NEWS
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OF THE UNIVERSITY OF NORTH CAROLINA

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RESEARCH ASSESSES THREAT TO WATER SUPPLY SITES AND WATERSHEDS IN NORTH CAROLINA

North Carolina has a limited number of sites suitable for the development of water supply reservoirs, yet the protection of prospective sites is not considered seriously by many local governments. This conclusion is found in an interim report by Dr. Raymond Burby of the Center for Urban and Regional Studies at the University of North Carolina at Chapel Hill.

Dr. Burby is heading a research team that is assessing the nature and immediacy of the threat of urbanization to future water supply reservoir sites and watersheds in North Carolina. Findings from the study were presented to the Environmental Management Commission, whose Water Supply Committee is considering new water supply classifications. The study uses eight cases to illustrate a wide spectrum of types of water systems, levels of existing watershed development, and degrees of concern for protecting such areas from future urban encroachment.

The study found most of the communities studied had experienced a water shortage in the past five years requiring them to purchase water from another water system or to draw water from a back-up reservoir.

While some counties have land-use plans and zoning ordinances to protect existing watersheds and prevent pollution of water supplies, few have such measures for potential future water supply watersheds. In some cases, county officials felt it was not their responsibility to initiate water quality protection measures,or such measures could not be enacted because of financial and political constraints.

According to the draft report, a major constraint in future source protection measures is the needed coordination among public agencies. If an agency has regulatory authority over land development, its land development regulations are rarely coordinated with water supply protection, in part because water supply is the responsibility of another department or another government.

This Water Resources Research Institute-supported study is expected to be completed by June 30, 1985.

PROPOSED NEW WATER SUPPLY CLASSIFICATIONS

The Environmental Management Commission's Water Supply Committee, chaired by David H. Howells, is proposing new water supply classifications. Three new classifications would give greater attention to potential sources of pollution in watersheds, with the emphasis on protecting community water supply sources. The need to strengthen classifications stems from local governments' and citizens' concerns about the thousands of toxic substances being found in drinking water sources and the limited mechanisms available to the state to control them.

Under the proposed program, land-use regulations in watersheds will be the responsibility of local governments, with the Division of Environmental Management assuring that no point discharges would be permitted to conflict with the desired water supply classification. Three classifications are under consideration:

· Water Supply - Level I

This classification would expand the current A-1 classification to include watersheds with controlled private development but no discharges. Watersheds where this classification existed would permit private development, but all point source discharges would be prohibited and nonpoint sources would be suitably controlled through the adoption of land-use restrictions by local government.

· Water Supply - Level II

This classification fits between the current A-1 and A-11, where some non-toxic discharges may be allowed. In watersheds with the Water Supply Level II classification, domestic wastewater discharge would be permitted. Industrial wastewater discharges would be prohibited, although some non-process waters may be allowed. Local land-use restriction would be required to assure appropriate nonpoint source control.

· Water Supply - Level III

- This category is similar to the current A-11 classification, except for strengthening the control of toxics in industrial wastewater discharges. Special requirements to be added would include full disclosure of toxics, development of spill and failure control plans, and increased monitoring of toxics.

Public hearings on the proposed water supply classifications are expected in May.

HYDRILLA SEED FOUND IN WAKE COUNTY PONDS

A new twist in North Carolina's battle against hydrilla favors the spread of the noxious aquatic weed. The discovery that hydrilla can produce viable seed in N. C. lakes signals yet another means of reproduction for the plant--one that can result in long-distance dispersal and genetic recombination.

Research Technician Cynthia B. Smith and Institute Researcher Dr. Ken A. Langeland of the N. C. State University Crop Science Department observed the seed production in two Wake County ponds last fall. Aquatic plant researchers have observed hydrilla seed production in recent years under controlled conditions, but this is the first time it has been found in a natural setting. The finding is significant for North Carolina and other states as well. Seed can be ingested by birds and carried long distances. It can pass in and out of dormacy, surviving heat and cold until it finds a suitable environment. Genetic recombinations enable the plant to develop variations, changing itself over a period of time to adapt to its environment in an evolutionary way and to compete with other species.

One of the characteristics of hydrilla that makes it so difficult to control is that it has several methods of reproducing, including fragmentation, tubers, and turions or winter buds. But until recently it was believed that reproduction of the plant in the U. S. only occurred by such vegetative, asexual means. Control strategies have been planned accordingly, with strong emphasis given to educational efforts; for example, informing boaters of the ease with which bits of hydrilla can cling to propellers and trailers and be carried to new locations. Sexual reproduction of the plant was not known to occur in the Northern Hemisphere.

In Florida, where hydrilla was first introduced into the U. S. and where the plant has been studied for many years, only female plants have been observed. Without the male flower, pollination could not occur, and reproduction has been through vegetative means. However, in recent years monoecious hydrilla, which has both male and female flowers on the same plant, has been observed in several locations, including North Carolina. It is monoecious hydrilla that has produced the seed.

Dr. Langeland, who is presently conducting an Institute project on chemical control of hydrilla and alligatorweed, told of the hydrilla seed observation at the January meeting of the N. C. Aquatic Weeds Council.

TARGETING AREAS TO CONTROL EROSION IS WORKING

According to a recent U. S. Soil Conservation Service summary of work on the Piedmont Bright Leaf Targeted Area in North Carolina, a concerted effort to reduce erosion has been successful. The U. S. Soil Conservation Service summary says that "a consistent program of technical assistance, coupled with financial assistance and a strong information and education program, can produce positive results."

The Bright Leaf Targeted Area includes 13 counties in North Carolina and 14 in Virginia where cropland erosion losses were among the greatest. Soil losses on cropland in the 13-county area in North Carolina were reduced by about 240,000 tons on almost 27,000 acres. Of this total about 17,000 acres were treated to the extent that soil losses were reduced to or below the acceptable tolerance level for the given soil type. Seventy-one (71) percent of the acreage treated had, before treatment, soil-loss rates greater than twice the acceptable tolerance level. Erosion was reduced on the land eroding at rates greater than twice the tolerance level by an average of 11.3 tons/ac/yr.

According to SCS officials, much of the success of the program is attributed to the good working relationships between farmers, agencies, other organizations, and community leaders. Among the agencies participating in the program were the Soil Conservation Service (SCS), Agricultural Stabilization and Conservation Service (ASCS), the Agricultural Extension Service, Farmers Home Administration, and N. C. State University.

CLARK COUNTY, VA, SEEKS SPECIAL GROUND WATER PROTECTION

Clark County in northern Virginia has taken a step to protect its ground water supply by applying to EPA for sole-source designation of one of its aquifers. The county becomes one of a few in the nation to take this step. If granted, the designation of the aquifer as a sole source of drinking water would result in the denial of federal funds for any project that might endanger the aquifer according to an article in a recent issue of U. S. Water News.

The county's concern over the quality of its ground water supplies follows the abandonment in 1981 of its largest public water supply after the discovery of contamination--traces of nitrates, herbicides, and phenol--the source of which was never found. Also significant bacterial contamination has been found in the county's private wells, the article said.

The matter of sole-source aquifer protection will be before the U. S. Congress this year in the form of a bill introduced January 3 by Senator Daniel P. Moynihan (D-NY). This bill (S-24), described in the Bureau of National Affairs Environment Reporter of January 18, "would establish procedures and provide $165 million in federal funds over four years for protecting ground water from contamination (and) would apply to 17 aquifers that the Environmental Protection Agency has designated the sole-source of drinking water."

Under the bill, a community could petition its state governor for designation of an area as a "special protection area." The governor would establish and submit to EPA information on boundaries and the planning process for the area. EPA

would decide if the state is eligible for a 50-percent matching grant to develop the protection program. The article states that under the bill, "after the state develops a protection program, the governor could submit the plan to EPA for approval. If approved, the state would be eligible to receive a 50-percent federal matching grant of up to $25 million for putting the program into effect." The grants could be used to buy land in critical areas where the aquifer is replenished.

STUDY EXAMINES PHYTOPLANKTON IN JORDAN

Early study results confirm that B. Everett Jordan Lake is one of many eutrophic lakes in North Carolina; but apparently, severe water quality problems have not yet arisen.

With funding from the UNC Water Resources Research Institute, the first stage of a study of the productivity and nutrient status of phytoplankton in Jordan Lake has been completed. The major goals are (1) to determine the relative importance of nitrogen, phosphorus, or other nutrients as controls of phytoplankton growth rate and abundance using an algal assay procedure; (2) to measure rates of uptake of inorganic nitrogen and phosphorus by phytoplankton, bacteria, and suspended sediments in the lake at several stations throughout the year; and (3) to measure rates of primary production in the water column for correlation with independent measures of nutrient concentrations, nutrient uptake rates, phytoplankton abundance, light, and temperature at several stations throughout the year.

Sampling trips are made approximately monthly to several stations in the Haw River and New Hope River arms of the lake. In situ measurements are made of temperature, conductivity, dissolved oxygen, and underwater light intensity. Water samples for algal assay, nutrient concentration measurements, and nutrient uptake are collected from the euphotic zone, primarily because this is the region of greatest immediate interest. Algal assay procedures to determine nutrient limitation are performed to determine whether nitrate or phosphate is most likely to be limiting.

The first year of study, Fall 1983 - Fall 1984, is complete. Early results show large seasonal differences and some spatial differences in concentrations and in rates which are worthy of discussion. (Final interpretation must, however, await conclusion of the second year of data collection, especially the summer periods in 1984 and 1985.)

Algal assay experiments conducted during May-August 1984 generally showed that neither nitrogen or phosphorus was in short supply relative to the other. During the summer period when phytoplankton was most abundant and productivities were highest, the concentrations of ammonia and phosphate decreased to low levels, although nitrate tended to be abundant in the Haw River area. There was a general pattern of increased nitrogen and phosphate uptake during the warm season, but significant differences existed from one station to another. Phosphate uptake by suspended sediments appeared high during the cool part of the year but was dominated by biological processes in the summer. Primary productivity peaked in summer when the phytoplankton took advantage of the high temperature and abundant light. In spite of considerable respiration within the water column, there appeared to be an excess of production in the lake.

It is important to recognize the seasonal and spatial variations in each of the parameters used to define trophic state. However, none of the research suggests that Jordan's trophic state will be much different from that of other lakes in the North Carolina Piedmont. Algal assays which are planned for the future will provide more insight into nutrient limitations in the lake. These additional data will permit better understanding of the functioning of the phytoplanktonic system, better prediction of the future trophic state of the lake, and a basis on which to propose alternative management strategies.

. . . by Dr. E. J. Kuenzler
ESE Notes

PPP CHALLENGE GRANTS

The Department of Natural Resources and Community Development (NRCD) has announced a program to challenge businesses and communities to identify and apply pollution prevention and waste reduction techniques to reduce, prevent, recycle, or eliminate toxic and hazardous wastes, wastewater discharges, and air emissions. Under the grant program, NRCD's Pollution Prevention Program would provide financial assistance in the form of matching grants to encourage and assist small businesses and communities to implement pollution prevention and waste-reduction techniques.

Approved projects may receive grant support on a one-to-one basis up to a $5,000 maximum. Proposals should be received by March 15, 1985.

The Challenge Grant Project for Pollution Prevention is a cooperative state effort through the lead of the Pollution Prevention Pays Program in NRCD. Additional funding is made available from the N. C. Board of Science and Technology and a grant from the U. S. Environmental Protection Agency. Technical support is provided through the Hazardous Waste Management Branch, Department of Human Resources, and through the Governor's Waste Management Board.

Questions concerning Challenge Grants for Pollution Prevention or other elements of the State's efforts should be directed to:

Mr. Roger N. Schecter, Director
Pollution Prevention Pays Program
Dept. of Natural Resources & Community Development
P. O. Box 27687
Raleigh, NC 27611
Telephone: (919) 733-5083

DEM EXPANDS LABORATORY CERTIFICATION PROGRAM

The Division of Environmental Management (DEM) is expected to expand its certification program for laboratories that analyze water samples. Currently, DEM has certified 74 commercial laboratories in North Carolina. Under the new program the number of certified laboratories would expand dramatically, with 190 larger Class III and IV wastewater treatment facilities now required to have certified laboratories. DEM will also require the certification of laboratories for smaller Class I and II municipal plants that have pretreatment programs. The laboratories are inspected and certified by the DEM. The Division's expanded program is expected to be largely self-supporting, with a minimum annual fee for certification of $250. Small facilities are normally certified for 6 parameters, such as BOD, pH, chloride, fecal coliform, turbidity, whereas the large laboratories might receive certification for 12-15 parameters. Commercial laboratories may be certified for an even larger number of parameters.

Certification of laboratories is based on adequate personnel, equipment, and quality assurance; use of approved methodology; and performance on evaluation samples.

The overall intent of the certification program is to improve, maintain, and document the quality of environmental data reported to the Division of Environmental Management.

Additional details regarding the laboratory certification regulations may be obtained by writing or calling: William B. Edwards, Division of Environmental Management, P. O. Box 27687, Raleigh, NC 27611. Telephone (919) 733-3908.

REMOVAL OF NITROGEN FROM WASTEWATER PONDS MODELED

The use of ponds for the treatment of wastewater is becoming more common because of low labor and energy requirements of this technology. Pond water can be discharged to a nearby drain or water course, or be used in combination with land application.

A primary objective of wastewater treatment is nitrogen removal. The concentration, forms, and transformations of nitrogen in wastewater are factors influencing pond design and water quality decisions. Nitrogen can promote eutrophication of receiving waters; and ammonia, one form of nitrogen, can be toxic to a wide variety of fish species at low concentrations.

A recent study by the U. S. Army Corps of Engineers Cold Regions Research and Engineering Laboratory has produced a design equation that can be used to estimate nitrogen removal in wastewater pond systems. The publication, Nitrogen Removal in Wastewater Ponds, by Sherwood C. Reed, discusses the physical and chemical factors that must be accounted for in the design equation, methods for estimating pH and temperature, and the possibilities of vegetation or crop selection based on pond design and management.

The study concludes that almost almost all of the nitrogen in the effluent from the ponds will be low and in either the ammonia or organic form. Under favorable conditions, nitrogen removal may exceed 80 percent. Removal is dependent on pH, temperature, and detention time. The interaction of these three parameters results in the loss of gaseous ammonia to the atmosphere--the major nitrogen removal mechanism in the pond system.

The study also examines the effect of ice cover in wastewater ponds and concludes that ice-covered, non-aerated ponds will produce very poor effluent quality. The model developed in the study can be used to ensure maximum cost effectiveness for design of new wastewater pond facilities requiring nitrogen removal.

For a copy of the report, write: National Technical Information Service, 5285 Port Royal Rd., Springfield, VA 22161. Include CRREL Report 84-13.

. . . *Water Impacts*
Michigan State University

INTEREST IN GROUND WATER SEMINARS HIGH

Over 80 persons, including representatives of state and local governments and industry, and consulting engineers have registered for a series of 10 seminars to be given on key ground water topics, scheduled for February through June. Topics and speakers were given in last month's issue of the NEWS.

These seminars are sponsored by the Water Resources Research Institute in cooperation with the U. S. Geological Survey and the Departments of Civil Engineering and Marine, Earth and Atmospheric Sciences at North Carolina State University.

NEW INSTITUTE RESEARCH EXAMINES STORMWATER MANAGEMENT APPROACHES FOR URBAN COLLECTOR STREAMS

A new Water Resources Research Institute project supported by the City of Charlotte seeks to integrate the management of urban collector streams with the comprehensive stormwater and flood-plain management programs. The research is intended to provide information for local officials to use in establishing a stormwater management program for these streams, whose watersheds range from 20 acres to one square mile. Most North Carolina cities experience considerable damage and inconvenience associated with the misbehavior of urban collector streams, which consists mainly of flooding and streambank degradation. Watersheds smaller than 20 acres generally are drained by systems of gutters, inlets, pipes, and small swales provided at the time of development.

The specific objectives of this research project are:

- To characterize the behavior of the current stream system as to location, severity, and classification of problems identified through records of citizen complaints and excessive maintenance expenditures.
- To define levels of service appropriate to urban collector streams.
- To define an assortment of feasible physical treatments that may be applied to various streams.
- To estimate the magnitude of the investment required to bring the streams to appropriate levels of service.
- To consider alternate means of financing the management program.
- To propose elements of a management plan such as modifications of current ordinances, physical management strategies for the stream system, prioritized schedule of stream-channel improvements with preliminary cost estimates, and system maintenance policies.

Principal Investigator for the project is Dr. Rooney Malcom, Associate Professor in the Department of Civil Engineering at North Carolina State University. The project is expected to be completed by December 31, 1985.

POLLUTION TRADING PROVIDES ECONOMIC INCENTIVE FOR COLORADO LOCAL GOVERNMENTS

A novel pollution-control program has been developed by a regional council of governments in Colorado. The program works by granting wastewater utilities credit for cleaning up runoff pollution. The pollution trading program is the first of its type in the nation and was developed by the Northwest Colorado Council of Governments. Tom Elmore, Water Quality Director for the NCCG explained how the program works in the National Association of Regional Councils' "Minute Memo" newsletter.

The program is being implemented by wastewater treatment plants surrounding the Dillon Reservoir, one of Denver's primary drinking water supplies, which is threatened by phosphorus from natural sources, stormwater runoff, and wastewater treatment plants. The treatment plants already use advanced techniques for phosphorus removal from sewage. The trading program allows these utilities to use low-technology treatment systems on stormwater runoff in return for credit for any phosphorus removed. This approach avoids the cost of adding even more expensive treatment systems such as reverse osmosis or activated alumina.

Point and nonpoint sources of pollution are rarely controlled by a coordinated program. At Dillon Reservoir, both sources contribute relatively equal amounts of phosphorus. The amount of phosphorus from wastewater is shrinking as advanced treatment systems are applied, while runoff sources are increasing as developed areas increase. The lake would deteriorate to unacceptable levels even if wastewater sources are eliminated.

In contrast to wastewater plants, low-technology methods are effective in removing phosphorus from runoff sources.

Fairly simple devices can remove large amounts of various pollutants including phosphorus. Settling ponds remove roughly half the phosphorus in runoff from urban areas. Rapid sand filters can remove another quarter of the incoming phosphorus. Percolating runoff into the ground water through unsaturated soil can remove virtually all the phosphorus.

Potential cost savings for wastewater utilities in the trading system are impressive. The point source improvement alternatives range from $824 to $7,861 per pound of phosphorus removed annually. The alternatives under consideration are land treatment, activated alumina, and reverse osmosis. The low-technology nonpoint source control alternatives have a predicted annual cost of $67 per pound of phosphorus removed.

The phosphorus control plan was developed by local governments in the Dillon watershed, where there is strong local support for maintaining the quality of the lake. The trading program rests on a federal, state, and local regulatory partnership. Local land-use authorities are used to hold future runoff sources to an acceptable level. These local requirements include erosion control, runoff controls, and streamside setbacks. Local governments agreed to prove the long-term effectiveness of phosphorus controls by instituting a locally supported monitoring program. A two-to-one trade ratio was also instituted to account for uncertainties in the system: two pounds of nonpoint phosphorus must be controlled to qualify for one pound of point source credit. Reports will be prepared annually to evaluate the effectiveness of the program.

For additional information, contact: The Northwest Colorado Council of Governments Water Quality Program, P. O. Box 739, Frisco, Colorado 80443. (303) 668-5445. A videotape on the project is available.

TRIANGLE CONFERENCE ON ENVIRONMENTAL TECHNOLOGY APRIL 2-4

The 1985 Triangle Conference on Environmental Technology will be held on April 2, 3, and 4 in Raleigh, North Carolina, at the Jane S. McKimmon Center, North Carolina State University. This meeting will be the 23rd Conference of a series sponsored by: North Carolina State University, Raleigh; University of North Carolina, Chapel Hill; and Duke University, Durham.

There will be a half-day pre-conference workshop on "Phosphorus Removal in Small Waste Water Treatment Plants" conducted by E. F. Barth, coauthor of the E.P.A. Technology Transfer Manual on Phosphorus Removal. This half-day pre-conference workshop will be held on Tuesday, April 2, 1985, from 1:00-5:00 p.m. at the McKimmon Center.

The two-day conference will open on Wednesday, April 3, with a plenary session on the Interrelationships of Air, Water, and Land Pollution Problems and Solutions. More than fifty papers will offer in-depth expert information on acid deposition, hazardous wastes disposal, municipal and industrial waste treatment and other current topics during concurrent sessions. Speakers at the luncheon meetings will also address topics relevant to state and federal government programs.

For further information regarding the content of both the pre-conference workshop and the conference, contact: Charles Smallwood, Professor, Conference Program Chairman, Department of Civil Engineering, Box 7908, N. C. State University, Raleigh, NC 27695-7908. Telephone: (919) 737-2331.

To receive a brochure and register, contact: Dora M. Shell, Continuing Education Specialist or Michelle Howell, Program Assistant, Division for Lifelong Education, Box 7401, N. C. State University, Raleigh, NC 27695-7401. Telephone: (919) 737-2261.

OTHER CONFERENCES AND WORKSHOPS

Basics of Groundwater Modeling is a short course being offered February 28-March 1 and March 4-8 at the Holcomb Research Institute in Indianapolis. The course is broken into two modules that can be taken together or separately, both providing hands-on training in the use of groundwater models. For information contact Paul van der Heijde, Director, International Groundwater Modeling Center, HRI, 4600 Sunset Ave., Indianapolis, IN 46208. Telephone (317) 283-9458.

Seminar on Leaking Underground Storage Tanks: Managing the Problem will be held March 19-20 in San Francisco. For information contact Richard M. Miller, American Ecology Services, Inc., 127 East 59th St., New York, NY 10022. Telephone (212) 371-1620.

Abstracts are due March 15 for the International Symposium on Management of Hazardous Chemical Waste Sites. Possible subjects for papers include groundwater and soil contamination studies, geohydrology, remedial response, and aquifer rehabilitation. The symposium is scheduled for October 9-10, 1985, at the Winston-Salem Hotel in Winston-Salem, NC. Contact Dr. Zubair A. Saleem, c/o Ebasco Services, Inc., 2211 W. Meadowview Rd., Greensboro, NC 27407. Telephone (919) 855-7500.

Mathematical Modeling of Lake and Reservoir Water Quality is a one-week, intensive course to be offered March 25-29, 1985, at Duke University. The course emphasizes practical applications of mathematical models in predicting the response of water bodies to pollutants. Registration is $350. Contact Julie Gay, Intensive Course Coordinator, School of Forestry and Environmental Studies, Duke University, Durham, NC 27706. Telephone (919) 684-2135.

Clean Water Through Controlling Nonpoint Sources is a conference designed to bring together all those concerned with nonpoint source pollution--including agricultural, forestry, mining, construction, industry, governmental, environmental and other interests, both public and private. This conference will be held May 19-22, 1985, at the Hyatt Regency Hotel in Kansas City, Missouri. For details write to North American Lake Management Society, P. O. Box 217, Merrifield, VA 22116.

POSITIONS AVAILABLE

The Water and Energy Research Institute at the University of Guam is now recruiting to fill 3 vacant research faculty positions in water resources. All disciplines will be considered, but first preference will be given to candidates with a background in groundwater, sanitary/environmental engineering, and hydraulics. A doctorate is required. All positions are locally funded and are tenure-track.

For further information, please contact: Dr. Stephen J. Winter, Director, Water and Energy Research Institute, University of Guam, UOG Station, Mangilao, Guam 96913.

The Pennsylvania State University invites applications to fill a tenure-track position at the rank of associate or full professor for the academic year beginning August 1985. Doctorate in environmental engineering or in an allied field, with research experience in the chemistry and transportation of organic aqueous environmental pollutants is required. Additional experience in physical-chemical treatment processes is desirable.

Qualified applicants should submit by April 15, 1985, a complete resume (including transcripts) and the names of three references to: R. M. Barnoff, Head, Department of Civil Engineering, The Pennsylvania State University, 212 Sackett Building, Box (G), University Park, PA 16802. Telephone: (814) 865-8391.

WATER RESOURCES CONDITIONS IN NORTH CAROLINA FOR JANUARY

Streamflows in the Mountains and Piedmont were below normal (in the lowest 25 percent of record) for the second consecutive month and remained in the normal range in the Coastal Plain. Although no flooding was reported, runoff from heavy rains on the 3rd and 4th caused moderate rises on most streams.

Monthly mean flow for selected stations, as compared to the median monthly flows for the reference period, are as follows:

French Broad River at Asheville (Mountains) 56 percent;
South Yadkin River near Mocksville (Piedmont) 65 percent;
Contentnea Creek at Hookerton (Coastal Plain) 73 percent.

Water levels in unconfined aquifers rose and were above long-term averages across the state.

. . . *U. S. Geological Survey*

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 organization issuing the publication. The addresses are provided by the NEWS for this purpose.)

Water Resources Planning

"The Potential for Water Yield Augmentation Through Forest and Range Management," 1983, ed. by S. L. Ponce, avail. from AWRA, 5410 Grosvenor Lane, Suite 220, Bethesda, MD 20814. (03B Water Yield Improvement)

"Recreational Use of Urban Water Storages and Catchments," (Water Mgt. Series #4), 1984, by Dept. of Resources and Energy, Australian Water Resources Council, Canberra. (06)

Water Quality Management

"Acid Rain - A Water Resources Issue for the 80's," 1983, ed. by R. Herrmann, et al., avail. from AWRA, 5410 Grosvenor Lane, Suite 220, Bethesda, MD 20814. (05C Acid Rain).

"The Ecology of the Pamlico River, North Carolina: An Estuarine Profile," (FWS/OBS-82/06), 4/84, by B. J. Copeland, et al, available from USDI, Fish and Wildlife Service, National Coastal Ecosystems Team, NASA, Slidell Computer Complex, 1010 Gause Blvd., Slidell, LA 70458. (02L)

"Indicators of Ground Water Quality and Yield for a Public Water Supply in Rock Fracture Zones of the Piedmont," (#115), 8/84, by D. S. Snipes, et al., WRRI, Clemson U., Clemson, SC 29631. (02F)

"Residual Aluminum in Potable Water," (#45), 7/84, by W. Sung, WRRC, U. of NH, Durham, NH 03824. (05F)

"Potomac River Water Quality 1982, Conditions and Trends in Metropolitan Washington," 8/83, by Dept. of Env. Programs, Metropolitan Washington COG, 1875 Eye St., NW, Suite 200, Washington, DC 20006, Price: $4. (Chesapeake Bay)

"Potomac River Water Quality 1983, Conditions and Trends in Metropolitan Washington," 7/84, by Dept. of Env. Programs, Metropolitan Washington COG, avail. from Metropolitan Info. Center, Metropolitan Washington COG, 1875 Eye St., NW, Suite 200, Washington, DC 20006, Price: $10. (Chesapeake Bay)

"The Acute Effects of Aluminum and Acidity Upon Nine Stream Insects," (#46), 9/84, by W. Cook, et al., WRRC, U. of NH, Durham, NH 03824. (05C Acid Rain)

"A Membrane-Organic Phase Oxidation Process for the Destruction of Toxic Organics in Hazardous Wastewaters," (#152), 8/84, by C. E. Hamrin, Jr., et al., WRRI, U. of KY, Lexington, KY 40506. (05D WW Treatment)

"Optimization and Dynamic Control of the Coagulation Process in Water Treatment," (#40), 5/83, by P. J. Ossenbruggen, WRRC, U. of NH, Durham, NH 03824. (05F)

Water Quantity Management

"Household Conservation During Water Emergencies (Two Case Studies)," (#44), 7/84 by L. C. Hamilton, WRRC, U. of NH, Durham, NH 03824. (03D Water Conservation)

"Discharge Ratings at Gaging Stations, (Techniques of Water-Resource Investigations of the United States Geological Survey),"(Bk3, ChA10), 1984, by E. J. Kennedy, for sale by Distribution Br., USGS, 604 S. Pickett St., Alexandria, VA 22304. (02E)

"Finite Element Simulation of Saturated-Unsaturated Subsurface Flow," (#155), WRRI, U. of KY, Lexington, KY 40506. (04B GW Mgt.)

"The Concord Water Survey," (#38), 1/83, by L. C. Hamilton, WRRC, U. of NH, Durham, NH 03824. (03D Water Conservation)

Miscellaneous

"Chesapeake Bay: A Framework for Action," 9/83, by Chesapeake Bay Program, USEPA, Reg. III, 839 Bestgate Rd., Annapolis, MD 21401. (Chesapeake Bay)

"Final Environmental Impact Statement, Proposed 1985 Outer Continental Shelf Oil and Gas Lease Sale Offshore the South Atlantic States," (OCS Sale No. 90), 12/84, by USDI, contact Archie Melancon, USDI, Minerals Management Service, 18th and C Streets, NW, Washington, DC 20240. (EIS)

SPECIAL

Monitoring for Toxic Substances in the Waters of North Carolina

Since Rachel Carson documented the long-term adverse effects of DDT in her book Silent Spring, published in 1963, Americans have become increasingly aware of the risk to human health and to fish and wildlife resulting from the widespread use of pesticides, herbicides, and a variety of industrial chemicals. Concern about risks of this type have matured to the point that they have been incorporated in a variety of legislative actions, including the Clean Water Act, the Clean Air Act, the Safe Drinking Water Act, the Toxic Substances Control Act, the Resource Conservation and Recovery Act, and "superfund" legislation.

Gross abuses in the disposal of hazardous chemicals at a number of locations across the nation are reported in the media almost daily. Accidental spills and incidents of leaking underground storage tanks are common occurrences. Yet, the extent of the problem in most states, including North Carolina, is poorly understood. Despite these well-publicized events and aggressive legislative action, there has been relatively little systematic monitoring to identify and quantify the nature, magnitude, and extent of contamination from toxic substances. North Carolina, as well as other states, has begun to develop and implement a program for monitoring toxic substances in its water resources, but these efforts are only a beginning. The N. C. Department of Natural Resources and Community Development has made the problem of toxic substances in the water resources a top priority in its budgetary requests submitted to the 1985 General Assembly.

In February 1984, Dr. David H. Moreau, Director of the Water Resources Research Institute of The University of North Carolina, appointed a special committee to advise the Institute on research needs and priorities necessary to support development of a monitoring program to be implemented by appropriate agencies of state government. Representatives of the University of North Carolina and state agencies were asked to join the committee. Members of the committee were:

Dr. Russell F. Christman, Professor and Chairman of the Department of Environmental Sciences and Engineering, University of North Carolina at Chapel Hill

David H. Howells, Professor Emeritus, North Carolina State University, and member of the North Carolina Environmental Management Commission

Linda C. Sewall, Assistant Chief, Environmental Health Section, Division of Health Services, N. C. Department of Human Resources

Dr. Ted Taylor, Toxicologist, Environmental Epidemiology Branch, Division of Health Services, N. C. Department of Human Resources

Forrest Westall, Head, Operations Branch, Water Quality Section, Division of Environmental Management, N. C. Department of Natural Resources and Community Development (now assigned to Asheville regional office of DEM)

This report begins with an examination of several problems that make the design of a monitoring program a complex undertaking. Then, it covers a brief review of existing monitoring programs in North Carolina and concludes with the findings and recommendations of the committee.

The Flow of Toxics in the Environment

Flows of these substances in the environment are depicted in the diagram on page 11. Even at their "sources," toxic substances may exist in heterogenous mixtures, requiring state-of-the-art analytical methods to identify their presence and estimate their quantities. As they are released into the environment through a variety of transport processes, they undergo physical, physical-chemical, and biochemical transformations through metabolic processes that further complicate identification of their parent compounds and sources. Their effects may be acute, exhibiting easily detected lethal effects on selected organisms. However, many of these substances, particularly those that cause cancer, have effects that result from long-term, low-level exposures that can be demonstrated only in large-scale animal tests with high dose rates.

Complexities of this kind present enormous challenges to the development of meaningful monitoring programs. Among the questions that such a monitoring strategy must address are:

1. Where in the system will measurements be made?
2. Given the measurement of a substance at a source, what inferences can be made about its fate in the environment, including its degradation products, spatial distribution, and accumulation?
3. Given the measurement of a substance in the ambient environment, what inference can be made about its precursors and sources?
4. At what frequency should measurements be made, and over what averaging intervals should they be taken?
5. What techniques should be used for indicating the presence of toxic substances and specific identification of offending compounds?
6. What statistical techniques should be used for drawing inferences from data collected in the monitoring system?

Review of Present Monitoring Program in North Carolina

Several water quality monitoring programs are being operated in North Carolina at the present time, including ones operated by state and federal agencies and self-monitoring by water suppliers and waste dischargers subject to state and federal regulations. The principal agencies are: (1) the North Carolina Department of Natural Resources and Community Development (NRCD), Division of Environmental Management (DEM); (2) the North Carolina Department of Human Resources (DHR), Division of Health Services (DHS); and (3) the U. S. Geological Survey (USGS). Programs operated by USGS and DEM also contribute to national water quality networks.

Water Quality Monitoring in NRCD

DEM operates an extensive ambient water quality monitoring network which has been in existence for many years. In the 1982-83 biennium it contained 346 stations, 285 freshwater streams and rivers, the balance in lakes and estuaries. These stations are sampled on a monthly basis. Data from this network are summarized and analyzed for trends in a series of biennial reports as required under Section 305b of the Federal Clean Water Act, the most recent being the 1982-83 report published in 1984 (DEM, Rpt. No. 84-11). DEM also conducts special investigations of ambient water quality conditions. Among those studies that are relevant to the problem of toxic pollutants are a statewide assessment of mercury in the waters of North Carolina (DEM, Rpt. No. 83-02, 1983) and a study of mercury and other metals in the fish of Jordan Lake (DEM, Rpt. No. 83-02, 1983).

Thirty-seven of the stations in the ambient quality network operated by DEM are part of the national basic Water Quality Monitoring Program (BWMP) begun in 1978. In 1979, biological parameters were added to the BWMP program, and in 1982 North Carolina expanded biological monitoring to 75 of the ambient stations. A variety of benthic macro-invertebrates, phytoplankton, and fish tissues are collected annually to assess the biological status and bioaccumulation of toxics at the gaging sites. Data from this subset of stations is summarized in a report issued by DEM in August 1983 (Rpt. No. 83-10).

Monitoring of wastewater discharge is required of each wastewater generator who holds a discharge permit under the National Pollutant Discharge Elimination System (NPDES). Regulations for this monitoring program are established by the Division of Environmental Management (NRCD). Details of these requirements are specified in each permit. Monitoring is usually required only for those parameters for which effluent limits are prescribed in the permit, but DEM has the authority to require monitoring for other substances they deem to be appropriate. Very few toxic substances have been included.

The most significant action by DEM in monitoring for toxics in wastewater discharges has been the implementation of biological toxicity testing. This bioassay procedure, promoted by EPA and adopted in several other states, is an important contribution to the monitoring program. It measures the immediate response of living organisms to a given waste without requiring the identification or quantitative measurement of specific chemicals or speculation about their additive or synergistic effects. Biological assays can also be used as a screening device for chemical analysis. Facilities are screened by collecting 24-hour composite samples of the effluent and performing a 48-hour toxicity test using daphnia pulex. Results of this test are used to determine the need for follow-up examinations. Follow-ups involve a 96-hour on-site flow-through test using a mobile bioassay laboratory. During that test, chemical and physical data on the effluent are also obtained. As of October 1984, DEM has conducted 194 tests at 133 facilities. Eighty-nine tests had been run at municipal facilities; 45 percent of those tests showed some form of toxicity. The other 105 tests were run on industrial facilities; 70 percent of these tests indicated some form of toxicity (Tedder, 1984).

Bioassay tests also led to further investigations of one group of effluents that indicated severe toxicity problems. Several textile mills were found to be using biocides that were being carried in the effluents, and further investigation led to the identification of triorganotin compounds as the offending chemical substance (DEM, Rpt. No. 83-09, 1983). The staff of DEM then requested action by the Environmental Management Commission to prohibit the discharge of these compounds into the waters of North Carolina (DEM, April 12, 1984).

Water Quality Monitoring in USGS

In addition to the monitoring programs operated by the state agencies or under their regulations, North Carolina is also engaged in a cooperative water resources data collection program operated by the U. S. Geological Survey. That program has a long history; it has been operated since 1895 with only an eight-year lapse between 1910 and 1918. In water year 1983, that program covered 147 streamflow gaging stations, 25 stage and content records for lakes and reservoirs, 90 water quality stations, and 60 groundwater observation wells (water-level observations). Data from this network are published in a series of USGS reports, the most recent being for 1983 (Hunter, et al.). Seven of the USGS stations are included in the National Stream Quality Accounting Network. All of these stations are also part of the BWMP program, and some of the chemical and biological data for these stations are supplied to USGS by NRCD. A substantial portion of the water quality data reported by USGS at other locations is also provided by NRCD.

Water Quality Monitoring in DHR

A different kind of water quality monitoring program is operated by the Division of Health Services in DHR. That agency is charged with the responsibility to regulate the quality of drinking water under several state and federal statutes. Monitoring requirements as specified in regulations developed pursuant to those statutes are shown in the accompanying table. The North Carolina requirements are the same as the federal ones except that the state also requires monitoring for iron, manganese, and pH. Except for turbidity, sodium, and corrosivity, all of the samples are taken at "representative" points in water distribution systems. All analyses are made by a certified laboratory, either the one operated by the state or through the private sector.

It should be noted that these regulations apply only to public water supplies defined as those systems that serve at least 15 connections or at least 25 people for 60 or more days per year. A large fraction of North Carolinians obtain their supplies from individual wells or springs for which no routine monitoring is provided despite the fact that there is considerable risk of bacteriological and chemical contamination of these sources.

Organic chemical monitoring, of special concern in monitoring for toxic substances, is required only for community systems that use surface sources. For the six organic chemicals other than trihalomethanes, each of these systems must collect only a single sample every three years. Surface and ground water systems that serve at least 10,000 persons must monitor for trihalomethanes. However, changes in these regulations are anticipated in the near future. In 1983, EPA published an advance notice of proposed rule making (ANPRM) to revise the National Primary Drinking Water Regulations (NPDWR) (Federal Register, March 4, 1983). Development of revised regulations for the NPDWRs is proceeding in four phases: Phase I - volatile synthetic organic chemicals; Phase II - synthetic organic chemicals, inorganics, and microbial contaminants; Phase III - radionuclides; and Phase IV - disinfectant by-products including

trihalomethanes. Phases I, II, and III were initiated in 1983. In June 1984, EPA proposed recommended maximum contaminant levels (RMCLs) for nine volatile synthetic organics as a first step in adopting enforceable regulations for these substances (Federal Register, June 12, 1984). As enforceable standards are adopted, monitoring and reporting requirements will be specified by EPA.

In addition to the routine monitoring programs outlined above, special studies are conducted by the field staff of DHR in response to incidents of surface and ground-water contamination. One special study of ground water was undertaken in 1981 by the EPA. Forty-four systems in North Carolina were included in the survey. Follow-up samples were taken in 1982. The presence of volatile organic chemicals other than total trihalomethane was confirmed in three of the supplies.

Research Activities

Although they fall outside the domain of water quality monitoring, several research studies completed within the past two years have focused on the problem of toxic substances in the waters of North Carolina. Turner, DiGiano, and DeRosa (1984) identified those public water supplies in North Carolina that were potentially exposed to chemical contamination by virtue of the fact that they were downstream of at least one waste generator for which a waste discharge permit had been issued. While data of this type are little more than suggestive of the possibility of contamination, it does show that a substantial proportion of the population in North Carolina is exposed to contamination if it exists. Also included in that report were estimates of the quantities of pesticides applied to agricultural lands in each of the major river basins.

Two other studies have been devoted to the development and testing of state-of-the-art analytical chemical techniques for the specific identification of synthetic organic chemicals in water. Dietrich, Millington, and Christman (1983) used gas chromatography/mass spectometry to identify several synthetic organics in Haw River water. Liquid-liquid and resin adsorption methods were used in this study to concentrate samples to levels that were sufficient to detect contaminants in the GC/MS process. A follow-up study is now underway to examine the adequacy of several extraction techniques, to select a comprehensive set of standards for evaluating these methods of analysis, and to optimize the set of parameters used for these investigations (Christman, 1984).

Findings and Recommendations

The State of North Carolina, acting through DEM and DHS, has taken progressive steps to initiate monitoring programs for toxic substances in wastewater and finished drinking water. Data currently available, particularly that obtained from biological monitoring of wastewaters, indicate that the waters of North Carolina are being contaminated by substances that exhibit some forms of toxicity. However, few specific chemicals that cause this toxicity have been identified. EPA policy encourages the use of a combination of biological and chemical methods to address toxic and non-conventional pollutants (Federal Register, March 9, 1984). Specific identification of offending chemicals is necessary before the effective corrective action can be taken. The case of organotin compounds illustrates that fact.

Recommendation 1. The current program of biological monitoring for toxicity should be continued. Expansion is necessary to include a broader range of sources, including nonpoint sources, and to extend coverage to ambient water quality.

Biological monitoring has been demonstrated to be useful in detecting the presence of some forms of toxic substances in water and wastewater. However, it does not provide a satisfactory substitute for firm chemical evidence. The current program in North Carolina does not include a systematic process for the specific identification of synthetic organic chemicals that may be present in surface and ground waters, finished drinking water, or wastewater discharges. Thus, with few exceptions, the evidence of chemical contamination of water in North Carolina is indirect and incomplete; that is, it is based upon biological toxicity in some effluents, the findings of a few research studies in selected waters, and a growing set of national data on the presence of organics in water that may or may not be applicable to North Carolina.

However, it would be unwise to ignore the implications that more specific chemical data are needed. First, the fact that some wastes are toxic to test organisms does not necessarily imply that those substances are toxic to humans or even to other aquatic organisms. Specific chemical information is necessary before inferences about human health can be drawn. Second, many of the substances of concern would not exhibit toxic effects as measured by the biological monitoring program and, thus, would otherwise go undetected. It is well known that health risks associated with known "carcinogens" cannot be demonstrated when test organisms are exposed to the low concentrations of these substances found in the ambient environment. Effects are caused by the cumulative exposure to low doses over long periods of time. Scientific principles for assessing the risks of such exposure have evolved from a long series of expert committees in the 1960s and 70s. In the first volume of Drinking Water and Health (1977), the Safe Drinking Water Committee of the National Academy of Sciences cited a number of these principles as guides to EPA programs affecting water quality. Among other things, the Committee stated that: (1) animal experiments, properly qualified, can be used to make inferences about health effects on humans; and (2) exposure of test animals at high dose rates is a necessary and valid method for discovering carcinogenic hazards to humans. Thus, laboratory experiments on test animals is both necessary and recognized as a scientifically valid method for assessing risks of cancer. It is unlikely that the State of North Carolina would be in the position of undertaking large-scale animal testing programs, but it is feasible for the state to determine the levels to which humans, fish, and wildlife are exposed to such chemicals. Nationally funded research studies can then be used to make valid inferences about health risks.

Recommendation 2. DEM and DHS should implement a systematic monitoring program to specifically identify synthetic organic chemicals in wastewater discharges and in the surface and ground waters of North Carolina. The monitoring network should cover each of the major river basins, with priority given to those segments of streams and ground water aquifers that are used for public drinking water supplies. The program should not be limited to those chemicals that appear in one or more lists of substances prepared by the state and federal governments, but analytical methods should include broad-band techniques capable of detecting a wide range of substances.

Recommendation 3. Whenever toxicity is indicated by biological monitoring, chemical analyses should be used in follow-up investigations until specific substances causing that effect have been identified.

Recommendation 4. Research should be undertaken to improve existing analytical methods and adapt these methods to the physical and chemical characteristics of North Carolina waters.

In the search for chemicals of the type that may find their way into the waters of North Carolina, it is both expensive and inefficient to make independent investigations of all types and sources of chemical contamination. One method for improving the efficiency of search processes is to exploit commonalities among types of activities that generate pollution; similar production and consumption processes may be expected to have some common types of waste products. A second is to exploit information about the precursors and reaction products of specific organic chemicals. For those chemicals that are identified in monitoring processes, it would be useful for investigators to identify their probable precursors and their probable sources. It would also be useful to know what toxic substances could be formed from the specific organic compounds that are identified.

Recommendation 5. As data from monitoring networks are generated, research should be undertaken to identify the most prevalent toxic chemicals in the waters of North Carolina, to identify their primary sources, and to identify their probable precursors and reaction products.

Testing programs for synthetic organic chemicals (SOCs), if carried out at the proper level of precision and accuracy, are too expensive to rely upon as the sole basis for a statewide monitoring program for toxics. Sampling and measurement of water for SOCs requires the use of state-of-the-art analytical chemical procedures and well-trained personnel. Furthermore, it can be characterized as a "needle-in-the-haystack" approach. The most cost-effective method for identifying potentially harmful materials is to require full disclosure of all substances used by chemical processors who discharge to streams and publicly owned waste collection systems. Such an approach raises a number of legal issues pertaining to the "right-to-know" and protection of confidentiality of proprietary information.

Recommendation 6. Research should be undertaken to formulate alternative approaches to implement disclosure of chemical substances used in activities that result in the discharge of waste to publicly owned waste management systems and directly to streams in the state. Legal bases for these approaches should be identified, including any necessary changes to current statutes.

Recommendation 7. Further development of monitoring programs for toxics in the waters of North Carolina should stress a balanced approach. Testing for specific organic chemicals should be included in the program, but it should be used judiciously. Results of biological monitoring and disclosure of chemicals could be used to guide investments in organic testing.

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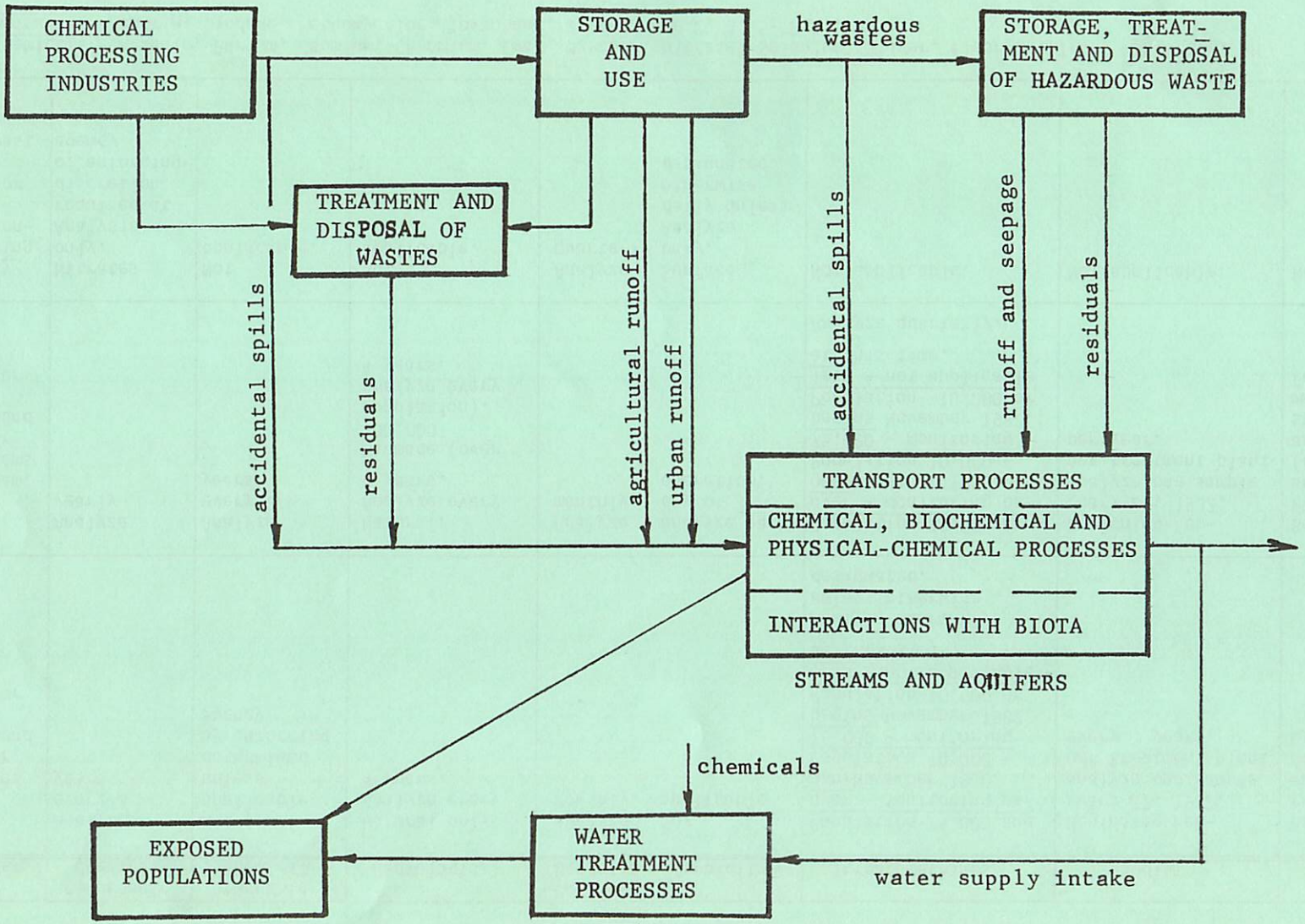
FLOWS OF TOXIC MATERIALS IN THE WATER RESOURCE



MONITORING REQUIREMENTS FOR PUBLIC WATER SUPPLIES IN NORTH CAROLINA

Type of System	*Inorganic Chemical	*Organic Chemical	Radiological	Coliform Bacteria	Turbidity	Trihalomethanes	Sodium	Corrosivity
Community Ground (Well supplies serving 15 or more year-round residential connections or more than 25 residents)	Analyze every 3 years	Not applicable unless determined by enforcing agency	Natural only. Analyze every 4 years.	Analyze monthly.	Not applicable	Population 75,000 and over - monitoring began November 1980. Population 10,000 - 75,000 - monitoring begins November 1982 Population 10,000 or less - not applicable at this time Analyze quarterly unless otherwise designated.	Beginning February 27, 1982, analyze one sample per treatment plant every 3 years.	Beginning February 27, 1982, analyze one sample per treatment plant by February 1983.
Community Surface (River, stream, or lake systems serving 15 or more year-round residential connections or more than 25 year-round residents)	Analyze yearly	Analyze every 3 years	Natural. Analyze every 4 years. Manmade (over 100,000 population). Analyze every 4 years.	Analyze monthly	Analyze each day of operation.	Population 75,000 and over - monitoring began November 1980. Population 10,000 - 75,000 - monitoring begins November 1982. Population 10,000 or less - not applicable at this time. Analyze quarterly.	Beginning February 27, 1982, analyze one sample per treatment plant per year.	Beginning February 27, 1982, analyze two samples (one in mid-winter and one in mid-summer) per treatment plant by February 1983
Non-Community (System serving 15 or more non-residential connections or at least 25 people at least 60 days per year)	Nitrates only. Analysis required at discretion of enforcing agency	Not applicable.	Not applicable.	Analyze quarterly	Surface only. Analyze daily unless otherwise designated.	Not applicable.	Not applicable.	Not applicable.

*Inorganic Chemicals - Arsenic, Barium, Cadmium, Chromium, Lead, Mercury, Nitrate, Selenium, Silver, Fluoride, Iron, Manganese, pH
*Organic Chemicals - Endrin, Lindane, Methoxychlor, Toxaphene, 2, 4-D, and 2, 4, 5-TP Silvex

Source: Division of Health Services, Department of Human Resources.

Pearsons Falls, Polk County. Photo by David H. Howells.
The NEWS encourages readers to submit photos of North Carolina Water Scenes, either scenic shots or pertaining to a particular water issue. The pictures should be black and white, either 8 x 10 or 5 x 7.

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