Publications Related to Water Resources Research Center Projects, 1965-71

ABSTRACT — INDEX

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WATER RESOURCES RESEARCH CENTER
UNIVERSITY OF MINNESOTA
GRADUATE SCHOOL

CONTENTS

FOREWORD

This Bulletin is published in furtherance of the purposes of the Water Resources Research Act of 1964. The purpose of the Act is to stimulate, sponsor, provide for, and supplement present programs for the conduct of research, investigations, experiments, and the training of scientists in the field of water and resources which affect water. The Act is promoting a more adequate national program of water resources research by furnishing financial assistance to non-federal research.

The Act provides for establishment of Water Resources Research Institutes or Centers at Universities throughout the Nation. On September 1, 1964, a Water Resources Research Center was established in the Graduate School as an interdisciplinary component of the University of Minnesota. The Center has the responsibility for unifying and stimulating University water resources research through the administration of funds covered in the Act and made available by other sources; coordinating University research with water resources programs of local, State and Federal agencies and private organizations throughout the State; and assisting in training additional scientists for work in the field of water resources through research.

This Bulletin is number 32 in a series of publications designed to present information bearing on water resources research in Minnesota and the results of some of the research sponsored by the Center. Information concerning publications related to Center projects 1965-71 is provided in this Bulletin.

INTRODUCTION

During the period 1965-71, the Water Resources Research Center, University of Minnesota through the Office of Water Resources Research, U.S. Department of the Interior has funded 38 research projects. Fifty-four technical reports, papers and theses have been published describing the results of these research projects. The Center alone has published and widely distributed more than 22,000 copies of 30 Bulletins concerning research results. In addition, upon request, the Center regularly distributes about 135 copies of its publications per month to research users throughout Minnesota and the Nation.

Despite these substantial information dissemination efforts, the Center questions whether its research project results have been as widely disseminated as they should and whether the findings have been put to full practical use. The purpose of this Bulletin is to improve the information dissemination program of the Center by making information concerning its research project publications more readily available to research users. Hopefully, this Bulletin will improve communication between researchers and research users.

Information concerning 54 publications related to Center research projects conducted during the period 1965-71 are summarized in this Bulletin. Data on Project Number, Project Title, Principal Investigator, Period of Investigation, FCST Research Category, Publication Short Title, Publication Abstract, Publication Authors, Publication Title, Publication Source, Publication Corporate Authors, Publication Descriptors, Publication Identifiers and Publication Availability are presented. Additional information concerning research projects is contained in the publication "Information Concerning Water Resources Research Center Projects, 1965-1970", Bulletin 19, Water Resources Research Center, 1970.

Information concerning the Center's publications and projects is also provided by the Water Resources Scientific Information Center. The Water Resources Scientific Information Center (WRSIC) traces its origin to the Water Resources Research Act of 1964 which created the Office of Water Resources Research (OWRR). The Center was formally established by the Secretary of the Interior on January 25, 1966. In December of that year the Federal Council for Science and Technology designated WRSIC as the national center for scientific and technological information in water resources.

WRSIC seeks to disseminate scientific and technical information to the national water resources community through: abstracting journal, published indexes, catalogs of active research projects, topical bibliographies, state-of-the-art reviews, and retrospective searching of information base. The guiding principal is the use of existing research resources and competencies of Federal agencies, Universities, and other organizations, including the major information and documentation services, as sources of processed information. All input is made machine-readable for the continuing job of searching, retrieval, and composition by computer, as well as to permit taking advantage of the advances in information handling, and toward integration into evolving national systems for information transfer. Input from published literature is derived from

three principal sources: Universities with active research programs in water resources, either through direct arrangement with OWRR or indirectly through other Interior agencies supporting university research; State water resources research institutes, and contractors and grantees of OWRR reporting on supported research projects; and Federal agencies with water-related research programs, through exchange agreements with OWRR. A directory of these sources appears in each issue of Selected Water Resources Abstracts. Input on current research is collected from principal investigators by: Science Information Exchange, Smithsonian Institution, which assembles data on active research projects.

Publications of WRSIC are:

Selected Water Resources Abstracts - Published twice a month; each issue has an ABSTRACT section (500 abstracts average), SUBJECT INDEX, AUTHOR INDEX, ORGANIZATIONAL INDEX, AND ACCESSION NUMBER INDEX: Official use subscriptions available to Federal agencies and their grantees in water resources, on application to the Manager; and Paid subscriptions available at $22 a year ($27.50 foreign mailing) from the Clearinghouse for Federal Scientific and Technical Information, Springfield, Virginia 22151.

Selected Water Resources Abstracts - Published once a year, in January; cumulative indexes from semimonthly issues; and supplied automatically as part of subscription to Selected Water Resources Abstracts.

Water Resources Research Catalog - Compiled annually through an arrangement with Science Information Exchange, Smithsonian Institution; Lists active research projects on file at SIE; Available from Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402; andPrice varies from year to year.

Research Reports supported by Office of Water Resources Research under the Water Resources Research Act of 1964 - Issued quarterly on fiscal year basis and intended primarily for individuals and organizations directly associated with OWRR programs.

Selected Urban Storm Water Runoff Abstracts - Permuted Title Index to Water Research Journals 1967 - A Selected Annotated Bibliography of the Analysis of Water Resource Systems - Topical bibliographies, special indexes, state-of-the-art reviews; Published irregularly as demands and needs dictate; and apply to Manager for titles published and availability.

Services of WRSIC are:

Processing inquiries on existence, location, and availability of documents in the field of water resources; computer-searching of information base on any one, combination of several, or all data elements making up the abstract records, upon negotiated agreement with Federal agencies and their grantees in water resources; and supporting studies towards compatibility and convertibility standards in information processing, and identifying and meeting the current and changing needs of users for information.

Additional information concerning WRSIC can be obtained from:

Manager
Water Resources Scientific Information Center
Office of Water Resources Research
Department of the Interior
Washington, D.C. 20240

Telephone (202) 343-8435

Abstracts of Center publications are shortened versions containing or referring to essential parts of the original publications. Other terms more or less synonymous are extract, synopsis, summary, digest, and condensation. Because of its abbreviated content, an abstract cannot contain all the information given in the complete publication; however, it can provide the reader with useful information and with a means of determining whether the complete document should be obtained for study. Informative abstracts are provided. An informative abstract is one that contains the essential facts reported in a publication, including conclusions or recommendations. It may satisfy the information needs of the reader without his having to see the complete publication.

Indexing publications in depth provides multiple access to the publication from many subject-matter points or concepts. Descriptors are provided to index Center project related publications. All descriptors listed are contained in the "Water Resources Thesaurus - A Vocabulary for Indexing and Retrieving the Literature of Water Resources Research and Development," developed by the U.S. Department of the Interior, Office of Water Resources Research, Washington, D.C., November 1966.

The Thesaurus is a listing of terms selected to represent all facets of the water-resources field. Broader and narrower terms are given in hierarchical schemes. For easier indexing, related terms are given to suggest to the indexer other descriptors that may be applicable to the publication being indexed. Other descriptors that may be applicable to the publication being indexed. Other terms not listed in the Thesaurus as descriptors may be found with a "use" reference indicating a substitute approved term.

All descriptors used in indexing a publication are not of equal importance in representing the contents. Asterisks are used to designate the three most important descriptors.

The Thesaurus was compiled to include as many terms as were thought to represent that field at the time. One should recognize inadvertent omissions are impossible to avoid and that new terms are being coined constantly, thereby working toward incompleteness. Thus, useful indexing terms not included in the Thesaurus may be needed and are listed as identifiers.

The Thesaurus is for sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402 - Price $2.00, and was prepared to improve communications and facilitate storage, dissemination, and retrieval of scientific and technical information on water resources. A reference copy of the Thesaurus is available at Water Resources Research Center, Univ. of Minn., Room 107 Hubbard Building, 2675 University Ave., St. Paul, Minnesota 55114 (646-6309).

In publication descriptions, research efforts in the 10 water resources research categories used by the Committee on Water Resources Research, Federal Council for Science and Technology (FCST) are identified to provide information on the nature of research projects. FCST Research Categories are listed below:

FCST Research Categories

I. Nature of Water

Category I deals with fundamental research on the water substance.

A. Properties of water
Study of the physical and chemical properties of pure water and its thermodynamic behavior in various states.

B. Aqueous solutions and suspensions
Study of the effects of various solutes on the properties of water; surface interactions; colloidal suspensions.

II. Water Cycle

A. General
Studies involving two or more phases of the water cycle such as hydrologic models; rainfall-runoff relations; surface and ground-water relationships; watershed studies, etc.

B. Precipitation
Investigation of spatial and temporal variations of precipitation; physiographic effects; time trends; extremes; probable maximum precipitation; structure of storms, etc.

C. Snow, ice, and frost
Studies of the occurrence and thermodynamics of water in the solid state in nature; spatial variations of snow and frost; formation of ice and frost; breakup of river and lake ice; glaciers, permafrost, etc.

D. Evaporation and transpiration
Investigation of the process of evaporation from lakes, soil, and snow and of the transpiration process in plants; methods of estimating actual evapotranspiration; energy balance; etc.

E. Streamflow
Mechanics of flow in streams; flood routing; bank storage; space and time variations (includes high- & low-flow frequency); droughts; floods; etc.

F. Groundwater
Study of the mechanics of groundwater movement; multiphase systems; sources of natural recharge; mechanics of flow to wells and drains; subsidence; properties of aquifers; etc.

G. Water in soils
Infiltration, movement, and storage of water in the zone of aeration, including soil.

H. Lakes
Hydrologic, hydrochemical, and thermal regimes of lakes; water level fluctuations; currents and waves.

I. Water and plants
Role of plants in hydrologic cycle; water requirements of plants; interception.

J. Erosion and sedimentation
Studies of the erosion process; prediction of sediment yield; sedimentation in lakes and reservoirs; stream erosion; sediment transports, etc.

K. Chemical processes
Chemical interactions between water and its natural environment; chemistry of precipitation.

L. Estuarine problems
Special problems of the estuarine environment; effects of tides on flow and stage; deposition of sediment; sea water intrusion in estuaries.

III. Water Supply Augmentation and Conservation

As water use increases we must pay increasing attention to methods for augmenting and conserving available supplies. Research in category III is largely applied research devoted to this problem area.

A. Saline water conversion
Research and development related to methods of desalting sea water and brackish water.

B. Water yield improvement
Increasing streamflow or improving its distribution through land management; water harvesting from impervious areas; phreatophyte control; reservoir evaporation suppression.

C. Use of water of impaired quality
Research on methods of agricultural use of water of high salinity; use of poor quality water in industry, crop tolerance to salinity.

D. Conservation in domestic use
Methods for reducing domestic water needs without impairment of service.

E. Conservation in industry
Reduction in both consumption and diversion requirements for industry.

F. Conservation in agriculture
More efficient irrigation practices. Chemical control of evaporation and transpiration; lower water use plants; etc.

IV. Water Quality Management and Control

Category IV includes research directed to the management of water exclusive of conservation, and the effects of related activities on water.

A. Control of water on the land
Effects of land management on runoff; land drainage; potholes; etc.

B. Groundwater management
Artificial recharge; conjunctive operation; relation to irrigation.

C. Effects of man's related activities on water
Impact of urbanization, highways, logging, etc., on water-yields and flow rates.

D. Watershed protection
Methods of controlling erosion to reduce sediment load of streams and conserve soil.

V. Water Quality Management and Protection

An increasing population increases the wastes and other pollutants entering our water supplies. Category V deals with methods of identifying, describing, and controlling this pollution.

A. Identification of pollutants
Techniques of identification of physical, chemical, and biologic pollutants; rational measures of character and strength of wastes.

B. Sources of pollution
Determination of the sources of pollutants in water; the nature of the pollution from various sources; path of pollutants from sources to stream or ground water.

C. Effects of pollution
Definition of the effect of pollutants, singly and in combinations, on man, aquatic life, agriculture, and industry under conditions of sustained use; eutrophication.

D. Waste treatment processes
Research to improve conventional treatment methods to gain efficiency or reduce cost; processes to treat new types of waste; advanced treatment methods for more complete removal of pollutants including purification for direct reuse.

E. Ultimate disposal of wastes
Disposal of residual material removed from water and sewage during the treatment process; disposal of waste brines.

F. Water treatment
Development of more efficient economical methods of making water suitable for domestic or industrial use.

G. Water quality control
Research on methods to control steam and reservoir water quality such as flow augmentation; stream and reservoir aeration; control of natural pollution; control of pollution from pesticides and agricultural chemicals; control of acid mine drainage; etc.

VI. Water Resources Planning

The problems of achieving an optimal plan of water development are becoming increasingly complex. Category VI covers research devoted to determining the best way to plan, the appropriate criteria for planning and the nature of the economic, legal and institutional aspects of the planning process.

A. Techniques of planning
Application of systems analysis to project planning; treatment of uncertainty; probability studies.

B. Evaluation process
Development of methods, concepts, and criteria for evaluating project benefits; discount rate; project life; methods for economic, social and technological projections; reliability of projections; research on the value of water in various uses.

C. Cost allocation, cost sharing, pricing, and repayment
Research on methods of calculating repayment and establishing prices for vendible products; techniques of cost allocation; cost sharing; pricing and repayment policy.

D. Water demand
Research on the water quantity and quality requirements of various uses, both diversion and consumption.

E. Water Law
A study of State and Federal water law looking to changes and additions which will encourage greater efficiency in use, investigation of institutional structures and constraints which influence decisions on water at all levels of government.

F. Nonstructural alternatives
Exploration of methods to achieve water development aims by nonstructural methods such as flood plain zoning.

G. Ecologic impact of water development
Effects of water management operations on the overall ecology of the area. Excludes effect of pollution under V.C.

VII. Resources Data

Planning and management of our water resources require information. Category VII includes research oriented data needs and the most efficient methods of meeting these needs.

A. Network design
Studies of data requirements and of the most effective methods of collecting the data.

B. Data acquisition
Research on new and improved instruments and techniques for collection of water resources data; telemetering equipment.

C. Evaluation, processing, and publication
Studies of effective methods of processing data; form and nature of published data; maps of data.

VIII. Engineering Works

To implement water development plans requires engineering works. Category VIII describes research on design, materials, and construction which is generally useful to all aspects of water management. Works relevant to a single specific goal, such as water treatment or desalination, are included elsewhere if an appropriate category exists.

A. Design
Research leading to improved design of dams, canals, pipelines, locks, fishways, and other works required for water resources development.

B. Materials
Research to improve existing structural materials and to develop new materials; subsurface exploration of foundations; corrosion; etc.

C. Construction and operation
Research on efficient constructions methods, operating systems, and maintenance procedures.

IX. Manpower, Grants and Facilities

Trained manpower is an essential ingredient of research on water resources and the planning and design of water development projects. Category IX describes plans for support of education and training. It also includes grant and contract programs for which advance distribution to specific categories is impossible.

A. Education-extramural
Support of education in water resources at universities (not including research support under other categories).

B. Education - in-home
Government employee training programs.

C. Research facilities
Laboratories, field stations, etc.

D. Grants, contracts, and research act allotments
Allotments to university water resources research institutes under Public Law 88-379, OWRR, HEW, NSF, CSRS and other grants which cannot be distributed to categories in advance.

X. Scientific and Technical Information

Development of adequate procedures for storing, locating, and exchanging scientific and technical information is vital to the success of a research program. Category X includes efforts directed toward the planning and performance of the functions involved in acquiring, processing, and communicating scientific and technical information. The category does not include data acquisition or the handling of unprocessed data.

A. Publication
Includes reproduction and distribution of recorded scientific and technical information.

B. Bibliographic Services
Acquisition, abstracting, translating, and other services associated with storage and retrieval of scientific information.

C. Direct Communication
Support of technical meetings, symposiums, and other forums for oral exchange of scientific information.

D. Research and Development in Information Science
Research on new methods, techniques, and systems for improving scientific and technical information services in the areas of water management and water research.

INFORMATION CONCERNING PUBLICATIONS

ANNUAL ALLOTMENT PROJECTS

OWRR Project No.: A-001-Minn.

Project Title: The Effect of Pothole Drainage Upon Groundwater Resources

Principal Investigator: P.W. Manson, Univ. of Minn., Department of Agricultural Engineering

Project Began: May 15, 1965 Project Ended: June 30, 1968

FCST Research Category: IV-A

Publication Short Title: Hydrology of Potholes - Minnesota

Publication Abstract:

About 46 small lakes, potholes and ponds were studied in an area extending from Mankato on the south to Detroit Lakes on the northwest. Water levels and ice levels were measured during the period 1962-65. Based on hydrologic data, the average seepage loss through the beds of the small bodies of water is 1.17 feet per year. The main controlling factor in the level of the water in ponds is the relation between precipitation and evaporation. The permeability of the soil and glacial drift adjacent to a small lake or pond is usually much greater than that of the bed. From field and laboratory studies, the movement of water in and around potholes was correlated with shallow and deep groundwater bodies. It is concluded that the best way to conserve water for groundwater supplies is to induce infiltration over the land surface rather than to store water in open ponds where evaporation causes it to be lost to the atmosphere.

Publication Authors: Manson, P.W. Schwartz, G.M., and Allred, E.R.

Publication Title: Some Aspects of the Hydrology of Ponds and Small Lakes

Publication Source: Univ. of Minn., Agricultural Experiment Station, Tech. Bull. 257, 1968. 88 p., 55 fig., 40 tab., 14 ref.

Publication Corporate Author: Univ. of Minn., St. Paul

Publication Descriptors: / *potholes/ *seepage/ *groundwater/ water-table/ precipitation/ evaporation/ Minnesota/ hydrology/ ice/ rain gage/ sediments/ soils/ glacial deposits/ topography/ snowmelt

Publication Identifiers: / *small lakes/ *test holes/ *water level gages

Publication Availability:

Refererence copy at Water Resources Research Center, Univ. of Minn., Room 107 Hubbard Building, 2675 University Ave., St. Paul, Minnesota 55114 (646-6309). Limited number of free copies available at Agricultural Experiment Station, Univ. of Minn., 220 Coffey Hall, St. Paul, Minnesota 55101 (373-0751).

OWRR Project No.: A-004-Minn.

Project Title: Factors Influencing Soil Freezing in Forest and the Importance of Their Effect on Runoff

Principal Investigator: D.M. Thorud, Univ. of Minn., School of Forestry

Project Began: May 15, 1965 Project Ended: June 30, 1967

FCST Research Category: IV-A

Publication Short Title: Freezing in Forest Soil - Minnesota

Publication Abstract:

Laboratory experiments involving freezing small artificially prepared soil solumns were conducted to obtain knowledge concerning the forest-associated variables that control soil freezing. Specific evaluations included loamy sand and silt loam soil types, compacted and uncompacted loamy sand, oak, red pine, and white pine litter in both air-dry and moist states, and shallow snow layers accumulated naturally on both bare soil (loam) surfaces and on a red pine litter surface. Soil texture variations have much less influence on frost penetration and therefore surface runoff than forest litter variations. The rate of frost penetration can be ranked from the most rapid to the slowest as follows: bare - oak - red pine - white pine. Forest litter and snow cover appreciably affect soil freezing in that the litter and snow act as insulators.

Publication Authors: Thorud, D.M. and Anderson, D.A.

Publication Title: Freezing in Forest Soil as Influenced by Soil Properties, Litter and Snow

Publication Source: Univ. of Minn., Water Resources Research Center, Bull. 10, 1969. 41 p., 20 fig., 16 tab., 19 ref.

Publication Corporate Author: Univ. of Minn.

Publication Descriptors: / *Frozen soils/ *forests/ *runoff/ snow cover/ Minnesota/ soil types/ soil monoliths/ soil moisture/ vapor pressure/ field capacity/ soil density/ thermal conductivity/ organic matter

Publication Identifiers: / *forest litter/ *litter moisture/ *freezing experiment/ freezer/ ambient temperature/ insulators

Publication Availability:

Free copies available at Water Resources Research Center, Univ. of Minn., Room 107 Hubbard Building, 2675 University Ave., St. Paul, Minnesota 55114 (646-6309).

OWRR Project No.: A-006-Minn.

Project Title: Water Adsorption and Its Interactions with Clay and Quartz

Principal Investigator: G.R. Blake, University of Minn., Department of Soil Science

Project Began: May 15, 1965 Project Ended: June 30, 1968

FCST Research Category: II-G

Publication Short Title: Porosity and Pore-Size of Soils - Minnesota

Publication Abstract:

Differences in aggregate porosity due to soil type, aggregate size and cultivation condition were investigated using samples from 6 Minnesota soils. Porosity characteristics were determined by the glassbead displacement and thin section methods and with Hg-porosimeter measurements. Aggregate porosity was higher in soils developed on loess and lower in those on till. Porosities ranged from 0.253 to 0.497. Aggregate porosity of virgin soil was higher than that of cultivated soil. Specific pore volume of pores of diameters 0.012 to 17μ ranged from 0.124 to 0.272 cc/g. Over 90% of the specific pore volume was contributed by pores of diameter greater than 0.2μ. The proportion of intraaggregate porosity to the total porosity was found to be about 0.30 for cultivated soils and 0.30 to 0.40 for virgin soils.

Publication Author: Lin, Shen-maw

Publication Title: Porosity and Pore-Size Distribution of Soil Aggregates

Publication Source: Univ. of Minn., Water Resources Research Center, Bull. 29, 1971. 32 p., 6 fig., 8 tab., 43 ref.

Publication Corporate Author: Univ. of Minn., St. Paul

Publication Descriptors: / *porosity/ *soil types/ *pores/ aggregate/ Minnesota/ cultivated lands/ miscroscopic/ bulk density/ voids/ sand/ clay/ silt/ loess/ glacial drift

Publication Identifiers: / *pore-size distribution/ *glassbead displacement/ *Hg-porosimetry/ intraaggregate/ interaggregate/ thin sectioning

Publication Availability:

Free copies available at Water Resources Research Center, Univ. of Minn., Room 107 Hubbard Building, 2675 University Ave., St. Paul, Minnesota 55114 (646-6309).

OWRR Project No.: A-007-Minn.

Project Title: Studies on the Use of Planktonic Desmids as Indicators of the Trophic Status and Water Quality of Freshwater Lakes

Principal Investigator: A.J. Brook, Univ. of Minn., Department of Ecology and Behavioral Biology

Project Began: May 15, 1965 Project Ended: June 30, 1967

FCST Research Category: V-A

Publication Short Title: Desmids of Minnesota Lakes

Publication Abstract:

Desmids (green algae) may prove to be valuable as indicators of the trophic status of lakes in Minnesota. Plankton collections were made from 150 lakes in different parts of the State; the lakes sampled being representative of a wide spectrum of chemical and overenrichment types. These range from the lakes in the northeast which are low in fertility to the artificially enriched lakes in the southwest. In the analysis of these collections, compound phytoplankton quotients were determined for each lake. Comparison of the quotients gives an indication of the relative fertility of the lakes. The algae studied indirectly or directly are sensitive to pollution, therefore, desmids may serve as useful indicators of eutrophication.

Publication Author: Brook, A.J.

Publication Title: The Phytoplankton of Minnesota Lakes

Publication Source: Univ. of Minn., Department of Ecology and Behavioral Biology, 1968. 13 p.

Publication Corporate Author: Univ. of Minn. Minneapolis

Publication Descriptors: / *phytoplankton/ *eutrophication/ *oligotrophy/ Minnesota/ lakes/ glacial drift/ nutrients/ salinity/ algae/ diatoms/ limnology/ pollution/ zooplankton

Publication Identifiers: / *desmids/ *euplankton/ *limnoplankton/ marl/ eutrophic

Publication Availability:

Reference copy at Water Resources Research Center, Univ. of Minn., Room 107 Hubbard Building, 2675 University Ave., St. Paul, Minnesota 55114 (646-6309). Reference copy at Department of Ecology and Behavioral Biology, Univ. of Minn., 349 Bell Museum of Natural History, Minneapolis, Minnesota 55455 (373-5177).

OWRR Project No.: A-008-Minn.

Project Title: Water Quality, Organic Productivity, and the Distribution of Organisms in Minnesota Lakes

Principal Investigator: H.E. Wright, Univ. of Minn., Limnological Research Center

Project Began: May 15, 1965 Project Ended: June 30, 1967

FCST Research Category: V-B

Publication Short Title: Primary Productivity of Minnesota Lakes

Publication Abstract:

A mobile water chemistry laboratory was outfitted to permit water samples to be analyzed at lakeside before nutrient concentrations are altered by biological activity. It also provides facilities for measuring the growths rates of algae and determining the fertility of lake waters. The oxygen light-dark-bottle method was used to compare the algal productivity of 14 lakes in different parts of Minnesota. The carbonate saturometer was used to determine the degree of calcium carbonate saturation at different times of the year and at various depths in the lakes. The epilimnign of lakes in regions with calcareous drift is oversaturated with calcium carbonate and the hypolimnion is undersaturated. Water at all depths is undersaturated in winter but oversaturated in spring. The rate of calcium depletion is highest in lakes with the highest rate of photosynthetic carbon uptake by algae. There is a correlation between gross photosynthesis and the quantity of plant pigments preserved in surficial lakes sediments. Mean gross productivity of lakes ranged from 0.37 $gC/m^2/dy$ in Kandiyohi lake to 2.42$gC/m^2/dy$ in Sallie Lake.

Publication Author: Megard, R.O.

Publication Title: Limnology, Primary Productivity, and Carbonate Sedimentation of Minnesota Lakes

Publication Source: Univ. of Minn., Limnological Research Center, Interim Rept. No. 1, 1967. 69 p., 25 fig., 11 tab., 7 ref.

Publication Corporate Author: Univ. of Minn., Minneapolis

Publication Descriptors: / *primary productivity/ *lakes/ *photosynthesis/ limnology/ Minnesota/ plant pigments/ algae/ sediments/ organic vegetation/ epilimnion/ hypolimnion

Publication Identifiers: / *oxygen light-and-dark-bottle method/ *carbonate saturometer/ *mobile limnological laboratory/ oxygen concentration

Publication Availability:

Reference copy at Water Resources Research Center, Univ. of Minn., Room 107 Hubbard Building, 2675 University Ave., St. Paul, Minnesota 55114 (646-6309). Limited number of free copies available at Limnological Research Center, Univ. of Minn., 207a Pillsbury Hall, Minneapolis, Minnesota 55455 (373-4508).

Publication Short Title: Plankton and Calcium Carbonate in Lakes - Minnesota

Publication Abstract:

The environment of carbonate sedimentation in lakes Itasca, Long, Elk, Mary, Sallie and Francis in Minnesota were studied with particular emphasis on the relations between planktonic photosynthesis and calcium carbonate precipitation. The primary productivity of the lakes was measured by use of oxygen light-and-dark-bottle experiments. Carbonate saturation appears to be controlled by the balance between carbon dioxide assimilation by planktonic photosynthesis and carbon dioxide release by respiration. The seasonal changes of calcium concentrations are balanced by chemically equivalent alkalinity changes, but magnesium concentrations do not fluctuate. The daily rates of calcium depletion are directly proportional to the mean daily rates of planktonic carbon assimilation. The molar ratios of calcium depletion to net carbon assimilation are 0.25 in 4 of the 6 lakes, and the ratios in 2 lakes are 0.1 and 0.4.

Publication Author: Megard, R.O.

Publication Title: Planktonic Photosynthesis and the Environment of Calcium Carbonate Deposition in Lakes

Publication Source: Univ. of Minn., Limnological Research Center, Interim Rept. No. 2, 1968. 47 p., 6 fig., 6 tab., 33 ref.

Publication Corporate Author: Univ. of Minn., Minneapolis

Publication Descriptors: / *Lakes/ *calcium carbonate/ *photosynthesis/ plankton/ Minnesota/ phytoplankton/ primary productivity/ respiration/ ions/ limnology/ alkalinity/ organisms/ littoral/ sediments/ aquatic plants

Publication Identifiers: / *carbonate sedimentation/ *oxygen light-dark-bottle method/ *carbonate saturometer/ carbonate precipitation

Publication Availability:

Reference copy at Water Resources Research Center, Univ. of Minn., Room 107 Hubbard Building, 2675 University Ave., St. Paul, Minnesota 55114 (646-6309). Limited number of free copies available at Limnological Research Center, Univ. of Minn., 207a Pillsbury Hall, Minneapolis, Minnesota 55455 (373-4508).

OWRR Project No.: A-009-Minn.

Project Title: Groundwater Contribution to Streamflow and Its Relation to Hydrogeologic Basin Characteristics and Recharge Rates to Aquifers in Minnesota

Principal Investigator: E.A. Ackroyd, Univ. of Minn., Minnesota Geological Survey

Project Began: July 1, 1965 Project Ended: June 30, 1966

FCST Research Category: IV-B

Publication Short Title: Groundwater Contribution to Streamflow-Minnesota

Publication Abstract:

Annual groundwater contributions to streamflow from 38 drainage basins in Minnesota were estimated by use of standard streamflow hydrograph separation methods. The general characteristics of the drainage basins were determined from published reports and maps. Relations between groundwater runoffs and basin characteristics such as geologic environment, precipitation and temperature, and percentage of lake and wetland cover were determined by statistical analysis. Groundwater runoff is least from glaciated basins with surface lakebed sediments or gray drift ground moraine immediately underlain by relatively impermeable bedrock. Groundwater runoff is greatest from glaciated basins with surface sand and gravel deposits immediately underlain by relatively impermeable bedrock and glaciated basins with thick surface loess deposits immediately underlain by permeable bedrock. In northern parts of the State annual groundwater runoff is greatly affected by the degree of lake and wetland cover. Lakes and wetlands act as natural reservoirs which sustain and regulate streamflow during rainless periods. Because many aquifers in Minnesota are deeply buried not all groundwater runoff can be diverted into cones of depression.

Publication Authors: Ackroyd, E.A., Walton, W.C. and Hills, D.L.

Publication Title: Ground-Water Contribution to Streamflow and its Relation to Basin Characteristics in Minnesota

Publication Source: Univ. of Minn., Minnesota Geological Survey Rept. of Investigations 6, 1967. 36 p., 13 fig., 6 tab., 17 ref.

Publication Corporate Author: Univ. of Minn., St. Paul

Publication Descriptors: / *Streamflow/ *geohydrologic units/ *hydrograph analysis/ aquifers/ Minnesota/ lake beds/ sediments/ glacial drift/ climate/ forests/ bedrock/ runoff/ evapotranspiration/ groundwater recharge/ groundwater/ wetlands/ lakes basins

Publication Identifiers: / *Groundwater runoff/ *flow-duration curve/ *geologic environment/ basin characteristics/ groundwater storage

Publication Availability:

Free copies available at Minnesota Geological Survey, 1633 Eustis, St. Paul, Minnesota 55101 (373-3372).

OWRR Project No.: A-010-Minn.

Project Title: Analysis of Factors Affecting Aquifer Test Results Under Induced Streambed Infiltration Conditions with Electric Analog Computers

Principal Investigator: W.C. Walton, Univ. of Minn., Graduate School

Project Began: May 15, 1965 Project Ended: June 30, 1966

FCST Research Category: II-F

Publication Short Title: Water Levels in Wells near Streams

Publication Abstract:

Electric analog computers were used to appraise the accuracy of estimated effects of streambed induced infiltration on ground water levels based on the image-well theory. Electric analog computers for two aquifer test sites for which field data are available were constructed. The analog computers consist of analog models and excitation-response apparatus. The analog models are regular arrays of resistors and capacitors and are scaled-down versions of aquifer stream situations. The excitation-response apparatus consists of a power supply, waveform generator, pulse generator and an oscilloscope. It is concluded that, during induced infiltration aquifer tests, the image-well theory closely describes drawdowns on the land sides of streams with a high degree of accuracy whether the cone of depression spreads beneath and beyond or only part way beneath the streambed. Drawdowns beneath or beyond the streambed and the streambed areas of infiltration based on the image-well theory are not those which are observed in the field. However, the streambed infiltration rates per foot of head loss based on hypothetical drawdowns beneath streambeds and streambed areas of infiltration computed with the image-well theory seem to be empirically correct.

Publication Authors: Walton, W.C. and Ackroyd, E.A.

Publication Title: Effects of Induced Streambed Infiltration on Water Levels in Wells during Aquifer Tests

Publication Source: Univ. of Minn., Water Resources Research Center, Bull. 2, 1966. 43 p., 21 fig., 4 tab., 25 ref.

Publication Corporate Author: Univ. of Minn., St. Paul

Publication Descriptors: / *induced infiltration/ *aquifers/ *water levels/ streambed/ Ohio/ Illinois/ groundwater/ recharge/ analog models/ drawdown/ glacial drift/ hydrology/ hydrogeology/ aquifer characteristics/ pumping/ scaling/ mathematical models

Publication Identifiers: / *aquifer-stream relation/ *cone of depression/ *recharge boundary/ aquifer test/ electric analog computer/ image-well theory

Publication Availability:

Free copies available at Water Resources Research Center, Univ. of Minn., Room 107 Hubbard Building, 2675 University Ave., St. Paul, Minnesota 55114 (646-6309).

OWRR Project No.: A-011-Minn.

Project Title: A Study of the Open Water Distribution and Abundance of of Net Plankton as an Index of Eutrophication in Lake Superior

Principal Investigator: T.A. Olson, Univ. of Minn., School of Public Health

Project Began: May 15, 1965 Project Ended: June 30, 1969

FCST Research Category: V-C

Publication Short Title: Second Trophic Level - Lakes Superior, Michigan and Huron

Publication Abstract:

A series of lake-long transect tows were made with the Continuous Plankton Recorder in Lakes Superior, Michigan and Huron, 1966-68. All tows were made at ten meters depth with either #60 mesh Grit Gauze or #15 mesh Silk Bolting cloth. Information was obtained on organism distribution in both space and time. The density and distribution of ecologically related groups in plankton indicate the relative tropic status of the bodies of water sampled. Lake Superior is the most oligotrophic, Lake Huron the most eutrophic and Lake Michigan more mesotrophic. A mean of 200 to 300 organisms per section was seen in Lake Superior; a range of 5,000 to 6,000 organisms per section was seen in Lake Michigan and from 20,000 to 21,000 organisms were observed from one year to another and from one season to another. Marked variations in both numbers and species of organisms were evident in the lakes. Limitations of the Continuous Plankton Recorder method are described.

Publication Authors: Swain, W.R., Olson, T.A. and Odlaug, T.O.

Publication Title: The Ecology of the Second Trophic Level in Lakes Superior, Michigan and Huron

Publication Source: Univ. of Minn., Water Resources Research Center, Bull. 26, 1970. 151 p., 91 fig., 43 tab., 85 ref.

Publication Corporate Author: Univ. of Minn., St. Paul

Publication Descriptors: / *tropic level/ *Lakes Superior, Michigan and Huron/ *plankton/ ecology/ zooplankton/ eutrophication/ pollution/ organisms/ aquatic environment/ limnology/ vertical migration/ biogeography/ phytoplankton/ crustaceans

Publication Identifiers: / *continuous plankton recorder/ *multi-depth plankton indicator/ *tow-net technique/ grit gauze/ silk bolting cloth

Publication Availability:

Free copies available at Water Resources Research Center, Univ. of Minn., Room 107 Hubbard Building, 2675 University Ave., St. Paul, Minnesota 55114 (646-6309).

Publication Short Title: Continuous Plankton Recorder

Publication Abstract:

The literature concerning the Continuous Plankton Recorder (C.P.R.) is reviewed. This review is in the form of extended abstracts supplimented selected figures and graphs. The CPR can be towed behind a commercial vessel proceeding at normal speed. Organisms of the plankton assemblage are swept into the mouth of the sampler and then are carried back to a point where a slowly moving bolting cloth band crosses the water tunnel. The band, which forms a complete barier at this point is supported at the back by a coarse grid. It strains out the organisms as it unrolls from the supply spool and is carried across the tunnel to the take-up roller. When the bolting cloth band passes through the exit slot it meets another similar band of fresh bolting cloth which covers its exposed surface and prevents the escape or loss of organisms which have accumulated. The two layers of the band, compressed at each edge by special rollers, and with the plankton catch sandwiched between them, are next fed to the storage or "take-up" roller which is submerged in a preservative formalin bath. Later, in the laboratory, the bands can be unrolled on a special stage and examined under a microscope. Since the towing path and speed are known and the rate of tape advance within the sampler is also known, specific portions of the bolting cloth surface can be associated with definite lake areas and a mile by mile estimation of the net-plankton distribution is possible. The use of the recorder has been limited almost entirely to the marine environment but the same technique should be readily applicable to studies of the organisms comprising the second trophic level in fresh water. It would appear, therefore, that the Continuous Plankton Recorder will be a useful fool for ecological studies in the Great Lakes.

Publication Authors: Olson, T.A., Odlaug, T.O. and Swain, W.R.

Publication Title: The Continuous Plankton Recorder - A Review of the Literature

Publication Source: Univ. of Minn., Water Resources Research Center, Bull. 3, 1966. 221 p.

Publication Corporate Author: Univ. of Minn., St. Paul

Publication Descriptors: / *plankton/ *tropic level/ *marine microorganisms/ phytoplankton/ zooplankton/ crustaceans/ diatoms/ larvae/ nets

Publication Identifiers: / *Continuous Plankton Recorder/ *silk bolting cloth/ *grit gauze/ tow-net technique/ biogeographic

Publication Availability:

Free copies available at Water Resources Research Center, Univ. of Minn., Room 107 Hubbard Building, 2675 University Ave., St. Paul, Minnesota 55114 (646-6309).

Publication Short Title: Zooplankton Distribution - Lake Superior

Publication Abstract:

During the months of July, August, and September of 1966, preliminary studies were directed toward biogeographical distributions of some of the principal zooplankters in Lakes Superior and Michigan. These analyses were based on continuous transect samples taken by means of the Continuous Plankton Recorder. The recorders sampled a transect segment of water one-half inch square and 300-500 miles in length in both Lakes Michigan

and Superior. The zooplankters were concentrated on a continuously moving belt of silk eighteen and one-half feet long. These silks were of two mesh sizes, #60 grit and #15 silk bolting cloth, respectively. Tows were made aboard the S.S. Cason J. Callaway, a commercial ore carrier which followed the normal navigation routes in both lakes. Significant differences were noted between the characteristic species of the two lakes. In addition, a numerical difference was evident. Marked diunal variations in both numbers and in species were observed at the 10 meter depth, with the highest concentrations occurring in the nighttime hours. Marked regional differences were noted which contributed to "patchiness" of zooplankton distribution.

Publication Authors: Swain, W.R., Olson, T.A., and Odlaug, T.O.

Publication Title: Preliminary Studies of Zooplankton Distribution with the Continuous Plankton Recorder

Publication Source: Univ. of Minn., Water Resources Research Center, Bull. 7, 1968. 21 p., 14 fig., 9 ref.

Publication Corporate Author: Univ. of Minn., St. Paul

Publication Descriptors: / *zooplankton/ *Lake Superior/ *Lake Michigan/ limnology/ organisms/ plankton

Publication Identifiers: / *Continuous Plankton Recorder/ *silk bolting cloth/ *navigation routes/ biogeographic/ towing depths

Publication Availability:
Free copies available at Water Resources Research Center, Univ. of Minn., Room 107 Hubbard Building, 2675 University Ave., St. Paul, Minnesota 55114 (646-6309).

Publication Short Title: Periphyton in Lake Superior

Publication Abstract:
The study, conducted 1965-67, was directed toward the determination of the extent of the natural periphyton growth upon rocks in selected areas of Lake Superior as measured qualitatively and quantitatively by numerical and mass methods, the speed and phases of growth demonstrated by periphyton in re-establishing itself on an artificially denuded natural substratum, the effects of various ecological factors upon the periphyton, and the productivity potential of the periphyton in relation to the typical productivity of water in the open lake. The area from which the majority of samples were obtained was a small bay at the western end of Lake Superior which is known locally as Stony Point Bay. The plant portion of the epilithic periphyton of the western arm of Lake Superior was found to consist solely of representatives from three phyla of algae, the Chyrysophyta, the Chlorophyta, and the Cyanophyta. It is concluded that the organisms found in the periphyton of the western arm of Lake Superior are indicative of clean water. The extensive shallow water area of Lake Superior supports large quantities of attached algae, which, as primary producers, form the first link in the food chain.

Publication Authors: Fox, J.L., Odlaug, T.O. and Olson, T.A.

Publication Title: The Ecology of Periphyton in Western Lake Superior

Publication Source: Univ. of Minn., Water Resources Research Center, Bull. 14, 1969. 127 p., 87 fig., 24 tab., 79 ref.

Publication Corporate Author: Univ. of Minn., St. Paul

Publication Descriptors: / *periphyton/ *Lake Superior/ *plankton/ algae/ phytoplankton/ zooplankton/ organisms/ aquatic environment/ productivity/ photosynthesis/ respiration/ nutrients/ oligotrophic/ microrganisms

Publication Identifiers: / *regrowth capabilities/ *blue-green algae/ *substrata/ toxonomy

Publication Availability:
Free copies available at Water Resources Research Center, Univ. of Minn., Room 107 Hubbard Building, 2675 University Ave., St. Paul, Minnesota 55114 (646-6309).

Publication Short Title: Carbon Fourteen Productivity - Great Lakes

Publication Abstract:
Carbon fourteen productivity studies were carried out in four of the five Great Lakes, namely, Superior, Michigan, Huron, and Erie, during the 1967 and 1968 shipping seasons. Production rates were determined using the carbon fourteen technique with light, temperature and incubation time remaining constant. Sample activity was measured with an Ansitron II liquid scintillation counter. Baselines of primary surface water productivity were established for the lakes studied. A comparison of the mean productivity rates shows Lake Superior to be the most oligotrophic of the Great Lakes studied. Eutrophication becomes more pronounced in Lake Huron, Michigan, and Erie, respectively with Michigan and Erie being most productive. Productivity variations of considerable magnitude were found to exist within a given lake and during the same sampling trip. It is believed these variations represent population differences within individual water masses encountered while crossing the lake. Productivity rates with respect to time and lake position were not linear, with the exception of Lake Erie which was less extensively sampled. Productivity was found to be cyclic in nature, its rate depending upon the environmental conditions. Mean productivity rates in mg. C/m^3/day in Lakes Superior, Huron, Michigan and Erie were: 16.62, 23.04, 3762 and 175.20.

Publication Authors: Parkos, W.G., Olson, T.A. and Odlaug, T.O.

Publication Title: Water Quality Studies on the Great Lakes Based on Carbon Fourteen Measurements on Primary Productivity

Publication Source: Univ. of Minn., Water Resources Research Center, Bull. 17, 1969. 121 p., 38 fig., 35 tab., 70 ref.

Publication Corporate Author: Univ.of Minn., St. Paul

Publication Descriptors: / *primary productivity/ *Great Lakes/ *eutrophication/ phytoplankton/ organisms/ biomass/ alkalinity/ carbon dioxide/ aquatic environment/ plankton, weather/ lakes/ nutrients/ algae/ phosphates/ light intensity/ effluents/ limnology

Publication Identifiers: / *carbon fourteen/ *scintillation counter/ *shipping routes/ blue-green algae

Publication Availability:
Free copies available at Water Resources Research Center, Univ., of Minn., Room 107 Hubbard Building, 2675 University Ave., St. Paul, Minnesota 55114 (646-6309).

Publication Short Title: Photosynthetic Pigments - Lake Superior Periphyton

Publication Abstract:

A comprehensive project designed to measure productivity and explore the biodynamics of Lake Superior periphyton was carried out during the summers of 1966, 1967, and 1968. The biomass, community structure, and photosynthetic activity of epilithic periphyton from a representative area, Stony Point Bay, were determined by examination of a variety of parameters. Naturally occurring periphyton and regrowth organisms were studied. Pigment concentrations show that the biomass of the periphyton of Lake Superior's north shore is similar in magnitude to other oligotrophic bodies of water. Total pigment concentrations ranged from 0.338 to 3.59 milligrams per 100 square centimeters of rock surface, and averaged 1.36 mg./100 cm^2. Pigment ratios indicate most of the north shore periphyton to be dominated by organisms of the Division Chrysophyta. In water up to about forty feet deep in Lake Superior, periphyton can be five to six times as important in primary production as the phytoplankton.

Publication Authors: Stokes, L.W., Olson, T.A., and Odlaug, T.O.

Publication Title: The Photosynthetic Pigments of Lake Superior Periphyton and Their Relation to Primary Productivity

Publication Source: Univ. of Minn., Water Resources Research Center, Bull. 18, 1970. 150 p., 110 fig., 26 tab., 168 ref.

Publication Corporate Author: Univ. of Minn., St. Paul

Publication Descriptors: / *periphyton/ *Lake Superior/ *primary productivity/ algae/ photosynthesis/ phytoplankton/ biomass/ light intensity/ respiration/ organisms/ incubation/ turbitity/ chlorophyll/ temperature/ nutrients

Publication Identifiers: / *regrowth capabilities/ *apparent photosynthesis/ *net assimilation/ pigment concentration/ respirometer

Publication Availability:

Free copies available at Water Resources Research Center, Univ. of Minn., Room 107 Hubbard Building, 2675 University Ave., St. Paul, Minnesota 55114 (646-6309).

OWRR Project No.: A-013-Minn.

Project Title: Review and Analysis of Precipitation and Runoff Data from Selected Watersheds in Minnesota

Principal Investigator: C.E. Bowers, Univ. of Minn., St. Anthony Falls Hydraulic Laboratory

Project Began: July 1, 1965 Projected Ended: June 30, 1968

FCST Research Category: IV-A

Publication Short Title: Rainfall and Runoff for Watersheds in Minnesota

Publication Abstract:

Five watersheds scattered throughout the State were selected for analysis of available rainfall and runoff data to assist in the evaluation of peak rates of runoff for design purposes. Physical and hydrologic characteristics of the watersheds were described. Rainfall and runoff data were analyzed for 51 flood events in the watersheds. An optimization computer program was used to optimize nine variables associated with the watersheds, develop characteristic unit hydrographs, and evaluate loss rates for the watershed in terms of the mathematical model represented by the optimization program. Data on annual maximum floods as well as maximum summer floods were plotted on log-probability paper and theoretical flood-frequency curves determined by the log-Pearson Type III distribution. The maximum loss rate for alone-inch-per-hour rainfall was 0.9 inch in the Root; minimum loss rate was 0.45 inch. Storm pattern, storm location, and storm direction have considerable affect on the shape of unit hydrographs developed for large watersheds.

Publication Authors: Bowers, C.E. and Pabst, A.F.

Publication Title: Review and Analysis of Rainfall and Runoff Data for Selected Watersheds in Minnesota

Publication Source: Univ. of Minn., Water Resources Research Center, Bull. 8, 1968. 70 p., 55 fig., 9 tab., 10 ref.

Publication Corporate Author: Univ. of Minn., St. Paul

Publication Descriptors: / *Rainfall-runoff relation/ *watershed/ *unit hydrograph/ precipitation/ Minnesota/ basins/ drainage density/ stream forecasting/ floods/ streamflow/ peak discharge/ optimization/ time of concentration/ hydrographs/ computers/ stream gages

Publication Identifiers: / *hydro-meteorology/ *loss rate/ *flood frequency/ storm pattern/ recurrence interval/ basin slope

Publication Availability:

Free copies available at Water Resources Research Center, Univ. of Minn., Room 107 Hubbard Building, 2675 University Ave., St. Paul, Minnesota 55114 (646-6309).

OWRR Project No.: A-014-Minn.

Project Title: Recharge from Induced Streambed Infiltration Under Varying Stream-Stage and Aquifer Water Level Conditions

Principal Investigator: W.C. Walton, Univ. of Minn., Graduate School

Project Began: July 1, 1966 Project Ended: June 30, 1967

FCST Recharge Category: II-F

Publication Short Title: Groundwater Recharge From Streambed Infiltration

Publication Abstract:

An aquifer-stream system for which hydrogeologic data are available was studied using electric analog computers and analytical methods to gain insight into the magnitude of recharge by indirect streambed infiltration under complex stream-stage and groundwater-level conditions. The profound influence of changes in stream stage on recharge from induced streambed infiltration is illustrated by the results of the analytical studies. The results of the electric analog computer studies demonstrate that much greater drawdowns are computed for an aquifer-stream system when maximum infiltration conditions are taken into account that when maximum infiltration conditions are ignored. The electric analalog computers consist of low impedance analog models and excitation-response apparatus. The analog models are regular arrays of resistors, capacitors, transistors, and diodes and are scaled-down versions of the aquifer-stream system. The excitation-response apparatus consists of two power supplies, a waveform generated, a pulse generator, two power amplifers and an oscilloscope. Analog model streambed elements were designed with resistors, transistors, and diodes to correctly simulate leakage through the streambed under maximum infiltration conditions.

Publication Authors: Walton, W.C., Hills, D.L. and Grundeen, G.M.

Publication Title: Recharge From Induced Streambed Infiltration Under Varying Groundwater-Level and Stream-Stage Conditions

Publication Source: Univ. of Minn., Water Resources Research Center, Bull. 6, 1967. 42 p., 19 fig., 3 tab., 19 ref.

Publication Corporate Author: Univ. of Minn., St. Paul

Publication Descriptors: / *Groundwater recharge/ *analog models/ *streambeds/ aquifers/ aquifer characteristics/ water table/ infiltration/ hydrogeology/ Ohio/ water levels/ surface water/ pumping/ simulation technique/ scaling

Publication Identifiers: / *electric analog computers/ *excitation-response apparatus/ *recharge boundary/ stream stage/ aquifer-test data

Publication Availability:

Free copies available at Water Resources Research Center, Univ. of Minn., Room 107 Hubbard Building, 2675 University Ave., St. Paul, Minnesota 55114 (646-6309).

OWRR Project No.: A-015-Minn.

Project Title: Hydrologic and Other Aspects of Water Laws in Minnesota

Principal Investigator: W.C. Walton, Univ. of Minn., Graduate School

Project Began: July 1, 1967 Project Ended: June 30, 1969

FCST Research Category: VI-E

Publication Short Title: Water Laws in Minnesota

Publication Abstract:

During Fiscal Year 1968, The numberous legislative enactments bearing on water and related land resources that are contained in the codified laws of Minnesota were collected and processed for publication. In addition, selected uncodified legislative enactments and ordinances of villages and cities bearing on water and related land resources which have the force and application of law were compiled. All pertinent uncodified laws enacted during the 1965 Legislative Session are presented together with selected uncodified laws of other Legislative Sessions to provide the reader with an insight into the nature and scope of uncodified laws in the field of water and related land resources. The offices of selected villages and cities in Minnesota with varying water problems were visited during 1968 and a sampling of local water use regulations was compiled. The local ordinances presented in this report indicate the extent to which the development and management of water resources presently resides in local units of government.

Publication Authors: Walton, W.C., Haik, R.A. and Hills, D.L.

Publication Title: Codified and Uncodified State Laws and Municipal Ordinances Bearing on Water and Related Land Resources in Minnesota

Publication Source: Univ. of Minn., Water Resources Research Center, Bull. 9, 1968. 640 p.

Publication Corporate Author: Univ. of Minn., St. Paul

Publication Descriptors: / *water laws/ *legislation/ *State government/ Minnesota/ legal aspects/ regulation/ water management/ local governments/ water policy/ water permits/ zoning/ riparian rights

Publication Identifiers: / *codified laws/ *uncodified laws/ *ordinances

Publication Availability:

Free copies available at Water Resources Research Center, Univ. of Minn., Room 107 Hubbard Building, 2675 University Ave., St. Paul, Minnesota 55114 (646-6309).

Publication Short Title: Aspects of Water Laws in Minnesota

Publication Abstract:

There are several examples of the nullifying effect of existing water laws. Statements concerning mandatory coordination and cooperation of State, local, and Federal agencies and other organizations such as commissions and compacts contained in the codified and uncodified State water laws, for the most part, are weak expressions describing piece-meal cooperation, often on a voluntary basis, between agencies and organizations. Responsibility for comprehensive coordination and cooperation within the water and related land resources development and management

field is not centralized. Consideration should be given to legislative enactments which would require State and local agencies, charged with developing water policy through the issuance or denial or resource use permits, to develop and publish within a specified time rules, regulations, and criteria that form the basis of evaluating and processing a permit application. The legislative formal declarations and statements are broad from a comprehensive viewpoint. Considerable latitude is given to State agencies to formulate policy through the adoption of detailed rules and regulations. Little has been done to eliminate conflicts between rules and regulations formulated by special interest State agencies nor to weld together legislative formal declaration and statements and State agency detailed rules and regulations into a unified State policy for water and related land resources development and management. The present legal classifications of waters, necessitated in part by the meagerness of knowledge concerning the interrelationship of waters in bygone days, is hydrologically unsound and in need of revision in light of present knowledge.

Publication Authors: Haik, R.A., Walton, W.C. and Hills, D.L.

Publication Title: Aspects of Water Resources Law in Minnesota

Publication Source: Univ. of Minn., Water Resources Research Center, Bull. 11, 1969. 143 p., 9 ref.

Publication Corporate Author: Univ. of Minn., St. Paul

Publication Descriptors: / *water laws/ *legislation/ *State government/ Federal government/ local government/ Minnesota/ water policy/ water permits/ zoning/ coordination/ regulation/ water management/ riparian rights/ hydrology/ priorities

Publication Identifiers: / *court law/ *classification of waters/ *public water/ common enemy doctrine/ percolating waters/ prescriptive rights

Publication Availability:
Free copies available at Water Resources Research Center, Univ. of Minn., Room 107 Hubbard Building, 2675 University Ave., St. Paul, Minnesota 55114 (646-6309).

OWRR Project No.: A-016-Minn.

Project Title: Primary Productivity of Selected Minnesota Lakes

Principal Investigator: H.E. Wright, Univ. of Minn., Limnological Research Center

Project Began: July 1, 1967 Project Ended: June 30, 1970

FCST Research Category: V-C

Publication Short Title: Planktonic Algal Productivity-Lake Minnetonka

Publication Abstract:
Population densities of planktonic algal, daily rates of photosynthesis, nutrient concentrations, and other limnological parameters were measured at 11 localities in Lake Minnetonka during 1968-70. Algal productivity is near an upper limit in some basins, the productivity in one basin is similar to that of unpolluted Lake Itasca. Maximum population densities of planktonic algae during summer in the lower lake are 2 or 3 times higher now than 30 years ago. Blue-green algae are now much more numerous than diatoms. Phosphorus alone limits the algae during the summer. Results of studies suggest that the initial management objective for most of the lake should be to prevent concentrations of total phosphorus from exceeding 45 mg/m^3 during mid-summer. The lower lake will improve to conditions prevailing in the summer of 1967 within 3-5 years after the flow of sewage stops and the phosphorus influx is reduced. A mathematical model developed enables lake productivity to be estimated much more efficiently than with other methods.

Publication Author: Megard, R.O.

Publication Title: Lake Minnetonka: Nutrients, Nutrient Abatement, and the Photosynthetic System of the Phytoplankton

Publication Source: Univ. of Minn., Limnological Research Center, Dec. 1970. 210 p., 21 fig., 10 tab., 22 ref.

Publication Corporate Author: Univ. of Minn., Minneapolis

Publication Descriptors: / *phytoplankton/ *algae/ *algal productivity/ *phosphorus/ basins/ inorganic compounds/ photosynthesis/ respiration/ alkalinity/ fertility/ chlorophyll/ algal productivity/ diatoms/ eutrophication/ lake/ ammonia/ sediment/ bioassay/ mathematical model/ sewage

Publication Identifiers: / *Lake Minnetonka/ *phosphorus budget/ *phosphorus abatement/ lake response/ residence time/ nutrient influx

Publication Availability:
Reference copy at Water Resources Research Center, Univ. of Minn., Room 107 Hubbard Building, 2675 University Ave., St. Paul, Minnesota 55114 (646-6309). Limited number of free copies available at Limnological Research Center, Univ. of Minn., 207a Pillsbury Hall, Minneapolis, Minnesota 55455 (373-4508).

Publication Short Title: Photosynthesis in Shagawa Lake, Minnesota

Publication Abstract:
Photosynthesis in Lakes Shagawa; Clearwater, Trout, Kimball and Minnetonka was measured in 1967 by determining the oxygen produced by algae. The phytoplankton of Shagawa Lake was doninated by a blue-green

alga in summer and a diatom in winter. Most algae were concentrated near the surface, in depths above 4m, both in winter and in spring. The average daily rate of photosynthetic carbon assimilation was 42 µgC/ug chlorophyll; this was also the rate at the same temperature in Lake Minnetonka. Average daily gross photosynthesis in Shagawa Lake was 2.02gC/m^2/dy. Photosynthesis in 3 other lakes in notheastern Minnesota range from 0.38 to 0.78gC/m^2/dy, but it was 3.10gC/m^2dy in Lake Minnetonka, which is also enriched with sewage effluent. Experiments concerning different kinds of sewage effluent on algal growth indicate photosynthetic capacity was stimulated 40% by 5% and 10% secondary sewage effluent but inhibited by 20% secondary effluent.

Publication Author: Megard, R.O.

Publication Title: Algae and Photosynthesis in Shagawa Lake, Minnesota

Publication Source: Univ. of Minn., Limnological Research Center, Interim Rept. No. 5, 1969. 36p., 5 fig., 10 tab., 8 ref.

Publication Corporate Author: Univ. of Minn., Minnesota

Publication Descriptors: / *photosynthesis/ *phytoplankton/ *lakes/ algae/ primary productivity/ water chemistry/ Minnesota/ salinity/ phosphorus/ plankton/ chlorophyll/ sewage effluents/ water analysis/ waste treatment/ diatoms

Publication Identifiers: / *photosynthetic capacity/ *algal density/ *carbon assimulation/ secondary treatment/ morphometry/ blue-green algae

Publication Availability:
Reference copy at Water Resources Research Center, Univ. of Minn., Room 107 Hubbard Building, 2675 University Avenue, St. Paul, Minnesota 55114 (646-6309). Limited number of free copies available at Limnological Research Center, Univ. of Minn., 207a Pillsbury Hall, Minneapolis, Minnesota 55455 (373-4508).

OWRR Project No.: A-017-Minn.

Project Title: Effects of Areal and Time Distribution of Runoff Supply on Watershed Hydrographs

Principal Investigator: C.L. Larson, University of Minn., Department of Agricultural Engineering

Project Began: July 1, 1967 Project Ended: June 30, 1970

FCST Research Category: II-A

Publication Short Title: Small Watershed Runoff Hydrographs - Minnesota

Publication Abstract:
A mathematical watershed model of 1.456 square miles was developed to route runoff through overland flow and through the channel system. Excess rainfall was used as input data and the flow was routed by the successive numerical solution of the kinematic wave equations to produce outflow hydrographs for elementary (first order) watersheds. These hydrographs were used as input to the channel system where the flow was routed by the successive numerical solution of the dynamic wave equations to yield the outflow hydrograph for the model watershed. Backwater effects were considered at most of the junctions of the model watershed. The model was used to study the effects of time distribution and aread distribution of rainfall, storm movement and watershed shape on the runoff hydrograph. In each study, attempts were made to find a relationship between an appropriate input parameter and a modification (peak flow) coefficient, to be used in adjusting the peak discharge estimated by conventional methods, which normally assume a stationary, constant intensity storm uniformly distributed over the watershed. The results of this study indicate that, in general, the selected factors have significant effects on peak discharge.

Publication Authors: Wei, T.C. and Larson, C.L.

Publication Title: Effects of Areal and Time Distribution of Rainfall on Small Watershed Runoff Hydrographs

Publication Source: Univ. of Minn., Water Resources Research Center, Bull. 30, 1971. 118 p., 31 fig., 28 tab., 71 ref.

Publication Corporate Author: Univ. of Minn., St. Paul

Publication Descriptors: / *rainfall-runoff relationships/ *mathematical model/ *peak discharges/ watershed/ Minnesota/ climate/ precipitation/ hydrographs/ storm runoff/ routing/ computer/ overland flow/ channels/ geology/ soil types/ topography

Publication Identifiers: / *watershed model/ *rainfall excess/ *storm movement/ lag time/ time distribution/ areal distribution

Publication Availability:
Free copies available at Water Resources Research Center, Univ. of Minn., Room 107 Hubbard Building, 2675 University Ave., St. Paul, Minnesota 55114 (646-6309).

OWRR Project No.: A-018-Minn.

Project Title: Methodology for Integrating Water Quality Management with Management of the Total Water Resources in Minnesota

Principal Investigator: C.P. Straub, Univ. of Minn., School of Public Health

Project Began: July 1, 1967 Project Ended: June 30, 1970

FCST Research Category: V-G

Publication Short Title: Water Quality Management Institutions - Minnesota

Publication Abstract:

Water resources management is a governmental response to the growing need to maximize the productivity of hydrologic resources. Six characteristics of water resources are contributory factors to the need for governmental involvement in water resources management. Water quality management encompasses data collection, research and analysis, and technical engineering and policy measures. Regulation, effluent charges, and incentive payments should be considered in systems analysis. Water quality management should play the role of the integrator of the various aspects of water resources management. Seven criteria for water management institutions and the roles of different levels of government are proposed. The institutional approaches the four foreign countries and two regions in the United States and water resources management in Minnesota are described. Three alternatives are proposed for the achievement of integrated water resources management in Minnesota. Common to all proposals are increased public representation on the decision-making bodies of State and regional bodies and regional decentralization. Research needs are stressed.

Publication Authors: Gibson, U.P. Straub, C.P. and Bond, R.G.

Publication Title: Integrating Water Quality Management into Total Water Resources Management in Minnesota

Publication Sources: Univ. of Minn., Water Resources Research Center, Bull. 23, 1970. 376 p., 53 fig., 14 tab., 112 ref.

Publication Corporate Author: Univ. of Minn., St. Paul

Publication Descriptors: / *water quality control/ *water resources development/ *institutions/ Minnesota/ political aspects/ hydrology/ government/ commissions/ waste disposal/ system analysis/ assimilative capacity/ waste water treatment/ pollution abatement

Publication Identifiers: / *river authorities/ *water resources intelligence/ *effluent charges/ reducing wastes/ scale economics

Publication Availability:

Free copies available at Water Resources Research Center, Univ. of Minn., Room 107 Hubbard Building, 2675 University Ave., St. Paul, Minnesota 55114 (646-6309).

OWRR Project No.: A-019-Minn.

Project Title: Economics of Water Quality Control in the Upper Mississippi River, Minnesota

Principal Investigator: J.J. Waelti, Univ. of Minn., Department of Agricultural and Applied Economics

Project Began: July 1, 1968 Project Ended: June 30, 1971

FCST Research Category: VI-B

Publication Short Title: Water Quality Costs - Upper Mississippi River, Minnesota

Publication Abstract:

Seven principal organic waste sources including 5 municipal sewage treatment plants, are present along the Mississippi River in the Minneapolis-St. Paul area with severe pollution. The Minnesota Pollution Control Agency and Sewer Service Board, Metropolitan Council are concerned with water quality programs in the area. Under present conditions, the treatment facilities are discharging more BOD into the river than the river can assimilate at the seven consecutive day summer low flow that occurs once in ten years. A mathematical model for combining the DO say curve resulting from organic waste disposal in the river, with the cost of sewage treatment was devised to estimate the least cost method of attaining alternative levels of DO. In order to achieve the current river standard of 3 mg/l with least increases in total annual treatment expenditures, percent BOD removed by the Mpls.-St. Paul San. Dist. plant needs to be increased from 48.8% to 87.6%; the BOD removal rate of 90% by So. St. Paul plant needs to be maintained; and the Newport St. Paul Park and Cottage Grove plants need only primary treatment. With a cost minimizing management plan, the current river standard could be maintained for an additional annual expenditure of 4.8%.

Publication Author: Lewis, R.C.

Publication Title: The Marginal Costs of Alternative Levels of Water Quality in the Upper Mississippi River

Publication Source: Univ. of Minn., Water Resources Research Center, Bull. 25, 1970. 59 p., 12 fig., 6 tab., 37 ref.

Publication Corporate Author: Univ. of Minn., St. Paul

Publication Descriptors: / *pollution abatement/ *treatment facilities/ *cost comparisons/ sewage/ waste water disposal/ institutional arrangements/ water quality control/ dissolved oxygen/ mathematical model/ marginal costs/ financing/ waste assimilative capacity/ biochemical oxygen demand/ cost analysis/ waste water treatment

Publication Identifiers: / *cost minimizing management plan/ *dissolved oxygen sag curve/ *least cost strategy/ cost functions

Publication Availability:

Free copies available at Water Resources Research Center, Univ. of Minn., Room 107 Hubbard Building, 2675 University Ave., St. Paul, Minnesota 55114 (646-6309).

OWRR Project No.: A-021-Minn.

Project Title: Water Resources Administration in Minnesota

Principal Investigator: W.C. Walton, Univ. of Minn., Graduate School

Project Began: July 1, 1969 Scheduled Completion: June 30, 1972

FCST Research Category: VI-E

Publication Short Title: Water Resources Administration in Minnesota, 1970

Publication Abstract:

In 1970, Minnesota's State government contained at least 46 departments, agencies, boards, commission, committees, etc. with water and related land resources responsibilities. Expenditures by these organizations increased from $5.7 million in 1950 to $31.9 million in 1970. About 86% of expenditures were made by the Department of Conservation. Total State agency staff complements increased from 1,100 in 1960 to 1,400 in 1970. Prime responsibility for water and related land resources programs rested in 3 committees of the Senate and 2 committees in the House. The Governor's and Legislature's control of the State's administrative apparatus is hampered through fragmented organization. A recommended plan of reorganization centers on consolidation of major functions within a Department of Natural Resources. There is need for the Legislature to enunciate a comprehensive environmental policy for the State.

Publication Authors: Walton, W.C. and Hills, D.L.

Publication Title: Water and Related Land Resources State Administration, Legislative Process and Policies in Minnesota, 1970

Publication Source: Univ. of Minn., Water Resources Research Center, Bull. 27, 1971. 344 p., 19 fig., 18 tab.

Publication Corporate Author: Univ. of Minn., St. Paul

Publication Descriptors: / *State government/ *legislation/ *water policies/ administration/ budgeting/ programs/ coordination/ institutions/ Minnesota/ organizations/ water law/ water districts/ political aspects/ environment

Publication Identifiers: / *State governmental reorganization/ *legislative process/ State environmental policy/ environment impact statements

Publication Availability:

Free copies available at Water Resources Research Center, Univ. of Minn., Room 107 Hubbard Building, 2675 University Ave., St. Paul, Minnesota 55114 (646-6309).

OWRR Project No.: A-022-Minn.

Project Title: Zooplankton Biomass and Incipient Eutrophication in Lake Superior

Principal Investigator: T.A. Olson, Univ. of Minn., School of Public Health

Project Began: July 1, 1969 Scheduled Completion: June 30, 1972

FCST Research Category: V-C

Publication Short Title: Algal Bioassay and Eutrophication - Minnesota

Publication Abstract:

A practical algal bioassay which can be used in the evaluation of the state of water enrichment was developed. Selenastrum gracile was found to be the most satisfactory assay organism. A routine procedure was developed for the preparation of test samples. Optimal conditions for the incubation of cultures were determined by respirometry and incubation experiments. Growth of cultures was measured by the microscopic cell count technique and chlorophyll determinations. The assay procedure was found to be extremely sensitive in detecting small changes in the nutrient composition of waters. Assay experiments were carried out using water samples from the lower St. Louis River and Lake Superior. The bioassay procedure was applied to the measurement of the growth inhibiting properties of sulfite waste liquor.

Publication Authors: Johnson, J.M., Odlaug, T.O., Olson, T.A. and Ruschmeyer, O.R.

Publication Title: The Potential Productivity of Fresh Water Environments as Determined by an Algal Bioassay Technique

Publication Source: Univ. of Minn., Water Resources Research Center, Bull. 20, 1970. 79 p., 36 fig., 5 tab., 183 ref.

Publication Corporate Author: Univ. of Minn., St. Paul

Publication Descriptors: / *bioassay/ *algae/ *eutrophication/ water pollution/ water quality control/ Minnesota/ primary productivity/ biomass/ organism/ water analysis/ phytoplankton/ nutrients/ chlorophyll/ enrichment/ sewage/ incubation/ organic/ Lake Superior

Publication Identifiers: / *assay organism/ *algal culturing/ *growth inhibiting/ microscopic cell count/ St. Louis River/ blue-green algae

Publication Availability:

Free copies available at Water Resources Research Center, Univ. of Minn., Room 107 Hubbard Building, 2675 University Ave., St. Paul, Minnesota 55114 (646-6309).

Center Director's Office OWRR Annual Allotment Program:

Director: W.C. Walton, Univ. of Minn., Graduate School

Program Began: September 1, 1964 (continuing)

Publication Short Title: Federal, State, Local Water Agencies in Minnesota

Publication Abstract:

Information is included for 16 Federal, State and local agencies having a major interest in water resources. The list of agencies is not intended to be all-inclusive; however, most of the water resources activities in the State are described. Data are given on agency history; responsibilities; jurisdictions; past and present programs including projects completed, underway and studies in preparation; and research needs. Agency programs through June 30, 1965 are inventoried. The Water Resources Research Center must give due regard to water resources programs being conducted or supported by agencies of Federal, State, and local governments and private organizations and to the water resources research needs of the State. To enable the Center's research and training program to be integrated and coordinated with water resources programs of organizations outside the University, information on past, present and planned water resources projects must be made available to research workers. This information is needed by the Center as one of the tools for administration of its program so as to avoid undesirable duplication of research. Probably of equal value, it will enable all those concerned with water resources research to be knowledgeable about what water resources programs have been and are being supported or planned, by whom, how, and where.

Publication Author: Anon

Publication Title: Federal, State and Local Agencies Concerned with Water Resources Research in Minnesota

Publication Source: Univ. of Minn., Water Resources Research Center, Bull. 1, 1965. 122 p.

Publication Corporate Author: Univ. of Minn., St. Paul

Publication Descriptors: / *water resources/ *programs/ *projects/ Minnesota/ hydrology/ water quality control/ water supply/ wildlife/ minerals/ lakes/ streams/ regulation/ planning/ geology/ soils/ sewage/ eutrophication/ water law/ navigation/ flood control/ climate

Publication Identifiers: / *Federal agencies/ *State agencies/ *localagencies

Publication Availability:

Free copies available at Water Resources Research Center, Univ. of Minn., Room 107 Hubbard Building, 2675 University Ave., St. Paul, Minnesota 55114 (646-6309).

Publication Short Title: Water Quality Controversy in Minnesota

Publication Abstract:

This publication is designed to assist Minnesotans in attaining an elementary understanding of some of the more important aspects of water pollution and to facilitate meaningful, rational debate and better communications between citizen and government. Information is presented on classification of pollutants, degradable and nondegradable pollutants, natural and manmade pollution, organic matter, BOD, oxygen sag, existing waste treatment facilities, onsite disposal systems, eutrophication and pollution of lakes, agricultural pollution problems, industrial pollution, economic aspects of pollution, governmental responsibility in water quality control, and an interpretation of the controversy. Major issues facing the people of Minnesota include lake-front zoning, stream water quality standards, coordination of waste treatment facilities in the Twin Cities Metropolitan Area, enactment of water quality policies, and administration of water quality control programs.

Publication Author: Waelti, J.J.

Publication Title: Understanding the Water Quality Controversy in Minnesota

Publication Source: Univ. of Minn, Agriculture Extension Service, Extension Bull. 359, 1969. 27 p., 11 ref.

Publication Corporate Author: Univ. of Minn., St. Paul

Publication Descriptors: / * water quality control/ *waste treatment/ *social costs/ Minnesota/ economics/ lakes/ streams/ zoning/ chemical degradation/ inorganic compounds/ organic matter/ biochemical oxygen demand/ oxygen sag/ eutrophication/ algae/ nutrients/ anaerobic conditions

Publication Identifiers: / *controversy/ *onsite disposal systems/ *feed lot pollution/ oxygen profile/ degradable/ nondegradable

Publication Availability:

Free copies available at Water Resources Research Center, Univ. of Minn., Room 107 Hubbard Building, 2675 University Ave., St. Paul, Minnesota 55114 (646-6309). Free copies available at Agricultural Experiment Station, Univ. of Minn., 220 Coffey Hall, St. Paul, Minnesota 55101 (373-0751).

Publication Short Title: Power Requirement Impacts in Minnesota

Publication Abstract:

The objectives of the Conference held on December 10, 1970 were: to discuss future electric energy needs in the State of Minnesota and alternative means for meeting these requirements and to identify issues associated with: impact of power plant and transmission line proliferation on the natural environment, impact of power plant and transmission line proliferation on the economics of the affected areas, on the life of the people; impact of power plant and transmission line proliferation on the politico-legal situation in the affected areas, and impact on State if power plants and transmission lines are not built. The emphasis was on examination of all possible issues and not on problem solutions. Papers are presented on the following topics: power generation and the environment, background report on energy needs and tentative plans of utilities to meet these needs, and panel discussion on ramifications of tentative plans.

Publication Author: Anon

Publication Title: Conference on Impact of Future Electric Power Requirements in the State of Minnesota-An Issue Analysis

Publication Source: Univ. of Minn., Water Resources Research Center, Bull. 28, 1971. 39 p., 6 fig.

Publication Corporate Author: Univ. of Minn., St. Paul

Publication Descriptors: / *electric power plants/ *environment/ *thermal pollution/ energy/ Minnesota/ power operation and maintenance/ policy/ economics/ planning/ electric power costs/ government/ legislation/ ecology/ technology/ conservation

Publication Identifiers: / *environmental protection/ *issues/ *recycling waste heat

Publication Availability:
Free copies available at Water Resources Research Center, Univ. of Minn., Room 107 Hubbard Building, 2675 University Ave., St. Paul, Minnesota 55114 (646-6309).

Publication Short Title: Lake Eutrophication in Minnesota

Publication Abstract:
This bulletin contains the papers presented at the "Save the Lakes" Symposium at Detroit Lakes on August 18-19, 1969. The program focused on lake pollution and eutrophication: what it is, what causes it, the technology needed and available to control it, and the type of community action that can and must be taken to achieve effective control and to improve Minnesota lakes. Papers are presented on the following topics: clean lakes - our heritage and our responsibility, how action plans were developed in the Detroit lakes area, the technology available and needed to control eutrophication, the legislative interest in our lakes, a challenge to save the lakes, the eutrophication - pollution situation in the Detroit lakes area, the scientific aspects of lake eutrophication, and the role of Federal, State and local governments in saving our lakes.

Publication Author: Anon

Publication Title: Lake Eutrophication - Water Pollution Causes, Effects and Control

Publication Source: Univ. of Minn., Water Resources Research Center, Bull. 22, 1970. 61 p.

Publication Corporate Author: Univ. of Minn., St. Paul

Publication Descriptors: / *eutrophication/ *pollution/ *lakes/ Minnesota/ wastes/ waste treatment/ algae/ nutrients/ primary productivity/ watersheds/ sewage/ government/ environment technology/ phosphates/ ecology/ legislation

Publication Identifiers: / *nutrient removal/ *harvesting of aquatic weeds/ *blue-green algae/ public opinion

Publication Availability:
Free copies available at Water Resources Research Center, Univ. of Minn., Room 107 Hubbard Building, 2675 University Ave., St. Paul, Minnesota 55114 (646-6309).

Publication Short Title: Water Resources References - Minnesota

Publication Abstract:
Published literature and books bearing on water resources in Minnesota as of December 1966 is widely scattered and it has been difficult for research workers to be acquainted with available literature. This Bulletin, containing a list of references bearing on water resources in Minnesota and a list of selected books bearing on the physical, biological, and social aspects of water resources in Minnesota, should prove helpful to researchers and to people concerned with water resource development and management. More than 600 references are cited. References are related to: climate, forests and water, geology and groundwater, lakes, land and water, legal aspects, streamflow and floods, waterbased recreation, water pollution, water resources, wetlands, conservation, hydrology, soil water and water supply and waste disposal.

Publication Author: Walton, W.C.

Publication Title: Lists of References and Selected Books Bearing on Water Resources in Minnesota

Publication Source: Univ. of Minn., Water Resources Research Center, Bull. 4, 1966. 36 p.

Publication Corporate Author: Univ. of Minn., St. Paul

Publication Descriptors: / *publications/ *water resources/ *Minnesota/ climate/ forests/ geology/ groundwater/ lakes/ streams/ streamflow/ floods/ pollution/ wastes/ wetlands/ conservation/ soil water/ water supply/ hydrology

Publication Identifiers: / *references/ *books/ *water-based recreation/ soil-plant-water relationships

Publication Availability:
Free copies available at Water Resources Research Center, Univ. of Minn., Room 107 Hubbard Building, 2675 University Ave., St. Paul, Minnesota 55114 (646-6309).

Publication Short Title: Water Resources Research Needs, 1966 - Minnesota

Publication Abstract:
A Conference was held on November 15-16, 1966 to determine water resources research and educational needs in Minnesota. Papers are presented on the following subjects: research on water supply, research on water pollution, research on floods, research on land and waters, research on lakes and water-based recreation, research on social-economic aspects and education in water resources. A list of 160 research topics was compiled. Additional research is needed most in areas bearing on social-economic aspects, water pollution, and floods, about in that order. A limited number of specialized, interdisciplinary courses or seminars in water resources is needed.

Publication Author: Anon

Publication Title: Water Resources Research and Educational Needs in Minnesota

Publication Source: Univ. of Minn., Water Resources Research Center, Bull. 5, 1967. 120 p.

Publication Corporate Author: Univ. of Minn., St. Paul

Publication Descriptors: / *research facilities/ *water resources/ *education/ priorities/ Minnesota/ water supply/ pollution/ floods/ social aspects/ economic aspects/ legal aspects/ recreation/ wildlife/ lakes

Publication Identifiers: / *research needs/ *educational needs/ Interdisciplinary/ land and water/ water-based recreation

Publication Availability:
Free copies available at Water Resources Research Center, Univ. of Minn., Room 107 Hubbard Building, 2675 University Ave., St. Paul, Minnesota 55114 (646-6309).

Publication Short Title: Water Pollution by Nutrients - Minnesota

Publication Abstract:
This Bulletin contains papers presented at a Conference held on January 8, 1969. The overall objective of the Conference was to provide an understanding of the problem of nutrient pollution in Minnesota. Papers are presented on the following topics: effect of eutrophication on fish and related organisms, nutrients and other forms of pollution, diagnosing pollution in lake Minnetonka, implementing pollution control, septic tank effluents, meeting water quality standards and regulating nutrient sources, treatment of municipal wastes, ranging livestock wastes to control pollution, runoff and sediment as nutrient sources, controlling nutrients and organic toxicants in runoff, health aspects, surface and ground waters, water pollution in recreational areas, and animal waste disposal problems and trends in Minnesota.

Publication Author: Anon

Publication Title: Water Pollution by Nutrients - Sources, Effects and Control

Publication Source: Univ. of Minn., Water Resources Research Center, Bull. 13, 1969. 79 p.

Publication Corporate Author: Univ. of Minn., St. Paul

Publication Descriptors: / *nutrients/ *pollution/ *Minnesota/ eutrophication/ lakes/ water quality control/ sediment/ groundwater/ surface water/ recreation/ waste treatment/ fish/ wildlife/ runoff/ livestock

Publication Identifiers: / *feedlot pollution/ *septic tank pollution/ *health aspects/ animal wastes/ agricultural runoff

Publication Availability:
Free copies available at Water Resources Research Center, Univ. of Minn., Room 107 Hubbard Building, 2675 University Ave., St. Paul, Minnesota 55114 (646-6309).

Publication Short Title: Water Resources Education - Univ. of Minn.

Publication Abstract:
The first objective of this Bulletin is to collect all the existing information on graduate courses and programs at the University of Minnesota related to water resources and make this information available to new graduate students, faculty members and others. A second major objective is to provide information not included in the University Graduate

Bulletin which can be helpful in planning graduate programs in any of the various aspects of water resources. This is accomplished by indicating appropriate, alternative ways of satisfying general requirements, by listing the many relevant courses, and by giving a number of actual M.S. and Ph.D. programs in water resources as examples. It is not a complete guide, however, since needs and practices vary with individual departments. There are two types of Master's degree programs in water resources, the Master of Science degree and the professional Master's degree. The M.S. program is more common. Ph.D. programs specializing in the physical, biological or social science aspects of water resources may be arranged in most of the departments at the University of Minnesota. Although there is no such designation, Ph.D. programs may be discipline-oriented, indicating a high degree of specialization, or interdisciplinary to a considerable degree.

Publication Author: Anon

Publication Title: Graduate Education in Water Resources at the University of Minnesota - 1969

Publication Source: Univ. of Minn., Water Resources Research Center, Bull. 15, 1969. 39 p., 4 tab.,

Publication Corporate Author: Univ. of Minn., St. Paul

Publication Descriptors: / *education/ *water resources/ *Minnesota

Publication Identifiers: / *graduate education/ *courses/ *discipline/ interdisiplinary/ doctoral/ masters/ thesis/ undergraduate

Publication Availability:
Free copies available at Water Resources Research Center, Univ. of Minn., Room 107 Hubbard Building, 2675 University Ave., St. Paul, Minnesota 55114 (646-6309).

Publication Short Title: Water Resources Research in Minnesota, 1963-68

Publication Abstract:
An inventory of water resources research conducted in Minnesota during the period 1963-68 is presented. The number of ongoing projects rose from 53 in 1963 to 96 in 1967 and was 73 in 1968. Total expenditures increased from $629,000 in 1963 to $1.8 million in 1967 and were $1.5 million in 1968. Man-years of effort rose from 43 in 1963 to 98 in 1967 and was 81 in 1968. During the period 1963-68, the University of Minnesota was the organization conducting the greatest amount of research with Federal Agencies; State and private Colleges and private enterprises (others); and State Agencies following in that order. In 1968, expenditures by the University of Minnesota, Federal Agencies, State Agencies and others were $637,000; $506,000; $46,000; and $304,000 respectively. While the University of Minnesota conducts the largest amount of research, much of this research is funded by Federal Agencies and State. For example, in 1968 funding of research projects conducted at the University of Minnesota was about as follows: Federal - $525,000 and State - $95,000. In general, research effort by all measures has been consistently high in the following 4 research topic categories: Water Cycle, Water Quantity Management and Control, Water quality management and Protection, and Engineering Works.

Publication Author: Anon

Publication Title: Inventory of Water Resources Research Conducted in Minnesota, 1963 through 1968

Publication Source: Univ. of Minn., Water Resources Research Center, Bull. 12, 1969. 57 p., 9 fig., 6 tab.

Publication Corporate Author: Univ. of Minn., St. Paul

Publication Descriptors: / *research/ *water resources/ *Minnesota/ research facilities/ manpower/ projects/ expenditures/ government/ University/ water management/ water pollution control/ water resources development/ Water Resources Research Act

Publication Identifiers: / *researchers/ *applied research/ *basic research/ physical-biological-economic-social aspects/ faculty

Publication Availability:
Free copies available at Water Resources Research Center, Univ. of Minn., Room 107 Hubbard Building, 2675 University Ave., St. Paul, Minnesota 55114 (646-6309).

Publication Short Title: Ongoing Water Resources Research, 1970 - Minnesota

Publication Abstract:
A conference was held on March 26, 1970 to acquaint those concerned with water resources in Minnesota with the nature of ongoing water resources research activities in Minnesota. Papers are presented on the following subjects: research activities of the Water Resources Research Center, water research program of the Minnesota Pollution Control Agency, water resources research conducted in Minnesota by Northern States Power Company, Minnesota Agricultural Experiment Station water resources research program, water resources research programs at the North Star Research and Development Institute, water resources research conducted by the Minnesota Department of Iron Range Resources and Rehabilitation, current research at the Limnological Research Center, U.S.G.S. water resources research activities, research activities of the Department of Entomology, Fisheries, and Wildlife in Water Resources, ongoing water resources research in Minnesota, Agricultural Research Service, U.S.D.A., and water resources research activities of the Department of Civil Engineering and Hydraulics.

Publication Author: Anon

Publication Title: Proceedings of Conference on Ongoing Water Resources Research in Minnesota, March 1970.

Publication Source: Univ. of Minn., Water Resources Research Center, Bull. 21, 1970. 56 p., 6 fig., 1 tab.

Publication Corporate Author: Univ. of Minn., St. Paul

Publication Descriptors: /*research/ *water resources/ *Minnesota/ research facilities/ projects/ expenditures/ government/ University/ eutrophication/ waste treatment/ pollution/ limnology/ fish/ wildlife/ electric power plants/ wetlands/ water management

Publication Identifiers: / *water desalination/ *ongoing research/ *interdisciplinary/ waste heat/ environmental protection/ lake management

Publication Availability:
Free copies available at Water Resources Research Center, Univ. of Minn., Room 107 Hubbard Building, 2675 University Ave., St. Paul, Minnesota 55114 (64606309).

Publication Short Title: Water Resources Research Center Projects, 1965-70

Publication Abstract:
Information concerning completed projects, projects underway, and authorized projects funded during the period 1965-70 by the Minnesota Water Resources Research Center through the Federal Office of Water Resources Research is summarized. Data on the costs of projects, man years of effort, publications resulting from projects, and research results are presented to partially inform the reader of the nature and magnitude of the Center's research program.

Publication Author: Anon

Publication Title: Information Concerning Water Resources Research Center Projects, 1965-70

Publication Source: Univ. of Minn., Water Resources Research Center, Bull. 19, 1970. 32 p.

Publication Corporate Author: Univ. of Minn., St. Paul

Publication Descriptors: / *research/ *water resources/ *Minnesota/ projects/ manpower/ expenditures/ groundwater/ lakes/ streams/ eutrophication/ pollution/ ponds/ hydrology/ water law/ mathematical model/ economics/ State government/ policy/ potholes/ rainfall-runoff relationships

Publication Identifiers: / *watershed model/ *aquifer-stream relation/ *waste heat/ lake management/ court law/ pore-size distribution

Publication Availability:
Free copies available at Water Resources Research Center, Univ. of Minn., Room 107 Hubbard Building, 2675 University Ave., St. Paul, Minnesota 55114 (646-6309).

Publication Short Title: Water and Related Land Resources Planning-Minnesota

Publication Abstract:
A Conference was held on June 22, 1967 to acquaint those concerned with water and related land resources planning in Minnesota with the organization and activities of Federal, State, local and private ongoing planning efforts and future planning needs. Papers are presented on the following subjects: Minnesota Water Pollution Control Com. Activities Related to planning, Federal Water Pollution Control Administration Activities related to planning, local planning Activities Under Section 701, of the housing Act of 1954, Water Resources Planning Research, U.S. Department of Interior, Bureau of Sport Fisheries and Wildlife activities related to planning, U.S. Department of Agriculture, Soil Conservation Service planning projects, U.S. geological Survey activities related to planning, U.S. Army Corps of Engineers planning projects, Great Lakes Basin Commission, U.S. Bureau of Outdoor Recreation activities related to planning, Water Resources Planning Act of 1965, and Minnesota State Planning Agency.

Publication Author: Anon

Publication Title: Papers Presented During Conference on Water and Related Land Resources Planning in Minnesota

Publication Source: Minnesota State Planning Agency, Water Resources Coordinating Committee, Bull. 1, 1967. 122 p.

Publication Corporate Author: Minnesota State Planning Agency, St. Paul
Univ. of Minn., St. Paul

Publication Descriptors: / *planning/ *regional analysis/ *Water Resources Planning Act/ Minnesota/ government/ water development/ water management/ programs/ projects/ basins/ watershed/ conservation/ data collections/ legal aspects/ long-term planning/ river basin commissions

Publication Identifiers: / *functional planning/ *water and related land resources planning/ *Federal-State plans/ State plan

Publication Availability:
Reference copy available at Water Resources Research Center, Univ. of Minn., Room 107 Hubbard Building, 2675 University Ave., St. Paul, Minnesota 55114 (646-6309). Limited number of free copies available at Water Resources Coordinating Committee, Minnesota State Planning Agency, Capitol Square Building, 550 Cedar Street, St. Paul, Minnesota 55101 (221-3986).

Publication Short Title: Minnesota Water Resources Research Center, 1965

Publication Abstract:
The Fiscal Year 1965 budget of the Center was $52,297. The Center financed 7 research projects involving 7 faculty members. These research projects were concerned with: pothole drainage and groundwater resources, soil freezing in forests and runoff soil water, plankton desmids and pollution of lakes, organic productivity of lakes, induced streambed infiltration and groundwater resources, and net plankton and eutrophication in Lake Superior. About 15 students received employment through the Center's program. There were 6 new courses in water resources developed and 2 new staff members were added to water resources programs. During the academic year 1964-65, there were 10 master degree students, 24 doctoral students and 3 post-doctoral students enrolled in water related fields. About 20 masters degree candidates and 12 doctoral degree candidates majoring in water related fields graduated.

Publication Author: Walton, W.C.

Publication Title: First Annual Report Water Resources Research Center

Publication Source: Univ. of Minn., Water Resources Research Center, 1965. 37 p.

Publication Corporate Author: Univ. of Minn., St. Paul

Publication Descriptors: / *research/ *water resources/ *Minnesota/ education/ projects/ expenditures/ manpower/ water management/ water pollution/ Water Resources Research Act

Publication Identifiers: / *researchers/ *applied research/ *basic research/ physical-biological-economic-social aspects/ faculty

Publication Availability:
Reference copy available at Water Resources Research Center, Univ. of Minn., Room 107 Hubbard Building, 2675 University Ave., St. Paul, Minnesota 55114 (646-6309).

Publication Short Title: Minnesota Water Resources Research Center, 1966

Publication Abstract:
The Fiscal Year 1966 budget of the Center was $130,278. The Center financed 14 research projects involving 11 faculty members. These research projects were concerned with: pothole drainage and groundwater resources, soil freezing, in forests and runoff, soil water, plankton desmids and pollution of lakes, organic productivity of lakes, induced streambed infiltration and groundwater resources, net plankton and eutrophication in Lake Superior, groundwater contribution to streamflow, rainfall-runoff relationships, plankton in lakes, soil moisture movement, runoff from watersheds and soil-water storage. About 34 students received employment through the Center's program. There were 10 new courses in water resources developed and 6 new staff members added to water resources programs. During the academic year 1965-66, there were 31 seniors, 51 master degree students and 28 doctoral degree students enrolled in water related fields. About 45 students graduated with a major in water related fields.

Publication Author: Walton, W.C.

Publication Title: Second Annual Report Water Resources Research Center

Publication Source: Univ. of Minn., Water Resources Research Center, 1966. 39 p.

Publication Corporate Author: University of Minn., St. Paul

Publication Descriptors: / *research/ *water resources/ *Minnesota/ education/ projects/ expenditures/ manpower/ water management/ water pollution/ Water Resources Research Act

Publication Identifiers: / *researchers/ *applied research/ *basic research/ physical-biological-economic-social aspects/ faculty

Publication Availability:
Reference copy available at Water Resources Research Center, Univ. of Minn., Room 107 Hubbard Building, 2675 University Ave., St. Paul, Minnesota 55114 (646-6309).

Publication Short Title: Minnesota Water Resources Research Center, 1967

Publication Abstract:
The Fiscal Year 1967 budget of the Center was $146,279. The Center financed 13 research projects involving 10 faculty members. These research projects were concerned with pothole drainage and groundwater resources, soil freezing in forests and runoff, soil water, plankton desmids and pollution of lakes, organic productivity of lakes, induced streambed infiltration and groundwater resources, net plankton and eutrophication in Lake Superior, rainfall-runoff relationships, plankton in lakes, soil moisture movement, runoff from watersheds and soil-water storage. About 45 students received employment through the Center's programs. There were 3 new courses in water resources developed and 3 new staff members were

added to the water resources programs during the academic year 1964-65. There were 21 masters degree students, 13 doctoral students and 4 post-doctoral students enrolled in water related fields. About 14 masters degree candidates and 4 doctoral degree candidates majored in water related fields graduated.

Publication Author: Walton, W.C.

Publication Title: Third Annual Report Water Resources Research Center

Publication Source: Univ. of Minn., Water Resources Research Center, 1967. 81 p.

Publication Corporate Author: Univ. of Minn., St. Paul

Publication Descriptors: / *research/ *water resources/ *Minnesota/ education projects/ expenditures/ manpower/ water management/ water pollution/ water Resources Research Act

Publication Identifiers: / *researchers/ *applied research/ *basic research/ physical-biological-economic-social aspects/ faculty

Publication Availability:
Reference copy available at Water Resources Research Center, Univ. of Minn., Room 107 Hubbard Building, 2675 University Ave., St. Paul, Minnesota 55114 (646-6309).

Publication Short Title: Minnesota Water Resources Research Center 1968

Publication Abstract:
The Fiscal Year 1968 budget of the Center was $210,260. The Center financed 14 research projects involving 12 faculty members. These research projects were concerned with pothole drainage and groundwater resources, soil water, plankton and eutrohpication in Lake Superior, runoff from watershed, water law, eutrophication in lakes, watershed hydrographs, water quality management, channel runoff, soil moisture, soil movement, phosphorus and pollution in lakes and phytoplankton and pollution in Mississippi river. About 50 students received employment through the Center's program. There were 2 new courses in water resources developed and 1 new staff members added to water resources programs. During the academic year 1968-69, there were 28 seniors, 40 masters degree students, and 30 doctoral degree students enrolled in water related fields. About 44 students graduated with a major in water-related fields.

Publication Author: Walton, W.C.

Publication Title: Fourth Annual Report Water Resources Research Center

Publication Source: Univ. of Minn., Water Resources Research Center, 1968, 73 p.

Publication Corporate Author: Univ. of Minn., St. Paul

Publication Descriptors: / *research/ *water resources/ *Minnesota/ education/ projects/ expenditures/ manpower/ water management/ water pollution/ water Resources Research Act

Publication Identifiers: / * researchers/ *applied research/ *basic research/ physical-biological-economic-social aspects/ faculty

Publication Availability:
Reference copy available at Water Resources Research Center, Univ. of Minn., Room 107 Hubbard Building, 2675 University Ave., St. Paul, Minnesota 55114 (646-6309).

Publication Short Title: Minnesota Water Resources Research Center, 1969

Publication Abstract:
The fiscal Year 1969 budget of the Center was $237,000. The Center financed 14 research projects involving 12 faculty members. These research projects were concerned with: Eutrophication in Lake Superior, Water Laws in Minnesota, Primary Productivity of Minnesota Lakes, Watershed Hydrographs, Water Quality Management, Economics of Water Quality Control, Moverment of Water in Soils, Overfertilization of Surface Waters and Irrigation. About 39 students received employment through the Center's program. There were 5 new courses in water resources developed and 3 new staff members added to water resources programs. During the academic year 1968-69, there were 20 seniors, 18 masters degree students, and 13 doctoral degree students enrolled in water related fields. About 51 students graduated with a major in water-related fields.

Publication Author: Walton, W.C.

Publication Title: Fifth Annual Report Water Resources Research Center

Publication Source: Univ. of Minn., Water Resources Research Center, Bull. 16, 1969. 66 p.

Publication Corporate Author: Univ. of Minn., St. Paul

Publication Descriptors: / *research/ *water resources/ *Minnesota/ education/ projects/ expenditures/ manpower/ water management/ water pollution/ water Resources Research Act

Publication Identifiers: / *researchers/ *applied research / *basic research/ physical-biological-economic-social aspects/ faculty

Publication Availability:
Free copies available at Water Resources Research Center, Univ. of Minn., Room 107 Hubbard Building, 2675 University Ave., St. Paul, Minnesota 55114 (646-6309).

Publication Short Title: Minnesota Water Resources Research Center, 1970

Publication Abstract:
The Fiscal Year 1970 budget of the Center was $298,906. The Center financed 14 research projects involving 12 faculty members. These research projects were concerned with: primary productivity of lakes, watershed hydrographs, water quality management, water quality control economics, computer programs in hydrology, water resources administration, eutrophication in Lake Superior, phosphorus and lake pollution, overfertilization of surface waters, mist irrigation, soil water movement, participatory ecology and Mississippi river ecology. About 27 students received employment through the Center's program. There were 4 new courses in water resources developed and 5 new staff members added to water resources programs. During the academic year, 1968-69, there were 20 seniors, 50 masters degree students, and 21 doctoral degree students enrolled in water related fields. About 42 students graduated with a major in water related fields.

Publication Author: Walton, W.C.

Publication Title: Sixth Annual Report Water Resources Research Center

Publication Source: Univ. of Minn., Water Resources Research Center, Bull. 24, 1970. 90 p.

Publication Corporate Author: Univ. of Minn., St. Paul

Publication Descriptors: / *research/ *water resources/ *Minnesota/ education/ projects/ expenditures/ manpower/ water management/ water pollution/ Water Resources Research Act

Publication Identifiers: / *researchers/ *applied research/ *basic research/ physical-biological-economic-social aspects/ faculty

Publication Availability:
Free copies available at Water Resources Research Center, Univ. of Minn., Room 107 Hubbard Building, 2675 University Ave., St. Paul, Minnesota 55114 (646-6309).

Matching Grant Projects

OWRR Project No.: B-001-Minn.

Project Title: Diatoms and Zooplankton in Minnesota Lakes

Principal Investigator: H.E. Wright, Univ. of Minn., Limnological Research Center

Project Began: October 1, 1965 Project Ended: September 30, 1967

FCST Research Category: V-C

Publication Short Title: Chemistry of Some Minnesota Lakes

Publication Abstract:
Based on existing and generated information on climatic, geologic, botanical and limnological parameters, the lakes of Minnesota and adjacent South Dakota are empirically characterized on the basis of their solutes. There is a general increase in salinity and in the concentrations of sodium, potassium, calcium, magnesium, sulfate, bicarbonate, and silica from northeast to southwest in Minnesota. Solutes in lakes reflect regional difference in climate, bedrock and surficial deposits. In regions where limestone and dolomite are abundant or where the glacial drift is calcareous, lakes are not necessarily richer in calcium and bicarbonate due to the ionic omposition of groundwaters. There is more manganese, copper and zinc available to lakes in areas of podzols and podzolic soils than to lakes in areas of other soils. The results of the research show remarkable similarities between macrophyte and diatom floras with respect to water chemistry.

Publication Author: Bright, R.C.

Publication Title: Surface-Water Chemistry of Some Minnesota Lakes, with Preliminary Notes on Diatoms

Publication Source: Univ. of Minn., Limnological Research Center, Interim Rept. No. 3, April 1968. 59 p., 53 fig., 41 ref.

Publication Corporate Author: Univ. of Minn., Minneapolis

Publication Descriptors: / *Lakes/ *solutes/ *diatoms/ salinity/ soil types/ climate/ Minnesota/ basins/ vegetation/ bedrock/ water balance/ groundwater/ algae/ conductivity/ alkalinity/ elements/ ions/ aquatic life/ surface-groundwater relations/ water analysis

Publication Identifiers: / *ionic balance/ *lake-water quality/ *surficial materials/ redox potentials/ groundwater runoff

Publication Availability:
Reference copy at Water Resources Research Center, Univ. of Minn., Room 107 Hubbard Building, 2675 University Ave., St. Paul, Minnesota 55114 (646-6309). Limited number of free copies available at Limnological Research Center, Univ. of Minn., 207a Pillsbury Hall, Minneapolis, Minnesota 55455 (373-4508).

Publication Short Title: Potholes and Groundwater - Minnesota

Publication Abstract:

Net seepage from a typical glacial Minnesota pothole (Pitcher Lake) was determined by means of a water budget analysis. A 1966 study shows the net seepage for the period May through October was 0.398 foot; the evaporation for the same period totaled 2.357 feet. The hydrologic regimen of Pitcher Lake was largely controlled by precipitation, evaporation, transpiration and runoff. Net seepage was a minor factor. Small and shallow nearly potholes that are not lined with well-developed plot and/or gyttia, displayed larger water losses. The mass-transfer theory was utilized to calculate evaporation.

Publication Author: Reinke, J.W.

Publication Title: The Hydrology of a Typical Ice Block Glacial Lake

Publication Source: Univ. of Minn., Department of Agricultural Engineering, M.S. Thesis, 1968. 162 p., 11 fig., 10 tab., 28 ref.

Publication Corporate Author: Univ. of Minn., St. Paul

Publication Descriptors: / *potholes/ *seepage/ *groundwater/ water table/ precipitation/ evaporation/ Minnesota/ hydrology/ ice/ rain gage/ sediments/ peat/ soils/ glacial deposits/ topography/ snowmelt

Publication Identifiers: / *small lakes/ *test holes/ *water level gage/ gyttja

Publication Availability:

Reference copy available at Water Resources Research Center, Univ. of Minn., Room 107 Hubbard Building, 2675 University Ave., St. Paul, Minnesota 55114 (646-6309). Reference copy available at Department of Agricultural Engineering, Univ. of Minn., 213 Agricultural Engineering, St. Paul, Minnesota 55101 (373-1304).

OWRR Project No.: B-002-Minn.

Project Title: The Effect of Natural Sealing of Potholes Upon Water Movement and Groundwater Resources

Principal Investigator: P.W. Manson, Univ. of Minn., Department of Agricultural Engineering

Project Began: July 1, 1965 Project Ended: June 30, 1968

FCST Research Category: IV-A

Publication Short Title: Hydrology of Ponds and Small Lakes - Minnesota

Publication Abstract:

The study of the hydrology of small lakes and ponds in Minnesota started in 1962 as a project based on measuring the change in water and ice levels on 46 small bodies of water. The result of 3 years of study were published in 1968. Four of the 46 bodies of water were selected for more detailed studies. Water budgets were calculated by a computer program from field data collected by recording instruments. Evaporation and net seepage were calculated with the quasi-mass transfer equation. Average net seepage of the four bodies of water was 1.2 feet per year. The seepage rate accounts for about 12 to 20 percent of the total losses. It is concluded that the regimen of shallow bodies of water in Minnesota is controlled primarily by the ratio between precipitation and evaporation. The way to conserve water resources for groundwater supplies is to induce infiltration over the surface rather than to store water in open ponds where evaporation causes it to be lost to the atmosphere.

Publication Authors: Allred, E.R., Manson, P.W., Schwartz, G.M. Golany, P., and Reinke, J.W.

Publication Title: Continuation of Studies on the Hydrology of Ponds and Small Lakes

Publication Source: Univ. of Minn., Agricultural Experiment Station, Tech. Bull. 274, 1971. 62 p., 33 fig., 45 tab., 30 ref.

Publication Corporate Author: Univ. of Minn., St. Paul

Publication Descriptors: / *ponds/ *seepage/ *hydrology/ precipitation/ evaporation/ lakes/ lake beds/ transpiration/ groundwater/ water budget/ ice/ mass transfer/ rain gage/ recharge/ evaporation pans/ topography/ soil/ sediments/ chemical analysis/ computer programs

Publication Identifiers: / *Minnesota/ *distance thermograph/ *water level recorders/ totalizing anemometer/ *hygrothermograph

Publication Availability:

Reference copy at Water Resources Research Center, Univ. of Minn., Room 107 Hubbard Building, 2675 University Ave., St. Paul, Minnesota 55114 (646-6309). Limited number of free copies available at Agricultural Experiment Station, Univ. of Minn., 220 Coffey Hall, St. Paul, Minnesota 55101 (373-0751).

OWRR Project No.: B-003-Minn.

Project Title: Storage and Movement of Water in Soils as Related to Spatial and Time Changes in the Clay-quartz Matrix

Principal Investigator: G.R. Blake, Univ. of Minn., Department of Soil Science

Project Began: January 1, 1966 Project Ended: February 28, 1969

FCST Research Category: II-G

Publication Short Title: Soil Matric Suctions - Minnesota

Publication Abstract:

Soil matric suctions were measured with time in soil samples in which the water content was varied in a series to obtain information on the processes occurring as stable structural units develop during aging. Soil matric suctions of Clarion loam surface soil were measured by tensiometers. It is concluded that water stability of synthetic soil aggregates increases with time. At low water contents ($\theta_w < 0.258$g/g) there was a rapid decrease in soil matric suction with time after pressing that indicates an increase in the frey energy state of water in the system. At higher water contents the rate of decrease in matric suction was smaller; at $\theta_w = 0.258$g/g suction remained constant with time. At water contents over 0.258g/g soil matric suction increased with time.

Publication Author: Fuentes, V.C.

Publication Title: Soil Matric Suction Changes with Time in Pressed Soil Briquettes

Publication Source: Univ. of Minn., Department of Soil Science, M.S. Thesis, 1970. 68 p., 13 fig., 2 tab., 59 ref.

Publication Corporate Author: Univ. of Minn., St. Paul

Publication Descriptors: / *soil stability/ *soil aggregates/ *tensiometers/ clay/ Minnesota/ loam/ moisture/ aging/ cation/ soil water/ colloidal

Publication Identifiers: / *soil matric suctions/ *water stability/ soil structure/ tillage/ thixotropic/ colloidal surface

Publication Availability:

Reference copy available at Water Resources Research Center, Univ. of Minn., Room 107 Hubbard Building, 2675 University Ave., St. Paul, Minnesota 55114 (646-6309). Reference copy available at Department of Soil Science, Univ. of Minn., Room 125 Soil Science, St. Paul, Minnesota 55101 (373-1062).

OWRR Project No.: B-009-Minn.

Project Title: Relation of Phosphorus in Lake-bottom Deposits and Pollutional History of Minnesota Lakes

Principal Investigator: Joseph Shapiro, Univ. of Minn., Limnological Research Center

Project Began: July 1, 1967 Project Ended: June 30, 1970

FCST Research Category: II-H

Publication Short Title: Algae and Phosphorus, Lake Minnetonka, Minnesota

Publication Abstract:

Chlorophyll analyses and photosynthesis experiments were performed during 1968 in Lake Minnetonka to measure the degree of eutrophication in basins. In terms of algae growth at depths where light is optimal Lower Lake Minnetonka ranks third among 15 lakes that have been studied in Minnesota. Photosynthesis beneath a unit of lake surface, however, is greater in Minnetonka than in the other lakes. It is estimated that the daily production of organic matter could be reduced more than 50% if the phosphorus concentration in surface waters could be reduced from 50µg/L, which was the typical concentration, to 30µg/L, which was the lowest concentration that was measured. Depth maps indicate that the basin is virtually the same in 1968 as it was in 1905. Sedimentation rates evidently have not accelerated significantly during the last 50 years and there is no limnological reason why the lake could not be rejuvenated.

Publication Author: Megard, R.O.

Publication Title: Algae and Phosphorus in Lake Minnetonca

Publication Source: Univ. of Minn. Limnological Research Center, Interim Rept. No. 4, 1968. 26 p., 9 fig., 3 ref.

Publication Corporate Author: Univ. of Minn., Minneapolis

Publication Descriptors: / *phosphorus/ *eutrophication/ *lakes/ pollution abatement/ Minnesota/ algae/ chlorophyll/ photosyntheses/ organic matter/ nitrate/ nutrient/ fertility/ diatom/ sewage/ watershed/ limnology/ waste treatment/ sediments

Publication Identifiers: / *lake management/ *rejuvenate/ *algal density/ blue-green algae/ threshold

Publication Availability:

Reference copy at Water Resources Research Center, Univ. of Minn., Room 107 Hubbard Buiding, 2675 University Ave., St. Paul, Minnesota 55114 (646-6309). Limited number of free copies available at Limnological Research Center, Univ. of Minn., 207a Pillsbury Hall, Minneapolis, Minnesota 55455 (373-4508).

OWRR Project No.: B-010-Minn.

Project Title: A Study of Techniques for Determining Changes in Phytoplankton in Clouds of Fluorescent Dye Moving in the Mississippi River.

Principal Investigator: Edward F. Miller, St. Mary's College, Department of Biology

Project Began: July 1, 1967 Project Ended: June 30, 1969

FCST Research Category: V-C

Publication Short Title: Phytoplankton in Mississippi River, Minnesota

Publication Abstract:

The portions of the Mississippi River used in this study lies between the dams at Trempeauleau, Wisconsin and Winona, Minnesota. The Mississippi River in the Winona area carries a rich planktonic flora principally composed of blue-green algae and diatoms. Little is known concerning parameters of population dynamics for species of these organisms in the river. If the identity of a particular mass of water could be maintained to any degree, then estimates might be made on fecundity, mortality rate, immigration and emigration in a plankton population. The sloughs and marshy areas along a river which contribute heavily to the plankton of the main stream could be identified. A new technique involving Rhodamine WT was used to identify a mass of moving water traveling across two transects. Due concentrations along the course indicated regular patterns of 3-dimensional mixing. The best estimate of cloud shape is one of an equal-sided parallelogram having a depth equivalent to the mean or the depth at the transect. The water in which the periphery of the cloud moved in expanding contained essentially the same number of individual plankton individuals per unit volume as the upstream cloud, with the exception of the general Melosira. The water gained by the cloud while in transit contained fewer Melosira per unit volume thus diluting the population so that the downriver mean was significantly different from that upriver.

Publication Author: Johann, D.R.

Publication Title: A New Fluorescent Technique for the Determination of Changes in Selected Phytoplankton Populations in Lotic Aquatic Ecosystems

Publication Source: St. Mary's College, Department of Biology, M.S. Thesis, 1969. 21 p., 6 fig., 1 tab., 7 ref.

Publication Corporate Author: St. Mary's College, Winona

Publication Descriptors: / *fluorometry/ *dye releases/ *phytoplankton/ Minnesota/ Mississippi river/ plankton/ zooplankton/ diatoms/ pollution/ organisms/ bacteria/ aereal photography

Publication Identifiers: / *fluorescent dyes/ *mass of water/ *Rhodamine WT/ blue-green algae/ aquatic fungi

Publication Availability:

Reference copy at Water Resources Research Center, Univ. of Minn., Room 107 Hubbard Building, 2675 University Ave., St. Paul, Minnesota 55114 (646-6309). Limited number of free copies available at Department of Biology, St. Mary's College, Winona, Minnesota 55987.

OWRR Project No.: B-015-Minn.

Project Title: Characteristics of the Soil Matrix That Affect Water Storage and Movement

Principal Investigator: G.R. Blake, Univ. of Minn., Department of Soil Science

Project Began: January 1, 1969 Scheduled Completion: December 31, 1972

FCST Research Category: II-G

Publication Short Title: Stabilization of Field Soils - Minnesota

Publication Abstract:

Aggregates were collected from 4 soil types at five field sites in southern Minnesota immediately after plowing. Experiments were conducted to test the hypothesis that freshly formed aggregates in field soils stabilize over a period of time after formation. Aggregates were aged at constant water content and wet sieved at different times. Natural aggregates from field soils showed an increasing stability with time. It is concluded that after plowing secondary tillage should not be carried out until aggregates can withstand further sheer forces placed upon them. The waiting period should be at least 10 to 12 hours. Rain soon after plowing will do a greater damage to soil structure that at a later time when intraaggregate lands have strengthened.

Publication Author: Arya, L.M.

Publication Title: Stabilization of Shear-Generated Soil Aggregates

Publication Source: Univ. of Minn., Department of Soil Science, M.S. Thesis, 1969. 63 p., 8 fig., 14 tab., 48 ref.

Publication Corporate Author: Univ. of Minn., St. Paul

Publication Descriptors: / *soil aggregates/ *soil stability/ *infiltration/ plant growth/ soil erosion/ soil texture/ soil water/ loan/ soil types/ topography/ soil classification/ moisture/ clay/ shear/ aging/ porosity/ surface tension/ rainfall

Publication Identifiers: / *interparticle spacing/ *soil structure/ *tilth/ thixotrophy/ wet sieving/ tillage

Publication Availability:

Reference copy available at Water Resources Research Center, Univ. of Minn., Room 107 Hubbard Building, 2675 University Ave., St. Paul, Minnesota 55114 (646-6309). Reference copy available at Department of Soil Science, Univ. of Minn., Room 125 Soil Science, St. Paul, Minnesota 55101 (373-1062).

Publication Short Title: Wet Strength of Silica - Diluted Soil - Minnesota

Publication Abstract:

Synthetic soil aggregates were made of Clarion clay loam or Port Byron silt loam soils diluted with sphirical glassbeads or with angular quartz sand of various quantities and sizes. The relative stabilities of the synthetic soil aggregates were determined by use of the wet sieving method. Stability increased as the first increments of quartz were added to Clarion clay loam but decreased as added quartz increased from 4.5 to

14.5%. Synthetic aggregates of both soils generally decreased in stability as size of added quartz increased. Analysis of variance showed that soil type, kinds of quartz with which the soil was diluted, size and quantity of the added quartz, are important factors affecting the wet strength of soil aggregates.

Publication Author: Hwang, Chyi-sheng

Publication Title: Wet Strength of Silica - Diluted Synthetic Soil Aggregates

Publication Source: Univ. of Minn., Department of Soil Science, M.S. Thesis, 1969. 48 p., 12 fig., 9 tab., 38 ref.

Publication Corporate Author: Univ. of Minn., St. Paul

Publication Descriptors: / *soil stability/ *soil aggregates/ *soil water/ clay/ loam/ quartz/ soil types/ silts/ organic matter/ surfaces/ Minnesota/ particle size/ particle shape/ aging

Publication Identifiers: / *silicic acid/ *polymerization/ *wet sieving/ silica-organic complexes/ polymer/ water stabilization

Publication Abailability:
Reference copy available at Water Resources Research Center, Univ. of Minn., Room 107 Hubbard Building, 2675 University Ave., St. Paul, Minnesota 55114 (646-6309). Reference copy available at Department of Soil Science, Univ. of Minn., Room 125 Soil Science, St. Paul, Minnesota 55101 (373-1062).

OWRR Project No.: B-031-Minn.

Project Title: Participatory Ecology: A study of citizens groups involved at the grass roots to improve the water resources environment

Principal Investigator: L.P. Gerlach, Univ. of Minn., Department of Anthropology

Project Began: July 1, 1969 Scheduled Completion: June 30, 1972

FCST Research Category: VI-B

Publication Short Title: Ecology Movement

Publication Abstract:
More than 7,000 Natural History Magazine readers responded to an ecology survey questionnaire published in June 1970. For purposes of analysis, the sample was divided in several ways: on the basis of age, of sex, of occupation and of participation in environmental groups. The much-touted generation gap is not apparent at least on environmental issues. Most feel that all families should limit the number of children. Most feel a personal involvement in pollution and ways to abate pollution including radical changes in life-style. Only 18% felt that the environmental crisis can be solved primarily through technological advances. Most disagree with the statement that plants and animals exist primarily for man's use and enjoyment. Conservation-oriented respondents question the capacity of American economic and political institutions to solve environmental problems. The assumption that economic growth is generally good is clearly challenged. On environmental issues, differences in attitudes are not so much a function of age as of the degree of commitment.

Publication Authors: Hine, V. and Gerlach, L.P.

Publication Title: Many Concerned, Few Committed

Publication Source: Natural History Magazine, The Museum of Natural History, New York, Dec.-Jan. 1971. p. 17, 76-80.

Publication Corporate Author: Univ. of Minn., Minneapolis

Publication Descriptors: / *ecology/ *environment/ *movement/ attitudes/ population/ technology/ conservation/ social values/ economics/ natural resources/ profit/ political aspects/ social change/ technology/ social participation

Publication Identifiers: / *environmental issues/ *beliefs/ *commitment/ generation gap/ assumptions/ life-style/ religion/ social institutions

Publication Availibility:
Reference copy at Water Resources Research Center, Univ. of Minn., Room 107 Hubbard Building, 2675 University Ave., St. Paul, Minnesota 55114 (646-6309). Reference copy at Department of Anthropology, Univ. of Minn., 210 Ford Hall, Minneapolis, Minnesota 55455 (373-2601).

OWRR Project No.: B-032-Minn.

Project Title: Mississippi River Ecology Associated with Heated Power Plant Effluent

Principal Investigator: A.J. Hopwood, Department of Biology, St. Cloud State College, St. Cloud, Minnesota 56301

Project Began: July 1, 1969 Scheduled Completion: June 30, 1972

FCST Category: VI-G

Publication Short Title: Fish Study on Mississippi River - Minnesota

Publication Abstract:

A nuclear-fueled electrical generating plant will operate on the Mississippi River near Monticello. Coolant for condensers will be returned to the river and the heated discharge water is expected to manigest changes in the existing biota of the river. This study was made to establish fish baselines before operation of the plant so that changes can be delineated. Population makeup, by species; migration patterns; indices of physical condition; and the use of microhabitat by the various species are determined one mile above and five miles below the plant. Population estimates by use of the Schnabel method, were made for the two dominent species, northern redhorse and carp. Each species had particular requirements of habitat wherein it was best ablt to function.

Publication Author: Scherer, H.P.

Publication Title: A Fish Study on the Mississippi River at Monticello, Minnesota

Publication Source: St. Cloud State College, Biology Department, M.S. Thesis, 1970. 75 p., 11 fig., 15 tab., 12 ref.

Publication Corporate Author: St. Cloud State College, St. Cloud

Publication Descriptors: / *fish/ *Mississippi River/ *nuclear power plant/ ecology/ pollution/ environment/ ecosystems/ Minnesota/ organisms/ heated water/ coolants/ population/ species/ migration patterns/ vegetation/ temperature/ aging

Publication Identifiers: / *microhabitat/ *electrofishing/ *Schnabel method/ gamefish/ physical abnormalities

Publication Availability:

Reference copy available at Water Resources Research Center, Univ. of Minn., Room 107 Hubbard Building, 2675 University Ave., St. Paul, Minnesota 55114 (646-6309). Reference copy available at Biology Department, St. Cloud State College, St. Cloud, Minnesota 56301 (255-2037).

Publication Short Title: Macroinvertebrates of Mississippi River - Minnesota

Publication Abstract:

A nuclear-fueled electrical generating plant will operate on the Mississippi River near Monticello. Coolant for condensers will be returned to the river and the heated discharge water is expected to manifest changes in the existing biota of the river. This study was made to determine the quality and quantity of the microinvertebrates population and to determine those factors affecting it so that changes caused by operation of the plant can be appraised. The major groups represented

in a survey were the Coleoptora, Ophemeroptera and Hemiptera. Invertibrate bottom fauna were very dependent upon current, depth and river bottom characteristics. The major components of the invertebrate bottom fauna were the Tricoptera and the Ephemoroptera.

Publication Author: McConville, D.R.

Publication Title: Macroinvertebrates of the Mississippi River in the Monticello Region

Publication Source: St. Cloud State College, Biology Department, M.S. Thesis, 1969. 85 p., 13 fig., 16 tab., 34 ref.

Publication Corporate Author: St. Cloud State College, St. Cloud

Publication Descriptors: / *invertibrates/ *Mississippi River/ *nuclear power plant/ water quality/ Minnesota/ temperature/ currents/ limnology/ ecosystem/ environment/ nutrients/ pollution

Publication Identifiers: / *macroinvertibrates/ *substrata/ *taxonomic keys/ river bottom samples

Publication Availability:

Reference copy available at Water Resources Research Center, Univ., of Minn., Room 107 Hubbard Building, 2675 University Ave., St. Paul, Minnesota 55114 (646-6309). Reference copy available at Biology Department, St. Cloud State College, St. Cloud, Minnesota 56301 (255-2037).

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