

**REQUEST FOR INITIAL ALLOTMENT
TO ESTABLISH A WATER
RESOURCES RESEARCH INSTITUTE
FOR THE STATE OF OHIO**

to

Director, Office of Water Resources Research
The United States Department of Interior

Submitted by:

Water Resources Center
The Ohio State University

November 30, 1964

THE OHIO STATE UNIVERSITY
ENGINEERING EXPERIMENT STATION
WATER RESOURCES CENTER
1791 NEIL AVENUE
COLUMBUS, OHIO 43210
November 30, 1964

293-6108

Dr. John C. Calhoun, Jr.
Acting Director
Office of Water Resources Research
The United States Department of Interior
Washington, D. C. 20240

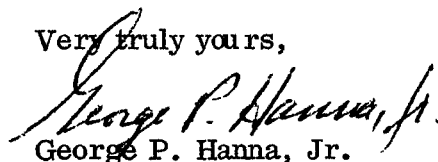
Dear Sir:

The Water Resources Center of The Ohio State University hereby respectfully submits its request for an initial allotment of \$75,000.00 for the fiscal year 1964-65 to continue operations of a Water Resources research facility serving the State of Ohio. It is intended that the allotment will be utilized to provide assistance in conducting basic and applied water resources research as designated under Public Law 88-379.

The accompanying request evidences the various requirements for program participation in accordance with part 502 of the Office of Water Resources Notice of Proposed Rules and Regulations, as published in the Federal Register, Volume 29, Number 212, October 29, 1964. The request further documents the water research and development needs in the State of Ohio, and sets forth an integrated and comprehensive long range program to achieve the intended goals.

The detailed program included under the initial allotment request will provide assistance for completing links in and providing an integrated coordination of existing programs, will initiate new programs, and will bolster the necessary cooperation with other agencies and groups active in the water resources field.

Very truly yours,


George P. Hanna, Jr.

Director, Water Resources Center

GPH:dmm

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TABLE OF CONTENTS

	page
a. Requesting Institution	1
b. Responsibility for Accounting and Reporting	1
c. Institutional Qualifications	2
d. Participation by Other Colleges or Universities	5
e. Institutional Capabilities	6
1. General Plan of Operation	6
(a) Organization	6
(b) Proposed Program	7
(1) Aims and Goals	7
(2) Initial Efforts	11
<u>a</u> The Acid Mine Drainage Program	13
Development of a "Natural" Laboratory for the Study of Acid Mine Drainage	15
A Study of the Microbial Flora of Acid Waters	24
A Biological Survey of Acid Mine Waters	30
<u>b</u> The Oilfield Waste Disposal Problem	38
A Study of Ground Water Contamination due to Saline Waste Water Disposal in the Morrow County Oil Fields	38
2. Facilities	45
3. Personnel	49
4. Funds	49
f. External Cooperation	50
1. Cognizance of Other Research Projects	50
2. Personnel Displacement	51

	page
3. Water Resources Needs - State of Ohio	51
4. Advice and Assistance	54
5. Program Coordination with Others	55
g. Development Rights Agreement	56
h. Financial Plan	56
i. Notice of Research Project	57

APPENDICES

	page
Appendix A - Designation and Appointments	59
History - The Ohio State University	61
Appointment of Mr. C. V. Oster	63
Appointment of Water Resources Center Advisory Committee	64
Appendix B - Research Activities	65
Recent Major Research Programs	67
Toxic Waste Studies	67
Acid Mine Drainage	67
Engineering Geology of the Shoreline of Lake Erie	71
Fram Pond Studies	71
Septic Tank Evaluations	72
Detergent Biodegradability	72
Aquatic Biology Studies	73
Hydrological Classification of Rivers	76
Current Research Projects	77
Appendix C - Biographies	87
Appendix D - Notices of Research Projects	135

REQUEST FOR INITIAL ALLOTMENT
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Director, Office of Water Resources Research
The United States Department of the Interior

a. Requesting Institution

The Water Resources Center of The Ohio State University hereby requests an initial allotment of \$75,000.00 for the fiscal year 1964-1965 to provide assistance in conducting basic and applied water resources research as designated under Public Law 88-379, and in accordance with Part 502 of the Office of Water Resources Research, Notice of Proposed Rules and Regulations, as published in the Federal Register Volume 29, Number 212, October 29, 1964.

The Ohio State University, Columbus, Ohio, is an institution of learning established in accordance with the Act of July 2, 1862 (12 Stat. 503), entitled "An Act donating public lands to the several States and territories which may provide colleges for the benefit of agriculture and the mechanic arts," and it is the only institution of learning established under this Act in the State of Ohio. A copy of the "History" portion of General Information section of The Ohio State University Bulletin for 1964-65 is included in Appendix A as further evidence that the requesting institution conforms to the requirements of Section 100 of the Water Resources Research Act of 1964.

b. Responsibility for Accounting and Reporting

Clinton V. Oster, Controller, The Ohio State University, has been

appointed by the University President as the officer to receive and account for all funds paid under the Act (i. e., Public Law 88-379); and to make annual reports to the Secretary of the Interior, together with a detailed statement of the amounts received under any provision of the Act during the preceding fiscal year, and of its disbursement, on schedules prescribed by the Secretary. A copy of Mr. Oster's appointment is included in Appendix A.

The Director of the Water Resources Center is responsible for the planning of the work performed through, and for the annual reporting of work accomplished and status of projects underway for the entire water resources research program established under the provisions of Public Law 88-379.

c. Institutional Qualifications

The Ohio State University has in existence a Water Resources Center which has plans for and is qualified to conduct:

1. Competent research, investigations and experiments of both a basic and practical nature in relation to water resources, and
2. The training of scientists through such research investigations and experiments.

The Water Resources Center was created as a separate area of research under the Engineering Experiment Station in 1958. It is an outgrowth of the older Waste Treatment Laboratory which has been in existence since 1947. In April 1964, the University administration assigned the direction and coordination of all multidisciplinary research in the water resources area at The Ohio State University to the Water Resources Center.

The research programs at the Center are both of a fundamental and applied nature involving the study of basic scientific phenomena and their

relation and application to the water resources field. Some of the major water resource projects which have been pursued at this University in the recent past are: the effect of heavy metals on the biological treatment processes; several aspects of the acid mine drainage problems; a study of the engineering geology of the shoreline of Lake Erie; evaluation of the farm pond problem; septic tank evaluations; investigations of the biodegradability of various detergents; aquatic biology studies; and a hydrological classification of river systems in the Great Lakes-St. Lawrence Basin. The above listed areas of research are described more fully in Appendix B. The scope of some of these projects will demonstrate the continuity of effort expended, and the extent to which interdisciplinary participation has been achieved at this University.

The projects mentioned above have provided thesis and dissertation materials for numerous graduate students pursuing studies in the various colleges during the past few years, and publications relating to these projects are to be found in past and current technical journals, as referenced in individual biographies included in Appendix C.

Current water resources research at The Ohio State University includes a vast spectrum of activity ranging from investigations of hydrologic phenomena to water utilization and water quality considerations.

The activities may be broadly grouped into the following categories:

1. General small watershed hydrological investigations, irrigation problems, soil erosion studies, and soil porosity and drainage studies conducted by the College of Agriculture and the Agricultural Experiment Station.
2. Water quality studies as defined by physical, chemical and biological characteristics in relation to intended uses with specific emphasis on potable water supplies.

3. Studies leading to the reclamation of domestic and industrial waste waters, and the return of these waters to the hydrological cycle for eventual reuse.
4. The ecology of the water environment, interrelationships, and effects on water quality.
5. The application of physical laws and chemical equilibrium observations to study the movement of water masses.

The major portion of research involves several departments in the colleges of Agriculture, Arts and Sciences, and Engineering. An extensive and broad program of both basic and applied research related to water resources is underway. Many of these projects are conducted cooperatively by more than one department, and in some cases with other agencies. This allows an effective team approach on problems where pooling of several fields of knowledge and scopes of action are required.

A number of the current studies are described more fully in Appendix B.

The training of scientists through research, investigations and experiments is carried on through established graduate programs. These graduate programs leading to the Master and Doctor of Philosophy degrees are available in all departments cooperating in the interdisciplinary water resources field. A Public Health Service Grant established for five years beginning July 1, 1964, in the amount of \$160,000.00, provides for graduate interdisciplinary training in the Water Supply and Pollution Control field. A National Science Foundation fellowship and a J.B. Clow (Industrial) fellowship are also available for training of sanitary engineers. In addition, three-year graduate fellowships are available under the National Defense Education Act for study in Isotope Geology - Geochemistry. Several Research Assistantships and Teaching Assistantships are also

available among the various disciplines for water resource study.

Currently, graduate seminars are being conducted biweekly in conjunction with the Public Health Service Training Grant program. These seminars cover a broad scope of water resource and management activities as presented by leaders in the water resources field from federal, state, and local agencies.

Recent graduates with advanced degrees are now in education; public agencies (Public Health Service, Department of Interior); industries (Mead Paper, West Virginia Pulp and Paper, Sharpe and Doane, Procter and Gamble) and with consulting engineering firms.

Seminars were conducted by the Institute of Natural Resources and supported by University funds relating to Water Management Systems in 1961-62 and Water Supply and Pollution Control in 1962-63. These seminars resulted in bringing national authorities to the University to participate in discussions involving University and public agency personnel, and focused attention on these problems through published proceedings.

Evidence of continued plans for interdisciplinary competent research, investigations, and experiments, both of a basic and applied nature, relating to water resources may be inferred from the past and current performances as indicated above, and from the more specific research plans as described in the following section e 1 (b).

d. Participation by Other Colleges or Universities

Current University cooperation with other universities exists in a number of other areas, thus establishing the precedence for cooperative efforts which are anticipated in this area. Participation of Ohio Wesleyan University in this

program will be pursued as indicated in the proposal entitled "A Biological Survey of Acid Mine Wastes" included under Section e 1 (b).

e. Institutional Capabilities

The Ohio State University has the capability of doing effective work in the various water resources research activities contemplated by the Water Resources Research Act of 1964 as is evidenced by the research and associated teaching of physical, social, and biological scientists and engineers which has been accomplished in the past and which is being currently accomplished, as previously indicated in section c above.

1. General Plan of Operation

(a) Organization

The Ohio State University is organized to do effective work in the water resources research area through its Water Resources Center. The Water Resources Center, administered through the Engineering Experiment Station, is an interdisciplinary function of the University and is charged with the direction and coordination of all research in the water resources area at The Ohio State University. Its Director is appointed by the Dean of the College of Engineering. It is the philosophy of this University to host interdisciplinary activities within one of the major participating colleges, both for the purpose of more effective administration and to assure that all participants in the programs will maintain academic relations in their respective departments. Further, since the Center is hosted in the College of Engineering for administrative purposes, the Dean of the College of Engineering has a responsibility to the Vice President for

Research and the Vice President for Instruction to insure that the interdisciplinary effort is maintained.

The Water Resources Center staff is comprised of personnel from all areas which have a definite interest in the water resources field and are participating in projects administered through the Center. An advisory committee to the Center is appointed by the President from the various colleges and departments evidencing an interest in the water resources field. Currently, the Colleges of Engineering, Agriculture, Arts and Sciences, and Commerce are represented on an advisory committee through the Departments of Agriculture, Agricultural Engineering, Chemical Engineering, Civil Engineering, Economics, Geology, Geography, Microbiology, and Sociology and Anthropology. The functions of the committee are to advise and coordinate the activities of the Water Resources Center with the interests of their respective departments, to review the Center's activities, to advise the Director, and to review proposals and make appropriate recommendations. Basically, the committee will operate to insure that an interdisciplinary character is maintained in the Water Resources Center's research studies, training programs, and activities. A copy of the latest letter of appointment constituting the Advisory Committee to the Water Resources Center is included in Appendix A.

(b) Proposed Program

(1) Aims and Goals

In the overall planning associated with the future of Ohio, it will be necessary to predict the effects of available water resources on the impending sociological and economic developments. The major goal of the Water Resources

Center will be to further the optimum utilization of water resources consistent with these developments. In order to achieve this major goal it will be necessary to develop a "Center of Excellence" of research and training, and an associated task force to which the various groups concerned with water resources will look for information and guidance; to establish a means of information exchange with the various agencies involved in the water resources area; and to provide a reservoir of well trained personnel in the various water specialties to fulfill the needs of industry and public service.

The development of a continuous research program is envisioned which will be cognizant of current needs and which will integrate separate but related studies into a comprehensive program directed toward these goals.

Research in water resources problems of any kind leads inevitably to study of related social, economic, and governmental problems since water problems ultimately involve social causes, social and economic consequences, and social process in their development and solution.

It is to be anticipated that insights and research talents from such areas as urban sociology, ecology and demography, resource geography, economics, community and regional analysis, social organization, and mass communication, will be required in definite research focused on problems of water use and abuse. Mounting population pressure, rural to urban migration, and urban to suburban migration multiply problems of water conservation. Predictable changes in the character of urban populations and economics foreshadow developing problems involving water resources. Economic and social criteria must be developed in order to assess optimum values both with respect to individual and multiple use functions. The impounding of waters in rural and

suburban areas by metropolitan authorities for use in urban centers, for example, generates problems of inter-community conflict, regional and area planning, mass communication, and mass education. Such problems are already acute. Their solution requires research in such areas as social organization, power structure analysis, decision-making process, attitude analysis, information diffusion, and social action. Talent for research of this kind is available and will be utilized as the program develops.

Further, as the present research into pollution problems evolves, there will be a greater opportunity for the social scientist to undertake research related to rural and urban populations, industrial water users, etc. Specific areas in which a geographer, for example, might make significant and unique contributions to a total research program in the pollution field include:

- (a) Spatial mapping of water and pollution problems and their consequences.
- (b) Detailed map analysis of any pollution problem as it is related to social and economic problems (included here would be computer mapping and interpretation).
- (c) Study of the perception of the pollution problem -- i. e., an analysis of the perception of flood problems, drainage problems, diffusion of pollution and its consequences.
- (d) Perception studies of the population's willingness to invest in pollution control and/or flood protection (as examples).
- (e) Resource allocation -- i. e., costs or prevention vs. social costs.

Such resource problems are part of the total problems of pollution and pollution control.

Data necessary for the optimum social and economic utilization of water resources will include a definition of the extent and availability of water resources in the State of Ohio with respect to both water quality and water quantity. Definition

of the quantity of available water resources requires the quantitative determination and characterization of the overall hydrologic cycle. Predictions of the effects of groundwater development, flood control projects, and other factors affecting a change on the overall hydrologic cycle will then be possible. A considerable amount of progress has already been accomplished in terms of a quantitative inventory of Ohio water resources, by the Ohio Division of Water.

Water quality studies are intimately related to water quantity, and are based on the measurement of all materials dissolved or suspended in waters, on the mechanisms by which these materials gain access to the waters, and on related biological activity.

A more immediate goal of water quality and quantity investigations is the optimum possible degree of management and control of these factors. Before such management and control can be realized, old methods must be modified, and new methods developed leading to more valid and applicable measurements of all aspects of water quantity and quality. Second, efficient management and control must necessarily be based on a thorough understanding of the fundamental mechanisms whereby water circulates through all portions of the hydrologic cycle, and whereby all contaminants (suspended and dissolved) enter waters, either through natural circumstances, or as a result of man's activities. This knowledge, together with the continued development of such operations as waste treatment methods, acid mine waste drainage alleviation, surface water impoundment procedures, low flow augmentation, flood control, and similar water quality and quantity control methods will lead to optimum water resource control and management.

The above statements of the major aims and goals help to establish a

general direction of effort, and provide an overall guide for plotting a course of research toward their attainment. The more immediate research and development goals are viewed as dynamic factors which must be re-evaluated at regular intervals in order to keep pace with the ever-changing needs and the new knowledge forthcoming from current and future research efforts.

It is fully expected that the members of the Advisory Committee to the Water Resources Center, all of whom are active researchers and directors of research in their respective areas, will maintain an awareness of changing emphasis on research and development needs, and will through regular meetings of the Committee coordinate the separate concepts into an integrated dynamic plan. It is further contemplated that regular reports to the Committee of research progress pursued through the Center will be made in order to permit the re-evaluation of the research, development, and training aims for each successive fiscal year, or stage of development.

(2) Initial Efforts

In order to initiate the program and at the same time to pursue a meaningful research study it has been necessary to consider the available talent, interest, and background of the University personnel as well as available facilities, and pertinent water problems of major concern to the State. Fortunately these considerations have produced agreeable results, and consequently the Committee has selected for study two areas of immediate concern, acid mine drainage, and the oil field brine wastes.

The problem of acid mine drainage while of long standing is of special importance at this time because of its relationship to the attention being given at national and state levels to economic and social problems in the Appalachian

Plateau region. It is, therefore, proposed to utilize a portion of funds made available through the first allotment to pursue some phases of the acid mine drainage research and development effort which have not been previously supported, and which are deemed necessary parts of the overall program in reaching definite conclusions relating to this important problem.

A portion of these funds will also be utilized to begin new or "seed" research projects dealing with other current problems. The general concept will be maintained that once a new project is underway, every effort will be made to secure other support wherever possible for the project or for its separate phases so that further funds provided under Public Law 88-379 may be utilized in support of necessary phases of the project that cannot be otherwise supported, or in support of new advancements. It is proposed that initially the new "seed" project to be supported involves the brine pollution problem from the current increased oil-field activity in the central Ohio region.

Biological studies are contemplated to be carried out and simultaneously with other investigations relating to each program undertaken. This necessitates the development of a biological survey team to conduct these activities. The initial phase of this work is therefore directed toward equipping of such a survey team, and beginning studies in the acid mine drainage problem commensurate with the other planned activities.

Further, this proposal allots a portion of initial funds for a special seminar or conference which will be planned for the early spring of 1965, involving University water resource personnel, state agency and inter-state agency personnel, and others concerned with the Ohio problems in order to report on the current Center activities, to report on the current Ohio water resource problems, and to maintain a close working relationship with the operating agencies charged with water resource

responsibilities in the state.

a The Acid Mine Drainage Program

The acid mine drainage problem as it relates to the economy and re - development of the coal mining regions has been well documented in numerous reports (1, 2, 3, and 4 below). The problem is one which has received considerable attention at this University, and a large measure of interdisciplinary competence has been developed as is evidenced in the appended information (Appendix B-1, Recent Major Research Programs).

Basically, the acid waters originate from exposure of natural sulfuritic materials to degradation processes and weathering as a result of the mining operations. Removal of the coal with its attendant exposure of these sulfur bearing materials to air and water activates a reaction ultimately producing sulfuric acid dilutions in the tributary streams. Natural oxidation and hydrolysis results in the characteristic red or brown sludge deposits of iron hydroxides which accumulate and smother biologic life natural to the waterways. The acid water production is closely associated not only with the active coal mining operations, but also with the inactive and abandoned workings which continue to spill forth acid waters. It has been variously estimated that some 2-1/2 million tons of sulfuric acid from active and abandoned workings pour into the Ohio River and its tributaries each year.

The problem is of specific major concern to Ohio since it affects some twenty-five percent of the entire Ohio area, contributing to the water pollution in a broad band covering the southeastern portion of the state, and extending north along the eastern portion, in general following the belt embraced by past and present coal mining activities.

Acid discharges destroying the natural alkalinity of tributary streams reduces

the water suitability for recreational, industrial, and municipal use due to increased acidities, total solids, sulfates, and iron. Successful attraction of industrial development to supplement the economy in depressed areas depends in good measure upon the ability to furnish an adequate supply of clean water, relatively free of solids and scale and corrosion producing characteristics, to satisfy its cleaning, cooling, and production consumption requirements. The potential risk that acid waters may develop is a deterrent to capital investment for either industrial or recreational expansion. Six counties in the Southern Ohio coal areas have experienced population decrease from 1.4 percent to 14.9 percent as compared to an overall state average increase of some 20 percent in the 1950 through 1959 decade, pointing out the total absence of a subsisting economy.

Much of the depressed area is forest oriented, and reforestation in some cases is a sound approach for area recovery. However, the length of time required for productive return from new plantings does not offer the more immediate economic gain that can be realized from industrial and/or recreational development. The maintenance of acid free waters in depressed areas as exemplified by southern Ohio would be a strong motivation for expansion of recreational facilities to serve the nearby urban areas. In addition, an assured supply of clean water is essential to attract industries.

Acid mine drainage studies currently underway at the University (appendix B-1) include "Aquatic Bacteria Related to Acid Mine Drainage," by Dr. C. I. Randles (NIH - Grant WP-0014 209) and "Study of the Sulfide to Sulfate Reaction Mechanism," by Dr. E. E. Smith (NIH - Grant WP-00-340). Both of the above projects involve fundamental laboratory mechanism investigations, and both are now to the point of

desirable confirmation by field experiment. Other related current activity is a basic study entitled "The Effect of Non-Toxic Organic Nutrients on Inhibition of Autotrophic Organisms" conducted by Dr. P. R. Dugan (NSF - Grant No. B 17313).

Individual proposals are detailed below.

The following proposal is submitted to develop a field facility in order to permit field evaluations of theories and ideas conceived in the laboratory. Such a facility would be maintained in order to gather long range information to the acid mine drainage problem.

DEVELOPMENT OF A "NATURAL " LABORATORY FOR THE STUDY OF ACID MINE DRAINAGE

Purpose

The purpose of this proposed program is to develop a versatile field system that can be used to confirm theories and abatement procedures suggested by basic mechanism studies.

At the present time there is no intermediate research facility between the laboratory and the (essentially) uncontrolled field experiment. The desirability of a "pilot-scale" research facility can be illustrated by the following examples:

It is well known that certain anti-oxidants and bactericides have a profound effect on pyrite oxidation in the laboratory. In the field, their effectiveness is short-lived. Evaluation of such abatement methods, and development of procedures to increase their period of effectiveness would require closely controlled field

experiments . In evaluating the effectiveness of water-flooding, the rate of acid production from the pyrite which is immersed and that which is exposed to air must be known. Reaction rates determined in the laboratory under different exposure conditions may be only an indication of what occurs under natural conditions. To relate laboratory information to field conditions, the field evaluation would require control of atmospheric and liquid phase oxygen concentration, as well as liquid level control, all of which could be incorporated into the research facility proposed.

An existing small sealed mine (known as the McDaniels Mine) in southeastern Ohio is considered a suitable location for the test facility. The complete facility is described in The Ohio State University Engineering Experiment Station Bulletin No. 166 . The mine has a volume of only some 130 cubic yards, and is sufficiently isolated from any other mining operations to preclude any flow communication there-with. A concrete seal was established on this mine in 1957 in an effort to pursue studies relating to the effectiveness of mine seals in general. Prior to constructing the seal some historical evaluations were made on water quality, water quantity, structural condition of the mine, a petrographic study of the coal, and a statistical sampling of the sulfur burden related to specific levels in the coal strata.

Water samples taken at irregular intervals have revealed a marked decrease in acidity. The atmosphere in the mine since the seal was constructed has remained remarkably uniform, with oxygen at an encouragingly low level. In general the study resulted in encouraging evidence that mine sealing may, under favorable circumstances, provide a means of minimizing oxygen production within a mine.

Although a program related to that proposed was considered, adequate funding was not available at the time the mine seal was constructed to collect all the required inventory information nor to build-in the desired testing and control facilities. Also, the characteristics of the mine to be determined could not be well-defined at that time since little was known of the mechanism by which pyrite was oxidized.

The work now being conducted under Grant WP 00340 from the National Institutes of Health at The Ohio State University has shown that: the oxidation rate is apparently controlled by a physical rather than a chemical reaction; that the reaction is first order in respect to water concentration in vapor phase oxidation and varies with the concentration of dissolved oxygen when pyrite is immersed. In addition, the relative reaction rates of different types of pyritic material are related to the total surface area of pyrite exposed.

These plus other findings made during the course of this project will be used, first, as a basis for making as complete an inventory of the mine's characteristics as practical, and then to evaluate the relative importance of these characteristics under field conditions.

Requirements of Field System

The facility should be, as far as possible, a "closed" system. Since complete isolation is impossible without loss of "natural" conditions, inputs and outflows must be known to accurately make material and energy balances.

The following broad characteristics of the system must be known or included in its facilities:

(a) Knowledge of:

(1) Surface area of exposed pyritic material at different levels of exposure.

- (2) Water and air permeability to the facility.
- (3) Data relating to the reaction rate of the different pyritic strata.
- (b) Ability to control atmosphere
- (c) Ability to predict and (at least partially) control water influx as affected by rainfall and water table level.
- (d) Ability to vary the microbiological environment.
- (c) Adequate facilities for sampling vapor and liquid phases without disturbing the system.

Detailed programs to develop the necessary information and facilities will require the closely coordinated efforts of hydrologists, microbiologists, and chemical, civil and mining engineers.

Specific Research Goals

With such a research facility available, a number of studies could be conducted in a quantitative manner which heretofore would have been impossible to carry out or would have given only qualitative information at best.

For example, a long range goal will be the verification of information necessary to predict the quantity and concentration of acid from a particular mine. Laboratory studies now indicate only a few factors need be specified to determine reaction rate. Verification under field conditions would provide the only acceptable proof.

Other specific studies would include:

- (a) Determination of effective period bactericides and oxidation inhibitors in a natural environment, and methods of prolonging effectiveness.
- (b) Methods of surface treatment to decrease oxidation and spalling in abandoned areas.

Specific Proposal: Initial Effort

It is proposed to drill a series of six (6) test holes in the vicinity of the sealed

mine; four are to be in a line perpendicular to the mine face and extending back away from the mine, and one is to be drilled on each side - all intercepting the water table in order to provide a means of "sounding" the piezometric level. Cores from these test holes will be examined in the Soil Mechanics Laboratory of the Civil Engineering Department to determine types of strata, and porosity and permeability. The laboratory data together with field observations of water levels will establish a flow pattern and provide information on mine inflow and outflow. Further, a small weir will be constructed in front of the mine to trap the flow from the immediate vicinity of the highwall around the mine. A water balance would then be possible resulting in an evaluation of the percolation of water held behind the mine seal into the subsoil and eventually reaching the water table level in front of the mine. It is anticipated that such data would be useful in terms of estimating the amount of acid contamination entering the water table through leaching from a sealed mine.

Samples of the different pyrite-bearing strata will be taken. These samples will be examined petrographically and mineralogically, to determine the total quantity and type of pyritic materials present, the absolute surface area of pyrite exposed, and the structure (physical properties) of the material in relation to its stability and change with exposure.

Laboratory rates for both liquid and vapor phase environment will be determined on the total samples and the "pure" pyritic material obtained by "float-and-sink" or heavy media separation.

Air permeability of the mine will be determined by injecting a known quantity of air into the sealed mine and measuring the rate of pressure dissipation. The current mine seal is structurally sound, and can be made air tight with a minimum of caulking.

Then, by pressurizing the mine to about 1/2 atmosphere and measuring the time for pressure to reach equilibrium, an idea of air permeability can be obtained. With this permeability factor and the difference in oxygen concentrations measured inside and outside of the mine (average oxygen concentration in mine equals about 11 percent) an overall rate of oxygen diffusion can be obtained. This provides a reasonable estimate of the amount of oxygen utilized inside the mine. This may be compared to estimated oxidation rates determined from laboratory evaluations of strata samples. These determinations would be made for different levels of flooding to determine, for example, the relative importance of liquid and vapor phase oxidation in mines.

Mechanical systems for collecting vapor and liquid samples at different points in and surrounding the mine and means for controlling the atmosphere; i. e., the concentration of oxygen, in the mine will be incorporated into the facility.

It is anticipated that the first six-months of effort will be utilized in tooling up for the experiment, in terms of the necessary construction and developments. Initially samples collected from the mine strata will be analyzed, and studied for oxidative characteristics. Following this initial phase, the water seal will be applied, and the long-term studies continued.

One of the first in terms of the long range experiments is the rate of acid production at different strata levels in the mine. This will be attempted by flooding the mine to different levels. The differential oxidations at these different levels measured in terms of acid production and the change in oxygen concentration in the vapor phase would indicate a relative measure of oxidation occurring in the vapor and the liquid phases. Successive air and water samplings will be necessary at regular intervals

until a measure of equilibrium has been reached before proceeding from one water level to the next. No attempt will be made here to estimate the time interval required for this equilibrium to occur until results of the first test have been evaluated. The amount of spalling that occurs from the mine roof and walls is also significant since it exposes fresh areas to oxidation. Routine examinations to determine amount of spalling will be made between testing stages. The information from these inspections coupled with vapor and liquid phase test data is expected to provide a more quantitative measure of the efficacy of the mine seal. If, for example, the major portion of the oxidation appears to occur in the vapor phase, mine flooding might be considered a successful expedient in the control of acid production.

Further studies with such a test facility might involve evaluation of the field biological oxidations through inoculation of the mine with a heavy culture of oxidative organisms. A comparative effect of biological oxidation related to the mine wastes might thus be field tested. The facility would also offer a potential for inhibitory studies in terms of wall seals or sprays, or in terms of testing of vapors or foams considered to have oxidative inhibitory qualities.

Although this project is expected to continue for some time, no estimate of activity is included for future years, pending the outcome of the first six months activity and accomplishments.

Personnel

Professional personnel participating in this study with their approximate percentages of time involved are as follows:

Dr. E. E. Smith, Department of Chemical Engineering Principal Investigator	15%
Dr. K. S. Shumate, Department of Civil Engineering	25%

Dr. W. H. Perloff, Jr., Department of Civil Engineering 10%

Biographies of the above personnel are included in Appendix C.

Budget - January 1, 1965 through June 30, 1965

(a) Personnel

Salaries - (Professional Personnel)	\$3,230.00	
Salaries - (Technical Staff) (1/2 time graduate student)	1,748.00	
Wages - (1 man full-time @ \$2.00 per hour)	2,016.00	
	<hr/>	
Total for personnel		\$6,994.00

(b) Consumable Supplies

2-inch casing for 6 bore holes @ 80 ft. each 480 ft. @ \$1.20 per ft.	576.00	
Chemicals and miscellaneous supplies	800.00	
	<hr/>	
Total for consumable supplies		\$1,376.00

(c) Travel Expenses

Travel to mine site for study, observation and sample collections (approximately 2 trips per week)	1,040.00	
Travel to scientific meeting (1 man)	150.00	
	<hr/>	
Total for travel		\$1,190.00

(d) Other Expenses

Area preparation, installation, and maintenance costs:		
Labor and equipment charges for site clearing, etc.	1,000.00	
Borings for observation wells and setting of casings	3,000.00	

Construction of impoundment and weir in front of mine opening	500.00	
Reports	200.00	
	<hr/>	
Total other expenses		\$ 4,700.00
		<hr/>
TOTAL BUDGET		\$14,260.00

Acid Mine Drainage References

- (1) Hanna, G. P. et al "Acid Mine Drainage Research Potentialities"
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The Ohio State University, Engineering Experiment Station Bulletin
179 (1960) .
- (3) Moulton, E. Q. et al "The Acid Mine Drainage Problem in Ohio"
The Ohio State University, Engineering Experiment Station Bulletin
166 (1957) .
- (4) Report of the Ohio River Committee - Letter from the Acting Secretary
of War on Ohio River Pollution Control, House Document No. 266 (1943).

A STUDY OF THE MICROBIAL FLORA OF ACID WATERS

Introduction

The role of microbiology in water resources research involves specific considerations of the natural metabolic functions performed by organisms in relation to their aquatic environment. Microorganisms play a significant role in the biological food chain and are therefore intimately related to the biological productivity of any body of water. Bacteria are recognized as being the most active biochemical systems known. These biochemical activities are responsible in large measure for maintenance of water as an environment which is suitable for growth of other oxygen requiring life forms. It is this type of microbial activity that is harnessed and exploited in processes designed to treat gross pollution by sewage and other contaminants.

In contrast to the role of microbes in reducing pollution of various types, many situations are recognized in which they are causative agents of specific types of pollution. For example, the relationship of bacteria to acid production from pyritic materials in abandoned coal mines is well established (see previous proposal).

The water quality of southeastern Ohio is of special significance from a biological viewpoint because it is a particularly valuable resource in this relatively poor economic area, and much of it is becoming polluted.

Objectives

The broad objectives of this proposal are twofold. First, to obtain information as to the microbial flora of non-polluted water in this geographical area, as compared

to the flora in water which has been polluted by sulfuric acid, iron ions, brine, oil and organic wastes -- all of which are indigenous to the area. Microorganisms can be categorized with respect to metabolic types. Knowledge of numbers and types of organisms therefore could serve as indicators of kinds of pollution entering a body of water and would allow some prediction as to the effect of specific pollutants on a watershed, based upon stimulation or retardation of types of metabolic activity in the microorganisms.

More specifically, we would begin with the studies outlined below. Emphasis is on acid mine drainage pollution because it is one of the primary unsolved pollution problems in Ohio, but the problem is not unrelated to other pollution problems in the same geographical area, such as that caused by oil well brine. The initial investigation would be to study qualitatively and quantitatively the microbial flora of acid mine waters and compare the flora to that of similar but non-acid waters. Thus far, all of the bacteria which have been implicated in the direct production of acid from pyritic materials belong to the Thiobacillus-Ferrobacillus group of chemoautotrophic organisms. Other microorganisms have been consistently isolated from acid mine waters but their role in the pollution process is not understood. For example, Pseudomonas bacteria, Euglena algae, as well as certain molds and yeasts appear to be indigenous to acid mine waters. Undoubtedly other organisms would also be recognized as potentially important during the course of this phase of the investigation.

Information gleaned from the above studies would serve also to suggest possible methods of reclaiming acid waters or at least suggest biological processes which might be exploited to abate the problem.

A second broad objective of the proposed research is therefore directed toward treatment of extent pollution in the southeast Ohio area, by microbiological processes. Again particular emphasis is placed upon mineral pollution by acid mine waters as well as by oil well brine.

Specific experimental approaches to this aspect of the problem involve microbiological processes for relieving the acid load in water. Pollution with acid mine water presents a different type of problem than with most pollutants in that the sulfuric acid responsible is already in the oxidized state and it cannot serve as a source of energy for microorganisms.

There is available, at least in theory (and with some very preliminary experimental support), an anaerobic process whereby sulfate acidity may be reduced. The process depends upon the ability of certain anaerobic organisms to reduce sulfuric acid to hydrogen sulfide in the presence of organic matter. This organic material may be supplied by sewage (when available) hence, associating this problem with sewage pollution or other waste organic materials. Hence, information on the organic content of acid water is needed.

Some provision for removal of the hydrogen sulfide from solution is also necessary, otherwise it would be reoxidized to sulfuric acid by aeration. While there are several possibilities, the samples at present would involve precipitation of sulfide by iron. If the acid water were treated before the oxidation and precipitation of its normal iron content, this amount of iron would precipitate one half of the sulfide as FeS , a very significant amount. If FeS_2 were formed, of course, greater amounts of sulfide would be removed from circulation with correspondingly greater reductions in acid load.

In particular we intend to set up laboratory and pilot models to examine

whether the process outlined above is feasible. These model experiments will be set up to approximate field conditions and to be reasonably close to what would be practical on a larger scale in the field.

Additional specific approaches to the problem of reclaiming acid and inorganic ion polluted waters through the mediation of biological processes involve the technique of passing the contaminated water through lagoons. Techniques are now under investigation which employ microorganisms as "complexing" agents for the purpose of concentrating and binding metal ions to the organisms. In this regard, two additional experimental approaches have merit: (1) A study of effects of intentionally added organic pollutants on the overall reduction of total pollution by mineral and organic substances. Addition microbial nutrients to an already polluted water may stimulate biochemical activity to an extent where the net effect on pollution would be a reduction. (2) The rational applied in (1) above may be exploited to cause metabolic synthesis of alkaline by-products for the purpose of neutralizing acid pollution.

Initial Experimental Activity

The first experiments will be directed toward an inventory of organisms in typical acid mine waters, and then relating the species of microorganisms to specific biochemical patterns (enzymatic activities) known to exist within the microorganisms found. One of the first acid mine sites to receive attention will be the controlled field laboratory mine described in the previous proposal "Development of a 'Natural' Laboratory for the Study of Acid Mine Drainage". This will allow a comparison to the biological activity within the mine before and after engineering control methods are put into effect.

It is anticipated, based upon preliminary data, that heterotrophic organisms will be identified. Because heterotrophic microorganisms must utilize organic nutrients for their existence we can predict to some extent the type of organic nutrients present in the waters from our knowledge of the biochemical activities of the organisms isolated. We will then proceed to verify our hypothesis in this regard, by standard analytical techniques (both wet and instrumental).

Once this has been attained we will direct efforts toward finding the source of such nutrients, why they are present, and how their presence influences the activities of the autotrophic bacteria known to oxidize iron and produce acid in mine waters. At this point the specific experimentation is beyond the scope of the initial effort anticipated in this project. The long range effort must be formulated in specific terms after initial data are evaluated.

Experiments conducted during the initial period will be essentially laboratory oriented, based upon samples from the field.

Summary of Microbiological Section of Proposal

The research described in this section can be described as an effort to obtain answers to the following basic biological questions concerning water pollution in southeastern Ohio, as exemplified by the acid mine drainage situation.

What other types of pollutants, particularly organic compounds, are in acid mine waters in addition to acid, iron, and sulfur compounds? What organisms are present in these waters and what is the consequence of their presence in these waters? Do their metabolic activities raise or lower the organic load or the mineral load of the water? Can the biochemical activity of the microbes be modified and exploited to effect a reduction in the pollutional load of the water? Finally, can water conditions be modified to favor growth of organisms which might

have a beneficial effect of pollution reduction?

Personnel

Professional personnel participating in this study with their approximate percentages of time involved are as follows:

Dr. P. R. Dugan - Department of Microbiology Principal Investigator (25%)
Dr. C. I. Randles - Department of Microbiology (25%)

Biographies of the above personnel are included in Appendix C.

The proposed research is a comprehensive long range program with some phases contingent upon completion of preliminary phases. The minimum level of effort deemed essential to develop this part of the research program is outlined below:

Personnel

1/2 year of senior staff time (faculty)	\$7,770.00	
1 year of technical staff (2 graduate students or 1 post-doctorate)	<u>6,475.00</u>	
Total for personnel		\$14,245.00

Travel

(a) for field investigations, 20 days at \$12.00 per day plus 100 miles at \$.08 per mile	\$400.00	
(b) to scientific meetings	<u>300.00</u>	
Total for Travel		\$700.00

Equipment (non moveable)

Linear Programmed Gas Chromatograph	\$3,000.00	
Sharples supercentrifuge air driven model	<u>1,500.00</u>	
Total for Equipment		\$4,500.00

Supplies

Chemicals, glassware, isotopes, regents, growth media, and expendable supplies		\$1,500.00
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Reports

		<u>200.00</u>
Total Budget		\$21,145.00

A continuation of support is anticipated for a period of two additional years at approximately the same level of effort.

A BIOLOGICAL SURVEY OF ACID MINE WATERS

Introduction and Objectives

Recent sophistication of monitoring equipment for measuring stream conditions has greatly enhanced detection of deterioration of water quality in major stream systems. The equipment is, however, limited to certain physical and chemical measurements of environmental conditions and too expensive for application to lesser tributary waters and impoundments. Conventional physical and chemical measurements of water quality relate to the time of sampling. Quantitative and qualitative studies of aquatic organisms provide a measure of water quality over an extended period of time because of the variations in tolerance to specific environmental conditions exhibited by certain species. Certain bottom feeding organisms, such as Mayflies (*Hexagenia* spp., *Ephoron album* (say) and *Ephemera simulane* walker), for example, appear abundantly only under conditions of continuous high oxygen availability, whereas certain midges (*Tentipedidae*) become dominant under near anerobic conditions. Certain vertebrate organisms also reflect changes in water quality (2, 3, 5). Ecological study of streams and impoundments provide a useful tool for detecting water quality characteristics inimical to certain uses and a guide to the degree of treatment of watershed modification necessary to achieve optimum water utilization. The method is readily adaptable to waters of varying characteristics; it is mobile, and a direct measure of water quality related to aquatic production is provided. Such studies have not been conducted on the Olentangy, Big Walnut and Hocking rivers in recent times and are a necessary step in the establishment of criteria by which

research on effects of acid mine and brine waste effluent can be measured. Previous studies of Raccoon Creek (5) provide guides to establishing effective sampling procedures.

Through the Water Resources Research Institute and in cooperation with the existing inter-institutional Ohio Biological Survey (a unit of The Ohio State University), two stream and lake survey teams would be developed to conduct biological studies of aquatic organisms and related physical and chemical conditions in the Raccoon Creek, Hocking River, Olentangy River (above Delaware Dam), and Big Walnut Creek watersheds (an aggregate area of approximately 2,500 square miles). The first two named watersheds are in an area affected by acid mine drainage from abandoned, inactive and working drift and strip coal mines. Staff and students from The Ohio State University and Ohio University would be utilized in developing the survey team and in conducting surveys.

The Olentangy and Big Walnut watersheds are principal sources of water for the central Ohio Metropolitan complex. These waters are currently threatened with contamination from oil well operation and resulting by-products escaping into ground and surface waters. Staff and students from The Ohio State University and Ohio Wesleyan University would be utilized in developing this survey team and in conducting surveys.

Specialists in appropriate taxonomic groups located in other colleges and universities would also be utilized. A related objective of this project would be the development of a core of specialists who could be called upon as needed and who would undertake special assignments on water research projects

in their field of competence and their geographic area. It is anticipated that similar teams will ultimately be organized for studies in other watersheds and will involve personnel from other colleges. A long range objective is the development of environmental quality measurements at index stations in the principal stream systems and impoundments of the State, against which future changes in water quality can be measured.

Methods

Through field reconnaissance, index sampling stations will be established in each stream system. These will be related to such physical features as tributary streams, riffles, pools, back waters, dams, and waste disposal outlets and such experimentation in quality control and related studies as may be undertaken by other segments of the project. Conventional sampling techniques for vertebrate and invertebrate animals and phytoplankton will be utilized (5, 6). Special attention will be given to fishes, bottom inhabiting invertebrates, and to phyto- and zooplankton in surface waters. Trial runs will be conducted to determine sampling procedures and sampling intensity necessary to assure statistical significance for each situation. Pertinent physical data and location will be recorded on forms developed for the project. Oxygen, Ph, temperature, and flow readings at desired locations will be taken with standard instruments. Water and bottom samples will be collected for laboratory analysis. Laboratory determinations will be related to suspected causal situations. Water analysis equipment and services described elsewhere in the proposal will be utilized. Identifications of organisms will be made by project personnel and appropriate specialists in cooperating institutions.

At seasonal intervals continuous 24-hour measurements of water quality and aquatic organism activity will be undertaken at selected index stations. This will include continuous recording of dissolved oxygen, Ph, and temperature changes. Distribution of major components of the vertebrate and invertebrate fauna will be observed throughout the 24-hour periods.

Grab sampling will be conducted between index stations to determine precise point of entry of sources contributing to water quality deterioration or improvement. These sources will be traced to their point of origin and appropriate qualitative and quantitative measurements will be made.

All data will be recorded on punch cards for computer analysis and indexed for retrieval purposes. Location maps for sampling stations will be prepared. Index stations will be shown by symbol on maps and identified in the field by triangulation. Biological quality maps will be prepared for each stream system studied. These maps will show location of sampling stations, principal species, ecological associations present, and degree of utilization of aquatic plant and animal resources.

Future Work

The ultimate goal of this sub-project is a comprehensive appraisal of the biological characteristics of Ohio waters which can be used as a guide to the development and implementation of water management programs, including: storage, low-flow augmentation, waste treatment, in-stream treatment, land surface treatment, and public recreational use. A minimum of 20 years of survey work on a watershed by watershed basis is anticipated. Priority of bio-assay survey work will be determined by urgency and the location of related

studies undertaken or to be undertaken by the Water Research Institute or other agencies.

Personnel Needed

Two field crews are needed for this initial project. Each crew would include an established vertebrate or invertebrate ecologist who would serve as leader. Qualifications for personnel available in The Ohio State University for these investigations are listed elsewhere. Qualified personnel are also available in other Ohio institutions. Two field assistants majoring in aquatic biology would be needed for each crew. Part-time clerical help would be needed for record-keeping, data-posting, and minor computations. One crew would be assigned to the Olentangy and Big Walnut Creek watersheds and the other to the Hocking River and Raccoon Creek watersheds. The project leaders would devote full-time to the project during the warm months of the year (3 months) and 10 per cent of their time in supervision of field assistants the rest of the year. The project would be expected to pay the salary and expenses for the field assistants and the leaders for the summer months in the initial year. In subsequent years field assistants would be employed for a full twelve-months service. Specialists for difficult identifications would be employed as needed. Anticipated personnel costs in the initial year aggregate \$14,540.

Equipment and Supplies

Some items needed are available in the Universities' pool of limnological equipment. Additional portable oxygen and Ph meters, car-top boat carriers, light-weight boats and oars, portable generator and electrical fish shockers, hand seines, field chemical kits will be needed, as will miscellaneous supplies

for sorting, preserving and storing collections. Estimate cost for equipment and supplies is \$3,232 (\$1,200 for Ph and oxygen meters, \$600 for boats and carriers, \$800 for portable generators and shockers, \$632 for chemical and collecting supplies).

Travel Expenses

Considerable field travel is essential to this sub-project. Assuming a minimum of 50 field days per crew with 40 nights' lodging at \$8.00 per night, 50 days' meals at \$4.00 per day, and 6,000 miles of vehicle travel at the University vehicle rate of \$.08 per mile, estimate travel costs total \$4,080.

Summary of Sub-project Costs (for one calendar year):

Personnel	\$14,540
Equipment and Supplies	3,232
Travel	<u>4,080</u>
Total	\$21,852 *

* This figure does not include costs for special chemical determinations.

Personnel

Professional personnel participating in this study with their approximate percentage of time involved are, as follows:

Dr. C. A. Dambach, Department of Zoology and Entomology Principal Investigator	(5%)
Dr. N. Wilson Britt, Department of Zoology and Entomology	(5%)
Dr. C. E. Taft, Department of Botany and Plant Pathology	(5%)

Budget Summary (January 1 through June 30, 1965)

Personnel (one-half year)	\$ 7,270
Equipment and Supplies	3,232
Travel (one-half year)	<u>2,040</u>
Total	\$12,542

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b. The Oilfield Waste Disposal Problem

A STUDY OF GROUND WATER CONTAMINATION DUE TO SALINE WASTE WATER DISPOSAL IN THE MORROW COUNTY OIL FIELDS

Background of Problem

The disposal of saline waste waters produced from oil wells is of major importance in the current development of oil fields. While the effect of saline water entering surface streams is serious, the result of the entry of saline water to a ground water body may be relatively more serious, due to the extremely slow rate of ground water movement, and the resulting long lasting effects which can result from saline water contamination in a given area.

The newest oil producing area in Ohio, a five hundred square mile area centered in Morrow County, is presently experiencing the waste saline water disposal problem. For the past two years, millions of gallons of waste waters with chloride concentrations averaging 140,000 mg/l have been disposed of in brine pits, the primary method of saline waste disposal in this area. In view of the recommended upper limit for chlorides in potable water of 250 mg/l, set by the United States Public Health Service, it is apparent that the influx of this highly saline water into the superficial glacial material of this area poses a definite hazard to accessible groundwater supplies. Although proposed future legislation will very likely place controls on the subsurface disposal of saline waste waters in Ohio, it is possible that severe damage to groundwater supplies in the Morrow County area and surrounding area will have been, or already has been, accomplished. Present or future groundwater contamination of this type may prove an obstacle to future potential development of this sparsely populated area.

The brine pits or disposal ponds referred to above consist of large pits constructed by bulldozing a basin into the soil. The saline waste water is then pumped directly into the basins. These pits might be more properly termed saline wastewater infiltration pits, since this is the primary end result of their use. Although evaporation, either natural or aided by a gas flare, is supposed to keep water levels low in these pits, the permeability characteristics of most of the pits permit the saline water to seep directly into the ground through the bottom and sides. In addition, many pits overflow and allow the waste to infiltrate into the ground surface, or to reach surface streams. It is doubtful that any of these installations actually dissipate sizable quantities of water by evaporation. Instead, it is likely that the bulk of the waste water moves down to the water table, where due to its high density, it becomes well mixed with the fresh groundwater body. It should be noted that in addition to disposal of saline wastes in brine pits, some saline waste water is removed from the oil fields by truck on a bulk load contract basis, and dumped directly into the surface streams. No action has been taken to prevent this means of disposal.

Objectives

The proposed investigation will be directed toward the determination of the source, severity, approximate areal extent, and probable future movements of contaminants stemming from saline oil field waste waters in both ground and surface waters, as well as toward making an appraisal of future water problems that may be expected to develop. It is believed that the identification of knowledge now lacking for fully assessing the feasibility of various alternate solutions of the saline waste problem that have been or may be proposed will also result from such a study.

Conferences with Mr. Ralph Bernhagen, Chief, and Mr. Russell A. Brant, Assistant Chief, of the Ohio Geological Survey have revealed their interest in the study. They consider the project feasible and significant, and have proffered assistance in selection of suitable sites that can be used for the study.

Methods

Field investigations will be centered in the Morrow County area, an area ideal for a comprehensive study of the effects of the brine pit waste disposal method because of the high permeability of the superficial material, the shallowness of the water table, and the lack of development of the unconfined groundwater system. The latter factor is important, because in areas of intense groundwater development the problem of flow analyses becomes increasingly complex, whereas in this area it should prove to be relatively uncomplicated, thereby lending itself to thorough analysis.

The investigation will for the present be confined to a study of a small number of different disposal pits, each having different environments and regimes. Although it may ultimately be possible to make a comprehensive study of the entire 500 square mile area, it is believed that the study of the pollutional problems stemming from individual selected disposal pits is a more practical starting point for a comprehensive definition and understanding of the overall problem.

The investigation will consist of a three-year study of three saline waste water disposal pits which vary quite distinctly with regard to the environmental hydrologic regimes.

The first pit is in Cardington township, in Morrow County, and has been in operation for nearly the entire two years of the current oil boom. It is

located near a small municipality which previously took its water supply from the waste table aquifer which has now been contaminated by the saline waste. Excellent records of salt water encroachment are available from the local well records, and good approximations of salt water discharge over the past two years have also been made. These past records, coupled with a continuous study of the pit in the next three years, will yield reasonable long-term results of such waste disposal in an area where some groundwater development has existed.

The second disposal pit occurs on the flood plain of the Olentangy River in Delaware township of Delaware County and has been in use for less than one year. This location presents the possibility of studying the direct relationship between a groundwater and surface water system as affected by brine pit saline waste disposal. This pit drains extremely fast, the bottom frequently being exposed when inflow is unable to overtake the infiltration rate.

The third pit to be studied is just now being placed into operation at the site of one of the newest oil strikes in the Morrow County area, located in Peru Township. A study of this pit will enable us to make hydrologic measurements of the infiltrating saline water in all its phases, beginning with the initiation of the operation of the disposal pit.

While each pit offers a special insight into the contamination problem, it also offers excellent grounds for comparison in that all three are surrounded by very similar geologic conditions. All of the pits are located in glacial till ranging in thickness between 50' to 100', underlain by shale. Water tables in the area range between 5' and 35'.

Present plans call for the emplacement of an array of 32 two-inch diameter observation wells surrounding each pit. These fields will comprise a highly adequate control system for a thorough shallow level geophysical measurement using equipment now on hand in the Geology Department of The Ohio State University, the spacing of the proposed 32 observation wells can be greatly increased without loss of detail. Exact determinations of the well spacing will not be made until the results of information gained from water quality tests on the initial observation wells will yield a thorough analysis of the hydrologic characteristics of the superficial aquifer. Geologic samples from the augered holes will give an indication of the superficial geology. Periodic water samples and water level readings will be made on all wells. Water samples will be taken from varying depths within the wells. The water level readings will enable accurate plotting of the water table and prediction of the flow net present in the system. Water quality tests will allow a determination of the movement of salt water within the system both as a result of hydrodynamic flow, mechanical mixing, and chemical dispersion. Chemical tests of water above and within the shale bedrock may make possible the determination of the degree of interaction, if any, between the glacial aquifer above the shale bedrock and the limestone aquifer below it. A complete hydrologic balance of saline waste water into and out of the disposal pit by infiltration and evaporation will be measured in order to accurately describe the quantity of the source of contamination.

In addition to the intensive study of the groundwater system, a thorough study of the surrounding surface water bodies will be made. The surface streams will be monitored for both quality and quantity of flow. This portion of the study will be facilitated by the fact that the U.S. Geological Survey Surface Water Branch

is presently gaging many of the streams in this area with respect to discharge, while the U.S. Public Health Service has been monitoring the water quality of surface streams since the initiation of saline waste water disposal.

It is expected that a compilation of both surface water and groundwater data will result in the determination of the relationships between groundwater and surface water contamination in the area.

As adequate data is accumulated on the hydrologic system controlling the movement of the contaminating saline water in both the groundwater and surface water phases, it will become possible to begin work on laboratory models of this system. These will be consolidated porous matrix models of the type developed by J. H. Lehr (references in Appendix C) under National Science Foundation Grant No. G17703 of the New Laboratory Equipment Program. A groundwater-surface water system will be synthesized in these models similar to that occurring under field conditions and the system will be studied both qualitatively and quantitatively, by means of visual observations and measurements. By acceleration of the time factor, predictions of future flow patterns in the field situation will be possible, which can then be checked during the future months of the field research operations.

Personnel

Professional personnel participating in this study with their approximate percentage of time involved is as follows:

Dr. J. H. Lehr - Department of Geology

Principal Investigator

25%

Budget (Estimated for three years)

	<u>1st six months</u>	<u>2nd</u> <u>Budget Year</u>	<u>3rd</u> <u>Budget Year</u>	<u>Total</u>
<u>(a) Personnel</u>				
Hydrogeologist on Summer Salary at 2/9 annual salary for three years		\$2,104	\$2,104	\$4,208
3 Graduate Research Assistants on Salary at \$1200 each per year for 3 periods.	\$1,942	3,890	3,890	9,722
<u>(b) Equipment and Facilities</u>				
96 Observation wells at an average cost of \$60 per well including Labor and Equipment	\$5,760			\$5,760
3 Evaporation Pans	180			180
3 Surface Water Level Recorders	600			600
3 Portable Pumps	1,000			1,000
3 Non Recording Rain Gauges	180			180
1 Salinity Meter	400			400
6 Water Level Recorders for Wells	1,500			1,500
Equipment for Construction of Hydraulic Models		1,500	700	2,200
Supplies, Services and Miscellaneous Equipment	1,500	1,500	1,500	4,500
<u>(c) Travel Expenses</u>				
Field Expenses for Graduate Students and Hydrogeologist (20 days in field per year)	\$ 640	\$1,280	\$1,280	\$3,200
Travel Expenses (for short daily trips)	300	600	600	1,500
Totals	\$14,002	\$10,874	\$10,074	
<u>Grand Total</u>				\$34,950

2. Facilities

The Ohio State University possesses the required facilities with which to pursue an effective water resources research program. The Water Resources Center Building physically comprises a research and training facility of approximately 9,700 square feet devoted to investigations of water and waste water problems. Excellent modern analytical equipment is available for studies pertaining to water quality. These include the following major equipment items:

- (a) Spectrophotometric equipment consisting of a Beckman DU Spectrophotometer, a Perkin-Elmer infra-red unit, a Coleman Model 14, and a Bausch and Lomb Spectronic 20.
- (b) Gas Chromatograph (Wilkins Model A-600C), thin layer chromatography equipment, and a paper chromatograph.
- (c) Warburg Respirometers (2-20 flask capacity each).
- (d) Radioactive Tracer Laboratory, with various counters and a Tracer-lab Versimatic II Scaler.
- (e) Research model microscopes equipped with photographic attachments.
- (f) Ultra-Centrifuge.
- (g) Beckman oxygen analyzer.

In addition, complete equipment is available for standard analyses of water and waste water. Constant temperature rooms are available for special studies (one at 37°C, one at 20°C, and one variable between 10°C and 48°C). Other laboratory apparatus includes turbidimeters; pH meters; conductivity meters; stirrers; analytical balances; electrophoresis apparatus; constant temperature ovens; muffle furnaces; media preparation rooms with autoclave, drying oven, etc.; and adequate refrigeration and incubation

facilities. Basic equipment for acquiring hydrological data includes flow meters, water level recorders and rain gages. Several special pieces of equipment have also been provided in the laboratory for bench type plant work, including carbon and liquid-liquid extraction apparatus. The general facility provides approximately 15 work stations for graduate personnel. The Center also has complete conventional pilot sewage treatment plant facilities of about 50 gallons per minute flow capacity consisting of primary settling, aeration, final settling, standard filtration, digestion--including heat exchange equipment, four separate septic tanks and one small aerobic digestion unit.

In addition to the above facilities, interdepartmental cooperation makes possible the use of related laboratories in the departments of Chemical Engineering, Microbiology, Agronomy, Agriculture, Botany, Geology, Zoology, etc., for specific studies closely related to these areas.

An Hydrology Laboratory of some 500 square feet has been established by the Department of Geology to be used for hydrological training and research with ground water studies involving two and three-dimensional flow models. The Department of Geology also has geophysical equipment including electrical resistivity and shallow refraction apparatus directly useable in subsurface studies in support of hydrological investigations. The geochemistry facilities currently are being increased in include a mass spectroscope unit, which will be useful in isotopic studies.

The Department of Agronomy possesses a Soil Physics Laboratory consisting of one large laboratory with about 1500 square feet of floor space and 450 square feet of table top, a 120 square foot constant temperature room

and a small shop and tool area

Major items of equipment available include:

- (a) An electrical resistance network analog for simulating water flow in porous materials. It contains 575 variable resistors and the necessary electronic equipment for imposing boundary conditions and read out of voltages.
- (b) One GC-2A Beckman gas chromatograph.

General facilities in the Soil Physics Laboratory include two sand tank tables, one equipped with pressure sensing apparatus; O₂ and CO₂ gas analyzers; and special facilities for measuring permeability, plasticity, moisture extraction, swelling and shrinkage in soils.

Facilities in laboratories adjacent to the Soil Physics Laboratory, and which laboratories are also available for water resources research, include six plant growth rooms with controlled light and temperature, an infra-red spectrophotometer, a multi-channel analyzer for gamma emission, X-ray equipment, freeze drier equipment, and electrophoresis apparatus.

The Department of Agricultural Engineering controls two major buildings containing approximately 21,200 square feet of laboratory space that is available to graduate students and staff members. The department also has two well equipped shops and an undeveloped hydraulics laboratory which could accommodate a 60-foot flume.

In addition, the following items of equipment are available in this department for use by graduate students and staff members: pumps and flow meters; turbidimeters; colorimeter; electrometer amplifiers and recorders; four analog computers (1 Boeing, 1 Pace TR-48-2, 2 Heath); combination pulse-height

analyzer, computer and scaler for radioactive work; viscosimeter; several recording potentiometers; Beckman oxygen analyzer and associated equipment; eight wet-and-dry-bulb recorders; spectrophotometer; vacuum pumps; signal generators; photomultiplier; microphotometer; cathetometer; optical bench; spectrograph, Bausch and Lomb, 1.5 meter; six oscilloscopes; oscilloscope camera; freezers and ovens; two X-Y recorders; neutron soil moisture probe and scaler; eight large climate control chambers; soil mechanics equipment; and flying-spot scanner

Access is provided through the College of Agriculture to facilities of the Ohio Agricultural Experiment Station at Wooster Ohio, and at eight outlying research farms. Approximately 90 per cent of the Experiment Station staff are also faculty members of the University; hence, the Station's personnel and physical facilities are available for water resources research activities.

Among its physical facilities, the following may be made available for water resources research:

- (a) Thirty lysimeter plots of 1/500 acres each for investigation of the disposition of radioactive contaminants in soils and runoff.
- (b) Experimental plots for evaluating the disposition of excess water by surface and underground drains.
- (c) Radioactive tracer laboratories specializing in plant, soil, and animal analyses
- (d) Three thousand acres of crop and woodland which are available for water yield, pesticide residue, evapotranspiration and underground recharge studies.
- (e) Two farm ponds, one with an adjoining household water treatment plant.
- (f) Laboratory facilities and an active research program for evaluating moisture relations in the major soils of Ohio.
- (g) Portable rainfall simulators and associated equipment for measuring

runoff and sediments.

The Ohio State University has in operation a swimming pool type Nuclear Reactor which is licensed by the United Atomic Energy Commission for operation at power levels up to 10 kilowatts. This is a versatile installation with Uranium enriched to 93 per cent in Uranium isotope 235. It is contemplated that this facility may be used in future studies relating to tracer work involving activation analysis.

In addition to the above facilities, The Ohio State University maintains a central library and branch libraries containing over 1,500,000 volumes, as well as a Numerical Computation Center with both 1620 and 7090 digital computers and auxiliary equipment. The latter facility, in addition to being a research tool, conducts training programs for staff and students in computer programming and data analysis.

3. Personnel

The Ohio State University has a complete staff of personnel from varied disciplines who are competent, experienced, interested and possessed of the requisite qualifications and time for research, investigations, experiments, and teaching in the water resources field.

Biographies of these staff members are contained in Appendix C. The available release time of each individual to conduct research or training in water resources is indicated in each biography.

4. Funds

The facilities described in Section e-2 above are available for water resources research, and the use of these facilities on any projects financed

under the Water Resources Research Act may be considered as a portion of the University contribution to the projects. Current funds for the fiscal year 1964-65 devoted to Water Resources Research at this University from sources other than this requested allotment of federal funds amount to approximately \$150,000.00. The major portion of these funds comes from non-university sources (sponsored research).

The sources of funds for support of water research since 1960 are as follows:

<u>Year</u>	<u>University Budget</u>	<u>Sponsored Research</u>	<u>Total</u>
1960-61	\$14,345	\$112,459	\$126,804
1961-62	13,661	110,113	123,774
1962-63	16,767	130,246	147,013
1963-64	8,859	133,413	142,272

f. External Cooperation

1. Cognizance of Other Research Projects

It is the philosophy and policy of this University to promote original study by building upon the foundations of existing knowledge. For this reason, extensive library searches precede all research attempts in order to provide the researcher with the current level of knowledge in the area he is investigating, in order to prevent duplication of effort and in order to provide orientation and direction for his intended work into more productive areas. Current periodicals relating to all technical fields are available through the library facilities. In addition, the interlibrary loan service makes available any rare publications held by participating libraries. More recently, advantage is being taken of the Smithsonian Institution Science Information Exchange to determine the research currently underway. Current lists of grants awarded through the National

Science Foundation and National Institutes of Health are also reviewed in an effort to reduce duplication of work. Direct contact maintained through frequent visits to the R. A. Taft Sanitary Engineering Center at Cincinnati keeps the staff well informed on activities pursued there. Exchange of information regarding current research projects is also maintained with many other institutions.

2. Personnel Displacement

In view of the fact that the University already has competent personnel staffing the various disciplines included in water resources, and in view of contemplated cooperation with other agencies and institutions, only staff changes as occasioned by retirement, normal growth and development, and normal attrition are contemplated in the future. No undue displacement of scientists elsewhere engaged in water resources research is intended.

3. Water Resource Needs - State of Ohio

The State of Ohio has, of necessity, been long engaged in an inventory of its water resources. Currently, this responsibility rests with the Division of Water of the Ohio Department of Natural Resources. In 1955, the General Assembly gave this division a mandate "to conduct basic inventories of water and related natural resources in each drainage basin in the State and to develop a plan on a watershed basis which recognizes the variety of uses to which water may be put and the need for its retention and control." This inventory is now well underway, and several reports on major basins are complete and available in printed form. These reports include data on water supply, both underground and surface water, flood profiles, sedimentation survey data, water resource needs, water supply available (including yields), potential reservoir sites,

water quality, and water use. A staff of hydrologists, engineers, geologists, cartographers, editors, and related personnel is maintained for this purpose.

The availability of inventory information collected by the Division of Water provides a basis for identifying the more critical water problems in need of research and avoids the necessity of costly inventory programs essential to much basic research. Close liaison with the Division of Water and other data collection agencies is maintained through conferences and exchange of information to avoid any duplication of effort and to assure availability of all pertinent information relative to research projects undertaken.

In addition to the Division of Water, the State has a Water Commission which conducts hearings, makes studies, reviews developments in each watershed, and has the power to make recommendations concerning the needs for legislation to the governor and the General Assembly. It works closely with the Division of Water and utilizes in its work the information assembled by that agency.

The Water Pollution Control Act of Ohio, passed in 1951, created a separate Water Pollution Control Board with broad administrative, regulatory and quasi-judicial powers. This Board functions administratively within the Ohio Department of Health. The Director of Health is designated by law as chairman of the Board and may exercise in the name of the Board all powers of the Board except the power to adopt and promulgate rules and regulations, revoke permits, and issue or modify orders. The five-member Board also includes the Directors of the State Departments of Commerce (Vice Chairman) and Natural Resources, plus two appointive members, one to represent municipalities and one to

represent industries, each for overlapping four-year terms.

Recent discussions with these Division Chiefs have elicited the following concern regarding Ohio's water problems:

Mr. Vernon Youngquist, Chief, Division of Water, Ohio Department of Natural Resources, has suggested that future Ohio problems will be associated with water quality considerations for both surface and underground waters. He suggests that the water quality will be most affected by pollutions from such sources as oil drilling operations, coal mining operations (including abandoned mines), and pesticide concentrations due to runoff from both urban and rural areas. The overall planning of water resources with specific emphasis on the acquisition of reservoir sites, their projected uses, and the social and economic implications of such pre-planning was further suggested as a major problem.

Mr. George Eagle, Chief, Bureau of Sanitation, Ohio Department of Health, emphasized the importance of pollution problems due to high industrial waste flows into relatively small streams, in relation to the projected re-use of Ohio's waters. He further emphasized Mr. Youngquist's views regarding acid mine drainage problems.

Mr. S. L. Frost, Executive Secretary, Ohio Water Commission, proposed a more comprehensive evaluation in suggesting that the Ohio problems may be classified as institutional, financial and technological. The institutional approach would include evolvement of a mechanism to manage the State's water resources, in terms of correlating the efforts of the several state agencies, districts, and local entities. Financial problems involve lack of criteria to evaluate optimum system economics, and methods of financing water resource projects.

Technological problems involve the quality of water for re-use in terms of public and industrial requirements, including recreational and esthetic factors. It is with these evaluations in mind that the Water Resources Center program is proposed as outlined in Section e 1 (b) above.

The Water Resources Center at The Ohio State University maintains a continuing contact with the above state agencies most concerned with water problems of Ohio. This contact is facilitated by its proximity to the State offices in Columbus. Past research on water problems at the University has been sponsored both by the Ohio Department of Health and by the Ohio Department of Natural Resources.

In addition, cooperation with the Ohio Geological Survey on past acid mine studies was accomplished through the participation of Mr. Russel A. Brant, Assistant Chief, Ohio Geological Survey, in the project work carried out through the Water Resources Center from 1958 through the present date. Joint publications relating to this work are included in the listing in Appendix B.

The Department and Division heads most vitally concerned with the water resource problems are in regular attendance and have been participants in the Natural Resources Institute seminars held monthly throughout the school year.

4. Advice and Assistance

Advice and assistance as provided by the Director, Office of Water Resources Branch, Department of the Interior, have been obtained through telephone conversations between Professor G. P. Hanna, Director of the University's Water Resources Center and Mr. Eaton, Associate Director, Office of Water Resources Research; and through visits to the latter's office by Mr. Mario G. Vangeli, the Washington, D. C. liaison agent for this University's Engineering Experiment

Station. Also, Mr. Robert J. Tait, Acting Executive Director of the Engineering Experiment Station, is a member of the Water Resources Committee, Association of State Universities and Land-Grant Colleges, and has participated in meetings with personnel from the Office of Water Resources Research concerning establishment of rules and regulations for the administration of the Water Resources Research Act of 1964.

5. Program Coordination with Others

The Water Resources Center has a history of cooperative efforts with other agencies as has been outlined in Section f. 3. above, and indicated in the listings of sponsored research. Further cooperative efforts currently exist in exchange of data and information regarding problems of mutual interest.

The Ohio State University is a member of Universities Council on Water Resources, being one of some 40 major universities participating in an inter-university effort to promote more water resource research and training to meet future increasing needs. The University is also a member of the Committee on Institutional Cooperation (CIC Group of Big Ten Schools and Chicago) and actively participates in the CIC Advisory Committee to the Water Pollution Control Laboratory being established by the Public Health Service at Ann Arbor, Michigan. The Director of the Water Resources Center is The Ohio State University representative on both of the above groups.

Through these various groups and agencies, and through direct contacts with other Water Resource Institutes, some of which have already been established, and through inquiries regarding organizations and programs, the Water Resources

Center at The Ohio State University will make every effort to insure coordination of its programs with those of the other groups.

g. Development Rights Agreement

The Ohio State University expresses a willingness to enter into a standard agreement in a form approved by the Secretary of the Interior and the Attorney General that all information uses, products, processes, patents and other developments resulting from any scientific or technological research or development activity financed with funds supplied pursuant to the Water Resources Act of 1964 will be made freely and fully available to the general public.

h. Financial Plan

Program Budget (Jan. 1 - June 30, 1965)

1. Program Administration

Salaries

Program Director (50% of Time)	\$3,959	
Secretary	<u>1,942</u>	
		\$ 5,901

Maintenance

Repair, replacement, and service	1,000	
Parts, supplies and equipment	2,000	
Communications	<u>850</u>	
		3,850

Travel - for coordination of work throughout area - and to attend meetings, seminars, etc.		1,000
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Subtotal		\$10,751
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2. Projects

Development of a "Natural" Laboratory for Study of Acid Mine Drainage	\$14,260
A Study of the Microbial Flora of Acid Waters	21,145
A Biological Survey of Acid Mine Waters	12,542
A Study of Ground Water Contamination Due to Saline Waste Water Disposal in the Morrow County Oil Fields	<u>14,002</u>
Subtotal	\$61,949

3. Seminars and Conferences

Seminars with federal, state, county and local governmental agencies to coordinate Water Resource Activities; meetings and conferences with non-governmental groups concerned with water resources in the state	<u>2,300</u>
Total	\$75,000

Expenditure Plan

The following schedule indicates the proposed rate of program activity for the period of January 1 through June 30, 1965 and further indicates times at which there will be a need for the budget amounts as specified:

January 1	\$15,000
February 15	15,000
April 1	15,000
May 1	15,000
June 1	<u>15,000</u>
Total	\$75,000

i. Notice of Research Project

An appropriate "Notice of Research Project" for each separately identifiable research project that the University Water Resources Center will undertake under this request for an initial allotment of funds to pursue Water Resources Research in Ohio is included in Appendix D. Copies of these notices will be furnished to the Smithsonian Institution Science Information Exchange upon project approval.

APPENDIX A

DESIGNATIONS AND APPOINTMENTS

History - The Ohio State University

Appointment of Mr. Clinton V. Oster

Appointment of Water Resources Center Advisory Committee

HISTORY

The land grant made by the United States under an act approved by President Abraham Lincoln on July 2, 1862, provided that there should be granted to each state an amount of public land equal to 30,000 acres for each senator and representative to which the state was entitled by the apportionment of the census of 1860.

The proceeds arising from the sale of these lands were to constitute a fund that was to remain forever undiminished.

Interest from the fund was to be applied by each state claiming benefits of the act to the endowment, support, and maintenance of at least one "college where the leading objects shall be, without excluding other scientific and classical studies and including military tactics, to teach such branches of learning as are related to agriculture and the mechanic arts, in such manner as the legislature of the state may respectively prescribe in order to promote the liberal and practical education of the industrial classes in the several pursuits and professions of life."

Ohio Governor Todd, in November 1862, brought the subject of this act before the State Board of Agriculture and later to the attention of the Legislature. In January 1864, the Hon. Columbus Delano introduced a bill accepting the grant. The bill finally became a law February 8, 1864, pledging the faith of the State to the performance of all conditions and provisions of the act.

In 1866, an act introduced by the Hon. J. T. Brooks was passed, providing for the establishment of the Ohio Agricultural and Mechanical College, but the provisions were not carried into effect.

In 1870, a second act, introduced by the Hon. R. P. Cannon, was passed, entitled, "An act to establish and maintain an Agricultural and Mechanical College in Ohio." Under provisions of this act the institution was located in Columbus. The Board of Agriculture proceeded to the organization of the college and the election of a faculty of instruction, and the institution was opened for the reception of students on September 17, 1873.

The Legislature changed the name to "The Ohio State University" in 1878. With the reorganization came a larger and broader view of the State's relation to public education, and since that time The Ohio State University has enjoyed more

generous support by the State.

The original endowment has been supplemented and the objects of the University promoted by a permanent annual grant from the United States under an act of 1890, by special appropriations of the General Assembly, and by a permanent annual grant from the State under an act of 1891, a grant that was doubled by the Legislature in 1896 and that has been subsequently increased from time to time.

In accordance with the spirit of the law under which it was organized, The Ohio State University aims to furnish ample facilities for education in the liberal arts, the industrial arts, the sciences, and the languages, and for thorough technical and professional study in agriculture, engineering in its various departments, veterinary medicine, pharmacy, law, medicine, nursing, dentistry, applied optics, commerce and administration, social administration, occupational therapy, and journalism.

Through aid received from the federal and state governments, the University is able to offer its undergraduate instructional facilities at a reasonable cost to all persons of either sex who are qualified for admission.

The only land-grant institution to be established in Ohio and the largest of the state-assisted universities, The Ohio State University today is a bustling center of higher education for over 30,000 students.

The University is the major center for graduate education in Ohio. The Master's degree is awarded by 74 departments and the Ph.D. by 60. Ohio State ranks seventh in the nation in the number of baccalaureate and first professional degrees conferred and eight in the number of doctorates.

THE OHIO STATE UNIVERSITY

190 NORTH OVAL DRIVE
COLUMBUS, OHIO 43210
November 24, 1964

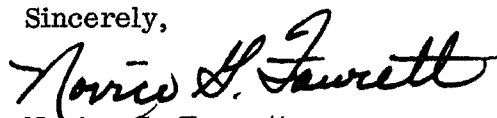
OFFICE OF THE PRESIDENT

Mr. C. V. Oster
Controller
The Ohio State University
Campus

Dear Mr. Oster:

You are hereby appointed as the University's representative to receive and account for all funds paid under the provisions of The Water Resources Research Act of 1964 (Public Law 88-379), and to make annual reports to the Secretary of the Interior together with a detailed statement of the amounts received under any provisions of this Act during the preceding fiscal year, and of its disbursement on schedules provided by the aforementioned Secretary.

Sincerely,



Novice G. Fawcett
President

NGF:dmm

THE OHIO STATE UNIVERSITY
190 NORTH OVAL DRIVE
COLUMBUS, OHIO 43210

OFFICE OF THE PRESIDENT

October 1, 1964

Professors G. P. Hanna
R. A. Tybout
E. E. Smith
G. S. Taylor
R. E. Stewart

Professors H. J. Pincus
H. L. Hunker
P. R. Dugan
C. A. Dambach
R. P. Bullock

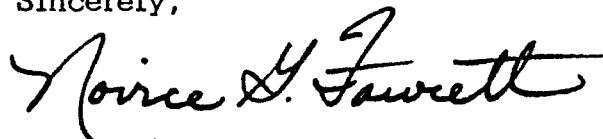
Dr. J. W. Riddle, Office of Instruction, Ex officio
Dr. G. E. Briggs, Office of Research, Ex officio
Mr. G. G. Warner, Engineering Experiment Station, Secretary

Gentlemen:

As you know, in recent years there has been increasing interest in the problems related to water resources--problems which The Ohio State University has been studying for many years. In view of the recent passage of Federal legislation in support of water resources research, it seemed appropriate that The Ohio State University formalize some informal relationships which have existed for many years. Accordingly, upon the recommendation of Vice President Garrett, and after consultation with other appropriate administrative officers, I am pleased to ask you to serve as the membership of The Ohio State University Advisory Committee to the Water Resources Center. I am hopeful that each of you will be willing to accept appointment to this University-wide Committee. I know that I am really only asking you to continue the important work with water resources problems which you have been doing over the years.

I am sure that the University will benefit from your services on this Committee; and I hope that you will find professional and personal satisfactions from this service also.

Sincerely,



Novice G. Fawcett
President

NGF:tab

cc: Vice President Alfred B. Garrett
Vice President John C. Weaver
Dean Harold A. Bolz

APPENDIX B

RECENT MAJOR RESEARCH PROGRAM

Toxic Waste Studies
Acid Mine Drainage
Engineering Geology of the Shoreline of Lake Erie
Farm Pond Studies
Septic Tank Evaluations
Detergent Biodegradability
Aquatic Biology Studies
Hydrological Classification of Rivers

CURRENT RESEARCH PROJECTS

RECENT MAJOR RESEARCH PROGRAMS

Toxic Waste Studies

Studies relating to the effect of metallic wastes on the biological treatment processes, sponsored by the Ohio Department of Health, and financed through a special state legislative appropriation were pursued from 1953 through 1962. Funds were provided for the pilot waste-treatment plant facility elsewhere described, for other laboratory equipment, and for active research support. Several publications, including a "Standardized Procedure for Evaluation of Toxic Effects on Activated Sludge" by E. Q. Moulton and L. S. Directo, Engineering Experiment Station Bulletin No. 191 (1962), were realized from these studies.

Acid Mine Drainage

The acid mine water research program began at The Ohio State University in late 1956 with a grant from the Ohio Department of Health, Water Pollution Control Board to study the effects of acid mine water on stream pollution. The Project was attacked by a task force of eight staff members, representing five interested disciplines; and culminated in the publication of the Engineering Experiment Station Bulletin No. 166 which generally described the effects of acid water on the stream pollution, evaluated abatement methods in the Raccoon Creek Area of Ohio, and furnished a completed annotated bibliography. A mine seal was constructed with project funds on a small abandoned drift mine (McDaniels mine seal) in the Lake Hope area, and observation began on the effect of abatement measures.

Concurrent bacteriological studies from 1957 to present date have been pursued by Dr. C. I. Randles of the Department of Bacteriology under National Institutes of Health Grant No. WP - 00147 - 09, "Aquatic Bacteria Related to

Acid Mine Drainage " The studies have involved an investigation of pertinent data and information of the role of micro-organisms in the acid mine problem, both from the formation of acid and the abatement measures

A further project, extending the acid mine drainage work, was sponsored by the Department of Natural Resources, State of Ohio from March 1, 1958, to June 30, 1959. This entailed a study of the acid mine drainage problems involving chemical and biological concepts, further investigations and correlations of the mine seal data, and design of an impoundment for the Puritan Run area. Because of unforeseen circumstances, the Puritan Run impoundment program was abandoned.

Simultaneously, a separate project, sponsored by the Division of Wildlife through the Natural Resources Institute of the Ohio State University, resulted in publication of the "Acid Mine Drainage Manual", Engineering Experiment Station Bulletin No. 179. This manual of practice summarized the factors contributing to the occurrence of acid mine waters, the known fundamental factors of acid formation, and the current alleviation procedures. This Bulletin has been given wide circulation to interested parties, and has received very favorable comment.

In 1956, P. O. Krumin, in work at the Engineering Experiment Station, The Ohio State University, recognized three sulfur forms in coal: (1) with iron as pyrite or marcasite and referred to as pyritic sulfur; (2) small amounts especially in weathered coal combined with calcium, magnesium, or iron in the sulfate form; and (3) with organic compounds as a part of the coal substance. Quantitative determination methods used by Krumin involved extraction of sulfate and pyritic sulfur from finely ground samples with dilute acids for long periods.

An evaluation of the information to date revealed a basic need for a planned sequential program to correlate available information and to place it in proper perspective and to re-establish the need for further studies in order to tie together the known work and provide continuity of information toward the ultimate goal of abatement of the acid mine drainage. The Ohio River Valley Water Sanitation Commission (ORSANCO) sponsored the conduct of this evaluation by an interdisciplinary task force of the Water Resources Center. The study provided an evaluation of the status of acid mine drainage control, and developed a planned research program to insure proper coordination of all the phases and interrelated aspects of the problem. The study was published as Engineering Experiment Station Report No. 179, The Ohio State University (1961), and later published in part in Journal, Water Pollution Control Federation (Vol. 35, p. 275).

A limited project, sponsored by The Ohio State University, provided continuity of activity in the acid mine field from the termination of the other projects to June 30, 1963. This made possible the continuing collection and evaluation of information from the McDaniels mine seal, established under the Ohio Department of Health Grant, and permitted a minimum of monitoring of the acid condition in the streams draining the mine seal location.

A National Institute of Health Research Grant WP - 00 - 340 awarded Dr. E. E. Smith to perform a "Study of the Sulfide-to-Sulfate Reaction Mechanism" began on May 1, 1962, and will continue through April 30, 1965. This study is attempting to define the fundamental reaction mechanism for oxidizing of pyrite to sulfate through a direct analytical approach in searching for intermediate products,

and through studies involving chemical reaction kinetics.

The following publications by members of The Ohio State University staff have resulted from these acid mine drainage studies:

"The Acid Mine Drainage Problem in Ohio" - E. Q. Moulton, ed., Engineering Experiment Station Bulletin No. 166, The Ohio State University (1958).

"A Field Study in Acid Mine Drainage" - J. Richard Lucas - Preprint No. 60F35 Society of Mining Engineers of AIME, paper presented at Annual Meeting of American Institute of Mine, Metallurgical, and Petroleum Engineers, Inc., New York, Feb., 1960.

"Acid Mine Drainage Manual" - R. A. Brant and E. Q. Moulton, Engineering Experiment Station Bulletin No. 179, The Ohio State University (1960).

"Analysis of Fundamentals of Acid Mine Drainage" - G. P. Hanna, Jr., R. A. Brant, J. R. Lucas, E. E. Smith, C. I. Randles; Engineering Experiment Station Report No. 175, The Ohio State University (1961). Also published in Journal Water Pollution Control Federation 35, 3, 275 (March, 1963).

"Stratigraphic Relations to Acid Mine Water Production" - G. P. Hanna, Jr. and R. A. Brant, paper presented at 17th Annual Purdue Industrial Waste Conference, (May, 1962).

"The Relation of Water to Stripmine Operation" - G. P. Hanna, Jr., Ohio Journal of Science 64, 2, 120 (March, 1964).

"Fossil Iron Bacteria Preserved in Pyrite" - E. G. Ehlers, J. M. Schopf, D. V. Stiles, J. P. Birle, Submitted to Science for publication (1964)

"Electropolishing of Pyrite" - E. G. Ehlers and J. D. Birle, American Mineralogist 49, 800 (1964).

Engineering Geology of the Shoreline of Lake Erie

A study of the Engineering Geology of the Ohio Shoreline of Lake Erie from 1950 through 1962, involving all active processes bearing on shore erosion in relation to engineering design and decisions, was directed by Dr. Howard Pincus, Department of Geology, and sponsored by the Ohio Division of Shore Erosion (the functions of which are now in the Ohio Geological Survey). The study involved cooperative surveys with state, federal, and Canadian agencies. The group directed by Dr. Pincus mapped bottom deposits, participated in a synoptic survey, and obtained water samples for chemical analysis. Numerous publications in the Ohio Division of Shore Erosion Technical Reports are formed from these studies.

Farm Pond Studies

The quality of rural water supplies and the feasibility of farm pond for general rural supply use has been a major subject of study at the Ohio State University since 1958. Working under National Institutes of Health Grants RG-735, RG-895 and EF-00189, an interdisciplinary group from the Departments of Agricultural Engineering and Microbiology have, with the cooperation of the Ohio Agricultural Experiment Station, made an evaluation of the physical, chemical, and bacteriological quality of water from fourteen farm ponds, as affected by the physical and cultural features of the watershed, vegetation in or near the water, chemicals applied to the pond, presence of animals in or near the pond, depth of water and climatic conditions.

Further studies evaluated pond water treatment systems at various farms over a four-year period (1958-1962), and established the need for better filtration

and disinfection techniques.

In 1960, a field laboratory was established at the Southern Substation, Ohio Agricultural Experiment Station near Ripley, Ohio, for the purpose of evaluating various filtration and disinfection methods under actual field conditions. The slow sand filter, pressure type rapid sand filters, and cartridge and granular carbon filters were studied, as were various bactericidal treatments.

Currently a study by Dr. H. H. Weiser supported by National Institutes of Health Grant No. EF-0024-06 is underway involving the possible presence of enteroviruses and bacteriophage in farm pond waters.

Major publications from the above research include:

"Quality of Water in Ohio Farm Ponds" - R. H. Hill, G. O. Schwab, G. W. Malaney, H. H. Weiser; Ohio Agricultural Experiment Station Research Bulletin 922 (October, 1962).

"Evaluation of Pond Water Treatment Systems" - R. D. Hill, G. W. Malaney, G. O. Schwab, H. H. Weiser; Ohio Agricultural Experiment Station Research Bulletin 957 (December, 1963).

"Filtration and Disinfection of Farm Pond Water" - R. D. Hill, G. O. Schwab, G. W. Malaney, H. H. Weiser; Ohio Agricultural Experiment Station Research Bulletin 966 (August, 1964).

Septic Tank Evaluations

Evaluations of small anaerobic-aerobic digestion systems were performed in 1959-1961. Contracts with the Robert A. Taft Sanitary Engineering Center, The Yeomans Brothers Pump Company, and The Ohio Septic Tank Association provided support for these studies. The effects of varying conditions of waste loading and plant operation were measured in terms of standard efficiency parameters.

Detergent Biodegradability

Investigations relative to the biodegradability of selected detergent products,

sponsored by the Procter and Gamble Company, have been conducted by long term studies of both anaerobic (septic tank) systems, and an aerobic (rated aeration) waste disposal system. Both the tetrapropyl (ABS) product and the newer straight chain compound were evaluated.

A current study sponsored by the Soap and Detergent Association is under-way to establish a base-line for current product degradability by activated sludge treatment in order to provide a comparison with the new biodegradable products, expected to be on the market within a few months.

Aquatic Biology Studies

The Ohio State University has conducted biological research related to Lake Erie and maintained a biological laboratory there since 1896. In recent years the Natural Resources Institute has been responsible for use of these laboratory facilities. The Laboratory has also been used by staff from other Ohio colleges and universities. The long range goal of much of the research has been an understanding of the phenomenon which effect the use of Lake Erie waters for many purposes. This following list of selected projects indicates the nature of the researches recently conducted.

A. Projects supported through University funds.

Quantitative Study of Zooplankton of Western Lake Erie

Ronald Engel, Department of Zoology and Entomology,
The Ohio State University

B. Projects supported through Grants from the Ohio Department of Natural Resources.

A Study of Aquatic Nematodes in Western Lake Erie

Dr. John W. Crites, Department of Zoology and Entomology,
The Ohio State University

The Biology of Lake Erie Microcrustaceans

Dr. C. C. Davis, Department of Biology,
Western Reserve University

Extended Limnological Survey of Western Lake Erie

Dr. N. Wilson Britt, Department of Zoology and Entomology,
The Ohio State University, 1959-1964

Refinement of Methods for Determining Effect of Dissolved Oxygen Level on
Survival of Lake Erie Fishes

Gedeon D. Tetit, Department of Zoology,
The Ohio State University

Plankton Productivity in Western Lake Erie

Dr. Charles C. Davis, Department of Biology,
Western Reserve University

A Quantitative Study of Bacteria in Lake Erie

Philip Halicki, Department of Biology,
Bowling Green State University

C. Projects supported through Federal Grants, N. S. F. and N. I. H.

Productivity of the Microplankton in Lake Erie

Dr. Jacob Verduin
Miss Eloise Whitmer
Miss Frances Piaseck
Bowling Green State University

Environmental Factors Effecting Productivity of Lake Erie Waters

Dr. Jacob Verduin, Department of Biology,
Bowling Green State University

Basic Productivity in Lake Erie Waters

Dr. Jacob Verduin, Department of Biology,
Bowling Green State University

Taxonomy and Distribution of Diatoms in the Bass Island Region

Dr. C. E. Taft, Department of Botany, The Ohio State University
Dr. Mathew Hohn, Department of Biology, Central Michigan State University

Research has been initiated on the limnology of stream impoundments and above stream level water storage reservoirs in several parts of the state. These studies are largely aimed at determining safe levels of watershed treatment with

agricultural chemicals consistent with multiple purpose use of the confined waters.

A. Projects supported through University funds.

Effects of Various Dissolved Oxygen Levels on Fish Activity

Donald Mount, Department of Zoology,
The Ohio State University

Central Ohio Stream Survey

Dr. Milton B. Trautman, Department of Zoology,
The Ohio State University

B. Projects supported through Grants from the Ohio Department of Natural Resources.

The Toxicity of Six Chlorinated Organic Insecticides to Bluegills

Loren W. Moseley, The Ohio State University

A Limnological Survey of Acton Lake

Drs. Edward Ingersoll, Robert Strecker and Robert Winner,
Department of Biology,
Miami University, 1959-1964

Limnological Studies of Archbold and Wauseon Reservoirs

James T. Addis, Department of Zoology,
The Ohio State University

Oxygen Tolerances of Fishes

Part I - A Continuous Flow of Water De-Oxygenating System for
Measuring Oxygen Tolerances of Fishes

Part II - Observations on Yellow Walleye, Yellow Perch and
Northern Bluegill Sunfish

Gedeon D. Petit, Department of Zoology and Entomology,
The Ohio State University

Limnology of Five Above Ground Level Reservoirs

James T. Addis, Department of Zoology and Entomology,
The Ohio State University

Uptake and Distribution of Copper in the Ecosystem of a Controlled Aquatic Environment

James T. Addis, Department of Zoology and Entomology,
The Ohio State University

C. Projects supported through Federal Grants, N.S.F. and N.I.F.

The Physiology of Photosynthetic Bacteria

Dr. John Taylor, Department of Microbiology,
The Ohio State University

Hydrological Classification of Rivers

A study of streamflow characteristics of the Great Lakes-St. Lawrence Basin resulted in a classification of tributary river systems according to their unit hydrographs. The study involved an extensive correlation of streamflow records, resulting in significant relationships permitting classifications according to similar characteristics. This study was University supported.

CURRENT RESEARCH PROJECTS

The following are current water resources research projects listed by title and name of principal investigator(s); with a brief description of each project:

"Microbiological Aspects of Farm Pond Water Supplies"

Dr. H. H. Weiser - Department of Microbiology - (National Institute of Health Grant No. EF 00024-06)

Studies are currently underway to determine the possible presence of enteroviruses and bacteriophage in farm pond waters. Survival studies of these groups are also in progress. Investigations will be made to determine whether any relationship exists between coliform, enteroviruses and bacteriophages with respect to the survival of any one or all of these organisms.

Publications from this project are as follows: Ohio Agricultural Experiment Station Research Bulletin 922 and 957; AWWA Vol. 44 May 52; Vol. 53 Jan. 1961; Vol. 55 May 1963.

"Relationship of Iron Oxidation by *Ferrobacillus ferrooxidans* to Acid Production, and the Methods of Inhibiting Iron Oxidation"

P. R. Dugan - Department of Microbiology

This represents a continuation of prior investigations into the mechanisms of ferrous iron oxidation by the bacterium *Ferrobacillus ferrooxidans* and the relationship of iron oxidation to production of acid by the organisms. The studies include possible means of interfering with the enzymatic oxidation mechanism thereby reducing or inhibiting the associated production of acid. This is of possible significance in control of acid mine pollution.

"Development of Carbon Filter Technique for Organic Spray Removal and Concentration for Analysis"

G. P. Hanna, Civil Engineering; W. D. Sheets, Chemical Engineering

Carbon filter units are being tested for suitability in concentration of the organic complexes. Various solvents are being experimented with for extraction of absorbed contaminants from the filter. Attempts at infrared spectrophotometer analysis were limited because of the relatively low ranges of concentration encountered. Gas chromatographic techniques are not being used for quantitative evaluations of the contaminants.

"Some Effects of Lindane on the Structure and Growth of *Chlorella Pyrenoidosa*"

C. E. Taft - Botany and Plant Pathology

Growth rate of chlorella was determined spectrophotometrically and cell structure examined microscopically. Algal growth rates were observed in relation to varying amounts of lindane added. Dextrose added to lindane containing cultures prior to inoculation had a protective effect against inhibition of growth and induction of structural changes. Dextrose when added to lindane medium after culturing has proceeded for several days did not evidence the protective effect.

"Study of the Sulfide - to - Sulfate Reaction Mechanism"

E. E. Smith - Chemical Engineering (principal investigator)
C. I. Randles - Microbiology
E. Ehlers - Mineralogy
G. P. Hanna - Civil Engineering
(National Institute of Health Grant No. WP-00-340)

The specific aim of this project is to determine the basic rate-determining mechanism of the sulfide - to - sulfate reaction, the reaction responsible for production of acid mine drainage. Knowledge of the rate-determining mechanism will indicate the factor influencing the rate of acid production and assist in finding the most efficient and effective methods for abatement.

Mineralogical studies are being made to determine if any intermediate phases exist during the oxidation of pyrite to sulfates. Reaction kinetic studies have shown that the rate of reaction is physically controlled when pyrite is immersed in water and is proportional to humidity of air and varies with oxygen concentration in vapor phase oxidation. The effect of bacteria on reaction rate is also being studied. This project led to M. S. Thesis by John David Birle, "Sulfide to Sulfate Reaction Mechanism in Pyritic Materials", The Ohio State University 1963.

(Three papers are currently in process: two accepted for publication)

"COD Analysis versus Optical Density to Evaluate Waste Strengths"

W. D. Sheets - Chemical Engineering

The COD analysis currently involves a final titration with 0.26 N ferrous ammonium sulfate. This study involves the use of spectrophotometry to measure the optical density of the processed sample. Thus correlation of this OD versus COD value would eliminate the titration, normality corrections and some calculations. Interferences such as chlorides, straight chain aliphatics, aromatic hydrocarbons, etc., are to be evaluated.

"The Effect of Velocity Gradient on Oxygen Uptake"

W. D. Sheets - Chemical Engineering

The study of the mixing action of inert gases on the oxygen uptake of activated sludge. This involves a gas transfer evaluation of mass or gas volume, and turbulence of the system. Dissolved oxygen values are being monitored by electric probe.

"The Degradability of Selected Detergent Products in Domestic Waste by Full Scale Aerobic Digestion"

G. P. Hanna, Civil Engineering; W. D. Sheets, Chemical Engineering
(Sponsored by The Procter and Gamble Company, Cincinnati, Ohio)

A full scale test of degradability of selected detergents in a prototype rated aeration sewage treatment system. The effects of variation of detention times and air supply on straight-chain and tetrapropyl products were studied. The methylene blue chloroform extraction method was used for ABS measurements. Operation control was monitored by chemical oxygen demands and suspended solids tests.

A paper has been submitted to Water and Sewage Works for early publication research leading to a Master's thesis by Mr. Douglas Lair is based on this study. This research involves the mechanism of ABS breakdown under aerobic biological action, and the relative degradation versus absorption to the sludge formed.

"A Study to Determine Degradability of Selected Detergent Material by Septic Tank Treatment"

G. P. Hanna - Civil Engineering
(Sponsored by The Procter and Gamble Company, Cincinnati, Ohio)

This study involved the measurement of anaerobic degradation of three basic detergent products (tetrapropyl, straight chain ABS and lauryl sulfate) as monitored by radioactive tracer techniques.

Sulfur 35 attached to the benzene ring of the selected detergent served as the indicator in order to provide a means of selective differentiation between the added detergent and that already in the waste sewage fed to the pilot plant. Chloroform extractions were used to separate the breakdown products and the counting was performed on the extracted portions.

A final report is being prepared for submission to the sponsor.

"Evaluation of Effects of Enzyme Products on the Efficiency of Biological Sewage Treatment Processes"

K. S. Shumate - Civil Engineering
(Sponsored by Rohm and Haas Company)

The effects of a variety of commercial enzyme preparations of the anaerobic biological degradation of organic waste are being observed. The experimental units simulate septic tanks, which are continuously fed sewage for 12 hours out of each day. The anaerobic unit (septic tank) effluent is then passed through a sand filter which simulates a leaching bed. The enzyme preparations being tested include esterases, proteases and starch hydrolyzing enzymes. The waste treatment efficiency of the units is monitored by such tests as BOD, COD, suspended solids and gas production.

Mr. Parvis Monadjemi, a Masters candidate, conducting his research on the anaerobic degradation of lipids, utilized the control unit and one of the enzyme dosed units as sources of influent and effluent sewages for his study.

"Septic Tank Effluent Disposal in Soil"

Joe H. Jones, Agronomy; W. D. Sheets, Chemical Engineering
(Sponsored by the National Institute of Health Grant No. EF - 00263)

This work has been directed primarily toward an evaluation of conditions which affect clogging of soil absorption systems by effluent applications. Results to date show that (a) clogging occurs at an interfacial region where the effective grain size is reduced abruptly, (b) an anaerobic environment is conducive to rapid clogging, (c) fine grained materials clog faster than coarse grained ones, (d) initial filtration of effluent through a relatively coarse texture such as gravel delays clogging in soil, and (e) filtration of effluent through sand-sized materials reduces biochemical oxygen demand and suspended solids by 75 to 80%.

Manuscript entitled "Septic Tank Effluent Percolation Through Sands Under Laboratory Conditions" submitted to Soil Science, April 1964.

"Isotope Geochemistry of Sr in the Great Lakes and Their Tributaries"

G. Faure - Geology

Approximately fifty samples of modern mollusk shells and water (1 or 2 gal.) were collected from tributaries of Lake Superior, and Lake Huron as well as the lakes themselves. The mollusk shells will be used to determine the average Sr ⁸⁷/Sr ⁸⁶ ratio in the water. The water samples will be used to determine total

Sr concentration. The data will be used to develop an understanding of the geochemistry of Sr isotopes. An attempt will be made to use Sr ⁸⁷ as a natural tracer to study circulation and mixing of water masses.

Preliminary data were published in: "An estimate of the isotopic composition of Sr in rocks of the precambrian shield of North America", J. Geophys Res., vol. 68, pp 2323-2329.

"Fish Susceptibility to Pesticides and Detergents"

Dr. P. R. Dugan - Department of Microbiology
(United States Public Health Service Grant No. WP-00793-01-TOX)

The project will evaluate the effects of long term exposure of fish to sub-lethal concentrations to anionic detergents, on lethal effects due to subsequent exposure of fish to certain chlorinated hydrocarbon pesticides.

"Present and Prospective Farm Use of Water: Sources, Requirements, Costs and Institution Factors Involved"

J. H. Sitterly - Department of Agricultural Economics and Rural Sociology

Analyses of questionnaires sent to Farm Bureau councils to provide information on present use of water, the sources, dependability and adequacy of sources to enable Ohio citizens to make maximum use of this resource; and to develop a technique whereby actual water consumption can be estimated.

"Treatment of Farm Pond Water for Domestic Use"

G. O. Schwab
Department and Cooperating Agencies: Departments of Agricultural Engineering and Microbiology, Ohio State University, in cooperation with: Ohio Department of Health; and National Institutes of Health.

A study to develop techniques and specific equipment for treating water from farm ponds for domestic use; to evaluate the performance of newly developed or commercial equipment for treating water from farm ponds, to determine physical, chemical and bacteriological quality of pond water and those factors that affect quality. Current studies are underway on removal of suspended solids from water by electrokinetic methods.

"Hydrologic Aspects of Drain Depth and Spacing as Related to Soil Physical Properties, Climate, Crop Response and Crop Rotations"

G. O. Schwab
Department and Cooperating Agencies: Departments of Agricultural

Engineering and Agronomy, in cooperation with: Ohio State Department of Welfare; and Agricultural Research Service, U. S. Department of Agriculture.

A study to evaluate effectiveness of various tile depths and spacings in removing excess water from soils are influenced by soil physical properties, crops and tillage practices; to maintain and evaluate long time drainage and climatic records, and to develop practical drainage recommendations for important soil types.

"Effectiveness of Surface and Subsurface Drainage for Slowly Permeable Soils"

G. O. Schwab

Department and Cooperating Agencies, Departments of Agricultural Engineering and Agronomy, in cooperation with: Agricultural Research Service, U. S. Department of Agriculture.

Studies to determine relative effects of various drainage systems on crop response, soil moisture conditions and other soil physical conditions. Data are also collected on tile outflow, surface runoff and soil nutrient losses for improving system design standards. The effects of soil moisture levels on physiology of plants in the field are also studied.

"Soil Characteristics Which Affect Subsurface Drainage"

G. S. Taylor

Department and Cooperating Agencies: Departments of Agronomy and Agricultural Engineering, in cooperation with Agricultural Research Service, U.S.D.A.

Effects of soil hydraulic conductivity and drainable porosity on water table drawdown by subsurface drains is being studied by field experiments, tank models, electrical analogs, and computer systems.

"Improved Methods and Equipment for Subsurface Drainage"

G. O. Schwab

Department and Cooperating Agencies: Department of Agricultural Engineering, in cooperation with Agricultural Research Service, U. S.D.A.

New Principles for controlling grade on trenching machines are being developed and tested in field experiments. Various types of materials and methods of improving subsurface drainage, such as plastic-lined mole drains, are being developed and tested.

"Reclamation and Use of Stripmined Land in Ohio: Spoil Properties and the Establishment of Forage Species"

P. H. Struthers

Department and Cooperating Agencies: Departments of Agronomy and Forestry.

Chemical, mineral and physical properties of raw spoil materials are being investigated with respect to influence on plant growth and re-vegetation. Rate of weathering of spoil materials is being observed by chemical analyses of effluent drainage in both field and lysimeter studies.

"Irrigation Requirements and Potentials of Field and Horticultural Crops"

R. Bruce Curry

Department and Cooperating Agencies: Departments of Agricultural Engineering, Agronomy and Horticulture.

Evaluations of water requirements and evapotranspiration rates of crops, the long-time response of these crops to irrigation, and the drought potentials of major soils and correlation to crop response--and the application of this information to development of design criteria to irrigation systems.

"Flow of Colloidal Suspensions in Porous Media"

R. B. Curry

Department and Cooperating Agencies: Departments of Agricultural Engineering and Agronomy, in cooperation with National Science Foundation.

Development and laboratory testing of a mathematical model to describe fundamental principles underlying the flow of colloidal suspensions into or through porous media.

"Fundamentals of Soil Erosion by Water and Their Application to the Design of Control Measures"

R. B. Curry

Department and Cooperating Agencies: Departments of Agricultural Engineering and Agronomy, in cooperation with Agricultural Research Service, U. S. Department of Agriculture.

Development and evaluation of laboratory methods to determine: the factors involved in soil erodibility, the relative erodibility of major Ohio soils, and development of a mathematical model to study the energy of falling raindrops--and the use of this data to improve designs and efficiency of soil and water conservation structures.

"Hydrologic Characterization of Small Watershed"

R. B. Curry and G. O. Schwab

Department and Cooperating Agencies: Department of Agricultural Engineering, in cooperation with: North Central Region agricultural experiment stations; and Agricultural Research Service, U.S.D.A.

The objective of this new region-wide effort is to investigate the use of mathematical, electrical and hydraulic models to study hydrologic phenomena of watersheds.

The Ohio Agricultural Experiment Station is also cooperating with the Agricultural Research Service, U. S. Department of Agriculture in the following projects at the Soil and Water Conservation Research Station at Coshocton, Ohio:

"Point Rainfall Measurement Study"

J. L. McGuinness

Department and Cooperating Agencies: Agricultural Research Service, U. S. Department of Agriculture, in cooperation with O.A.E.S.

Study of the problems of obtaining accurate measurement of point rainfall are being made to determine if any bias exists in the measurement of point rainfall using conventional gaging methods, to determine the causes of existing bias, and test possible corrective measures. The weighing lysimeters at Coshocton provide a reliable standard against which rain gage measurements can be checked.

"Study of Interflow Related to Precipitation and Soil Moisture"

C. R. Amerman

Department and Cooperating Agencies: Agricultural Research Service, U. S. Department of Agriculture, in cooperation with O.A.E.S.

The phenomenon of interflow and its relation to precipitation, soil moisture and soil properties is being investigated to determine the conditions of soil moisture, precipitation and soil profile under which interflow occurs. Interflow is the lateral movement of water through the upper soil horizons which eventually returns to the soil surface at some point down slope from its point of infiltration.

"Interflow-Streamflow Relations"

C. R. Amerman

Department and Cooperating Agencies: Agricultural Research Service, U.S.D.A., in cooperation with O.A.E.S.

Instrumented watersheds and recording rain gages are being used to investigate the importance of interflow as a component of storm runoff and total water yield from a watershed.

"Study of the Variability of Soil Moisture on a Small Watershed Area"

J. L. McGuinness

Department and Cooperating Agencies: Agricultural Research Service, U.S.D.A. in cooperation with O.A.E.S.

An intense network of soil moisture instruments is being used to gather data for a statistical study to provide a guide to the degree of sampling

intensity required to determine an average value of soil moisture, or of a change in soil moisture for a small watershed area within a given area limit.

Additional projects being carried on at the Coshocton station by the Agricultural Research Service include:

Studies of Precipitation Characteristics Influencing Runoff from Agricultural Watersheds.

Moisture Regimes of Agricultural Watersheds.

Studies in Subsurface Hydrology.

Runoff Studies of Unit Source Area Watersheds.

Sediment Production from Unit Source Area Watersheds.

Studies of Runoff from Complex Watersheds.

Study of Areal Distribution Characteristics of Severe Local Storms in Northeast Ohio.

Several other drainage projects are also being carried out by the Soil and Water Conservation Research Branch, Agricultural Research Service, U.S.D.A., located at and cooperating closely with the Department of Agricultural Engineering and Agronomy, Ohio State University:

Field Test Evaluation of Plastic Lined Mole Drains.

Accelerated Field Test of the Zipper Plastic Mole Line and Shallow Drain Tile.

Analog Studies of Subsurface Drainage on Flat and Sloping Land.

Electrical Techniques for Measuring and Recording Drainage Data--Water Table Measurement.

APPENDIX C
BIOGRAPHIES

Name

Carroll R. Amerman

Date of Birth

July 25, 1930

Education

B S. , Agricultural Engineering, Purdue University, 1957.

M S. , Agricultural Engineering, Purdue University, 1958.

Experience

1958 to date: Agricultural Research Service, United States
Department of Agriculture.

1957 - 1958: Teaching Assistant, Purdue University.

1949 - 1952: United States Army.

Research

Participated in research studies on agricultural watershed hydrology
from 1958 to date, and in pond water treatment as a Research
Assistant at Purdue University in 1957 - 1958.

Principal Publications

"Evaluating effect of land use on stream flow." 1960 (with D. L. Brakensiek).
Agricultural Engineering 41, No. 3, 158-161.

"Hydrogeologic nature of stream flow on small watersheds." 1961 (with
J. L. McGuinness and L. L. Harrold). Proceedings of the American
Society of Civil Engineers, Separate 2700, 87, 1-13.

"Influence of land use and treatment on the hydrology of small watersheds at
Coshocton, Ohio, 1938-1957." 1962 (with L. L. Harrold, D. L.
Brakensiek, J. L. McGuinness and F. R. Dreibilbis). Technical
Bulletin No. 1256.

"Land use, soil type and practice effects on the water budget." 1964 (with
F. R. Dreibilbis). Journal of Geophysical Research 69, No. 16.

"Evapotranspiration (ET) and water storage opportunity." 1964 (with
F. R. Dreibilbis). Now in the process of being printed.

Time Available for Water Resources Activities

100%

Name

N. Wilson Britt

Date of Birth

January 3, 1913

Faculty Appointment

Associate Professor, Zoology.

Education

B.S., Biology, Western Kentucky State College, 1939.

M.S., Entomology, The Ohio State University, 1947.

Ph.D., Hydrobiology, The Ohio State University, 1950.

Experience

1950 to date: Instructor to Associate Professor, Department of Zoology and Entomology, The Ohio State University.

Research

Principal research interests concern changes in bottom fauna of lakes and streams in relation to limnological conditions and studies concerning the effects of oxygen depletion in large bodies of water.

Pertinent Publications

"New methods of collecting bottom fauna from shoals or rubble bottoms of lakes and streams." 1955. Ecology 36 (3), 524-526.

"Stratification in Western Lake Erie in summer of 1953: Effects on the Hexagenia (Ephemeroptera) population." 1955. Ecology 36 (2), 239-244.

"Biology of two species of Lake Erie mayflies, Ephoron Album (Say) and Ephemera Simulans Walker." 1962. The Ohio Biological Survey, New Series I(5), 1-72.

Time Available for Water Resources Activities

30%

Name

Colin B. B. Bull

Date of Birth

June 13, 1928

Faculty Appointment

Associate Professor, Geology

Education

B.S., Physics, Birmingham University, England, 1948.

Ph.D., Physics, Birmingham University, England, 1951.

Experience

1961 to date: Associate Professor, Geology, The Ohio State University.

1956-1961: Senior Lecturer, Physics, Victoria University, New Zealand.

1955-1956: Research Fellow, Geophysics, Birmingham University (England)

1951 & 1955: Shell Student, Cambridge University (England)

1952-1954: Chief Scientist, British North Greenland Expedition.

Research

Extensive research in field glaciology and geophysics (3 years in the Northern Hemisphere - mainly Greenland - and 15 months in Antarctica)

Principal Publications

10 articles in the Journal of Glaciology.

3 articles in the Geophysical Journal.

3 articles in the New Zealand Journal of Geology and Geophysics.

Time Available for Water Resources Activities

5%

Name

Robert P. Bullock

Date of Birth

October 12, 1908.

Faculty Appointment

Professor, Sociology.

Education

A. B. , Public School Administration, Colorado State College of Education, 1931

M. A. , Sociology, Colorado State College of Education, 1932.

Ph. D. , Sociology (Research Methodology, Social Organization and Industrial Sociology), The Ohio State University, 1951.

Experience

1960 to date: Professor, Department of Sociology, The Ohio State University.

1955 to 1960: Associate Professor, Department of Sociology, The Ohio State University.

1951 to 1955: Assistant Professor, Department of Sociology, The Ohio State University.

1947 to 1951: Instructor, Department of Sociology, The Ohio State University.

1945-1946: Assistant Principal, Greeley Public High School, Greeley, Colorado.

1942 to 1945: Radar Technician, U.S. Army Signal Corps.

1937 to 1942: Boys' Advisor and Director of Guidance, Greeley Junior High School, Greeley, Colorado.

1939 to 1942: Chairman of Curriculum Study, Department of Social Studies, Greeley (Colorado) Public Schools.

1934 to 1937: High School Principal, Ault, Colorado.

1932 to 1934: Teacher, Social Studies, Ault Public High School, Ault, Colorado.

Research

1962 - 63: Research Consultant and Research Associate, Ohio State University Research Foundation Project No. 1384, "Improved Competence of Nursing Faculty in Research."

1955-1958: Directed a research project intended to develop techniques by which public school administrators may analyze and utilize community factors and resources of importance in school administration.

1953 - 1954: In charge of the morale and job-satisfaction study for the Ohio State Nurses' Association.

Research, continued

1953: Research Associate, Ohio State University Research Foundation
Project No. 494, "Attitudes of Downtown Shoppers vs. Suburban
Shoppers."

Principal Publications

"Social Factors Related to Job-Satisfaction: A Technique for the
Measurement of Job-Satisfaction." 1952. Research Monograph
No. 70, Bureau of Business Research, The Ohio State University.

"Some Cultural Implications of Year-Round Schools." 1962. Theory
into Practice 1, No. 3, Bureau of Educational Research and
Service, The Ohio State University.

"Power Elite in Your Community." 1959. The School Executive 78, No. 7,
59-61.

"Morale Problems in Hospital Nursing Service." 1953. Ohio Nurses
Review 28, No 1.

"Position, Function and Job-Satisfaction of Nurses." 1953. Nursing
Research, The American Journal of Nursing 2, No. 2.

"Social and Economic Trends Affecting Hospitals and Nursing Service."
1953. Ohio's Health, Ohio Department of Health 5, Nos. 4 and 5.

"What Rewards Do Student Nurses Expect of Nursing?" 1953. Ohio
Nurses Review 28, No. 5.

"The Importance of Professional Status for Nurses." 1953. Ohio Nurses
Review 28, No. 3.

Time Available for Water Resources Activities

10%

Name

R. Bruce Curry

Date of Birth

September 24, 1929.

Faculty Appointment

Associate Professor, Agricultural Engineering.

Education

B.S., Agricultural Engineering, Kansas State University, 1951.

M.S., Irrigation Engineering, Colorado State University, 1955.

Ph.D., Agricultural Engineering, University of Missouri, 1960.

Experience

July 1960 to date: Assistant Professor, Agricultural Engineering, Ohio Agricultural Experiment Station. Research in the area of soil and water conservation.

August 1955 to July 1960: Instructor, Agricultural Engineering, University of Missouri. Teaching and research in soil and water conservation subjects (irrigation, drainage, erosion control and hydrology).

March 1954 to August 1955: Graduate Fellow, Irrigation Engineering, Colorado State University.

February 1952 to February 1954: U.S. Army Chemical Corps (Scientific and Professional Personnel). Classified Research in the Biological Warfare Division.

August 1951 to February 1952: Civil Engineer, U.S. Bureau of Reclamation, Office engineering work on an irrigation development project.

Research

1952 - 1954: Research in irrigation.

1954 - 1955: Investigation of the basic factors involved in the development of the sedimentation method of lining irrigation canals.

1955 - 1960: Research studies performed in (1) the fundamental factors involved in the flow of colloidal suspensions through porous media and the interrelationship of these factors; (2) the hydraulics of surface irrigation; and (3) an investigation of soil moisture used by corn as related to climatological factors, and the amounts of soil moisture used from various zones of the soil profile.

1960 to date: Research in progress includes (1) a basic study of the phenomena involved in the flow of colloidal suspensions

Research, continued

1960 to date: Research in progress includes (1) a basic study of the phenomena involved in the flow of colloidal suspensions through porous media; (2) an investigation of the irrigation requirements and potentials of field and horticulture crops with particular emphasis on water requirements and irrigation systems; (3) a study of the fundamentals of soil erosion by water and their application to the design of control measure; and (4) an investigation of the hydrology of small watersheds.

Principal Publications

- "Penetration and Retention of Bentonite Suspensions in Porous Media." Unpublished Master's thesis, Colorado State University.
- "An Investigation of the Flow of Colloidal Suspensions Through Porous Media." Unpublished Ph.D. dissertation, University of Missouri.
- "An Investigation of the Flow of Colloidal Suspensions Through Porous Media." Research Bulletin 711, University of Missouri, Missouri Agricultural Experiment Station. 1960.

Time Available for Water Resources Activities

100%

Name

Charles A. Dambach

Date of Birth

December 31, 1911

Faculty Appointment

Professor, Agriculture, and Director, Natural Resources Institute,
The Ohio State University.

Education

B.S., Agriculture and Entomology, The Ohio State University, 1937.

M.S., Animal Ecology, The Ohio State University, 1941.

Ph.D., Animal Ecology, The Ohio State University, 1945.

Experience

1955 to date: Director, Natural Resources Institute, The Ohio State
University.

1950 to 1955: Chief, Division of Wildlife, Ohio Department of Natural
Resources.

1945 to 1950: Director of Conservation Curriculum and Associate Professor
of Zoology, The Ohio State University.

1942 to 1945: Assistant Leader of Wildlife Research Unit, The Ohio
State University.

1934 to 1942: Junior forester, project biologist, and regional biologist,
U.S. Soil Conservation Service.

Research

Principal current research interests are in the area of resource admini-
stration and resource use education, and teaching includes parti-
cipation in several interdepartmental degree programs in the
several fields of resource conservati on, including projects con-
cerned with the utilization of above-ground reservoirs and studies
on the economic development of a water shed affected by acid mine
drainage.

Principal Publications

"Recreational Use of Impounding Reservoirs." 1956. Journal American
Water Works Association 48, No. 5, 517-524.

"Conservation of Natural Resources." 1958. (Contributing author, edited
by Guy-Harold Smith.) John Wiley and Sons, Inc.

"The Relative Importance of Resource Department Consolidation." 1958.
April. American Forests Magazine.

"Conservation Training in American Colleges and Universities." 1962.
Transactions of the Annual Meeting of Soil Conservation Society
of America.

Time Available for Water Resources Activities

25%

Name

Patrick R. Dugan

Date of Birth

December 14, 1931

Faculty Appointment

Assistant Professor, Microbiology

Education

B.S., Bacteriology, Syracuse University, 1956.

M.S., Microbiology, Syracuse University, 1959.

Ph.D., Microbiology, Syracuse University, 1963.

Experience

1963 to date: Assistant Professor, Microbiology, The Ohio State University.

1959 - 1963: Associate Research Scientist, Syracuse University.

1956 - 1959: Research Assistant, Microbiological and Biochemical Center, Syracuse University Research Corporation.

Research

Research experience includes a wide variety of trace analysis of organic and inorganic compounds, including methods development, microbial physiology - particularly of aquatic organisms, effects of pesticides and detergents in aquatic environment, and investigations of the formation of iron ions and acid as a result of the metabolism of iron oxidizing bacteria.

Principal Publications

"Isolation of the Floc forming organism *Zoogloea ramiborgii* and its culture in complex and synthetic media." 1960 (with D. G. Lundgren). Applied Microbiology 8, 357.

"Evaluation of marine toilet chlorinator units." 1962 (with R. Pfister). Research Report No. 9 (58 pp.), published by New York State Department of Health.

"Pesticide analysis in a New York watershed, an application of electron capture gas-liquid chromatography." 1963 (with J. H. Nair, R. D. O'Neil and M. Sprague). Proceedings of the 145th American and Chemical Society, Agriculture and Food Division.

"Evaluation of the extent and nature of pesticide and detergent involvement in surface waters of a selected watershed." 1964 (with R. Pfister, M. Sprague and R. D. O'Neil). Research Report No. 10, Part I (76 pp.), published by the New York State Department of Health.

"Bibliography of organic pesticide publications having relevance to public health and water pollution problems." Research Report No. 10, Part II (122 pp.), published by the New York State Department of Health.

Principal Publications, continued

- "Acid production by Ferrobacillus ferrooxidans and its relation to water pollution." 1964. (with D. G. Lundgren). Advances in Industrial Microbiology 5, 220-257.
- "Microdetection of meradione, coenzyme Q6 and certain related quinoid compounds in biologic materials by electron-capture gas chromatography." 1964. (with D. G. Lundgren). Analytical Biochemistry 8, 312-318.
- "Model mechanism of iron oxidation by the chemoautotrophic bacterium Ferrobacillus ferrooxidans." 1964. (with D. G. Lundgren). Bacteriology Proceedings 92.

Time Available for Water Resources Activities

75%

Name

Ernest G. Ehlers

Date of Birth

January 17, 1927

Faculty Appointment

Associate Professor, Mineralogy

Education

M.S. , Geology, University of Chicago, 1950

Ph.D., Geology, University of Chicago, 1952.

Experience

1957 to date: Associate Professor, Mineralogy, The Ohio State University.

1954 - 1957: Assistant Professor, Mineralogy, The Ohio State University.

1952 - 1954: Geologist, The New Jersey Zinc Company

Research

Participated in research on lightweight aggregates and acid mine waste.

Also, participated in mineralogic research in petrography and phase equilibrium.

Principal Publications

"The Mechanism of Lightweight Aggregate Formation." 1958.

The American Ceramic Society Bulletin 37, No. 2, 95-99.

"An Investigation of the Stability Relations of the Al-Fe Members of the Epidote Group." 1953. Journal of Geology 61, No. 3.

"Electropolishing of Pyrite." 1964. (with John D. Birle). American Mineralogy 49, 800-804.

Time Available for Water Resources Activities

20%

Name

Daniel Oliver Fletcher

Date of Birth

April 8, 1930.

Faculty Appointment

Associate Professor, Economics.

Education

A. B. , Economics, Oberlin College, 1952.

M. A. , Economics, University of Michigan, 1956.

Ph. D. , Economics, University of Michigan, 1960.

Experience

1963 to date: Associate Professor of Economics, The Ohio State University.

1959 to 1963: Assistant Professor of Economics, The Ohio State University.

1957 to 1959: Instructor in Economics, University of Michigan.

July, 1963 to July, 1964: Economist, Office of Industrial Analysis,
Business and Defense Services Administration, U.S. Department
of Commerce, Washington, D. C. (while on leave from OSU).

Summer, 1962: Consultant, Ohio Bell Telephone Company.

Spring, 1962: Member, Wage Board for Laundry Industry, Department
of Industrial Relations, State of Ohio.

Principal Publications

"Transportation and Communications," in Thompson and McKinney, Eds.,
Change and Continuity in the South, to be published by Duke University
Press in 1964.

"Review of George Hilton." 1963. The Great Lakes Car Ferries, The
Business History Review 37, No. 1-2.

"Business Review." 1964. Encyclopedia Britannica, Book of the Year.

"Business Review." 1963. Encyclopedia Britannica, Book of the Year.

"The Decline of the Great Lakes Package-Freight Carriers." 1962.
The Business History Review 36.

"Package Freighters: Victims of War." 1961. Inland Seas 17, No. 2.
Great Lakes Historical Society.

Time Available for Water Resources Activities

25%

Name

Richard Parker Goldthwait

Date of Birth

June 6, 1911

Faculty Appointment

Professor, Geology, and Director, Institute of Polar Studies

Education

A. B. , Geology, Dartmouth College, 1933.
M. A. , Geology, Harvard University, 1937.
Ph.D. , Geology, Harvard University, 1939.

Experience

1946 to date: Associate Professor and Professor, Department of Geology, The Ohio State University.
1942 to 1946: Technical Consultant and Materials Engineer, U.S. Army Air Force.
1939 to 1944: Instructor and Assistant Professor, Department of Geology, Brown University.

Research

1946 to 1964: Glacial mapping and stratigraphy in Ohio for the Ohio Division of Water and the United States Geodetic Survey.
1958-59-61-63: National Science Foundation research projects in Alaska and the Yukon.
1953-54-55-56: U.S. Army Engineer research projects in Greenland.
1929 to 1940: Glacial mapping in New Hampshire for the State Highway Department and the Development Commission.
1939 to 1941: Glacial geology of Cape Cod for the United States Geological Survey.
1933-1934: Chief Scientist, Harvard-Dartmouth Alaska Expeditions.

Principal Publications

"Geology of New Hampshire, Part I." (with others).
"Study of ice cliff in Nunatarssuag, Greenland." Cold Regions and Engineering Laboratory Technical Report No. 39.
40 articles on glacial geology of New Hampshire, Ohio and Alaska.
Supervisor of the following reports:
"USNC-IGY Antarctic Glaciological Data" and
"Ohio State University Institute of Polar Studies Research Reports."

Time Available for Water Resources Activities

25%

Name

George P. Hanna, Jr.

Date of Birth

March 25, 1918.

Faculty Appointment

Associate Professor, Civil Engineering and Director, Water Resources Center

Education

B.S., Civil Engineering, Illinois Institute of Technology, 1940.

M.S., Sanitary Engineering, New York University.

Experience

1959 to date: Associate Professor, Department of Civil Engineering.

1954 to 1959: Engineer, Creole Petroleum Corporation, Maracaibo, Venezuela. Supervised all water supply planning, studies, and operations during 5 years. Performed hydrologic and economic evaluation of water resources in Bolivar Coastal Field. Supervised utility design sub-section for one year. Assistant to the Division Engineer, supervising contracted work and correlating inter-company activities relating to engineering for one year. Supervisor, Civil Engineering Design Section - responsible for all civil engineering planning and design of projects (up to 2 million dollars value) - for 2 years. Area Engineer - responsible for operations and construction activities - for one year.

1952 - 1953: Design engineer with consulting engineers. Planned and designed water supply, waste disposal and drainage projects.

1950 - 1952: Assistant Professor, Civil Engineering Department, Syracuse University.

1948 - 1950: Director, Bureau of Sanitation, Syracuse, N. Y.; supervised environmental sanitation activities relating to water supply, waste disposal, pest control, food sanitation and nuisance abatement.

1946 - 1948: Design engineer with consulting engineers. Planned and designed water supply, waste disposal and drainage projects.

1943 - 1946: Commissioned officer, Sanitary Corps, U.S. Army. Supervised sanitation activities.

1942: Sanitary Engineer, U.S. Army Engineers District Office, Philadelphia, Pennsylvania. Designed water sewerage and drainage facilities.

Research

- Directed research activities in water resources at the Water Resources Center, The Ohio State University, since 1959.
- Project supervisor, Ohio River Valley Water Sanitation Commission, sponsored acid mine drainage study for development of organized research plans for improving control of acid mine drainage pollution.
- Supervised study sponsored by the State of Ohio, relating to acid potential production relative to different geographical strata.
- Administrative supervision of studies sponsored by the Ohio Department of Health relating to the effect of toxic wastes (heavy metals) on biological treatment processes; and of studies sponsored by the United States Public Health Service, Yeomans Brothers Pump Company and Ohio Septic Tank relating to anaerobic-aerobic digestion processes.
- Supervised studies sponsored by Procter and Gamble Company relating to degradation of detergents by biological processes, and studies sponsored by Rohm and Haas Company of enzyme effects on anaerobic processes.
- Joint supervision with Boris S. Browzin of a study relating to a Rational Classification of river systems in the Great Lakes - St. Lawrence Basin in terms of their unit hydrographs.
- Participated in a study sponsored by the National Institutes of Health (WP-00340), entitled "Study of the Sulfide to Sulfate Reaction Mechanism," relating to the mechanisms of acid mine drainage. This study was awarded to Dr. E. E. Smith, The Ohio State University.
- Advised on thesis work involving:
- "Fundamentals of Alum Flocculation as Applied to Water Purification."
 - "Toxic Effect of Copper Shock Loading to Activated Sludge as Monitored by the Warburg Respirometer."
 - "Degradation and Adsorption of ABS by Aerobic Digestion."
 - "A Study of Anaerobic Degradation of Higher Fatty Acids."
 - "Use of Algae in Removing Phosphates from Sewage Treatment Plant Effluent."

Principal Publications

- "Water Supply Study, Bolivar Coastal Fields, State of Zulia, Venezuela." 1955. General Engineering Report No. 24, Creole Petroleum Corporation, Caracas, Venezuela.
- "Approaches to Water Supply and Sewage Disposal Problems." Proceedings of First Annual Community Development Conference November 1959, Engineering Experiment Station, The Ohio State University.

Principal Publications, continued

- "Toxicity of Selected Ions on Activated Sludge Treatment." 1960 (with E. Q. Moulton). Public Works 91, No. 7.
- "Domestic Use and Reuse of Water Supply." Journal of Geography, January 1961.
- "Stratigraphic Relations to Acid Mine Water Production." 1962 (with R. A. Brant). Proceedings, 17th Annual Purdue Industrial Waste Conference.
- "Analysis of Fundamentals of Acid Mine Drainage - A Basis for Future Investigations." 1963 (with others). Journal, Water Pollution Control Federation 35, 3, 275.
- "Classification of Rivers in the Great Lakes - St. Lawrence Basin." 1963 (with B. S. Browzin). Engineering Experiment Station Report No. WRC-4, The Ohio State University.
- "The Relation of Water to Stripmine Operation." 1964. Ohio Journal of Science 64, 2, 120.
- "A Field Study of LAS Biodegradation." (with others). Accepted for publication - Water and Sewage Works December 1964.
- "Temporal Variations in River Water Characteristics." 1964. Paper delivered to Ohio Section, American Water Works Association (unpublished).

Time Available for Water Resources Activities

100%

Name

Richard N. Kinsley, Jr.

Date of Birth

October 22, 1929.

Title

Assistant Professor, Microbiology.

Education

A. B. , Biology, Earlham College, 1951.

M. A. , Mycology, Washington University, 1956.

Ph.D. , Microbiology, Purdue University, 1962.

Experience

1962 to date: Assistant Professor, The Ohio State University.

1958 to 1962: Research Fellowship, Purdue University

1956 to 1958: Working on variations in commercial yeast for
Anheuser Busch, Inc. , St. Louis, Missouri.

1954 to 1956: U.S. Army Chemical Center (working on microbiology
and wounds).

1951 to 1954: Graduate Assistant, Washington University.

Research

Performed research on yeasts and the breeding of *Drosophila* and on
the antagonism between fungi and yeasts.

Principal Publication

"The effect of 2 hepta-5-methylbenzimidazole and hydrochloric acid
on the growth of microflora found on poultry carcasses." 1964.
(with G. J. Mountney, U. B. Blackwood and J. E. O'Malley).
Poultry Science 43, 778-780.

Time Available for Water Resources Activities

15%

Name

Jay H. Lehr

Date of Birth

September 11, 1936.

Faculty Appointment

Assistant Professor, Geology, The Ohio State University.

Education

B.S.E., Geological Engineering, Princeton University, 1957.

Ph.D., Hydrology, University of Arizona, 1962.

Experience

1964 to date: Assistant Professor Geology, The Ohio State University.

1963 - 1964: Assistant Professor, Hydrology, University of Arizona.

1962 - 1963: Instructor, Hydrology, University of Arizona.

1957 - 1959: Commissioned officer, U.S. Navy. Highest rank: Lieutenant (jg)

1955 - 1957: Part-time Hydrologic Field Assistant, U.S. Geological Survey, Ground Water Branch, Mineola, New York.

Research

1963 to date: "Development of Three-Dimensional Porous Matrix Models for Studying Ground Water Movement." \$11,000 grant from the National Science Foundation under the New Laboratory Equipment Program.

1961 to date: "Development of Hydraulic Models Analogous to Subsurface Geologic Conditions for Studying and Demonstrating the Characteristics of Ground Water Movement." \$22,000 grant from the National Science Foundation under the New Laboratory Equipment Program.

Principal Publications

"Empirical Studies of Laminar Flow in Porous Consolidated Media."
Abstract, Geological Society of America Bulletin, December 1961.

"Ground Water: Flow Toward an Effluent Stream." 1963. Science 140,
No. 3573.

"Development of Ground Water Flow Models Simulating Subsurface Geology."
Journal of Geologic Education, December 1963.

"Model Analysis of Water Table Drawdown Surrounding Pumping Wells."
Journal of Soil and Water Conservation, September-October 1963.

"Ground Water Flow Around and Through Lenticular Beds." Journal of the Water Pollution Control Federation, December 1963.

Time Available for Water Resources Activities

25%

Name

William Harry Perloff, Jr.

Date of Birth

May 2, 1936

Faculty Appointment

Assistant Professor, Civil Engineering

Education

B.S., Civil Engineering, Swarthmore College, 1957

M.S., Civil Engineering, Northwestern University, 1958

Ph.D., Civil Engineering, Northwestern University, 1962

Experience

1962 to date: Assistant Professor, Department of Civil Engineering,
The Ohio State University

1960-1961: Research Assistant, Department of Civil Engineering,
Northwestern University

1959-1960: Teaching Assistant, Department of Civil Engineering,
Northwestern University

1958-1959: Research Assistant, Caisson Corporation Grant,
Department of Civil Engineering, Northwestern University

1958: Soils Laboratory Technical, Metcalf and Eddy, Consulting
Engineers, Boston Massachusetts

1956-1957: Soils Engineer, Frederic R. Harris, Incorporated,
Consulting Engineers, New York, New York

Research

Model study of horizontal pressure on a retaining wall due to a line load
surcharge, 1956-1957

Study of the consolidation behavior of an organic silt, 1957-1958

Study of Stress-strain characteristics of compacted clay under varied rates
of strain, 1958-1959

Review of current status of research in glaciology, 1959

Study of Stress history and strain rate effects on the undrained sheer strength
of cohesive soils, 1960-1962

Study of a thermodynamic approach to the ultimate strength of cohesive soils, 1962-present

Study of the effect of principal stress ratio on the consolidation characteristics of a cohesive soil, 1962-1963

Development of a system for measurement of pore water pressure at the base of a one-dimensional consolidation test, 1962-1963

Study of the pressure-penetration relationships for model footings on cohesive soil, 1963-1964

Experimental study of the effect of load cycling on the consolidation process for a cohesive soil, 1963-1964

Study of off-road mobility of tracked vehicles on soft soils, 1963-present

Study of pore water pressure and permeability changes during consolidation of cohesive soils, 1963-present

Analysis of stresses in an elastic medium due to pressures exerted by a buried footing, 1964-present

Study of long-term deformations of compacted cohesive soil embankments, 1964-present

Experimental study of stresses and displacements within a cohesive soil mass being penetrated by a model footing, 1964-present

Study of effect of cyclic loading on the stress-strain properties of cohesive soil, 1964-present

Principal Publications

"Consolidation Behavior of an Organic Salt", M.S. Thesis, Northwestern University, 1958

"Stress Strain Characteristics of Compacted Clay Under Varied Rates of Strain", (with J. O. Osterberg), Proceedings of the Highway Research Board, v. 39, 1960, p. 605.

"The Effect of Stress History and Strain Rate on the Undrained Shear Strength of Cohesive Soils", Ph.D. Thesis, Northwestern University, 1962.

Discussion of "Design of Swiss Roads Against Frost Action" by A. von Moos, Highway Research Record Number 33, "Pavement Design in Frost Areas", 1963, p. 167.

- "The Effect of Strain Rate on the Undrained Shear Strength of Cohesive Soils", (with J. O. Osterberg) Proceedings of the Second Pan American Conference of Soil Mechanics and Foundation Engineering, 1963, p.103.
- "A New Approach to Off-the-Road Mobility of Tracked Vehicles on Soft Soil" (with K. Nair), presented at the Second Canadian American Regional Meeting of the International Society for Terrain-Vehicle Systems, 1963.
- "Stress History Effects on Strength of Cohesive Soils" (with J. O. Osterberg), Highway Research Record Number 48, "Measurement and Relationships of Soil Stress and Strength", 1964, p. 49.
- "The Pressure-Penetration Relationships for Model Footings on Cohesive Soil" , Final Technical Report to the Land Locomotion Laboratory, U.S. Army Tank-Automotive Command, Ohio State University Report RF 1745-4, 1964.
- "Effect of Load Cycling on the Consolidation Process for a Cohesive Soil", (with H.P. Johnson and W. L. DeGroff), accepted for presentation of the 44th. Annual Meeting of the Highway Research Board, and subsequent publication, 1965.
- "Measurement of Pore-Water Pressure in the One-Dimensional Consolidation Test" (with W. L. DeGroff), to be presented at the 1965 Annual Meeting of the American Society for Testing and Materials, June 1965.
- "Stresses Within A Cohesive Soil Mass Being Penetrated by a Model Footing", to be presented at the 1965 Annual Meeting of the American Society for Testing and Materials, June 1965.
- "Effect of Measuring System on Pore Water Pressures in the Consolidation Test", (with K. Nair and J. G. Smith), accepted for publication in the Proceedings of the Sixth International Conference on Soil Mechanics and Foundation Engineering", September 1965.

Time Available for Water Resources Activities

10%

Name

Howard J. Pincus

Date of Birth

June 24, 1922.

Faculty Appointment

Professor, Geology and Chairman of the Department of Geology.

Education

B.S., Mathematics and Statistics, City College of New York, 1942.

A.M., Geology, Columbia University, 1948.

Ph.D., Geology, Columbia University, 1949.

Experience

1949 to date: Instructor to Professor, Department of Geology,
The Ohio State University.

1962 to date: Summer and intermittent Consultant, United States
Bureau of Mines.

1950 - 1960: Summer-time Geologist, Ohio Division Geological Survey.

1949 - 1952: Summer and part-time Research Associate, Columbia University.

1959 to date: Independent, part-time Consultant on Geology and Geophysics.

Research

Past research activities have been in the fields of engineering geology and geophysics and in shoreline processes. Current research activities include rock mechanics, statistical methods in geology and geophysics and geologic mapping by radar.

Publications

"Engineering Geology of the Ohio Shoreline of Lake Erie." (7 maps with texts). Ohio Division of Shore Line Erosion Technical Report No. 7, 1960 - 1962.

"Science of the Sea." American Educational Press. 32 pp.

33 other articles appearing in the below listed journals:

- 1 - Transactions, American Geophysics Union
- 2 - American Association of Advancement of Science
- 2 - American Society of Civil Engineers
- 1 - Council on Wave Research
- 7 - Bulletin, Geological Society of America
- 1 - Great Lakes Research
- 1 - Journal, American Statistical Association
- 2 - Journal, Geology
- 2 - Journal, Geological Education
- 1 - Bulletin, Ohio Conservancy
- 3 - Ohio Division Geological Survey

Publications, continued

- 7 - Ohio Division of Shore Erosion
- 1 - Ohio Historical Society
- 1 - Ohio Journal of Science
- 1 - Photogrammetric Engineering

Time Available for Water Resources Activities

5%

Name

Wilford L. L'Esperance

Date of Birth

December 9, 1930

Faculty Appointment

Assistant Professor, Economics

Education

A.B., Columbia College, 1951.

M.S., Graduate School of Business, Columbia University, 1952.

Ph.D., University of Michigan, 1963.

Experience

1963 to date: Assistant Professor, Department of Economics, The Ohio State University; Consultant, Bureau of Commercial Fisheries, U.S. Department of the Interior. Research in the areas of economic models and statistical analysis.

1962 to 1963: Economist, Bureau of Commercial Fisheries, U.S. Department of the Interior, Ann Arbor, Michigan.

1961 to 1963: Research Assistant, Research Seminar in Quantitative Economics, Department of Economics, University of Michigan.

1956 to 1960: Lecturer in principles of economics, business statistics, economic history, Indiana University Center, Fort Wayne, Indiana.

1952 to 1953; 1955 to 1960: Marketing Research Analyst, General Electric Company, New York, N. Y. and Fort Wayne, Indiana.

1953 to 1955: Mathematical Analyst, U.S. Army, Guided Missile Development Division, Huntsville, Alabama.

Principal Publications

"An Econometric Model of the Market for Yellow Perch." 1963. (with W. H. Locke Anderson). Proceedings of the 26th Annual Meeting of the American Society of Limnology and Oceanography in Conjunction with the Sixth Conference on Great Lakes Research. University of Michigan.

"A Case Study in Prediction: the Market for Watermelons." 1964. Econometrica 32, No. 1-2.

"A Case Study in Prediction: A Rejoinder." 1964. Econometrica 32, No. 3.

"On the Predictive Power of Various Estimators." 1963. Paper presented at the Winter Meetings of the Econometric Society. Abstract to appear in Econometrica.

Wilford L. L'Esperance, page 2

Principal Publications, Continued

"The Variability of Trawl Catches in the Western Basin of Lake Erie."

A forthcoming report of the Bureau of Commercial Fisheries,
U. S. Department of the Interior.

"Further Evidence on the Predictive Power of Various Estimators."

To be published in International Economic Review.

Time Available for Water Resources Activities

20%

Name

James L. McGuinness

Date of Birth

November 22, 1917

Experience

1955 to date: Statistician in hydrologic research, Agricultural Research Service.

Principal Publications

- "Plant nutrient losses in lysimeter percolates." 1957. (with F. R. Dreibelbis). Agronomy Journal 49, 523-527.
- "The calculation of rates and amounts of runoff." 1957. (with M. K. Royer). Research Report 299, incorporated in Field Manual for Research in Agricultural Hydrology by Holtan, Minshall, Harold, United States Department of Agriculture Handbook 224 157-159, 1962.
- "A short method of obtaining mean weight-diameter values of aggregate analyses of soils." 1957. (with R. E. Youker). Soil Science 83, 291-294.
- "Leaching loss." 1958. (with F. R. Dreibelbis). Crops and Soils 10, 24.
- "The effect of non-representative sampling on linear regressions as applied to runoff." 1958. (with D. L. Brakensiek). Discussion by W. D. Potter, Transactions American Geophysics Union 39, 497-498.
- "Transpiration evaluation of corn grown on a plastic -covered lysimeter." 1959. (with L. L. Harrold, D. B. Peters and F. R. Dreibelbis). Soil Science Society of America Proceedings 23, 174-178.
- "Evaporation as major source of moisture loss." 1959. (with L. L. Harrold, D. B. Peters and F. R. Dreibelbis). Crops and Soils 11, 25.
- "Some effects of land use treatment on small single crop watersheds." 1960. (with L. L. Harrold and F. R. Dreibelbis). Journal of Soil and Water Conservation 15, 65-69.
- "Hydrogeologic nature of streamflow on small watershed." 1961. (with L. L. Harrold and C. R. Amerman). Proceedings, American Society of Civil Engineers, Sep. 27 00, 87, 1-13. Selected for inclusion in Transactions, American Society of Civil Engineers 127, 763-775, 1962.
- "Soil moisture measurements with the neutron method supplement weighing lysimeters." 1961. (with F. R. Dreibelbis and L. L. Harrold). Soil Science Society of America Proceedings, 25, 339-342.
- "Influence of land use and treatment on the hydrology of small watersheds at Coshocton, Ohio." 1962. (with L. L. Harrold, F. R. Dreibelbis, C. R. Amerman and D. L. Brakensiek). United States Department of Agriculture Bulletin 1256, 194 pp.
- "Seasonal and areal effects on small-watershed streamflow." 1962. Journal of Geophysical Research 67, 4327-4334.
- "Accuracy of estimating watershed mean rainfall." 1963. Journal of Geophysical Research 68, 4763-4767.
- "Simplified techniques for fitting frequency distributions to hydrologic data." 1964. (with D. L. Brakensiek). United States Department of Agriculture Handbook No. 259, 42 pp.

Principal Publications, continued

"Soil moisture sampling plan for watersheds." 1964. (with J. R. Urban).
Agricultural Research Service 41-87, 12 pp.

"The role of storm surveys in small watershed research." (in preparation).

Time Available for Water Resources Activities

100%

Name

Henry J. Mederski

Date of Birth

January 24, 1922

Faculty Appointment

Professor of Agronomy

Education

B.S., Agriculture, Michigan State University

Ph.D., Soils and Plant Nutrition, The Ohio State University, 1950.

Experience

1964 and Professor, Ohio Agricultural Experiment Station
1958 - 1962:

1963: Consultant to International Atomic Energy Commission,
Vienna, Austria.

1954 - 1958: Associate Professor, Ohio Agricultural Experiment Station.

1950 - 1954: Assistant Professor, Ohio Agricultural Experiment Station.

Research

Devotes full time to research in the general area of soil-plant relationships. During the past four years, his main interest has been in the relation of plant growth to micro-climate with emphasis on the effect of climate on internal water stress, and the relation of plant growth to internal water stress. Earlier, his interests were in the effect of environment on the mineral nutrition of plants.

Principal Publications

"Determination of internal water status of plants by beta ray gauging." 1961. Soil Science 92, 143-146.

"Relation of soil moisture to ion absorption by corn plants." 1960. Soil Science Society of America Proceedings 24, 149-152.

"Relation of plant growth and ion accumulation to soil moisture levels stabilized with a dividant root technique." 1960. Seventh Congress International Society of Soil Science 3, 467-474.

"Effect of soil temperature on corn plant development and yield." 1963. Soil Science Society of America Proceedings 27, 186-192.

"Manganese deficiency in soy beans." 1958. Trace Elements, 99-108.

Time Available for Water Resources Activities

40%

Name

Chester Irvin Randles

Date of Birth

September 18, 1918.

Faculty Appointment

Professor, Microbiology

Education

B.S., Bacteriology, Kent State University, 1942.

Ph.D., Bacteriology, The Ohio State University, 1947.

Experience

1949 to date: Assistant Professor to Professor, Microbiology,
The Ohio State University.

1947 to 1949: Assistant Professor, Rutgers University.

1944 to 1946: U.S. Army and U.S. Navy. In latter service served
as a member of the Naval Medical Research Unit No. 1,
Berkeley, California. Highest rank: Ensign.

Research

Participated in an Enzyme Institute at the University of Wisconsin in
the summer of 1951. Most recent research work has been
primarily in the area of bacterial metabolism.

Principal Publications

- "Respiratory pathogenicity of Bacillus anthracis spores. III Changes
in pathogenicity due to nutritional modifications." 1946.
(with R. E. Lincoln, M. R. Zelle, J. L. Roberts and G. A.
Young). Journal of Infectious Diseases 79, 254-265.
- "Variants of Escherichia coli, Pseudomonas aeruginosa and Bacillus
subtilis requiring streptomycin." 1947. (with T. Kushnick,
C. T. Gray, and J. M. Birkeland). Science 106, 587-588.
- "The oxidation of fatty acids by Neisseria catarrhalis." 1954.
Journal of Bacteriology 60, 627-634.
- "The oxidative dissimilation of mannitol and sorbitol by Pseudomonas
fluorescens." 1952. (with O. K. Sebeck). Journal of
Bacteriology 63, 693-700.
- "The oxidation of the stereoisomeric 2, 3-butanediols by Pseudomonas."
1952. (with two others). Arch. Biochemistry Biophysics 40, 373-380.
- "The influence of environmental factors on the molecular size of dextran."
1953. (with H. Nadel and G. L. Stahly). Applied Microbiology 1,
217-224.

Principal Publications, continued

- "The oxidation of polyhydric alcohols by bacteria " 1954. Ohio State University Engineering Experiment Station News, 45-47.
- "The fermentation of sorbitol by certain acidogenic oral micro-organisms." 1956. (with T. E. Shockley and M. C. Dodd). Journal Dental Research 35, 233-240.
- "Some characteristics of a phenol-oxidizing Pseudomona." 1956. (with M. K. Hamdy, E. L. Sherrer, H. H. Weiser and W. D. Sheets). Applied Microbiology 4, 71-75.
- "Mannose utilization by Pseudomonas fluorescens." 1956. (with R. G. Eagon). Bulletin Georgia Academy of Science 14, 76-77.
- "The Acid Mine Drainage Problem in Ohio." 1957. (with E. Q. Moulton). Ohio State University Engineering Experiment Station Bulletin No. 166.
- "B-Hydroxypropion-aldehyde, an intermediate in the formation of 1, 3-propanediol by Aerobactic aerogenes." 1960. (with R. H. Abeles and A. M. Brownstein). Biochemistry Biophysics 41, 530-531.
- "Acid Mine Drainage Research Potentialities." 1963. (with G. P. Hanna, J. R. Lucas, E. E. Smith, and R. A. Brandt). Journal, Water Pollution Control Federation 35, 275-296.
- "The Rh_0 (D) specificity of a polysaccharide isolated from a species of Pseudomonas." 1963. (with N. J. Bigley, M. C. Dodd, V. B. Geyer and A. G. Lazen). Journal Immunol. 90, 526-531.

Time Available for Water Resources Activities

25%

Name

Glen Orville Schwab

Date of Birth

December 30, 1919

Faculty Appointment

Professor of Agricultural Engineering

Education

B.S., Agricultural Engineering, Kansas State University, 1942.

M.S., Agricultural Engineering, Iowa State University, 1947.

Ph.D., Agricultural Engineering and Soil Physics, Iowa State University, 1951.

Experience

1956 to date: Professor, Agricultural Engineering, The Ohio State University, and Professor in Charge of soil and water area, Ohio Agricultural Experiment Station.

1948 to 1951 and 1953 to 1956: Assistant Professor to Professor, Agricultural Engineering, Iowa State University.

1952 to 1953: Leave of absence to prepare manuscript for a textbook sponsored by Ferguson Foundation.

1946 to 1947: Part-time teaching, Agricultural Engineering, Iowa State University.

1942 to 1946: Coast Artillery and Corps of Engineers, U.S. Army.

Research

1947-1956: Spent half-time on research in the areas of drainage, hydrology and irrigation.

1956 to date: One-third time devoted to research in drainage, pond water treatment and irrigation.

Principal Publications

"Subsurface drainage with small perforated flexible tubes in mole drains." 1951. Unpublished Ph.D. thesis, Iowa State University.

"The effect of circular perforations on flow into subsurface drain tubes." 1951. (with D. Kirkham). Agricultural Engineering 32; 211-214 and 270-274.

Principal Publications, continued

- "Water yield prediction based on watershed characteristics." 1961. (with P. R. Nixon). Iowa State Journal of Science 35, 331-342.
- "Plastic tubing for subsurface drainage." 1955. Agricultural Engineering 36, 86-89.
- "Engineering aspects of land drainage" - a part of Chapter 3 in Agronomy Monograph, Drainage of agricultural lands. 1957. American Society of Agronomy.
- "Effect of tile spacing on crop yield and water table level in a Planosol soil." 1957. (with D. Kirkham and H. P. Johnson). Soil Science, Am. Proc. 21, 448-452.
- "Tile-trenching machine performance." 1956. (with R. K. Frevert and L. L. DeVries). Agricultural Engineering 37, 469-472.
- "Surface storage reservoirs." - Chapter 4 in Iowa's Water Resources. 1956. Iowa State College Press.
- "Research on irrigation of corn and soybeans at Connesville and Arkeny, Iowa." 1951-55. (with W. D. Schrader, P. R. Nixon, and R. Shaw). Iowa Agricultural Experiment Station Research Bulletin No. 458, March 1958.
- "Tile flow measured electrically." 1960. (with R. H. Hahn). Agricultural Engineering 41, 822-823.
- "Rate, duration and frequency of tile flow." 1961. (with J. L. Fouss and A. P. Leech). Agricultural Engineering 42, 546-549, 555.
- "Pond water quality and field evaluation of treatment systems." 1960. (with R. D. Hill). Submitted to Agricultural Engineering for publication.
- "Soil and water conservation engineering." 1955. (with R. K. Frevert, T. W. Edminster and K. K. Barnes). John Wiley and Sons.
- "Elementary soil and water engineering." 1957. (with R. K. Frevert, K. K. Barnes and T. W. Edminster). John Wiley and Sons.
- "Tile and surface drainage of clay soils. I. Hydrologic performance with grass cover." 1963. (with T. J. Thiel, A. S. Taylor and J. L. Fouss). Ohio Agricultural Experiment Station Research Bulletin No. 935.
- "Quality of water in Ohio farm ponds." 1962. (with R. D. Hill, G. W. Malaney and H. H. Weiser). Ohio Agricultural Experiment Station Research Bulletin No. 922.

Time Available for Water Resources Activities

20%

Name

Waldron D. Sheets

Date of Birth

September 9, 1903.

Faculty Appointment

Associate Professor, Chemical Engineering

Education

B.S., Chemical Engineering, The Ohio State University, 1931.

M.S., Chemical Engineering, The Ohio State University, 1932.

Ch.E., The Ohio State University, 1940.

Experience

1958 to date: Associate Professor, Chemical Engineering, The Ohio State University, and member of staff of Water Resources Center.

1947 to 1958: Part-time position, as Research Engineer and then Assistant Professor, The Ohio State University, to promote and assist in establishing the Waste Treatment Laboratory. Also, Sanitary Engineer III for the Ohio Department of Health.

1947 to date: Private practice as a consulting engineer on industrial wastes and design, construction and operation of treatment facilities.

1946 - 1947: Burgess and Niple, Consulting Engineers, Columbus, Ohio

1943 to 1946: Captain and Major, Sanitary Corps, U.S. Army.

1940 - 1943: Burgess and Niple, Consulting Engineers, Columbus, Ohio. Worked on design, construction, operation and technical supervision of water and waste-water treatment plants.

1931-1940: Division of Engineering, City of Columbus, Ohio. Worked on research, design construction and operation of a 50,000,000 gallon per day waste-water treatment plant.

Research

1962 to date: A field study sponsored by Procter and Gamble on the biodegradation of the old (ABS) and the new (LAS) detergents.

1960 - 1961: A study sponsored by the Sidney (Ohio) Tanning Company on a pre-treatment method for tannery wastes, prior to release to the municipal waste-water system.

1953 - 1962: Conducted investigations sponsored by the Ohio Department of Health on the toxicity of metal-finishing wastes, on a pilot scale model. These studies also included the toxic effect of the wastes on the anaerobic digestion process.

Research, continued

- 1950 - 1953: Conducted investigations sponsored by the United States Public Health Service on the toxicity of metal-finishing wastes to the biological treatment processes, to include the determination of relative toxicity values, as well as the synergistic and antagonistic properties of compounds in this class of materials.
- 1948 - 1950: Worked on a Water Pollution Control Federation project sponsored by the National Institutes of Health which involved analytical procedures on butadiene, detergents, phenol, oil, grease and cyanide.
- 1947 - 1949: Extensive investigations on character and response to various methods of treatment of coffee and tea processing wastes for the Nestle Company.
- 1930 - 1933: Studies on vacuum filtration of digested sludge, to include pilot plant operation, for the Division of Engineering, City of Columbus, Ohio.

Principal Publications

- "Tannin Interference in D. O. Determinations." 1949. Water and Sewage Works 96, 240-242.
- "Microbiological Studies on the Treatment of Petroleum Refinery Phenolic Wastes." 1944 (with others). Sewage and Industrial Wastes 26, 862-868.
- "I. Effect of Synthetic Detergents on BOD Test. II. Some Characteristics of a Phenol-Oxidizing Pseudomonas." 1955 (with others). The Ohio State University Engineering Experiment Station Bulletin No. 157.
- "Disposal of Cannery Wastes by Irrigation." 1955 (with others). Food Packer, Part I, 36, 28-32 and Food Packer, Part II, 36, 30-32.
- "Synthetic Detergents and the BOD Test." 1956 (with others). Sewage and Industrial Wastes 28, 10-17.
- "Pilot Trickling Filter Handles Chromium Plating Wastes." 1956 (with others). Industrial Wastes.
- "COD Values of Syndets, Surfactants, and Builders." 1956 (with others). Eleventh Industrial Waste Conference, Purdue University Extension Series No. 91, pp. 185.
- "Detergent Builders and BOD." 1957 (with others). Sewage and Industrial Wastes 29, 263-267.
- "Toxicity Studies of Metal-Finishing Wastes." 1957 (with others). Sewage and Industrial Wastes 29, 1380-1384.
- "Toxic Effect of Metallic Ions on Sewage Microorganisms." 1959 (with others). Sewage and Industrial Wastes 31, 1309-1315.
- "Effects of Anionic Surface Active Agents on Wastewater Treatment Units." 1960 (with others). Journal Water Pollution Control Federation 32, 1161-1172.

Time Available for Water Resources Activities

100%

Name

Kenesaw Sloan Shumate

Date of Birth

June 25, 1937

Faculty Appointment

Assistant Professor, Civil Engineering

Education

B.S., Civil Engineering, Case Institute of Technology, 1959.

M.S., Sanitary Engineering, The Ohio State University, 1961.

Ph.D., Civil Engineering, The Ohio State University, 1963.

Experience

1963 to date: Assistant Professor, Department of Civil Engineering,
The Ohio State University.

1961 - 1963: Research Assistant, Water Resources Center,
The Ohio State University.

Research

In addition to the experience connected with the Master's thesis and the Doctor of Philosophy dissertation, research experience includes work on metallic ion toxicity studies. Current research activity is directed toward an investigation of the effect of commercial enzyme preparations on septic tank operation.

Principal Publications

"The Physical and Biological Effects of Copper on Aerobic Biological Waste Treatment Processes." 1963 (with E. Q. Moulton).
Proceedings of the 18th Industrial Waste Conference, Purdue University.

"Physical and Biological Effects of Copper on the Activated Sludge Process." 1963. Ph.D. dissertation, The Ohio State University.

Time Available for Water Resources Activities

100%

Name

Edwin Earle Smith

Date of Birth

January 18, 1923

Faculty Appointment

Associate Professor, Chemical Engineering, and Director of Chemical Engineering Research, Engineering Experiment Station.

Education

B. Ch. E., Chemical Engineering, The Ohio State University, 1944.

M.S., Chemical Engineering, The Ohio State University, 1946.

Ph.D., Chemical Engineering, The Ohio State University, 1949.

Experience

1956 to date: Associate Professor of Chemical Engineering and Director of Chemical Research, Engineering Experiment Station, The Ohio State University.

1949 to 1956: Assistant Professor, Chemical Engineering and Professor-in-charge, Petroleum Research Laboratory, Engineering Experiment Station, The Ohio State University.

Research

Performed research in the petroleum field particularly in the area of analysis and refining of high molecular weight hydrocarbons. As a member of the University interdisciplinacy task force studying the acid mine drainage problem for the past six years, performed research on the sulfide - to - sulfate reaction mechanism.

Principal Publications

"Analysis of Lubricating Oils." 1953. Ohio State University Engineering Experiment Station Bulletin No. 152.

"Calculation of Heat Requirements to Prevent External Freezing of Piping." 1953. (with T. H. Kerr). GAS 24, No. 12.

"Refining Requirements for Ohio Crude Oils." 1955. News in Engineering, The Ohio State University, February 1955.

"Propane Fractionation and Solvent Extraction." 1956. Ohio State University Engineering Experiment Station Bulletin No. 160.

"Here's Data on Propane Fractionation." 1957. Petroleum Refining 36, 141-145.

"Acid Mine Drainage Research Potentialities." 1963. (with G. P. Hanna, R. A. Brant, J. R. Lucas and C. I. Randles). Journal, Water Pollution Control Federation 35, 275-296.

"Evaluation of Traffic Paints." 1964. Ohio State University News in Engineering 36, No. 2.

Time Available for Water Resources Activities

20%

Name

Robert E. Stewart

Date of Birth

May 4, 1915.

Faculty Appointment

Professor, Agricultural Engineering.

Education

B.S., Agricultural Engineering, University of Missouri, 1948.

M.S., Agricultural Engineering, University of Missouri, 1950.

Ph.D., Agricultural Engineering, University of Missouri, 1953.

Experience

1961 to date: Professor and Chairman, Department of Agricultural Engineering, The Ohio State University,

1954 - 1961: Professor, Agricultural Engineering, University of Missouri.

1953 - 1954: Associate Professor, Agricultural Engineering, University of Missouri.

1948 - 1953: Instructor, Agricultural Engineering, University of Missouri.

Recent Publications

"Effects of Growth and Environmental Temperature on Surface Temperatures of Beef Calves." 1958 (with M.D. Shanklin). Missouri Agricultural Experiment Station Research Bulletin 656,

"Effects of Selected Environmental Factors on the Absorption of Radiation from a 100^o F Surface by Cold Plates." 1958 (with C. N. Hinkle). Missouri Agricultural Experiment Station Research Bulletin 662.

"Relief of Thermally-Induced Stress in Dairy Cattle by Radiation Cooling." 1958 (with M. D. Shanklin). Missouri Agricultural Experiment Station Research Bulletin 670.

"Agricultural Engineer and Architect." Missouri Engineer, June 1958.

"Environmental Requirements for Poultry Shelter Design." 1959 (with C. N. Hinkle). Agricultural Engineering 40, 532-535.

"A Ten-Year Summary of the Psychroenergetic Laboratory Dairy Cattle Research at the University of Missouri." 1959 (with R. G. Yeck). Transactions of the American Society of Agricultural Engineers 2, No. 1.

"Physical Environment and Confinement Housing of Dairy Cows." 1960. Agricultural Engineering 41, 596-598. (Journal Paper Award of the American Society of Agricultural Engineers).

Recent Publications - Continued

- "Radiation Cooling by Means of Cold Plates." 1960 (with C. N. Hinkle). Transactions of the American Society of Agricultural Engineers 3, No. 2.
- "Radiation Cooling of Dairy Cattle." 1960 (with H. O. Shanklin). Transactions of the American Society of Agricultural Engineers 3, No. 2.
- "Design Factors for Air-Conditioning and Ventilating Dairy-Cattle Structures." 1960 (with R. G. Yeck and M. D. Shanklin). Transactions of the American Society of Agricultural Engineers 3, No. 2.
- "Effect of Growth on Surface Temperatures of Dairy Calves at 50° and 80° F Environmental Temperatures." 1960 (with M. D. Shanklin). Transactions of the American Society of Agricultural Engineers 3, No. 2.
- "Stable Heat and Moisture Dissipation with Dairy Calves at Temperatures of 50° and 80° F." 1960 (with R. G. Yeck). Missouri Agricultural Experiment Station Research Bulletin 759.
- "Effect of Humidity on Total Heat and Total Vapor Dissipation of Holstein Cows at 65°, 80° and 90° F." 1961 (with B. F. Cargill). American Society of Agricultural Engineers Paper No. 61-931.
- "Effect of Humidity on Total Room Heat and Vapor Dissipation of Holstein Cows." 1962 (with B. F. Cargill and H. D. Johnson). Missouri Agricultural Experiment Station Research Bulletin 794.
- "Calorimetry Proposed for Study of Animal Regulation of Heat." 1963. Transactions of the American Society of Agricultural Engineers 6, No. 2.
- "Preliminary Report of 1962 Field Tests of Summer Air Conditioning for Dairy Cattle in Ohio." 1963 (with others). American Society of Agricultural Engineers Paper No. 63-313.
- "Direct Calorimetry in Animal Thermoregulation Research ... A Theoretical Approach." 1963. Third International Bioclimatology Congress, Pau, France.
- "Animal Thermoneutrality as a Thermodynamic Rate Process." 1963. Third International Bioclimatology Congress, Pau, France.

Time Available for Water Resources Activities

5%

Name

Clarence E. Taft

Date of Birth

November 13, 1906.

Faculty Appointment

Professor, Botany.

Education

Teachers Life Certificate, Michigan State Normal College, 1927.

A. B., Botany, Michigan State Normal College, 1929.

M.S., Botany, University of Oklahoma, 1931.

Ph.D., Botany, Ohio State University, 1934.

Experience

1934 to date: Instructor to Professor, Department of Botany, The Ohio State University.

1937 - 1938: Exchange Instructor, Cornell University.

1940 to date: Consultant, Division of Water, Columbus, Ohio

Research

1934 to date: Continued research in Algae.

Principal Publications

"Asexual and sexual reproduction in *Platydorina caudata* kofoid." 1940.
Transactions of the American Microscopical Society 59(1), 1-11.

"Pectyodictyon, a new genus in the Family Seenedosmaceae." 1945.
Transactions American Microscopical Society, 64(1), 25-28.

"The Algologist's part in City and Industrial Water Supply Problems."
1949. Symposium, American Academy of Arts and Sciences.

"Water and Algae - World Problems." a book in press.

Time Available for Water Resources Activities

15%

Name

George S. Taylor

Date of Birth

November 29, 1920

Faculty Appointment

Professor of Agronomy

Education

B.S., Agriculture, North Carolina State College.

M.S., Soils, North Carolina State College.

Ph.D., Soils and Mathematics, Iowa State University.

Experience

1961 to date: Professor, Soil Physics, The Ohio State University.

1956 to 1958 and 1959 to 1961: Associate Professor, Soil Physics,
The Ohio State University.

1958 to 1959: Visiting Associate Professor of Irrigation, The University
of California.

1951 to 1956: Assistant Professor, Soil Physics, The Ohio State
University.

Research

Twelve years' experience at The Ohio State University in the physics of fluid flow through porous media, with emphases on water flow in soils. One year's experience in soil drainage at The University of California. Served as research leader of projects on water flow in soils, disposal of septic tank effluent in soils, gas composition of soils, stabilization of soils by polyelectrolytes and effect of mechanical alterations of soil. Experience in flow models, analogs and electronic computers.

Principal Publications

"Ponded water flow in layered soils." 1960. Transactions, 7th International Congress of Soil Science 1, 480-485.

"Predicted and experimental water table drawdown during tile drainage." 1961. Hilgardia 31 (11): 389-417.

"The use of electronic computers to solve subsurface drainage problems." 1963. Hilgardia 34 (12): 543-548.

George S. Taylor - Page Two

Principal Publications, continued

"Drainage porosity evaluations from outflow measurements and its use of drawdown equations." 1960. Soil Science 90, 338-343.

"Simulating water flow in soil with an electrical resistance network." 1962. U.S. Department of Agriculture, Agricultural Research Service, 41-65.

Time Available for Water Resources Activities

30%

Name

Richard Alton Tybout

Date of Birth

September 28, 1920

Faculty Appointment

Professor, Economics

Education

B. Ch. E., Chemical Engineering, University of Delaware, 1943.

M. S. E., Chemical Engineering, University of Michigan, 1947.

M. A., Economics, University of Michigan, 1949.

Ph. D., Economics, University of Michigan, 1952.

Experience

October 1962 to date: Professor, Economics, The Ohio State University.

October 1957 to October 1962: Associate Professor, Economics,
The Ohio State University.

October 1954 to October 1957: Assistant Professor, Economics,
The Ohio State University.

September 1952 to September 1954: Instructor, Economics, and Research
Associate, Public Administration, University of Michigan

September 1951 to September 1952: Price Economist, Office of Price
Stabilization, Washington, D. C.

June 1943 to September 1946: Corps of Engineers, U.S. Army.
Highest rank: Captain.

Principal Publications

"Government Contracting in Atomic Energy." 1956. University of
Michigan Press.

"Atomic Power and Energy Resource Planning." 1958. Ohio State
University Bureau of Business Research Monograph 94.

"The Reactor Supply Industry." 1960. Ohio State University Bureau
of Business Research Monograph 97.

"Economics of Research and Development." To be published. Ohio
State University Press.

"The Contractor System." 1953. Annals of the American Academy
of Political and Social Science 290, 82-89.

"The Public Investment in Atomic Power Development." 1956. Law and
Contemporary Problems 21, 60-90.

"The Economics of Nuclear Power." 1957. American Economic Review,
Papers and Proceedings 47, 351-360. This article appeared in
condensed and translated form in the Italian Journal Mercurio,
April, 1959.

Principal Publications, Continued

- "Atomic Power and the Public Interest." Land Economics 36, 281-289
- "Logistics and Economic Theory." 1959. Proceedings: Conference on National Security and Research in Logistics. Ohio State University Engineering Experiment Station.
- "Fundamentals of Economics of Transportation." 1959. Proceedings of the Thirteenth Annual Ohio Highway Engineering Conference. Ohio State University Engineering Experiment Station.
- "Data Analysis and Conclusions for the Ohio Highway Needs Study." 1961. (in collaboration with Robert F. Baker). Ohio State University Engineering Experiment Station.
- "Government and Invention." 1961. Centennial Review 5, 436-455.
- "Financing Transportation." 1961. Proceedings of Third Annual Community Development Conference. Ohio State University Engineering Experiment Station.
- "Implications of Economic Efficiency for Highway Planning and Finance." 1962. Proceedings of the Sixteenth Annual Ohio Highway Engineering Conference. Ohio State University Engineering Experiment Station.
- "The Problem of Nonuser Revenues." 1963. Highway Research Record 20, 114-122. National Academy of Sciences.
- "Economic Criteria for Evaluating Power Technologies in Less Developed Areas." 1963. U.S. Papers Prepared for United Nations Conference on the Application of Science and Technology for the Benefit of Less Developed Areas 1, 177-201. The same paper in shorter version appeared as United Nations E/Conf. 39/A/358, 1962.
- "Public Utilities and Transportation." 1961. American Economic Review, Papers and Proceedings 51, 338-340.

Time Available for Water Resources Activities

50%

Name

Harry H. Weiser

Date of Birth

January 26, 1898.

Faculty Appointment

Professor, Microbiology.

Education

B.S., Biochemistry, The Ohio State University, 1923.

M.S., Biochemistry, The Ohio State University, 1926.

Ph.D., Microbiology, The Ohio State University, 1936.

Current Activities

Professor, Department of Microbiology, The Ohio State University,
and Professor of Bacteriology, Department of Animal Science,
the Ohio State Agricultural Experiment Station.

Adviser for graduate students specializing in Food and Sanitary Microbiology.

Director of a sanitary program for all campus dining halls.

Abstracting for several journals in the food industry area and
several journals in the biological sciences area.

Active membership on the following committees:

Administrative Board and Policy Committee,
Institute of Foods and Nutrition.

Advisory Committee for the Investigation of Industrial Wastes.
Special sub-committee, appointed by U.S. Public Health
Service to study and recommend Applied Laboratory
Methods for the microbiological examination of dairy
and food products.

Councilor for the Ohio Valley Section, Institute of Nutrition
and Food Technology.

Current Research

Serves on Advisory Committee, The Institute of Nutrition and Food
Technology in cooperation with the Ohio Agricultural Experiment
Station on U.S. Public Health Service Project AM-07041-01
entitled "Germ free gnotobiotic ruminant studies."

Advisory Committee, The Ohio Department of Health, Division of
Foods, involving research in the detection of Salmonella
species present in shell eggs and egg products.

Active membership in the following committees:

Research Committee, Institute of Foods and Nutrition.

Research Committee, Department of Dairy Technology.

Advisory Committee for Research, the Ohio State Agricultural
Experiment Station.

Recent Publications

- "Effect of Lime-Treated Water upon Survival of Bacteria." 1952
(with M. L. Riehl and B. T. Rheins). Journal, American Water Works Association 44, No. 5, 466-470.
- "Microbiological Factors in the Treatment of Phenolic Wastes." 1954
(with M. K. Hamdy, E. L. Sherrer and W. D. Sheets). Journal of Applied Microbiology 2, No. 3, 143-148.
- "Some Bacteriological Studies on the Angle-Jet Versus the Vertical-Jet Drinking Fountains." 1954 (with J. M. Jay). The Sanitarian 17, No. 1, 25-28.
- "Detection of Fungicides and Insecticides by Microbiological Techniques." 1954 (with R. Angelotti, G. A. Fletcher and H. D. Brown). Journal American Society of Horticulture Science 63, 285-288.
- "Biological Dephenolization of Waste Liquors." 1955 (with M. K. Handy and W. D. Sheets). The Ohio State University Engineering Experiment Station's News in Engineering 28, No. 1, 26-29.
- "Some Characteristics of a Phenol-Oxidizing Pseudomonas." 1955 (with E. L. Sherrer, M. K. Handy and W. D. Sheets). The Ohio State University's Engineering Experiment Station Bulletin No. 157.
- "Disposal of Cannery Wastes by Irrigation." 1955 (with H. D. Brown and H. H. Hale). Food Packer 36, No. 8, 28-30.
- "Application of membrane filter to determine the sanitary quality of farm pond waters." (with R. M. Gerhold, G. W. Malaney and G. O. Schwab). The Ohio State Agricultural Experiment Station News, December 1959.
- "Evaluation of methods for coliform counts in farm pond waters." 1961 (with G. W. Malaney, R. M. Gerhold, and F. A. Garver). Journal, American Water Works Association 53, No. 1, 43-48.
- "Modification of the pad-plate method of determining chlortetracycline in egg white." (with A. R. Winter, et al). Journal of Food Science, May 1961.
- "Laboratory manual for general bacteriology." (with G. L. Stahly and G. M. Malaney). W. C. Brown Company, Publishers, Revised edition, December 1961.
- "Coliforms, enterococci, thermodurics, thermophiles and psychrophiles in untreated farm pond waters." 1962 (with G. W. Malaney, R. O. Turner and Marilyn Van Horn). Journal of Applied Microbiology 10, No. 1.

Time Available for Water Resources Activities

20%

APPENDIX D

NOTICE OF RESEARCH PROJECTS

NOT FOR PUBLICATION OR PUBLICATION REFERENCE

NOTICE OF RESEARCH PROJECT
SCIENCE INFORMATION EXCHANGE
SMITHSONIAN INSTITUTION

SIE NO.
AGENCY NO.

OFFICE OF WATER RESOURCES RESEARCH
DEPARTMENT OF THE INTERIOR

SUPPORTING AGENCY:

TITLE OF PROJECT:

Development of a "Natural" Laboratory for the Study of Acid Mine Drainage

Give names, departments, and official titles of PRINCIPAL INVESTIGATORS and ALL OTHER PROFESSIONAL PERSONNEL engaged on the project.

- E. E. Smith, Associate Professor, Chemical Engineering (Principal Investigator)
- K. S. Shumate, Assistant Professor, Civil Engineering
- W. H. Perloff, Jr., Assistant Professor, Civil Engineering

NAME AND ADDRESS OF INSTITUTION:

The Ohio State University, Columbus, Ohio

SUMMARY OF PROPOSED WORK - (200 words or less.) - In the Science Information Exchange summaries of work in progress are exchanged with government and private agencies supporting research, and are forwarded to investigators who request such information. Your summary is to be used for these purposes.

The purpose of this program is to develop a versatile field system that can be used to confirm theories and abatement procedures suggested by acid mine drainage basic mechanism studies. The facility will be developed around a small pilot scale drift mine and will initially be used to evaluate acid production rates from various levels of interrupted coal strata. Ultimately it is anticipated that results will indicate the efficacy of the use of mine sealing as a control measure. The project will begin in January, 1965, and will continue for an indefinite period.

SIGNATURE OF PRINCIPAL INVESTIGATOR

Edwin E. Smith
E. E. Smith

PROFESSIONAL SCHOOL (medical, graduate, etc.)

College of Engineering

NOT FOR PUBLICATION OR
PUBLICATION REFERENCE

NOTICE OF RESEARCH PROJECT
SCIENCE INFORMATION EXCHANGE
SMITHSONIAN INSTITUTION

SIE NO.
AGENCY NO.

OFFICE OF WATER RESOURCES RESEARCH
DEPARTMENT OF THE INTERIOR

SUPPORTING AGENCY:

TITLE OF PROJECT:

A Study of the Microbial Flora of Acid Waters

Give names, departments, and official titles of PRINCIPAL INVESTIGATORS and ALL OTHER PROFESSIONAL PERSONNEL engaged on the project.

Patrick R. Dugan, Assistant Professor, Department of Microbiology (Principal Investigator)
Chester I. Randles, Professor, Department of Microbiology

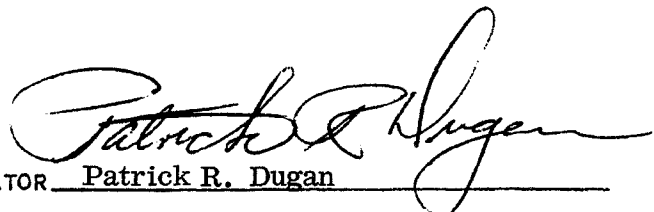
NAME AND ADDRESS OF INSTITUTION:

The Ohio State University, Columbus, Ohio

SUMMARY OF PROPOSED WORK - (200 words or less.) - In the Science Information Exchange summaries of work in progress are exchanged with government and private agencies supporting research, and are forwarded to investigators who request such information. Your summary is to be used for these purposes.

This research is aimed at obtaining basic microbiological data on acid mine polluted waters. An inventory of heterotrophic organisms in acid mine water will be made and the consequence of the presence of heterotrophic organisms will be evaluated by correlating species present with known biochemical and enzymatic activities of these organisms. The relationship of heterotrophic metabolism to autotrophic metabolism of iron and sulfur oxidizing bacteria known to be present in such waters will be examined, with the long range objective of utilizing the data obtained to develop control and reclamation measures based upon exploitation of microbiological processes.

This project will begin in January, 1965, and extend for a period of three years.



SIGNATURE OF PRINCIPAL INVESTIGATOR Patrick R. Dugan

PROFESSIONAL SCHOOL (medical, graduate, etc.) College of Arts and Sciences

NOT FOR PUBLICATION OR
PUBLICATION REFERENCE

NOTICE OF RESEARCH PROJECT
SCIENCE INFORMATION EXCHANGE
SMITHSONIAN INSTITUTION

SIE NO.
AGENCY NO.

OFFICE OF WATER RESOURCES RESEARCH
DEPARTMENT OF THE INTERIOR

SUPPORTING AGENCY:

TITLE OF PROJECT:

A Biological Survey of Acid Mine Waters

Give names, departments, and official titles of PRINCIPAL INVESTIGATORS and ALL OTHER PROFESSIONAL PERSONNEL engaged on the project.

- C. A. Dambach, Professor, Zoology and Entomology (Principal Investigator)
- N. Wilson Britt, Associate Professor, Zoology and Entomology
- C. E. Taft, Professor, Botany and Plant Pathology

NAME AND ADDRESS OF INSTITUTION:

The Ohio State University, Columbus, Ohio

SUMMARY OF PROPOSED WORK - (200 words or less.) - In the Science Information Exchange summaries of work in progress are exchanged with government and private agencies supporting research, and are forwarded to investigators who request such information. Your summary is to be used for these purposes.

This program involves the development of a research survey team to evaluate the biological characteristics of polluted streams and lakes, and to initiate biological studies in watersheds affected by acid mine wastes. Index sampling stations are to be established in each area related to the pertinent physical features of the watershed. The ultimate goals involve the improvement of techniques of utilizing ecological studies to detect water quality characteristics, and to provide a guide to the degree of treatment of watershed modification necessary to achieve optimum water utilization. The study will begin in January, 1965, and extend for a period of three years.

Charles A. Dambach
SIGNATURE OF PRINCIPAL INVESTIGATOR C. A. Dambach
PROFESSIONAL SCHOOL College of Agriculture
(medical, graduate, etc.)

NOTICE OF RESEARCH PROJECT
SCIENCE INFORMATION EXCHANGE
SMITHSONIAN INSTITUTION

SIE NO.

AGENCY NO.

NOT FOR PUBLICATION OR
PUBLICATION REFERENCE

OFFICE OF WATER RESOURCES RESEARCH
DEPARTMENT OF THE INTERIOR

SUPPORTING AGENCY:

TITLE OF PROJECT:

A Study of Groundwater Contamination Due to Saline Water Disposal in the Morrow County Oil Fields

Give names, departments, and official titles of PRINCIPAL INVESTIGATORS and ALL OTHER PROFESSIONAL PERSONNEL engaged on the project.

J. H. Lehr, Assistant Professor, Department of Geology

NAME AND ADDRESS OF INSTITUTION:

The Ohio State University, Columbus, Ohio

SUMMARY OF PROPOSED WORK - (200 words or less.) - In the Science Information Exchange summaries of work in progress are exchanged with government and private agencies supporting research, and are forwarded to investigators who request such information. Your summary is to be used for these purposes.

A field study of selected saline waste water disposal pits to determine the source, severity, approximate areal extent, and probable future movements of contaminants stemming from saline oil field waste waters in both ground and surface waters, as well as to appraise the future water problems that may develop from this contamination. Water quality tests will allow a determination of the movement of salt water within the system both as a result of hydrodynamic flow, mechanical mixing, and chemical dispersion. The study will begin in January, 1965, and will extend for a period of three years.

SIGNATURE OF
PRINCIPAL INVESTIGATOR

J. H. Lehr
J. H. Lehr

PROFESSIONAL SCHOOL
(medical, graduate, etc.)

College of Arts and Sciences