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MEMORANDUM FOR: Malcolm R. Knapp, Chief
Geotechnical Branch
Division of Waste Management

FROM: Michael F. Weber
Geotechnical Branch
Division of Waste Management

SUBJECT: REPORT ON THE 1984 MEETING OF THE NORTHEAST SECTION OF THE GEOLOGICAL SOCIETY OF AMERICA, PROVIDENCE, RHODE ISLAND

On Wednesday, March 14, 1984, I travelled to Providence, Rhode Island to participate in the Annual Meeting of the Northeast Section of the Geological Society of America. The primary purpose of this trip was to present the paper entitled "Implementing the Disturbed Zone Concept in Evaluations of HLW Repository Performance: A Thermohydrologic Analysis" in the Hydrotechnology Symposium. By providing a forum for the discussion of advanced applications of numerical modeling and geophysical techniques in hydrogeologic investigations, this symposium attracted the largest attendance of the Annual Meeting with participants from throughout the United States and Europe.

At the beginning of the symposium's last session, I presented the paper co-authored by myself and Matthew Gordon. Other papers presented in the symposium discussed low-level radioactive wastes, so the transition to this paper on HLW was easily facilitated. Copies of my slides are enclosed with this memorandum as Attachment 1; Attachment 2 provides the schedule of the Hydrotechnology Symposium. My 15-minute presentation was followed by a question and answer period during which I addressed the following questions:

1. What kinds of system testing (site characterization) does NRC recommend to develop the information to better calibrate performance assessment models of BWIP?

2. Does NRC participate in or conduct thermohydrologic analyses (similar to the one presented) for the STRIPA project in Sweden?

3. How far above the hypothetical underground facilities does waste heating perturb ground-water flow paths and travel times?

My presentation provided the audience with insight into some of the activities conducted by and issues examined by the NRC staff.

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The symposium began with a keynote address by George Pinder of Princeton University. John Guswa followed Dr. Pinder with a discussion of the importance of multi-phase flow of Non-Aqueous Phase Liquid (NAPL) in designing remedial actions at the S-area landfill in Niagra Falls, New York. Jeffrey Tracey presented an innovative paper during the afternoon session about the use of infrared thermography to determine aquifer discharge areas in the Canadian Shield.

Of particular significance to NRC's review of HLW repository siting, Jane Long presented a status report on current activities at Lawrence Berkley Laboratory (LBL) on characterizing and simulating groundwater flow in fractured, crystalline rock. One of the objectives of this research attempts to answer the question "when is it necessary to simulate ground-water flow by a discontinuum fracture-flow representation rather than a continuum porous media representation." By using a simple, 2-dimensional, parallel-plate flow simulation, LBL researchers have determined that for the system modeled (with specified statistical characteristics of fracture density, aperture, length, and orientation) porous media behavior is observed if fracture length exceeds 12 centimeters. Other preliminary conclusions of the LBL research include the following:

1. Heterogeneity in frature distribution reduces the overall medium permeability compared to the permeability of a medium with a similar bulk density of fractures using Snow's representation.

2. Long fractures with wide apertures, with a positive correlation between fracture length and aperture, behave as "superconductor" fractures. As observed in field studies of crystalline rock masses, such as at the Underground Research Laboratory (URL) in Canada, these superconductor fractures conduct greater than 90% of the ground-water flowing through the rock.

3. Fracture flow models are inherently three-dimensional; two-dimensional models are non-conservative representations because two fractures that do not intersect in the plane of the 2-D model may intersect in the third dimension.

4. Although ground-water flow through fractured media is critically dependent on fracture aperture distributions, LBL researchers have not successfully characterized aperture distributions in fractured crystalline media using existing techniques.

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DATE	03/ /84					

Paul Hsieh, USGS, followed Dr. Long's presentation during the afternoon session by presenting results of NRC-sponsored research that he participated in while at the University of Arizona. Mr. Hsieh's presentation primarily summarized the cross-hole testing strategy presented in NUREG/CR-3213.

This memorandum describes only those presentations which I consider to have immediate applications to activities of the Division of Waste Management. If you would like more information on any of the other papers presented at the Hydrotechnology Symposium or if you have questions about the papers described in this memorandum, please contact me.

"ORIGINAL SIGNED BY"

Michael F. Weber
Geotechnical Branch
Division of Waste Management

Enclosures:
As Stated

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NAME	MWeber:dm					
DATE	03/23/84					

IMPLEMENTING THE DISTURBED ZONE CONCEPT IN EVALUATIONS OF HLW REPOSITORY PERFORMANCE: A THERMO-HYDROLOGIC ANALYSIS

MICHAEL WEBER AND MATTHEW GORDON

MARCH 15, 1984

DIVISION OF WASTE MANAGEMENT

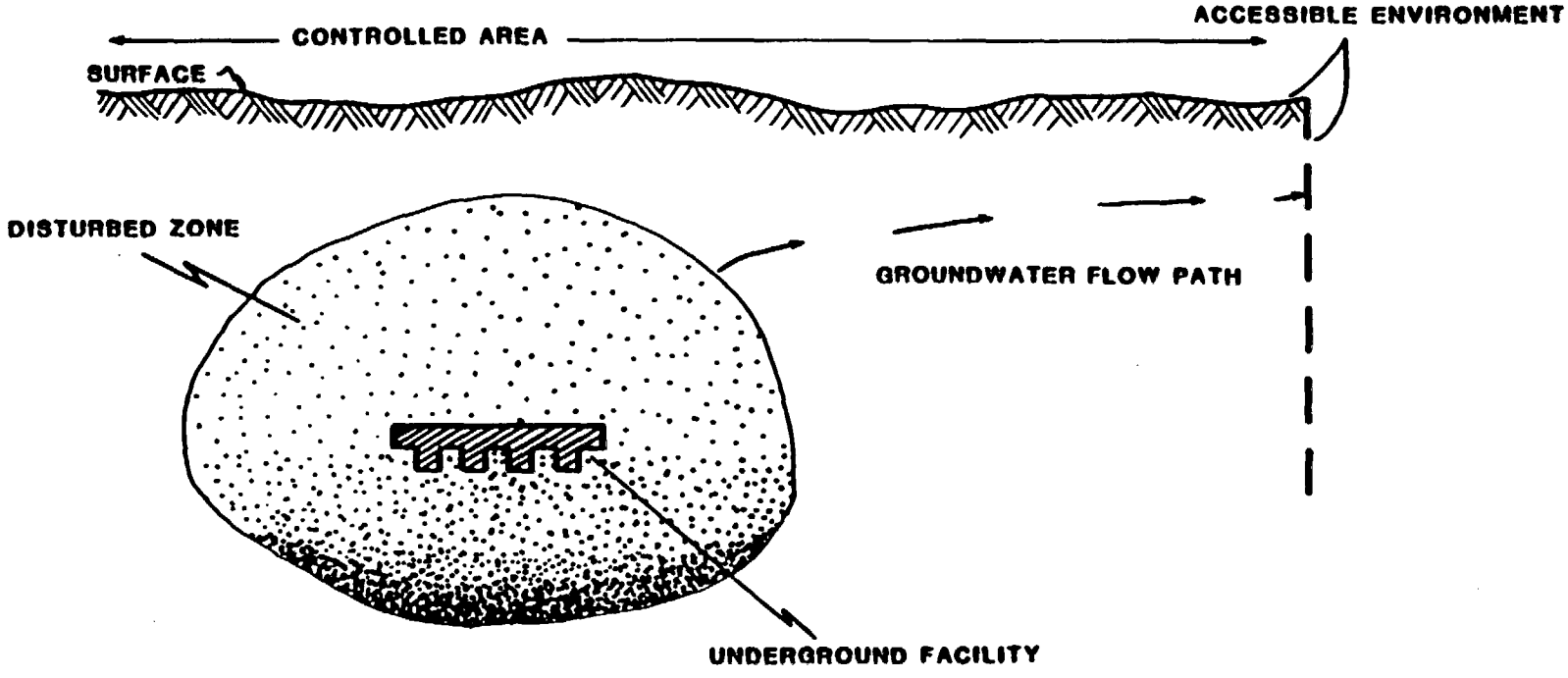
U.S. NUCLEAR REGULATORY COMMISSION

ATTACHMENT 1

OBJECTIVES OF PRESENTATION

- DEFINITION OF CONCEPT
- SCOPE OF PROBLEM
- AN ILLUSTRATION
- CONCLUSIONS

DISTURBED ZONE



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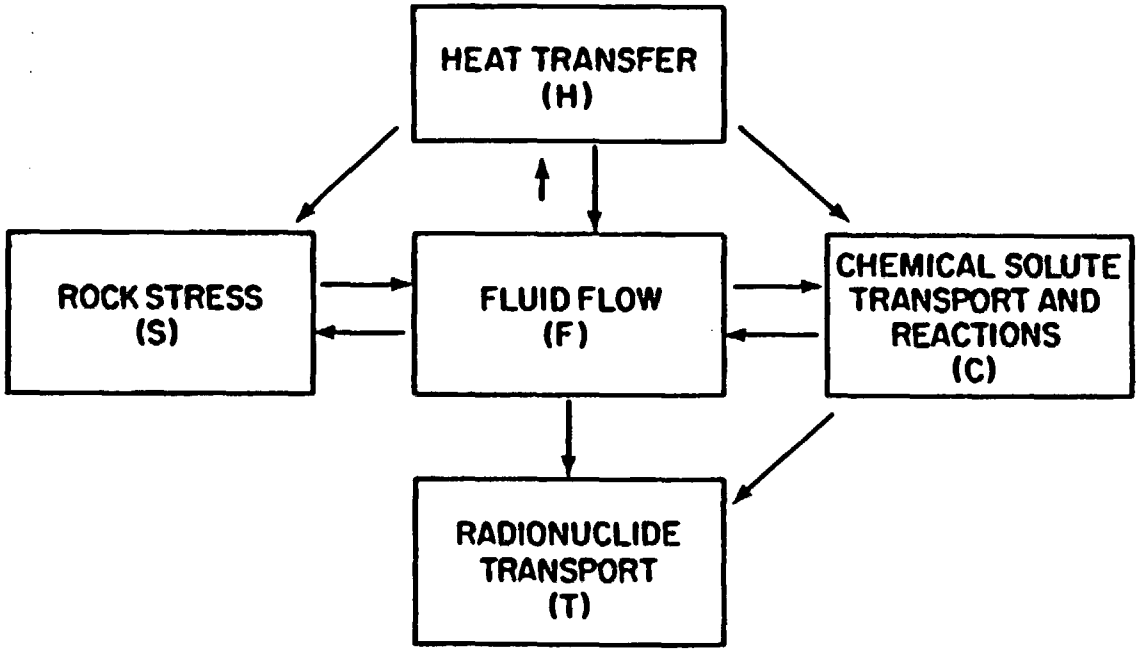
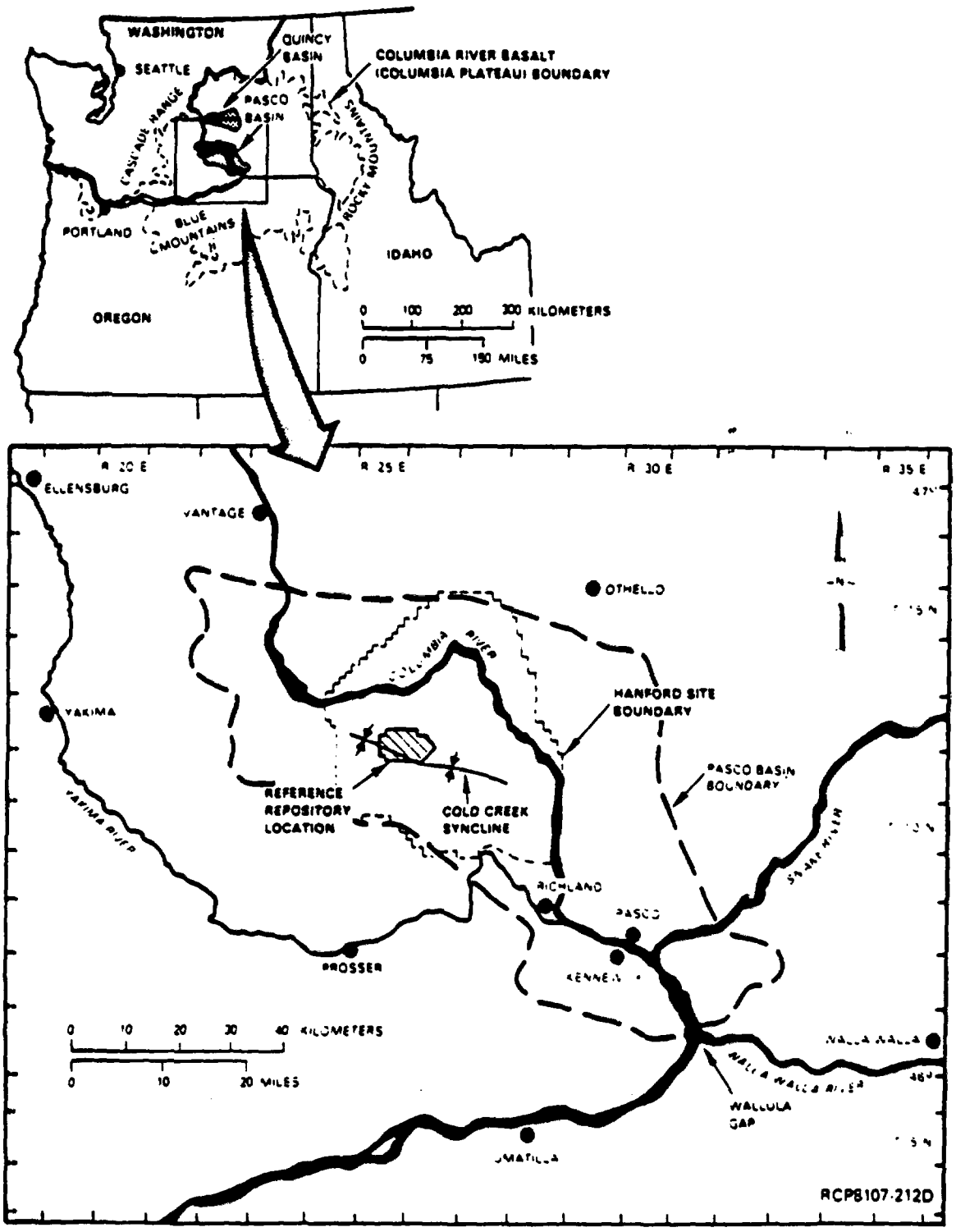
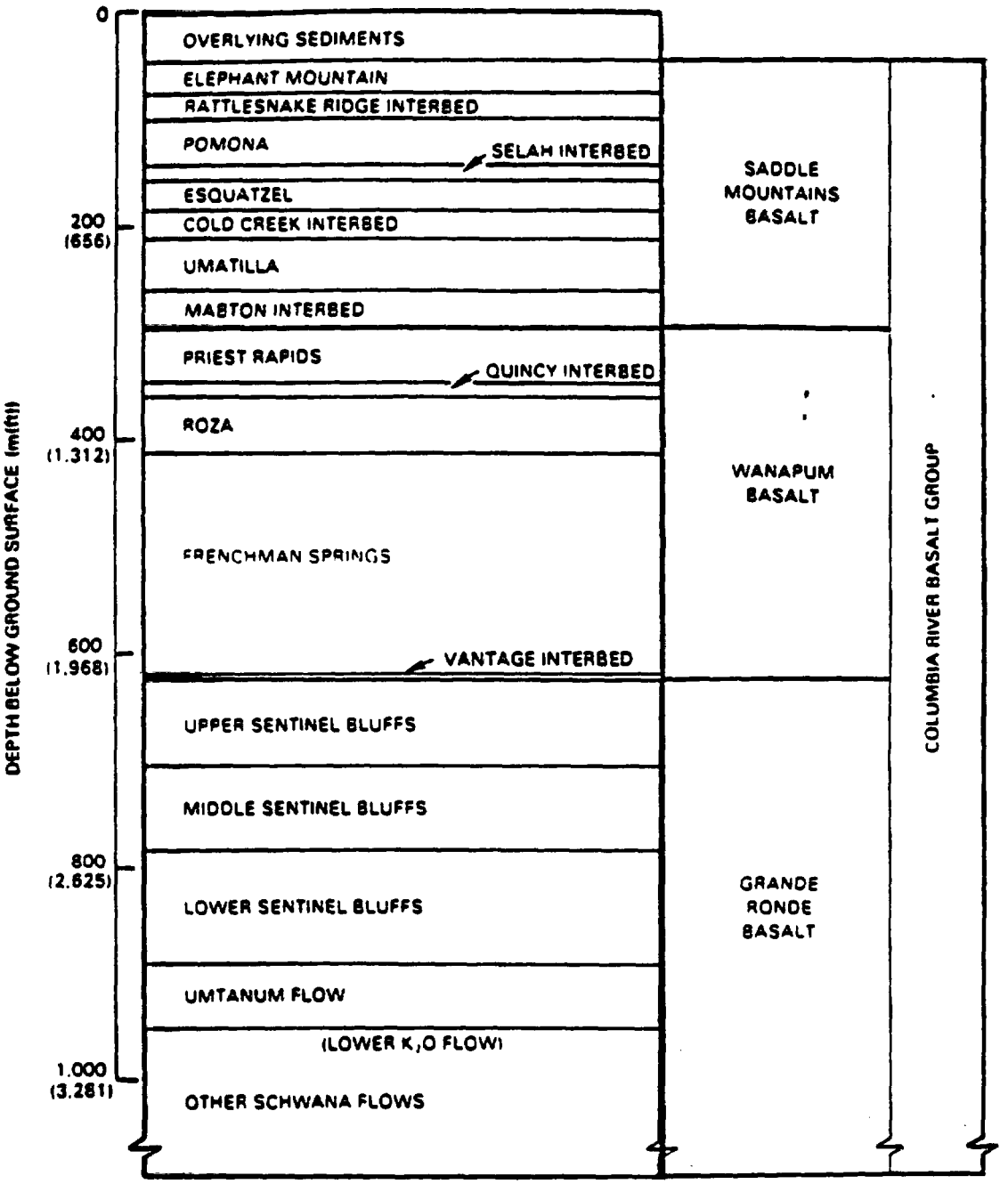
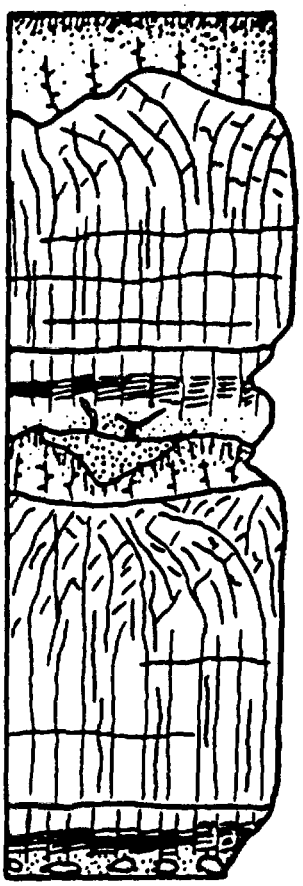

HEAT TRANSFER
(H)
ROCK STRESS
(S)
FLUID FLOW
(F)
CHEMICAL SOLUTE
TRANSPORT AND
REACTIONS
(C)
RADIONUCLIDE
TRANSPORT
(T)


WASHINGTON
SEATTLE
QUINCY BASIN
COLUMBIA RIVER BASALT (COLUMBIA PLATEAU) BOUNDARY
PASCO BASIN
CASCADE RANGE
ROCKY MOUNTAINS
PORTLAND
BLUE MOUNTAINS
IDAHO
OREGON
0 100 200 300 KILOMETERS
0 75 150 MILES
R 20 E
R 25 E
R 30 E
R 35 E
ELLENSBURG
VANTAGE
OTHELLO
COLUMBIA RIVER
YAKIMA
HANFORD SITE BOUNDARY
PASCO BASIN BOUNDARY
REFERENCE REPOSITORY LOCATION
COLD CREEK SYNCLINE
YAKIMA RIVER
SNAKE RIVER
RICHLAND
PASCO
PROSSER
KENNEWICK
WALLA WALLA
WALLULA GAP
UMATILLA
0 10 20 30 40 KILOMETERS
0 10 20 MILES
RCP8107-212D


DEPTH BELOW GROUND SURFACE (m(ft))
0
200 (656)
400 (1,312)
600 (1,968)
800 (2,625)
1,000 (3,281)
OVERLYING SEDIMENTS
ELEPHANT MOUNTAIN
RATTLESNAKE RIDGE INTERBED
POMONA
SELAH INTERBED
ESQUATZEL
COLD CREEK INTERBED
UMATILLA
MABTON INTERBED
PRIEST RAPIDS
QUINCY INTERBED
ROZA
FRENCHMAN SPRINGS
VANTAGE INTERBED
UPPER SENTINEL BLUFFS
MIDDLE SENTINEL BLUFFS
LOWER SENTINEL BLUFFS
UMTANUM FLOW
(LOWER K,O FLOW)
OTHER SCHWANA FLOWS
SADDLE MOUNTAINS BASALT
WANAPUM BASALT
GRANDE RONDE BASALT
COLUMBIA RIVER BASALT GROUP

HYDROSTRATIGRAPHIC UNITS



FLOW TOP 1

DENSE INTERIOR 1

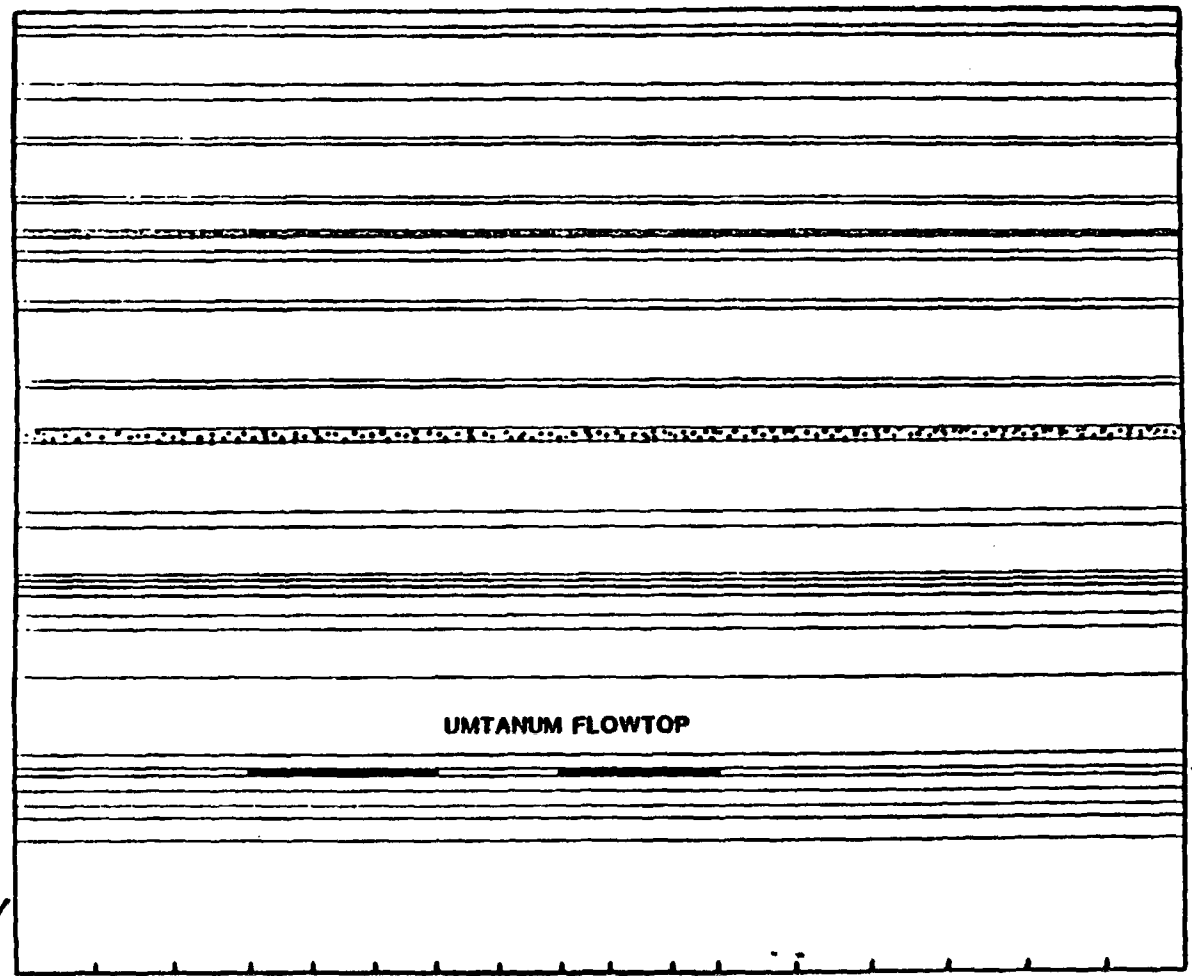
FLOW TOP 2

DENSE INTERIOR 2

FLOW TOP 3

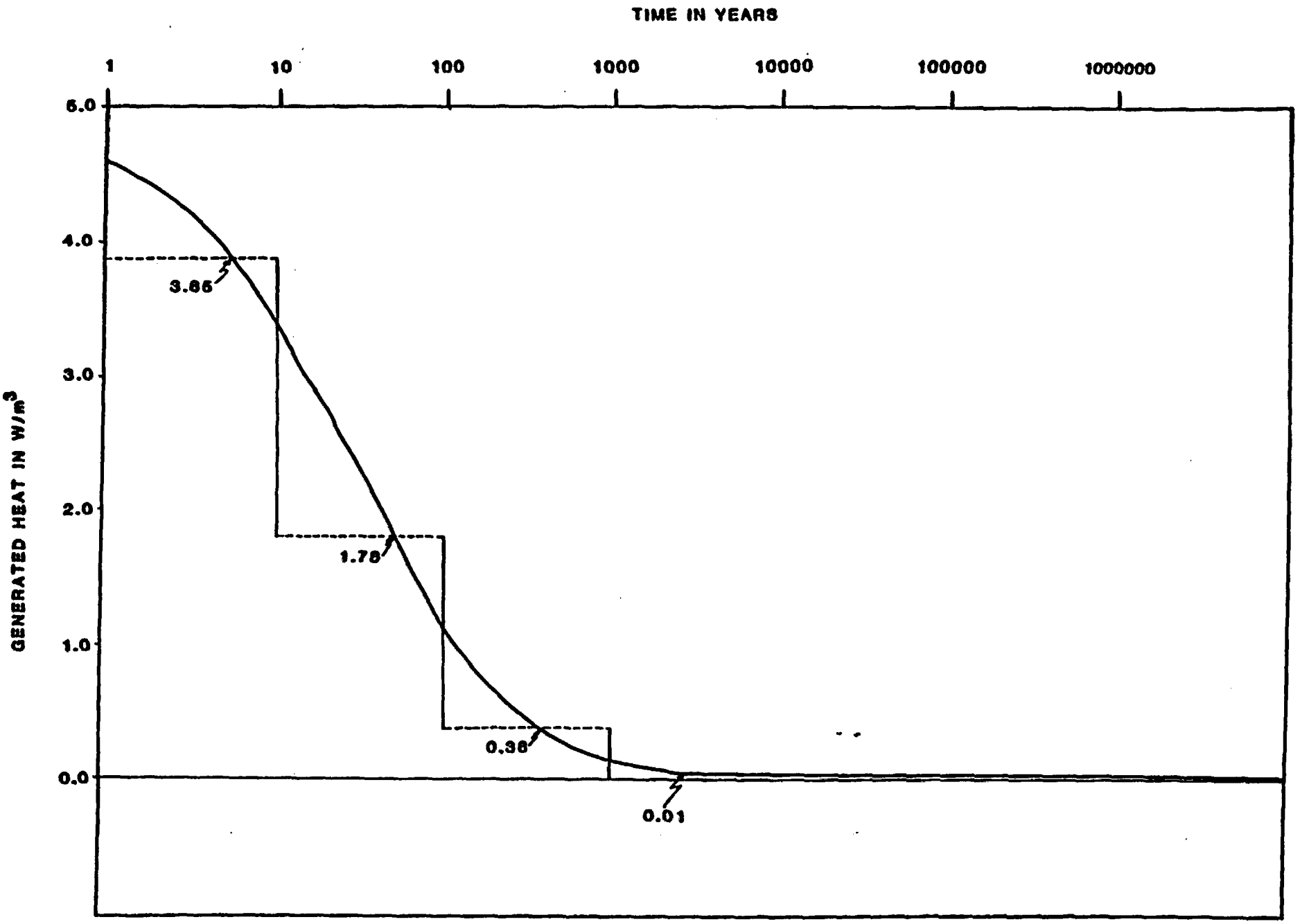
SCALE 6 m

2-D CONCEPTUAL MODEL



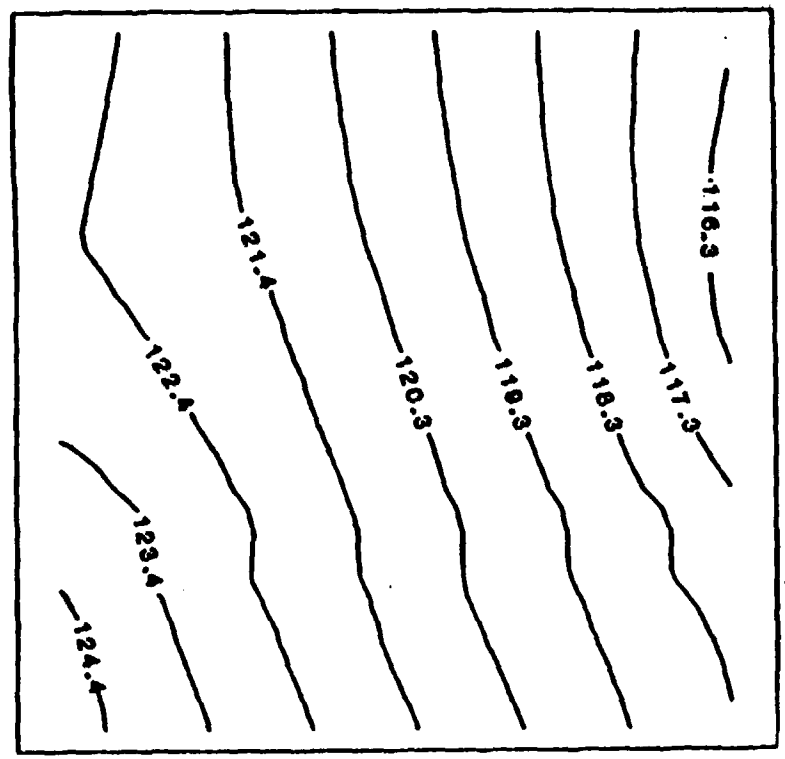
ALL BOUNDARIES ARE CONSTANT TEMPERATURE,

CONSTANT PRESSURE



THERMAL SOURCE DECAY

SWIFT 2-D ANALYSIS MODEL: 1-U-1



VERTICAL SCALE IN METERS

100
0
100

HEAD CONTOUR IN METERS

123.5

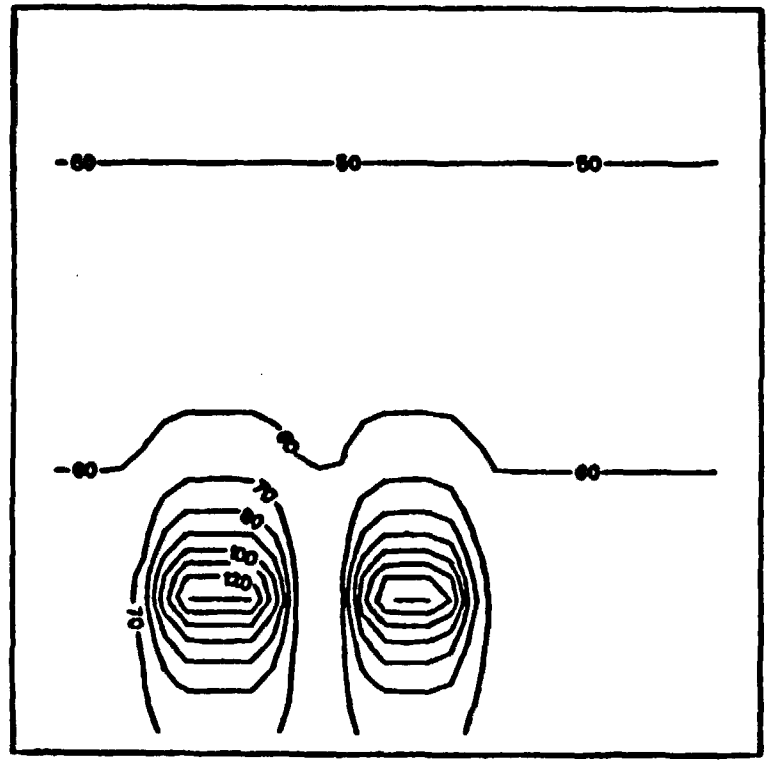
Repository Horizon

1000 0 1000

HORIZONTAL SCALE IN METERS

TIME: 0 YEARS

SWIFT 2-D ANALYSIS MODEL: 1-U-1



VERTICAL SCALE IN METERS

100
0
100

TEMPERATURE CONTOUR IN °C

60

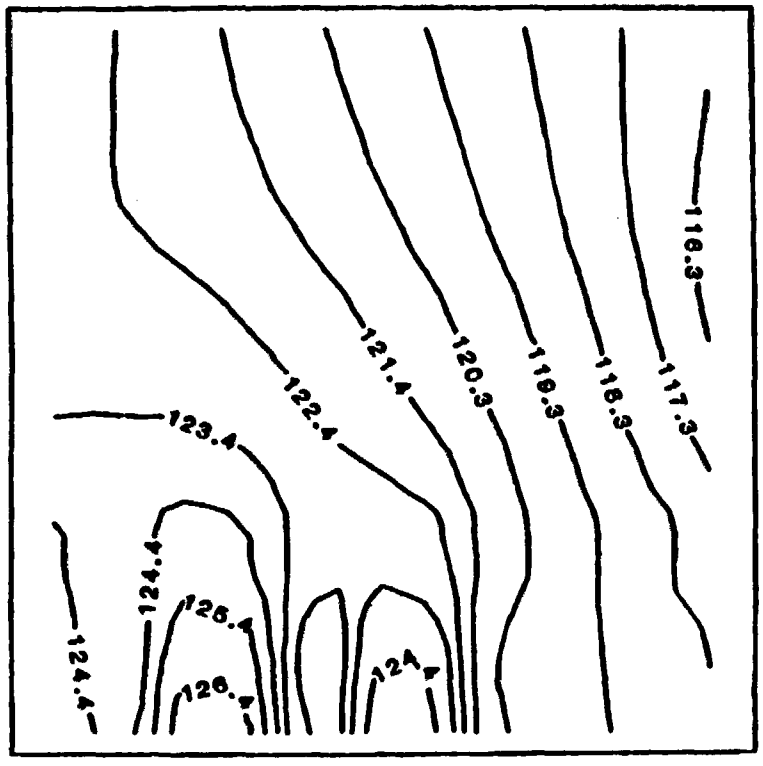
Repository Horizon

1000 0 1000

HORIZONTAL SCALE IN METERS

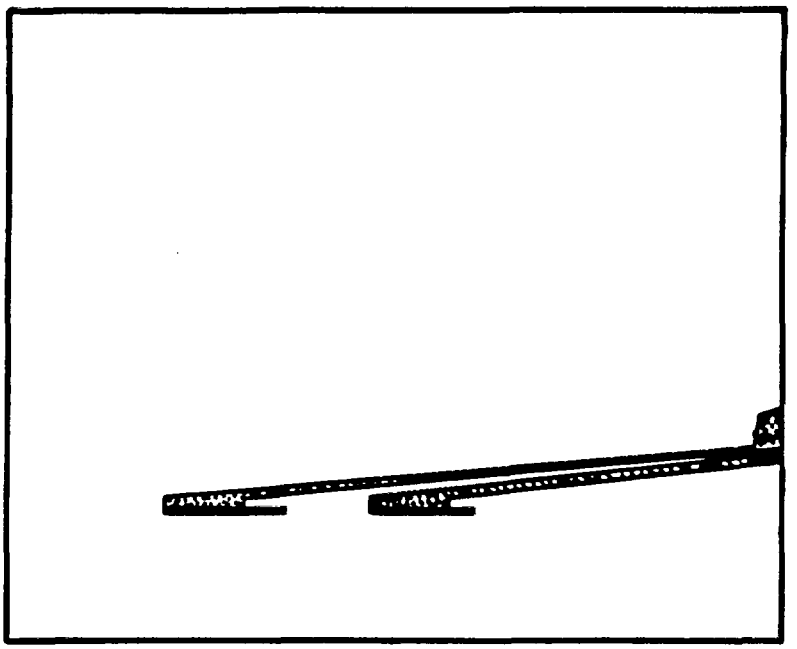
TIME: 100 YEARS

SWIFT 2-D ANALYSIS MODEL: 1-U-1

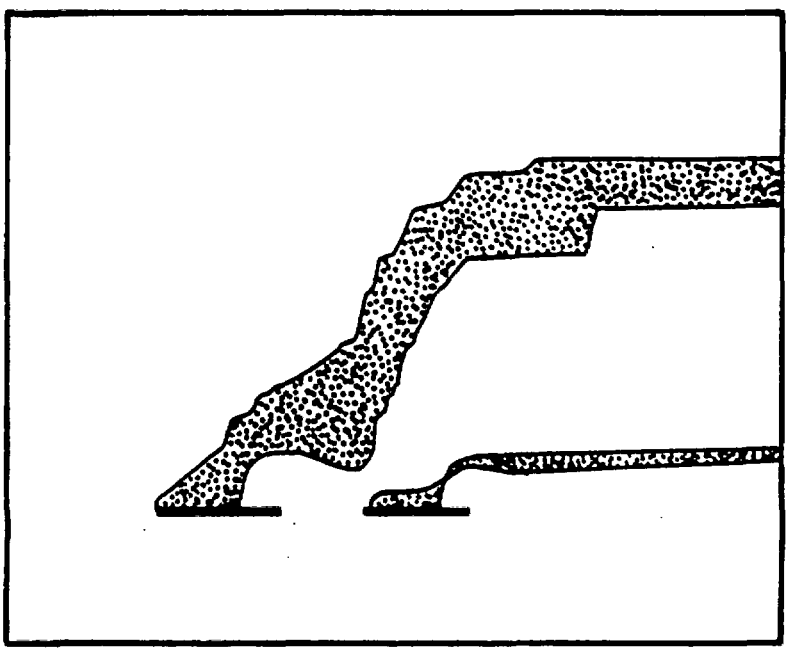


TIME: 100 YEARS

GROUNDWATER PATHTUBES



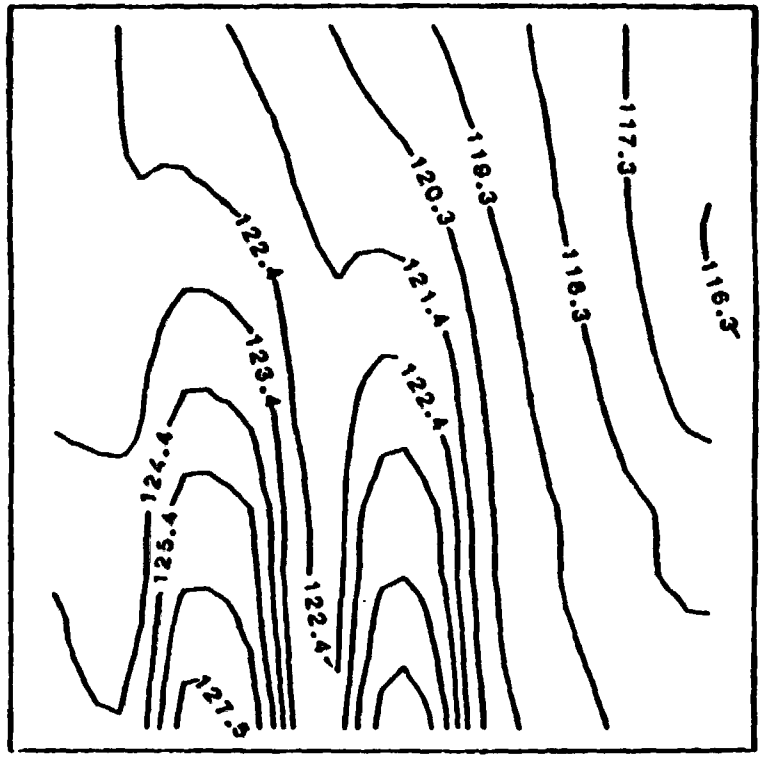
PRE-EMPLACEMENT



POST-EMPLACEMENT

PARTICLES RELEASED AT 1,000 YEARS

SWIFT 2-D ANALYSIS MODEL: 1-U-1



VERTICAL SCALE IN METERS

100
0
100

HEAD CONTOUR IN METERS

123.6

Repository Horizon

1000 0 1000

HORIZONTAL SCALE IN METERS

TIME: 2000 YEARS

CONCLUSIONS

- THERMAL-INDUCED BUOYANCY CAN SIGNIFICANTLY AFFECT GROUNDWATER TRAVEL TIMES AND FLOW PATHS AWAY FROM UNDERGROUND FACILITIES FOR HLW.

- CONDUCTIVE HEAT TRANSFER DOMINATES CONVECTIVE HEAT TRANSFER AWAY FROM THE MODELED UNDERGROUND FACILITY FOR HLW.

- SIMILAR ANALYSES SHOULD BE PERFORMED TO HELP IDENTIFY SIGNIFICANT PROPERTY CHANGES WHICH MAY AID DOE IN IMPLEMENTING THE DISTURBED ZONE CONCEPT.

HYDROTECHNOLOGY SYMPOSIUM

ATTACHMENT 2

March 15, 1984

Chairpersons:	Frank J. Wobber, Office of Energy Research, Department of Energy, Washington, D.C. George Pinder, Princeton University, Princeton, New Jersey	
8:30 a.m.	Introductory Remarks and Scope of Symposium.....	F. Wobber DOE
8:35 a.m.	Keynote Address: Advances in Computer Technology for Hydrogeological Predictions.....	G. Pinder Princeton Univ.
9:15 a.m.	Application of Multiphase Flow Theory to Design of Remedial Action Programs.....	J. Guswa A.D. Little, Inc.
9:45 a.m.	Hydrology of Discontinuous Fracture Networks.....	J. Long and P. Witherspoon, LBL
10:15 a.m.	COFFEE BREAK	
10:30 a.m.	An Introduction to the Advanced French Satellite System (SPOT).....	G. Weill SPOT Image, Inc.
10:40 a.m.	Use of SPOT Simulation Data for the Study of Hydrologic Transport Processes.....	T. Gardner Penn State Univ.
11:10 a.m.	Role of VLF-EM in Hydrologic Studies.....	E. Rothchild ORNL
11:35 a.m.	Resistivity Methods Applied to Pollution Detection in Ground Water Systems.....	D.P. Sanders and R.K. Frohlich Univ. of RI
12:00 noon	Closing Remarks/Lunch	

AFTERNOON SESSION

1:10 p.m.	Introductory Remarks.....	J. Sgambat Geraghty & Miller, Inc.
1:15 p.m.	The Effectiveness of Solute Transport Modeling in Ground-Water Contamination Problems.....	K. Atobrah Geraghty & Miller, Inc.
1:45 p.m.	Detection and classification of Ground-Water Discharge Sites with Airborne Infrared Thermography.....	G. R. Lawrence and J.P. Tracey, Intera
2:15 p.m.	Pressure Testing of Fractured Rocks Using the Cross-Hole Test Method.....	P. A. Hsieh U.S.G.S.
2:45 p.m.	Experience with Ground-Water Modeling as a Supportive Tool in a Hydrologic Investigation.....	E. J. Quinn Northeast Utilities
3:15 p.m.	COFFEE BREAK	
3:30 p.m.	Implementing the Disturbed Zone Concept in Evaluations of HLW Repository Performance.....	M. F. Weber and M. J. Gordon - NRC
4:00 p.m.	A Comparison of DC Resistivity and Terrain Conductivity Measurements for Ground-Water Contamination Investigations.....	A. L. Tolman and J. S. Williams - Maine Geol. Survey and Maine Dept. of Env. Prot.
4:30 p.m.	Use of a Computer Model to Obtain a Permit for a Landfill.....	M. B. Rinaldo - Lee Thomsen Associates
5:00 p.m.	Closing Remarks	