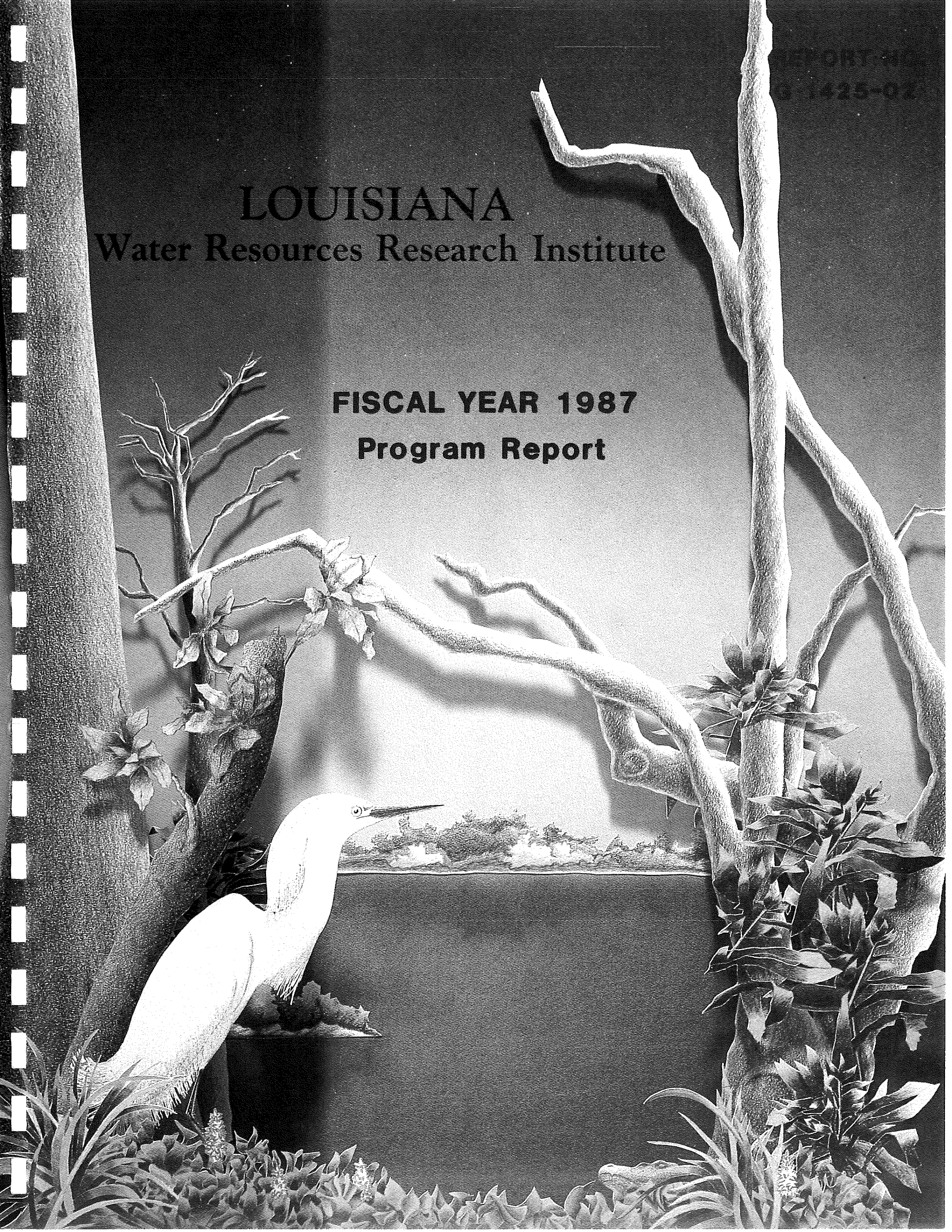
LOUISIANA
Water Resources Research Institute

FISCAL YEAR 1987
Program Report



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G 1425-02

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Grant No. 14-08-0001-G1425

for

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Geological Survey

by

Louisiana Water Resources Research Institute
Louisiana State University
Baton Rouge, LA 70803

Marty Tittlebaum, Director

September 1988

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ABSTRACT

The 1987 cooperative research program of the Louisiana Water Resources Research Institute addressed priority water resources problem areas identified for Louisiana - management of surface water supplies, ground water quality control and restoration, and wastewater treatment alternatives.

Four research projects funded to address these priority issues were: (1) Stable Isotope Tracing of Surface-Water Contamination and Cross-Formational Flow in the Baton Rouge Aquifer, (2) The Reduction of Trihalomethane and Other Chlorinated Hydrocarbons in Drinking Water of Municipalities of Less than 10,000 Via Incline Cascade Air Stripping, (3) Use of Stable Nitrogen Isotopes in Determining Nitrogen Sources Entering Louisiana Surface Waters, (4) Performance Evaluation of an Artificial Wetland Treating a Facultative Lagoon Effluent.

Cooperative efforts, both in research and in information transfer, were expanded in Fiscal Year 1987. Joint activities between the institute and state agencies, and between the institute and other university organizations were developed.

Water Problems and Issues of Louisiana

Louisiana is blessed with an abundance of water resources and occasionally plagued with severe flooding. Key water resources issues, therefore, become managing the resources present and protecting the quality of those resources to assure continued availability and useability for future generations. Important water resources issues include the problems associated with wetlands and coastal zones, water resources planning and management, and water quality protection.

Louisiana's vast wetlands make up approximately 40% of the nations wetlands. These areas are composed of very sensitive, often delicately balanced ecosystems and are, therefore, particularly vulnerable to contamination or destruction due to both man's activities and natural occurrences. Understanding these threats and finding management alternatives for these unique resources are priority issues needing attention.

Resource planning and management are also ever-present issues for Louisiana. Flooding of urban and residential areas periodically causes severe economic loss and human suffering. Yet through flood water control and diversion, valuable sediment load previously available to nourish the state's coast line is diminished or unavailable to the areas most in need. Water resources and environmental issues are intricately interconnected, therefore changes in one aspect produce a corresponding responsive change in another. To effectively manage these resources, holistic strategies need to be developed.

Water quality protection, particularly of ground water resources, is an emerging issue of concern in Louisiana. Delineating aquifer recharge areas, understanding the impacts of industrial activities on these water resources, and exploring protection alternatives are issues at the forefront of researchers and citizens minds alike.

Program Goals And Priorities

The primary goal of the Louisiana Water Resources Research Institute (LWRRI) for the Fiscal Year (FY) 1987 was to help meet the present and future water resources research needs of the state and the region, with the research contributing to national water research needs. Specific objectives of the Institute were to encourage and support research efforts that help provide answers or alternative solutions to protect and properly manage the state's valuable surface and ground water resources, to train students to be water resources scientists and engineers capable of solving present and future water resources problems, and to transfer research results and findings and provide technical assistance to governmental and industrial personnel as well as the citizens of Louisiana.

The priority problems addressed by the Institute in its FY 1987 program were:

* Management of surface water supplies,
* Ground water quality control, especially that research related to the fate of hazardous materials,
* Aquifer restoration techniques, disposal and treatment systems, and
* Legal and institutional issues for water resources management and development.

These priority problems for Louisiana were specified in the survey conducted by the National Association of Water Institute Directors (NAWID) during 1986. The Louisiana priority problems were also identified as mutual Southern Plains Region problems; therefore, research to address one will benefit all.

Other priorities of the Institute have been and continue to be the restoration of the Institute to a position of leadership within Louisiana for water resources issues and concerns. Objectives through which this is being achieved are to increase operational efficiency of the Institute, to increase funds available to faculty researchers, and to develop and implement an aggressive information transfer program that will bring recognition to the Institute and its researchers while providing valuable information and education to Louisiana's citizens.

Research Project Synopsis

The Institute's FY 1987 cooperative program addressed the specific research priorities identified above. Four projects were funded. Projects addressed: water treatment (03), wastewater treatment (04), ground water quality (02), and nonpoint sources of pollution (05). The projects were:

02 Stable Isotope Tracing of Surface-Water Contamination and Cross-Formational Flow in the Baton Rouge Aquifer - Michael A. Simms

03 The Reduction of Trihalomethane and Other Chlorinated Hydrocarbons in Drinking Water of Municipalities of Less than 10,000 Via Incline Cascade Air Stripping - Brace H. Boyden and Joseph B. Fernandes

04 Use of Stable Nitrogen Isotopes in Determining Nitrogen Sources Entering Louisiana Surface Waters - R.D. DeLaune, C.W. Lindau, and W.H. Patrick, Jr.

05 Performance Evaluation of an Artificial Wetland Treating a Facultative Lagoon Effluent - Ronald F. Malone and Walter H. Zachritz.

A synopsis of each project follows.

SYNOPSIS

Project Number: 02

Starting Date: 09/01/87
Ending Date: 08/31/88

Title: Stable Isotope Tracing of Surface-Water Contamination and Cross-Formational Flow in the Baton Rouge Aquifer

Investigator: Michael A. Simms
Department of Geology
Louisiana State University
Baton Rouge, Louisiana 70803

COWRR: 02-F

Congressional District: sixth

Descriptors: Ground Water, Isotopes, Ground-water Quality

Problem and research objectives: A river or other surface-water body may lose water to aquifers if its surface elevation is higher than the head of the surrounding ground water. This condition may be met if the aquifers are being pumped or if the surface-water body is confined by levees or dikes that are higher than the surrounding land surface. Surface-water recharge to ground water may cause changes in ground-water quality. Whether they are beneficial or detrimental, these changes may also result in geochemical reactions that affect the physical properties of the aquifer. Surface water, in some locations, may also function as a natural tracer if it possesses unique characteristics unchanged by water-rock interaction. A conservative tracer may be used to discern ground-water flow patterns and flow rates and the geographic extent of surface-water recharge.

This study attempts to use the isotopic composition of water molecules to identify and trace recharged Mississippi River water in the shallow subsurface of the Baton Rouge, Louisiana area. The river water has a depleted isotopic composition due to its origin in the interior of the continent. Delta O-18 ranges from -6 to -8 per mil and delta deuterium from -40 to -54 per mil. Local groundwater is derived from coastal rainfall enriched in O-18 and deuterium (delta O-18 from -4 to -5 and delta deuterium from -15 to -25 per mil). Water-rock interaction in the shallow aquifers does not affect the isotopic composition of the water so that these compositions provide a basis for distinguishing water types.

In the Baton Rouge area, heavy pumping of shallow aquifers by petrochemical industries since the early 1900's has reduced heads below sea level. The shallow aquifers are

truncated by the alluvial-valley fill and in hydraulic communication with the river. The cones of depression terminate against the Baton Rouge Fault (a growth fault) so that pumping does not affect heads on the south side of the fault. South of the fault, the land surface is low and the river recharges the shallow aquifers during periods of high stage.

The objectives of this study are to 1) determine the extent of river-water recharge, 2) determine the extent of cross-formational flow, and 3) describe the restriction of ground-water flow caused by the Baton Rouge Fault. These objectives allow assessment of the threat of aquifer contamination by surface water and provide a visualization of detailed flow patterns in the aquifers.

Methodology: Samples of ground water, Mississippi River water, and rain water were taken so that the oxygen and hydrogen isotopic composition could be measured. Ground-water samples were obtained from over 200 water-supply wells and observation wells. All wells were purged of at least two to three well volumes. More than half of the wells did not have operating pumps and were sampled by air lift with a mobile air compressor. River water samples were taken near the river bank on a monthly basis south of Baton Rouge. River samples were also obtained from the U.S. Geological Survey.

Samples were analyzed for isotopic composition at the University of Miami, Florida by Dr. Peter Swart.

Principal findings and significance: The results available so far indicate that river water has entered the shallow aquifers in areas of heavy ground-water production north of the fault. The samples obtained from the areas of large drawdown should provide an evaluation of flow through aquifer interconnections. The fault does not provide a barrier to flow in the shallowest aquifers. River water occurs in the shallowest aquifers near the river south of the fault. Near the fault, deeper ground waters have isotopic compositions that may be altered by geochemical processes such as sulfate reduction.

The significance of this study will be in providing an assessment of aquifer contamination by river water and in determining flow patterns in the shallow aquifers.

Publications and professional presentations: None

Masters theses: None

Ph.D. dissertations: None

SYNOPSIS

Project Number: 03

Start: 09/01/87
End: 08/31/88

Title: The Reduction of Trihalomethane and Other Chlorinated Hydrocarbons in Drinking Water of Municipalities of less than 10,000 Via Incline Cascade Air Stripping.

Investigators: Brace H. Boyden and Joseph B. Fernandes
Department of Chemical Engineering
Louisiana Tech University
Ruston, LA 71272

COWRR: 05-F

Congressional District: 5th

Descriptors: Water Treatment, Stripping, Chlorinated Hydrocarbons, Drinking Water, Surface Water, Aeration

Problem and research objectives: The problem was the identification of economical alternatives to the use of packed beds for the removal of chlorinated hydrocarbons from drinking water. Specifically smaller municipalities of less than 10,000 make up 65% of the water systems in the U.S., serving approximately 37 million people. Yet often the budget of a small municipality is insufficient to pay the capital and operating costs of packed column strippers. An economical alternative to the packed bed would extend to this segment of the population the benefits of reduced chlorinated hydrocarbons in the drinking water supplies.

The objectives of this investigation were based on work performed in 1970 whereby an inclined, transversely corrugated board was used to oxygenate high BOD sugar industry wastes. Because of the early success in this application, it was determined that such an apparatus could also be used for stripping. Therefore, based on this early work, this research project involved itself with the following objectives:

1. To define the performance of an inclined, transversely corrugated surface with respect to stripping chlorinated organics from drinking water,

2. To optimize flow rates and liquid residence times on the board for 10 chlorinated hydrocarbons, and

3. To calculate mass transfer coefficients from which the design of other cascade boards can be made.

Methodolgy: The inclined, transversely corrugated surface, a

cascade board, was constructed of plywood and lumber. The board was 16 ft. long and 2 ft. wide. On the surface of the board was placed standard fiberglass (1" diameter) roofing, the corrugation transverse to flow down the board. The board was adjustable from 30 to 70 degrees in 5 degree increments. The plumbing associated with the cascade board consisted of a continuous tap water supply and source of chlorinated organic chemicals. The chemicals were introduced into the tap water via an ejector and the aspiration effects of the water flow. The inlet chemical concentration on top of the cascade board was set to be ca. 30 ppb (some of the chemicals included 1,1,1-trichloroethane, chloroform, carbon tetrachloride, and bromoform to name 4). The ability of the cascade board for chemical stripping was tested at 10, 20, and 30 gallons/minute at angles of 35, 45, 60, and 70 degrees. Plots of the log of the change in concentration verses residence time on the board (a result of the mass balance for this system) yielded first-order curves. The overall mass transfer coefficients were determined from the slope of these plots.

Chemical analyses were performed on a Hewlett-Packard 5840A gas chromatograph. Double fluid samples collected at 4, 8, 12, and 16 feet down the board were initially extracted with pentane to remove remaining organics. The hydrophobic fraction was then analyzed on the column of the GC for residual chlorinated organics.

Principal findings and significance: The principal finding of this investigation was the fact that the experimentally derived, overall mass transfer coefficients were an order of magnitude higher than those reported for the same chemical(s) in packed towers. The coefficients ranged from 0.09 to 0.58 s-1. For chloroform at 70 degrees and 20 gpm, a 93% stripping of the chemical from tap water was achieved in only 4 seconds of residence time on the board. Additionally, the overall mass transfer coefficients were found to be independent of liquid flow rate. This phenomena would allow large liquid loading rates. Also, for chemicals with Henry's law constants above 400 atm., the maximum mass transfer coefficient was measured at 60 degrees. The chemicals with Henry's law constants below 200 atm exhibited no maximum and continued to increase up to 70 degrees.

In conclusion, 10 chemicals were stripped from tap water on the cascade board. Mass transfer coefficients were measured which would allow this small pilot size apparatus to be scaled up. More work is needed to generate the data needed for empirical curve fits of overall mass transfer coefficient verses a Reynolds-Schmidt number relationship. This would allow design of similar apparatuses without the need for initial experimentation. Extended runs would also be desirable for the study of long term problems such as scaling and

the formation of algae or slime as well as allow a detailed economic study.

Publications and professional presentations: Paper in progress for submittal to the Jour. of AWWA, future presentations will also be forthcoming.

M.S. thesis: A master's thesis will result in December, 1988 from this investigation to be entitled similarly to the name of the project.

Ph.D. dissertation: None

Synopsis

Project Number: 04

Start: 09/87
End: 08/88

Title: Use of Stable Nitrogen Isotopes in Determining Nitrogen Sources Entering Louisiana Surface Waters

Investigators: R. D. DeLaune, C. W. Lindau, and W. H. Patrick, Jr., Laboratory for Wetland Soils and Sediments, Center for Wetland Resources, Louisiana State University

COWRR: 5B Congressional District: Sixth

Descriptors: surface water, contamination, nitrogen, isotopic signature

Problem and research objectives: In many areas of Louisiana, water quality is deteriorating rapidly. Natural and cultural enrichment with nutrients can result in excessive phytoplankton growth, thereby reducing the use and the quality of surface waters. Many streams and lakes are rapidly becoming eutrophic. This is the cumulative result of numerous interacting factors, many of which have a cultural origin. Agricultural runoff, and municipal waste treatment plants are sources of large quantities of nutrients entering surface water. Wastes from industrial sites are also sources of high nutrient input. In order to provide this information to regulatory agencies for mitigating these inputs, it is necessary to know the source of nitrogen entering water bodies.

Nitrogen isotopes ($^{15}N/^{14}N$) have been used to identify the sources of ground and surface water NO_3-N contamination. The three main sources of nitrogen pollution to the environment are fertilizers, animal or sewage wastes, and mineralization of soil organic matter. These sources can produce nitrogen with distinguishable $^{15}N/^{14}N$ ratios which can be used to determine the sources of the NO_3-N entering water bodies. Nitrate formed by mineralization of soil organic nitrogen has a $\delta^{15}N$ range of +4 to +9‰. Ammonium and NO_3-N fertilizers have $\delta^{15}N$ values close to zero. Nitrogen in animal and sewage waste is mainly in the form of urea which is hydrolyzed to ammonia and eventually converted to nitrate. The ammonia lost by volatilization from the system will be strongly depleted in ^{15}N and the remaining ammonium in solution will be

correspondingly enriched in ^{15}N. Most of this NH_4^+ can be converted to ^{15}N enriched nitrate. Hydrolysis of urea from animal wastes ($\delta^{15}N$ = +5‰) is converted to ^{15}N nitrate with $\delta^{15}N$-values in the range of +10 to +20‰. Using this approach our specific objective was to determine the source of nitrogen entering surface water of selected water bodies along the Louisiana Gulf Coast.

Methodology: Surface water samples were collected seasonally from streams in selected drainage basins. Point sources from a sewage treatment plant and industrial NH_4^+-N discharge were analyzed for $^{15}N/^{14}N$ ratios. The nitrogen signature in water samples with distance from the source was determined. Steam distillation and Kjeldahl procedures were used to prepare N samples for natural abundance $^{15}N/^{14}N$ analysis. In these procedures the inorganic N fraction was converted to NH_4^+-salt and conversion of NH_4^+-N to N_2 for mass spectrometer analysis was done by reacting with NaOBr. The purified N_2 gas sample was analyzed on a Finnigan Mat Delta E isotope ratio mass spectrometer and the $^{15}N/^{14}N$ ratio determined.

Principal Findings and Significance: Our research has provided a means for identifying sources of inorganic nitrogen entering Louisiana surface water. The isotopic signature of NH_4^+-N in water samples taken from selected streams was used to assess the contribution of NH_4^+-N from point source discharge. Ammonia nitrogen from sewage and industrial source was found to have distinct signatures which were different from down stream inorganic nitrogen sources. We measured $\delta^{15}N$ ‰ values for NH_4^+-N ranging from +30 at point sources to as great as +200 with distance from the source. The hydrology of the stream was important in dilution of the NH_4^+-N source. In a slow flowing stream the signature was apparent for approximately 10 miles. In a stream with larger flow the signature was not identifiable for as great a distance indicating dilution.

The large positive increase in $\delta^{15}N$ values over distance from a point source may also be showing that the original NH_4^+ is undergoing transformations over time but is not as significant as the dilution effect. The changes in $\delta^{15}N$ values could also be due to kinetic isotope fractionation associated with bacteria. If the surface water pH is high, some of the original NH_4^+ can be lost through volatilization, which results in an isotopically heavier residual NH_4^+

pool. Volatilization is probably not a major loss mechanism because the pH of these surface waters is not high enough to support ammonia volatilization. The oxidation of NH_4^+ to NO_3^- (nitrification) in the oxygenated surface waters is also taking place. Nitrification of NH_4^+ would result in a remaining residual NH_4^+ pool which would be highly enriched in N-15 compared to the NO_3^- N formed. As the residual NH_4+ is reworked and transformed further down stream, the remaining inorganic NH_4^+ pool would decrease in concentration and increase in N-15 content. The ammonium pool involved in equilibrium and kinetic isotopic fractionation reactions could be reduced in contaminated surface waters. Part of the ammonium pool could be lost as gaseous end products (NH_3, N_2O, N_2) through volatilization and denitrification reactions. As the NH_4^+ or NO_3^- moves away from the point source, dilution and bacterial effects alter the nitrogen isotopic values of the original nitrogen. This is reflected in the heavier $\delta^{15}N$ ammonia values over time and distance, which we feel is mainly due to dilution of the original $NH_4^+$with an isotopically heavier source down stream. Bacterial fractionation of point source NH_4^+ is probably only of minor significance in this case.

The fractionation of nitrogen isotopes by dilution and bacterially-mediated reactions is complex and not completely understood. For this reason the use of $\delta^{15}N$ values in identifying inorganic nitrogen surface water sources should only be used for semi-quantitative interpretations. The large range of $\delta^{15}N$-NH_4^+ values in this study suggest that nitrogen isotope ratios have the potential to be used as tracers in the nitrogen cycle in surface contaminated waters.

Publications: A manuscript is currently being prepared for submission to a refereed water resource journal.

M.S. thesis: None. However, research did provide post graduate training for a geologist, which allowed him to obtain employment in the water resources field as a hydrogeologist.

Ph.D. dissertations: None

SYNOPSIS

Project Number: 05

Start: 9/01/87
End: 8/31/88

Title: Performance Evaluation of an Artificial Wetland Treating a Facultative Lagoon Effluent

Investigators: Malone, Ronald F. and Zachritz II, Walter H.,
Department of Civil Engineering
Louisiana State University
Baton Rouge, LA 70803

COWRR: 5D

Congressional District: sixth

Descriptors: Wastewater Treatment, Artificial Wetlands, Facultative Lagoons, Sagittaria, Rock Filter

Problem and research objectives: Facultative lagoons are employed by thousands of small to medium sized communities in the United States. Many of these systems exceed effluent standards for BOD5 and TSS during summer months of operation, due primarily to naturally occurring algae. Artificial wetlands have demonstrated the potential to be a cost effective method of upgrading wastewater treatment plants to meet more stringent discharge standards; however, little information is available on the ability of these systems to control TSS and BOD5 resulting from a facultative lagoon discharge.

The objective of this research was to evaluate the performance of an existing artificial wetlands treatment system used to polish effluent from a facultative wastewater stabilization lagoon.

Methodology: The treatment plant facility used in this study was located at the United States Department of Public Health Gillis W. Long Hensen's Disease Center, Carville, Louisiana. This research hospital serves about 500 resident and non-resident patrons. In March 1986 the existing treatment plant was upgraded from a conventional trickling filter with an anerobic digestor to an aerated lagoon/facultative lagoon/artifical wetlands treatment system.

The artificial wetlands filter was designed to meet effluent standards of 10 mg/l BOD5, 15 mg/l TSS, and 5 mg/l ammonia nitrogen, using a design flow of 150,000 gpd (104 gpm) and detention time of about 24 hours. Arrowhead or Swamp Potato (Sagittaria latifola) and Duck Potato (Sagittaria falcata) were planted on one foot centers in the pea gravel over the surface of the filter.

Evaluation of the performance of the treatment system at the Carville site was carried out over a three month period from February through June of 1988. Samples were collected twice a week throughout this time period. Sample stations were established after each of the treatment components. Field samples were taken by the Environmental staff at the Carville site. Field data were recorded and samples were transported to the LSU Department of Civil Engineering laboratories for analysis.

Flowrates, temperature and pH were measured in the field. Temperature and pH were measured directly with Cole-Palmer Mini pH meter. Flowrate data were taken from inplant flow recording equipment. Samples were stored at 4 deg C until analyzed in the laboratory for BOD5, TSS, and VSS. All analyses were done in accordance with Standard Methods (1980). Rainfall data for the Carville area were collected at the St. Gabriel weather station.

Principal findings and significance: The artificial wetlands filter examined in this study was effective at controlling BOD5 and TSS concentrations below 10 and 15 mg/L, respectively. This is well within existing 30 mg/L BOD, 30 mg/L TSS standard requirements. Thus, the artificial wetlands filter tested in this research appears capable of effectively controlling algal solids and BOD discharged from facultative lagoons. In addition, high pH (mean value of 8.9) resulting from algal respiration was effectively reduced in the filter to a mean pH value of 7.7. BOD5, TSS, and VSS were reduced by at least 40 to 50 percent in the first 1/3 of the filter volume, indicating that splitting the influent to the filter into several separate flows introduced at measured intervals along the filter bed could improve overall plant growth and filter performance.

Publications and professional presentations:

Rock-reed filters for small domestic wastewater flows. Zachritz II, W. H. , Louisiana Environmental Health Annual Educational Conference, January 21-22, 1988.

M.S. theses: None

Ph.D. dissertations: None

Information Transfer Activities

The information transfer activities of the Institute were expanded during Fiscal Year 1987 to include new routine activities as well as the initiation of extensive new programs and/or activities.

Initial activities have included in-house organizational activities to collect and document all works published during the history of the Institute and to present faculty and students with water resources news and information of particular importance to them. A listing of the publications of the Institute, previously only partially documented, has been compiled and will be annually updated. The resulting list, now available for public distribution, provides ordering information for requesting the water resources information and materials available through the Institute. A copy of the publications list is found in Appendix A. A water resources bulletin board is now being maintained to announce upcoming meetings, job opportunities for both students and faculty, award opportunities for students, and calls for papers.

A major information transfer activity of the Institute for FY 1987 was the First Annual Research Symposium held on November 17, 1987, on the LSU campus. This event was initiated to provide a mechanism to communicate the research plans and accomplishments of the Institute. FY 1986 faculty researchers summarized the results of their recently completed research, and FY 1987 researchers (work just beginning) presented highlights of their proposed work. Attendance at the symposium was by invitation with one hundred and fifty persons from state and federal government, regional regulatory agencies, local industry, consulting firms, professional organizations, and Louisiana universities invited to attend. Approximately sixty persons representing all the invited groups attended the Symposium. This event will be an annual activity of the Institute and is anticipated to follow a similar format in future years. The program for the Symposium is contained in Appendix B.

The Institute's staff has, in FY 1987, placed particular emphasis on acquainting Louisiana's research community with the research funding opportunities through the U.S. Geological Survey Sections 104 and 105 research programs. Announcements for both research programs were widely distributed to Louisiana's colleges and universities and to research organizations throughout the state. In addition, public announcements were made at professional and faculty meetings to help assure wide participation in the programs. A significant increase in participation in these programs by Louisiana researchers occurred in the FY 1988 programs. This increase appears to be evidence of the success of these

efforts. Table 1 depicts these changes in participation.

Table 1. Louisiana's Participation in Section 104 and 105 Research Programs

Year	Proposals Submitted Section 104	Section 105
1987	9	10
1988	34	13

Presentations have been given to civic and professional organizations to help acquaint these audiences with the activities of the Institute. These were given to the Louisiana Environmental Health Association (January, 1988) and the Louisiana Federation of Garden Clubs (August, 1988). Poster and exhibit materials have been displayed at other meetings attended by research faculty and are currently displayed thoughout the College of Engineering building on campus.

An advanced wastewater treatment short course was developed and conducted for Gulf States Utilities personnel at the Riverbend Nuclear Power Plant on August 29 and 30, 1988. The course was designed to meet the Louisiana Department of Health and Hospitals recertification requirements for wastewater treatment plant operators and was attended by fifteen professionals. The course addressed the specific wastewater characteristics of the nuclear power plant.

The Institute co-sponsored a conference, Ground Water Protection in Louisiana: Quality, Risk Assessment and Remediation, held on May 12, 1988. The conference program was structured to provide timely information about the latest technological advancements, to identify and assess new issues and concerns, recent developments and new problems facing Louisiana, and to enhance understanding of current approaches to solving critical and politically sensitive environmental issues. More than two hundred persons with professional interests in Louisiana's ground water resources attended.

Two information/fact sheets were prepared for distribution at professional meetings and at other times when opportunities for publicizing the Institute are appropriate. The first provides general information about the Louisiana institute, its goals and its history. A second fact sheet receiving wide distribution identifies the Louisiana governmental agencies with water resources regulatory and/or management authority and briefly describes their responsibilities.

Future information transfer activities include the development of a brochure about the Institute, the regular circulation of the Institute's newsletter "Louisiana Water Research", and the development of a water quality education and training program for the general public.

Cooperative Arrangements

Cooperative efforts, both in research and in information transfer, were expanded in Fiscal Year 1987. Joint activities between the Institute and state agencies and between the Institute and other university organizations were developed.

Research

The Institute staff has dedicated a significant amount of time to improving research coordination and developing cooperative research proposals and projects with other university and /or state agencies. New activities are listed below and the status of each is given.

* Proposal developed jointly with NASA-Earth Resources Laboratory and the Louisiana Department of Natural Resources.

  Project Title: Remote Sensing Application to Petroleum Waste Management

  Status: Not funded

* Proposal jointly developed with LSU offices of Hazardous Waste Research Center and Center for Wetlands Resources.

  Project Title: Research Needs Workshop: Development of Leach Tests for Contaminated Dredged Material

  Status: Funded, and completed (project described below)

* Project jointly initiated with U.S. Public Health Service and Hansen's Disease Center

  Project Title: An Evaluation of a Full Scale Rock-Reed Filter Wastewater Treatment System

  Status: On-going; project duration is twelve months. (The project is described below.)

The research needs workshop was hosted by the Institute on June 23-24, 1988. Funding was provided by the Long-Term Effects of Dredging Operations (LEDO) research program, U.S. Army Corps of Engineers which is implemented by the Environmental Laboratory (EL), U.S. Army Engineer Waterways Experiment Station (CEWES), Vicksburg, Mississippi. The workshop, also hosted by LSU's Hazardous Waste Research Center and the Center for Wetland Resources, gathered together national experts on contaminated dredged material to perform

an evaluation of the LEDO research program. Eleven representatives from unversities and federal agencies participated in the workshop. A synopsis of the workshop was published.

The U.S. Public Health Service (PHS) and LWRRI are presently working together to evaluate a unique, full-scale, rock-reed filter wastewater treatment system. The system is located at the Gillis W. Long Hansen's Disease Center in Carville, Louisiana. After this initial evaluation, the U.S. PHS has indicated an interest in funding LWRRI to perform future research dealing with wastewater-treatment problems.

Other cooperative research efforts included the expansion of the Institute's two advisory boards and their active participation in guiding and supporting the research program. New guidelines for the functioning of the advisory boards were developed and implemented with the convening of the FY 1987 boards.

In September, 1987, thirteen members were appointed to the State Advisory Board. Members represent federal, state and local governments, industry, professional organizations and other Louisiana universities. This board provides technical program guidance to the Institute staff. The membership of this board and specific responsibilities of the board members are given in Appendix C.

The University Advisory Board has been restructured and reorganized to enhance the interaction of the Institute with other on-campus centers. Seven members have been selected from the university faculty, and one more appointment remains to be made. This advisory board structure is such that a broad range of disciplines and research interests are represented. The current membership and the disciplines represented are shown in Appendix D. This board continuously provides input into the Institute's research and administrative activities.

Information Transfer

A new working relationship has been established with the Louisiana Cooperative Extension Service (CES) at LSU. Louisiana's water quality has been identified as a topic of mutual interest and one around which a cooperative program can be developed between LWRRI and the CES. The Institute's staff and researchers are providing technical assistance to the CES on specific water-quality-engineering problems encountered. In addition to this, a joint project to design and implement a water-quality-education program for Louisiana's citizens will begin in FY 1988. Under the new education program, the CES will be the primary implementation network, and the LWRRI will perform administrative,

planning, and program materials develop services. The Louisiana Department of Transportation and Development - Office of Public Works is also cooperating in this program. Other cooperative arrangements with CES are being considered.

Training Accomplishments

The LWRRI is committed to training science and engineering students to assume leadership roles in current and future water resources and environmental problem solving. Research projects that incorporate extensive student training elements in the proposed research are given preferential consideration over proposed research involving faculty participation only. Table 2 summarizes the student training benefits of the current program.

Table 2. Training Accomplishments

Field of Study	Academic Level: Undergraduate	Master's Degree	Ph.D. Degree	Post-Ph.D.	Total
Chemistry					
Engineering					
- Agricultural - Civil - Environmental - Soils - Systems	4				4
- Other *		1			1
Geology		1			1
Hydrology					
Agronomy					
Biology					
Ecology					
Fisheries, Wildlife and Forestry					
Computer Science					
Economics					
Geography					
Law					
Resource Planning					
Other (specify)					
TOTAL:	4	2			6

* Less than 5 student in any one field of study

APPENDIX A

Publications List

PUBLICATIONS

OF THE

LOUISIANA WATER RESOURCE RESEARCH INSTITUTE

Dr. Marty E. Tittlebaum
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November 1987

10/87

LWRRI PUBLICATIONS: Bulletins

Handbook of Basic Water Law	Bulletin 1	June 1966
The Measurement and Comparison of Costs for Alternative Water Replacement Projects	Bulletin 2	October 1966
Salt-Water Encroachment Into Aquifers	Bulletin 3	October 1968
Water-Resources Manpower Supply and Demand Patterns to 1980	Bulletin 4	May 1970
The Present and Future Ground-Water Supply of the Baton Rouge Area	Bulletin 5	February 1970
Subsidence and Ground-Water Offtake in the Baton Rouge Area	Bulletin 6	October 1970
An Economic Reappraisal of the Toledo Bend Multiple-Purpose Water Project	Bulletin 7	October 1970
Geochemical Hydrology of the Baton Rouge Aquifers	Bulletin 8	March 1972
The Mississippi River - A Water Source for Texas?	Bulletin 9	March 1973
Cyclic Storage of Fresh Water in Saline Aquifers	Bulletin 10	May 1975
Aquifers as Processing Plants for the Modification of Injected Water	Bulletin 11	August 1980
If the Old River Control Structure Fails?	Bulletin 12	September 1980
Alternate Water Sources for the Baton Rouge - New Orleans Industrial Corridor	Bulletin 12A	September 1980
A Change in the Course of the Lower Mississippi River: Description and Analysis of Some Economic Consequences	Bulletin 12B	September 1980

LWRRI PUBLICATIONS: Technical Reports

The Recent Alluvium of Thomas and Duncan Points	Technical Report 1	June 1967
The Present and Future Ground Water Supply of the Baton Rouge Area	Technical Report 2	Sept 1967
A Summer Limnological Study of Lake Pontchartrain, Louisiana	Technical Report 3	Sept 1968
Physical, Chemical, Bacterial, and Plankton Dynamics of Lake Pontchartrain, Louisiana	Technical Report 4	Sept 1969
Epifaunal Invertebrates as Indicators of Water Quality in Southern Lake Pontchartrain, Louisiana	Technical Report 5	May 1975
Demonstration Project to Store Fresh Water in a Saline Water-bearing Formation: City of Houma, Louisiana	Technical Report 6	Feb 1979
Water Related Problems in the Coastal Zone of Louisiana	Technical Report 7	Nov 1980
Plan of Study for Evaluating the Effects of Lignite Mining in Louisiana on Water Resources	Technical Report 8	Aug 1981
Use of Twin Wells and Water-Source Heat Pumps for Energy Conservation in Louisiana	Technical Report 9	Dec 1981

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LWRRI PUBLICATIONS: GT Series

The Flood Control Capabilities of the Atchafalaya Basin Floodway	Bulletin GT-1	April 1967
Hydrology of Neogene Deposits in the Northern Gulf of Mexico Basin	Bulletin GT-2	April 1969
Economic Aspects of Ground-Water Basin Control	Bulletin GT-3	February 1970
Geohydrology of the Shallow Aquifers of Baton Rouge, Louisiana	Bulletin GT-4	October 1969
Possible Failure of the Low-Sill Control Structure at Old River, Louisiana: Economic and Physical Consequences	Bulletin GT-5	July 1976

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PROJECT COMPLETION REPORTS

TITLE	AUTHOR(S)	QUANTITY
Algae Removal by Induced Air Flotation (May 1982)	Tittlebaum, Holtman	5
Application to the Principle of Maximum Entropy (POME) to Hydrologic Frequency Analysis (1984)	Singh, Rajagopal	18
Biodegradation of Hazardous Chemical Wastes (1984)	Pelon, Murray	28
Biological Removal of Chlorinated Hydrocarbons from Water (Oct 1985)	Templet	19
Chemical Quality of Surface and Sediment Pore Water in Louisiana and Mississippi Estuaries (Oct 1973)	Snowden, Otvos	1
Comparative Evaluation of Estimators of Some Flood Frequency Models Using Monte Carlo Simulation	Vijay P. Singh, Kishore Arora	3
A Continuum Mechanics Approach to Streamflow Modeling (July 1983)	V. Singh, S. Prasad, L. Ubertini	2
Co-treatment of Water Softening and Wastewater Sludges (May 1982)	Bowie, Gautreaux	6
Design of Rainfall Networks Using Entropy (Oct. 1986)	Vijay P. Singh, P.K. Krstanovic	3
Development of a Methodology for Evaluating Waste Disposal Sites (August 1982)	J. Hill, R. Malone, S. R. Alston	14
Development of a Simplified Chlorinated Hydrocarbon Screening Technique for Water and Sediment (August 1984)	Templet	8

PROJECT COMPLETION REPORTS

TITLE	AUTHORS	QUANTITY
A Discrete Kernel Model for Simulation of Multilayered Aquifers (1984)	Illangasekare	17
The Dispersion of Continuously Injected Effluents in Open Cannels (Feb 1973	Harrison, Wehe	3
Effect of Diverting Mississippi River Water To Texas on Sedimentation in the River (March 1974)	Alawady	2
Effect of Viscosity Ratio on the Recovery of Fresh Water Stored in Saline Aquifers (April 1977)	Kimbler, Whitehead	10
Evaluation of Parameter Estimation Methods for Flood Frequency Analysis: Computer Programs	Vijay P. Singh, Kishore Arora	3
Evaluation of Some Empirical Methods for Flood Frequency Analysis 2. Data and Computer Programs (Marchl987)	Vijay P. Singh, Deepak Jain	3
Fate of PCB and Dioxin in Louisiana's Aquatic Environment (Sept 1983)	Pardue, DeLaune, Patrick	6
Floodwater Nutrient Processing in a Louisiana Swamp Forest Receiving Agriculture Runoff (Dec 1981)	Kemp, Day	1
A Geomorphic Approach to Hydrograph Synthesis, with Potential for Application to Ungaged Watersheds (June 1983)	V. Singh	4

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TITLE	AUTHOR(S)	QUANTITY
Hydraulic Conductivity of Rockfill (July 1983)	A. A. Hannoura, K. McManis	35 Vol I 5 Vol II
Information Dissemination for a Better Understanding of Louisiana's Water Resources (Sept 1984)	Worm	7
An Investigation Into the Removal of Algae by Fine Sand/Silt Filtration (Nov 1981)	Naghavi, Malone	8
Mathematical Models for Ungaged Watersheds with Potential for Quantifying the Effect of Land Use Changes on Streamflow (Oct 1984)	Singh	3
A Method of Determining the Quality of Irrigation Water to Achieve Optimum Growth of Bottomland Hardwoods in North Louisiana (Feb 1970)	Wilson, Miller, Banks	1
A Multivariate Approach to the Investigation of Nutrient Interaction in Barataria Basin, Louisiana (April 1983)	A. Witzig, J. Day	10
Nutrient Assimilation Capacity of Shallow Coastal Lakes (1983)	Delaune, Smith, Patrick, Sarafyan	8
Optimum Treatment for Coal Pile Runoff in Louisiana (August 1984)	Hendershot, Tittlebaum	5
Oxidation of Trace Contaminants in Drinking Water (Dec 1985)	F. Groves	20

PROJECT COMPLETION REPORTS

TITLE	AUTHOR(S)	QUANTITY
Prediction of Hydrothermal Regimes in the Proposed Darlington Reservoir (Sept 1986)	Field	5
Prediction of Hydrothermal Regimes in the Proposed Darlington Reservoir Volume Supplement (Sept 1986)	Field	4
Radioactivity in Mississippi River Water (April 1977)	Iddings, Knaus	5
Reaeration Rate Estimation Using the LAG in Dissolved Oxygen Concentration (Jan 1983)	M. Waldon	4
Reclamation of Polluted Farm Ponds (July 1977)	Robbins, Nelson	19
Reliability Analysis of BOD Kinetics in a Small Southern Stream Governed by the Discharge of an Oxidation Pond (1981)	Crane, Malone	3
Role of Mycorrhizae in Land Application of Municipal Wastewaters (August 1983)	J. Robbins	5
Sucrose Removal From Cane Sugar Mill Waste Streams by Ion Exchange (Oct 1976)	F. Groves	12
THM Precursors Removal From Surface Waters Using Ozone-Hydrogen Peroxide Oxidation (July 1982)	Fernandes	10
A Trophic State Index for the Louisiana Coastal Zone (April 1983)	A. Witzig, J. Day	4

PROJECT COMPLETION REPORTS

TITLE	AUTHOR(S)	QUANTITY
Wastewater Treatment by Ligand Exchange (Junel983)	F. Groves	5
Water Quality Variation in the Potable Water of Grand Isle, Louisiana During Periods of Water Shortage (Feb 1983)	M. B. Walsh, R. Malone, E. Dantin	5
A Multivariate Stochastic Flood Analysis Using Entropy (October 1986)	Vijay P. Singh, P.K. Krstanovic	3

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LWRRI THESES

TITLE	AUTHOR	QUANTITY
Analog Simulation of Anisotropic Permeability (May 1974)	Ronald E. Rinard	1
Black Willow (Salix Nigra Marsh) as a Bioaccumulator of Radioactive Pollutants in Fresh Water Ecosystem (Dec 1976)	Lynn R. Curry	1
The Design, Construction, and Testing of Consolidated Anisotropic Sand Models (May 1972)	D. L. Hinners	1
Dispersion & Gravity Segregation of Miscible Fluids in Porous Media for Stratified Radial Flow Systems (Jan 1968)	Anil Kumar	2
Effect of Dip on the Subsurface Storage or Disposal of Fluids in Saline Aquifers (August 1975)	Joseph A. D'Amico	1
Effect of Failure of the Old River Control Structure on Municipal and Industrial Water Supplies (May 1977)	Howard J. Redmond	1
The Effect of Flux & Gravitational Forces on Miscible Displacement in a Thin Homogeneous Bed (August 1973)	Walid J. Esmail	1
The Effect of Mixed Zone Length on the Growth of Viscous Fingers During a Miscible Displacement (August 1977)	Calvin C. Barnhill	1
Effect of Viscosity Ratio on the Recovery of Fresh Water Stored in Saline Aquifers (Dec 1975)	Bipin K. Agrawal	1

LWRRI THESES (Cont.)

TITLE	AUTHOR	QUANTITY
Environmental Factors Affecting the Properties & Precipitation of Coloring Colloids in Aquatic Habitats (August 1973)	Billy R. Bordelon	1
Enzyme Process Design for Water Treatment (Dec 1976)	Steven W. Johnston	1
An Evaluation of Twin Wells for Use with Water Source Heat Pumps (May 1981)	Joseph R. Buller	1
Experimental Study of Multi-Cation Diffusion in an Artificial Quartz Sandstone (Dec 1974)	Ronald K. Stoessell	2
Geological Factors Influencing Recharge to the Baton Rouge Ground-water System, with Emphasis on the Citronelle Formation (August 1967)	Brian E. Parsons	2
The Influence of Brackish-Water Intrusion on Macro-invertebrate Associations of the Lower Tchefuncte River, Louisiana (August 1975)	Maureen M. Mulino	2
Investigation of the Technical Feasibility of Storing Fresh Water in Saline Aquifers (August 1966)	Omar J. Esmail	1
Measurement of & Calibration for Gamma Spectroscopy of Mississippi River Water (August 1976)	Orren W. Williams	1
The Relationship Between the Presence of Dissolution Features at the Salt-Caprock Interface & Saline Plumes in Aquifers Surrounding Salt Domes (Dec 1982)	Martin L. Wouch	2

LWRRI THESES (Cont.)

TITLE	AUTHOR	QUANTITY
The Simulation of Whole Core Permeameter Flow Geometry (August 1974)	Louis O. Chemin Jr.	1
A Study of the Technical and Economic Feasibility of Using Sewage Effluent for Irrigation in Lincoln Parish (August 1967)	Robert P. Cantrell	5
A Study of the Technical and Economic Feasibility of Using Sewage Effluent for Irrigation in Quachita Parish (Nov 1968)	Fernando A. Calvo	2
A Technique for Irrigating Bottomland Hardwood Trees with Papermill Effluent in North Louisiana (May 1970)	Ishtiaq Ahmed	6
The Transport of Chlorinated Hydrocarbons in Dilute Aqueous Solution Through Saturated Cohesive Deposits of Southern Louisiana (August 1987)	Laqique Haider	1
Unequal Density Miscible Displacement in Thin Homogeneous Tilted Beds (Dec 1971)	Thomas R. Painter	1
The Use of Bounding Wells to Control Flux in Underground Water Storage Projects (August 1974)	Edmond J. Langhetee	1
The Use of Bounding Wells to Counteract the Effects of Gravity in Dipping Aquifers (May 1978)	Thomas E. Williams	1
Use of Bounding Wells to Negate the Effects of Gravity and Pre-Existing Groundwater Movement in Dipping Aquifers Used for Storage (August 1979)	Paul J. Abadie	1

LWRRI THESES (Cont.)

TITLE	AUTHOR	QUANTITY
Zonation of Lake Pontchartrain Invertebrates in a Polluted New Orleans Outfall Canal (August 1978)	Michael F. Rayle	2

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LWRRI DISSERTATIONS

TITLE	AUTHOR	QUANTITY
Discharge Model of the Mississippi River Evaluation of the Impact of Diversion of Water to Texas (May 1972)	O. Arguello	1
Economic Aspect of Ground-Water Basin Control (May 1979)	Larry Falk	1
Storage of Fresh Water in Saline Aquifers Using a Well Field (August 1974)	W. Whitehead	1
Geochemical Hydrology of Ground Water in Baton Rouge, Louisiana (Jan 1971)	Rashid A. Khan	3
Movement in an ACHM Overlay in the Vicinity of Overlaid Joints on a PCC Pavement (1978)	Terry J. Dantin	1

APPENDIX B

Research Symposium Program

***** ***** WATER RESOURCES RESEARCH SYMPOSIUM ***** *****

AGENDA

10:00 a.m. INTRODUCTION --MARTY TITTLEBAUM, Director

10:30 a.m. "A Simplified Extreme Value Method of Flood Frequency Prediction for Louisiana Streams" -- JAMES CRUISE

11:00 a.m. "A Multivariate Stochastic Analysis of Flood Magnitude, Duration, and Volume" -- VIJAY SINGH

11:30 a.m. "Evaluation of Factors Influencing Migration and Transport of Biocidal Agents to Groundwater and Surface Water Resources" -- DIPAK ROY, Donald Adrian

12:00 p.m. LUNCH -- On Your Own

1:30 p.m. "Tritium Age Dating in the Recharge Area of the Baton Rouge Aquifer" -- MICHAEL SIMMS, Paul Aharon, Ray Ferrell

2:00 p.m. "The Transport of Chlorinated Hydrocarbons in Saturated Cohesive Deposits of Southern Louisiana" -- YALCIN ACAR

2:30 p.m. "The Reduction of Trihalomethane and Other Chlorinated Hydrocarbons in Drinking Water of Municipalities of Less Than 10,000 Via Air Stripping" -- BRACE BOYDEN, Joseph Fernandes

2:45 p.m. BREAK

3:00 p.m. "Innovative and Alternative Treatment Options for Louisiana Seafood Processors and Aquaculture Facilities" -- Ronald Malone, W. ZACHRITZ

3:15 p.m. "Rock-Reed Filters for Treatment of Small Domestic Wastewater Flows" -- Ronald Malone, W. ZACHRITZ

3:30 p.m. "Use of Stable Nitrogen Isotopes in Determining Nitrogen Sources Entering Louisiana Surface Waters" -- RONALD DELAUNE, C. W. Lindau, W. H. Patrick, Jr.

3:45 p.m. "Stable Isotope for Tracing of Surface Water Contamination and Cross-Formational Flow in the Baton Rouge Aquifer" -- MICHAEL SIMMS, Paul Aharon

4:00 p.m. CLOSING REMARKS -- MARTY TITTLEBAUM, Director

4:30 p.m. RECEPTION -- Courtyard, Center for Business & Engineering Building (CEBA)

APPENDIX C

State Advisory Board

STATE ADVISORY BOARD
Louisiana Water Resources Research Institute

Purpose: To assist the Director, Louisiana Water Resources Research Institute (LWRRI), in identifying water resources research needs for the State of Louisiana.

Membership: Board members represent the water resources professional communities of the State of Louisiana, and are selected for their knowledge of and active participation in an area of water resources management or research. The Board consists of 13 members who are appointed by the President, LSU. Each member represents a distinctly different water resources focus area and serves a 5 year term.

Requirements: Each member shall participate in the annual meeting of the Board. This meeting shall be called by the Institute Director and shall be held at the convenience of all Board members.

Benefits: An opportunity to guide the research activities of Louisiana Water Resources Research Institute

An opportuinty to communicate with fellow water resources professionals in the State, sharing ideas and expressing research needs.

Service to Louisiana

MEMBERSHIP
STATE ADVISORY BOARD

Number of Representatives	Agency or Interest Group	Representative
2	City / Parish Govt.	
	o Mayor, New Orleans	Sidney Barthelemy
	o Mayor, Shreveport	John Hussey
3	Federal Governm. Agencies	
	o US Army Corps of Engin.	Thomas Sands, Major Gen. Mississippi River Div.
	o US Dept. of Agriculture	Harry Hawthorne Soil Conservation Service
	o US Geological Survey	Darwin Knochenmus District Chief
1	Industry	Jerry Daigre Dow Chemical Co.
2	Professional Organizations	
	o American Water Resources Assn. - Louisiana Chapt.	Rod Emmer, President Baton Rouge
	o Louisiana Marine Consortium	Don Boesch, Director Chauvin
4	State Agencies	
	o Dept. of Environ. Quality	Maureen O'Neill, Asst. Adm.
	o Dept. of Health & Human Res.	Bobby Savoie, Env. Consult.
	o Dept. of Natural Resources	Chip Groat, Director La. Geol. Survey
	o Dept. of Transportation & Development	Neil Waggoner, Secretary
1	University	Bobby Price, Director Water Resources Center, La. Tech Univ., Ruston

13 Members

APPENDIX D

University Advisory Board

UNIVERSITY ADVISORY BOARD

Purpose: To develop specific task-oriented Request for Proposals statements from the research needs listing identified by the State Advisory Board.

To assist the Director in prioritizing the identified research areas.

To identify potential investigators who can participate in the priority research areas.

To identify and promote areas where cooperative research programs can be developed between LWRRI and other organizations, both on and off campus.

Membership: Board members are selected from the Louisiana State University faculty, and are selected for their knowledge of and active participation in an area of water resources research. The Board consists of eight members appointed by the Chancellor, LSU. Each member represents a distinctly different water resources focus area and serves a 5 year term.

Requirements: Each member shall participate in the annual meeting of the Board convened to assess the research needs and priorities for the Institute's annual research program. This meeting shall be called by the Director, Louisiana Water Resources Research Institute, and shall be held at the convenience of all Board members.

Members shall also participate in the review of research preproposals and proposals, and rank these documents for funding preference.

Benefits: Service to LSU

Service to the State of Louisiana

An opportunity to guide the research activities of Louisiana Water Resources Research Institute

An opportunity to communicate with fellow water resources professionals in the university and state, sharing ideas and expressing research needs.

UNIVERSITY ADVISORY BOARD MEMBERSHIP

Number of Representatives	Discipline	Representative
1	Agriculture	Hussein Selim Dept. of Agronomy
1	Biological Sciences	Not yet Designat.
1	Business	Steve Farber Dept. of Economics
1	Engineering	Marty Tittlebaum Director, LWRRI Dept. of Civil Engr.
1	Physical Sciences	Robert Muller Dept. of Geog.
3	Special Research Interests	
	• Coastal Studies	John W. Day
	• Environmental Studies	Ed. Overton
	• Wetlands Resources	Flora Wang
8	Members	

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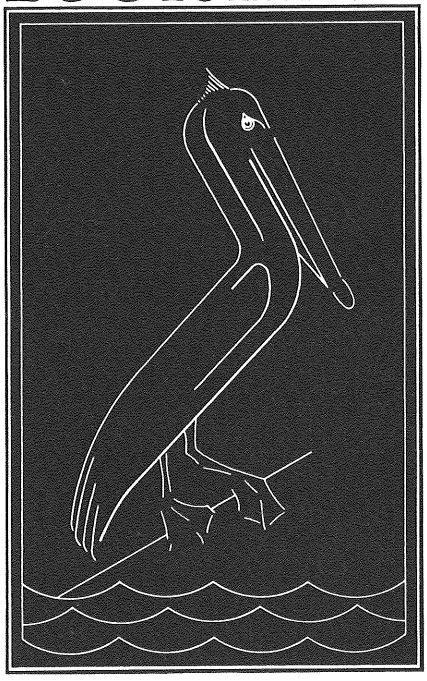

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