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L+U F.

UNITED STATES
ATOMIC ENERGY COMMISSION

OAK RIDGE OPERATIONS
P.O. BOX E
OAK RIDGE, TENNESSEE 37830

AREA CODE 615
TELEPHONE 483-8611

NOV 19 1969

Ralph Elson, Director, Contract Division

REQUEST FOR CONTRACT ACTION

It is requested that you take the necessary steps to process the following described contract action (CA):

1. Nature of Action Requested:

[ ] Selection of New Contractor and/or Negotiation of Contract
Number:
Contractor:

[XX] Modification of Contract
Number: **AT-(11-1)-490**
Contractor: **University of Texas at Austin**

2. Nature of Services To Be Covered by Contract: Research

Title: **"Transport of Radionuclides in Water (Model River and Ecological System)"**

3. Type of Contract:

[X] Support Agreement [ ] Cost Type [ ] Other

4. Amount of AEC Funds To Be Obligated by This CA: **$60,000.00**

5. AEC Percentage of Est. Total Cost To Be Shown by This CA: **100%**

6. Description of Other Changes To Be Covered by This CA:
Modify contract to provide for the performance of additional research to be completed during the period October 1, 1969, through September 30, 1970. The AEC support ceiling for the extended period is $60,000.00. Title to equipment, if any, shall vest in the contractor under authority of the PL-85-934.
Reporting requirements will remain the same as provided in Appendix "E" to Modification No. 14 to the contract.

7. Authority:

Form AEC-481 (Cont. Aug) fr. Milton Shaw to S. R. Sapirie dtd 10-28-69

CONTRACTS — 490 (Texas)

Herman M. Roth
Herman M. Roth, Director
Laboratory and University Division

OLE: LM

Medley 11-18-69

1138778

REPOSITORY Oak Ridge Operations Records Holding Area
COLLECTION Box, 1944-69
BOX No. A-78-3 Bldg. 2714-H
FOLDER Contract 490 Texas E.A. 11-18-69

UNIVERSITY OF TEXAS CONTRACT NO. AT-(11-1)-490

APPENDIX "A"

For the Contract Period October 1, 1969, through September 30, 1970.

A-I RESEARCH TO BE PERFORMED BY CONTRACTOR

The Contractor will apply the computer program of the model river and ecosystem developed under work previously supported by the AEC to an actual river or river system and to the discharge from selected nuclear power stations. In particular:

1. Adaptation of existing computer programs to predict detention and transport of radionuclides in water, sediments and biomass of streams.

2. Application of the computer program to predict the transport of radionuclides released from a nuclear power reactor into a selected reach of a stream.

3. Continuation of long-term, steady state experiments, using the model river system for prediction of factors and coefficients needed for computer program under various environmental conditions of selected streams.

4. Generalization of the computer program for prediction of transported radionuclides in river systems from current or future planned nuclear power stations.

5. Evaluation of the uptake and retention of organically bound tritium and tritium oxide by biota in flowing and non-flowing systems; and incorporation of the uptake and release coefficients obtained into the program describing radionuclide transport. Measurement of equilibrium rates for tritium in biota and sediments will be investigated. Such measurements will include the retention and movement of tritium through plankton rooted plants and small fish.

The Principal Investigator expects to devote approximately 10% of time during the academic year and 100% of time during two summer months to the work.

1138779

A-II WAYS AND MEANS OF PERFORMANCE

(a) Items Included in Total Estimated Cost:

(1)	Salaries and Wages:	$42,624.00
	Dr. E. F. Gloyna, Principal Investigator 3 Research Associates Nuclear Chemist Research Assistant Research Analyst	
(2)	Employee Benefits:	1,076.00
(3)	Computer Time:	3,000.00
	(10 hours @ $300.00/hr)	
(4)	Materials and Supplies:	1,000.00
	Chemicals, glassware, and computer cards and paper	
(5)	Travel:	1,000.00
(6)	Publications:	1,300.00
(7)	Indirect Costs (20% of direct costs):	10,000.00

(b) Items Significant to the Performance of this Contract, But Excluded From Computation of Total Cost and From Consideration in Proportioning Costs:

None

(c) Time or Effort of Principal Investigator to be Contributed by Contractor:

None under this paragraph

A-III The total estimated cost of items under A-II (q) above for the contract period stated in this Appendix "A" is $60,000.00; the Commission will pay 100% of the actual costs of these items incurred during the contract period stated in this Appendix "A", subject to the provisions of Article III and Article B-XXVII. The estimated AEC support cost for the contract period stated in this Appendix "A" is $60,000.00.

1138780

Form AEC-481
(6-67)

AECPR 9-4.51

U. S. ATOMIC ENERGY COMMISSION

CONTRACT AUTHORIZATION

1. DATE: OCT 2? 1969

2. AUTHORIZATION NO.: 70-002

3.A. TO: S. R. Sapirie, Manager
Oak Ridge Operations Office

3.B. FROM: Milton Shaw, Director
Division of Reactor Development and Technology

4.A. CONTRACTOR (Name, Address, Department, etc.)
University of Texas
Austin, Texas

4.B. PRINCIPAL INVESTIGATOR(S)

5. ☐ NEW CONTRACT ☒ RENEWAL ☐ OTHER

6. TERM OF CONTRACT: See attached 11A.

7. CONTRACT NUMBER: AT(11-1)-490

8. RECOMMENDED TYPE OF CONTRACT:
☐ FIXED PRICE ☐ OTHER
☐ COST REIMBURSEMENT
☒ SPECIAL RESEARCH SUPPORT AGREEMENT (SRSA)

9. PROPERTY TITLE TO VEST IN:
☐ AEC
☐ CONTRACTOR

10. SECURITY CLASSIFICATION:
UNCLASSIFIED
Work to be performed is under category ____
as defined by AEC Manual Appendix 3401.

11. PROJECT TITLE
Transport of Radionuclides in Water (Model River and Ecological System)

12. HEADQUARTERS TECHNICAL CONTACT
Chief, Environmental and Sanitary Engineering Branch, Division of Reactor Development and Technology

13. FINANCING

A. OPERATING EXPENSES

New AEC Funds (Initial AEC Support ceiling, if SRSA) . . . . . $ 60,000

Estimated AEC Balance From Prior Term, if any . . . . . $ ____

Total AEC Funding (If SRSA, ____% of Total Cost, up to Maximum of) . . . . . $

Estimated Contractor Contribution, if any . . . . . $ ____

Total Estimated Project Cost . . . . . $ ____

Budget and Reporting Classification:
Allotment Transfer:

B. PLANT AND CAPITAL EQUIPMENT . . . . . $

Budget and Reporting Classification:

Allotment Transfer:

14. SPECIAL PROVISIONS AND INSTRUCTIONS:

The technical aspects of the proposed work have been reviewed and are approved. A need currently exists for the results of the research or other work that is to be undertaken. None of the AEC funds shall be used to confer a fellowship.

Please keep us informed as to any problems encountered in your negotiations, as well as the date of execution of this contract and the amount of funds obligated. If the budget as negotiated differs substantially from that in the proposal, please forward a copy of the revised budget to Headquarters.

If not already submitted, a 200-word summary of the proposed work should be forwarded by the contractor as soon as possible after negotiation of the contract.

See attached 11A.

Contractor should be requested to prepare a revised cost estimate reflecting the University's contribution on basis of a $60,000 program. Two copies of such estimate should be forwarded to the Management Services Branch, RDT.

15. SCOPE OF WORK See attached 11A.

Attachments:
Form 11A
Proposal

CONTRACTS — 490 (Texas)

~~110660~~

OCT 31 1969

1138781

FORM 11-A

DIVISION OF REACTOR DEVELOPMENT AND TECHNOLOGY

RECOMMENDATION FOR CONTRACT AUTHORIZATION

1. PROPOSED CONTRACTOR: University of Texas
Austin, Texas

2. PROJECT TITLE: TRANSPORT OF RADIONUCLIDES IN WATER (MODEL RIVER AND ECOLOGICAL SYSTEM)

3. RECOMMENDATION TO:

[X] ACCEPT UNSOLICITED PROPOSAL AS BASIS FOR NEGOTIATION OF CONTRACT:

PROPOSAL NO. Renewal Proposal for period 10/1/69 to 9/30/70 DATED 5/1/69 As amended by letter 7-15-69.

[ ] AWARD CONTRACT WITHOUT SOLICITING PROPOSALS FROM OTHERS

4. RECOMMENDATION RELATED TO:

[ ] NEW PROJECT

[X] INCREASE IN SCOPE OR COST OF PROJECT PREVIOUSLY AUTHORIZED:

PREVIOUSLY AUTHORIZED PER FORM 11-A DATED:

CONTRACTED FOR BY CONTRACT NO. AT(11-1)-490 P.A. NO. _____

5. PROGRAM DESCRIPTION AND JUSTIFICATION--SEE ANNEX "A"

6. CONTRACTUAL JUSTIFICATION--SEE ANNEX "B"

7. SCOPE OF WORK FOR CONTRACT--SEE ANNEX "C"

70 002

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8. PROJECT COST ESTIMATE:

	OPERATING COSTS	EQUIPMENT OBLIGATIONS	TOTAL COSTS
ESTIMATED COST OF WORK RECOMMENDED IN ANNEX "A":			
FY 70	60,000	-0-	60,000
FY			
FY			
FY			
TOTALS	60,000		60,000
ESTIMATED COST OF ANY FURTHER WORK, FOR WHICH FUTURE AUTHORIZATIONS WILL BE NECESSARY, TO COMPLETE ENTIRE PROJECT:			
FY			
FY			
FY			
TOTALS			
COSTS PREVIOUSLY AUTHORIZED ON PROJECT: FROM 10/1/61 TO 9/30/69	333,911		333,911
TOTAL ESTIMATED COST OF ENTIRE PROJECT	393,911		393,911
9. ESTIMATE OF FUNDS TO BE INITIALLY OBLIGATED IN CONTRACT	60,000		60,000

[X] THIS AMOUNT IS TO FUND THE ENTIRETY OF THE WORK RECOMMENDED IN ANNEX "A".

[ ] THIS AMOUNT IS TO FUND ONLY A PART OF THE TOTAL PROJECT RECOMMENDED IN ANNEX, "A", SPECIFICALLY THE FOLLOWING PERIOD OR TASKS:

10. FUNDS FOR ITEM 9 PROVIDED TO FIELD OFFICE AS FOLLOWS:

Cost ceiling in the amount of $60,000 is provided in current financial plan for Oak Ridge Operations Office.

Costs are to be charged to B&R # 04 60 40 01.

1138183

N. E. Pilch 4a.
CHIEF, PROGRAM BRANCH

9/30/69
Date

11. COSTS CHARGEABLE TO BUDGET ACTIVITY: OPERATING 04 60 40 01 ; EQUIPMENT

12. TYPE OF CONTRACT:

[ ] CPFF [ ] COST REIMBURSEMENT [ ] LUMP SUM [ ] FIELD OFFICE DETERMINATION

[ ] COST SHARING (STATE SHARING ARRANGEMENTS ON REVERSE) [X] OTHER: SPECIAL RESEARCH SUPPORT AGREEMENT

13. TERM OF CONTRACT:

[X] CONTRACT TO CONTAIN NO FIXED TERM, BUT TO OBLIGE CONTRACTOR TO INITIATE PROMPTLY AND USE BEST EFFORTS TO COMPLETE BY September 30, 1970

[ ] CONTRACT TO SPECIFY REQUIRED COMPLETION DATE OF _____

[ ] CONTRACT TO BE FOR PERIOD OF _____ MONTHS, STARTING _____

14. TITLE TO EQUIPMENT:

TO VEST IN [ ] AEC OR [ ] CONTRACTOR, EXCEPT AS FOLLOWS:

N/A

15. TECHNICAL REPORTING REQUIREMENTS:

	Category Designation*	No. of Copies for RDT Hqs.	No. of Copies for Field Office**
INFORMAL TECHNICAL PROGRESS LETTER - MONTHLY	NONE		
R&D PROGRESS REPORT - QUARTERLY	NONE		
R&D SUMMARY REPORT - ANNUAL	NONE		
R&D TOPICAL REPORTS (LIST ON REVERSE)	UC-70	10	
R&D FINAL REPORT	UC-70	10	

* CONTRACTOR TO MAKE STANDARD DISTRIBUTION PER TID-4500 OR M-3679 FOR CATEGORY DESIGNATION SHOWN, OR PROVIDE REPRODUCIBLE MASTERS TO DTIE FOR SUCH DISTRIBUTION.

** TO BE DETERMINED BY FIELD OFFICE, UNLESS NUMBER HERE SPECIFIED.

[ ] CONTRACTOR TO MAKE ADDITIONAL SPECIAL DISTRIBUTION, AS FOLLOWS:

DRAFT OF [X] ANNUAL [ ] FINAL REPORT TO BE SUBMITTED TO RDT FOR REVIEW.

REPORT TO BE ISSUED 30 DAYS AFTER RDT APPROVAL OF DRAFT.

[ ] FIELD OFFICE TO EVALUATE REPORTS AND PROVIDE COMMENTS AND RECOMMENDATIONS (INCLUDING FUTURE WORK) TO RDT.

1138784

Topical Reports Requirements

1. A computer program describing the transport and retention of radionuclides in a freshwater system.

2. A comparison of a predicted and m easured radionuclides transport and retention in a real river system.

3. The description of organically bound tritium and tritium oxide in the biota of flowing and non-flowing freshwater systems.

1138785

16. PATENT PROVISIONS:

☐ CLAUSE REQUIRED (A-B-C): A ☐ CLAUSE TO BE DETERMINED BY FIELD.

☐ BACKGROUND RIGHTS TO BE OBTAINED AS FOLLOWS:

17. OTHER CONTRACTUAL DATA:

Highest priority is to be assigned to the application of the mathematical model for the prediction of the transport of radionuclides released from a nuclear power plant site.

Such work is to be completed and reported upon by September 30, 1970.

THE PROPOSER'S COST ESTIMATE HAS NOT BEEN SUBJECTED TO FINANCIAL REVIEW IN HEADQUARTERS. CONSEQUENTLY, THE AMOUNTS SHOWN IN ITEMS 8 AND 9 ABOVE ARE SUBJECT TO ADJUSTMENT BY THE FIELD OFFICE BASED ON ITS REVIEW OF THE COST ESTIMATE IN THE COURSE OF NEGOTIATING THE CONTRACT, EXCEPT AS FOLLOWS:

18. CLASSIFICATION CATEGORY: Unclassified
(IF CLASSIFIED, SHOW HERE CONCURRENCE OF DIVISION OF CLASSIFICATION:

_____)

19. FIELD OFFICE TO NEGOTIATE AND ADMINISTER CONTRACT: Oak Ridge

20. RDT TECHNICAL POINT OF CONTACT: Environmental and Sanitary Engineering Branch

21. ☐ RDT PARTICIPATION IN CONTRACT NEGOTIATION IS DESIRED, AS FOLLOWS:

1138786

ANNEX "A"

PROGRAM DESCRIPTION AND JUSTIFICATION

Knowledge of the behavior of radionuclides released to freshwater environments particularly the transport, retention and movement throughout the biota is important to the proper siting, design and operating control of nuclear power stations. Research work at the University of Texas on the model river has provided much useful radionuclide transport information. Also considerable information has been gained through operating experience at Oak Ridge, Savannah River, Hanford and at commercial nuclear power stations. There remains a need to incorporate this information into a form that can be used to predict the behavior of radionuclides at a given location prior to the release of these radionuclides to the environment and to demonstrate the accuracy of such a prediction technique. The first step, i.e. the development of a computer program, was completed at the University of Texas this summer. The next step is to verify the program by predicting transport and comparing with field measurements at a location where radionuclides are being released into a river system. It is anticpated that a nuclear power plant location will be selected from which field data are already and will continue to be available thus minimizing the field work required by University of Texas of personnel. The contractor is highly qualified to perform this work and has an excellent record of performance on previous AEC sponsored work.

1138787

ANNEX "B"

CONTRACTUAL JUSTIFICATION

The work outlined in this unsolicited proposal is the result of original ideas and concepts developed by the principal staff of the University of Texas commencing in 1961 and is not in response to a solicitation by AEC made to the contractor.

The work included in this proposal does not duplicate research already in process or contemplated by AEC, and supplements the Nuclear Safety research efforts being carried out at PNL, ANL, ORNL.

In view of the preceeding and the unusual expertise of the Principal Investigator (Dr. E. F. Gloyna) as well as the availability of previously developed facilities and computer codes, it is recommended that the proposed one year extension of this program be approved.

1138788

ANNEX "C"

SCOPE OF WORK FOR CONTRACT

The scope for work

Apply the computer program of the model river and ecosystem developed under work previously supported by the AEC to an actual river or river system and to the discharge from selected nuclear power stations. In particular:

1. Adaptation of existing computer programs to predict detention and transport of radionuclides in water, sediments and biomass of streams.

2. Application of the computer program to predict the transport of radionuclides released from a nuclear power reactor into a selected reach of a stream.

3. Continuation of long-term, steady state experiments, using the model river system for prediction of factors and coefficients needed for computer program under various environmental conditions of selected streams.

4. Generalization of the computer program for prediction of transported radionuclides in river systems from current or future planned nuclear power stations.

5. Evaluation of the uptake and retention of organically bound tritium and tritium oxide by biota in flowing and non-flowing systems; and incorporation of the uptake and release coefficients obtained into the program describing radionuclide transport. Measurement of equilibrium rates for tritium in biota and sediments will be investigated. Such measurements will include the retention and movement of tritium through plankton rooted plants and small fish.

1138789

X

USAEC
F. CLARK HUFFMAN, ACTING CHIEF
REACTOR CONTRACTS BRANCH
LABORATORY AND UNIVERSITY DIVISION
OAK RIDGE, TENNESSEE

XX

Original signed by
F. CLARK HUFFMAN

F. CLARK HUFFMAN, ACTING CHIEF

NOV 3 1969

DR. E. F. GLOYNA
DEPT. OF CIVIL ENGINEERING
ENGINEERING LAB.BLDG.
UNIV. OF TEXAS
AUSTIN, TEXAS

INFO: JENS N. JACOBSEN
EXECUTIVE DIRECTOR
OFFICE OF SPONSORED PROJECTS
UNIV. OF TEX.
AUSTIN, TEXAS

WE HAVE AUTHORIZATION TO EXTEND CONTRACT NO. AT-(11-1)-490 THROUGH SEPTEMBER 30, 1970, WITH AEC FUNDS IN AMOUNT OF $80,000. PLEASE SUBMIT REVISED BUDGET ASAP BASED ON APPROVED FINANCING. PLEASE HAVE INFO SUBMITTED ENDORSED BY APPROPRIATE ADMINISTRATIVE OFFICIAL OF UNIV. OLE:LN -02

RECEIVED
ORO-AE
TELETYPE
NOV 3 11 18 AM 1969
BY

0 7312

CONTRACTS — 490 (Texas)

FROM ▶ Ser. Br. LN:slc	Reac. Cont. Br.				
SURNAME ▶ 3-4388	D Huffman				
DATE ▶ 10-31-69	11/3/69				

Form AEC-318 (Rev. 3-1-59) AECM 0240 ☆ U. S. GOVERNMENT PRINTING OFFICE: 1968 O-320-507

1138190

THE UNIVERSITY OF TEXAS AT AUSTIN
OFFICE OF SPONSORED PROJECTS
AUSTIN, TEXAS 78712

Post Office Box 7726
AC 512, 471-1353

November 7, 1969

U. S. Atomic Energy Commission
Laboratory and University Division
Post Office Box E
Oak Ridge, Tennessee 37830

Attention: Dent C. Davis, Jr.

Subject: Proposal for Renewal of Contract AT-(11-1)-490, submitted by E. F. Gloyna on June 25, 1969

Gentlemen:

At Dr. Gloyna's request we are submitting herewith a revised budget for use with the subject proposal.

Very truly yours,

Jens Jacobsen
Executive Director

JJ:cr
Enclosure

cc: E. F. Gloyna

CONTRACTS — 490 Texas

110995

NOV 12 1969

1138791

BUDGET

The estimated costs are $60,000 under a lump-sum contract. The duration of this particular project and funding period is estimated at one year, October 1, 1969, to September 30, 1970, inclusive.

		Total
SALARIES AND WAGES		$42,624.00
(Salaries paid from Government contract funds at The University of Texas at Austin conform to the rates approved by the Board of Regents for salaries paid from regular University funds.)		
Dr. E. F. Gloyna, Principal Investigator (10% Academic year and 100% for two summer months)*	$ 5,556.00	
Dr. Y. Yousef, Assistant Project Director and Research Engr.-Sci. (100% of time)	11,000.00	
Dr. F. Masch, Professor of Civil Engineering, Modeling Speciality (5% Academic year and 100% for one summer month)	1,778.00	
Dr. Allen White, Research Engr.-Sci., Computer Specialist (100% of time)	10,000.00	
Nuclear Chemist (100% for ten months)	10,000.00	
One Graduate Research Assistant (50% of time)	3,090.00	
Research Analyst, Typist, etc. (25% of time)	1,200.00	
MATERIALS, SERVICE, AND EQUIPMENT		5,300.00
(This item includes the operation of the flume, purchase of test equipment, expendable materials, minor equipment items, and occasional services of others not included in Salaries and Wages.)		
Computer (10 hrs @ $300.00/hr)	3,000.00	
Chemicals and Glassware	500.00	
Computer cards and paper	500.00	
Publications, Drafting, etc.	1,300.00	
TRAVEL		1,000.00
(Transportation expense of persons engaged in the work, including transportation by plane or rail and Pullman, or by private car at an allowance of not to exceed 10¢ per mile in lieu of actual expense, plus per diem on the quarter-day basis.)		

1138792

OPTIONAL FORM NO. 10
GSA-101

L+4

UNITED STATES GOVERNMENT

Memorandum

TO : Milton Shaw, Director, Division of Reactor Development & Technology, HQ.

DATE: JULY 18, 1969

FROM : Herman M. Roth, Director
Laboratory and University Division, OR

SUBJECT: RENEWAL OF CONTRACT NO. AT-(~~40-1)~~ (11-1)-490 WITH UNIVERSITY OF TEXAS

OLE:LM

Reference is made to our memorandum of July 9, 1969, submitting the renewal proposal and progress report under the subject contract.

We are enclosing for your information and use copies of the following listed documents submitted by the institution in connection with renewal of the contract:

[ ] Revised Budget

[ ] Financial Statement

[ ] Endorsement of Proposal

[ ] 200-Word Summary

[ ] Request for Additional Funds

[X] Letter dated July 15, 1969, to W. J. Larkin from E. F. Gloyna (4 copies)

Herman M Roth
Herman M. Roth

Enclosure(s):
ltr dtd 7-15-69 fr EFG to WJL (4 cys.)

ADMIN.SER.BR. L&U DIVISION
MEDLEY:FEF
JULY 18, 1969

Med
Exp

CONTRACTS — 490 (Tex.

0 4955 1138793

THE UNIVERSITY OF TEXAS
COLLEGE OF ENGINEERING
AUSTIN, TEXAS 78712

Department of Civil Engineering
Environmental Health Engineering
Engineering Laboratories Building 305

July 15, 1969

Dr. W. J. Larkin, Chief
Reactor Contracts Branch
Laboratory and University Division
Oak Ridge Operations
U. S. Atomic Energy Commission
P. O. Box E
Oak Ridge, Tennessee 37830

Dear Dr. Larkin:

In response to conversations which we have had on the telephone with the Washington Office, AEC, we would like to ammend our proposal to include the following task and budget increases.

Task

It is proposed to evaluate the uptake and retention of organically bound ^3H and tritium oxide biota in nonflowing and flowing ecosystems. Following this study the transport of tritium will be monitored in a model river system. Finally, the uptake and release coefficients describing the transport of tritium through an ecosystem will be incorporated into the overall transport model.

Measurement of equilibrium rates for tritium in biota and sediments will be investigated. Such measurements will include the retention and movement of tritium through plankton, rooted plants, and small fish.

Dr. Kwie, Ph.D., Organic Chemistry, has had experience in some work of this type. He is a member of our research faculty and will be personally involved in this study.

The precise methodology has not been decided upon, but the model ecosystems and flumes presently being used in this project will be made available for the tritium effort.

Budget

It is estimated that the overall budget must be increased from about $52,000 to $60,000.

Sincerely,

CONTRACTS - 40 (Tex.

Earnest F. Gloyna
Project Director

EFG:st

cc: Mr. Craig Roberts
Dr. W. W. Kwie
Mr. Jens Jacobson

A 7135

JUL 17 1969

1138194

L&C file

UNITED STATES
ATOMIC ENERGY COMMISSION

OAK RIDGE OPERATIONS
P.O. BOX E
OAK RIDGE, TENNESSEE 37830

AREA CODE 615
TELEPHONE 483-8611

July 9, 1969

Milton Shaw, Director, Division of Reactor Development and Technology, Headquarters

RENEWAL OF CONTRACT NO. AT-(40-1) (11-1)-490 with THE UNIVERSITY OF TEXAS AT AUSTIN

We are submitting for your review and appropriate action the following information concerning the contract which will expire on September 30, 1969:

1. Renewal Proposal (4)
2. Progress Report (4)
3. Financial Statement (4)
4. 200-Word Summary (3)

We shall appreciate your advising us of your decision so that we may proceed with the necessary contract action at the earliest possible date.

Herman M. Roth

Herman M. Roth, Director
Laboratory and University Division
Oak Ridge Operations

OLE:LM

Enclosures:
As Listed Above

DC: R. L. Sharman, DTIE
w/cy of Progress Rpt.
M. J. Larkin, w/cy of enclosures
D. S. Zachry, w/cy of Progress Rpt.
Alice Brown

ADMIN.SER.BR.
REDLEY:FEF
JULY 9, 1969

Redley

CONTRACTS - 490 (Texas)

Q 4696

1138795

THE UNIVERSITY OF TEXAS AT AUSTIN
OFFICE OF THE PRESIDENT
AUSTIN, TEXAS 78712

President

June 25, 1969

U. S. Atomic Energy Commission
Laboratory and University Division
Post Office Box E
Oak Ridge, Tennessee 37830

Attention: Dr. W. J. Larkin, Jr.
Chief
Reactor Contracts Branch

Subject: Contract AT-(11-1)-490

Gentlemen:

We are pleased to transmit six copies of Dr. Earnest F. Gloyna's proposal for renewal of his AEC research contract AT-(11-1)-490. This proposal has the approval of cognizant officials of the University.

Further information relating to the technical portions of this proposal may be obtained from Dr. E. F. Gloyna, Department of Civil Engineering, The University of Texas at Austin. Contractual matters should be referred to Mr. Jens Jacobsen, Executive Director, Office of Sponsored Projects, The University of Texas at Austin, Post Office Box 7726, Austin, Texas 78712.

Very truly yours,

Norman Hackerman

NH:ss
Enclosures: 6 cys proposal
OK 7 cys progress report
4 cys summary

cc: Dr. E. F. Gloyna

CONTRACTS — 4 cs

A 6479
JUN 27 1969

1138796

SI-SIE-78a

PUBLICATION BY AEC AUTHORIZED ☐

NOTICE OF RESEARCH PROJECT
SCIENCE INFORMATION EXCHANGE
SMITHSONIAN INSTITUTION

U.S. ATOMIC ENERGY COMMISSION

SIE NO.

AEC CONTRACT NO.

SUPPORTING DIV. OR OFFICE:

NAME & ADDRESS OF CONTRACTOR OR INSTITUTION: (State the division, department, or professional school, medical, graduate or other, with which this project should be identified.)

Environmental Health Engineering Laboratories
Department of Civil Engineering
The University of Texas at Austin
Austin, Texas 78712

TITLE OF PROJECT:

Transport of Radionuclides in Water (Model River and Ecological System)

NAMES, DEPARTMENT, AND OFFICIAL TITLES OF PRINCIPAL INVESTIGATORS AND OTHER PROFESSIONAL SCIENTIFIC PERSONNEL: (not including graduate students) engaged on the project, and fraction of man-year devoted to the project by each person.

E. F. Gloyna, Prof., CE - Princp. Invest. - 100% - 2 mo.; 10% - 9 mo.
F. Masch, Prof., CE - 100% - 1 mo.; 5% - 9 mo.
Y. Yousef, Asst. Proj. Dir. and Res. Eng. - 100% - 12 mo.
A. White, Computer Spec. - 100% - 12 mo.

NO. OF GRADUATE STUDENTS ON PROJECT: 2 NO. OF GRADUATE STUDENT MAN-YEARS: Each student 50% of tim

SUMMARY OF PROPOSED WORK: (200-300 words, omit Confidential Data). Summaries are exchanged with government and private agencies supporting research, are supplied to investigaters upon request, and may be published in AEC documents. Make summaries substantive, giving initially and for each annual revision the following: OBJECTIVE; SCIENTIFIC BACKGROUND FOR STUDY; PROPOSED PROCEDURE; TEST OBJECTS AND AGENTS.

(SEE CONTINUATION PAGE 1)

RESULTS TO DATE:

During FY 69 the transport of radionuclides in rivers was simulated using a rough mathematical model. The prediction model was partially verified through the use of the test flume (model river) for batch releases of ^{85}Sr.

A mathematical model was developed describing the migration of radionuclides into sediments.

	PROGRAM CATEGORY NO.
BUDGET	
PRIMARY	
SECONDARY	

Signature of Principal Investigator

DATE:

INVESTIGATOR – DO NOT USE THIS SPACE

1138797

SUMMARY OF PROPOSED WORK

It is proposed to:

1. Adapt the existing computer programs so that the model river and ecosystem data can be used to predict retention and transport of radionuclides in water, sediments, and biomass;

2. Apply the derived experimental data to a field problem or to a hypothetical nuclear power plant and stream system;

3. Relate the transport of radionuclides released from nuclear power reactors to mathematical models;

4. Establish a planning program for field verification;

5. Initiate a planning program for the application of prediction models on whole river systems as applicable to the Federal Power Commission's concept of nuclear power reactor requirements;

6. Continue evaluation of uptake and release characteristics of Zn, Co and Ru; and

7. Conduct long-term, steady state experiments, for verification purposes, using the model river system.

1138798

Form 189a Issue
12/1/67

Schedule 189a
Justification for Operating Costs & Equipment Obligations
For Reactor Development Programs

Ident. No.
OMIT
Col. 2-6

Oak Ridge Operations Office
Field Office or Laboratory

June 1, 1969
Date

1. Budget Activity No. 04 60 40 01 1 (1) Col. 7-17	2. Office OR Col. 18-20	3. Project Title Transport of Radionuclides in Water (Model River and Ecological System) Co. 21-80
4. Method of Reporting 1. Monthly 2. Quarterly 3. Semi Annual 4. Annual 5. Other		5. Person in Charge Principal Investigator E. F. Gloyna

6. Contractor	7. Working Location-City	8. State	9. Type	10. Contract	11. Task
Univ. of Texas	Austin	Tex	1. Industry [ ] 2. AEC Lab [ ] 3. Educational [X] 4. Government [ ] 5. Other Non Profit [ ]	0490	NA
(2) Col. 7-26	Col. 27-43	Col. 44-47	Col. 48	Col. 49-52	Col. 53-57

12. Reactor Application	13. Coolant	14. Division	15. Lead Branch	16. PPB Identification
1. Conv. CP [ ] 2. Adv. Conv. CP [ ] 3. Fast Breeder CP [ ] 4. Space Electric [ ] 5. Space Propulsion [ ] 6. Ship Propulsion [ ] 7. Terr. Low Power [ ] 8. Other [X]	1. Water [ ] 2. D_2O [ ] 3. Gas [ ] 4. Liq. Metal [ ] 5. Salt [ ] 6. Other [X]	1. RDT [X] 2. SNS [ ] 3. NR [ ]	NS-ES	1. Central Station [ ] 2. Military [ ] 3. Space [ ] 4. Other Civilian [ ] 5. Nuclear Support [X] Col. 66
Col. 58	Col. 59	Col. 60	Col. 61-65	17. Materials Code [ ] Col. 67-74

18. Contract Term-Begin	19. Contract Term-End	20. Termination Date of Funding
Month Day Year From 10 01 68	Month Day Year From 09 30 69	Month Day Year 09 30 70
Col. 7-12	Col 13-18	Col. 19-24

21. Man Years	FY 1969 (PY)	FY 1970 (CY)	FY 1971 (BY)
Scientific	4	4	4
Other Direct	1	1	1
Total Direct (No Fractions)	5	5	5
(3)	Col. 25-83	Col. 29-32	Col. 33-36
22. Costs			
a) Direct Salaries	26,250	37,300	37,300
b) Materials & Services	7,084	6,500	6,500
c) Subcontracts	0	0	0
d) Irradiation & Unit Costs	0	0	0
Total Direct Costs	33,334	43,800	43,800
e) Indirect Costs	6,666	8,760	8,760
f) Fee	0	0	0
Total Costs (In Thousands)	40,000	52,560	52,560
	Col. 37-45	Col. 46-54	Col. 55-63

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Schedule 189a (Continued)

23. Goods & Services on Order (In Thousands) (4)	FY 1969 (PY)	FY 1970 (CY)	FY 1971 (BY)
	0 Col. 7-13	0 Col. 14-19	Col. 20-25
24. Equipment a) B&R Classification	0 Col. 26-36	0	
b) Equipment Obligations (In Thousands)	0 Col. 37-41	0 Col. 42-46	Col. 47-51
c) Equipment Costs (In Thousands)	0 Col. 52-56	0 Col. 57-61	Col. 62-66

25. Project Cost and Development Schedule

NOT APPLICABLE

26. Dates and Title of Publications (Other than Progress Reports)

a) Armstrong, N. E. and E. F. Gloyna, "Mathematical Models for the Dispersion of Radionuclides in Aquatic Systems", Proceedings of the 2nd National Symposium on Radioecology, Ann Arbor, Michigan, pp. 329-335, May 15-17, 1967.

b) Shih, C. S. and E. F. Gloyna, "Influence of Sediments on the Transport of Solutes", Presented at the American Society of Civil Engineers' National Meeting on Environmental Engineering, Chattanooga, Tennessee, May 13-17, 1968. (Publication pending.)

c) Shull, R. D., and E. F. Gloyna, "Transport of Dissolved Wastes in Rivers", Presented at the American Society of Civil Engineers' National Meeting on Water Resources Engineering, New Orleans, Louisiana, February 3-7, 1969. (Publication pending.)

27. Scope

The contractor will continue to conduct research directed toward development of a mathematical prediction model which can be used to predict the transport of radionuclides produced by nuclear power reactors through aquatic systems.

Experimentation shall include: (Annex I, Work Plan, page 8)

1. Adaptation of existing computer programs so that the model river and ecosystem data can be used to predict retention and transport of radionuclides in water, sediments, and biomass;

2. Apply the derived experimental data to a field problem or to a hypothetical nuclear power plant and stream system;

3. Relate the transport of radionuclides released from nuclear power reactors to mathematical models;

4. Establish a planning program for field verification;

Schedule 189a (Continued)

27. Scope (Continued)

5. Initiate a planning program for the application of prediction models on whole river systems as applicable to the Federal Power Commission's concept of nuclear power reactor requirements;

6. Continue evaluation of uptake and release characteristics of Zn, Co and Ru; and

7. Conduct long-term, steady state experiments, for verification purposes, using the model river system.

28. Relationship to Other Federally Financed Projects

The model river study is related to the problems associated with nuclear power plant development. The project is related to full scale river studies on the Columbia River being carried out by the U. S. Geological Survey and the Pacific Northwest Laboratory and the completed Clinch River study conducted at ORNL. This project is related to the OWRR Project at The University of Texas which proposes to study aeration and reaeration of model river systems. Furthermore, the project is applicable to any new study involving the location of a nuclear facility on any watershed.

29. Technical accomplishments in FY 1969

During FY 69 the transport of radionuclides in rivers was simulated using a rough mathematical model. The prediction model was partially verified through the use of the test flume (model river) for batch releases of ^{85}Sr.

The delay in transport of radionuclides caused by the interaction of Cesium-137 between flowing water and bed sediments was investigated. The greatest uptake rate, K_{st}, by bed sediment was 88.7×10^{-4} [(cpm/cm^2)/(cpm/cm^3)]/sec with a velocity of 1.65 fps and a flow rate of 0.345 cfs/ft. In this case the sediment transport rate was 0.0795 lbs/sec/ft.

A mathematical model was developed describing the migration of radionuclides into sediments. The relative concentration of radionuclides on the surface of bottom sediments to that in bed sediments was found to be a function of depth, diffusion coefficient and time after migration started.

Dissolved oxygen sag curves and the diurnal variation of dissolved oxygen were determined, in the research flume, under a variety of organic loads and hydraulic conditions. Milk and domestic sewage were used as organic pollutants. Photosynthesis and respiration rates were calculated.

30. Expected results in FY 1970

The major effort will be directed to the adaptation of existing computer programs to a useful predictive model. The objective will be to predict retention and transport of radionuclides in water, sediments and biomass in model river systems. Coefficients will be established for steady state conditions. The experimental data will be applied to hypothetical field conditions where nuclear power plants are or will be located.

31. Expected results in FY 1971

By 1971 it will be possible to apply the prediction model to a section of some selected stream. Possibly a stream in South Carolina will be chosen.

32. Expected results beyond budget year

The project will be continued.

Schedule 189a (Continued)

33. Description and Justification of Major Materials, Subcontract Items and other unusual significant cost items.

Materials & Services	FY 1966	FY 1967	FY 1968	FY 1969	FY 1970	FY 1971*
Supplies	2,000	2,000	4,000	4,000	1,000	1,000
Report Preparation	1,500	1,500	1,500	1,500	1,500	1,500
Decontamination	1,000	1,000	834	834	0	0
Computer Time	1,500	500	500	500	3,000	3,000
Flume Repairs, Mod.	1,500	500	250	250	0	0
Total	7,500	5,500	7,084	7,084	5,500	5,500

*FY 1971 Budget will depend on selected site for field studies.

34. Description and Justification of all equipment items

No AEC capital equipment will be purchased.

35. Special Reactor Materials Requirements

None

36. Irradiated Material Reprocessing

None

37. Irradiation Services Budget. .6, irradiation units

None

38. Proposed Obligations for Related Construction Projects, if any

None

A Proposal to

The United States Atomic Energy Commission

TRANSPORT OF RADIONUCLIDES IN WATER

(MODEL RIVER AND ECOLOGICAL STUDIES)

The University of Texas
Department of Civil Engineering
ENVIRONMENTAL HEATLH ENGINEERING
Austin, Texas 78712

Submitted by
Earnest F. Gloyna
Professor of Civil Engineering
(Environmental Health Engineering)

May 1, 1969

1138803

Proposal to the Atomic Energy Commission
From The University of Texas
For Funds to Support Research on

Transport of Radionuclides in Water
(Model River and Ecological Studies)

for the period
October 1, 1969 - September 30, 1970

ABSTRACT

This is a request from The University of Texas for a cooperative lump-sum contract in the amount of $52,560.00 for the period October 1, 1969 - September 30, 1970, inclusive. Present contract No. AT(11-1)-490 expires September 30, 1969.

The most recent technical reports and papers have described the simulation of sustained releases to selected river environments, effects of organic pollution and the role of organic pollution and oxygen balance in transport.

An overall evaluation study is now in progress. A final summary report for the entire contract period will be completed by September 30, 1969. This report will summarize the previously issued technical reports and research efforts.

Future studies proposed include: (1) adapt existing computer programs so that the model river data can be used to effectively predict retention and transport of radionuclides in water, sediments, and biomass; (2) apply the derived experimental data to hypothetical or field situations; (3) relate the transport of radionuclides released from nuclear power reactors to mathematical models; (4) establish planning program for field verification; (5) initiate planning program for the application of prediction models on whole river systems as defined by the Federal Power Commission; (6) continue checking the uptake and release characteristics of ^{65}Zn, ^{58}Co and ^{103}Ru; and (7) conduct long-term, steady state studies using the model river.

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SUMMARY OF RESEARCH UNDER
TRANSPORT OF RADIONUCLIDES IN WATER SERIES
THROUGH FY 1968

Extensive research has been undertaken on the behavior of radionuclides in rivers. Experiments have involved both the development of physical and mathematical models. Analytical and numerical solutions to differential equations have been developed which assist in predicting the transport of pulses (unsteady state) of radionuclides through a model river. This, combined with a thorough study of a real river system involving Sr and Cs led to the development of a conceptual model which illustrates the importance of various environmental stresses on the transport and detention of radionuclides. Through these studies and model development, considerable insight has been gained regarding the possible behavior of radionuclides in river systems. The expense and effort has been much less than that required to conduct full-scale river experiments.

Quarterly reports were submitted regularly. Topical reports were submitted as specific phases of the project were completed. Since most of the phases of this project were associated with either master's or doctoral research projects, topical reports were published as the faculty approved the thesis or dissertation.

Titles of reports exclusive of those released during FY 1969 are listed below:

1. Reynolds, T. D. and E. F. Gloyna, Radioactivity Transport in Water--Transport of Strontium and Cesium by Stream and Estuarine Sediments, Technical Report No. 1 to the U.S. Atomic Energy Commission, 117 pp., (June, 1963).

2. Patterson, C. C. and E. F. Gloyna, Radioactivity Transport in Water--The Dispersion of Radionuclides in Open Channel Flow, Technical Report No. 2 to the U.S. Atomic Energy Commission, 87 pp., (June, 1963).

3. Story, A. H. and E. F. Gloyna, Radioactivity Transport in Water--Environmental Behavior of Nitrosylruthenium, Technical Report No.3 to the U.S. Atomic Energy Commission, 89 pp., (June, 1963).

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4. Bolch, W. E. and E. F. Gloyna, Radioactivity Transport in Water--Behavior of Ruthenium in Algal Environments, Technical Report No. 4 to the U.S. Atomic Energy Commission, 55 pp., (September, 1963).

5. Rowe, D. R. and E. F. Gloyna, Radioactivity Transport in Water--The Transport of Zn^{65} in an Aqueous Environment, EHE-09-6403, Technical Report No. 5 to the U.S. Atomic Energy Commission, 101 pp., (September, 1964).

6. Clanton, U. S. and E. F. Gloyna, Radioactivity Transport in Water--Sorption and Release of Radionuclides by Sediments of the Guadalupe River, EHE-10-6404, Technical Report No. 6 to the U.S. Atomic Energy Commission, 64 pp., (July, 1964).

7. Yousef, Y. A. and E. F. Gloyna, Radioactivity Transport in Water--The Transport of Co^{58} in an Aqueous Environment, EHE-12-6405, Technical Report No. 7 to the U.S. Atomic Energy Commission, 121 pp., (December, 1964).

8. Copeland, B. J. and E. F. Gloyna, Radioactivity Transport in Water--Structure and Metabolism of a Lotic Community, Part I (April-July, 1964), EHE-02-6501, Technical Report No. 8 to the U.S. Atomic Energy Commission, 51 pp., (February, 1965).

9. Bhagat, S. K. and E. F. Gloyna, Radioactivity Transport in Water--Transport of Nitrosylruthenium in an Aquatic Environment, EHE-11-6502, Technical Report No. 9 to the U.S. Atomic Energy Commission, 144 pp., (November, 1965).

10. Shih, C. S. and E. F. Gloyna, Radioactivity Transport in Water--Transport of Sr^{85} and Cs-137 in an Aquatic Environment, EHE-01-6602, Technical Report No. 10 to the U.S. Atomic Energy Commission, 97 pp., (January, 1966).

11. Canter, L. W. and E. F. Gloyna, Radioactivity Transport in Water--Transport of CR-51 in an Aqueous Environment, EHE-04-6701, Technical Report No. 11 to the U.S. Atomic Energy Commission, 241 pp., (May, 1967).

12. Shih, C. S. and E. F. Gloyna, Radioactivity Transport in Water--Mathematical Model for the Transport of Radionuclides, EHE-04-6702, Technical Report No. 12 to the U.S. Atomic Energy Commission, 179 pp., (June, 1967).

13. Purushothaman, K. and E. F. Gloyna, Radioactivity Transport in Water--Transport of ^{85}Sr and ^{137}Cs Under Induced Clay Suspensions, EHE-12-6701, Technical Report No. 13 to the U.S. Atomic Energy Commission, 120 pp., (January, 1968).

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14. Armstrong, N. E. and E. F. Gloyna, Radioactivity Transport in Water--Numerical Solutions of Radionuclide Transport Equations and Role of Plants in SR-85 Transport, EHE-12-6703, Technical Report No. 14 to the U.S. Atomic Energy Commission, 139 pp., (December, 1967).

15. Shull, R. D. and E. F. Gloyna, Radioactivity Transport in Water--Simulation of Sustained Releases to Selected River Environments, EHE-04-6801, Technical Report No. 15 to the U.S. Atomic Energy Commission, 237 pp., (May, 1968).

16. Futagawa, K. and E. F. Gloyna, Radioactivity Transport in Water--Effects of Organic Pollution on Radionuclide Transport, EHE-04-6803, Technical Report No. 16 to the U.S. Atomic Energy Commission, 61 pp., (May, 1968).

SUMMARY OF RESEARCH FY 1968 - FY 1969

The following reports were prepared and will be submitted to AEC prior to September, 1969:

1. Kudo, Akira and E. F. Gloyna, Radioactivity Transport in Water -- Interaction Between Flowing Water and Bed Sediment, EHE-69-03, CRWR-36, Technical Report No. 17 to the U. S. Atomic Energy Commission, 152 pp., (January, 1969).

The purpose of this research was to determine the delay in transport of radionuclides caused by the interaction between flowing water and bed sediments. This interaction phenomenon for cesium-137 was observed by using a set of flumes, each 50 feet in length and a model river which was 200 feet long.

The greatest uptake rate, Kst, by bed sediment was 88.7 x 10^{-4} [(cpm/cm^2)/(cpm/cm^3)]/(sec) with a velocity of 1.65 fps and a flow rate of 0.345 cfs/ft. In this case the sediment transport rate was 0.0795 lbs/sec-ft.

A mathematical model was developed describing the migration of radionuclides into the sediments. The relative concentration of radionuclides on the surface of the bottom sediments to that in the bed sediment was found to be a function of $z/(2\sqrt{Dt})$, where z,

1138807

D, and t, respectively, are the depth of bed sediment from the surface, diffusion coefficient of Cesium-137 in water, and time after migration started.

2. Patterson, C. C., Kudo, Akira, Eller, J. M. and E. F. Gloyna, Radioactivity Transport in Water -- The Role of Organic Pollution and Oxygen Balance in Transport, EHE-69-09, CRWR-42, Technical Report No. 18 to the U.S. Atomic Energy Commission, 49 pp., (May, 1969).

The ecological environment of a river system was simulated with a research flume. Dissolved oxygen sag curves and the diurnal variation of dissolved oxygen were determined under a variety of organic waste loads and hydraulic conditions. Powdered milk was used as the pollutant.

Photosynthesis less respiration was calculated from dissolved oxygen and inorganic carbon data. Net photosynthesis to nighttime respiration ratios were calculated at five points throughout the length of the flume. Respiration rates were also calculated with the use of respirometers and BOD reduction data.

The following report is now in preparation and will be submitted to the Atomic Energy Commission prior to October, 1969:

Yousef, Y. A. and E. F. Gloyna, Radioactivity Transport in Water -- Summary Contractual Report, Technical Report No. 19 to the U.S. Atomic Energy Commission (To be released October, 1969).

SCIENTIFIC SCOPE AND OBJECTIVES

Data need to be adapted to existing computer programs in order to predict the transport of radionuclides released from a hypothetical nuclear power plant into a selected stream.

To achieve the objectives certain continuation experiments and evaluation techniques will be conducted:

1. Adaptation of existing computer programs to predict detention and transport of radionuclides in water, sediments and biomass of streams through the use of data obtained from model river and ecosystem studies.

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2. Application of the computer program to predict the transport of radionuclides released from a nuclear power reactor into a selected reach of a stream. If it is not possible to locate a river whereby a modest test can be conducted or where assistance can be obtained in developing the test, a hypothetical river problem will be solved.
3. Continuation of long-term, steady state experiments, using the model river system for prediction of factors and coefficients needed for computer program under various environmental conditions of selected streams.
4. Generalization of the computer program for prediction of transported radionuclides in river systems from current or future planned nuclear power stations.

The Work Plan in Annex I, page 8, relates the proposed work for FY 1970 to previous studies and future field applications.

The major efforts as outlined above are depicted in the work plan. At least two topical reports will be developed for FY 1970.

PERSONNEL

The Principal Investigator will be E. F. Gloyna; Assistant Project Investigator will be Dr. Y. A. Yousef; Research Engineer-Scientist, Computer Specialist will be Dr. Allen White.

Advisers from areas other than those actively participating in the Environmental Health Engineering program will be Dr. B. J. Copeland, Assistant Professor, Institute of Marine Science; Dr. F. Masch, Associate Professor, Coastal Engineering and Hydraulics; Dr. H. Bold, Professor of Botany.

Research Assistants will be part-time faculty and graduate students. Additional staff will include electronics repairman, programmers, and general help.

In addition to acting as an Advisor to this project, Dr. Masch will spend 5% of the academic year and 100% time of one month (summer) in active research on this project.

1138809

ANNEX I

WORK PLAN

Radioactivity Transport in Water -- APPLICATIONS OF MODEL RIVER AND ECOSYSTEM DATA TO

← Previous	Proposed		
Model River - Ecosystem and Ecological Studies	Application of Prediction Models		
	Model River Verification	Stream Verification	River System Verification
	"Adaptation of Model Data to Existing Computer Programs and (Flume) Verification"	"Apply Transport Model to a Selected River Environment"	"Apply Prediction Models to Complete River Systems"
AT(11-1)-490	FY 1970	FY 1971	FY 1972
Total of 18 Topical Reports 1. Dispersion Studies 2. Uptake and release of Sr, Co, Zn, Cs, Ru, Cr on Biomass, and sediments 3. Lab., Ecosystem, and Model River Performance	Adapt Existing Computer Programs into prediction model → 1/1/70 Topical Report Apply Experimental Data to Hypothetical or Field Condition → Relate Transport to Nuclear Power Reactor Releases → Planning Effort for FY 1971 Initiate Planning for FY 1972 Con't. Zn, Co, Ru uptake & release Steady State Experiments Topical Report (7/1/70)	Application to Section of Selected Stream (Possibly Stream in South Carolina) (Topical Report)	Field Demonstration on River Basin
	pt. 30, 1969 t. 1, 1969	ct. 1, 1970	ct. 1, 1971

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Complete biographical information is included for Dr. E. F. Gloyna, Dr. F. Masch, Dr. Y. A. Yousef, and Dr. Allen White. (See Attachments 1-4.)

OTHER FINANCIAL ASSISTANCE

Students holding fellowships supported by U.S. Public Health Service, National Science Foundation, Federal Water Pollution Control Administration, etc., may participate in this project, and their thesis or dissertation research may be included in various reports. Otherwise, no other agency except The University of Texas is contributing to the support of this research project.

MATERIALS, EQUIPMENT, AND FACILITIES

By January 1, 1970 a $500,000.00 Water Resources Research Facility will be completed. It will be located adjacent to the present radionuclide transport project.

All of the research centers and research laboratories at The University of Texas are part of the graduate program. These laboratories and facilities are, in part, made available for acquainting science and engineering students with radiochemical techniques and the problems of radioactive waste treatment and disposal.

Most of the laboratory equipment, as well as utilities, will be furnished by The University of Texas.

Some of the available equipment consists of data acquisition units, spectrophotometers, electron microscopes, X-ray diffraction machines, a 512-channel gamma spectrometer, an electrometer for counting gaseous and liquid samples, a variety of window and windowless proportional flow counters, a gas flow proportional counting system, and an automatic low-level beta counter.

A flume has been constructed at the Balcones Research Center Laboratories that is being used as a model for evaluating radionuclide movement. This site was chosen because there are several large existing tanks that can be made available for this study. These tanks were formerly used as settling tanks. They vary in size from 50 feet to 150 feet in diameter and are about 8 feet deep.

1138811

The tanks can be used to grow aquatic organisms in sufficient quantities to conduct realistic experiments in the flume. Also, adequate shelter is available adjacent to the tanks for laboratory and instrumentation storage.

The Environmental Health Engineering Research Laboratories are available for this work, as well as those in the Department of Civil Engineering. Other scientific groups on the campus of The University of Texas are available for consultation.

1138812

BUDGET

The estimated costs are $52,560.00 under a lump-sum contract. The duration of this particular project and funding period is estimated at one year, October 1, 1969, to September 30, 1970, inclusive.

		Total
SALARIES AND WAGES		$35,800.00
(Salaries paid from Government contract funds at The University of Texas conform to the rates approved by the Board of Regents for salaries paid from regular University funds.)		
Dr. E. F. Gloyna, Principal Investigator (10% Academic year and 100% for two summer months)*	$ 4,500.00	
Dr. F. Masch, Professor of Civil Engineering, Modeling Speciality (5% Academic year and 100% for one summer month)	1,800.00	
Dr. Y. Yousef, Assistant Project Director and Research Engr.-Sci. (100% of time)	12,000.00	
Dr. Allen White, Research Engr.-Sci., Computer Specialist (100% of time)	10,000.00	
Two Graduate Research Assistants (50% time each)	5,000.00	
Research Analyst, Typist, etc. (50% of time)	2,500.00	
MATERIALS, SERVICE, AND EQUIPMENT		5,500.00
(This item includes the operation of the flume, purchase of test equipment, expendable materials, minor equipment items, and occasional services of others not included in Salaries and Wages.)		
Computer (10 hrs @ $300.00/hr)	$ 3,000.00	
Chemicals and Glassware	500.00	
Computer cards and paper	500.00	
Publications, Drafting, etc.	1,500.00	
TRAVEL		1,000.00
(Transportation expense of persons engaged in the work, including transportation by plane or rail and Pullman, or by private car at an allowance of not to exceed 10¢ per mile in lieu of actual expense, plus per diem not to exceed $16.00 per day on the quarter-day basis.)		

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BUDGET (Con'd)

	Total
INSURANCE . . . . . (Workmen's Compensation Insurance coverage, as may be required by University regulations under the University's self-insuring plan; plus Federal Social Security.)	$ 1,500.00
INSTITUTIONAL OVERHEAD AND INDIRECT COSTS**. . . . (Shared rate of 20% of all costs exclusive of overhead.)	8,760.00
TOTAL REQUESTED FROM AEC	$52,560.00

*Estimated Project Director for nine months is about $2,500.00. Also, graduate students who are on traineeships are not included in the cost contribution because the amount is not known presently. In the past, one or more such students have made contributions to the project. These efforts are equivalent to about one full time employee.

The current University provisional overhead rate is 32.3% of salaries and wages.

The University's contribution to the project is the difference between 20% of total direct costs and the audited indirect cost rate of 32.3% of salaries and wages $2,803.00

ADMINISTRATIVE INFORMATION

The University of Texas represents: (a) that it has not employed or retained any company or person (other than a full-time bona fide employee working solely for The University of Texas) to solicit or secure this contract and (b) that it has not paid or agreed to pay to any agency or person (other than a full-time bona fide employee working solely for The University of Texas) any fee, commission, percentage or brokerage fee, contingent upon or resulting from the award of this contract; and agrees to furnish information relating thereto as may be requested by the Contracting Officer.

Further information relating to the technical portions of this proposal may be obtained from Dr. E. F. Gloyna, Engineering Laboratories Building 305, Department of Civil Engineering (Environmental Health Engineering), The University of Texas, Austin, Texas 78712, telephone GReenwood 1-5602. Non-technical administrative and contractual matters should be referred to the University's Office of Sponsored Projects, Post Office Box 7726, Austin, Texas 78712, telephone GReenwood 1-1353.

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FINANCIAL STATEMENT

Category	Total Project Allowances	Expenditures to Date	Estimated Expenditure	Expected Balance at Expiration of Contract
Personnel	23,960.00	13,068.58	10,891.42	-0-
Travel	1,500.00	420.13	1,079.87	-0-
OASI and WCI	1,290.00	146.04	1,143.96	-0-
Other Expenses	6,584.00	5,196.38	1,387.62	-0-
Indirect	6,666.00	3,766.23	2,899.77	-0-
		22,597.36	17,402.64	-0-

The University's contirbution to the project through June 30, 1969, is estimated at $2,583. For the period July 1, 1969 through September 30, 1969, the University's contribution will be $860.00.

Original Signed By
Earnest F. Gloyna
Principal Investigator

ORIGINAL SIGNED BY
NORMAN HACKERMAN

Norman Hackerman, President
The University of Texas at Austin

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ATTACHMENT 1

September, 1968

BIOGRAPHICAL DATA SKETCH

Name: Earnest F. Gloyna

Title: Professor of Civil Engineering (Environmental Health Engineering)
Director, Center for Research in Water Resources
Director, Environmental Health Engineering Research Laboratories
The University of Texas at Austin, Austin, Texas 78712

Born: [redacted] Texas

Education: [redacted]

Honors: Tau Beta Pi; Sigma Xi; Chi Epsilon; Phi Kappa Phi; Honorary Member, Southwestern Society of Nuclear Medicine; The Harrison Prescott Eddy Medal, Water Pollution Control Journal (1959); Water Resources Division Award, American Water Works Journal (1959); American Men of Science; Who's Who in the Southwest; Who's Who in Atoms, International (1961); Who's Who in Engineering (1962); Leaders in American Science (1962); Dictionary of International Biography (1963-65); Who's Who in American Education (1963-64); World Who's Who in Science (1966); Tex. Soc. ASCE Paper Award (1968)

Membership in Professional Organizations:

National Society of Professional Engineers
American Institute of Chemical Engineers
American Society of Civil Engineers
American Association of Professors in Sanitary Engineering
American Water Works Association
Water Pollution Control Federation
Diplomate, American Academy of Sanitary Engineers, The American Environmental Engineering Intersociety Board
American Society for Engineering Education
U.S.-Mexico Border Public Health Association

Publications: Over 150

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ATTACHMENT 1

Dr. E. F. Gloyna September, 1968

Consultantships and Significant Assignments:

Select Committee on National Water Resources, U.S. Senate; U.S. Public Health Service; U.S. Air Force; U.S. Army; World Health Organization; Pan American Health Organization
50 Major Industries
20 State and Local Agencies

EXPERIENCE

Teaching: Professor of Civil Engineering, The University of Texas at Austin, 1959 - present
Associate Professor, The University of Texas, 1953 - 1959
Lecturer, Postgraduate School of Medicine, Department of Industrial Medicine, The University of Texas Medical School, Galveston, Texas, 1954 - 1960
Assistant Professor, The University of Texas, 1949 - 1953 (incl. a two-year leave of absence)
Instructor, The University of Texas, 1946 - 1949

Courses Taught:

Graduate	Undergraduate
Properties of Water, Water Supply and Treatment	Water Supply and Wastewater Disposal
Water Quality Improvement	Water Resources: Hydraulics
Advanced Laboratory, Water Quality Measurement and Process Control	Water Resources: Industrial Waste Treatment
Advanced Water and Air Analysis	Air Resources: Industrial Hygiene
Advanced Design of Water and Wastewater Systems	Design of Water and Wastewater Systems
Advanced Municipal Sanitation	Environmental Health and Sanitary Laboratory
Vector-Borne Disease Control	Highway Engineering
Radiological Health	Surveying
Administration of Municipal Public Works	
Research Seminar - Water Resources, Air Resources, and Environmental Health	
Thesis	
Dissertation	

Non-Teaching Professional Experience:

Consultant to numerous industrial organizations and governmental agencies on water and air resources as well as radiation control

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ATTACHMENT 1

Dr. E. F. Gloyna September, 1968

PUBLICATIONS

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14. Results of Wastewater Treatment Survey, Report to Stagecoach Inn, Salado, Texas, 17 pp. (April 1967).

15. Report on Biological Waste Treatment, with D. L. Ford, Report to the Pure Oil Company, Smiths Bluff Refinery, Nederland, Texas, 52 pp. (March 1967).

16. Report on Biological Waste Treatment, with D. L. Ford, Report to Atlantic-Richfield Company, Atreco Refinery, Port Arthur, Texas, 58 pp. (May 1967).

17. A Survey of Waste Disposal, with A. H. Ullrich, Report to Copropiedad Electrica Grupo Quimico, Monterrey, Nuevo Leon, Mexico, 66 pp. (July 1967).

18. A Report on Biological Waste Treatment for the Merichem Company, Houston, Texas, with D. L. Ford and N. K. Burleson, Center for Research in Water Resources, The University of Texas at Austin (1968).

1138834

ATTACHMENT 1

Dr. E. F. Gloyna

PARTIAL LIST OF CONSULTANTSHIPS

1. Amarillo, City of
2. Army Chemical Center, Nuclear Defense Laboratory
3. Atlantic Richfield
4. Brackenridge Hospital, Austin
5. Bryant-Curington Consulting Engineers
6. Convair (General Dynamics Corporation)
7. Dallas Power and Light Company
8. El Paso Products
9. Engineering-Science, Inc.
10. Esso Research & Engineering
11. Forrest and Cotton Consulting Engineers
12. Goodyear Rubber Company
13. Graphite Corporation of America
14. Guadalupe - Blanco River Authority
15. Gulf Oil Corporation
16. Humble Oil and Refining Company
17. Hundley and Halff Engineers
18. International Paper Company
19. Jefferson Chemical Company
20. Los Alamos Scientific Laboratory
21. Magnolia Petroleum Company
22. The Merichem Company
23. Monsanto Chemical Company
24. Morton Salt Company
25. Neches Butane
26. Northern Natural Gas
27. Pan American Oil
28. Pan American Sanitary Bureau, World Health Organization
29. Pittsburg Plate Glass Company
30. Pure Oil Company
31. San Marcos, City of
32. Shell Oil Company
33. Shreveport, City of
34. Southwestern Graphite
35. State Hospital, Austin
36. Tracor, Inc.
37. Turner, Collie & Braden
38. U. S. Public Health Service, Radiological Health Division
39. U. S. Public Health Service, Water Resources Division
40. U. S. Senate
41. World Health Organization

1138835

ATTACHMENT 2

BIOGRAPHICAL DATA

Name: Frank D. Masch

Title: Professor of Civil Engineering

Address: Department of Civil Engineering
The University of Texas at Austin
Austin, Texas 78712 Phone: (AC 512) 471-1375

Birthdate: [redacted]

Education: [redacted]

Honors: Tau Beta Pi; Chi Epsilon; Sigma Xi; National Science Foundation, Science-Faculty Fellowship; Engineering Foundation Faculty Improvement Grant, 1963-64; Listed in Who's Who in South and Southwest and Leaders in American Science; Who's Who in Texas Today; Texas Section ASCE, Technical Paper Award, 1966; Texas Section ASCE, John B. Hawley Award, February, 1967;

Membership in Professional Societies:
American Society of Civil Engineers; American Geophysical Union; International Association for Hydraulic Research; American Society for Engineering Education; American Society for the Advancement of Science; Registered Professional Engineer (Texas)

Professional and Technical Society Assignments:
Chairman, Task Committee on Erosion of Cohesive Materials, Sedimentation Committee, Hydraulics Division, American Society of Civil Engineers, 1961-
Chairman, Civil Engineering Division Committee No. 5, Applied Hydraulics, American Society for Engineering Education, 1962-65
Council on Wave Research, The Engineering Foundation, 1962-64
Coastal Engineering Research Council, American Society of Civil Engineers, 1964-

1138836

ATTACHMENT 2

Secretary, Waterways and Harbors Technical Group, Texas Section, American Society of Civil Engineers, 1961-68

Vice-Chairman, Waterways and Harbors Technical Group, Texas Section, American Society of Civil Engineers, 1968-

Technical Activities Committee, Austin Branch, American Society of Civil Engineers

Director, Civil Engineering Division, American Society of Engineering Education, 1966-68

Tidal Hydraulics Committee, Hydraulics Division, American Society of Civil Engineers, 1965-

Committee on Education and Research in Hydrology, Universities Council on Water Resources, 1968-

EXPERIENCE

Teaching:

Instructor of Civil Engineering, The University of Texas, 1955-59

Teaching Associate, University of California, Berkeley, 1959-60

Assistant Research Engineer, University of California, Berkeley, 1961-62

Assistant Professor of Civil Engineering, The University of Texas, 1962-64

Associate Professor of Civil Engineering, The University of Texas, 1964-68

Professor of Civil Engineering, The University of Texas, 1968-

Chairman, College of Engineering, Ocean Engineering Program, The University of Texas, 1968-

Graduate Courses Taught:

Coastal Engineering, River Hydraulics and Sediment Transport, Ground Water Hydrology, Special Studies in Civil Engineering, Seminar, Thesis, Dissertation

Undergraduate Courses Taught:

Fluid Mechanics, Hydraulics, Hydraulic Machinery, Hydraulics Laboratory, Testing Materials, Surveying

1138837

ATTACHMENT 2

Research: Research Engineer, Hydraulic Engineering Research, University of Illinois, 1957-59

Assistant Research Engineer, Ocean Outfalls Project, Division of Hydraulic and Sanitary Engineering, University of California, Berkeley, 1961-62

Scour of Cohesive Sediments, University of Texas Research Institute, 1962-63

Drag Forces in Velocity Gradient Fields, David Taylor Model Basin, U. S. Department of Navy, 1962-64

Cnoidal Waves, U. S. Army Corps of Engineers, Coastal Engineering Research Center, 1962-64

Wind Wave Overtopping of Shoreline Structures, Bureau of Engineering Research, University of Texas, 1963-64

Effects of Urbanization on Storm Runoff from Small Watersheds, Texas Water Commission, 1964-65

Current and Sediment Movement in Galveston Bay, Texas Parks and Wildlife Department, 1964-65

Performance of Circular Culverts on Steep Grades, Texas Highway Department, 1965-

Mixing and Dispersion of Contaminants in Reservoirs, U. S. Public Health Service, F. W. P. C. A., 1965-

Toledo Bend Model Study, Forrest and Cotton Consulting Engineers, 1965-65

De Cordova Bend Dam Model Study, Ambursen Engineering Corp, 1966-67

Relation of Pass Openings on Physical Exchange and Salinity in Estuaries, The Office of Water Resources Research, Department of the Interior, 1968-

Horizontal Dispersion in Shallow Estuaries of Irregular Shape, Office of Water Resources Research, Department of the Interior, 1967-

Selective Withdrawal at Lake Livingston, Office of Water Resources Research, Department of the Interior, 1968-

Consulting: C. W. Osborn, Calibration of Pilot Tubes for Irrigation Well Installation, 1958

Erickson and Vandertulip Consulting Engineers, Austin, Texas. Drought Studies on Trinity River Basin and Backwater Studies near San Marcial, New Mexico, 1959.

Santa Fe Railway Company, Western Lines, Amarillo, Texas, Scour Study on the Red River, 1962

Beach Erosion Board, Washington, D. C., Waves in Shoaling Water, 1962-64

Austin Country Club, Austin, Texas, Evaluation of Watering Distribution System, Water Well Drilling, Pump Test and Pump Selection, 1963

1138838

ATTACHMENT 2

Gage Brothers General Contractors, San Antonio, Texas, Damage at Galveston Oil Well from Wave Overtopping During Hurricane Cindy, 1963-64

Forrest and Cotton Consulting Engineers and Sabine River Authorities of Texas and Louisiana, Hydraulic Model Studies on Spillway Section of Toledo Bend Dam, 1964

Signal Oil Co., Wave and Vessel Motion of Signal Oil - Le Tourneau Offshore Rig No. 26, 1965

Texas Water Development Board and Bryant-Currington, Inc., Austin, Texas, Return Flows and Physical Exchange in Texas Embayments, 1965

Brown and Root Construction Co., Houston, Texas, Bryan Beach Development Site Wave Study, 1966

Ambursen Engineering Corp., Houston, Texas, and Brazos River Authority, Hydraulic Model Studies of De Cordova Bend Dam Outlet Works, 1966

Ray A. Pinnell, Jr., Consulting Structural Engineer, San Antonio, Texas. Wind Loads and Development of Shape Factor for Hemisfair Tower, 1966

Tracor, Inc., Austin, Texas, Ocean Science and Water Resources, 1967

Urban Engineering Co., Corpus Christi, Texas, Padre Island Seawall Development, 1968

1138839

ATTACHMENT 2

PUBLICATIONS

"Discussion of Tractive Resistance of Cohesive Channels," Jour. Soil Mech. and Found. Div., Proceedings, Am. Soc. Civ. Engr., Vol. 86, No. SM 2, April 1960.

"Streamlines in a Lucite Water Tunnel", Civil Engineering, Vol. 30, No. 4, April 1960.

"Drag Forces in Velocity Gradient Flow," (With W. L. Moore), Jour. Hyd. Div., Proceedings, Am. Soc. Civ. Engr., Vol. 86, No. HY 7, July 1960; Transactions, Am. Soc. Civ. Engr., Vol. 128, Part I, (paper No. 3394), 1963.

"Cnoidal Waves - Tables of Functions," (with R. L. Wiegel), Council on Wave Research, The Engineering Foundation, Berkeley, California, Copyright, 1961.

"Non-Linear Tidal Flows and Electrical Analogs," (with J. A. Harder) Jour. Waterways and Harbors Div., Proceedings, Am. Soc. Civ. Engr., Vol. 87, No. WW 4, November 1961.

"Experiments on the Scour Resistance of Cohesive Sediments," (with W. L. Moore), Jour. of Geophysical Research, Vol. 67, No. 4, April 1962.

"Discussion of Waste Disposal in Streams and Lakes," Proceedings Second Annual Industrial Water and Waste Conference, Texas Water Pollution Control Federation, The University of Texas, Austin, Texas, June 1962.

"Mixing and Dispersion of Waste by Wind and Wave Action," International Jour. Air and Water Pollution, Vol. 7, Nos. 6/7, August 1963. Waste Disposal Symposium, London, England, Vol. 3, Pergamon Press, June 1964.

"The Influence of Secondary Flows on Local Scour at Obstructions in Channels," (with W. L. Moore), Proceedings Federal Inter-Agency Sedimentation Conference, 1963, Agricultural Research Service, Miscellaneous Publication No. 970, pp. 314-19.

"Measurements of the Shear Resistance of Cohesive Sediments," (with W. H. Espey, Jr. and W. L. Moore), Proceedings, Federal Inter-Agency Sedimentation Conference, 1963, Agricultural Research Service, Miscellaneous Publication No. 970, pp. 151-55.

"Membrane Analogy Studies Employing Visible Contour Lines," (with R. L. Thoms), Proceedings, Southeastern Conference on Theoretical and Applied Mechanics, Atlanta, Ga., March 1964, Vol. 2, pp. 545-55.

"Cnoidal Waves in Shallow Water," Proceedings Ninth Conference on Coastal Engineering, Lisbon, Portugal, June 1964, Chap. 1, pp. 1-22.

1138840

ATTACHMENT 2

"Silt" Dredging and Erosion in Navigative Sedimentation," Coastal Engineering Chapter Meetings (Jointly Conference), American Society of Civil Engineers, Chapter 15, October 1965, pp. 377-[illegible].

"Abbreviated Bibliography on Erosion of Cohesive Materials," Task Committee on Erosion of Cohesive Materials, Committee on Sedimentation, Frank L. March, Chairman, Journal of the Hydraulics Division, Proceedings, American Society of Civil Engineers, Vol. 92, No. HY 2, March 1966, pp. 243-89.

"Study of Some Effects of Urbanization on Storm Runoff from a Small Watershed," (with W. H. Espey, Jr. and C. W. Morgan), Texas Water Development Board, Rep. 23, August 1966, pp. 110.

"Some Effects of Urbanization on Design Flood Criteria for Small Watersheds," (with W. H. Espey, Jr., and C. W. Morgan), Symposium on Consideration of Some Aspects of Storms and Floods in Water Planning, Texas Water Development Board, Rep. 33, Nov. 1966, pp. 137-154.

"Grain Size Distribution and Its Effect on the Permeability of Unconsolidated Sands" (with K. J. Denny), Water Resources Research, American Geophysical Union, Vol. 2, No. 4, 1966, pp. 665-677.

"Relationship Between the Physical and Biological Environments," (with Joe R. Wilson) Advances in Water Quality Improvement, Water Resources Symposium, No. 1, University of Texas Press, 1968, pp. 103-110.

"Discussion of Dredging Fundamentals," Journal of the Waterways and Harbors Division, Vol. 94, No. WW 2, May 1968, Proceedings, ASCE, pp. 258-266.

"Scour of Cohesive Sediments," F. D. Masch, Chairman, et. al. Committee on Sedimentation, Task Committee on Erosion of Cohesive Materials, Journal Hydraulics Division, Proceedings, ASCE, Vol. 94, No. HY 4, July, 1968.

1138841

ATTACHMENT 2

REFERENCES

"Wave Deflection of Cohesive Sediments," Bureau of Engineering Research, Report, The University of Texas, September 1959.

"Cnoidal Waves - Complete Tables of Functions for Theories of Korteweg-Petersen and Korteweg-De Vries," Available on Loan from The Council on Wave Research, The University of California, Richmond 4, California and The University of Texas Engineering Library, September, 1960.

"Tables of Jacobian Elliptic Functions," Available on Loan from The Council on Wave Research, The University of California, Richmond 4, California and The University of Texas Engineering Library, September 1960.

"Mixing and Dispersive Action of Wind Waves," Inst. Engr. Res. Tech. Rep., Series 138, Issue 6, University of California, Berkeley, California, November 1961.

"Observations on Vertical Mixing in a Closed Wind Wave System," Inst. Engr. Res. Tech. Rep., Series 138, Issue 7, University of California, Berkeley, California, January 1962.

"Wave Characteristics in Shoaling Water," Report to the Beach Erosion Board, U. S. Corps of Engineers, November 1962.

"A Study of Wave Heights at the Galveston Sea Wall as Influenced by Lowering of the Toe Protection," (with Walter L. Moore), February, 1963.

"Hydraulic Research Summary," First Annual Research Conference for Industrial Associates, College of Engineering, The University of Texas, March 1963.

"A Discussion of the Developing Role of Computers in Civil Engineering Education," Annual Meeting ASEE, Philadelphia, Pennsylvania, June 1963.

"Wave Action and Damage at the Galveston Sea Wall Resulting from Defective Toe Protection," (with Walter L. Moore), November 1963.

"Drag Forces in Velocity Gradient Fields," (with Charles Dalton), Hydraulic Engineering Laboratory, Tech. Rep. No. HYD 04-6401, The University of Texas, Austin, Texas, April 1964.

"Application of Cnoidal Wave Theory to the Transformation of Long Waves," Hydraulic Engineering Laboratory, Tech. Rep. No. HYD 05-6401, The University of Texas, Austin, Texas, June 1964.

"Progress Report on Current and Sediment Movement in Galveston and Trinity Bays," Hydraulic Engineering Laboratory, Tech. Rep. No. HYD 06-6501, The University of Texas, Austin, Texas, January 1965.

1138842

ATTACHMENT 2

"A Study of Some Effects of Urbanization on Storm Runoff From a Small Watershed," (with W. H. Espey, Jr., Carl W. Morgan) Tech. Rep. to the Texas Water Development Board, Tech. Rep. HYD 07-6501, CRWR-2, July 1965.

"The Influence of Secondary Flows on Drag Forces," (with Charles Dalton), Hydraulic Engineering Laboratory, Tech. Rep. HYD 04-6505, The University of Texas, Austin, Texas, July 1965.

"Spillway Model Studies - Toledo Bend Dam," (with Walter L. Moore), Tech. Rep. to Forrest and Cotton, Inc., Center for Research in Water Resources, Hydraulic Engineering Laboratory, Tech. Rep. HYD 08-6501, CRWR-6, The University of Texas, Austin, Texas, October 1965.

"Mudshell Dredging - A Factor in Sedimentation in Galveston Bay," Center for Research in Water Resources, Hydraulic Engineering Laboratory, Tech. Rep. HYD 06-6502, CRWR-7, The University of Texas, Austin, Texas, November 1965.

"Return Flows - Impact on the Texas Bay Systems," (with H. W. Curington, Dan M. Wells, B. J. Copeland and E. F. Gloyna, Tech. Rep. to the Texas Water Development Board, Bryant-Currington, Inc., Austin, Texas, January 1966.

"Model Studies - De Cordova Bend Dam Outlet Works Energy Dissipator," (with Carl W. Morgan and Walter L. Moore), Tech. Rep. to Brazos River Authority, Center for Research in Water Resources, Hydraulic Engineering Laboratory, HYD 09-6701, CRWR-16, The University of Texas, Austin, Texas, March 1967.

"Field Investigation of Mixing and Dispersion in a Deep Reservoir," (with Joe R. Wilson), Hydraulic Engineering Laboratory, Tech. Rep. HYD 10-6701, The University of Texas, Austin, Texas, June, 1967.

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ATTACHMENT 2

[illegible]

[illegible]

Honors: Listed in Dictionary of International Biography

Membership in Professional Societies:
International Oceanographic Society; American Society of Oceanography; Beach and Shore Preservation Society

Professional and Technical Assignments:

Task Committee on Evaluation of Influences of Sedimentation as a Factor in Water Quality, Sedimentation Committee, Hydraulics Division, American Society of Civil Engineers, 1968-

Chairman, Committee on Mixing and Dispersion Galveston Bay Water Quality Management Study - Planning Study.

Panel on Mans Effects on Gulf of Mexico, Gulf Universities Research Corporation, 1968.

Experience:

Teaching:
Advisory Committee, Center for Research in Water Resources, University of Texas at Austin.

Consulting: Padre Island Investment Corporation and Urban Engineering Company, Prediction of Storm Tides in Corpus Christi Bay and Laguna Madre, 1969.

Texas Electric Corp., Suggestions for Development of Numerical Models for the Temperature Structure in Inland Cooling Waters. 1969.

Texas Water Quality Board and Tracor, Inc., Development of Mathematical Models for Tidal Hydraulics and Transport Processes, Galveston Bay Water Quality Management Study 1968-

Texas Water Quality Board and Tracor, Inc., Preparation of Specifications for Physical Model Tests at U. S. C. E. Waterways Experiment Station on Galveston Bay Model.

1138844

ATTACHMENT 2

REPORTS

"Hydrodynamic and Transport Models for Galveston Bay - Recommended Models and Model Structure," Technical Report to Texas Water Quality Board and Tracor, Inc., August 1968, 48 pp.

"Galveston Bay Study - Phase I, Technical Report Summary" (with Espey, et al), Report to Texas Water Quality Board, October 1968, 35 pp.

"Galveston Bay Study - Phase I, Technical Report" (with Espey, et al), Report to Texas Water Quality Board, October 1969, 200 pp.

"Design Considerations for the Padre Island Sea Wall," Technical Report to Urban Engineering Company, February 1968, 46 pp.

"A Numerical Model for the Simulation of Tidal Hydraulics in Shallow Irregular Estuaries," (with Shankar, et al), Technical Report HYD 12-6901, Hydraulic Engineering Laboratory, The University of Texas at Austin, February 1969, 123 pp.

PUBLICATIONS

"Effects of Small Structures on Water Yield in Texas," (with S. P. Sauer), Proceedings, Conference on Effects of Watershed Changes on Streamflow, Water Resources Symposium, No. 2, University of Texas Press, 1969.

"Influence of Secondary Flow on Drag Force" (with C. Dalton), Journal of the Engineering Mechanics Division, Proceedings, American Society of Civil Engineers, Vol. 94, No. EM 5, October 1968, pp. 1249-1257.

1138845

ATTACHMENT 3

BIOGRAPHICAL DATA

NAME: Y. A. Yousef

DATE OF BIRTH: [redacted]

BIRTH PLACE: [redacted] Egypt

NATIONALITY: U. A. R.

DEGREES OBTAINED: [redacted]

HONORARY SOCIETIES: U. A. R. Engineering Syndicate
Sigma Xi
Chi Epsilon

EXPERIENCE: Since April, 1965 working with:

a. Head of Protection Engineering Division in the Radiation Protection Dept., U. A. R. A. E. E. and in charge of Radioactive waste management, Decontamination, Transportation of Radioactive Material and Radiation Protection Regulations and training progr[illegible]

b. Teaching for two years in the University of Alexandria on subject of Health Physics.

c. Teaching for one year in the University of Assuit on subject of water supply and public health engineering.

d. Working with the General Egyptian Establishment for Public Utilities in Technical Research.

From August 1960 until March 1965, working for my Ph.D. degree and part time Research Assistant in The University of Texas [illegible]

From June 1952 until August, 1960, working as Civil Engineer in the U. A. R. Ministry of Irrigation in charge of surveying, levelling, planning, designing and executing irrigation projects such as canals, barrages and bridges.

PUBLICATIONS: Co-author in:

1. "Coliform in Waste Stabilization Ponds," Thesis, The University of Texas, January, 1962.
2. "The Transport of ^{60}Co in an Aqueous Environment," The University of Texas, Ph.D. Dissertation, January, 1965.

1138846

ATTACHMENT 3

Y. A. Yousef

PUBLICATIONS: (Con'd) 3. "United Arab Republic Programme for Management and Treatment of Low and Intermediate Level Radioactive Waste," Symposium on Practices in the Treatment of Low and Intermediate-Level Radioactive Wastes, SM-71/67., I.A.E.A., Vienna, (Dec. 5-10, 1965).

4. "Transport of Radionuclides in a Model River," Symposium on Radioactive Wastes Into Seas, Oceans and Surface Waters, SM-72/2, I.A.E.A., Vienna, (1966).

5. Behavior of Certain Radionuclides in The Aquatic Ecology of Ismailia Canal," Annual Report Submitted to I.A.E.A., Research Contract No. 422/RB, (1st Oct. 1966-30th Sept. 1967).

6. I.b.I.d., Research Contract No. [illegible], (1st Oct. 1967-30th Sept. 1968). In print.

7. "Affinity of Ismailia Canal Bottom Sediments for Certain Radionuclides," J. of Isotope and Radiation Research, Vol. 1 No. 1, Published by Middle Eastern Regional Radioisotope Center, Cairo, U. A. R. (1968). In print.

1138847

ATTACHMENT 4

BIOGRAPHICAL DATA

NAME: William A. White

TITLE: Research Engineer-Scientist

DATE OF BIRTH: [redacted]

EDUCATION: [redacted]

HONORS: Chi Epsilon, Sigma Xi

AWARDS: U.S. Public Health Service Traineeship, 1966-1968

PROFESSIONAL AFFILIATIONS:

American Society of Civil Engineers
American Geophysical Union
Texas Water Pollution Control Association

EXPERIENCE: 1964-1966 - Research Engineer Scientist, The University of Texas

1968-Date - Research Engineering Scientist, The University of Texas, Consulting Engineer

PUBLICATIONS:

1. "Controlled Investigations of the Movement of Dredge Sediments as a Density Current," - Master's Thesis
2. "Thermal Structure in Inland Cooling Ponds" (Publication Pending), American Geophysical Union.
3. "Circulation in Shallow Estuaries" (Publication Pending), American Geophysical Union.
4. "A Numerical Model for the Simulation of Tidal Hydraulics in Shallow Irregular Estuaries," (with Masch et al), Technical Report HYD 12-6901, Hydraulic Engineering Laboratory, The University of Texas at Austin, February, 1969, 123 pp.

1138848

AUG 8 1969

Dr. Earnest F. Gloyna, Director
Environmental Health Engineering
Engineering Laboratories Building 306
The University of Texas
Austin, Texas 78712

PROPOSED FOREIGN TRAVEL - CONTRACT NO. AT-(11-1)-490

Dear Dr. Gloyna:

This will confirm Mr. William Adams' telephone message of August 5, 1969.

Forms AEC-445 covering your proposed travel to France during September 1969 were forwarded to the Director, Division of Reactor Development and Technology, AEC Headquarters, for consideration on June 23, 1969.

We have been advised that, due to the drastic curtailment of foreign travel funds and because RDT did not consider that there was sufficient programmatic interest in the conference at Cadarache to justify your participation at AEC expense, the request was disapproved.

Sincerely,

Original signed by
William D. Adams

for F. Clark Huffman
Acting Chief
Reactor Contracts Branch
Laboratory and University Division

OLE:LAF

CONTRACTS-490 (Texas)
For. Trav

Q 5499

	Adm. Ser. Br.	Reactor Contracts				
SURNAME ▶	Fuller:kb	Adams				
DATE ▶	8/7/69	8/8/69				

Form AEC-318 (Rev. 9-53) AECM 0240 ☆ U. S. GOVERNMENT PRINTING OFFICE: 1968 O-320-507

1138849

UNITED STATES
ATOMIC ENERGY COMMISSION
WASHINGTON, D.C. 20545

AUG 1 1969
8491

SUM. AUG 4 1969

S. R. Sapirie, Manager, Oak Ridge Operations Office

REQUEST FOR FOREIGN TRAVEL FOR EARNEST F. GLOYNA

9-43>4 LAF

As requested in Herman M. Roth's memorandum of June 23, 1969, the request for foreign travel for Earnest F. Gloyna, University of Texas at Austin, has been reviewed by this Division.

RDT does not consider that there is sufficient programmatic interest in the proposed conference at Cadarache to justify Mr. Gloyna's participation. It is therefore recommended that this request for foreign travel be disapproved.

A Grambsch acting
Milton Shaw, Director, Division of
Reactor Development and Technology

RDT:DP:202

Enclosure: OK
Form AEC-445 for Gloyna

cc: H. M. Roth, Director, Laboratory & University Div., OROO
D. F. Cope, RDT Senior Site Representative, ORNL

AUG 4

A 7735

1138850

CONTRACTS - 490 (Texas)

69 08325

Form AEC-445 (2-63) AECM 1501

U. S. ATOMIC ENERGY COMMISSION

REQUEST FOR APPROVAL OF OFFICIAL FOREIGN TRAVEL

TO:	FROM:
Dr. William J. Larkin, Chief Reactor Contracts Branch U.S. Atomic Energy Commission Oak Ridge, Tennessee 37830	Dr. Earnest F. Gloyna Project Director

PART A—To be completed by traveler

1a. NAME OF TRAVELER: Earnest F. Gloyna b. CITIZENSHIP: U.S.A.	c. DATE AND PLACE OF BIRTH: [redacted] Texas d. PASSPORT NUMBER (if available)
2a. HOME ADDRESS: [redacted]	b. BUSINESS ADDRESS: Engineering Laboratories Bldg. 305 Austin, Texas 78712
3a. EMPLOYER: The University of Texas at Austin	c. CONTRACT NUMBER: AT(11-1)-490
b. ORGANIZATIONAL UNIT: Environmental Health Engineering Division	d. POSITION TITLE (including profession): Professor, Civil Engineering Department (Environmental Health Engineering)

4. PURPOSE OF TRAVEL (In addition, specify nature and classification of information to be disclosed including titles of papers to be presented; nature of information to be obtained at each of the places to be visited and conferences to be attended and its relation to traveler's work. Travelers are responsible for obtaining clearances for papers or speeches when necessary. If more space is required, attach on a separate sheet. NOTE: IF THIS INFORMATION IS CLASSIFIED, BE SURE TO CLASSIFY THIS FORM APPROPRIATELY)

I have been asked by the French several times to participate in their conferences. This time I would like to accept and present a paper on "Radionuclide Transport in Model River Systems."

I believe that I will be able to obtain considerable information which will be beneficial to our AEC project, and thus benefit the entire radionuclide transport study effort. The scientific topics of this symposium will be:

1. Physical and chemical transfer processes
2. Fixation processes by freshwater animal and plant species
3. Fixation processes by cultivated plants
4. Fixation processes by natural species
5. Irradiation effects on ecosystem.

This paper will be based on non-classified experimental results derived from research sponsored under contract No. AT-(11-1)-490.

CONTRACTS — 490 (Texas)
A 5818 For. Trav
JUN 5 1969

1138851

5. PROPOSED ITINERARY (Account for all time from beginning and ending dates of travel. NOTE: IF INFORMATION IS CLASSIFIED, CLASSIFY THIS FORM APPROPRIATELY.)

DATES	LOCATION (Installation, city, country)	INDIVIDUALS TO BE CONTACTED	SUBJECT OF DISCUSSION	(Check one) CLASSIFIED	UNCLASSIFIED
Sept. 5-12, 1969	Centre de Etudes Nucleaires de Cadarache France	A. Grauby, Sec. Gen. H. Jammet	Symposium de Radioecologie		xx
9/5/69	Lv Austin, Texas				
9/7/69	Ar Cadarache, France				
9/12/69	Lv Cadarache, France				
9/13/69	Ar Austin, Texas				

6a. HAS FORM AEC-290 PURSUANT TO AEC CHAPTER 2502 BEEN SUBMITTED? (For visits to Soviet-bloc countries only)
☐ Yes ☐ No Not applicable

b. IF NOT, WHY NOT?
Not applicable

7. ARTICLE OF AGREEMENT FOR COOPERATION UNDER WHICH DISCUSSIONS WILL FALL (Information on the article may be obtained from local AEC Field Office)

8a. ESTIMATED COST OF TRAVEL TO AEC

Transportation $ 800.00
Per Diem and Miscellaneous $ 200.00
TOTAL $ 1000.00

Sufficient funds available under contract to cover cost of travel.

b. IF PART OF COST OF TRAVEL IS TO BE PAID OR HAS BEEN REQUESTED FROM SOURCES OTHER THAN AEC, INDICATE SOURCE AND AMOUNT.
No other

9. SIGNATURE OF TRAVELER
Earl D. Hagen

PART B—To be completed as follows (a) For AEC employees, by the Traveler's supervisor; (b) For Contractor employees, by the official responsible for supervising the activities involved in the proposed foreign travel or other official responsible for approving foreign travel under the terms of the contract.

10a. TRAVELER'S "Q" CLEARANCE NUMBER AND DATE
OR-9493-NY (Issued as OR-9493 April 24, 1950) (not sure if it is active)

b. ENDORSEMENT AND REMARKS

Recommended Approval

Ermin S. Perry
E. S. Perry, Acting Dept. Chairman
(Signature and Title of Supervisor)

1138852

PART C—To be completed at AEC Field Office and/or Laboratory

11. APPROVAL AND/OR REMARKS MANAGER OF FIELD OFFICE OR LABORATORY DIRECTOR

(Signature) (Date)

PART D—To be completed at Headquarters

CONCURRENCES AND/OR REMARKS

12. CONCURRENCE AND/OR REMARKS DIVISION OF SECURITY *(Note compliance with AEC Manual Chapter 2502)*

Title: (Date)

13. CONCURRENCE AND/OR REMARKS DIVISION OF INTELLIGENCE

Title: (Date)

14. CONCURRENCE AND/OR REMARKS DIVISION OF INTERNATIONAL AFFAIRS *(Note participation in classified discussions, if any)*

Title: (Date)

15. CONCURRENCE AND/OR REMARKS—OTHERS

Title: (Date)

HEADQUARTERS RECOMMENDATION

16. RECOMMENDATION AND/OR REMARKS OF PROGRAM DIVISION

Title: (Date)

APPROVAL

16a. FOREIGN TRAVEL AT AEC EXPENSE AS OUTLINED IN PART "A" IS: *(Check one)*

(1) Approved	
(2) Approved, subject to remarks and limitations	
(3) Disapproved	

b. REMARKS AND/OR LIMITATIONS ASSISTANT GENERAL MANAGER FOR ADMINISTRATION

(Signature) (Date)

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July 10, 1969

Dr. William J. Larkin, Chief
Reactor Contracts Branch
Laboratory and University Division
Oak Ridge Operations
U. S. Atomic Energy Commission
P. O. Box E
Oak Ridge, Tennessee 37830

A-6140 & file

Dear Dr. Larkin:

Attached is a copy of the paper which I propose to present at the Symposium de Radioecologie Continentale at Cadarache, France, September 8-11, 1969.

Sent to Shaw 6/23

AEC Form-445 has been forwarded previously. Please acknowledge approval for use of travel funds.

Sincerely,

Earnest F. Gloyna, Director
Environmental Health Engineering

EFG:st

Enclosure: One copy of report - "Transport of Radionuclides in a Model Aquatic System"
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TRANSPORT OF RADIONUCLIDES IN A MODEL AQUATIC SYSTEM*

by

Earnest F. Gloyna**

ABSTRACT

This paper describes some selected investigations on radionuclide transport. The overall objectives of these studies have been to develop a mathematical model which reasonably predicts the transport of various radionuclides under different environmental conditions.

The ecological environment was partially controlled, but all aspects were monitored. River systems were simulated with the aid of a research flume or "model" river. Laboratory and aquaria studies simulated closed ecosystems.

Basic hydrodynamic relationships were used to establish flow regimes; and uptake and release data were used to provide values for the various coefficients.

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* To be presented Symposium de Radioécologie Continentale, September 8-11, 1969, Cadarache, France

** Professor Environmental Health Engineering, and Director, Water Resources Center, The University of Texas at Austin, Texas, USA.

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1.0 INTRODUCTION

The movement of radionuclides in a stream is known to be a function of hydrodynamic mixing, physical sorption, biological up-take and chemical changes as related to environmental stresses. Because the fate of released radionuclides depends on the many environmental factors which influence biota, bottom sediments, and suspended debris, few investigators have considered more than one or two of these parameters at a time. Similarly, little attention has been given to the task of assembling these various transport relationships into working mathematical models.

Yet, there is a growing base of information which describes the behavior of radionuclides in aquatic ecosystems; and it is possible to write partial differential equations which represent many of the significant participating phenomena. Unfortunately, many of the aquatic systems are so complex that the resulting equations defy analytical solutions and frequently render numerical solutions impractical. The task of modeling radionuclide transport therefore becomes one of developing simplified but meaningful relationships.

These studies were made with the thought of examining simplified ecological systems, determining response of each component to various types of inputs, and modeling these responses with numerical or analytical solutions. This paper presents some illustrative data, and describes some of the modeling techniques.

2.0 ECOLOGICAL SYSTEM

By definition an ecosystem is any area of nature that includes living and non-living substances which interact to produce an exchange of materials between the living and non-living parts[1]. This is a broad concept which includes flowing and non-flowing aquatic systems as used in these investigations.

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Responses of total ecosystem and ecosystem components resulting from instantaneous and continuous release of radionuclides were studied in aquaria. These were conducted to simulate radionuclide releases into well-mixed bodies of water and to provide information for model river studies.

Model river studies were performed to determine component and whole system response to instantaneous and continuous releases of radionuclides in a stream environment and separate component responses were modeled for different environmental stresses.

2.1 Aquaria: Non-flowing experiments were conducted in aquaria which were 60 centimeters (cm) long, 26 cm wide, and 36 cm deep. They were filled to a depth of about 7 cm with lake sediment, and contained about 24 liters of water. Fluorescent lamps provided an artificial sunlight. These were operated on a 12 hour on-off cycle. Mechanical stirrers provided the desired mixing. According to dye studies completed mixing occurred within two minutes.

2.2 Model River: The model river consisted of metal flumes, water supply reservoirs, and pumping systems. The major flume system was 61 meters (m) long, 0.76 m wide, and 0.61 m deep. For some experiments the flume was divided into two channels. The slope was adjustable and the maximum flow was about 400 liters per minute. An overall view of the flume is given in Figure 1. The hydraulic characteristics of the model river with reference to a real river are shown in Figure 2.

Sediment from a local lake was placed in the flume to a depth of about 17 cm. X-ray diffraction analysis indicated that the sediment contained about an equal amount of clay, quartz, calcite, and dolomite. The organic content was less than 2 percent. The effect of particle size on the ion exchange capacity is given in Figure 3. The medium size was 0.150 mm while 10 percent was smaller than 0.050 mm and 90 percent was smaller than

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0.300 mm.

In some experiments plant and animal life was permitted to grow until a degree of stability developed. In other experiments macro-rooted plants such as Myriophyllum, Potamogeton, and Vallisneria were planted in bottomless containers spaced at various intervals along the flumes.

Two reservoirs, each having a capacity of 2,000 cubic meters, were used in association with the model river. One reservoir was used as a supply and recycle system while the second was used as an effluent monitoring tank.

3.0 EXPERIMENTAL PROCEDURE

Initially, field studies were conducted in real river systems utilizing fallout materials such as strontium and cesium. However, it soon became apparent that much more data were needed on the behavior of other radionuclides which might be in the effluent of nuclear power reactors, specifically, zinc, cobalt, chromium, and ruthenium. This led to the detailed laboratory tests and confirmatory aquaria and flume investigations.

Detailed data were obtained on uptake and release of selected radionuclides under different environmental stresses. Factors which may influence uptake or release were carefully monitored.

In order to cope with the task of data collection and analysis, continuous monitoring systems were installed; computerized data reduction programs were developed; and "model" ecosystems were developed. Some of the instrumentation provided continuous data on dissolved oxygen, useable light, filtered light, pH, water and air temperature, and oxidation-reduction potential (ORP). Measurements were made as required on: radionuclide concentrations and ionic species; carbon dioxide content; total biomass; specie diversification; velocity and flow characteristics; sediment concentration and movement; and productivity/respiration (P/R). Finally, detailed laboratory

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support studies were conducted to establish the chemical state of the radionuclides under each of the various environmental control conditions.

3.1 Ecological Studies: Ecological data were obtained from taxonomy, biomass, and productivity studies. Basically, this endeavor attempted to describe what type of biota was present, how much was there, and how it interacted with the non-living components such as dissolved gases and nutrients.

Plant biomass was obtained by pressing a pipe having a diameter of 15 cm into the sediment, removing all plants within the pipe, sorting, drying at 110°C, and weighing each species of plant. These weights were then converted to grams of dry weight per square meter of bottom surface area (gms O_2/m^2/day). Both plants and animals were identified. Large plants were identified during the sorting process while algae were identified by culturing them in water samples in the laboratory and then examining them.

Productivity was determined from oxygen data[2] and from pH data[3]. These methods are based on the theory that diurnal changes in oxygen and carbon dioxide are caused by biological activity and diffusion through the air-water interface. Contributions from diffusion can be subtracted to give oxygen produced in photosynthesis and taken up in respiration, and carbon dioxide taken up in photosynthesis and released in respiration. Gross production, P_G, is the total amount of oxygen produced in photosynthesis and has units of gms O_2/m^2/day. Net production, P_N, is gross production minus the oxygen removed by respiration during photosynthesis. Respiration, R, is the total amount of oxygen used in respiration and has units of gms O_2/m^2/day.

The ratio of gross photosynthesis to respiration, P_G/R, is a measure of the energetic balances of the ecosystem. If P_G/R is less than 1.0, the

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system is heterotrophic; if it is greater than 1.0, it is autotrophic.

3.2 Radionuclide Analysis: Radionuclide samples were counted on a multi-channel gamma spectrometer. Counting errors were maintained within 10 percent. Corrections were made for self-absorption, efficiency of counting, and decay so that final data were logged as disintegrations per minute (dpm) or microcuries (μ c).

3.3 Water Analysis: Two types of water samples were collected and processed. The first types of samples were those in which an aliquot was taken without any attempt to separate either dissolved or suspended fractions from the water. The other types of samples were those in which the suspended and dissolved fractions of a water sample were separated and radionuclide concentrations determined. The desired fractional separation was obtained by either centrifugation or centrifugation plus filtration through a membrane filter (0.45 micron opening). The radioactivity content for both the filtrate and the suspended material retained on the filter paper was measured.

3.4 Sediment Analysis: The sediment sampling device is shown in Figure 4. It is composed of a plunger, lucite tube, and sampling rod. The average inside diameter of the lucite tubes is 2.30 cm, and the cross-sectional area is 3.81 cm^2.

The sample core was either mixed and analyzed or the core was cut into five sections corresponding to incremental depths of about 1.5 cm, and a portion from each section analyzed.

3.5 Plant Analysis: Leaves were collected, washed, or wiped and washed prior to detailed radiological analysis. The weight of these samples varied from about 300 mg to 1,600 mg. These samples, including wash water and wipings, were analyzed for radioactivity.

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4.0 TRANSPORT MODELS

As has been demonstrated repeatedly, ecosystem contamination is a function of initial activity levels and contact time. Usually the uptake and release functions cannot be delineated because not enough plant samples are taken. This problem of inadequate data makes it difficult to examine the plant response as a radionuclide plume passes. Consequently, it is necessary to address ourselves directly to the subject of dispersion in streams, its measurement, and its significance to ecosystem responses.

The basic transport equation for flow in the x direction of a three-dimensional system may be written as:

$$\frac{\partial C}{\partial t} = \frac{\partial}{\partial x}\left(k_x \frac{\partial C}{\partial x}\right) + \frac{\partial}{\partial y}\left(k_y \frac{\partial C}{\partial y}\right) + \frac{\partial}{\partial z}\left(k_z \frac{\partial C}{\partial z}\right) - \bar{U}\frac{\partial C}{\partial x} \qquad 1$$

where C is the concentration at any point x, y, z, $\bar{U}$ is the velocity in the x direction and k_x, k_y, k_z are the turbulent dispersion coefficients in the x, y, and z direction respectively. Taylor[4] found that concentration curves could be represented by a simplified form of Eq. 1.

$$\frac{\partial C}{\partial t} = D_L \frac{\partial^2 C}{\partial x^2} - \bar{U}\frac{\partial C}{\partial x} \qquad 2$$

where D_L is called the longitudinal dispersion coefficient. A solution to this equation for a point source is

$$C(x,t) = \frac{M}{A\sqrt{4\pi D_L t}}\, e^{-\frac{(x-\bar{U}t)^2}{4D_L t}} \qquad 3$$

where M is the mass introduced and A is the channel cross-sectional area.

Fischer[5] has pointed out that initial dispersion of a point source does not follow Taylor's equation, but rather takes the shape of a skewed normal distribution because of the dominance of convection over diffusion. However, at some point downstream, the curves approach a form where the Taylor equation is valid. According to Sheppard, this initial period may be

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considered as the time required for the introduced material to assume the shape of the already established velocity gradients[6].

Shih and Gloyna developed a dispersion model to predict dispersion as well as uptake and release from the sorption phases[7]. For a general case it has the form

$$\frac{\partial C}{\partial t} = D_L \frac{\partial^2 C}{\partial x^2} - \bar{U}\frac{\partial C}{\partial x} + \sum_{i=1}^{n} \alpha_i [k_i \quad C_i - g_i \ (C)] \qquad 4$$

where α_i is a proportionality constant for phase i, k_i is the mass transfer coefficient for phase i, g_i (C) is a transfer function relating the concentration of activity in the water to the equilibrium level in phase i, and C_i is the specific activity in the i-th of n sorption phases. The other terms in the Taylor one-dimensional diffusion model have been defined previously. The activity in C_i is determined by

$$\frac{\partial C_i}{\partial t} = k_i \quad [g_i \ (C) - C_i] \qquad 5$$

For plants and sediments the term g(C) is linear and has the Freundlich isotherm form

$$\frac{x}{m} = kC^n = kC \qquad 6$$

so that Eq. 5 is linear and can be solved using one sorption phase and the following boundary and initial conditions:

$$C(x, 0) = 0; \quad x \to 0 \qquad 7$$

$$\lim_{t\to\infty} C(x,t) = C_\infty \text{ (finite)} \qquad 8$$

$$C_i \ (x,0) = 0; \quad i = 1, 2, \ldots, n \qquad 9$$

$$C(0,0) = \frac{M}{AU} \ \delta \ (t-0) \qquad 10$$

where δ (t-0) is the delta function. The solution is similar to Eq. 3 with a Bessel function term included.

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Probably one of the more frustrating aspects of dispersion studies is the measurement of the mean flow time and dispersion coefficient from observed concentration-time curves. It need only be noted that because the dispersion coefficient is calculated from the second moment of the curve, its magnitude is directly affected by the length of the tail used.

Methods are available for calculating the mean flow and the dispersion coefficient with little or no error if at least two concentration curves are obtained from stations well downstream from the point of release. The first and second moments (centroid, t_c, and variance, σ_t^2, respectively) are calculated by

$$t_c = \frac{\Sigma C_i t_i}{\Sigma C_i}, \quad i = 1, 2, \ldots, n \qquad 11$$

and

$$\sigma_t^2 = \frac{\Sigma C_i t_i^2}{\Sigma C_i} - \left(\frac{\Sigma C_i t_i}{\Sigma C_i}\right)^2, \quad i = 1, 2, \ldots, n \qquad 12$$

where C_i and t_i are concentration and time at interval i on the concentration-time curve which has been divided into n intervals.

Using these resutls the mean velocity of the tracer cloud between stations is

$$U_1 = \frac{X_1 - X_2}{t_{c_2} - t_{c_1}} \qquad 13$$

where X_1 and X_2 are distances from the point of release to stations 1 and 2 respectively. The dispersion coefficient is calculated by

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$$D_L = \frac{U_1}{2} \left[\frac{\sigma^2_{t_2} - \sigma^2_{t_1}}{t_{c_2} - t_{c_1}} \right] \qquad 14$$

where the centroid time and its variance are calculated for both stations. Station 2 is assumed to be downstream from Station 1.

A compartmental model for the aquaria may be applied to these studies since only three compartments are present; namely, water, sediment, and plants. If the flux of radionuclides into and out of these compartments is considered and if the plant and sediment compartments exchange material with the water phase only, then a mamillary system is said to exist[6]. The movement of radionuclides in this system may be described by the general equation

$$\overset{o}{C}_j = \sum_{i=1}^{n} a_{ij} C_i - \sum_{i-1}^{n} a_{ji} C_j, \quad j=1, 2, \ldots, n, \; i \neq j \qquad 15$$

where C_i and C_j are the microcurie levels in the i-th and j-th compartments respectively, $\overset{o}{C}_j$ is the time rate of change of the activity in the j-th compartment, and a_{ij} is the fraction of the material in the i-th compartment which is transferred to the j-th compartment per unit time, t. The aquaria systems are described by Eq. 15 if n is 3 and a_{23} and a_{32} are equal to zero. The transfer rates may be obtained by using several points on the time-concentration curves and by modifying Eq. 15 so that for compartment 1,

$$\overset{o}{C}_j = \sum_{i=1}^{n} a_{i1} C_{im} - \sum_{i=2}^{n} a_{1_i} C_{1m}, \quad m=1, 2, \ldots, r \qquad 16$$

where m is the sample number and r is the number of samples needed to obtain a solution - in this case four. The case is simpler for compartments

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2 and 3, for

$$\overset{o}{C}_{2m} = a_{12} C_{1m} - a_{21} C_{2m}, \; m = 1, 2 \qquad 17$$

and

$$\overset{o}{C}_{3m} = a_{13} C_{1m} - a_{31} C_{3m}, \; m = 1, 2 \qquad 18$$

Using determinants, a_{12}, a_{21}, a_{13}, and a_{31} may be calculated.

5.0 COMPARTMENTAL MODELING EXAMPLE

As shown in Figure 5 the transfer rates are not constant with respect to time. The small drawing shows that coefficients a_{12} and a_{21} (1 - water compartment, 2 - sediment compartment) decrease rapidly during the first few days then level out to constant values. This initial stage is the time when the tracer "catches up" with the system. Though the compartmental model is usually applied only to systems in study state, the initial stage may be modelled if the transfer coefficients are changed to

$$\bar{a}_{ij} = \frac{a_{ij}}{1-e^{-b-rt}} \qquad 19$$

where b and r are constants and t is time. A typical solution to the compartmental model is shown in Figure 5. In this case the integrating interval was 0.01 days. For this example the transfer coefficients remained fairly constant after five days, and this permitted the calculation of transfer coefficients between sediment and water.

6.0 SEDIMENT AS A RADIONUCLIDE RESERVOIR

The relative concentration of radionuclides on the surface of the bottom sediments to that in the bed sediment was found to be a function of

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$z/(2 \sqrt{Dt})$, where z, D, and t respectively, are the depth of bed sediment from the surface, diffusion in the water and time after migration began. Figure 6 shows the uptake rates of several radionuclides for non-flowing aquaria systems. For streams with low velocities the uptake rates were slightly higher.

It appears that the penetration of a sorbate into the bottom sediments may be based on a mass balance relationship. By considering the total mass of sorbate retained in a cube of sediments with infinitesimal depth, Δd, and unit area it is possible to write Equation 20.

$$M(d,t) - M(d + \Delta d,t) = p'(t) \left[\frac{M(d,t) + M(d + \Delta d,t)}{2} \right] \Delta d \qquad 20$$

where

$M(d,t)$	=	Total mass of sorbate per unit area at depth d and time t
$M(d+\Delta d,t)$	=	Total mass of sorbate per unit area at depth $d + \Delta d$ and time t
Δd	=	infinitesimal depth
$p'(t)$	=	probability of being retained in the sediments for unit mass of sorbate per unit length of penetration

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7.0 PLANTS AS A RADIONUCLIDE RESERVOIR

Any discussion of the importance of plants as a reservoir for radionuclides has to be qualified in space and time. This is true for any component of a river one may wish to consider.

The space dimension is considered because of the variable distribution of plant biomass, plant type and water quality. From the aquaria and model river studies, literature data, and consideration of the sorption model, it becomes obvious that plant uptake of radionuclides may be completely defined for any given plant type, biomass, surface to volume ratio (concentration factor indirectly), pH, concentration of competing ions and radionuclides. For certain radionuclides like ^{85}Sr, pH, competing ion concentration and plant type are not very important in natural waters and uptake may be predicted by biomass and surface to volume ratio data alone.

The amount of radionuclides taken up by plants during instantaneous release is significant for a short period, Table 1. Studies in the model river show, on a percent basis, that ^{65}Zn and ^{58}Co are retained for relatively long periods of time while ^{85}Sr and ^{137}Cs are released quite rapidly. Plants such as Vallisneria americans Michanx actually play an insignificant role in ^{85}Sr transport. In the case of ^{85}Sr the uptake by plants was similar to that normally observed for solid particles. In terms of total radionuclides contained in plants during the whole experiment, the percentages drop drastically. For ^{103}Ru and ^{85}Sr respectively, a maximum of 5 percent and 1 percent were found in the plants under favorable conditions.

It was possible to simulate observed uptake data by using the dispersion equation solution as an input. Notably, estimates of the mass transfer

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coefficient, k_2, and the equilibrium concentration factor, k_c, have to be made for each system since attached algae markedly affected these values.

Plant uptake in continuous release appeared to be lower on a mass balance basis than in instantaneous release since plants contained only about 5 percent of the ^{85}Sr activity after two days of release. However,

Table 1. Radionuclides in Plant Phase During Instantaneous Release Experiments

Release (Days)	Radionuclide				
	^{65}Zn* (%)	^{58}Co** (%)	^{137}Cs*** (%)	^{85}Sr**** (%)	^{85}Sr**** (%)
0	12.0	30.0	20.0	14.0	16.0
5	9.5	12.0	3.5	3.0	5.0
10	8.0	8.0	2.5	2.0	4.0
30	4.0	5.0	1.0	1.0	-
60	1.5	2.0	0.5	0.5	-

* Ref. 9
** Ref. 10
*** Ref. 7
**** Ref. 11

this apparent contradiction is dismissed when sorption rates of plants and sediments are compared. Since plants reach their maximum adsorption quickly and begin desorbing while the sediments are still tending toward their maximum level, the plants would exhibit an abnormally high percent of radionuclides at their peak uptake. A similar situation would occur under the continuous release conditions until the sediments "caught up," after which time plants would contain their observed percentage of ^{85}Sr.

8.0 EFFECTS OF POLLUTION STRESS ON SORPTION

A polluted stream was simulated in the model river by simultaneously releasing biodegradable waste and ^{85}Sr (0.05×10^{-3} μc/ml). The initial chemical oxygen demand (COD) in the polluted channel was 190 mg/l.

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As shown in Figure 7, the ^{85}Sr concentration in sediments containing degradable organic solids was higher than that found in the unpolluted sediments. Also, a significant increase in ^{85}Sr penetration was observed in the polluted sediments, Figure 8. The decreased penetration coefficient suggested that the biological activity and sorption was probably an important factor in controlling the migration of sorbate into the sediments. The rates of uptake, deposition and release are controlled, at least to a considerable degree, by the velocity, type of suspended sediment, and the environmental factors which influence the chemical and biological activity.

An example of the environmental changes brought about through the introduction of a biochemical oxygen demand (BOD) load is shown in Figure 9. There is a marked diurnal change in dissolved oxygen (DO) as well as a measurable photosynthesis-respiration (P-R) change downstream.

9.0 DISCUSSION

Numerical and analytical solutions to the dispersion equation with sorption terms for plants and sediments have been investigated. Certain restrictions are imposed on the analytical solution by the initial and boundary conditions. The numerical solution allows greater versatility. The error obtained in the numerical solution of the dispersion equation is dependent on the incremental distance and time, and on the size of the dispersion coefficient and mean velocity. It has been determined that the best "cut-off" point for determining how much of the concentration-time curve to use in calculating the dispersion coefficient was obtained when the point just less than one-tenth from the peak concentration was included.

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Examples of observed and calculated results are given in Figures 10 and 11. Continuous releases of ^{85}Sr provided the necessary data. If the velocity had been greater, the observed curves would have been estimated better. In this case, the velocity was only 16 cpm and the dispersion coefficient was 900 cm^2/min. Values of k, and mass transfer coefficient, respectively, were 260 dpm/gm/dpm/ml and 0.03 per hour. In both cases a refinement in coefficients would have improved the first.

10.0 CONCLUSIONS

1. Considerable insight has been gained into the behavior of radioactive wastes in river systems with relatively small nonflowing and flowing ecosystems. Gathering the same information by observation of real systems would have required considerably greater time and expenditures.

2. Both explicit finite-differences in numerical and analytical solutions have been derived for defining transport. It seems that the numerical solutions offer more promise because of the ease of setting boundary and initial conditions.

3. The numerical solution of the dispersion model has been used to predict transport curves of ^{85}Sr after instantaneous release with less than 3% error.

4. The uptake and release of radionuclides in plant and sediments have been modeled fairly well. Rapid transfer to plants was followed by slower transfer to sediments. Plants released rapidly in response to equilibrium conditions while sediments continued to take up activity through penetration. Equilibrium concentrations were effected by diurnal oxygen fluctuations.

11.0 ACKNOWLEDGMENTS

This project has been supported in part by the United States Atomic Energy Commission. The interest and direction of Mr. Walter Belter, Chief, and Mr. Craig

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Roberts, Sanitary Engineer of the Environmental and Sanitary Engineering Branch, Division of Reactor Development and Technology, United States Atomic Energy Commission are greatly appreciated.

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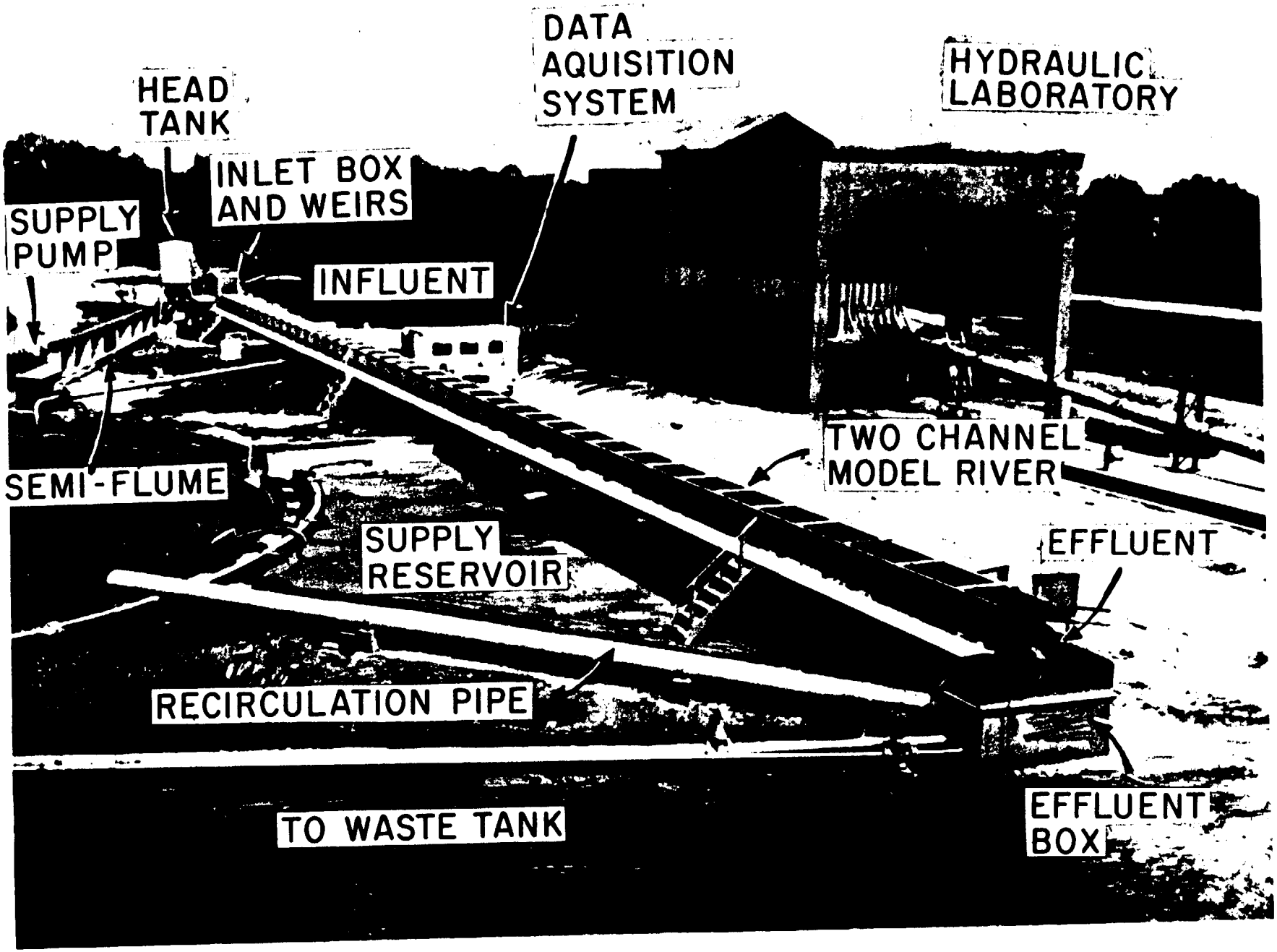

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FIG. 1 MODEL RIVER

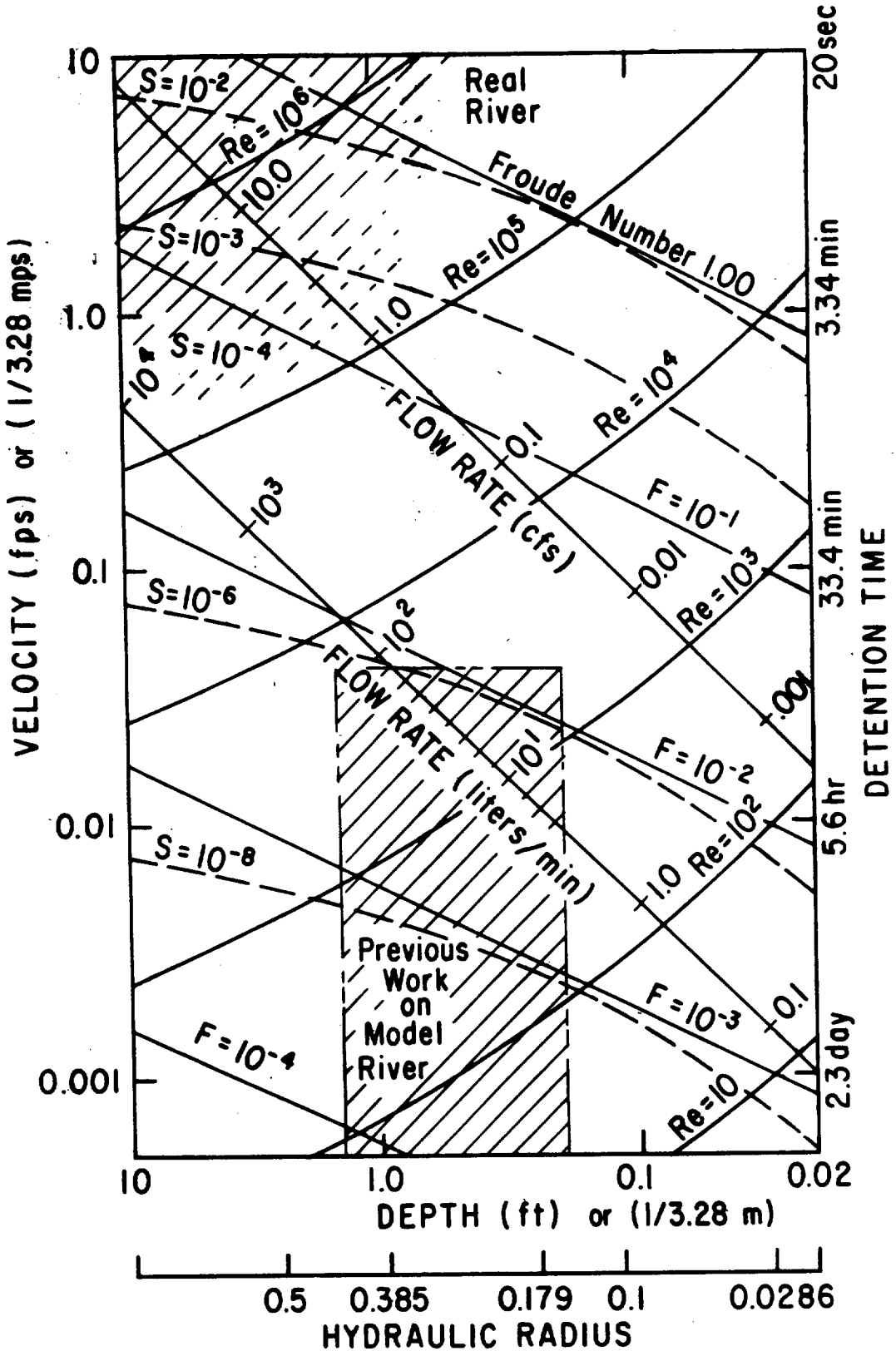

FIG. 2. HYDRAULIC CHARACTERISTICS OF MODEL RIVER

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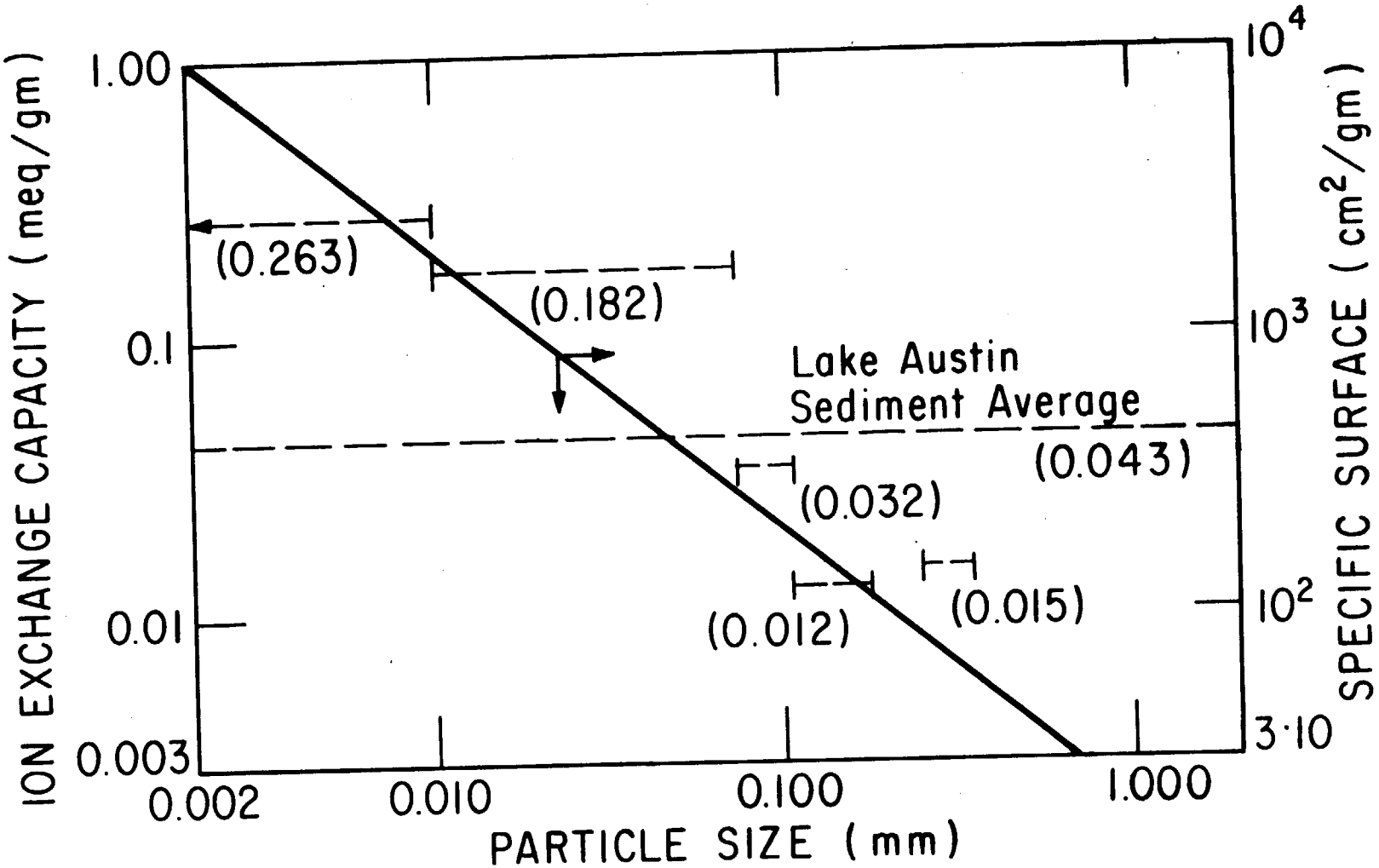

FIG. 3. EFFECT OF PARTICLE SIZE ON ION EXCHANGE CAPACITY

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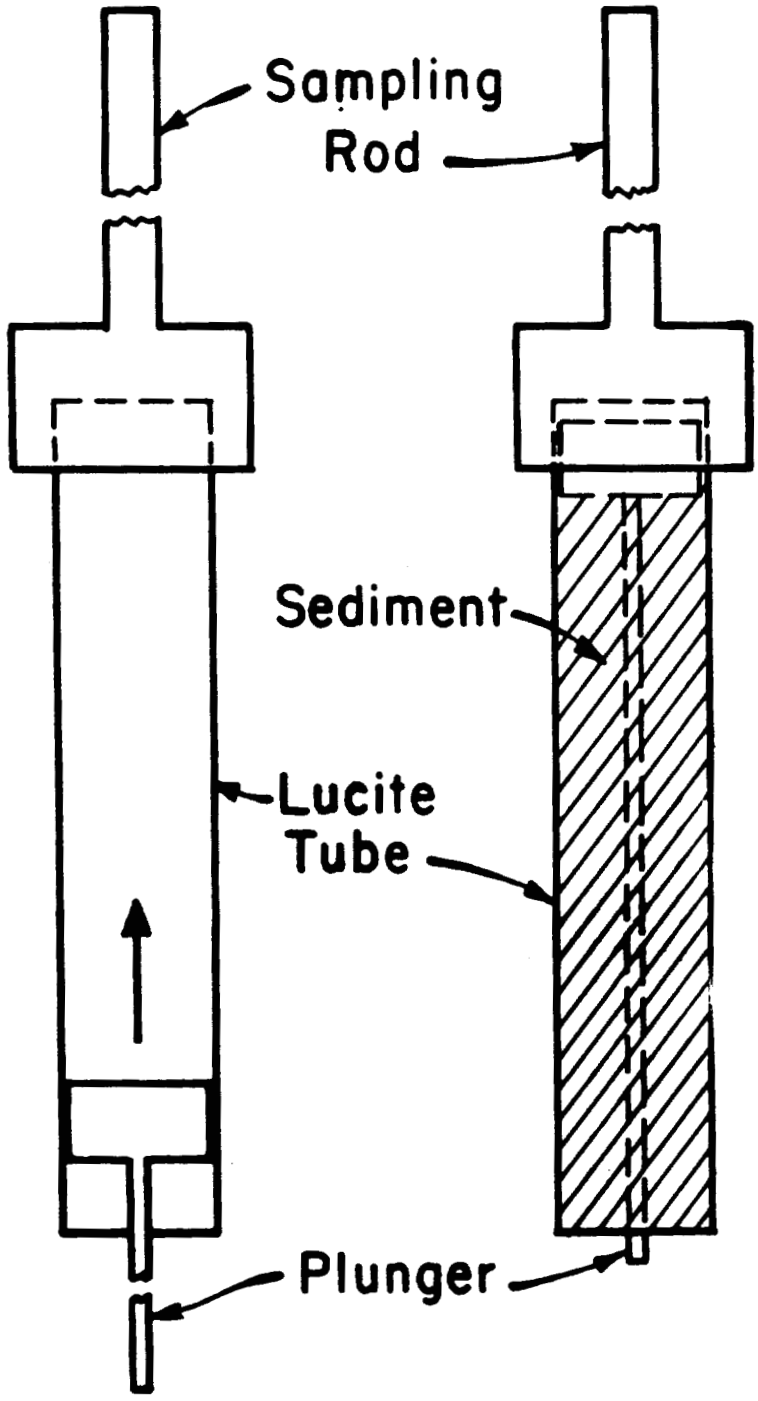

Before Sampling After Sampling

FIG. 4. SEDIMENT SAMPLER

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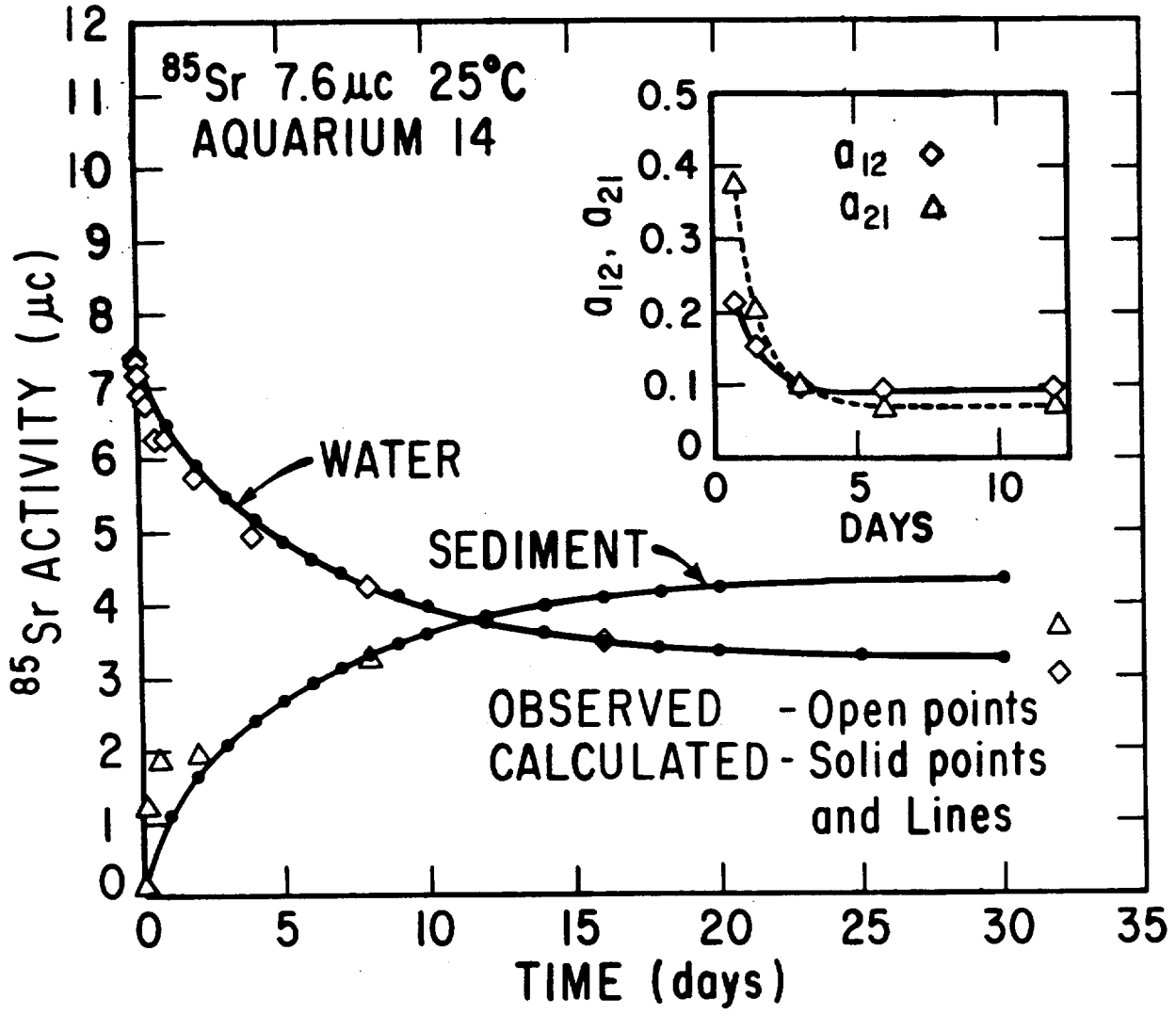

FIG. 5 COMPARTMENTAL MODEL SOLUTION COMPARED TO OBSERVED DATA

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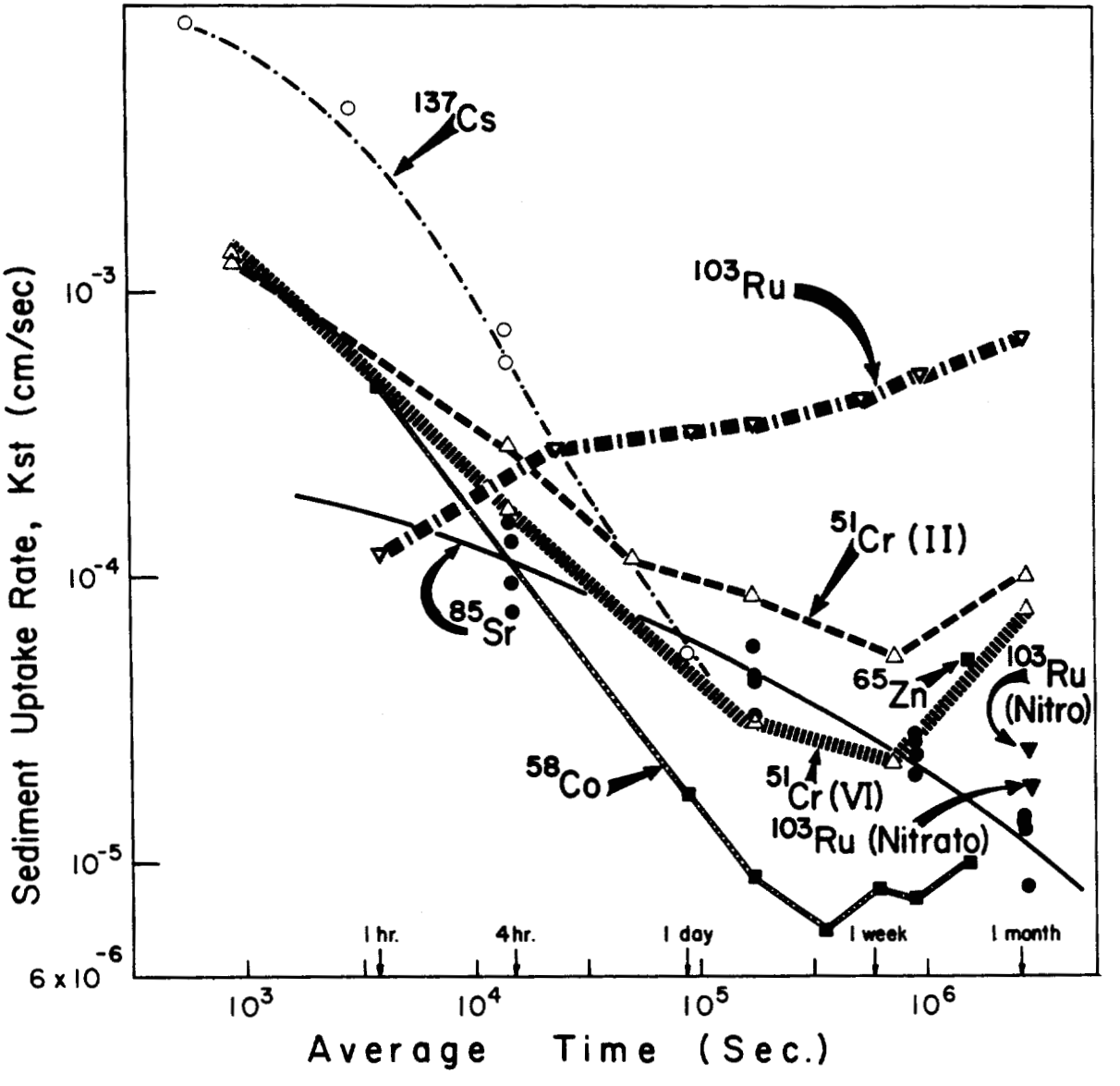

FIG. 6 UPTAKE RATE BY BED SEDIMENT

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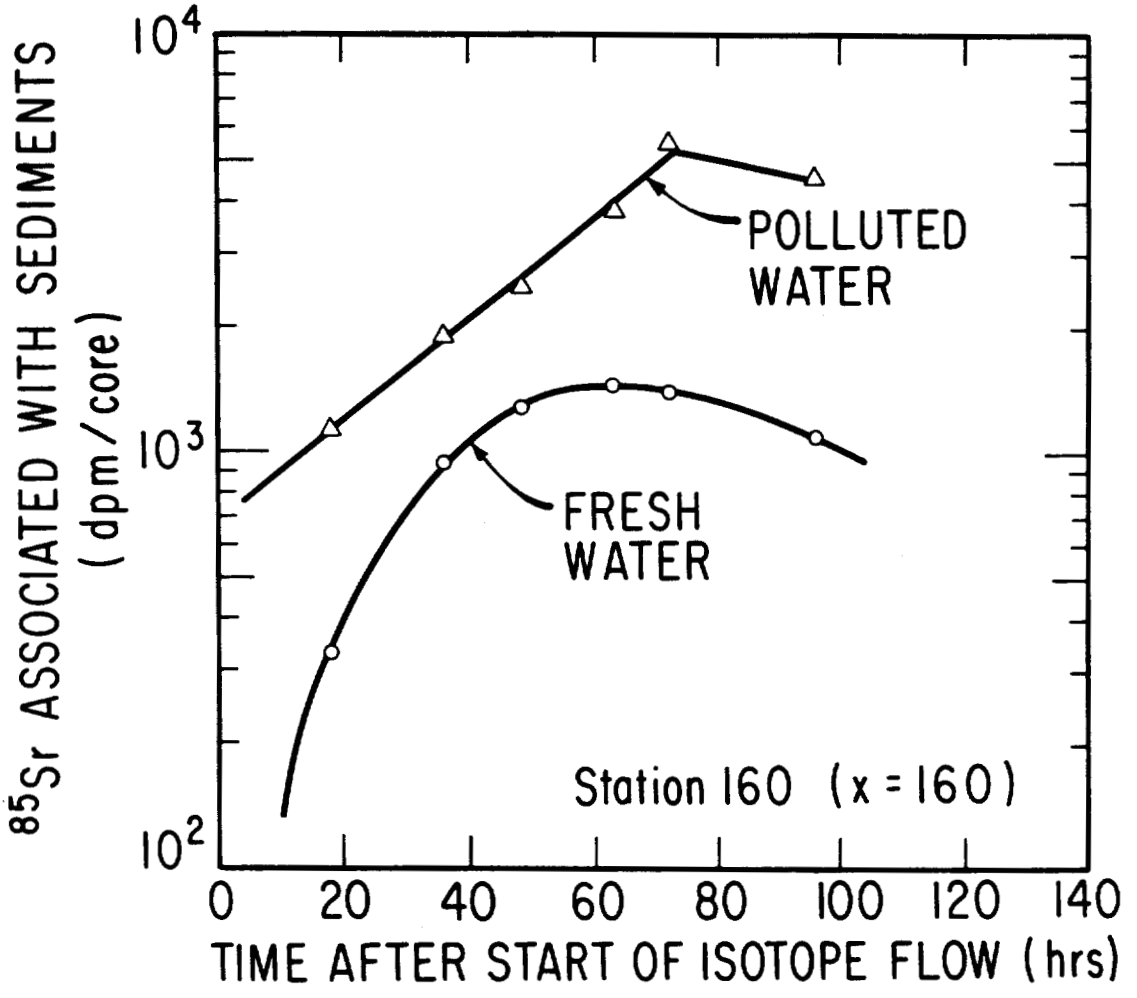

FIG. 7. ^{85}Sr ASSOCIATED WITH SEDIMENTS IN POLLUTED ENVIRONMENT

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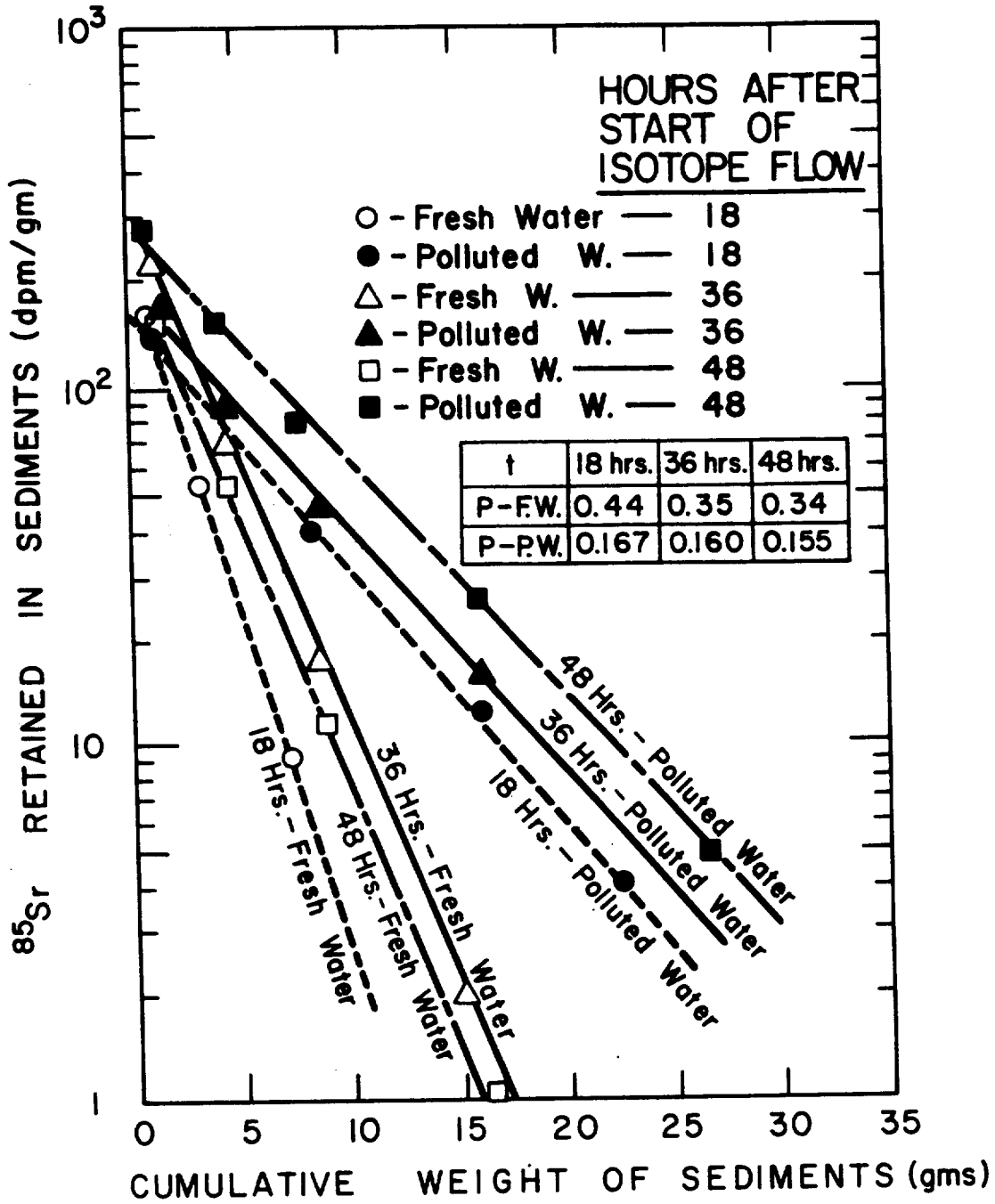

t	18 hrs.	36 hrs.	48 hrs.
P-F.W.	0.44	0.35	0.34
P-P.W.	0.167	0.160	0.155

FIG. 8. ^{85}Sr PENETRATION INTO THE SEDIMENTS IN POLLUTED ENVIRONMENT

1138880

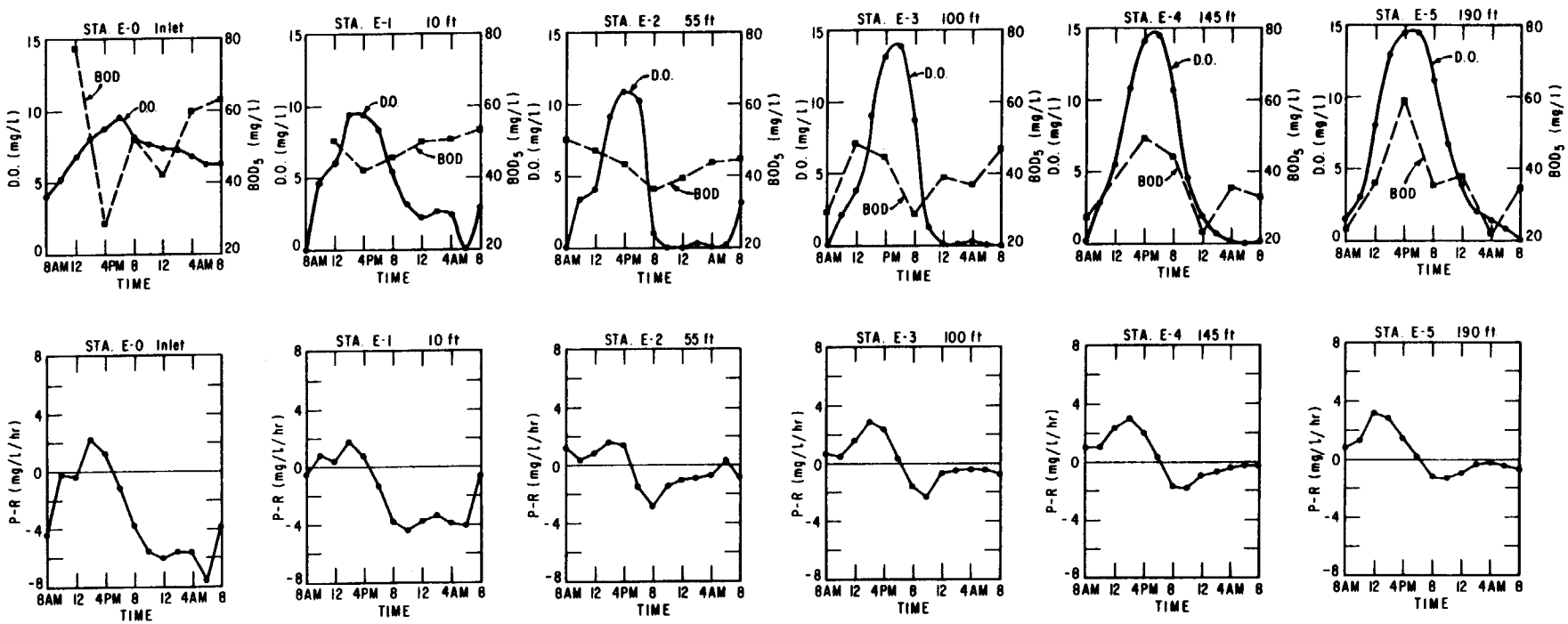

FIG. 9. DIURNAL VARIATIONS OF D.O., BOD AND P-R AT SELECTED STATIONS

1138881

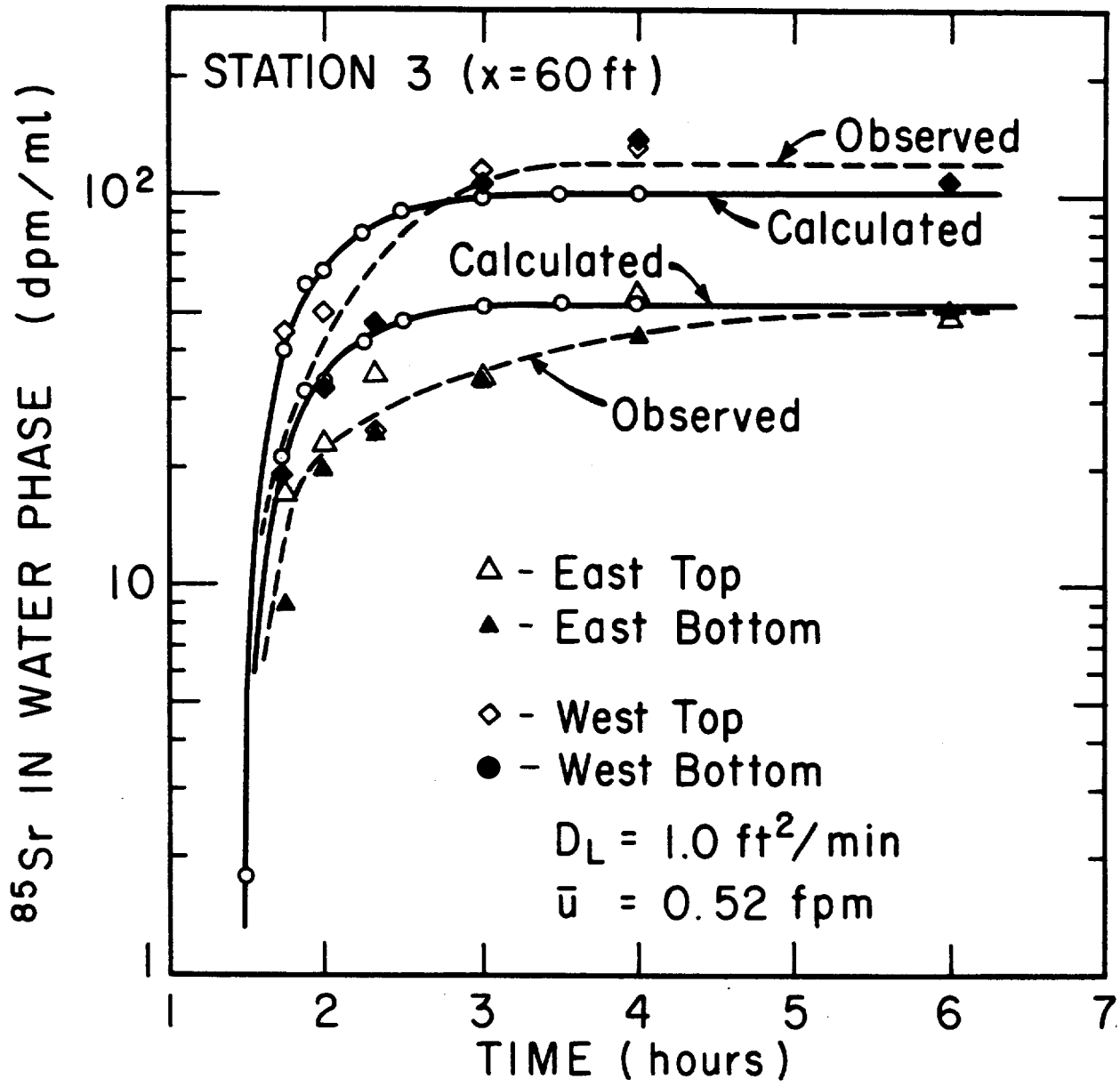

FIG. 10. PREDICTION OF ^{85}Sr EQUILIBRIUM LEVELS DURING CONSTANT RELEASE

1138882

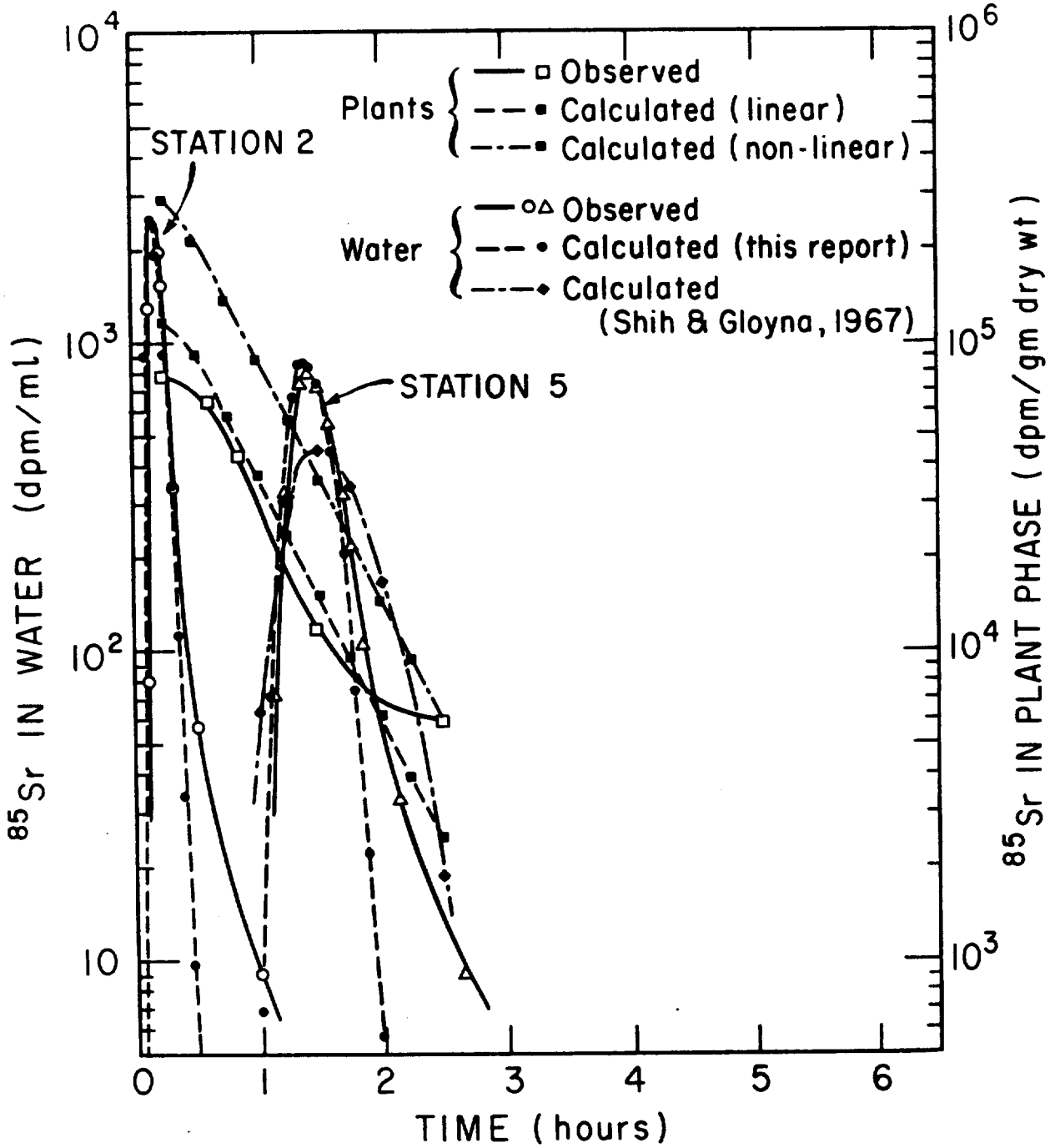

FIG. 11. COMPARISON OF OBSERVED AND CALCULATED INSTANTANEOUS RELEASE CURVES FOR WATER AND PLANTS

1138883

UNITED STATES
ATOMIC ENERGY COMMISSION
OAK RIDGE OPERATIONS
P.O. BOX E
OAK RIDGE, TENNESSEE 37830

AREA CODE 615
TELEPHONE 483-8611

L & U files

JUN 23 1969

Milton Shaw, Director, Div. of Reactor Development & Technology, HQ

PROPOSED FOREIGN TRAVEL

In accordance with the provisions of Manual Chapter AEC-1501, we are enclosing six copies of Form AEC-445 completed by the following individual:

Name : **Earnest F. Gloyna**

Organization : **The University of Texas at Austin**

Contract Number : **AT-(11-1)-490**

Period of Travel: **September 5-13, 1969**

Please advise us of your decision on this travel as soon as possible. If the travel is approved, indicate if a trip report is required (AEC IAD 1501-11).

Herman M. Roth
Herman M. Roth, Director
Laboratory and University Division
Oak Ridge Operations

OLE:LAF

Enclosure:
Form AEC-445 (6)

Adm. Serv. Br.
Fuller:kb
6/23/69

Reactor Cont. Br.

L & U Div.
6/23/69

CONTRACTS - 490 (Texas For. Travel)

6/23/69

1138884

THE UNIVERSITY OF TEXAS
COLLEGE OF ENGINEERING
AUSTIN, TEXAS 78712

Department of Civil Engineering
Environmental Health Engineering
Engineering Laboratories Building 305

June 16, 1969

Dr. William J. Larkin, Chief
Reactor Contracts Branch
Laboratory and University Division
Oak Ridge Operations
U. S. Atomic Energy Commission
P. O. Box E
Oak Ridge, Tennessee 37830

PROPOSED FOREIGN TRAVEL - CONTRACT NO. AT-(11-1)-490

Dear Dr. Larkin:

The following information is provided for the completion of AEC-445 (Request for Approval of Official Foreign Travel):

1. Date of departure from Austin - September 5, 1969;

2. Date of arrival in Cadarache, France - September 7, 1969;

3. Date of departure from Cadarache, France - September 12, 1969;

4. Date of arrival in Austin - September 13, 1969; and

5. There are sufficient avaiable funds in the contract to cover the estimated cost of this travel.

Sincerely,

Earnest F. Gloyna, Director
Environmental Health Engineering

EFG:st

CONTRACTS - 490
A 6140
JUN 19 1969

1138885

JUN 1 0 1969

Dr. Earnest F. Gloyna
Department of Civil Engineering
Engineering Laboratories Building 305
The University of Texas
Austin, Texas 78712

PROPOSED FOREIGN TRAVEL - CONTRACT NO. AT-(11-1)-490

Dear Dr. Gloyna:

Forms AEC-445 (Request for Approval of Official Foreign Travel) transmitted to this office by your letter of June 3 are being held in this office without action pending receipt of the following information:

1. Date of your proposed departure from Austin
2. Date of arrival in Paris
3. Date of departure from Paris
4. Date of arrival at Austin
5. A statement that there are sufficient funds available under the contract to cover the estimated cost of this travel, if this is the case. If additional funds will be required in order to pay for this travel, a statement to that effect should be furnished to this office.

When the above requested information is received, we will forward your request to AEC Headquarters for consideration.

Sincerely,

ORIGINAL SIGNED BY
W. J. LARKIN

William J. Larkin, Chief
Reactor Contracts Branch
Laboratory and University Division

0 3 LEGAL
0 3979

CONTRACTS - 490 (Texas)

OFFICE ▶	Adm. Ser. Br.	Rea. Cont.		For Trav	
SURNAME ▶	Fuller:kb				
DATE ▶	6/9/69				

Form AEC-318 (Rev. 9-53) AECM 0240 ☆ U. S. GOVERNMENT PRINTING OFFICE: 1968 O-320-507

1138886

THE UNIVERSITY OF TEXAS
COLLEGE OF ENGINEERING
AUSTIN, TEXAS 78712

Department of Civil Engineering
Environmental Health Engineering
Engineering Laboratories Building 305

June 3, 1969

Dr. William J. Larkin, Chief
Reactor Contracts Branch
Laboratory and University Division
U. S. Atomic Energy Commission
Oak Ridge Operations
P. O. Box E
Oak Ridge, Tennessee 37830

Dear Dr. Larkin:

Transmitted herewith are the original and seven copies of my "Request for Approval of Official Foreign Travel" to attend and participate in an International Symposium on Continental Radioecology in France, September 8-11, 1969.

If there is any other information needed please let me know.

Sincerely,

Earnest F. Gloyna, Professor
Environmental Health Engineering

EFG:st

Enclosures: Original and seven copies of "Request for Approval of Official Foreign Travel"

CONTRACTS - 490 (Texas)
A 5815
JUN 5 1969

1138887

MAY 1 2 1969

Dr. Earnest F. Gloyna
Director, Environmental
Health Engineering
Department of Civil Engineering
College of Engineering
The University of Texas
Engineering Laboratories Building 305
Austin, Texas 78712

FOREIGN TRAVEL - CONTRACT NO. AT-(11-1)-490 - UNIVERSITY OF TEXAS

Dear Dr. Gloyna:

This is in reply to your letter of May 2, 1969, wherein you request permission to attend and participate in an International Symposium on Continental Radioecology. Requests for foreign travel at AEC expense are submitted on Form AEC-445 to this office and are approved by AEC Headquarters. Enclosed is Form AEC-445 and instructions for its completion.

When this form is received in this office, properly completed, we will request that AEC Headquarters give consideration to your request to use AEC funds in the performance of this travel.

Sincerely,

ORIGINAL SIGNED BY
W. J. LARKIN

William J. Larkin, Chief
Reactor Contracts Branch
Laboratory and University Division

OLE:LAF

Enclosure:
Form AEC-445 w/instructions

This conference Not to be Coordinated by DTI, per John Konis off. T/r

OFFICE ▶	Admin.Serv.Br.	Rea.Contr.Br.		CONTRACTS	-490 (Texas)	
SURNAME ▶	Fuller:bj	Larkin			For Travel	
DATE ▶	5-9-69					

Form AEC-318 (Rev. 9-53) AECM 0240 U.S. GOVERNMENT PRINTING OFFICE : 1968 O—296-617

1138888

THE UNIVERSITY OF TEXAS
COLLEGE OF ENGINEERING
AUSTIN, TEXAS 78712

Department of Civil Engineering
Environmental Health Engineering
Engineering Laboratories Building 305

May 2, 1969

Dr. W. J. Larkin, Acting Director
Reactor Division
Oak Ridge Operations Office
P. O. Box E
Oak Ridge, Tennessee 37831

Dear Dr. Larkin:

This is a request for permission to attend and participate in an International Symposium devoted to Continental Radioecology to be held September 8 - 11, 1969, near Aix-en-Provence in France and to utilize contract funds for defrayment of travel, per diem, and registration expenses.

The paper I will present will be "Radionuclide Transport in Model River Systems."

I estimate the expenses to be ~~$887.00~~. 1000.00 E.F.G. Funds are available from my grant AT(11-1)-490, Transport of Radionuclides in Water (Model River and Ecological Systems).

Sincerely,

Earnest F. Gloyna, Director
Environmental Health Engineering

EFG:mhb

A 4131
MAY 6 1969
CONTRACTS - 490 (Texas)
For Direct

1138889