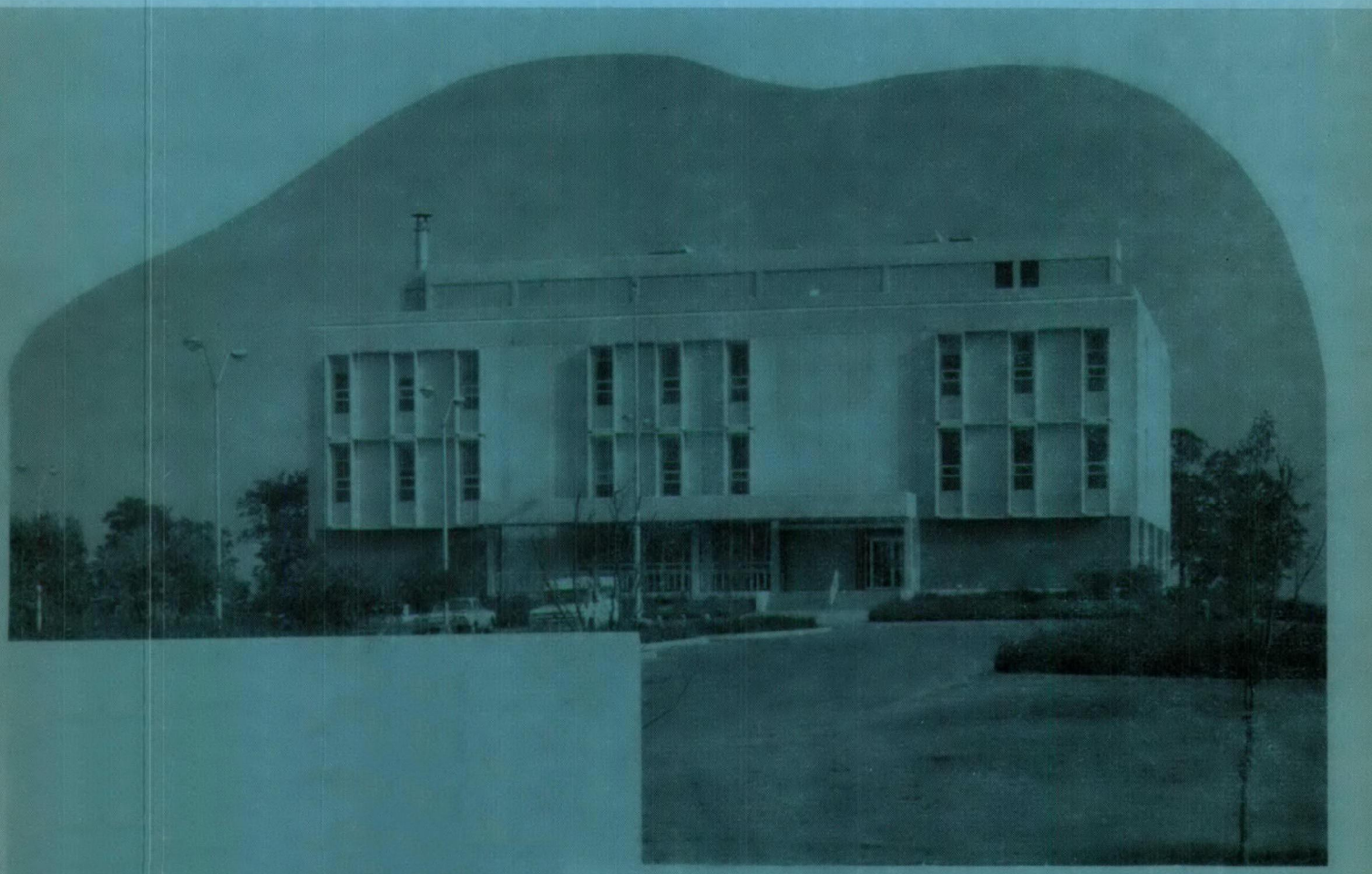
ENVIRONMENTAL PROTECTION AGENCY • OFFICE OF RESEARCH AND MONITORING

ROBERT S. KERR
WATER RESEARCH CENTER

ANNUAL REPORT
1971



INTRODUCTION

The Robert S. Kerr Water Research Center is located three miles south of Ada, Oklahoma, and eighty-five miles southeast of Oklahoma City, Oklahoma. Land surrounding the laboratory is within the great physiographic provinces of the United States known as the Central Lowlands and Great Plains regions. In the immediate vicinity, the terrain consists of rolling to gently rolling prairies, forested land, and some hilly land divided into two plains by an escarpment facing north and east.

Agricultural pursuits in the area are diverse. Wheat and other grains such as oats, rye, corn, barley, and forage sorghum are important cash crops in the region. The availability of these grains, the many kinds of excellent grazing grasses, and the climate make the raising of beef cattle a rewarding one.

Mining activities in the several state area around the laboratory include petroleum, natural gas, coal, zinc, lead, sulfur, salt, helium, iron, limestone, gypsum, asphalt, granite, marble, sandstone, fuller's earth, clays, sand, and gravel. By far the most significant in economic importance is petroleum production. Over one-half of the nation's mining of petroleum comes from Oklahoma, Arkansas, Kansas, Texas, and Louisiana. As would be expected, manufacturing facilities are closely allied to raw materials availability. Petroleum refining and petrochemical production are major activities, comprising a high percentage of the nation's capability in this area.

The national research programs conducted at the laboratory have been assigned on the basis of its proximity to these activities with the objective of meeting needs for controlling the wastes generated. During the past year, research activities on pollution problems undertaken by the personnel based at this site included the following areas: petrochemicals, petroleum refining, oil production, oil shale production, irrigation return flows, animal feedlots, meat packing, ground-water research, effects of pollutants on soil and ground ecology, control of pollution by means other than conventional treatment processes, and ultimate waste disposal in underground horizons. Summary statements concerning individual projects are presented under major organizational headings in the body of the report.

In addition to the normal work plans assigned during the early portion of the fiscal year, there have been other important contributions made to the overall effort of the Environmental Protection Agency. Typical examples of these include serving as consultants to major advanced waste water soil treatment systems; testifying before the Senate Subcommittee on Air and Water Pollution on treatment and the effects of subsurface disposal and surface impoundment of petrochemical wastes; providing project leadership on petroleum refining and petrochemical effluents; participating in international, national, and regional committees concerned with subsurface disposal of wastes, cattle feedlot wastes, irrigation return flows, and water quality research; and publishing a number of technical papers on various phases of our research findings.

Robert S. Kerr Water Research Center

Annual Report

FY 1971

ENVIRONMENTAL PROTECTION AGENCY

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Program Areas of Responsibility

NATIONAL GROUND WATER RESEARCH PROGRAM

The National Ground Water Research Program assumes responsibility for research directed in the areas of pollution fate in ground water, subsurface waste disposal, and in the areas of salt water intrusion and natural pollution so far as they are concerned with the subsurface environment or manipulations thereof. These responsibilities are addressed by both intramural and extramural research efforts.

The Program is concerned with the fate of man-made and natural pollutants entering, traversing, or emitting from the ground-water environment.

Particular emphasis is placed on research concerned with the vertical and horizontal pollutant transport phenomena through saturated and unsaturated zones, the rate and products of pollutant degradation in the subsurface environment, and the sorptive characteristics of parent and degradation compounds on the various earth materials encountered in a ground-water environment.

Activities in the area of pollution fate are primarily directed toward the conduct of fundamental and applied chemical, biochemical, and biological research required for the solution of problems pertaining to ground-water pollution and pollution control. Activities are principally concerned with ascertaining the fate of potential chemical and biological pollutants in a subsurface environment.

Research in the area of subsurface disposal is directed toward areas concerning the disposal of wastes by subsurface injection. Specifically, the research will involve research into adequate design and material specifications, formation pressure influences, possible geologic interconnections with material influences, operational and monitoring procedures adequate to protect the environment, and extent and nature of existing governmental regulations and administrative programs concerning subsurface waste disposal.

Included with this responsibility is work with other EPA offices and other Federal and State agencies and industry in establishing an EPA program directed toward this method of waste disposal.

Efforts in the area of quality control will be directed toward determining the extent of natural and man-made pollution imparted to ground water and for conducting research leading to technology for the prevention of ground-water pollution and the reclamation of contaminated ground-water resources. Such activities includes aquifer recharge; treatment, storage, ponding, and land spreading of municipal, agricultural, industrial, and radioactive solid and liquid wastes; and natural contamination.

NATIONAL TREATMENT AND CONTROL RESEARCH PROGRAMS

Treatment and control research consists of nine national research programs. These categories include petrochemical-industrial products, petroleum and coal products, meat packing products, irrigation return flows, animal feedlots, oil products, oil shale, mining sources other than phosphate rock, and joint industrial-municipal waste treatment. The mission of this group is to research, develop, and demonstrate wastewater treatment and control methods by the application of the principles of chemical, biological, and physical operations and processes. These include the following: absorption, adsorption, activated sludge, biofiltration chlorination, centrifugation, coagulation, distillation, drying, electrodialysis, evaporation, extraction, filtration, ion exchange, oxidation, ozonation, reverse osmosis, sedimentation, ultrafiltration, and others. There is an awareness of the necessity of applying recycling, reuse, by-product recovery, and other conservation techniques to prevent contamination of the environment and optimize use of our national resources.

The Treatment and Control Research staff at Ada is acutely aware of the interrelationships between the facets of environmental pollution by virtue of the national program assignments. As an example, the largest source of solid waste in the nation is animal husbandry; the volume is estimated to be in excess of one billion tons annually or four times the municipal refuse volume. Additionally, the National Animal Waste Research Program here at the Center has become quite aware of the obvious air pollution and pesticides facets while researching solutions to the water pollutional aspects of animal raising. The National Irrigation Return Flow Program is also cross-linked with the pesticides facet of environmental pollution.

Mining wastes, another national assignment at the laboratory, are estimated to constitute a solids waste volume three times that of municipal refuse in terms of the solids waste problem. The water pollution aspects of mining are apparent from acid drainage damage and, of course, the fact that the first 180-day Water Quality Standards Violation Conference took place as a result of wastes from zinc mining activities. The cross-linkage between water pollution control research on mining wastes and the radiological aspect of enyironmental pollution is again apparent in the mining and processing of uranium ores.

The National Petrochemical Wastes Research Program has in-house projects which include an evaluation of solvent extraction which has the potential of removing refractory organic chemicals thereby presenting a possibility of recycle or reuse of these organics. The pollutional parameters development project is necessary to define the effects of petrochemical wastes plus those specific parameters which need measurement to control and monitor the efficiency of waste treatment facilities. A project is under way to determine the feasibility of soil treatment systems to safely return to the environment certain petrochemical wastewaters which are difficult or impossible to treat by current methods. Work is under way to develop

additional treatment methods for refractory chemicals by such processes as activated carbon adsorption. A survey of sludge disposal methods is being conducted to determine if there are methods applicable to the safe disposal of petrochemical waste sludges. The group is monitoring extramural projects to determine the investigational requirements for the design of laboratory pilot plants and demonstration plants capable of treating petrochemicals and refinery waste effluents. The application of dialysis for removal of pollutants from industrial wastes is a project undertaken by the Department of Commerce and Industry in Louisiana. A demonstration of a biological treatment process to remove the organics from a fatty acid derivative plant is under way at Armour Industrial Chemical Company. Dow Chemical Company is engaged in developing and demonstrating a process to remove phenol and acetates from brine wastewaters thereby allowing recycle of the brines for caustic soda and chlorine production. Another Dow project has as an objective the determination of treatment methodology for wastes from the production of polyhydric organics such as glycols. The utilization of reverse osmosis membranes to separate pure water from petrochemical plant waste streams is being investigated. A project at Union Carbide in New Jersey has completed pilot-scale studies on the use of a combination anaerobic/aerobic process for the treatment of complex synthetic organics. Demonstration and evaluation of treatment facilities for polyvinyl chloride wastes is under way. A project located in Rhode Island will demonstrate the feasibility of multistage trickling filters for treatment of wastewaters from a plant producing several different organic chemicals. A final extramural project has as its objective the identification and control of those petrochemical waste pollutants which inhibit anaerobic treatment processes.

The National Refining and Coal Processing Wastes Research staff is summarizing the available treatment methods for wastewaters from these manufacturing processes. Activated carbon treatment for petroleum refinery effluents and a study to optimize design and operation of refinery treatment units are in-house projects. Extramural efforts include a state-of-the-art evaluation of the characteristics of petroleum and coal processing wastes; assessment of pollutional problems associated with these wastes; development of biological processes to remove carbon and nitrogen compounds from coking plant wastes; a study of waste sources and characteristics; alternate treatment processes on coal preparation plant wastes. There is a project with Shell Oil Company to demonstrate disposal of oily waste sludges by soil cultivation; and finally the determination of catalyzing the oxidation of phenols and amines by metal ions is under investigation.

The National Meat Processing Wastes Research Program has a combined in-house/extramural project under way to evaluate combinations of processes which can be utilized by small meat packers and one to determine the feasibility of by-product recovery from paunch wastes. Extramural projects monitored by the group include a demonstration in Iowa of the use of oxidation channels for treating packinghouse wastes and the

applicability of anaerobic lagoons and trickling filters for treating wastes from hog processing. A project in Illinois will demonstrate the feasibility of incineration of cattle paunch. Another Iowa project is to demonstrate the feasibility of completely separating product and paunch from slaughterhouse operations with subsequent conversion of paunch into animal feeds. A project in South St. Paul is demonstrating the use of polymers to improve treatment of combined packinghouse wastes and sanitary sewage.

The National Irrigation Return Flow Program has completed a project at Firebaugh, California, which has developed means of removing nitrates from agricultural wastewaters estimated to approximate 700 million GPD when the San Joaquin master drain is fully developed. Extramural projects in this program include nutrient removal from agricultural wastewaters in California; the effects of irrigation methods on potential groundwater pollution in Texas; and a determination of mechanisms which affect quality of irrigation return flows in Utah. On-farm management techniques involving spray, furrow, and trickle irrigation in conjunction with slow-nitrogen-release fertilizers are being evaluated.

The National Animal Waste Program has in-house projects designed to establish field research facilities; to disseminate waste management information on cattle feedlots; to determine the characteristics of feedlot runoff; and to evaluate the suitability of soils treatment systems in cooperation with the National Water Quality Control Research Program. Extramural projects include a demonstration of facilities for treatment and ultimate disposal of feedlot wastes; an evaluation of feedlot waste management alternatives by computer techniques; an abstracting survey on technical literature to maintain currency of the state-of-the-art report; a demonstration of handling and treatment processes for dairy cattle wastes; the development of criteria for design and operation of feedlots in the Southwest in ways to minimize water pollution; the determination of a closed waste management system at Michigan State University; and a project to evaluate tertiary treatment processes of animal wastewaters at Cornell University.

The National Oil Production Wastes Research Program's work includes assessment of needs and priorities of research on oil production pollution problems; an investigation of brine disposal practices; and determination of the use of aerial surveillance to locate leaks from improperly sealed or operated wells.

The National Oil Shale Wastes Research Program is completing a state-of-the-art report on oil shale pollution problems. Extramural projects being monitored by this group include an effort at Fort Collins, Colorado, to evaluate the potential pollution from spent oil shale residues.

The National Mining Wastes Research Program is investigating the state-of-the-art of wastewater treatment and control from sand and gravel operations, plus uranium mining and milling operations. This group has the responsibility for research on all mining wastewater problems except those of acid drainage and phosphate rock production.

NATIONAL WATER QUALITY CONTROL RESEARCH PROGRAM

The National Water Quality Control Research Program is responsible for conceiving, developing, and field testing any and all methodology for the improvement of water quality by means other than conventional waste treatment. This includes, but is by no means limited to: research on methods of modifying environmental conditions to minimize or reduce pollutional effects; changes in industrial technology to eliminate or reduce pollutants; techniques of managing waste discharges and their receiving waters to minimize pollutional effects; and the utilization of soil for the treatment of liquid wastes and sludges. It is the goal of this program to provide the technology to bridge the gap between the maximum effectiveness of treatment technology and water quality requirements.

The activities of the Program are divided into the following four areas according to common methodology and objectives:

Biological Control

Research is directed to the development of treatment applications, environmental management, and ecological technology development. This includes the development of non-conventional biological mechanisms for treatment of point-source pollutants, development of regulatory mechanisms to achieve a greater measure of control of the aquatic food chain to diminish the adverse effects of non-point-source pollutants, and development of ecological technology to maximize protection and utilization of aquatic resources.

Engineering Applications

Development of engineering systems for application in streams, lakes, and reservoirs to improve water quality. This includes such technology as in-stream aeration, artificial reservoir destratification, control of bottom sediments, and siltation control. The development of river basin water quality control systems combining management practices such as dispersion, detention, diversion, and flow regulation is also an area of interest.

Industrial Technology

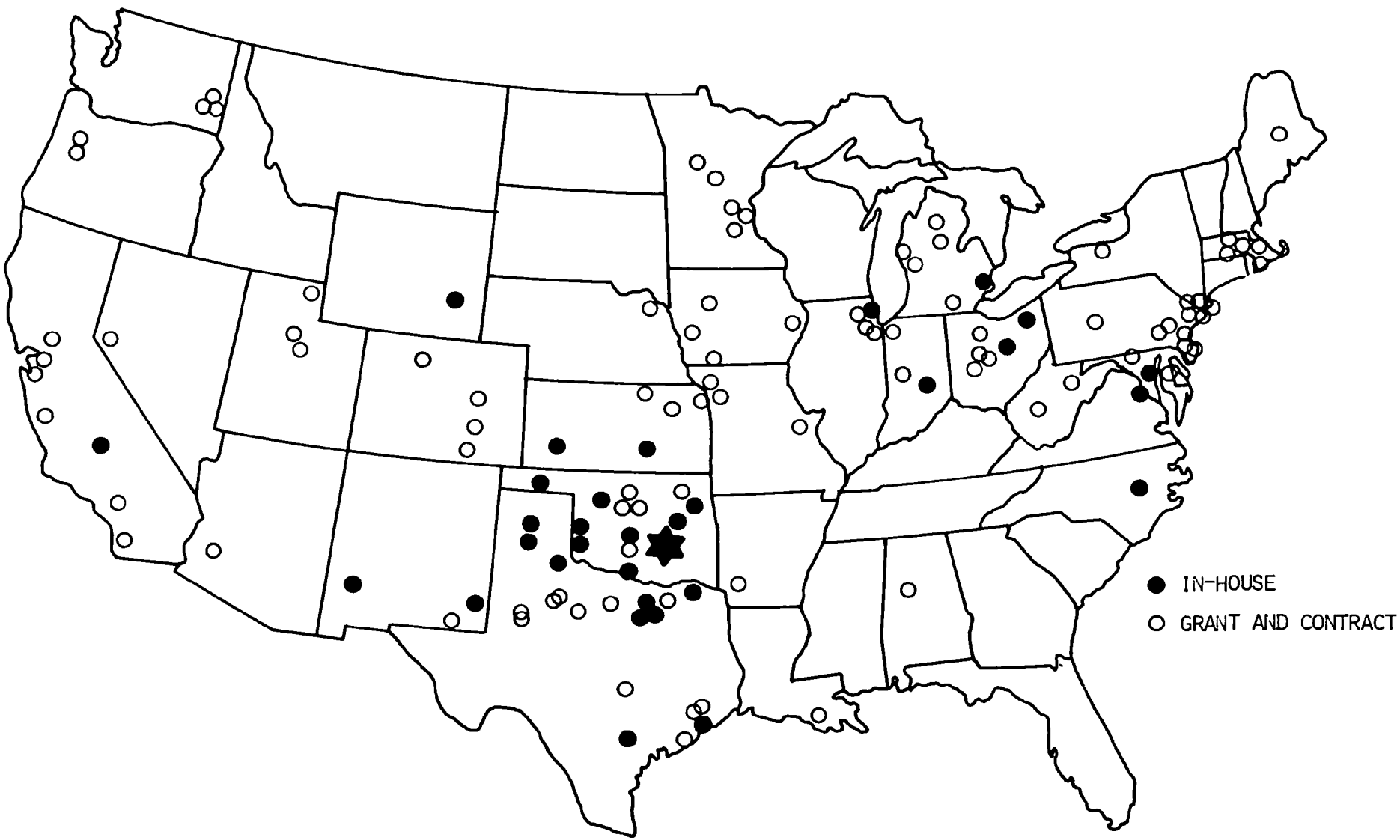
This area includes research and demonstrations to control pollution from industrial sources by in-plant changes such as process modifications, recovery and reuse of potential pollutants, the reduction of water use requirements, and any other means other than direct waste treatment. Also included is reformulation or other modifications of consumable products to reduce or eliminate their adverse environmental effects.

Soil Treatment

Research and development relates to the utilization of soils for treatment of municipal and industrial wastewaters. Research includes studies to determine the adaptability of different soil systems to treatment of various wastes and the development of fundamental knowledge basic to development of design and operating criteria for practical application.

ROBERT S. KERR WATER RESEARCH CENTER

PROJECT SITES THROUGH FY 1971



IN-HOUSE PROJECTS

Fate of Nitrilotriacetic Acid (NTA) in Ground Water, 16060 CNB
Project Leader: William J. Dunlap

The purpose of this project was to determine the potential effect of NTA on ground-water resources in the event the material could be substituted on a large scale for phosphates in detergents. Large aerobic and anaerobic sand, loam, and clay-loam soil columns were used to simulate the transport of NTA in both the saturated and unsaturated zones through which a waste containing NTA might move. Simulated aquifers were constructed and operated in a nitrogen atmosphere to determine the rate and products of anaerobic degradation. In all studies both stable and carbon-14 tagged NTA were used including studies to determine the adsorption characteristics of NTA on various soil types. The effect of NTA on heavy metals was investigated by adding metal salts and metal ores to sandy soils used in column studies. The effects of extraneous carbon on anaerobic degradation were also investigated.

The final report has been completed and is being reviewed in Headquarters prior to publication.

Degradation of DDT in a Ground-Water Environment, 16060 WNR
Project Leader: William J. Dunlap

This project was initiated following a field project carried out in cooperation with the U. S. Department of Agriculture in Bushland, Texas. Results of that work suggested the anaerobic degradation of DDT in a ground-water environment. Current studies are aimed at confirming DDT degradation in a ground-water environment while investigating the products of such degradation. Although the work has been virtually at a standstill for almost two years because of commitments to work with higher priority, this work was re-initiated in January.

Movement and Fate of Lagoon Leachates in Ground Water, 16060 PCD
Project Leader: Marion R. Scalf

Field projects have been on-going in eastern Kansas at Potwin and in western Kansas at Deerfield. The objectives of this work are to investigate the potential pollution to ground water from animal feedlots constructed on tight clay soils in one case and alluvial sands in another. Observation wells were drilled in the proximity of feed pens and waste lagoons and have been monitored during the project's conduct. This work complements that carried on under contract with Texas Tech University which investigated the effects of animal feeding operations on ground water in both caliche and eroded caliche soils.

Determination of Pollutional Potential of Ogallala Aquifer by Salt Water Injection, 16060 WOH
Project Leader: Leslie G. McMillion

This project was initiated to determine the effect of salt water disposal practices on the quality of fresh water overlying the disposal zone. Field work, which was conducted in the panhandle of Oklahoma, served to develop and demonstrate a technique by which formation hydraulic characteristics could be determined using existing salt water injection wells.

The final report was completed and transmitted to the Oklahoma Corporation Commission during the week of August 10. Meetings were held to discuss the technical findings with Mid-Continent Oil and Gas Association, Farm Bureau, and Texas County Irrigation Association. The report was introduced during a public hearing by the Oklahoma Corporation Commission for the purpose of ruling on salt water disposal practices in Texas County, Oklahoma, and the establishment of rules and regulations for monitoring salt water disposal wells in all of Oklahoma.

CONTRACTS/GRANTS

Distribution of Nitrogen in the Ground-Water Zone Below Feedlots, Texas High Plains
16060 EGS Contract 14-12-804 $39,364
Texas Tech University, Lubbock, Texas
Project Officer: Marion R. Scalf

The overall purpose of this study is to determine the distribution of nitrogen in the ground-water zone below feedlot operations in a semiarid climate and geological framework as exists in the Texas High Plains. Specific objectives are as follows:

1. Quantitative estimate of the nitrogen family in the ground-water zone below some major feedlot operations.

2. Vertical and horizontal distribution of nitrogen in the ground-water zone.

3. Determine rates of natural dispersal in the ground-water zone, and relative rates of movement from surface to ground-water zone under conditions existing in the field.

The project is complete. Conclusions were that feedlots are not a major threat to ground-water quality under the geologic conditions existing in the Texas High Plains although there is some localized nitrogen contamination associated with a few feedlots.

Study on Ground-Water Pollution Problems in the Southwestern United States
16060 ERU Contract 14-12-919 $59,000
Fuhriman, Barton & Associates, Provo, Utah
Project Officer: Jack W. Keeley

A comprehensive investigation of ground-water pollution problems which exist in the states of California, Nevada, Arizona, and Utah will be made. The investigation will consist of the following:

1. Ascertain, delineate and classify ground-water pollution problems which exist in the southwestern United States.

2. Evaluate and discuss the problems in terms of magnitude, extent, source of pollution and implications on the broad water supply picture.

3. Recommend research undertakings which might be effective in solving the problems.

4. Recommend relative priorities of research efforts to provide the maximum impact on the general area of ground-water pollution abatement.

This work complements that currently underway for the south central states and scheduled for the northeastern states.

National Ground Water Quality Symposium
16060 GRB Contract 68-01-0004 $18,725
National Water Well Association, Columbus, Ohio
Project Officer: Leslie G. McMillion

A National Ground Water Quality Symposium was held August 25-27, 1971, in Denver, Colorado and was cosponsored by the National Ground Water Research Program and the National Water Well Association. This symposium brought together the nucleus of men, methods, and ideas capable of yielding solutions to problems which will insure the protection and restoration of the quality of our vast ground-water resources, whose development is destined to double and perhaps triple in the coming decade. It is intended that the published transactions of the symposium will serve as a state-of-the-art handbook on ground-water quality. The planning and negotiations required to present this successful symposium have continued for almost a year.

Evaluation of Salt Water Disposal into Potential Ground-Water Resources
16060 HIJ $7,515 Oklahoma Corporation Commission, Oklahoma City
Project Officer: Leslie G. McMillion

This is a new project that was approved during the last week of the year. This project will involve the use of an abandoned exploration well in western Texas County to chemically evaluate native waters in the Glorieta Formation. The well will be appropriately reworked, perforated, and swabed until native Glorieta water is assured. This work will be contracted and supervised by the Oklahoma Corporation Commission. After appropriate sampling of the Glorieta water, chemical evaluation will be made by the National Ground Water Research Program. Following these sampling procedures, the well will be appropriately plugged under the auspicies of the Oklahoma Corporation Commission.

Project activities during the last week of June included construction of an access road and preparation of the test well by a welding company so that the cement plug in the top 30 feet of the well can be drilled out.

Consolidation of Available Subsurface Saline Water Analyses
16060 EQQ $38,675 Bureau of Mines, Bartlesville, Oklahoma
Project Officer: Jack W. Keeley

The purpose of the project is to consolidate all the available analyses of subsurface saline waters on magnetic tape for use in automatic data processing. The information is being placed in EPA's Storet system which was necessarily modified to accept this type of information.

Spreading Treated Sewage for Ground-Water Recharge
16060 DRV $12,300 Salt River Project, Phoenix, Arizona
Project Officer: Jack W. Keeley

The objective of this project is to determine feasibility of ground-water recharge by spreading treated effluent as part of future programs for waste water utilization, and to collect information for optimum design, management, and operation of spreading basins. Studies were made of the effectiveness of flowing effluent over densely vegetated surfaces as polishing treatment, of the resulting infiltration rates, the flow regimes and oxygen and nitrogen relationships in the percolation zone, and the hydrologic properties of the aquifer pertaining to the design and operation of spreading basins. The project has been completed and plans are now being made to build a full-scale system for all of the wastes from the city of Phoenix.

Demonstration of New and Improved Methods for Locating, Categorizing and Quantitating Sources of Salt Water Pollution in Ground Water
16060 FPY $49,945 Oklahoma Water Resources Board, Oklahoma City
Project Officer: Leslie G. McMillion

The objective of this work is to demonstrate a new and improved method of surface resistivity techniques in delineating and quantitating salt water pollution in shallow fresh water aquifers, to develop a method for identifying the source of salt brines on the basis of chemical analyses, and to develop an efficient approach integrating complementary disciplines for the study of salt water pollution in fresh water aquifers.

The primary area for the study is located in the Cimarron Terrace in northwestern Oklahoma. It is a strip of land which is about 100 miles long and 10 to 15 miles wide where the sedimentary bedrock is overlain by high terrace deposits.

Forty-Year Fertilizer Effects on NO_3 in Ground Water
16060 DOE $8,074 University of California, Riverside
Project Officer: Jack W. Keeley

The project is designed to study the fate of fertilizers beneath various plots which have been fertilized with different loadings and different fertilizer types for the past 47 years. This last phase of the project will be used to complete the soil and water analyses, summate the data, and prepare a final report. The project is scheduled for completion October 30, 1971.

Potential Pollution of the Ogallala by Recharging Playa Lake Water
16060 DCO $32,936 Texas Tech University, Lubbock
Project Officer: Marion R. Scalf

Research consisted of sampling water and sediment from some 39 playas in the High Plains to establish types and concentrations of herbicides and pesticides. The playas were selected to be representative of the several thousand lakes in the region with respect to soil type, types of crops, and varieties of herbicides and pesticides applied. Results were evaluated to determine the range and magnitude of any pollutional hazard which might result to fresh-water aquifers by artificial recharge with playa water. The final report is in preparation and will present conclusions that recharge with playa water should be encouraged.

Dispersion During Flow in Heterogeneous Porous Media
16060 DLL $14,568 Purdue University, Lafayette, Indiana
Project Officer: Jack W. Keeley

The objective of this project is to study the theory and measurement of dispersion in heterogeneous anisotropic porous media. A better understanding of dispersion phenomena is necessary to obtain useful flow models of real porous media. The differential equations associated with dispersion have been studied. Present statistical models will be extended to include heterogeneity and anisotropy. Dispersion coefficients have been measured in linear and radial flow in heterogeneous anisotropic media using tracer techniques and these data are compared with correlations of existing data and with theory. These comparisons were used to determine the statistical range of the dispersion coefficient in view of microscopic and macroscopic heterogeneity fluid properties, and anisotropy. The final report has been printed.

Rehabilitation of a Brine-Polluted Aquifer
15050 DLN $80,600 Arkansas Soil and Water Conservation Commission, Little Rock, Arkansas
Project Officer: Leslie G. McMillion

The purpose of this research and development project is to develop and demonstrate a method to rehabilitate a ground-water aquifer previously rendered useless by oil field brine pollution and to successfully dispose these waters into deep brine wells.

Objectives of the project are: (a) to demonstrate selective pumping techniques in the vicinity of a brine disposal pit as a method to prevent contamination of fresh-water aquifers; (b) to investigate how these brines can be reduced to a level suitable for irrigation; (c) to determine the economics of selective pumping as a method for removal of contamination from a fresh-water aquifer; (d) to provide further scientific and technical information, which will be of value to others concerned with fresh-water aquifers contaminated by oil field brines.

The first draft of the report has been reviewed. The project is scheduled to terminate October 30, 1971.

Reutilization of Wastewater Recycled Through Ground Water
16060 DDZ $25,000 Eastern Municipal Water District, Hemet, California
Project Officer: Jack W. Keeley

The purpose of this project is to investigate and report the effects of repeated recycling of wastewater through a restricted ground-water basin on the quality of water available for municipal, industrial, and agricultural use. A thorough study and report of the hydrologic, geologic, chemical, biological, and physical factors has been made. The work was carried on in the Upper San Jacinto Ground Water Basin near Hemet, California. The final report has been received and is under review.

Effects of Density Stratification on Aquifer Mixing
16060 ELJ $29,619 Massachusetts Institute of Technology, Cambridge
Project Officer: Jack W. Keeley

This research project is concerned with the mixing of water injected into ground-water aquifers through wells. The ultimate objective is to provide methods of predicting water quality when aquifers are used as storage areas for surface waters or disposal of wastes. The work has possible application in the area of thermal pollution in that ground-water aquifers may serve as disposal areas for hot water.

North Fork Alluvial Decontamination Project
14020 EHW $184,816 West Central Texas Municipal Water District, Abilene
Project Officer: Leslie G. McMillion

The goal of this project is the interception and subsurface disposal of sline ground waters that have been seeping into tributaries of Hubbard Creek Reservoir and increasing the salinity of the reservoir water to alarming levels. This project goal was realized during the past few months when shallow subsurface drains and wells of the project were pumped dry, or essentially so, and flows of the affected streams practically dried up. These results were apparently brought about by extremely dry weather conditions that existed in the area for the entire calendar year. It is anticipated that when natural recharge of the ground-water system occurs as a result of future precipitation, the ground water will still be somewhat saline as a result of residual salt in the water-bearing materials; and, consequently, there will remain the necessity of continuing the routine operation of the project, at least for its proposed operational period.

The project continues in its second phase which is pumping of contaminated waters from the alluvium of North Fork, disposal of this water into a deep subsurface zone, and observation of the effects on water quality in the alluvium and in the stream.

NATIONAL TREATMENT AND CONTROL RESEARCH PROGRAMS

IN-HOUSE PROJECTS

The Characteristics and Treatability of Petrochemical Wastes, 12020 WSO
Project Leader: James A. Horn

The objective was to determine the applicability of selected unit treatmen processes for the treatment and control of specific and refractory petrochemical wastes.

Studies were limited to the biotreatment process due to shortages in available manpower. A petrochemical plant waste containing tertiary butyl alcohol (TBA) was successfully biodegraded. TBA was formerly considered a classical refractory substance. TBA is a by-product of propylene glycol manufacturing via direct propylene oxidation. Its dehydration product, isobutylene, is coming into favor as a feedstock for alkylation units in the manufacture of lead-free high-octane gasoline. A paper entitled "Biological Degradation of Tertiary Butyl Alcohol" was presented at the 25th Annual Purdue Industrial Waste Conference and will be published in those Proceedings.

The project terminated due to reassessment of priorities by Headquarters. A final report will be prepared after high-priority assignments are completed.

Pollutional Parameters Development, 12020 RAO
Project Leader: James A. Horn

The objective was to evaluate available pollutional parameters with respect to petrochemical wastes.

Correlation and interpretation of unpublished industrial data have been completed by Engineering Science under Contract No. 14-12-588 (Project 12020 EID). Active grants and the literature have been reviewed to evaluate conventional and newly developed analytical techniques with respect to determining the pollution effects of petrochemical wastes and operation and control of pertinent waste treatment facilities. A preproposal regarding the development of gel permeation chromatography as a pollution monitoring technique was reviewed and forwarded to the Southeast Water Laboratory. A grant proposal to develop a physical-chemical control system for an activated sludge plant treating petrochemical wastes was reviewed and recommended for approval.

A paper is being prepared which evaluates new and conventional analytical techniques with reference to petrochemical waste characterization and treatment plant operation and control systems. Research needs statements regarding parameter development and verifying the applicability of instrumental techniques in stream assimulation models and for on-stream and continuous monitoring systems will be prepared and forwarded to Headquarters.

Develop Effective Treatment Methods for Refractory Chemicals, 12020 QNI
Project Leader: James A. Horn

Objectives were to develop and demonstrate optimum methods for treating petrochemical waste waters which (1) contribute significantly to known water pollution problems and (2) are reportedly resistant to biological degradation in conventional waste treatment facilities.

A limited amount of literature review has been completed. Carbon isotherms have been developed for several of the chemicals implicated in the Lower Mississippi taste and odor problem utilizing carbon samples from six major manufacturers. Progress has been slow due to technician time being limited.

Most of the project effort has been devoted to the formulation and organization of a comprehensive three-year R&D grant project through the Louisiana Department of Commerce and Industry to develop and demonstrate treatment and control technology for "problem" refractory chemicals present in the Lower Mississippi River. The project is in its final stages of development and should be funded during FY 1972. It will involve at least five petrochemical plants and will consist of bench-scale treatability studies and pilot plant trials. Processes to be investigated include biological, extraction, adsorption, and oxidation (ozone).

The annual status report will be completed in the near future. Activities to be completed include final organization and monitoring of the above grant project, preparation of indicated "statements of need," monitoring of grant project 12020 EPH (Celanese Chemical) and necessary literature review activities.

Sludge Disposal - Petrochemical Waste Treatment, 12020 WOW
Project Leader: James A. Horn

The project objectiyes were to determine present methods for disposing of petrochemical sludges, define research needs, and develop and demonstrate technology for improved disposal methods,

A limited literature review indicates little information available relating to industrial sludge disposal. A scope-of-work for a proposed contract to collect and report sludge sources, characteristics, disposal methodology, and economics thereof and an analysis of research needs was forwarded to EPA Headquarters. At this time, funds are not available to implement this investigation. A detailed status report has been prepared and forwarded to Washington.

Use of Solvents for Certain Industrial Waste Treatment, 12020 RAH
Project Leader: James A. Horn

The project is to develop and demonstrate extraction processes for the treatment or recovery of selected petrochemical wastes.

A state-of-the-art paper regarding the application of extraction to petrochemical waste waters has been completed and submitted for internal review. Necessary monitoring of a "high-pressure extraction process" investigation (Project No. 12020 GLN) was initiated. Arrangements were made with the Lower Mississippi River Basin Office to obtain several petrochemical waste streams for this investigation. A grant proposal is being developed with a nearby university to evaluate the applicability of conventional extraction techniques for treatment or recovery of "problem" refractory waste constituents.

Monitoring of the above extramural projects will be continued and a status report prepared when a significant amount of pertinent technology has been developed.

Soil Treatment Systems for Organic Industrial Wastewaters, 12020 RAI
Project Leader: James A. Horn

The objective was to determine the feasibility of using soil wastewater treatment systems for treatment and control of petrochemical wastes emphasizing those which are difficult to degrade by conventional treatment methods.

Due to other project commitments, very little effort has been devoted to this project. No references concerning application of soil-wastewater treatment systems to petrochemical wastewaters were found in the pertinent state-of-the-art paper. A detailed status report has been prepared and forwarded for internal EPA review. A nearby university research foundation is formulating a proposal to investigate the use of selected refinery and petrochemical wastes as soil stabilizers.

No additional activity is planned. Technology could be best developed by transfer to the National Water Quality Control Research Program due to their expertise in soils systems.

Base Level and Best Available Treatment and Control for the Petrochemical Industry, 12020 CNJ
Project Leader: James A. Horn

The objective of this operations contract was to develop effluent guidelines for the petrochemical industry. A long-range work plan was prepared and forwarded to Headquarters in October 1970. Tentative approval was obtained in November 1970. In February 1971, a "crash" program was initiated by Operations to develop such guidelines in a period of about two to three

months, by contracting with an appropriate consultant. Roy F. Weston was awarded this particular contract (14-12-963). Due to the large diversity in products and processes, the scope-of-work was limited to those 27 organic chemicals and petrochemical feedstocks comprising approximately 70 percent of total organic chemical production. Several time extensions have been awarded to allow sufficient time to obtain the necessary unit process information from industry.

A committee meeting to evaluate data generated by Weston's contract with respect to usage as effluent guidelines has been tentatively scheduled for August 24, 1971. If agreeable with Headquarters, it is planned to implement a long-term effort to develop effluent guidelines as per the original work plan for usage as a background reference during Corps of Engineers permit application review activities.

Activated Carbon Treatment of Petroleum Refinery Waste Water, 12050 WOR
Project Leader: Leon H. Myers

The objective of this project was to determine the feasibility of using activated carbon for treatment of refining waste water.

Adsorption isotherms were run on eleven activated carbon sources to determine the three most applicable sources for refining waste treatment. These sources were chosen and additional isotherms were determined for pulverized and granular adsorption capability. Dual-media filtration studies were conducted for pretreatment of the refining waste water. Sources of waste water were from the API separators of two refineries and clarifier effluent from one refinery.

Filtration studies with the dual-media system to remove oil and suspended matter, thereby increasing the efficiency and reducing the economics of the system, appeared feasible. Studies were made on both pulverized and granular carbon samples. Reproducibility was not good on the granular activated carbon, but the adsorption values were more realistic.

The project was terminated in April due to personnel needs in other projects. A draft report on the study is under review.

Reclamation of Petroleum Refining Waste Water by Reverse Osmosis, 12050 WSP
Project Leader: Leon H. Myers

The objective of this project was to increase the reuse of water for petroleum refining and related industries by removing the dissolved solids from the waste water.

A 10,000 g/d reverse osmosis system was installed at a refinery to determine the applicability of the system for water recycling purposes. Charge water was cooling tower blowdown and boiler blowdown. Economics were not evaluated during the study. Different flux rates were studied for removal of dissolved

solids, metals, and organics. The limiting parameter of concern was the calcium sulfate concentration.

A completed draft of the study has been submitted.

Automatic Monitoring of Petroleum Refining Waste Water, 12050 ---
Project Leader: Leon H. Myers

The objective was to examine the possibility of using automatic instrumentation in an oily environment for waste treatment process control.

An automatic monitor capable of measuring conductivity, temperature, pH, and DO was installed at an oxidation ditch and final clarifier to monitor the four parameters. Installation, operation, and maintenance problems were observed with the automatic analyzers due to oil. The results of the study indicate instrument modifications are needed before these instruments can successfully be used in water containing free or emulsified oil.

A draft report has been submitted on the study.

Treatment Methods Summary - Petroleum and Coal Products, 12050 CIW
Project Leader: Leon H. Myers

The project's objectives were to report the complexity of treating systems for refinery waste waters, removal efficiencies of major parameters, and major contributors to the system.

References were collected, evaluated, and compiled to write the report. An effort was made to obtain the major process units, their location, each refiner's crude charge, and their river basin location. A draft report has been submitted.

Optimization of Processes, 12050 WNH
Project Leader: Leon H. Myers

Optimization of a refinery waste water system for both treatment and water reuse was the objective of this study.

Discussions were conducted with refiners concerning process problem areas, the potential of oxidation towers polishing systems, and advanced waste treatment. Reuse discussions have been limited to thermal and ion exchange systems for dissolved solids removal.

Contacts have extended invitations to study pilot-plant systems on location in several refineries.

Specification of Base Level Treatment and Control and Best Available Treatment and Control for the Petroleum Refining Industry, 12050 CNI
Project Leader: Leon H. Myers

The contract objective as specified by Operations was to produce a set of effluent values based on amounts of pollutants per 1,000 barrels of crude which would be applied as guidelines for the Corps of Engineer permit application reviews.

The base level of treatment and best available treatment for refinery waste water discharges were also to be specified in conjunction with effluent guidelines. Guidelines were specified using treatment efficiency data supplied by Weston and primary effluent data from the American Petroleum Institute.

Small Meat Packers - Waste Treatment Systems, 12060 WNX
Project Leader: Jack L. Witherow

The project is evaluating the suitability of 12 treatment systems for small meat packers.

As a cooperative research project with East Central State College and W. E. Reeves Packing House, Ada, Oklahoma, it was developed, approved by the Oklahoma Water Resources Board, and funded under Project No. 12060 GPP. Construction of the anaerobic, transitional, and stabilization ponds and the soil treatment plots are complete. Only finish-grading and installation of minor appurtenances remain to be completed. The waste water has received treatment since February 1971. Student chemists have been trained and the evaluation Phase I is underway.

Small Meat Packers - By-Product Recovery Systems, 12060 WNZ
Project Leader: S. C. Yin

A research project designed and initiated to eliminate the small abattoir water polluting waste--cattle paunch content--by making it into an economically useful by-product as a food supplement in catfish farming. In-house research underway includes: (a) the experimental air drying of paunch manure in bench- and pilot-scale units and (b) a study of the frequency of occurrence of salmonellae in paunch.

Negotiations were conducted with Oklahoma State University for a complementary study to determine (1) the feasibility of utilizing dried paunch manure as a feed supplement in catfish farming and (2) the effects of catfish cage and pond culture on water quality with and without utilizing this abattoir waste by-product. The proposed project calls for a cooperative study comprising efforts by OSU and our own staff. This application is under consideration for funding.

Soil Treatment of Cattle Feedlot Runoff, 13040 RBQ
Project Leader: Marion R. Scalf

The project was designed to demonstrate a spray runoff system. The automatic spray runoff system and holding facilities were constructed, but the evaluation phase was halted after several months because the collected waste water had become too diluted for meaningful evaluation. Evaluation will not be reinitiated until Meat Producers, Inc., restocks the beef feedlot and runoff occurs.

Additional equipment has been ordered to cooperate in a similar project near Yates Center, Kansas, and to investigate this treatment system under other conditions at a third location.

Dissemination of Waste Management Information on Cattle Feedlots, 13040 WRW
Project Leader: Jack L. Witherow

The objective was to distribute available waste management information to feedlot operators. The first draft of the final report from Oklahoma State University on cattle feedlot waste management alternatives has been received and is being reviewed.

A feedlot waste management seminar was held in Amarillo, Texas, on June 22 and 23. The attendance was excellent and covered a three-state area. Written comments regarding the seminar were reviewed by staff and indicated the seminar had been very successful. A working draft of a feedlot design manual was distributed for review and comments from all in attendance.

A paper "Water Pollution Control in Cattle Feedlots" was prepared and presented at the ASAE meeting in Laredo, Texas, and to the Beef Cattle Conference in Lubbock, Texas. Another paper "Beef Cattle Feedlot Waste Management Program" was prepared in response to an inquiry by U. S. Senator Henry Bellmon. The paper has been accepted for publication in Feedlot Magazine.

Establish Field Facility for Cattle Feedlot Research, 13040 WSA
Project Leader: Marion R. Scalf

The project is proposed to allow better control of waste management research. A preliminary proposal for a research facility has been initiated. Dr. R. H. Diven, a consulting nutritionist from Amarillo, and Dr. Will O'Rourke, Manager of Alpha Cattle Company Feedlot near Hereford, Texas, are revising the proposal to comply with the reviewer's comments.

Needs and Priorities Report, 14020 WRY
Project Leader: Fred M. Pfeffer

The objective is a statement of the major areas of pollution and the research needs in those areas for the oil production industry. Meetings were held with representatives of the Oklahoma Corporation Commission, the Oklahoma Agricultural Research Service, the University of Oklahoma, and industry. A literature review was conducted and the report draft was initiated.

Aerial Surveillance of Brine Pollution, 14020 RCB
Project Leader: Fred M. Pfeffer

The primary objective is to demonstrate the usage of remote sensing in mapping land areas polluted by brine seepage from improperly sealed wells.

Information was obtained as to the qualifications and the applications of several remote sensing techniques. Sources included a literature review, personal contacts with representatives of manufacturing concerns and universities, and a symposium on remote sensing held at Oklahoma State University.

Oklahoma University is preparing a contract proposal for a project in this field.

State-of-the-Art Report, 14030 RCG
Project Leader: Fred M. Pfeffer

The primary objective of the report is a statement of the major areas of pollution and the research needs in those areas in the event an oil shale industry develops.

Information was obtained through meetings with the USDI Oil Shale Research Information Committee, principal investigators for a pertinent grant at Colorado State University, the Bureau of Mines at Laramie, Wyoming, and members of industry. State and federal reports dealing with the economics of environmental protection were reviewed and incorporated in a report draft.

Needs and Priorities Report, 14040 RCK
Project Leader: James E. Moyer

The purpose of this effort was to conduct a literature survey to establish the various water pollution problems common to the mining industry and determine research needs and priorities in this area.

The report draft has been transmitted to Headquarters for review and comment.

Determination of Methods for Control of Saline Water Encroachment, 15050 RCN
Project Leader: Bruce W. Maxwell

The project objective was an evaluation of methods of natural salinity control. This project was approved during the second quarter of FY 1971, and the PPB category has since been abolished. Literature search was completed, and a report is being prepared for typing.

Control of NaCl and $CaSO_4$, 15060 WSL
Project Leader: Bruce W. Maxwell

The objective was evaluation of methods of natural salinity control. This project was approved during the second quarter of FY 1971. Literature research was conducted and problem areas defined. An approach to treatment of sulfate waters was devised and bench-scale units were successfully operated with reduction from 1,400 mg/l to 65 mg/l on a continuous flow basis. Bench-scale work is continuing to determine the limiting and optimum parameters for operation of the biological system. This PPB category has been abolished.

CONTRACTS/GRANTS

Preliminary Investigational Requirements - Petrochemical and Refinery Waste Treatment Facilities
12020 EID Contract 14-12-588 $17,000
Engineering Science, Inc., Austin, Texas
Project Officer: James A. Horn

The project objective was preparation of a general guideline for the resources and technical knowledge required to conduct preliminary investigations for designing refinery and petrochemical waste treatment facilities. Several drafts of the final report were reviewed and recommendations returned to the contractor. The final report was approved and forwarded to the Government Printing Office for printing in quantity.

Effluent Guidelines for the Plastic Resin and Synthetic Fiber Industry
12020 CNJ Contract 68-01-0030 $35,800
Celanese Research Company, Summit, New Jersey
Project Officer: L. Frank Mayhue

The objective of this Operations contract was to define and establish waste effluent parameters and establish effluent guidelines of typical manufacturing processes in the plastic resin and synthetic fiber industries. The approach by the contractor was to gather data by direct contact with cooperating companies of the industry. Coordination of industrial contacts by the contractor was through the Manufacturing Chemists Association. Waste effluent guidelines establish the standard level of waste water treatment to be expected from the industry. The project has progressed through an interim review of the study to the submission of the final report draft on June 4 by the contractor. A review of the report had led to a request for additional data and clarification of the parametric classifications before final acceptance. This information is expected to be received during the month of July.

Industrial Waste Study of the Meat Product Industry
18000 HBA Contract 68-01-0031 $39,400
North Star Research and Development Institute, Minneapolis, Minnesota
Project Officer: Jack L. Witherow

The objective of this Operations contract was to develop effluent guidelines. A final report has been completed and is undergoing review.

Brine Disposal Treatment Practices Related to the Oil Production Industry
14020 FVW Contract 14-12-873 $29,835
Oklahoma University Research Institute, Norman, Oklahoma
Project Officer: Fred M. Pfeffer

Preparation of a manual for oil producers which will aid them in choosing the most satisfactory method(s) of brine disposal for their particular situation is the contract objective. Periodic meetings were held with the principal investigators. The contractor reviewed the results of an extensive survey of brine disposal practices in Texas at the invitation of the Texas Railroad Commission and is preparing the first draft of the final report.

Biological Removal of Carbon and Nitrogen Compounds From Coke Plant Wastes
12010 EDY $109,200 American Iron and Steel Institute, New York, New York
Project Officer: Leon H. Myers

The project includes a multistage biological process involving aerated tanks and an anaerobic system for organic carbon removal and conversion of ammonia through nitrate to free nitrogen with the objective of removal of organic carbon and ammonia from coke plant ammoniacal liquor by a unique treatment system. The system was designed, constructed, operated, and evaluated using coke plant liquor as the raw waste. A final report is now being prepared by the Armco Steel Corporation.

Research Study of Coal Preparation and By-Product Coke Plant Effluents
12010 DNF $86,500 CF&I Steel Corporation, Pueblo, Colorado
Project Officer; Fred M. Pfeffer

Demonstration of satisfactory methods of treating liquid wastes from coal washing, coking, and coke by-product operations is the project's objective. Several meetings were held with the principal investigators to review data and the first draft of the final report. The grantee is 11 months late in submitting the last draft of the final report with the cognition of the Washington grant specialist.

Efficiencies and Economy of Polymeric Sewage Clarification
11060 EKK $450,000 City of South St. Paul, Minnesota
Technical Consultant: Jack L. Witherow

Determination of polymer efficiencies in a mixed industrial-domestic waste was this project's objective. The final report was prepared, reviewed, revised, and sent for printing and distribution. An audit of the grant has been made which included an inventory of available equipment, and the project is completed.

Upstream Packing House Waste Treatment Demonstration, City of Stockton
11060 DRT $381,078 City of Stockton, California
Technical Consultant: Jack L. Witherow

The city decided not to proceed with Phase II. The final report on Phase I was prepared, reviewed, and revised. The report will not be published as considerable restructuring and additional effort was recommended. The project was terminated.

Anaerobic Treatment of Synthetic Organic Wastes
12020 DIS $220,400 Union Carbide Corporation, Texas City, Texas
Project Officer: James A. Horn

A project objective was to determine the technical and economic feasibility of an anaerobic-aerobic process for the treatment of combined organic chemical wastes from an integrated petrochemical complex. The optimum system determined from laboratory and semi-pilot studies was demonstrated for a period of one year. The 30 gpm demonstration plant consisted of anaerobic lagoons, aerated stabilization, and faculative lagoons arranged in series. Major organic constituents of the wastes included salts of volatile acids, alcohols, ketones, aldehydes, amines, and surfactants. Removal of BOD averaged approximately 90 percent with up to 70 percent being removed in the initial anaerobic process at a loading rate of 2 pounds of BOD or 4-5 pounds COD per day per 1,000 cubic foot. Although the wastes contain high sulfate concentrations (500-800 mg/l), purple sulfur bacteria have maintained sulfide produced from anaerobic conditions at a sufficiently low level to prevent sulfide toxicity and minimize the occurrence of objectionable odors. The demonstration period terminated June 30, 1971. Tentative completion of the final report will be in September 1971. The grantee is in the process of preparing a request for additional studies to (1) determine the limiting metabolic steps of the anaerobic lagoon and incorporate measures to improve treatment efficiency, (2) investigate the feasibility of oxygen aeration following anaerobic treatment, (3) conduct material balance studies throughout the treatment process, and (4) prepare a manual on monitoring and operation of anaerobic systems.

Treatment of Waste Waters Resulting From the Production of Polyhydric Organic Compounds
12020 EEQ $197,740 The Dow Chemical Company, Texas Division, Freeport, Texas
Project Officer: James A. Horn

This project was to develop a method of treating wastes from polyhydric manufacturing processes. The results will be used to develop a conceptual design of a waste treatment facility.

The optimum system determined from laboratory studies was demonstrated for a period of one year ending February 1971. The plant operated was a 0.5 gpm activated sludge unit with chemical flocculation of the secondary effluent.

Removal of total oxygen demand has averaged in excess of 90 percent at optimum temperatures of 30-35°C. Temperature and pH control and equalization facilities were provided. The wastes contain approximately 100,000 mg/l NaCl and 1,500 mg/l TOD. This study represents the first known demonstration of a feasible biotreatment system at this high level of salinity. The design of a full-scale plant based on the above study results has been completed.

The final report is in its final stages of preparation; estimated submittal date is August 1971. The grantee has applied for a new R&D grant to develop a comprehensive physical-chemical control system for the 0.5 gpm pilot unit.

Concentration and Removal of Industrial Wastes by Dialysis
12020 EMI $32,539 Dept. of Commerce and Industry, State of Louisiana, New Orleans, Louisiana
Project Officer: James A. Horn

Determination of the feasibility of the dialysis process for the treatment or recovery of selected petrochemical waste constituents is the objective of this project.

Two quarterly reports have been received. Results of dialysis separation of ethanolamine, phenol and aniline in water have been reported. Removal of aluminum, copper, and lead ions through hydrophilic membranes utilizing complexing and/or solvent extraction was discontinued due to unfavorable results. In response to the project officer's request, the applicability of dialysis for removal of chemicals identified in the New Orleans water supply was evaluated in a "paper" study. It was concluded that those chemicals having high vapor pressure and a reasonable level of solubility would have potential for removal by dialysis using pervaporation (permeated product removed as a vapor). Examples of likely candidates are chloroform, ethylene dichloride, trichloroethane and dichloroethylene. There is potential, however, for removal of low-vapor-pressure compounds since over 50 percent of a nitrobenzene solute was observed to be removed in one hour. Studies concerning pervaporation of the above chemicals will be completed during the next quarter. Types of pilot equipment are presently being evaluated. Pilot study of actual wastes containing chemical constituents most favorably removed during laboratory studies will be initiated during the next quarter.

Evaluation of Polymeric Material for Treatment and Recovery of Petrochemical Wastes
12020 DQC $48,295 Dept. of Commerce and Industry, State of Louisiana, New Orleans, Louisiana
Project Officer: James A. Horn

An evaluation of the reverse osmosis process for the recovery of selected petrochemical waste constituents is the project objective. A draft of the final report was reviewed during the first quarter. Economical recovery of glycerin from an actual glycerin production waste water was demonstrated by means of a 1 gpm multistage laboratory reverse osmosis unit. The final report has been approved, printed, and is now available for distribution.

Demonstration of the Recondition and Reuse of Organically Contaminated Brines From the Chemical Process Industries
12020 EAS $509,810 The Dow Chemical Company, Midland, Michigan

Project objective was to develop and demonstrate a chemical adsorption process for waste waters from a phenol manufacturing plant and to evaluate reuse of the reconditioned brine for chlorine production. Stripping of phenol and acetic acid from waste brine and subsequent reuse for chlorine production was demonstrated by means of a 100 gpm pilot plant. Design criteria developed during previous laboratory studies (FY 70) were used to design the plant unit. The grantee has concluded that adsorption of acetic acid at relatively high concentrations (1,500 mg/l) was not economical, and plans to investigate ultraviolet catalyzed chlorination as an alternative means. Demonstration studies were concluded June 30, 1971 and the final report is now being prepared.

Identification and Control of Petrochemical Pollutants Inhibitory to Anaerobic Treatment
12020 FER $49,118 Union Carbide Corporation, Charleston, West Virginia
Technical Consultant: James A. Horn

The objectives of this project are to identify and control chemical constituents in a mixed chemical waste which are inhibitory to anaerobic treatment processes. This project is a "spin-off" from Project 12020 DIS resulting from inhibition difficulties experienced during bench-scale anaerobic study of Union Carbide's Institute Plant wastes. The inhibition potential of 25 chemicals in a range of 10-1,000 mg/l has been determined by monitoring gas production utilizing a Warburg Respirometer. Batch-fed acclimation experiments have been completed with a variety of chemical constituents. Laboratory studies of light versus dark lagoons were conducted quantiatively to determine the benefits derived from the presence of sulfide-oxidizing photosynthetic bacteria, however, the purple sulfur bacteria observed in the anaerobic lagoons at Texas City (Project 12020 DIS) could not be established in the laboratory. A green sulfur bacterial population was established; however, the performance of the lagoons was not significantly different, therefore, study objectives were not obtained. Anaerobic digestion was inhibited at sulfate levels of 1,500-3,000 mg/l. A continuous feed packed-bed anaerobic reactor being fed crotonaldehyde up to 600 mg/l removed greater than 90 percent of the COD. The reactor was acclimated by gradual buildup of crotonaldehyde concentration over a period of 3-4 months. Two process wastes, one containing inhibitory chemicals and the other surfactants are being acclimated in similar reactors. COD removal is in the range of 60-90 percent.

The project has been extended for a period of 4 months until December 10, 1971, since progress had dropped behind schedule due to periodic process "upset" occurrence.

Geigy Chemical Waste Treatment Facility
12020 FOH $425,000 Geigy Chemical Company, Providence, Rhode Island
Technical Consultant: James A Horn

Demonstration of the feasibility of multistage plastic media for organic chemical wastes treatment is the project objective. Construction of the 1.4 mgd demonstration plant has been completed. No progress reports have been received from the project officer since the period engind December 31, 1970. Startup of the one-year demonstration phase was scheduled for April 1, 1971. A request for copies of current reports has been forwarded to the EPA project officer.

Armour Industrial Chemical Company Secondary Wastewater Treatment
12020 EFW $210,500 Armour Chemical Company, McCook, Illinois
Technical Consultant: James A. Horn

The objective is to develop and demonstrate a biological process to reduce the effluent from a fatty acid derivatives plant to less than 100 ppm of hexane soluble materials. Bench- and pilot-scale studies have been completed. The 0.5 mgd demonstration plant has been completed and is apparently operating. It consists of aerated lagoons and clarification with sludge recycle. Six months of demonstration plant operation remain to be completed.

Waste Treatment Facilities for a PVC Manufacturing Plant
12020 DJI $364,900 B. F. Goodrich Chemical Company, Summit, New Jersey
Technical Consultant: James A. Horn

Project objectives are to develop, demonstrate, and evaluate the biological process for treatment of wastes from a typical polyvinyl chloride manufacturing plant. The one-year demonstration phase at a scale of 0.5 mgd was completed in April 1971. BOD removals were consistently in excess of 90 percent. Sludge dewatering studies were also conducted. Studies related to the recycle of secondary effluent were made. All studies have been completed, and the final report has apparently been approved and forwarded for printing.

Extraction of Chemical Pollutants From Aqueous Industrial Streams with Volatile Solvents
12020 GLN $35,647 University of California, Berkeley, California
Project Officer: James A. Horn

Objectives are to evaluate the applicability of volatile solvents to treatment and control of selected refinery and petrochemical wastes and to develop scale-up information for full-scale design. The basic experimental unit has been designed and constructed. Various industries have been requested to provide samples for testing. "Shakedown" of the gas chromatograph has been completed. Work has been initiated to determine distribution coefficients for a variety of organic solutes between water and carbon dioxide or propane as a function of temperature. Most experimental work including pilot plant design and testing is still pending the completion date (December 16, 1971).

Demonstration of Oily Waste Disposal by Soil Cultivation Process
12050 EZG $100,000 Shell Refining Company, Deer Park, Texas
Project Officer: Leon H. Myers

A pilot study on degradation of oily compounds with controlled nutrient additives having as its objectives determination of the bacteria population, efficiency, and management techniques of oil disposal using soil cultivation as the treatment system. Deposition of three different refinery oily products on controlled test plots using different quantities of nutrient supplemtn, mixing techniques, and lab evaluation of the system is included. The project is near completion, and the results are being evaluated to prepare the final report.

State-of-the-Art Evaluation on Petroleum and Coal Wastes
12050 DVF $17,897 Oklahoma University Research Institute, Norman, Oklahoma
Project Officer: Leon H. Myers

Production of a "State-of-the-Art" report on petroleum production, refining and coal processing is the objective. Literature search, contacts, laboratory evaluation of process waste waters, and report preparation were the major activities. An approval copy of the report is presently being evaluated.

Construction and Study of a Demonstration Plant Utilizing the Aerobic Chennel Method for Treating Packinghouse Wastes
12060 EUB $489,000 John Morrell and Company, Ottumwa, Iowa
Project Officer: Jack L. Witherow

Project objective is demonstration of the channel method for treating meat packing wastes. Dr. Wayne Paulson was hired as a consultant, and a detailed evaluation plan was prepared and approved. Shakedown and modification of equipment continued to require considerable time and effort. The evaluation phase has been initiated, and a progress report was presented at the National Food Waste Symposium.

A Method of Manure Disposal for a Beef Packing Operation
12060 EOF $93,400 Illinois Packing Company, Chicago, Illinois
Project Officer: Jack L. Witherow

Objectives are to demonstrate manure disposal by dewatering and incineration. The equipment manufacturer completed the pilot-plant development studies and prepared to designs of the full-scale incinerator and mechanical dewatering systems. The project officer's recommendation to eliminate or reduce the resulting waste load discharge to the sewer was accepted when Chicago initiated an industrial sewer charge. Redesign of the dewatering system from a mechanical separation to a drying process was proposed by the manufacturer. A request for additional funds based on a change in project scope is being negotiated.

Elimination of Water Pollution by Packinghouse Animal Paunch and Blood
12060 FDS $161,398 Beefland International Company, Council Bluffs, Iowa
Technical Consultant: Jack L. Witherow

Project objective is waste elimination via byproduct development. Construction of the facilities including the analytical lab were completed. The evaluation phase was completed with odor problems, marketing the product, and control of conditions during data collection causing special concern. A progress report was presented at the National Food Wastes Symposium and the final report is being prepared.

Waste Treatment Facility, Farmbest, Inc.
12060 DFF $289,790 Farmbest, Inc., Denison, Iowa
Technical Consultant: Jack L. Witherow

This project's objective is the demonstration of hog slaughtering wastes treatment by anaerobic lagoons and trickling filters. The data collection phase was completed and a final report prepared and reviewed. The report needed additional evaluation of the collected data. The results of the project were presented at the National Food Waste Symposium.

Prediction of Mineral Quality of Return Flow From Irrigated Land
13030 EII $150,000 U. S. Bureau of Reclamation
Member Research Coordinating Committee: James P. Law, Jr.

Project objective is development of a math model for predicting irrigation return flow quality. Analytical data were collected on the Ashley Valley irrigation area at Vernal, Utah, throughout the year. Model design and testing with historical data have been completed. Further testing of the prediction model against data collected will be accomplished this fall. Work plans and budget requests for FY 1972 have been reviewed and submitted to Headquarters. These plans include testing the model against data from two additional irrigated areas--Cedar Bluff Irrigation District in Kansas and Grand Valley in Colorado.

Nutrient Removal From Agricultural Waste Waters
13030 ELY $64,000 California Department of Water Resources, Fresno
Project Officer: James P. Law, Jr.

The objective was determination of nutrient removal by algal harvesting. The work on this grant was completed on schedule at the end of May 1971. The final report from the Phase I studies was received, approved, and forwarded to the Project Reports System for printing. The final report from the Phase II studies has been reviewed in draft form and is being prepared in final form for printing.

Quality of Irrigation Return Flow
13030 FDJ $200,000 Utah State University, Logan, Utah
Project Officer: James P. Law, Jr.

The objective of this project is determination of mechanisms that control return flow quality. This project is in its third and final year, scheduled for completion by December 1971. The final report is expected by March 1972. Project officer assignment was transferred effective July 1, 1971.

Effect of Furrow, Sprinkler, and Subirrigation Methods on Potential Pollution of Groundwater by Nitrate and Other Solutes
13030 EZM $300,000 Texas A&M University, Agricultural Research and Extension Center, Lubbock, Texas
Project Officer: James P. Law, Jr.

This project whose objectives are explicit in the project title is completing its first year of activity. All irrigation systems, laboratory facilities, etc., have been installed and are operating. Data collection began with the current cropping season. The first annual report will be delayed to include data analyses from the first complete crop cycle. The first annual review of the project was held and all aspects of the work schedule are proceeding according to plan.

Grand Valley Salinity Control Demonstration Project
13030 DOA $76,000 Colorado State University, Fort Collins, Colorado
Project Officer: James P. Law, Jr.

Demonstration of salinity control through canal lining is the project's objective. This project officer assignment was transferred from Denver effective July 1, 1971. Construction was completed and post construction evaluation is proceeding on schedule.

Irrigation Return Flow Quality Literature Abstracting
13030 FVN $29,269 Colorado State University, Fort Collins, Colorado
Project Officer: James P. Law, Jr.

The project officer accompanied the project director on a tour of several western states for the purpose of gathering information needed to prepare a "Research Needs" report for the 13030 program. The first draft of this report will be completed in August. The literature abstracting portion of this project is proceeding on schedule.

Demonstration and Development of Facilities for the Treatment and Ultimate Disposal of Cattle Feedlot Wastes
13040 DAT $136,608 Kansas State University, Manhattan, Kansas
Project Officer: Marion R. Scalf

The primary objective of this project is to develop design criteria for land disposal of manure and stormwater runoff from cattle feedlots. The first season's data indicated that up to 100 tons per acre of manure or 12 inches of feedlot runoff water can be applied to corn land without decreasing crop yields. The project will be completed in September 1971, and a final report is expected in November 1971.

Characteristics of Wastes From Southwestern Cattle Feedlots
13040 DEM $74,995 Texas Tech University, Lubbock, Texas
Project Officer: Marion R. Scalf

This project was designed to determine the physical, chemical, and biological characteristics of rainfall runoff and manure from typical beef cattle feedlots of the southwest. The project has been completed, and a final report has been reviewed and approved and is currently being printed for wide distribution.

Closed System Waste Management for Livestock
13040 DKP $49,904 Michigan State University, East Lansing, Michigan
Project Officer: Marion R. Scalf

The principal objective of this project was the development of design criteria for a liquid manure processing-recycle system for cattle and swine feedlots. A final report draft has been completed and is undergoing review by the project officer.

Evaluation of Beef Feedlot Waste Management Alternatives
13040 FXG $33,690 Oklahoma State University, Stillwater, Oklahoma
Project Officer: Marion R. Scalf

The major objective of this project is to provide a technical and economic comparison of waste management alternatives currently available to feedlots under various climatic and other environmental conditions. The project was initiated in June 1970, and a first draft of the final report was submitted in June 1971. This report is currently under EPA review and should be published by October 1971.

Abstract Service on Animal Waste Technical Literature
13040 FUU $21,780 Iowa State University, Ames, Iowa
Project Officer: Marion R. Scalf

This project was initiated as an aid in the collection and dissemination of information related to animal waste management technology. Approximately 400 technical articles have been abstracted by Iowa State and abstracts and a copy of each article have been forwarded to the Robert S. Kerr Water Research Center and the Water Resources Scientific Information Center (WRSIC) in Washington. Personnel at WRSIC have indicated that these abstracts will be assembled into one publication sometime during the Fall of 1971. This project was first funded in June 1970 and has since been renewed for a second year at a similar funding level.

Microbiological Removal of Iron From Mine Drainage Water
14010 ENW $75,886 Continental Oil Company, Ponca City, Oklahoma
Project Officer: James E. Moyer

The primary objective of this project was the removal of iron from mine drainage waters by utilizing microorganisms to convert ferrous iron to ferric iron, a form which is much more readily precipitated. In this manner, limestone rather than slaked lime could be used to accomplish neutralization, thereby resulting in a considerable cost savings.

A secondary approach involved the precipitation of iron as iron sulfide through the action of sulfate-reducing bacteria. These bacteria are capable of producing large quantities of hydrogen sulfide from the sulfates present in mine drainage waters which could react to form an insoluble iron sulfide easily removed by conventional means.

1. Acidophilic iron bacteria can be employed to oxidize ferrour iron in acid mine drainage waters to prepare these waters for relatively inexpensive limestone neutralization. This was demonstrated on both a laboratory and pilot-plant scale.

2. Series multistaging of microbial oxidation vessels offers operational efficiency over a single oxidation vessel.

3. Minimal nutrient requirements for the bacteria to efficiently oxidize ferrous iron were determined, as well as temperature requirements.

4. Sulfate-reducing bacteria were unable to grow or produce H_2S under the low pH conditions existent in the mine drainage waters; hence, were not studied further.

The final report has been reviewed by the project officer and Headquarters staff. Suggested revisions have been transmitted to grantee. Final draft is now ready for typing with issuance date of September 1971.

Evaluation of Potential Water Pollution From Spent and/or Burned Oil Shale Residues
14030 EDB $38,000 Colorado State University, Ft. Collins, Colorado
Project Officer: Fred M. Pfeffer

The objective is the study of the solid waste residues from oil shale retorting operations and the potential water pollution (with rainfall) from those residues. Periodic meetings were held with the principal investigators. The grantee presented a progress report at the American Chemical Society National meeting in Los Angeles. An additional study involving snow-melt runoff was conducted by subcontract with the Bureau of Mines. The grantee has begun preparation of the first draft of the final report.

IN-HOUSE PROJECTS

Effects of Impoundments on Water Quality, 16080 WNV
Project Leader: William R. Duffer

The purpose of the project is to determine changes in stream water quality resulting from the construction of reservoirs. The Arbuckle Reservoir in south central Oklahoma was used for this purpose. Data collection was terminated in April 1970, at which time the data represented two years of pre-impoundment and two years of post-impoundment conditions. Statistical analyses of the accumulated physical, chemical, and biological data have been completed. The first draft of the final project report has been completed and publication is expected in the near future following final review and clearance.

Effects of Feedlot Runoff on Water Quality of Impoundments, 16080 WNW
Project Leader: William R. Duffer

The purpose of the project is to determine water quality changes in impoundments resulting from feedlot runoff. The project site used for this study was a 12,000-head capacity commercial feedlot located near McKinney, Texas. All collected data has been collated and analyzed and the first draft of the final project report has been completed. Early publication of this report is expected.

Water Quality Improvement by Purification with Higher Plants, 16080 WSY
Project Leader: William R. Duffer

The objective of this project is to develop a treatment process using higher plants to remove pollutants from various types of waste effluents. Recent experiments have shown that a few higher plant species can take up, accumulate and/or metabolize several types of pollutants from soil or water. Higher plant species are usually easy to manage and harvest and could provide a practical and economical means of removing pollutants from waste effluents. Plant screening tests were initiated during May 1971, and plans have been completed for construction of lysimeter units for experimental studies at the field site.

Management of Hydroelectric Pumped-Storage for Water Quality, 16080 WRM
Project Leader: Lowell E. Leach

The objective of this project is to provide operating agencies with design and operating guides for managing water quality of pumped-storage projects. The Salina Project in eastern Oklahoma, operated by the Grand River Dam Authority, is being used as a project site. The sample and data collection program was initiated during January 1971. This project is scheduled to continue through fiscal year 1972.

Covering of Sludge Deposits as a Water Quality Control Measure, 16080 WST
Project Leader: Lowell E. Leach

The objectives of this project are: (1) to evaluate a number of bottom sealing agents for retarding or eliminating oxygen uptake and nutrient transfer from bottom sludge deposits into overlying waters; (2) to determine the effect of sealing agents on algal productivity; and (3) to determine the feasibility of containing toxic materials in bottom sludges with various types of bottom sealants. This project was initiated during the last quarter of fiscal year 1971 and efforts thus far have consisted of experimental design and assembly of equipment.

State-of-the-Art on Artificial Reservoir Destratification, 16080 WPV
Project Leader: Lowell E. Leach

The objective of this project is to search the literature of all recently reported reservoir destratification systems from which evaluation and comparisons of destratification efficiency, oxygenation efficiency, range of effects and economic considerations can be made. It is intended that this work support and complement that already published by bringing together and comparing existing techniques in order that refinement of techniques, areas of additional research needs can be noted, and ultimate optimization of destratification systems can be accomplished. This project is expected to be completed and report published during the first half of fiscal year 1972.

Develop Technology for Soil Treatment of Runoff From Beef Cattle Feedlots, 16080 WNU
Project Leader: Richard E. Thomas

This project is to determine the suitability of spray-runoff soil systems for the treatment of feedlot runoff. It consists of two phases: (1) a pilot study using small plots for the purpose of determining approximate loading rates and removal efficiencies, and (2) a full-scale study at a 12,000-head capacity feedlot located near McKinney, Texas, for evaluation under actual operating conditions. Phase I was completed and used as the basis for the design of the full-scale system to be operated under Phase II. Operation of the full-scale system (Phase II) was initiated October 1, 1970. Data was collected on the full-scale system until March 1971, at which time activities of the project were temporarily suspended because of insufficient number of cattle in the feedlot. It is expected that this project will resume in September of 1971.

Evaluate Soil Treatment for Domestic Wastewaters, 16080 WPH
Project Leader: Richard E. Thomas

This project is to evaluate the feasibility of utilizing spray-runoff soil treatment for complete handling of wastewater from small communities. The study is being conducted at the Robert S. Kerr Water Research Center field site located near the Ada Sewage Treatment Plant. Three experimental plots are being used to evaluate treatment efficiencies for selected methods of application and wastewater loadings. The facility is designed to provide quantity and quality data for the wastewater, the runoff, and soil percolate. Air samples are being collected and assayed to measure possible drift of bacteria or viruses. This project will be continued during fiscal year 1972.

Soil Systems for Tertiary Treatment, 16080 WPR
Project Leader: Richard E. Thomas

The purpose of this project was to develop guidelines for the use of soil systems to treat or utilize effluent from conventional treatment of domestic wastewaters. A thorough literature search was conducted to obtain specific information on design technology, public health aspects, and regulatory controls. The results of this literature search were used as a basis for the workshop which was attended by invited nationally recognized experts for the purpose of developing a manual with guidelines for current use and to make recommendations for further research. The literature search and hosting of the workshop was conducted in cooperation with East Central State College, Ada, Oklahoma. The preliminary draft of the manual is now under review, and final publication should be in the near future.

Industrial Pollution Control by In-Plant Changes, 16080 WQV
Project Leader: Jack H. Hale

This project is to promote the elimination or reduction of pollution from industries by in-plant changes such as process modification. Through contacts with industries and industrial associations, projects in in-plant pollution control, by means other than conventional waste treatment, will be encouraged. Information is also gathered concerning various unit processes which should be helpful in evaluating possible in-plant changes.

Establishing the Feasibility of Physically Removing, or Sealing in Place, Mercury-Laden Sediments
16080 GWU Contract 68-01-0060 $166,244
JBF Scientific Corporation, Burlington, Massachusetts
Project Officer: Curtis C. Harlin, Jr.

Phase I of this project consists of laboratory studies of different methods of controlling or preventing cycling of mercury from mercury-laden bottom deposits. Various bonding agents will be investigated for the purpose of bonding mercury in sediment or making it insoluble. The effectiveness of removing mercury deposits by dredging will also be investigated. Phase II consists of selecting a site for field evaluating control techniques developed during Phase I. Sites representing various environmental conditions will be surveyed and one or more sites selected for testing purposes. A detail survey of the selected site or sites will be made as the basis for evaluating the effectiveness of the test method.

Development of Phosphate-Free Home Laundry Detergents
16080 DVF Contract 14-12-937 $118,338
IIT Research Institute, Chicago, Illinois
Project Officer: Curtis C. Harlin, Jr.

The purpose of this project is to develop model formulations of heavy-duty household detergents free of phosphates. Work is to concentrate on the three most successful surfactants studied under previous contract. Synthesis of these surfactant compounds will be scaled-up to provide kilogram quantities which will be sufficient to allow extensive testing. Studies will be conducted to ascertain the effects of varying the chain lengths of at least one of the three surfactants. Extensive testing will be conducted to determine the "biological compatibility" of the surfactant candidates, including toxicity and biodegradability studies.

Control of Pollution From Mercury-Laden Bottom Deposits in Streams and Lakes
16080 --- Contract 68-01-0089 $33,645
Martin Marietta Corporation, Baltimore, Maryland
Project Officer: Curtis C. Harlin, Jr.

The objective of this project is to establish the desirability of reducing or preventing mercury cycling from sediments by using porous coverings. Laboratory tests will be conducted to evaluate the effectiveness of applying sand, gravel, and/or "popcorn" concrete as the porous cover material. Mercury-enriched sediments will be examined to determine the effect on the migration of mercury into the water by varying cover material depths, concentration of organic matter, and reducing conditions.

Control of Pollution From Mercury-Laden Bottom Deposits in Streams and Lakes
16080 --- Contract 68-01-0087 $68,485
Midwest Research Institute, Kansas City, Kansas
Project Officer: Curtis C. Harlin, Jr.

Three different approaches for controlling pollution from mercury-laden bottom deposits of streams and lakes will be evaluated in the laboratory as follows:

1. Dredging and beneficiation--Various beneficiation procedures including flotation and chemical processes will be evaluated. If the mercury can be successfully removed from the sediments, sediment disposal problems will be reduced.

2. Chemical-physical sealing in place--These studies will consist of using scrap iron turnings to reduce the rate of transport of mercury from sediments to the overlying water. An overburden of clay or other material will be placed over the iron to further reduce mercury transport, act as a binder to hold the iron in place, and reduce the oxidation rate of the iron.

3. Enzyme inhibitors--This study will be directed to the interruption of the methylation process thus preventing the formulation of the highly toxic and water soluble methyl mercury.

The Control of Pollution From Mercury-Laden Bottom Deposits in Streams and Lakes
16080 --- Contract 68-01-0086 $42,930
Advanced Technology Center, Inc., Dallas, Texas
Project Officer: William R. Duffer

The objective of this project is to develop new and effective methods for controlling pollution from mercury-laden bottom deposits in streams and lakes. Under anaerobic conditions found in some bottom sediments, dissolved mercury exhibits a tendency to precipitate as the highly insoluble mercuric sulfide. This appears to be a significant natural scavenging process which occurs without destroying the ecological balance of the aquatic organisms in the contaminated area of concern. Experiments are designed to expand and enhance the natural scavenging process by artifically supplementing the reaction through use of sulfur-based mercury "getter" systems coated onto recoverable substrates. Inter-relationships of redox conditions, pH, and organic content of the sediments will be investigated with regard to volume, and chemical nature of the pollutants.

Control of Pollution From Mercury-Laden Bottom Deposits in Streams and Lakes
16080 --- Contract 68-01-0090 $32,840
A. D. Little, Inc., Cambridge, Massachusetts
Project Officer: Curtis C. Harlin, Jr.

The objective of this project is to investigate the use of proteinaceous materials to adsorb or bind mercury to prevent its escape from bottom sediments. Laboratory feasibility studies will be conducted to ascertain if proteinaceous substances are capable of binding practical amounts of mercury and to elaborate on parameters which might affect this adsorption at the trace concentrations normally found in the environment.

The Development of a Material-Equipment System to Overlay Mercury and Benthic Nutrient Contaminated Sludge Deposits with a Polymer Film, Phase I
16080 --- Contract 68-01-0088 $67,586
Battelle Memorial Institute, Columbus, Ohio
Project Officer: William R. Duffer

The objective of the project is to develop new and effective methods for controlling pollution from mercury-laden bottom deposits in streams and lakes. The approach of this research is to develop a barrier film which can be formed in situ to cover contaminated bottom sediments. Polymer film blankets will be developed and tested to determine their effectiveness for sealing-in mercury contaminants contained in bottom sediments. The continued generation of dimethyl mercury under anaerobic conditions established by the polymer film is of concern. Consequently, efforts will be directed toward developing a material which forms an impermeable membrane to solubles present beneath it and which has efficient scavenging properties.

Water Quality Control Through Single Crop Agriculture
16080 FQV $10,734 Bemidji State College, Bemidji, Minnesota
Project Officer: Richard E. Thomas

The rapid growth of the wild rice industry and the intimate association of the industry with the aquatic environment poses a potential threat to recreational waters. The purpose of this project is to study the impact of wild rice culture on water quality. The overall objective is to provide information that will make possible the development of the industry in such a manner as to minimize harmful ecological effects.

Design and Operation Manual: Soil Systems for Treated Municipal Wastewaters
16080 GWF $24,343 East Central State College, Ada, Oklahoma
Project Officer: Richard E. Thomas

The primary objective of this project is to develop a manual for use in the design and operation of soil systems which are utilized for recycling treated municipal waste effluents. This project is to be a joint effort combining the expertise of the Robert S. Kerr Water Research Center, selected nationally recognized authorities, and East Central State College.

Secondary objectives which will be realized during the project are:

1. The compilation of an annotated bibliography on the present state of the art in the subject field.

2. A summary of needed research.

Denitrification in Soil During Wastewater Disposal
16080 EIT $27,471 The Pennsylvania State University, University Park
Project Officer, Richard E. Thomas

It is the major purpose of this project to find means of stimulating and forcing the denitrification process. The project has the following specific aims:

1. To develop a simple applicable and reproducible method for the determination of the denitrifying power of an ecosystem under field conditions.

2. To investigate the pathway of nitrate reduction by various isolated soil microorganisms.

3. To study the effects under controlled laboratory conditions of individual variables and their interactions on the denitrification process with isolated denitrifiers, microbial communities and soil.

4. To study possible means of stimulating the denitrifying power of the soil ecosystem.

Hypolimnetic Flow Regimes in Lakes and Impoundments
16080 FVK $75,274 University of Pennsylvania, Philadelphia, Pennsylvania
Project Officer: Curtis C. Harlin, Jr.

This project is a combined laboratory and analytic investigation of hypolimnetic flows in impoundments. It is directed toward development of impoundment water quality management techniques through understanding of the applied hydraulics of such flows. This project will demonstrate the existence of many hydraulically different hypolimnetic flows, will develop methods of classification of these flows based on reservoir geometry and operation and will determine relationships among the quantitative parameters entering their description.

Lake Diking as a Water Pollution Management Tool
16080 EVT $72,559 Brigham Young University, Provo, Utah
Project Officer: Curtis C. Harlin, Jr.

The objectives of the project are to investigate the use of dikes to control water quality in natural or man-made lakes; to determine the effectiveness of the dike system in the management of lake water quality; to recommend location and management details which will provide optimum control of water quality; and to develop criteria and methodology for general application of diking to control water quality in natural or man-made lakes. Work of this project is being conducted at Utah Lake located at Provo, Utah. During the first year of this study, sampling stations were established within the Lake and its tributaries, and sampling for water quality was conducted. Gaging stations on tributaries and discharges from the Lake were also established where needed and hydrological data were developed. The second year's work will further develop water quality characteristics by continuing the sampling program and will concentrate on the computerized evaluation of available data.

The Development of an Engineering Methodology for the Reaeration of Rivers, Ponds, and Lakes
16080 FSN $27,320 JBF Scientific Corporation, Burlington, Massachusetts
Project Officer: Curtis C. Harlin, Jr.

The objective of this project is to develop an engineering design method for applying existing aeration technology to the reaeration of rivers and lakes. More specifically, it is to develop methods of transforming the available data that are taken on aeration devices and in streams into design formats (charts, formulas and tables) so that data can be used to credit the increase in DO in specific waters over given periods of time. The project emphasizes the development of the engineering design methods that can be used in actual practice and the presentation of the methods so that practical applications can be made to a specific river or lake by personnel with background in the biological sciences as well as the engineering sciences.

Correlated Studies of Vancouver Lake--Hydraulic Model Study
16080 ERP $52,376 Washington State University, Pullman, Washington
Project Officer: Curtis C. Harlin, Jr.

The principal objective of this project is to develop as complete an analysis as possible of the best methods for introducing "purer" water into Vancouver Lake from the Columbia River so as to establish and maintain higher water quality standards in the Lake. The hydraulic model studies will develop criteria for future projects of this type and will provide information necessary for the Water Quality Prediction Study being conducted under EPA grant 16080 ERQ.

Correlated Studies of Vancouver Lake--Water Quality Prediction Study
16080 ERQ $25,614 Washington State University, Pullman, Washington
Project Officer: Curtis C. Harlin, Jr.

The objective of the project is to gather such information and establish such techniques as would provide the basis of prediction of water quality in a shallow lake such as Vancouver Lake in Vancouver, Washington, resulting from different management practices and altered flow regimes. This involves the determination of seasonal variations in water quality in the Columbia River and in Vancouver Lake. These data and data provided by hydraulic model studies will be used to predict water quality in the Lake if the southern part of the Lake is connected with the Columbia River by a new channel. The hydraulic model data will be provided from grant project 16080 ERP.

Oxygen Regenration of Polluted Rivers
16080 FYA $29,000 Rutgers University, New Brunswick, New Jersey
Project Officer: Curtis C. Harlin, Jr.

This project continues work conducted during the preceding three years under Grant 16080 DUP. The objective is to provide answers to questions raised during the previous studies--specifically: (1) the condition of unusually high deoxygenation rates which occurred downstream of aerators; (2) the effectiveness of flow concentration devices used in conjunction with surface aerators; and (3) the comparison of mechanical aerators with pure oxygen diffusers. The test site for the project was located on the Passaic River near Pine Brook, New Jersey.

The Role of Trace Elements in the Management of Nuisance Growths
16080 FQK $85,694 Academy of Natural Sciences of Philadelphia
Project Officer: William R. Duffer

The objective of this project is to determine if more favorable conditions for species of algae which are a desirable food source in the aquatic ecosystem can be provided by manipulation of trace nutrients. Laboratory experiments, during this second year of the project, will be conducted to determine the effect of various concentratons of nickel, vanadium, chromium, and selenium on the development of various kinds of algae under nutrient enriched conditions. A practical application phase will be initiated for actual regulation of populations of nuisance algae. Experimentation in the application phase will determine the value of manganese additions in regulating algal populations in streams and ponds.

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   James P. Law, Jr.
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   March-April 1968.

4. "Pore Gas Composition Under Sewage Spreading"
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5. "Phosphate Removal by Activated Sludge, Amenability Studies at Baltimore, Maryland"
   M. R. Scalf, F. M. Pfeffer, L. D. Lively, J. L. Witherow, and C. P. Priesing.
   June 1968.

6. "Pollution Implications of Animal Wastes--A Forward Oriented Review"
   Raymond C. Loehr.
   FWPCA Contract No. 14-12-88.
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7. "Soil Response to Sewage Effluent Irrigation"
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8. "Is Treatment of Agricultural Waste Water Possible"
   Louis A. Beck and Percy P. St. Amant, Jr.
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11. "Use of Chemical Dispersants in the Enumeration of Bacteria in Activated Sludge"
    S. C. Yin and James E. Moyer.
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    F. M. Pfeffer, M. R. Scalf, B. L. DePrater, L. D. Lively,
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15. "Phosphate Removal by Activated Sludge, Amenability Studies at Smithfield, North Carolina"
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18. "Eufaula Reservoir Aeration Research--1968"
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19. "Water Pollution Control Research--South Central Region"
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20. "Pilot Study of Dynamics of Reservoir Destratification"
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Jack W. Keeley and Marion R. Scalf.
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