972

TITLE I

"DECLARATION OF GOALS AND POLICY"

SEC 101. Objective to restore and maintain the chemical, physical, and biological integrity of NATION'S WATERS.

NATIONAL GOAL

* discharge of pollutants into navigable waters eliminated by 1985;
* water quality providing for recreation, fish and wildlife by 1983;
* discharge of toxic pollutants prohibited;
* financial assistance for public waste treatment works construction;
* areawide waste management planning;
* research and development for technology to eliminate pollution.

POLICY OF THE CONGRESS to recognize, preserve, and protect primary responsibilities and rights of the States for control of pollution and land and water use planning.

Further, the POLICY OF THE CONGRESS that President take action to insure that foreign countries control pollution to same extent as United States.

PUBLIC PARTICIPATION to be provided for, encouraged, and assisted.

"COMPRFHENSIVE PROGRAMS FOR WATER POLLUTION CONTROL"

SEC 102. Administrator shall, in cooperation with other federal, state, and interstate agencies prepare COMPREHENSIVE PROGRAMS for control of pollution in navigable and ground waters.

Authorization for inclusion of storage in federal reservoirs for water quality control. Similar authority with respect to FPC licensing of hydroelectric power projects.

Federal grants for 50 percent of administrative expenses of planning agencies--not over 3 years--for development of comprehensive pollution control plans for river basins or portions thereof. Plans must be consistent with water quality standards, effluent, and other limitations; recommend treatment works to provide most effective and economical means of collection, storage, treatment and disposal of pollutants; and be consistent with comprehensive plans prepared by the Water Resources Council and other plans authorized by the Act.

"INTERSTATE COOPERATION AND UNIFORM LAWS"

SEC 103. Administrator shall encourage:

* cooperative activities by the states;
* enactment of improved and uniform state laws; and
* compacts between the states for the prevention, reduction and elimination of water pollution.

"RESEARCH, INVESTIGATIONS, TRAINING, AND INFORMATION"

SEC 104. Administrator shall:

* conduct and promote RESEARCH, INVESTIGATIONS, DEMONSTRATION AND TRAINING relative to causes, effects, extent, prevention, reduction, and elimination of pollution;
* provide TECHNICAL SERVICES to pollution control agencies;
* establish ADVISORY COMMITTEES to assist in examination and evaluation of research programs and proposals;
* establish, equip, and maintain a WATER QUALITY SURVEILLANCE SYSTEM for monitoring quality of navigable waters, ground waters, contiguous zone, and the oceans--utilizing NASA, NOAA, USGS, and the CG;
* promote, coordinate, and conduct research:
  - to develop most effective practicable tools and techniques for measuring SOCIAL AND ECONOMIC COSTS AND BENEFITS of activities subject to regulation under the Act;
  - on harmful effects of pollutants on HUMAN HEALTH and WELFARE--through HEW;
  - and demonstration on prevention, control, and elimination of pollution from OIL and HAZARDOUS SUBSTANCES--must also publish specifications on chemicals for use in control of oil and other hazardous substances spills;

- on methods to control release of PESTICIDES into the environment--to issue by January 1, 1973, latest scientific knowledge on effects of pesticides in water on health and welfare;
- on USED ENGINE and other WASTE OILS and their disposal--to report preliminary results to Congress within 6 months and final results within 18 months of enactment;
- to determine new and improved methods for preventing, reducing, and eliminating POLLUTION from AGRICULTURE:
- and pilot projects on new and improved methods of preventing, reducing, and otherwise eliminating POLLUTION from SEWAGE in RURAL AREAS where community sewage systems are impractical;
- and pilot projects on new and improved methods for joint treatment and disposal of LIQUID and SOLID WASTES:
- and demonstration of new or improved methods for control of POLLUTION in LAKES;
- and demonstration of PRACTICABLE MEANS of TREATING WATERBORNE WASTES to implement section 201;
- and demonstration of improved methods to identify and measure effects of pollution;
- and demonstration of methods for evaluating effects on water quality of AUGMENTED STREAMFLOWS for pollution not susceptible to other means of control;
- on the effects of POLLUTION in ESTUARINE ZONES--to report to the Congress at least once every 3 years;
- on devices, systems, INCENTIVES, pricing policy, and other methods of reducing total flow of sewage;
- of the effects and methods of control of THERMAL DISCHARGES, including:
  - latest available technology and economic feasibility,
  - total impact on the environment,

  results to be reported to the Congress within 270 days of enactment.

Secretary of the Department in which Coast Guard is operating shall:

* engage in research in demonstration relative to SEWAGE TREATMENT and disposal ABOARD VESSELS--to report to the Congress prior to effective date of regulations established under section 312;

Administrator shall:

* establish and maintain FIELD LABORATORY and RESEARCH FACILITIES for conduct of research, investigations, field demonstrations, and training with respect to preventing, reducing, and eliminating pollution--special provisions for the Great Lakes;

- finance pilot programs for MANPOWER DEVELOPMENT, training, and retraining in operation and maintenance of waste treatment works and related activities;
- enter into agreements to develop and maintain an effective system for FORECASTING supply and demand of PERSONNEL NEEDED for water pollution control;

Administrator is authorized to:

* enter into contracts or make grants for development and demonstration of NEW or IMPROVED METHODS for CONTROL of POLLUTION in LAKES;
* to make grants to colleges and universities for basic research into FRESH WATER ECOSYSTEMS to improve understanding of characteristics necessary to maintain the integrity of such systems;
* to make grants to one or more institutions of higher education--regionally located--to be designed as "RIVER STUDY CENTERS," to conduct research on the nature of river systems.

Administrator shall:

* report to the Congress by December 31, 1973, summarizing actions taken under this section and their effectiveness, together with estimates of future needs and recommendations for additional programs and legislation.

In carrying out this section, the Administrator is authorized to:

* collect and make available through publication and other means results of research and other activities;
* cooperate with public and private institutions and agencies, private industry, and individuals;
* make grants and contracts as necessary;
* establish and maintain research fellowships;
* collect and disseminate basic data on water quality and other information on prevention, reduction, and elimination of water pollution;
* develop effective and practical processes, methods, and prototype devices for prevention, reduction, and elimination of pollution; and
* provide training for personnel of public agencies and other persons.

"GRANTS FOR RESEARCH AND DEVELOPMENT"

SEC 105. Administrator is authorized to conduct and make grants to any states, municipality, or intermunicipal or interstate agency, for purpose of assisting in development of projects to demonstrate:

* new or improved methods of preventing, reducing, or eliminating discharge of POLLUTANTS from sewers which carry STORM WATER:
* ADVANCED WASTE TREATMENT and WATER PURIFICATION, or new or improved methods of JOINT TREATMENT of MUNICIPAL and INDUSTRIAL WASTES.

Administrator is authorized to make grants to any state or states or interstate agency to:

* demonstrate, in river basins or portions thereof, ADVANCED TREATMENT and ENVIRONMENTAL ENHANCEMENT techniques to control pollution from all sources WITHIN such BASINS.

To carry out provisions of section 301, Administrator is authorized to:

* conduct, make grants, or contract for research and demonstration projects for PREVENTION of POLLUTION by INDUSTRY.

Administrator shall conduct an accelerated effort to develop, refine, and achieve practical application of:

* WASTE MANAGEMENT and ADVANCED WASTE TREATMENT methods applicable to POINT and NONPOINT SOURCES; and
* improved methods to identify and measure EFFECTS of POLLUTANTS on the integrity of water.

Administrator is authorized to make grants for:

* research and demonstration projects with respect to new and improved methods of preventing, reducing, and eliminating POLLUTION FROM AGRICULTURE; and
* demonstration projects with respect to new and improved methods of preventing, reducing, and eliminating POLLUTION from SEWAGE in RURAL AREAS.

SEC 106. GRANTS FOR POLLUTION CONTROL PROGRAMS

Administrator is authorized to make grants to state and interstate agencies to assist in meeting the cost of administering water pollution control programs. $60 million authorized for FY 1973 and $75 million for FY 1974.

SEC 107. MINE WATER POLLUTION CONTROL DEMONSTRATIONS

Not relevant to North Carolina.

SEC 108. POLLUTION CONTROL IN GREAT LAKES

Not relevant to North Carolina.

SEC 109. TRAINING GRANTS AND CONTRACTS

Administrator is authorized to make grants or contracts with institutions of higher education to assist in carrying out programs for preparation of UNDERGRADUATE STUDENTS to enter occupations involving design, operation, and maintenance of POLLUTION CONTROL FACILITIES.

SEC 111. AWARD OF SCHOLARSHIPS

Administrator is authorized to award scholarships for UNDERGRADUATE study by persons who plan to enter an occupation involving the operation and maintenance of TREATMENT WORKS.

SEC 113. ALASKA VILLAGE DEMONSTRATION PROJECTS

Not relevant to North Carolina.

SEC 114. LAKE TAHOE STUDY

Not relevant to North Carolina.

SEC 115. IN-PLACE TOXIC POLLUTANTS

Administrator is directed to identify the location of in-place pollutants with emphasis on toxic pollutants in HARBORS and navigable WATERWAYS.

WATER RESOURCES LEGISLATION IN THE CONGRESS

Correction, please--The News erred in reporting enactment of the National Environmental Data System and State Environmental Centers Act (HR 56) in the October issue (p. 12). This was pocket vetoed by the President.

NEW PUBLICATIONS RECEIVED BY THE INSTITUTE

(Residents of North Carolina may borrow these from the Institute for a two-week period. Where individual copies are desired, readers are encouraged to request copies from the organizations issuing the publication. The addresses are provided by the News for this purpose.)

Abbreviations used throughout are as follows:

EPA	- Env. Protection Agency	USDI	- U.S. Department of the Interior
NCDNER	- N.C. Dept. Nat'l. & Econ. Res.	USGPO	- U.S. Gov't Printing Office
NTIS	- Nat'l. Tech. Information Serv.	WPC	- Water Pollution Control
NWC	- Nat'l. Water Commission	WQS	- Water Quality Standards
OWP	- Office of Water Programs	WRC	- Water Res. Center
OWRR	- Office of Water Resources Res.	WRRI	- Water Resources Research Inst.
USDC	- U. S. Department of Commerce	WRSIC	- Water Res. Sci. Infor. Center

Water Resources Planning

"Agricultural and Water Policies and the Environment: An Analysis of National Alternatives in Natural Resource Use, Food Supply Capacity and Environmental Quality," by E. Heady, et al, Cen. for Agr. & Rural Dev., Iowa St. U., Ames, Iowa 50010, June '72.

"Effect of Urban Development on Floods in the Piedmont Province of North Carolina," by A. Putnam, USGS, P. O. Box 2857, Raleigh, N. C. 27602, 1972.

"A Model Land Development Code," (Tentative Draft 4), by The Executive Office, The American Law Inst., 4025 Chestnut St., Philadelphia, Pa. 19104, Apr. 25, 1972.

"Land Policy Alternatives for North Carolina," (St. Plan. Rpt. 146.07), by F. Parker, et al, UNC-CH for N.C. St. Plan. Div., avail. from State Planning Div., Dept. Admin., 116 W. Jones St., Raleigh, N.C. 27603.

"A Program for Metropolitan Water Management," (ERC-0772), by G. Willeke, et al, Env. Res. Cen., Ga. Inst. of Tech., Atlanta, Ga. 30332, July 1972.

"Neuse River Basin," (Draft), N.C. Water Plan Progress Report, Chapter 34, NCDNER, OWAR, P. O. Box 27687, Raleigh, N. C. 27611, Sept. 1972.

"North Atlantic Regional Water Resources Study," (Annex 2 to Rpt.), by N. Atlantic Reg. Water Res. Study Group for N. Atlantic Reg. Water Res. Study Coord. Comm., N. Atlantic Div., U.S. Army Corps of Engrs., 90 Church St., New York, N.Y. 10007, May 1972.

"The Water Use and Management Aspects of Steam Electric Power Generation," (PB 210 355), by Consulting Panel on Waste Heat, NWC, avail. from NTIS, USDC, 5285 Port Royal Rd., Springfield, Va. 22151, Price $4.85, May 1972.

"Preliminary Study of Operating Guide Curves for Power Production," by Dept. of Army, Little Rock Dist., Corps of Engrs., Little Rock, Ark. 72201, Nov. 1971.

"Development of Regional Supply Functions and a Least-Cost Model for Allocating Water Resources in Utah: A Parametric Linear Programming Approach," by A. King, Utah St. U., Logan, Utah 84321, May 1972.

"Optimal Operation of Serially-Linked Water Reservoirs," (Cont. 138), by R. Vleugels, U. of Cal, WRC, Los Angeles, Cal 90024, Sept. 1972.

"The Rural Development Act of 1972--Analysis and Explanation," (Pub. Law 92-419), by Comm. on Agr. & Forestry, avail. from USGPO, Wash., DC 20402, Oct. 3, 1972.

"State Water-Rights Laws and Related Subjects: A Supplemental Bibliography, 1959 to Mid-1967," (Misc. Pub. 1249), by B. Holmes, et al, Econ. Res. Ser., USDA, avail. from Supt. of Doc., USGPO, Wash., DC 20402, Sept. 1972, Price $1.

"Estimated Use of Water in the United States in 1970," (Geol. Sur. Circ. 676), by C. Murray, et al, USGS, Wash., DC 20242, 1972.

"The Grass Roots and Water Resources Management," (Rpt. 10), by WRC, Wash. St. U., Pullman, Wash. 99163, July 1972.

Water Quality Management

"The Efficacy of the Complete Mix Activated Sludge Process in Modular Mode," by E. McGriff, Jr., Dept. of Civ. Engr., avail. from WRRI, Miss. St. U., State College, Miss. 39762, July 1972.

The following Biota of Freshwater Ecosystems Identification Manuals are available from EPA, USGPO, Wash., DC 20402:

Manual No.	
1	"Freshwater Planarians (Turbellaria) of North America," by R. Kenk, Smithsonian Inst., Feb. 1972, Price $2.50.
2	"The Genus Argulus (Crustaces: Branchiura) of the United States," by R. Cressey, Smithsonian Inst., Feb. 1972, Price $2.50.
3	"Freshwater Sphaeriacean Clams (Mollusca: Pelecypoda) of North America," by J. Burch, U. of Mich., Mar. 1972, Price $2.50.
4	"Freshwater Polychaetes (Annelida) of North America," by N. Foster, Dunbarton Col., Mar. 1972, Price $2.50.
5	"The Freshwater Amphipod Crustaceans (Gammaridae) of North America," by J. Holsinger, Old Dominion U., Apr. 1972, Price $2.75.
6	"Aquatic Dryopoid Beetles (Coleoptera) of the United States," by H. Brown, U. of Okla., Apr. 1972, Price $2.50.
7	"Freshwater Isopods (Asellidae) of North America," by W. Williams, Monash U., May 1972, Price $2.50.

Manual No.

8 "Freshwater Leeches (Annelida: Hirudinea) of North America," by D. Klemm, U. of Mich., May 1972, Price $2.50.

9 "Crayfishes (Astacidae) of North and Middle America," by H. Hobbs, Jr., Smithsonian Inst., May 1972, Price $3.25.

"Desalting," (PB-209 942), by V. Koelzer, NWC, avail. from NTIS, 5285 Port Royal Rd., Springfield, Va. 22151, May 1972.

"The Composition and Distribution of the Fish Fauna of the Navasota River," (TR-32), by E. Rozenburg, et al, Texas Water Resources Inst., Tex. A&M U., College Station, Tex. 77843, Aug. 1972.

"The Effect of Organic Amendments from Garbage Grinding on a Biological Treatment System," by J. Mahloch, Dept. of CE, avail. from WRRI, Miss. St. U., State College, Miss. 39762, June 1972.

"Assessment of the Effectiveness and Effects of Land Disposal Methodologies of Wastewater Management," (Wastewater Management Rpt. 72-1), by C. Driver, et al, Dept. of Army, Wilmington Dist., Corps of Engrs., P. O. Box 1890, Wilmington, N. C. 28401, Jan. 1972.

"Wastewater Management by Disposal on the Land," (SR 171), by S. Reed, Dept. of Army, Wilmington Dist., Corps of Engrs., P. O. Box 1890, Wilmington, N. C. 28401, May 1972.

"Role of Phosphorus in Eutrophication," (EPA-R3-72-001), by A. Bartsch, Nat'l. Env. Res. Cen., EPA, USGPO, Wash., DC 20402, Aug. 1972, Price 55¢.

"Community Productivity and Energy Flow in An Enriched Warm-Water Stream," (Tech. Rpt. 27), by R. Vannote, et al, Inst. of Water Res., Mich. St. U., East Lansing, Mich. 48823, Sept. 1972.

"Primary Considerations in Regional Wastewater Treatment Planning," by A. Shindala, Dept., of CE, avail. from WRRI, Miss. St. U., State College, Miss. 39762, June 1972.

"Public Attitudes Toward Reuse of Reclaimed Water," (Contribution 137), by W. Bruvold, U. of Cal., WRC, Berkeley, Cal. 94704, Aug. 1972.

"Rules and Regulations Governing State Grants for Wastewater Treatment Works, Wastewater Collection Systems and Water Supply Systems," by St. Bd. of Health, et al, avail. from NCDNER, OWAR, P. O. Box 27687, Raleigh, N. C. 27611.

"Trace Metals in Several Delaware Watersheds--A Progress Report," by R. Biggs, et al, U. of Del., WRC, Newark, Del. 19711, June 1972.

"Assessment of Turbidity, Color, and Odor in Water," (Tech. Rpt. 128), by D. Harris, Anacapa Sciences, Inc., for OWRR, USDI, Wash., DC 20240, Oct. 1972.

"Bibliography of Water Quality Research Reports," (WPC Res. Ser.), by Publications Branch (Water), Res. Inf. Div., Office of Res. & Monitoring, EPA, Wash., DC 20460, June 1972.

Water Quantity Management

"Development and Management of Ground Water and Related Environmental Factors in Arid Alluvial and Carbonate Basins in Southern Nevada," (Proj. Rpt. 18), by R. Bateman, et al, Cen. for Water Resources Res., Desert Res. Inst., U. of Nev. System, Reno, Nev. 89507, Jan. 1972.

"Hydrologic Data for Experimental Agricultural Watersheds in the United States 1966," (Misc. Pub. 1226), by J. Burford, Agr. Res. Sta., in coop. with State Agri. Exp. Sta., avail. from Supt. of Doc., USGPO, Wash., DC 20402, Price $3.50.

"A Physics-Based Approach to Hydrologic Response Modeling: Phase I - Model Development," (Comp. Rpt.), by R. Freeze, IBM Thomas J. Watson Res. Cen., Yorktown Heights, N. Y. 10598, Sept. 1972.

"The Influence of a New England Wetland on Water Quantity and Quality," (Res. Rpt. 4), by F. Hall, et al, Water Res. Res. Cen., U. of N. H., Durham, N. H. 03824, May 1972.

Miscellaneous

Annual Reports: State Water Resources Research Institutes

U. of Del.
U. of Minn. (8th)
U. of Wy. (8th)

"Changing Education Needs in the Field of Environmental Resources," (Proceedings of Conf.), by Univ. Coun. on Water Res., avail. from WRRI, 212 Ag. Engr., U. of Neb., Lincoln, Neb. 68503, July 1972.

"The Environment Film Review," by Environment Inf. Cen., Inc., Film Ref. Dept., 124 E. 39th St., New York, N. Y. 10016, Sept. 1972, Price $20.

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

PRINTED MATTER