one pocket - 5
enclosure

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Rec'd 6/12/85

1

SUMMARY MEETING NOTES
DOE/NRC MEETING ON THE
BWIP HYDROLOGIC CHARACTERIZATION

SILVER SPRING, MD
DECEMBER 12 - 13, 1984

Agenda: Attachment 1

Attendees: Attachment 2

Developments:

The BWIP presented an overview and status of the hydrologic characterization activities and plans as they relate to developments arrived at, and extending from, the DOE/NRC meeting on BWIP Hydrologic Characterization (June 1984). The intent of the BWIP presentation (Attachment 3) was to fulfill a commitment to consult with the NRC prior to implementation of the Large-Scale Hydraulic Stress (LHS) tests of RRL-2 (stage II) with the objective of detailing and supporting the key elements of the LHS tests. This commitment was made in the "General Understanding" agreed on during the DOE/NRC workshop on Hydrologic Testing (July 1983) and formalized in the NRC Site Technical Position Paper 1.1 (STP 1.1). The NRC, due to other programmatic commitments, stated their inability to provide complete review an formal comment on the information provided at this time. The NRC acknowledged the need for further consultation and stated their desire to meet early in 1985.

The BWIP presentations outlined the current BWIP Hydrology program relative to LHS testing and focused on the following key elements:

1) The BWIP Hydrology program relative to STP 1.1
2) The implementation and interpretation of Stage II LHS testing of the Grande Ronde Formation at RRL-2
3) The conceptual approach and criteria for the establishment of a groundwater level baseline for stage II testing purposes in the reference repository location (RRL).
4) A review of existing water-level data in the RRL and Hanford Site.
5) The status and plans for the Regional (extended Pasco Basin) Hydrology Investigation being performed by the Interagency Hydrology Working Group.

1410

The BWIP discussed the NRC comments on the following topics (final agenda item)

1) Applicability of the Van der Kamp method in slug test analysis. (NRC comments dated 11/4/83)
2) Analysis of two-well tracer tests with a pulse input. (NRC comments dated 4/6/84)
3) Comments on Hydrogeologic Test Data. (NRC comments dated 5/25/84)

The NRC stated that it could not fully respond to the discussion of items 1, 2, and 3 at this time.

DOE Comments comprise Attachment 4.
NRC Comments comprise Attachment 5.
Other participants comments comprise Attachment 6.

K. Michael Thompson, DOE

12/12/84
Date

Matthew J. Gordon for
Robert O. Wright, NRC

12/13/84
Date

ATTACHMENT 1

Cover sheet for summary meeting notes 131.2

AGENDA
FOR NUCLEAR REGULATORY COMMISSION MEETING TO DISCUSS STAGE 2 HYDROLOGIC TESTING AT THE BASALT WASTE ISOLATION PROJECT

DECEMBER 12-13, 1984

OVERVIEW (1 HOUR) — S. M. BAKER/S. M. PRICE

- GEOLOGIC SETTING
- CURRENT PROGRAM
- RELATIONSHIP TO STP 1.1
- HISTORY

WATER LEVEL BASELINE DATA (3 HOURS) — S. R. STRAIT

- BRL PIEZOMETERS
  - WATER LEVELS
  - PRESSURES
  - ACCURACY
  - USE OF MULTI-LEVEL DEVICES
- HANFORD WATER LEVEL DATA

WATER LEVEL BASELINE CRITERIA (1/2 HOUR) — L. S. LEONHART

- WATER LEVEL TRENDS AND PREDICTIONS
- UNCERTAINTY IN HYDRAULIC PROPERTIES DUE TO WATER LEVEL UNCERTAINTY

STAGE 2 TESTING STRATEGY AND PLAN (2 HOURS) — P. M. ROGERS

- TEST OBJECTIVES
- FACILITIES
- PRE TEST ANALYSES/DESIGN
- TEST EXECUTION
- TEST ANALYSIS
- SCHEDULE

REGIONAL HYDROLOGY INVESTIGATION (1/2 HOUR) — D. A. ZIMMERMAN

- EXTENDED PASCO BASIN MODEL
- STATUS OF WORK

DISCUSSION OF SPECIAL TOPICS (OPEN)

- VAN DER KAMP — S. R. STRAIT
- DATA REVIEW — S. R. STRAIT
- RECIRCULATING TRACER TEST — L. S. LEONHART
- UPPER COLD CREEK SYNCLINE HYDROLOGIC BARRIER — S. M. Price

ATTACHMENT 2

NAME	ORGANIZATION	PHONE NUMBER
Matthew Gordon	NRC-WMGT	FTS 427-4438
Roy E. Williams	NRC Consultant	(208) 885-6259
Dave H. Dahlem	USDOE-BWIP	(509) 376-3022
Jay L. Smith	Consultant to DOE-RL	(213) 595-5795
Robert J. Wright	NRC	FTS 427-4674
Leo Leonhart	Rockwell-BWIP	FTS 444-2655
Pat Domenico	Texas AM	(409) 845-0636
Atef Elzeftawy	NRC-WMRP	FTS 427-4675
John Kovacs	USDOE	FTS 444-7062
M. J. Furman	DOE-RL	FTS 444-7062
Myron Fliegel	NRC-WMGT	FTS 427-4094
Warren Rehfeldt	NRC-WMRP	FTS 427-4681
Philip Justus	NRC-WMGT	FTS 427-4684
Joel Hunt	NRC/WMEH	FTS 427-4744
B. Geoffrey Jones	Geotrans Inc./Yakima Indians	(703) 435-4400
Tony Zimmerman	Pacific Northwest Labs (PNL)	(509) 376-8333
Ron Arnett	Rockwell-BWIP	FTS 444-7716
David Siefken	Weston	(301) 963-6817
Harry Smedes	Weston Consultant	(301) 963-5219
Henry Bermanis	Weston	(301) 963-5236
Maxine Dunkelman	NRC-WMRP-BWIP	FTS 427-4685
Kristin Westbrook	NRC-WMGT	301 427-4532
Michael Blackford	NRC-WMGT	FTS 427-4597
David S. Ward	Geotrans Inc/Yakima Indians	(703) 435-4400
Glen L. Faulkner	USGS-WRD/DOE	(202) 252-1464
R. Kornasievicz	NRC-Research	(301) 427-4210
L. Brown	NRC-Research	FTS 427-4628
Todd Rasmussen	Un. of AZ/Rockwell Consultant	(602) 621-1661
Soroosh Sorooshian	Un. of AZ/Rockwell Consultant	(602) 621-1661
Steve Strait	BWIP/RHO	(509) 373-4226
Phil Rogers	BWIP/RHO	(509) 376-0822
Neil Coleman	NRC/WMGT	FTS 427-4131
Gerry Winter	Williams & Assoc./NRC	(208) 883-0153
Steve Baker	BWIP/RHO	(509) 376-0822
Jim Bazemore	BWIP/RHO	(509) 376-8807
Maurice D. Veatch	BWIP/RHO	(509) 376-8807
K. Michael Thompson	USDOE-RL	FTS 444-6421
Randolph Stone	BWIP/RHO	(509) 373-4542
Paul Davis	Sandia Labs/NRC	(505) 846-5421
Jerry Rowe	Golder/RHO	(206) 827-0777
Thomas J. Nicholson	NRC/RES	FTS 427-4039
Lynn W. Gelhar	MIT	(617) 253-7121
S. M. Price	BWIP/RHP	(509) 376-2421
Linda Lehman	Yakima Indian Nation	(612) 894-9359
Charles Faust	Yakima Indian Nation	(703) 435-4400

ATTACHMENT 4

DOE/BWIP COMMENTS
SPECIFIC COMMENT RELATIVE TO THE PRESENTATIONS

1. The strategy for Stage 2 (RRL-2B) hydrologic testing was presented to the NRC Staff. Details of the facilities and testing activities were described to the extent possible at this time. Present hydrologic test plans call for testing up to four horizons prior to construction of the exploratory shaft drilling within the Grande Ronde Basalts. NRC's comments noted at this time will be considered in the formulation and documentation of final plans. These plans will be provided to the NRC when complete.

2. Plans for the construction of new observation well (RRL-2C) as well as the configuration of the existing RRL-2A well as a monitoring facility for LHS testing at RRL-2B were presented. These facilities are intended to provide multi-level monitoring capabilities within Grande Ronde flow tops and dense interiors at different radii distant from the pumping well. Provisions to conduct LHS monitoring at existing facilities (e.g. DC-16, RRL-6, DC-19, -20, -22, etc.) were also described.

Schedule for construction of wells DC-18 and DC-23 were discussed in light of their intended purpose of addressing boundary conditions in tests to be completed after Stage 2 tests are completed.

3. Plans to convert borehole RRL-14 into a multilevel monitoring facility by means of a multiport piezometer system were described. It is anticipated that a competitive bid will be awarded in time to complete such a conversion so that RRL-14 will provide an additional multilevel monitoring facility during Stage 2 testing. If the contract award cannot be made in sufficient time to complete the RRL-14 facility with a multi-level system, then bridge plug(s) and a TAM packer will be utilized. Plans for a similar conversion at RRL-6 are dependent on the successful field operation of the RRL-14 prototype. The decision to utilize RRL-14 as the prototype facility is based largely on the apparent higher degree of hydraulic conductivity within key flowtops at that location, as well as the proximity to the DC-22 cluster.

4. A thorough description of all facets of the BWIP groundwater monitoring effort (RRL, Hanford Site, and Regional) was presented. In particular, data gathered from the RRL and Hanford Site were described using specific examples which also attempted to correlate observed water-level dynamics with known sources of stress. Additional mention was made of activities

associated with PNL's Hanford Site Shallow Groundwater System Assessment activities in support of BWIP as well as regional groundwater data being gathered in the extended Pasco Basin area by USGS.

5. In the course of presenting Stage 2 testing plans, an appraisal of the expectation for LHS tests to interrogate suspected hydrologic boundaries within the central Cold Creek Syncline was presented. The evaluation of these boundaries is also expected to be emphasized throughout later testing stages. However, the details of these investigations were not available at this time. Some details, apart from separate of plans for the geologic and hydrologic characterization of the Upper Cold Creek Syncline Hydrologic Barrier were given in the course of other discussions.

6. Plans for the evaluation of leakance and vertical hydraulic conductivity in conjunction with Stage 2 testing were presented. Borehole RRL-2C will be configured so as to allow the monitoring of pressures within the dense interiors of selected basalt flows. This will allow the utilization of ratio as well as Hantush methods for the evaluation of hydraulic diffusivity across the confining units. The success of these methods during Stage 2 will provide the basis for vertical hydraulic conductivity measurements during later stages. Inverse modeling techniques will also

be used to estimate vertical conductivity of flow interiors using water level data.

7. The initial element in defining hydraulic continuity is to ascertain the variability in parameter estimation at various scales. The Stage 2 tests are poised to provide such information at scales ranging from 250 ft to several miles. Additionally, there is some confidence that boundaries will be interrogated. thereby providing more regional-scale information on structural control of groundwater flow. This effort however, is expected to continue throughout hydrologic characterization.

8. A presentation on groundwater tracer experiments described plans to attempt to "piggyback" convergent radial flow tracer tests onto large-scale constant discharge tests to be conducted during State 2. It is expected that these opportunities, if successful, could provide significant additional information on porosity, dispersivity, and possibly retardation, all of which are important parameters for groundwater transport evaluation.

ATTACHMENT 5

NRC Comments:

Due to short notice and prior programmatic commitments, the NRC is unable to formally respond at this time to the information presented by the DOE. The NRC recognizes the need for such consultation and would like to work toward further interaction in early 1985.

NRC has requested and BWIP has agreed to provide to NRC by early 1985 the following items:

1) Documentation of all integrity checks on packer and cement seals that have been performed.
2) Pre-May monitoring data.
3) Documentation of methodology for pressure corrections and conversion to hydraulic head.

ATTACHMENT 6

Other Participant Comments

A request was made at the end of the meeting for comments by organizations other than BWIP or NRC, or by members of the public.

Representatives of the Yakima Indian Nation expressed gratitude for being invited to the meeting. Geoff Jones (YIN) indicated that they hoped to provide comments at some later date to DOE/BWIP on the material presented at this meeting.

The State of Washington was contacted by DOE prior to the meeting but was unable to attend. They requested that they receive a copy of the summary meeting notes.

No other groups or members of the public were present, or took this opportunity to make comment.

NRC — BWIP
MEETING TOPICS

- BWIP HYDROLOGY PROGRAM RELATIVE TO S.T.P.-1.1
- WATER-LEVEL BASELINE
- LARGE-SCALE HYDRAULIC STRESS (LHS) TESTING AT RRL-2
- USGS INTERPRETIVE DATA --IHWG (USGS/DOE)
- OTHERS

AGENDA
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TO DISCUSS STAGE 2 HYDROLOGIC TESTING
AT THE BASALT WASTE ISOLATION PROJECT

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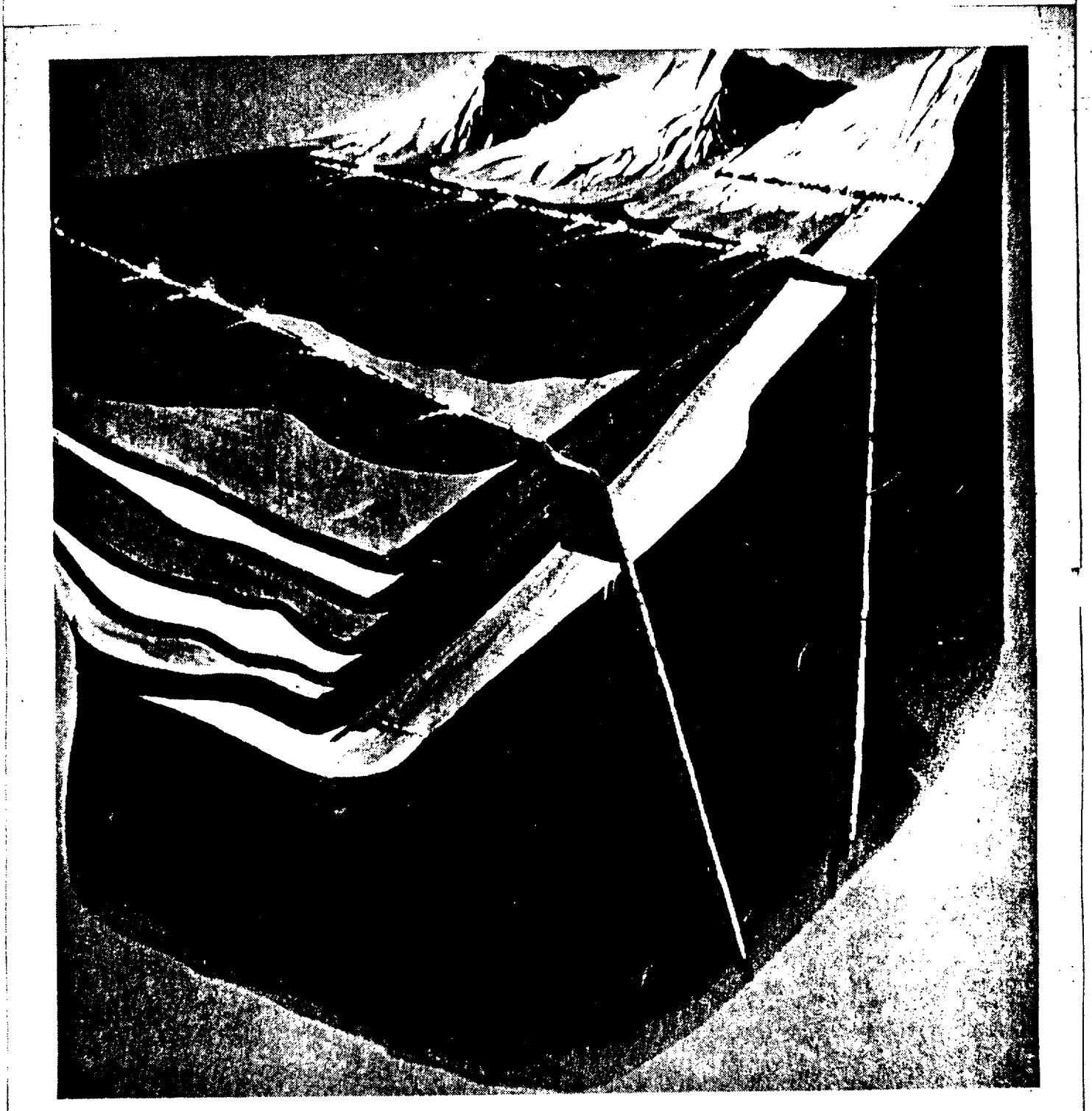
GEOLOGIC SETTING

S. M. PRICE



GENERALIZED MAP OF THE CENTRAL AND NORTHERN PORTION OF THE COLUMBIA PLATEAU

LEGEND

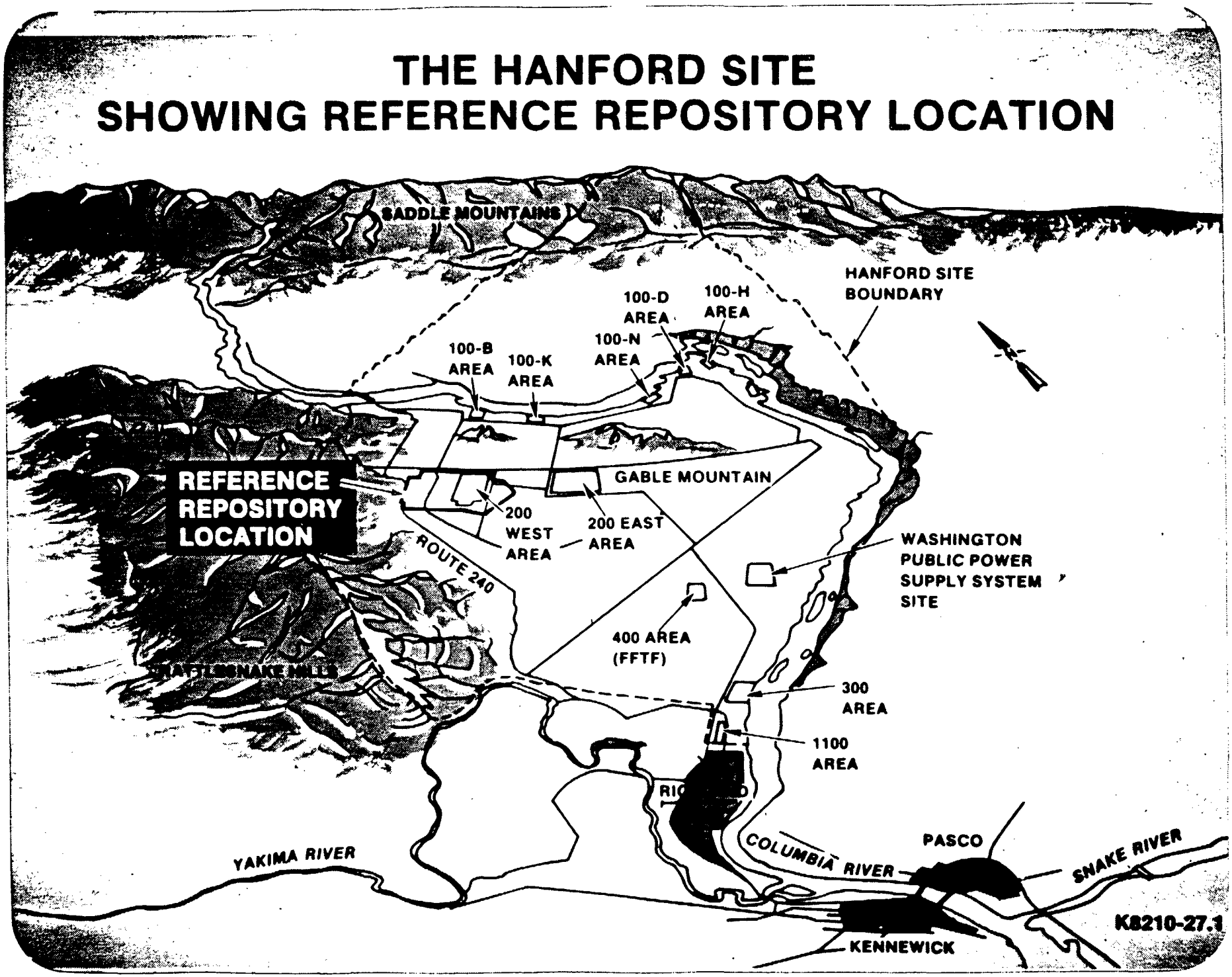
- SUPRABASALT SEDIMENTS
- SADDLE MOUNTAIN BASALT
- WANAPUM BASALT
- GRANDE RONDE BASALT
- IMNAHA BASALT
- PRE-BASALT BASEMENT ROCK

0 10 20 MILES

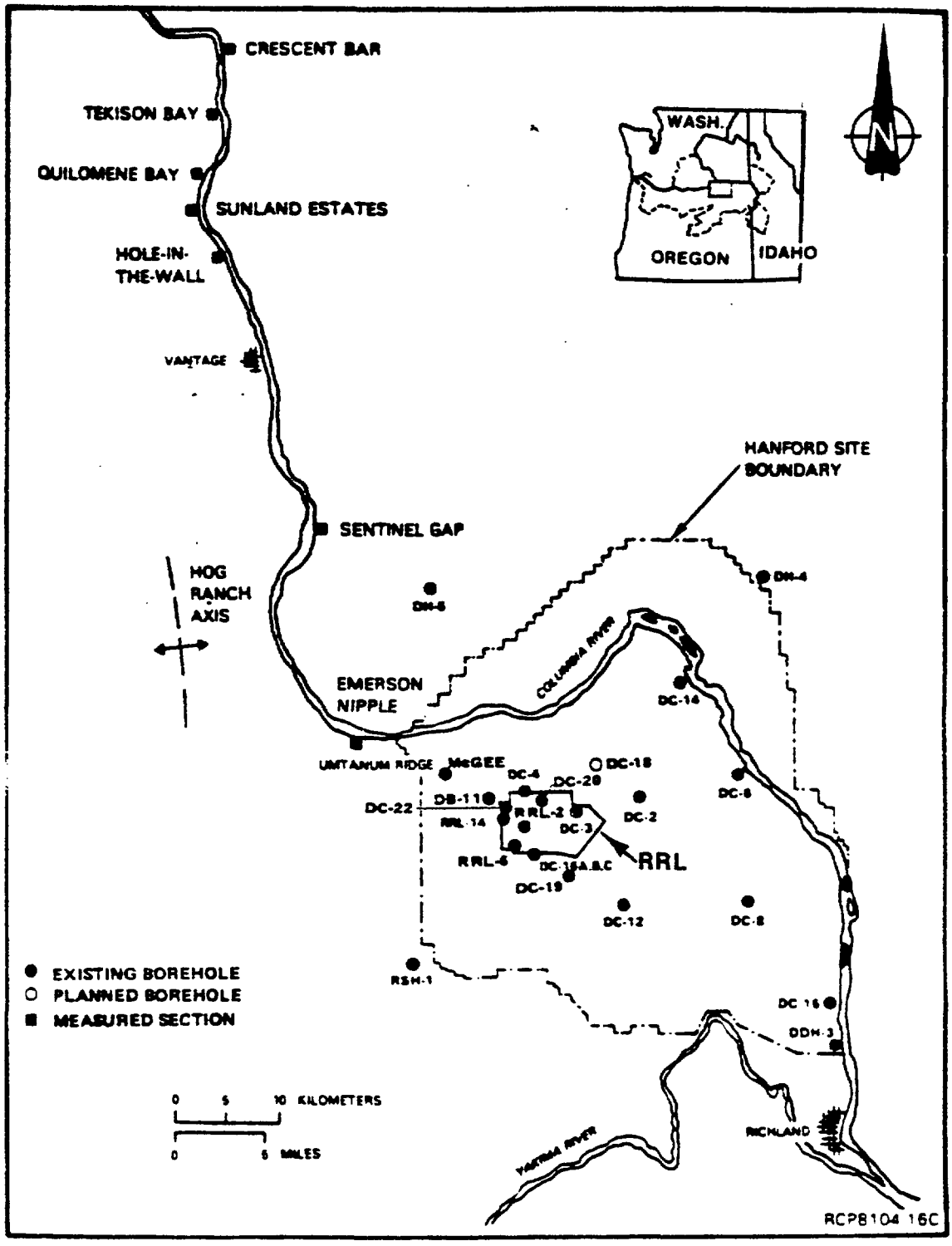
0 10 20 KILOMETERS

INDEX MAP

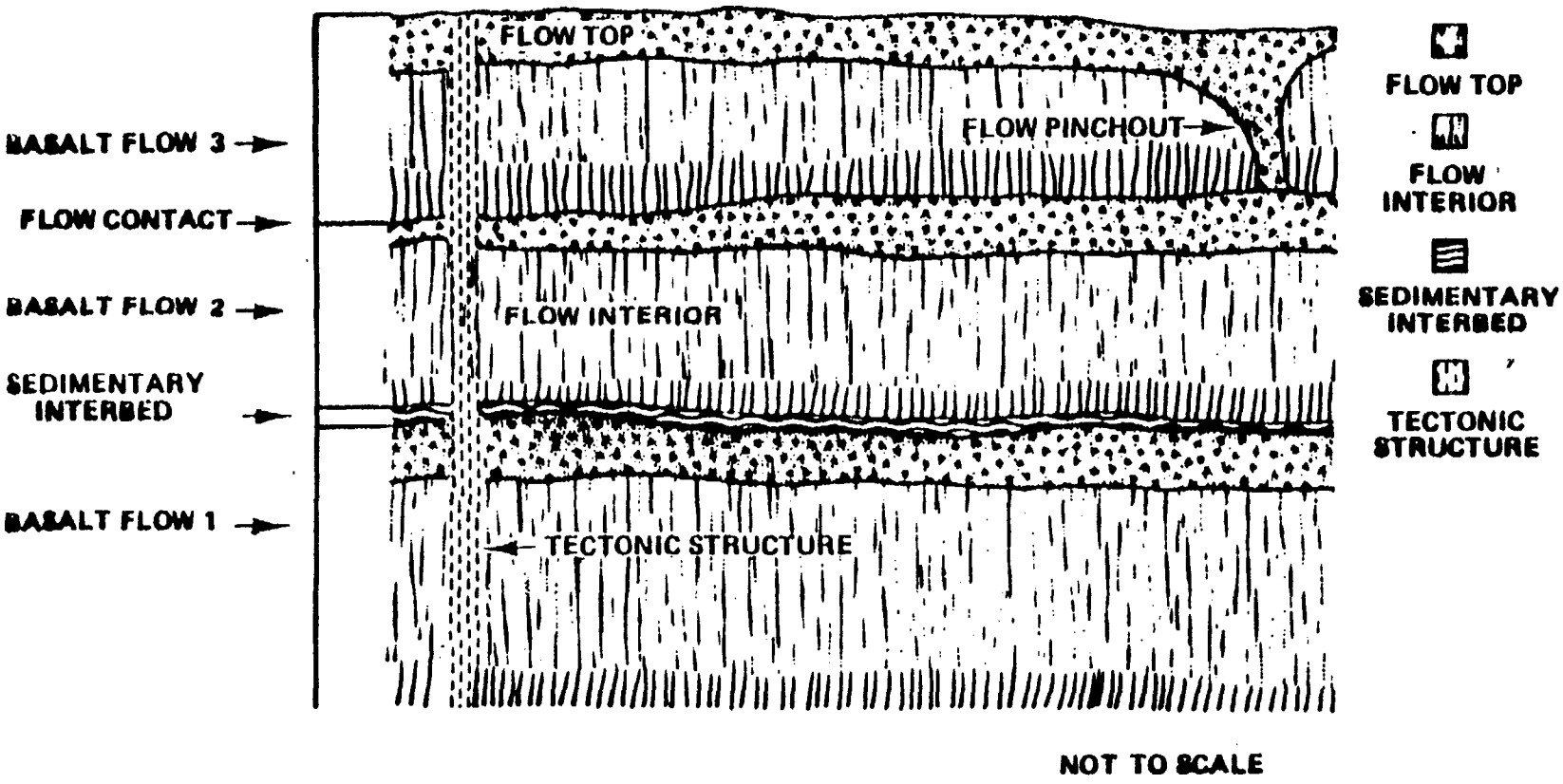
THE HANFORD SITE
SHOWING REFERENCE REPOSITORY LOCATION

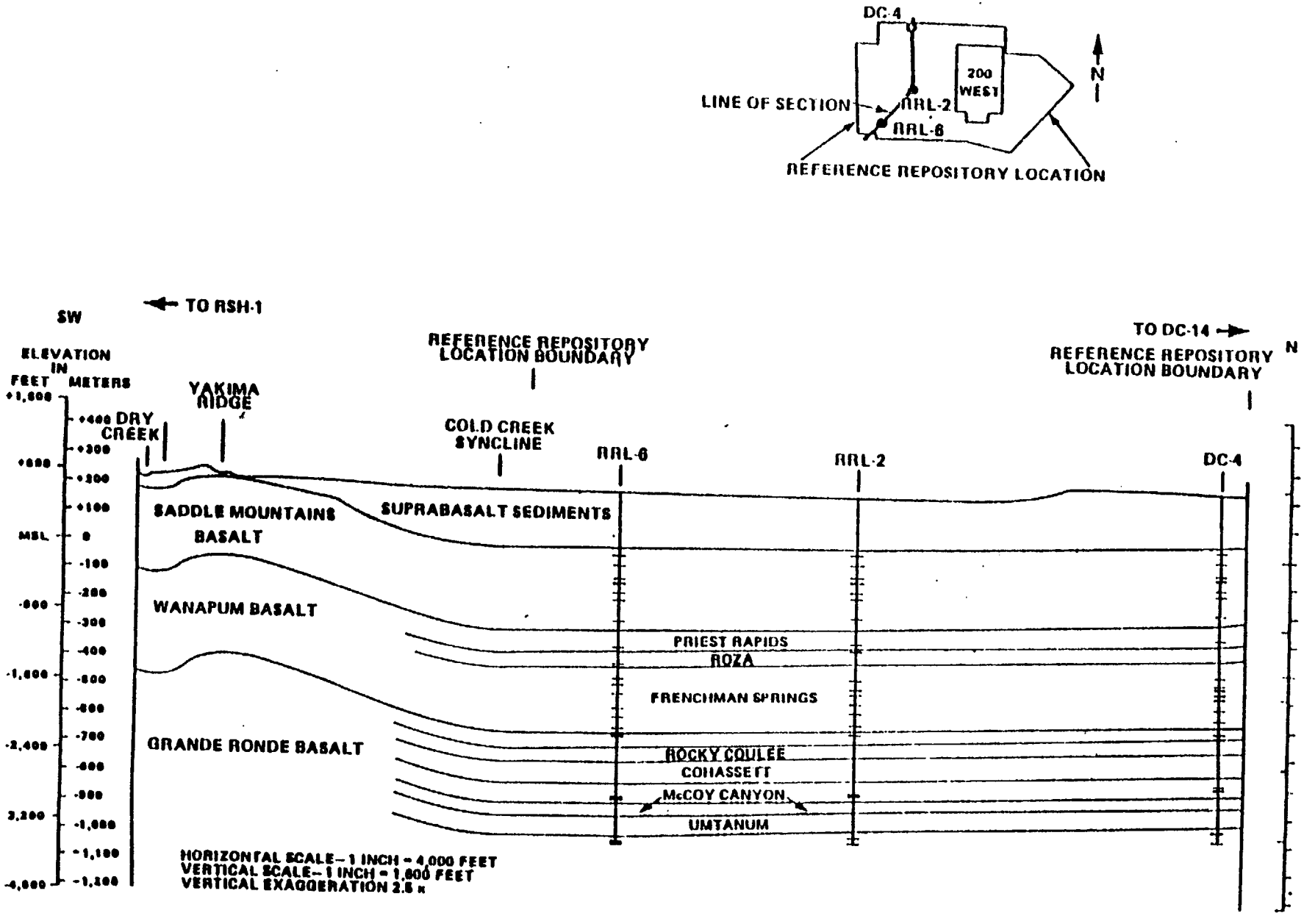


LOCATION MAP, PASCO BASIN AND SURROUNDING AREAS

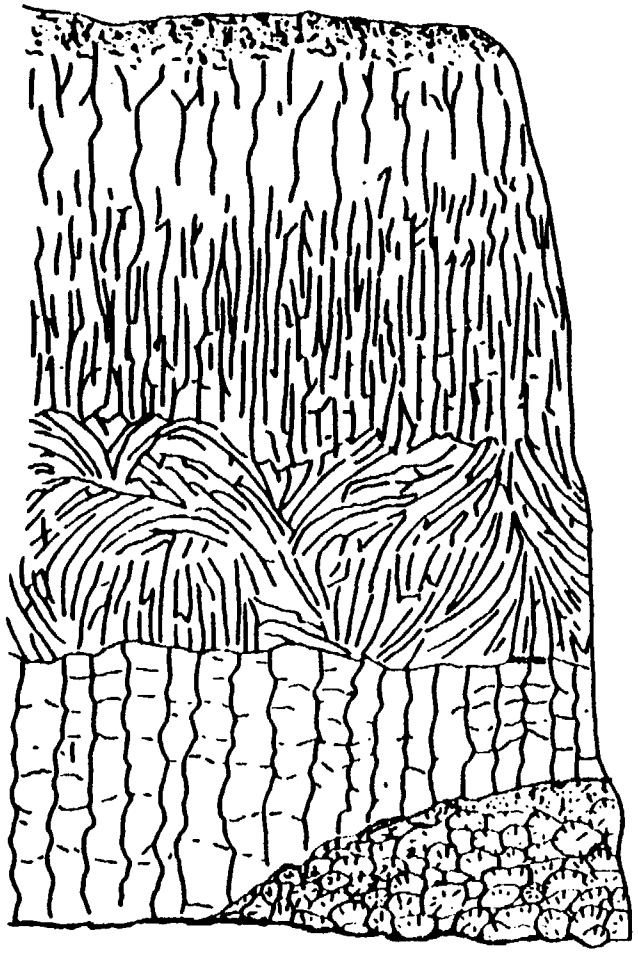


HYPOTHETICAL COMPOSITE CROSS SECTION OF GEOLOGIC FEATURES POTENTIALLY AFFECTING GROUNDWATER FLOW PATHS




DC-4
200 WEST
N
LINE OF SECTION
RRL-2
RRL-6
REFERENCE REPOSITORY LOCATION
TO RSH-1
SW
TO DC-14
N
ELEVATION IN FEET METERS
REFERENCE REPOSITORY LOCATION BOUNDARY
REFERENCE REPOSITORY LOCATION BOUNDARY
YAKIMA RIDGE
DRY CREEK
COLD CREEK SYNCLINE
RRL-6
RRL-2
DC-4
SADDLE MOUNTAINS BASALT
SUPRABASALT SEDIMENTS
WANAPUM BASALT
PRIEST RAPIDS
ROZA
FRENCHMAN SPRINGS
GRANDE RONDE BASALT
ROCKY COULEE
COHASSETT
McCOY CANYON
UMTANUM
MSL
+1,600
+400
+300
+200
+100
0
-100
-200
-300
-400
-500
-600
-700
-800
-900
-1,000
-1,100
-1,200
-1,600
-2,400
-3,200
-4,000
HORIZONTAL SCALE– 1 INCH = 4,000 FEET
VERTICAL SCALE– 1 INCH = 1,600 FEET
VERTICAL EXAGGERATION 2.5 x

INTRAFLOW STRUCTURES IN A HYPOTHETICAL FLOW



VESICULAR, LOCALLY BRECCIATED FLOW TOP

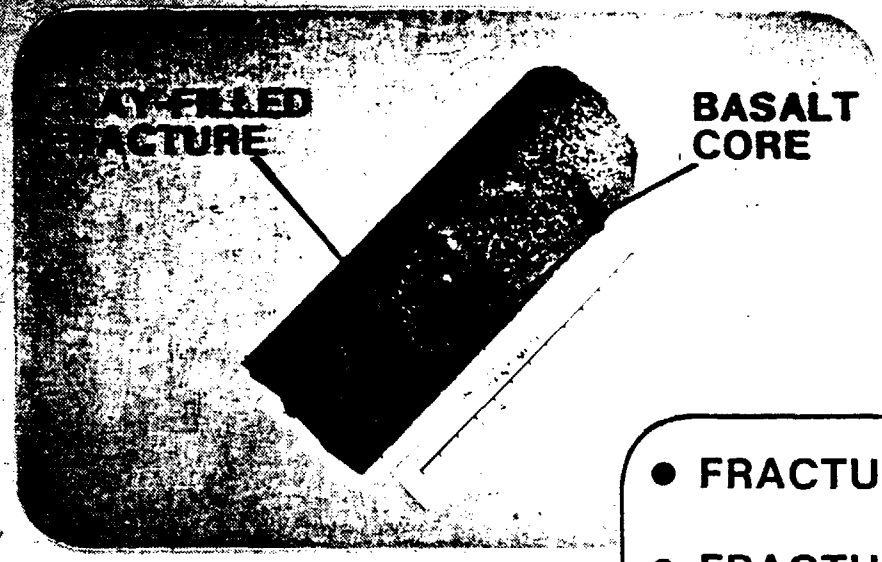
UPPER COLONNADE

ENTABLATURE

BASAL COLONNADE

PILLOW ZONE

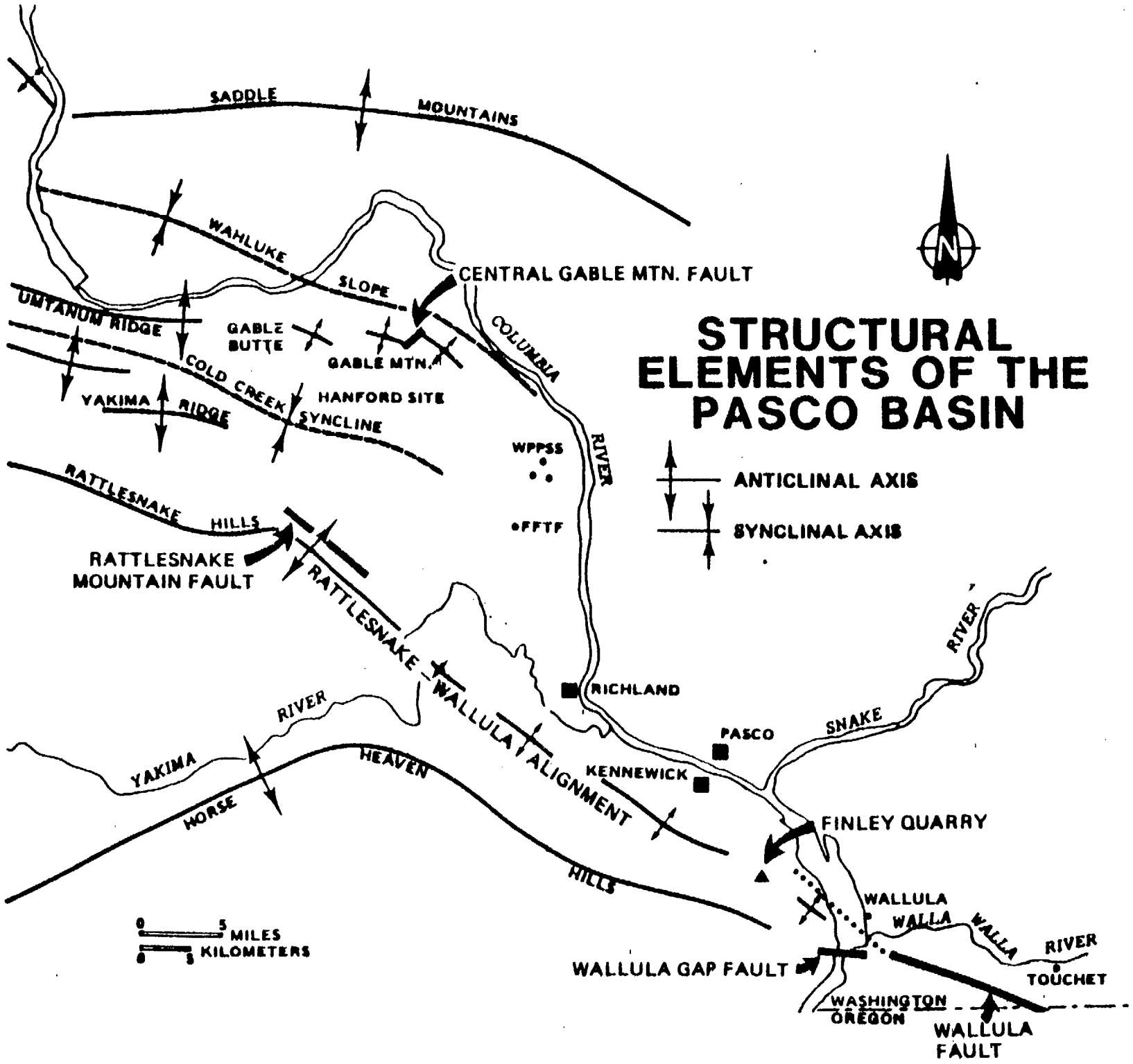
RCP8104-17



Fracture Analysis

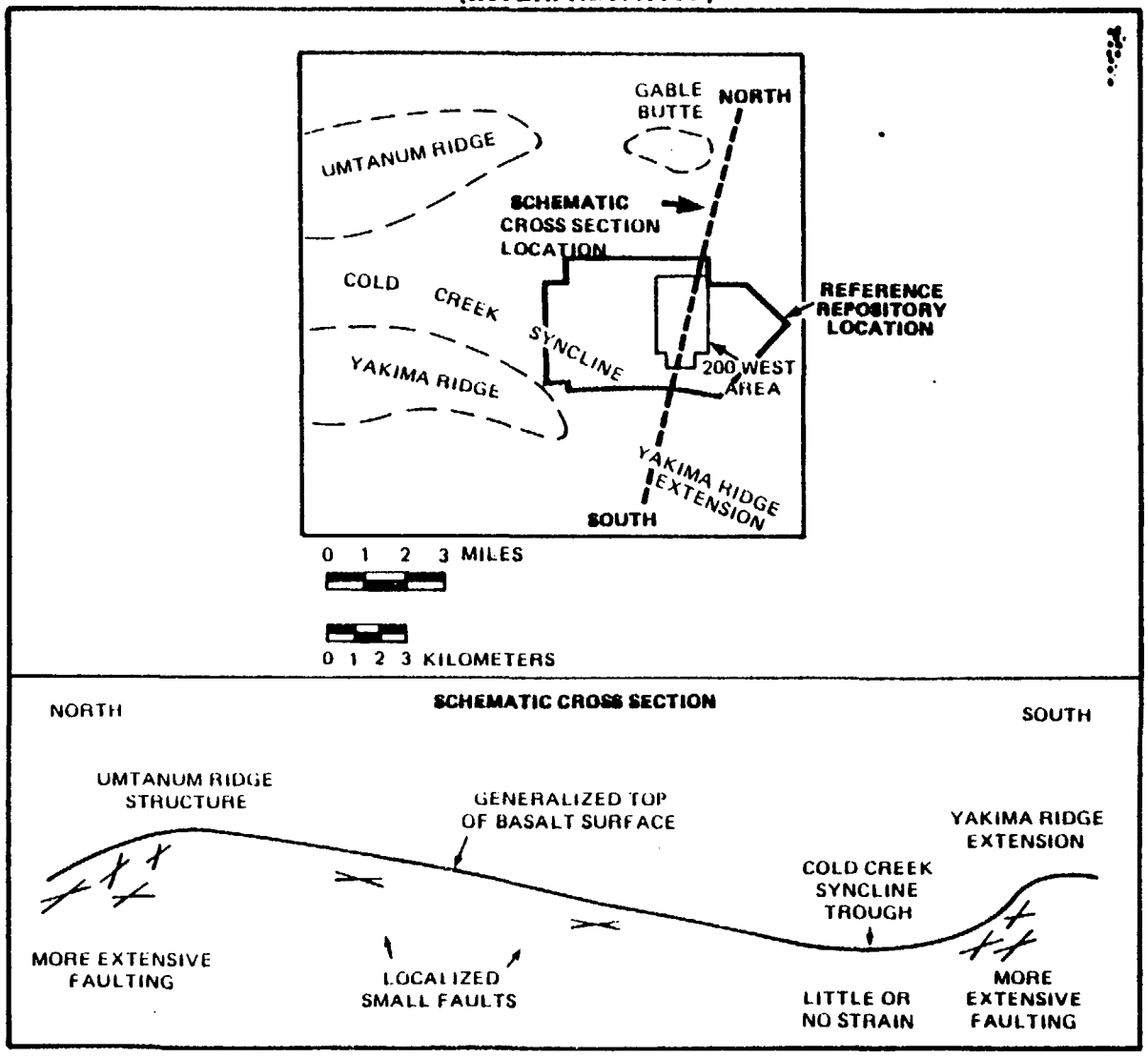
- FRACTURE ORIENTATION
- FRACTURE SPACING
- NATURE OF INFILLING MATERIAL
- NUMBER OF FRACTURES
- JOINT PROPERTIES
- NATURE OF MICROCRACKS AND VESICLES
- AGE OF SECONDARY vs. PRIMARY MATERIALS

V7709-18.35

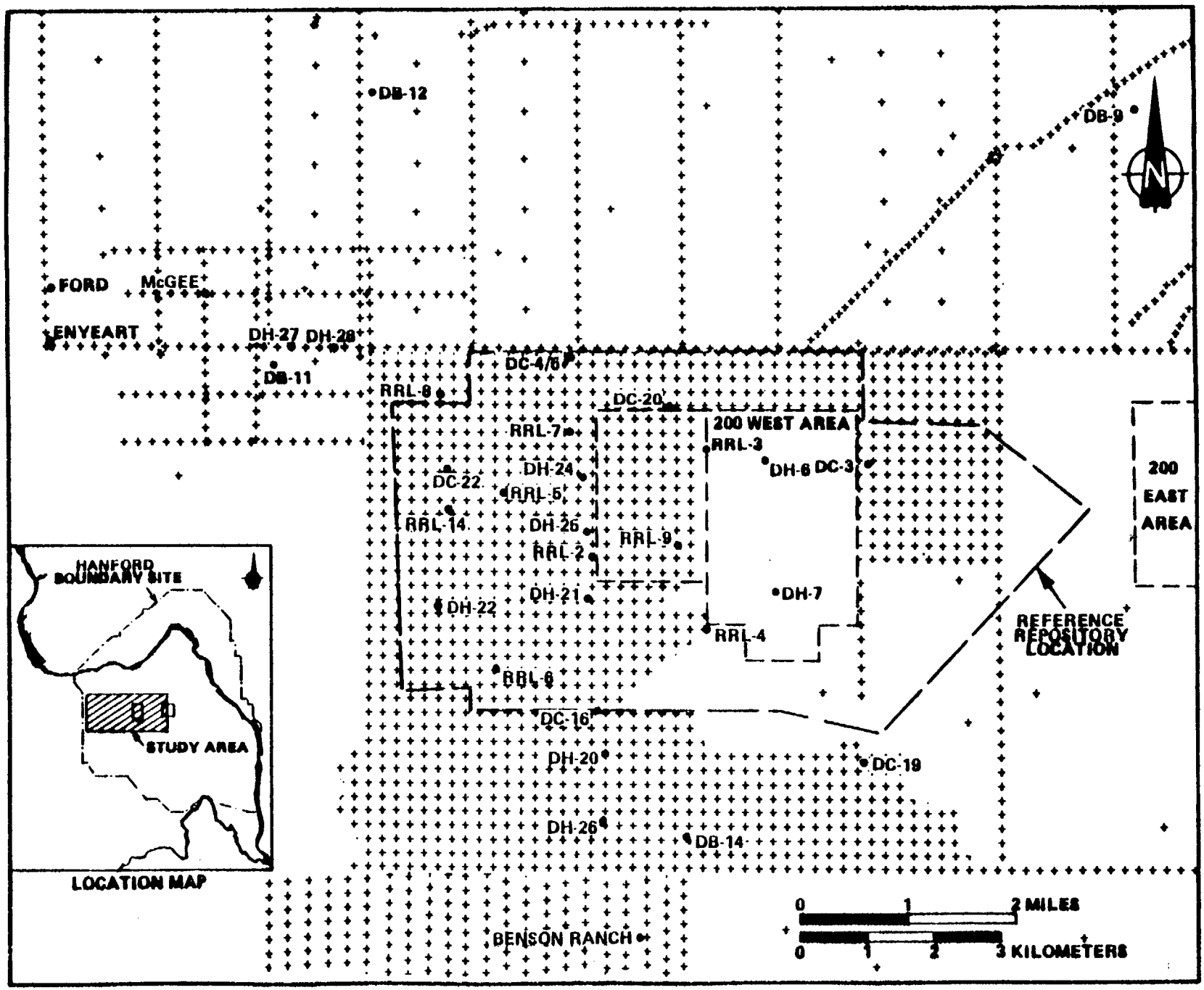

SADDLE
MOUNTAINS
WAHLUKE
SLOPE
CENTRAL GABLE MTN. FAULT
UMTANUM RIDGE
GABLE BUTTE
GABLE MTN.
COLUMBIA
RIVER
COLD CREEK
HANFORD SITE
YAKIMA
RIDGE
SYNCLINE
WPPSS
FFTF
RATTLESNAKE
HILLS
RATTLESNAKE
MOUNTAIN FAULT
RATTLESNAKE
WALLULA ALIGNMENT
RIVER
RICHLAND
PASCO
SNAKE
RIVER
KENNEWICK
YAKIMA
RIVER
HEAVEN
HORSE
HILLS
FINLEY QUARRY
WALLULA
WALLA
WALLA
RIVER
TOUCHET
WALLULA GAP FAULT
WASHINGTON
OREGON
WALLULA
FAULT
0 5 MILES
0 5 KILOMETERS
N
STRUCTURAL
ELEMENTS OF THE
PASCO BASIN
ANTICLINAL AXIS
SYNCLINAL AXIS

SCHEMATIC CROSS SECTION, COLD CREEK SYNCLINE

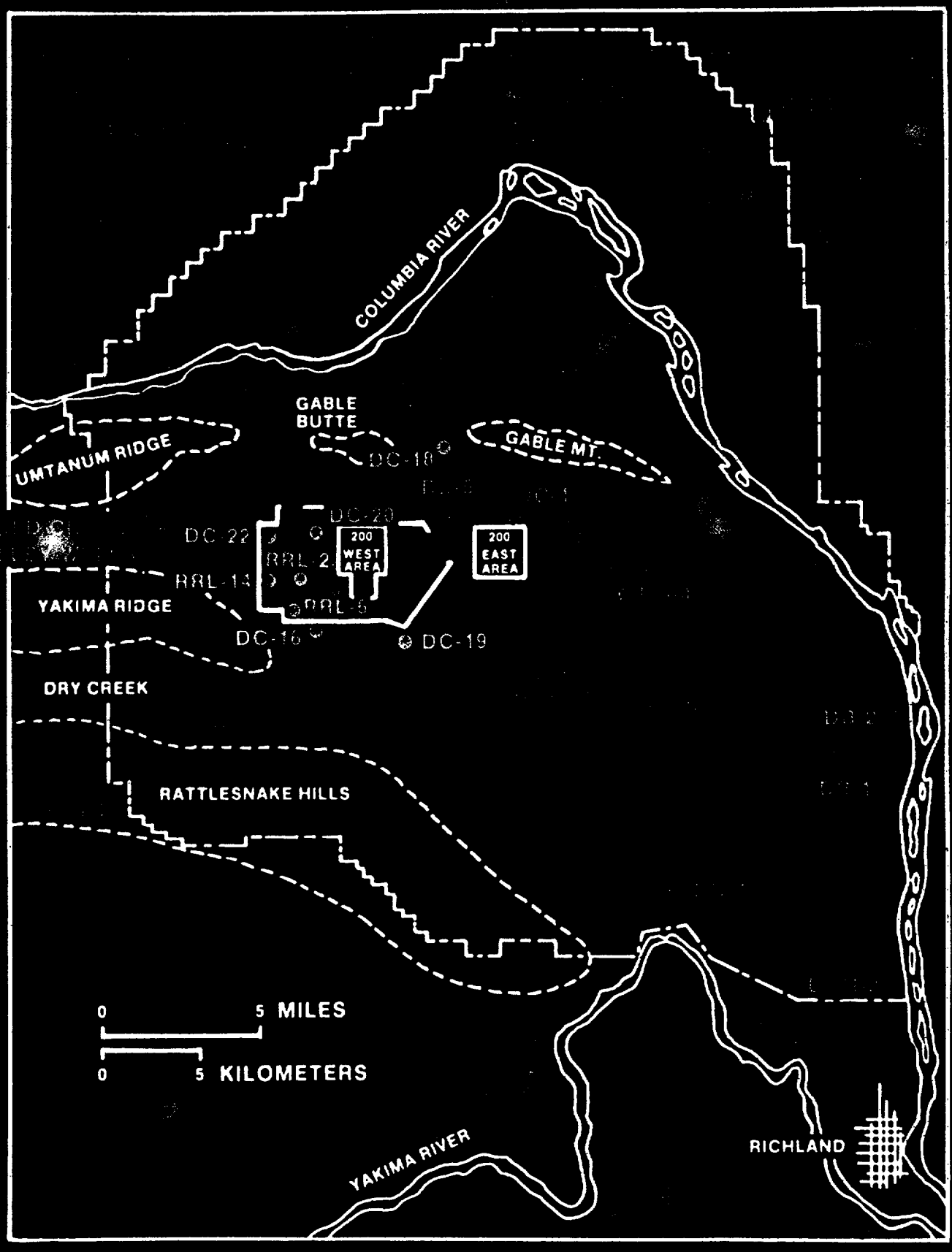
(INTERPRETATIVE)



LOCATION OF GEOPHYSICAL SURVEYS



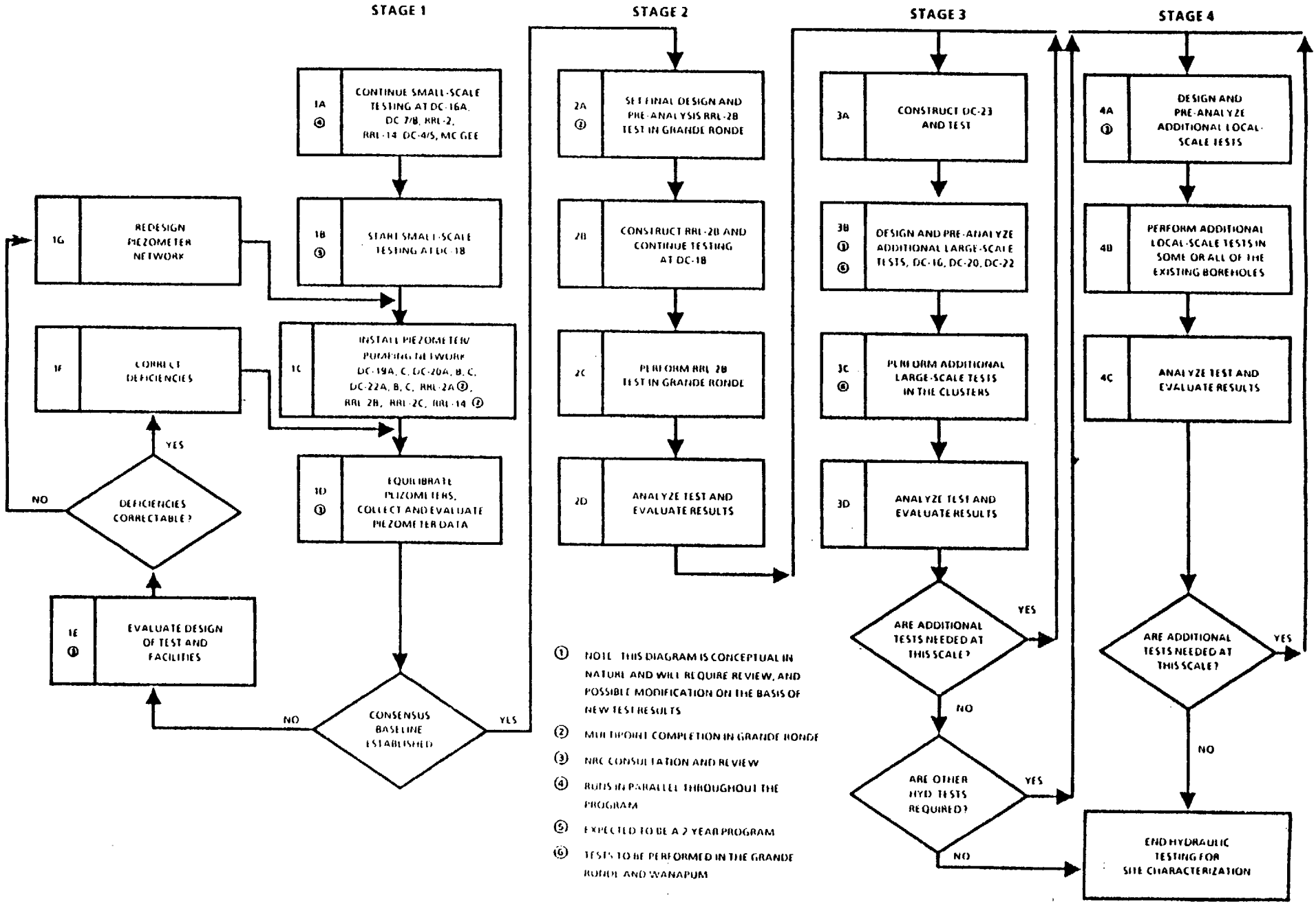
BOREHOLE DRILLING AND TESTING HISTORY



1982-PRESENT

LOGIC DIAGRAM FOR BWIP HYDROLOGIC TEST STRATEGY ①

(AFTER NUCLEAR REGULATORY COMMISSION, 1983)



① NOTE: THIS DIAGRAM IS CONCEPTUAL IN NATURE AND WILL REQUIRE REVIEW, AND POSSIBLE MODIFICATION ON THE BASIS OF NEW TEST RESULTS

② MULTIPORT COMPLETION IN GRANDE RONDE

③ NRC CONSULTATION AND REVIEW

④ RUNS IN PARALLEL THROUGHOUT THE PROGRAM

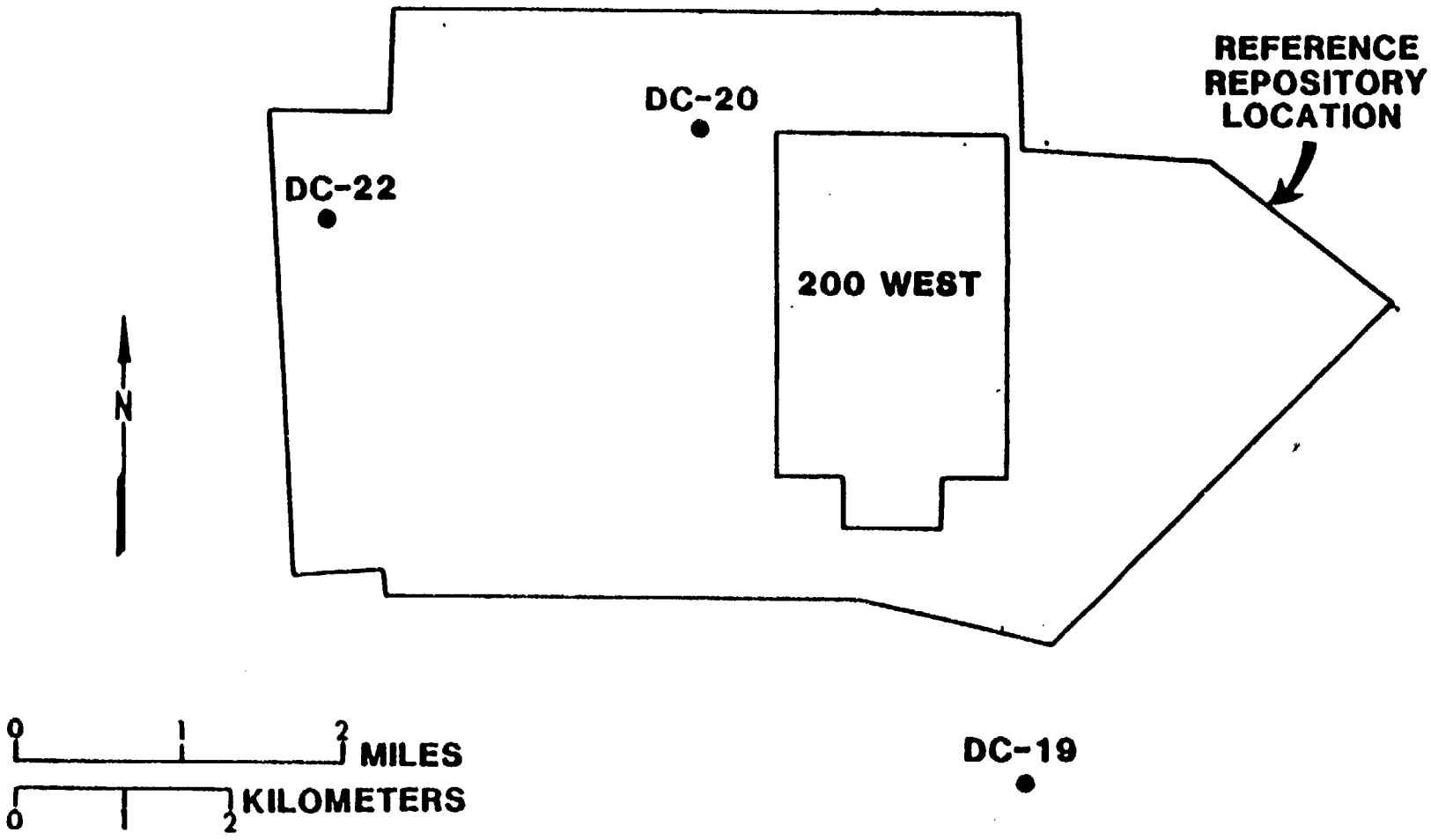
⑤ EXPECTED TO BE A 2 YEAR PROGRAM

⑥ TESTS TO BE PERFORMED IN THE GRANDE RONDE AND WANAPUM

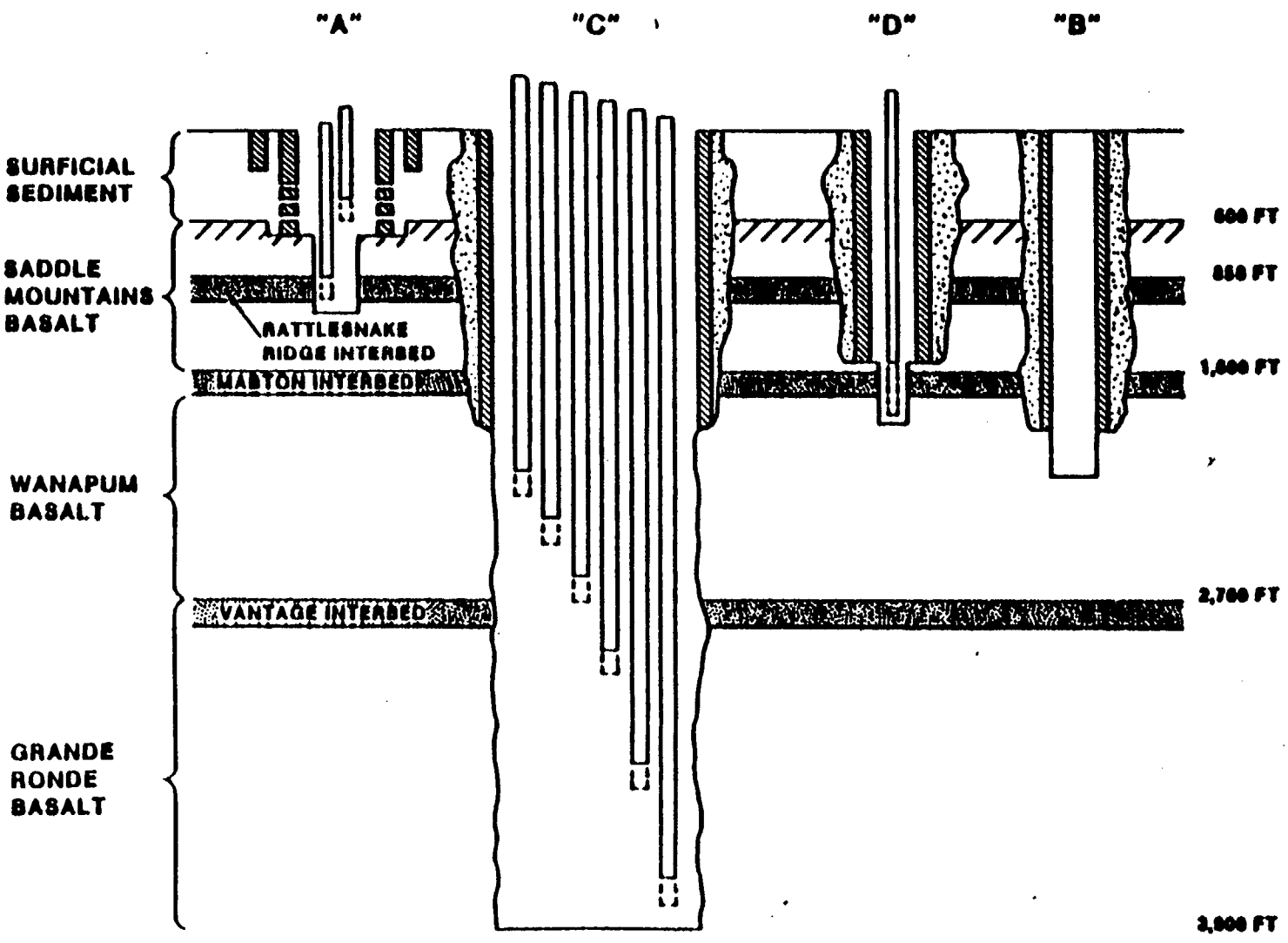
BWIP PROGRAM FOR HYDROLOGIC ISSUE RESOLUTION

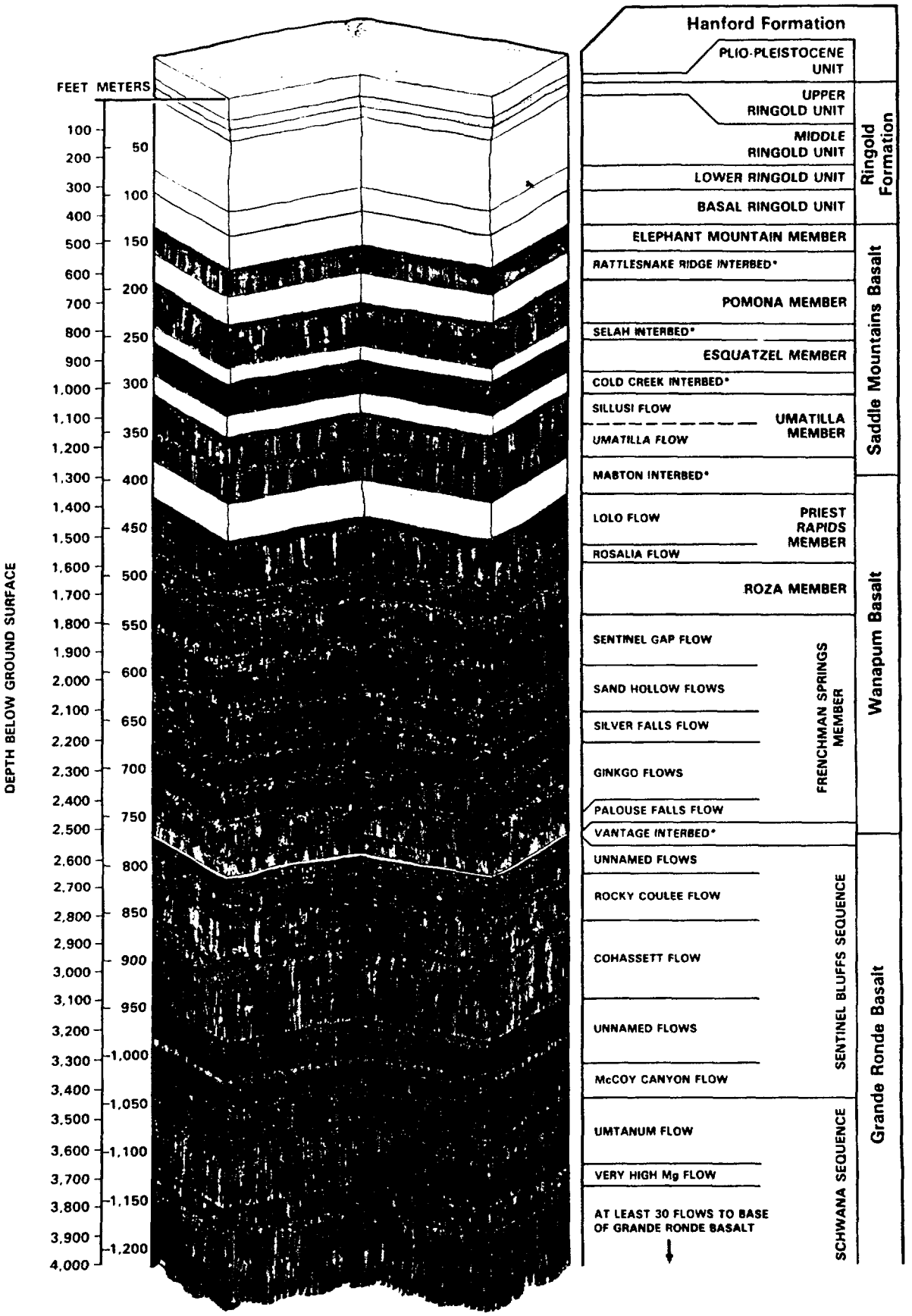
- NRC AND U.S.G.S. CONCERNS WILL BE ADDRESSED BY SIGNIFICANT ADDITIONAL DATA COLLECTION AND ANALYSES
- WATER LEVEL MONITORING FOLLOWED BY PUMPING TESTS
- FULL RANGE OF CONCEPTUAL MODELS WILL BE CONSIDERED

BASALT WASTE ISOLATION PROJECT
PIEZOMETER NETWORK



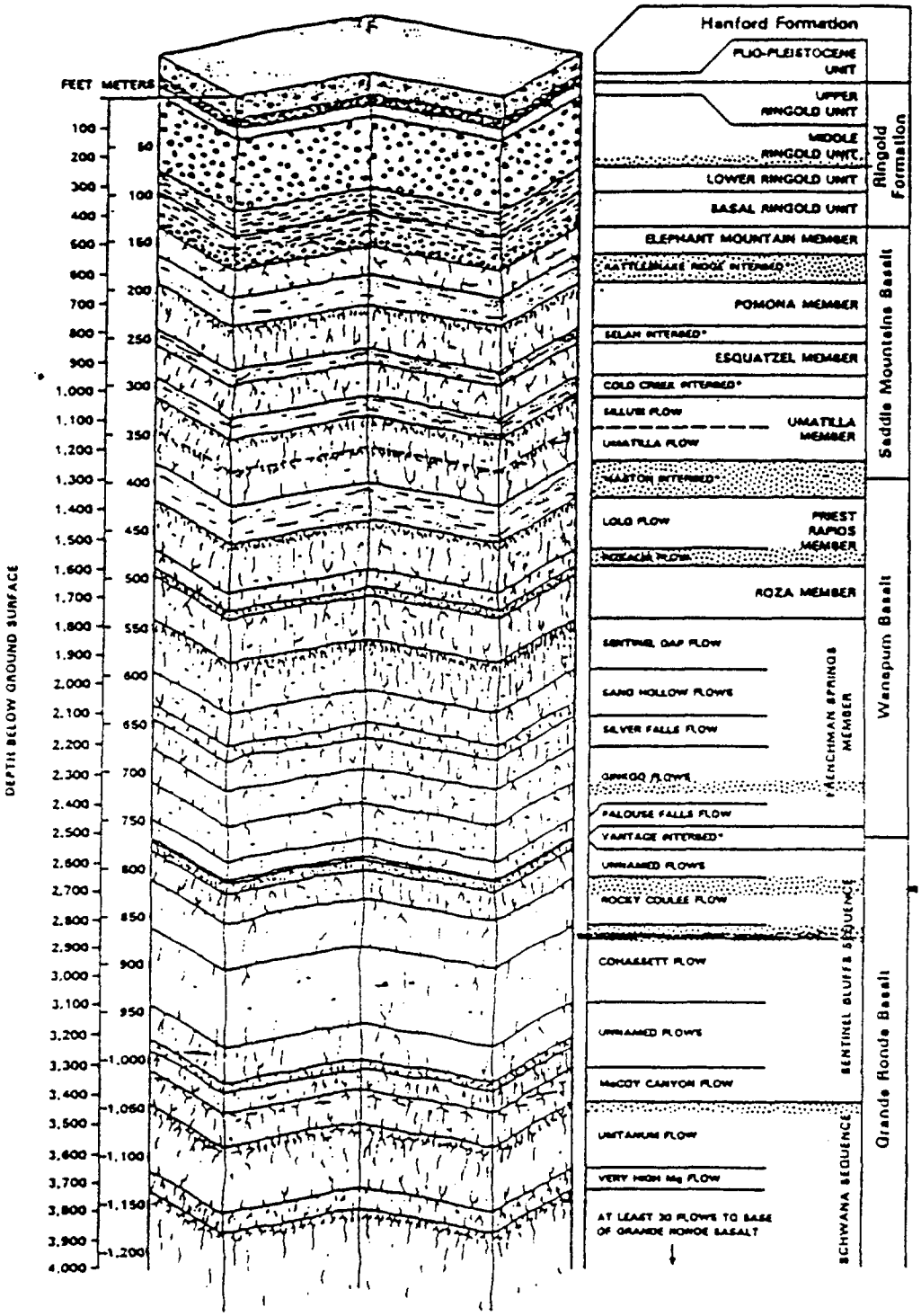
SCHEMATIC OF PIEZOMETER CLUSTER DESIGN





*INTERBEDS ARE STRATIGRAPHICALLY CONTAINED IN THE ELLENSBURG FORMATION

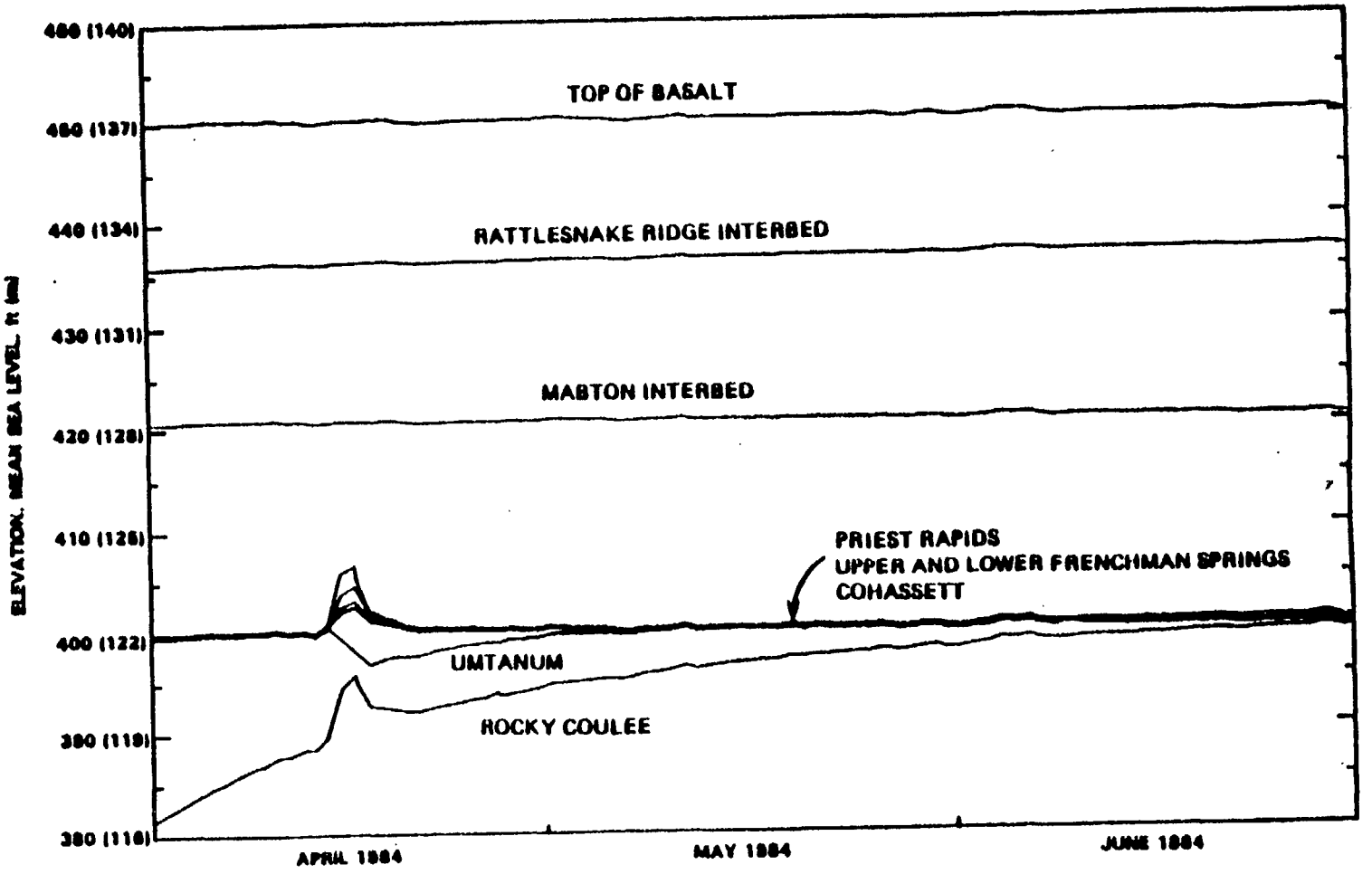
RCP8207-4K



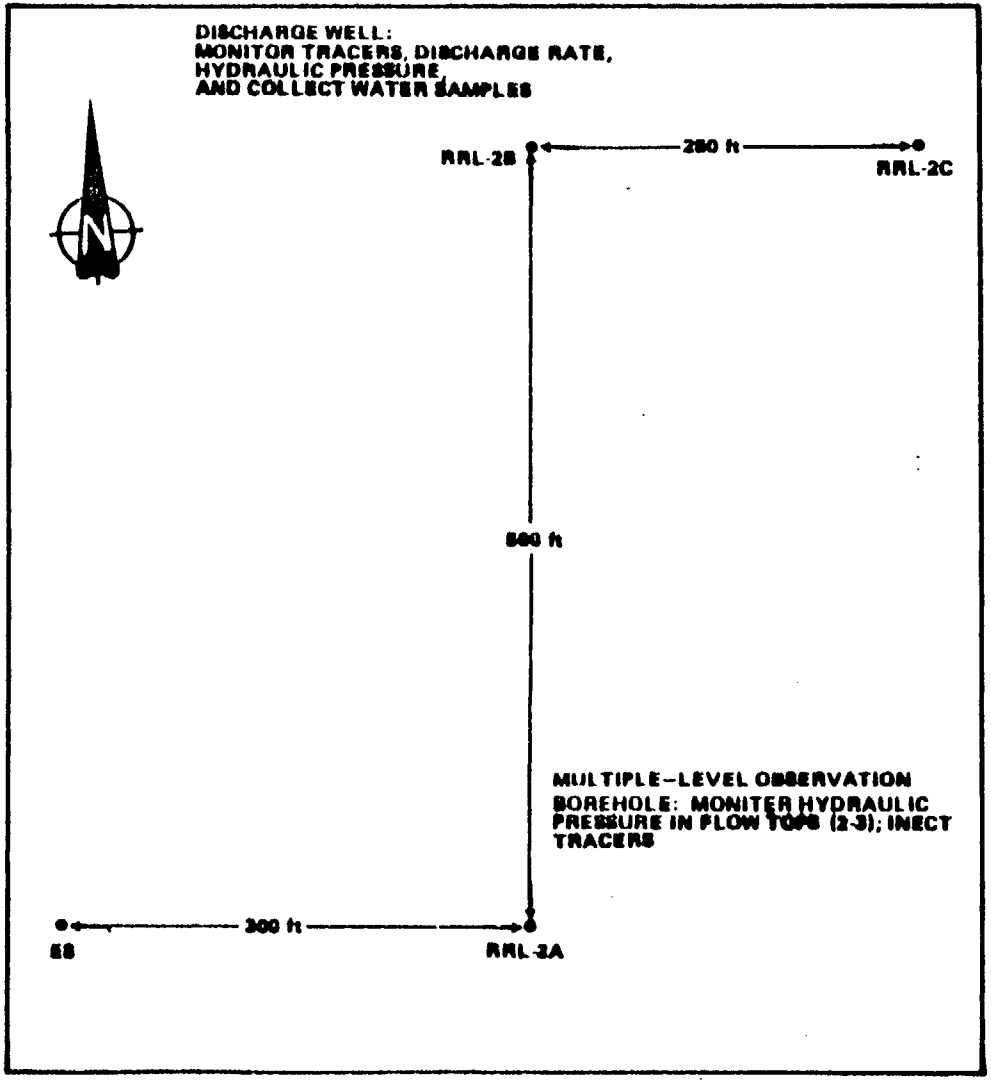
*INTERBEDS ARE STRATIGRAPHICALLY CONTAINED IN THE ELLENSBURG FORMATION

RCP8207-4E

HYDROGRAPH FOR BOREHOLE DC-19 IN SADDLE MOUNTAINS, WANAPUM, AND GRANDE RONDE BASALTS



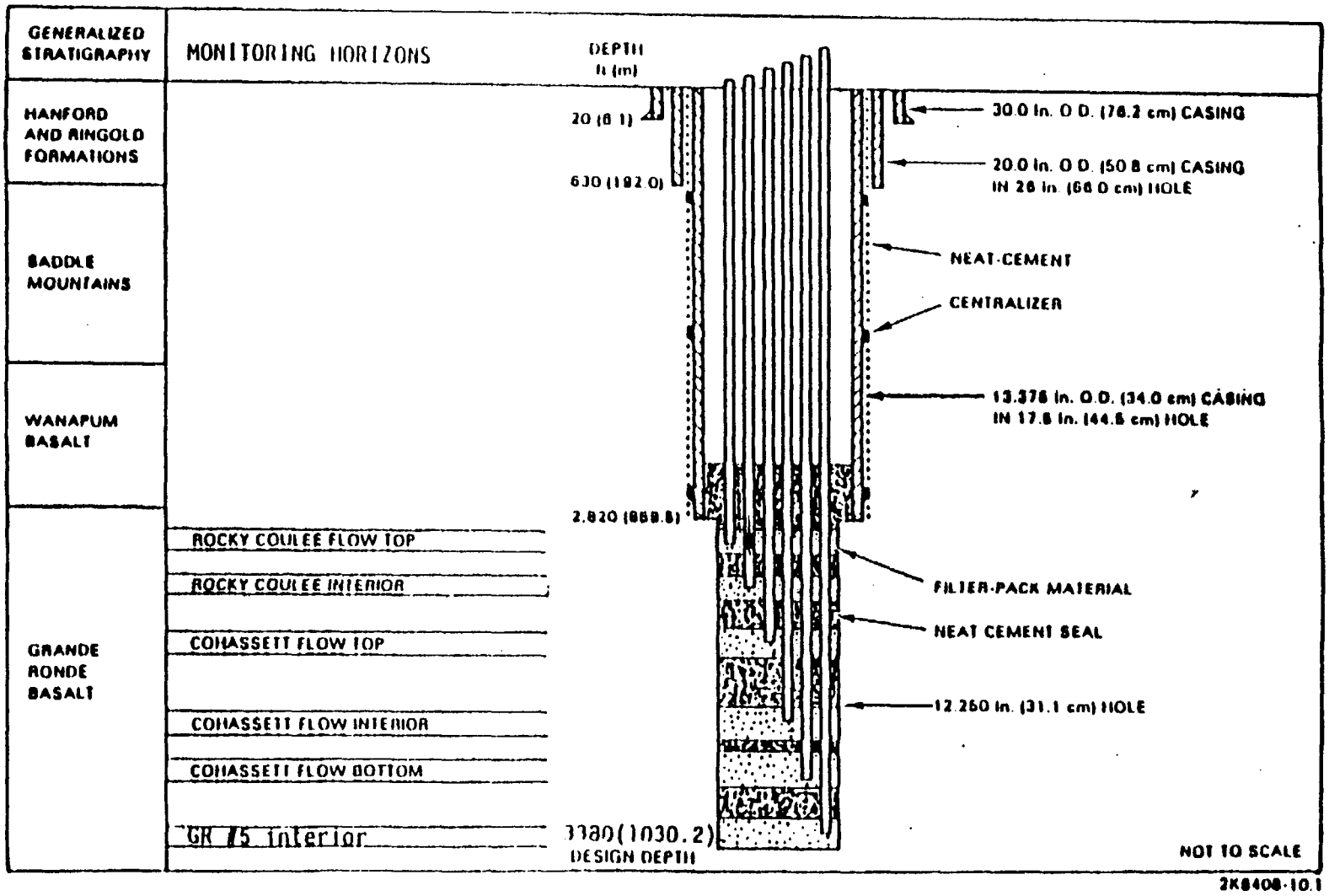
PLAN VIEW ILLUSTRATION THE RELATIONSHIP OF BOREHOLES AT THE RRL-2 SITE



GENERALIZED RRL-2 CONFIGURATION

DRAFT

PROPOSED CONCEPTUAL DESIGN OF WELL RRL-2C



POSITION PAPER 1.1 FEATURES

- DEFENSIBLE CONCEPTUAL MODELS BOUNDARY CONDITIONS, AND HYDRAULIC PARAMETERS
- REGULATORY GUIDANCE SHOULD PROVIDE AN "ENVELOPE" OF APPROACHES AND SHOULD NOT BE PRESCRIPTIVE
- RELY TO THE MAXIMUM EXTENT POSSIBLE ON "DIRECT TESTING" (SCALE AND COMPLETENESS)
- START WITH GRANDE RONDE: ADJUST SUBSEQUENT PROGRAM TO ACCOMMODATE EARLY RESULTS
- CONTINUING CONSULTATION

SIMILARITIES BETWEEN NRC AND BWIP PERSPECTIVES

- BOTH AGREE THAT MORE INTENSIVE DATA ANALYSES ARE NECESSARY
- BOTH AGREE THAT MONITORING FLOW INTERIORS SHOULD FACILITATE VERTICAL CONDUCTIVITY DETERMINATION
- BOTH AGREE THAT RRL-2A DEFICIENCIES MUST BE COMPENSATED FOR
- BOTH AGREE THAT EARLY RRL TESTING (RRL-2BAND RRL-2C) IS NECESSARY PRIOR TO DRILLING AT THE EXPLORATORY SHAFT

GENERAL DIFFERENCES BETWEEN NRC POSITION PAPER 1.1 AND BWIP PROGRAM

POSITION PAPER	BWIP PROGRAM
PIEZOMETER STRINGS	• NESTED PIEZOMETERS INSTEAD OF PIEZOMETER STRINGS • CONVENTIONAL PACKERS AT EXISTING WELLS
CONTINUOUS WATER LEVEL RECORDERS	• MEASUREMENT FREQUENCY DEPENDS ON WELL • WATER LEVEL, PRESSURE AND TEMPERATURE AT SOME WELLS
NEW WELL DC-X	• DC-23 DELAYED • NEW WELL RRL-2C • EXISTING HANFORD AND REGIONAL WELLS AVAILABLE FOR WATER LEVEL DATA • STAGE 2 COMPLETED BEFORE START OF EXPLORATORY SHAFT; STAGE 3 STARTED AFTER GROUTING OF BOTH EXPLORATORY SHAFTS

RECENT BWIP HYDROLOGIC CHARACTERIZATION HISTORY

• INITIATED INTERAGENCY HYDROLOGY WORKING GROUP	FEBRUARY 1982
• SITE CHARACTERIZATION REPORT	NOVEMBER 1982
• AGREEMENT ON NEW "APPROACH" WITH NRC STAFF	JULY 1983
• START ADDITIONAL DRILLING	SEPTEMBER 1983
• FINAL DESIGN OF FACILITIES	NOVEMBER 1983
• LAST PIEZOMETER INSTALLED	FEBRUARY 1984
• INITIAL REVIEW OF GROUNDWATER LEVEL BASELINE DATA	DECEMBER 1984

BASELINE MONITORING DATA

S.R.STRAIT

DECEMBER 12, 1984

AGENDA

BASELINE MONITORING DATA (DC-19, -20, AND -22)

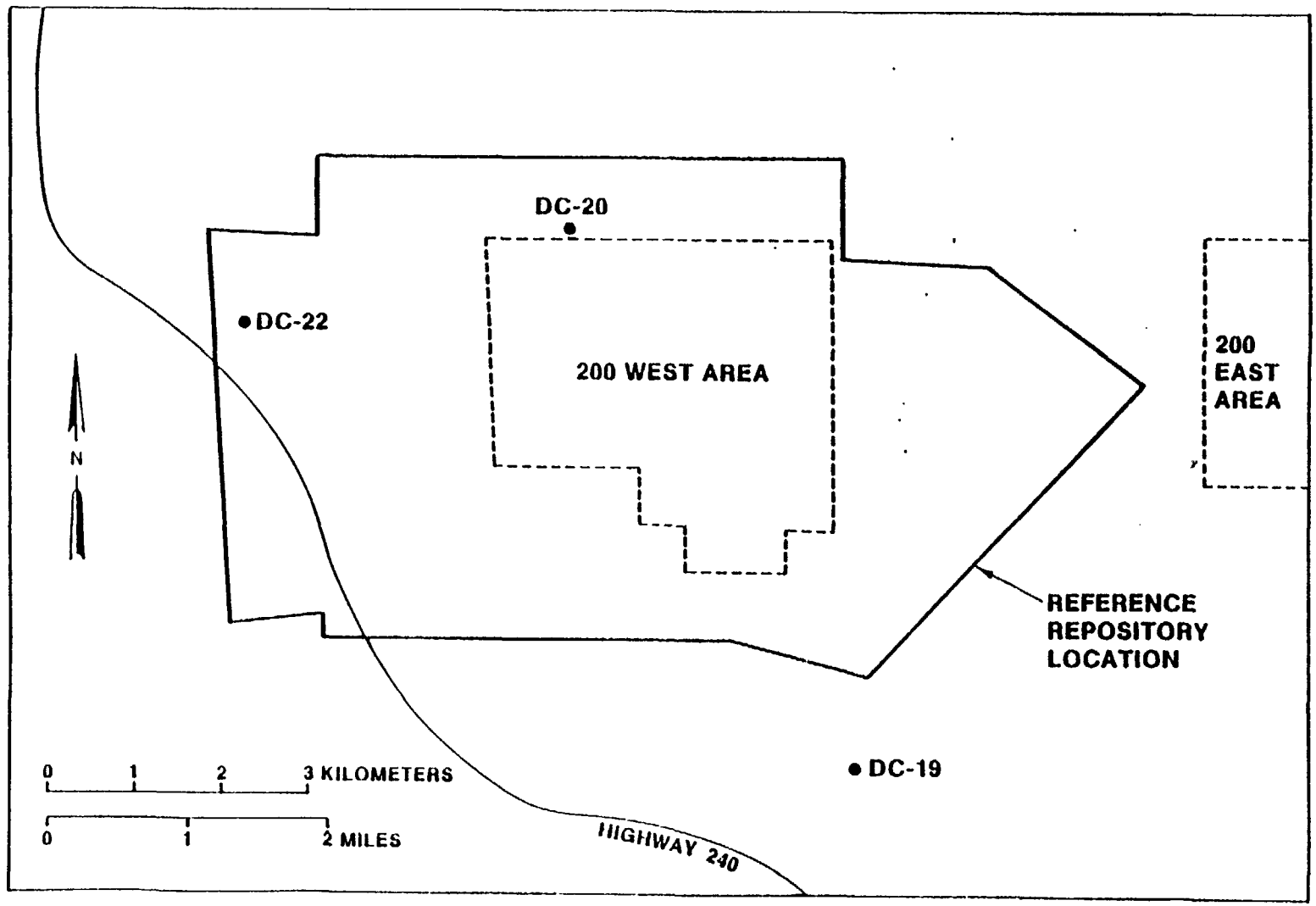
- -FACILITIES
- -TECHNIQUES
- -RESULTS

BASELINE MONITORING DATA (HANFORD SITE)

TECHNICAL SUPPORT

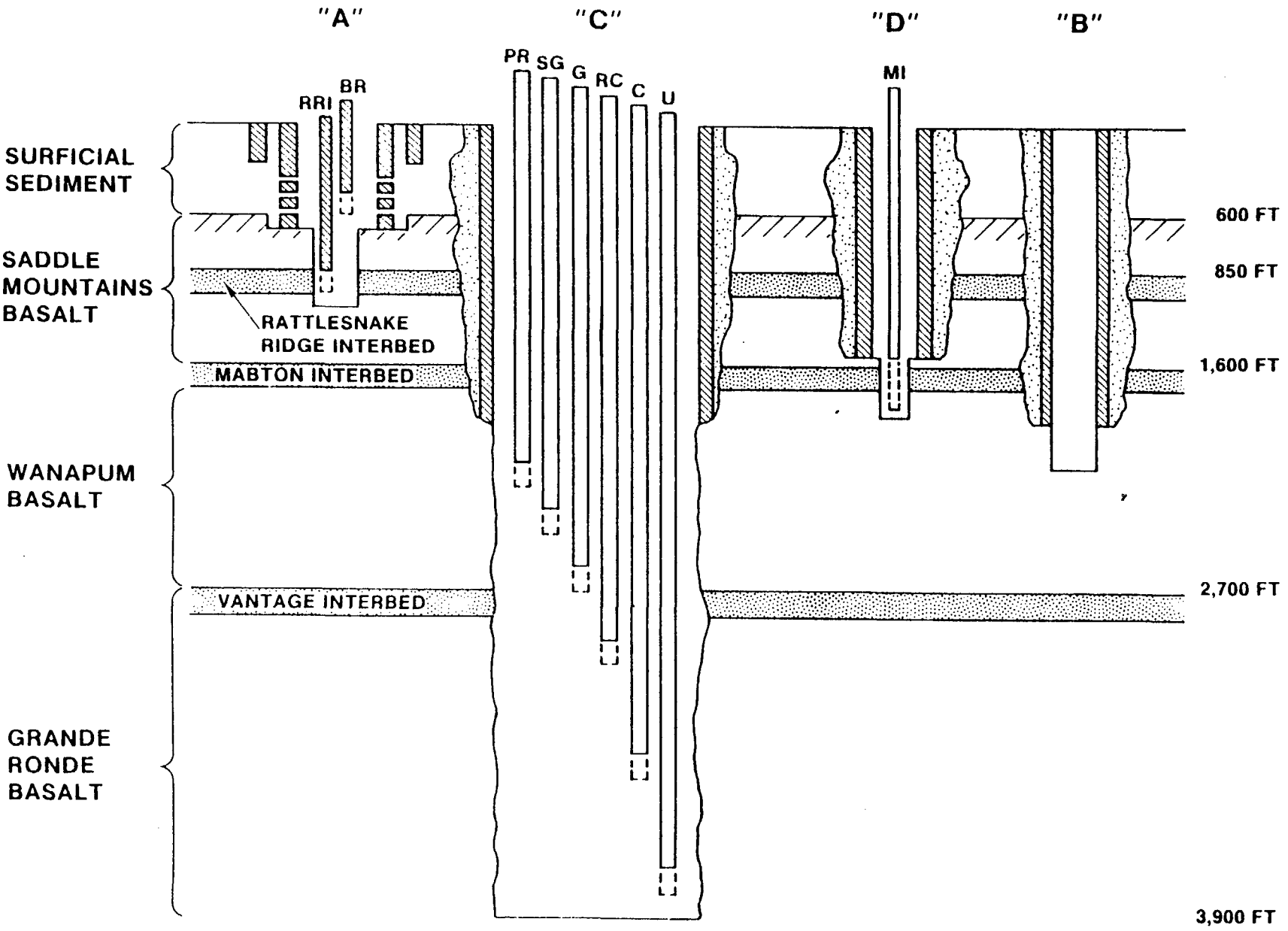
BOB BRYCE	TECHNICAL DIRECTOR
BOB YEATMAN	COMPUTER COORDINATOR
PAUL THORNE	SPECIAL PROBLEMS
BILL PIDCOE	CLARK'S METHOD
SCOTT WLCOX	COMPUTER GRAPHICS
CRAIG SWANSON	HANFORD SITE MONITORING
RUSS BROWN	INTEGRITY TESTING
RICH MERCER	FIELD COMPUTERS
LES WALKER GARY SETBACKEN MATT McELROY	FIELD SUPPORT

BOREHOLE CLUSTER SITES



2K8405-7.1

SCHEMATIC OF PIEZOMETER CLUSTER DESIGN



2K8405-7.2

STEEL TAPE MEASUREMENTS

-DAILY (7 DAYS PER WEEK)

-TWO MEASUREMENTS PER PIEZOMETER

-RESOLUTION OF ±0.02 FEET

-ALL DEPTH TO WATER LEVEL MEASUREMENTS ARE REFERENCED TO A DATUM (BRASS PLATE) WHICH IS REFERENCED TO MEAN SEA LEVEL

-DATUMS SURVEYED AGAINST USGS/NGS GEODETIC BENCH MARKS

-RELATIVE ACCURACY OF SURVEYED ELEVATION IS ± 0.01 FEET

PRESSURE INSTRUMENTATION

-DOWNHOLE DIGI-QUARTZ PRESSURE TRANSDUCER COUPLED WITH A TEMPERATURE TRANSDUCER

-RANGE 0-3000 PSIA

-ACCURACY ± 1.5 PSI

-RESOLUTION ± 0.15 PSI

-TEMPERATURE RANGE 0 - 82 C

-TEMPERATURE ACCURACY 1.0 C

-OUTSIDE PROBE DIAMETER 1.44-in and 1.00-in

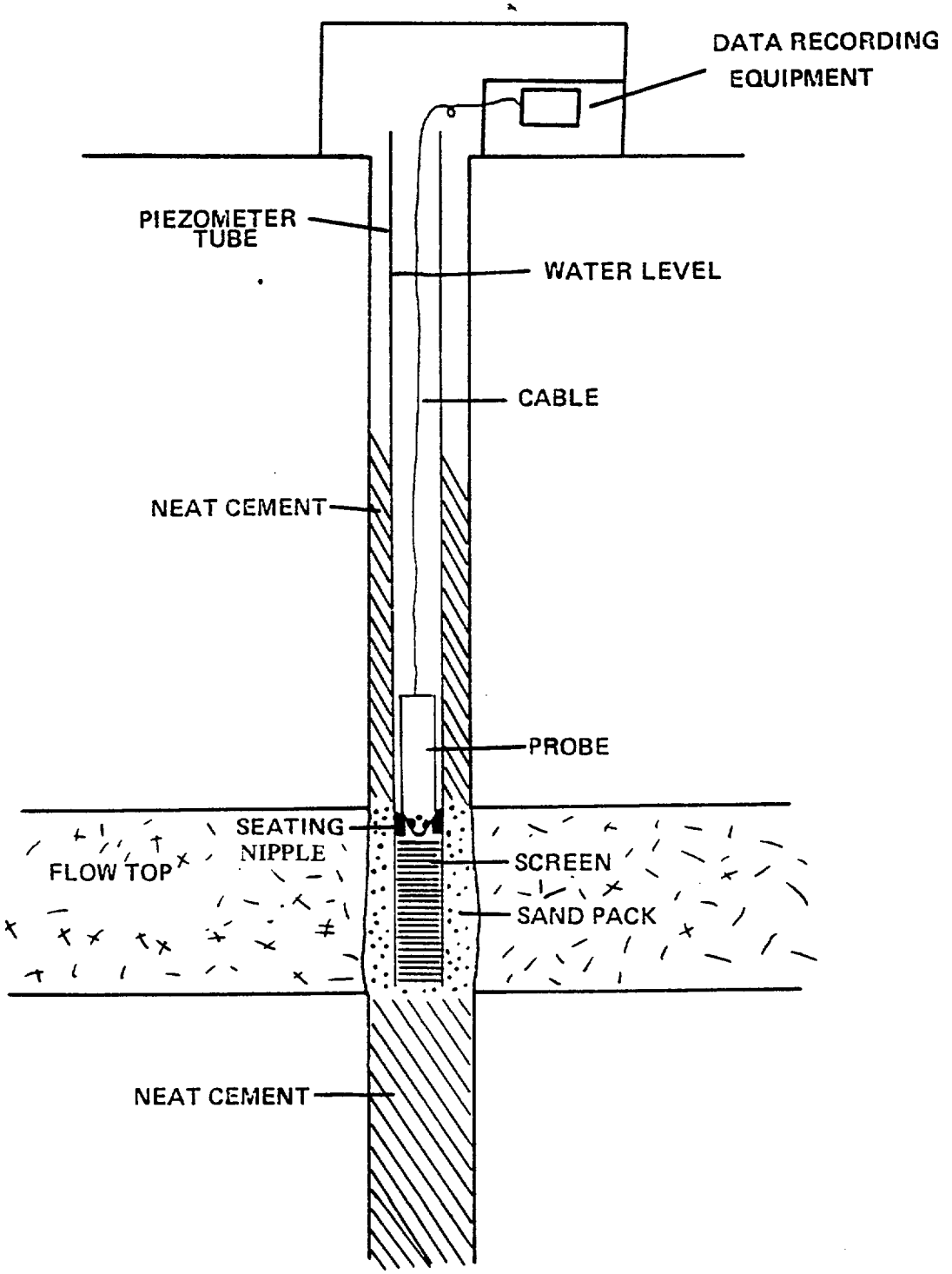
-ATMOSPHERIC DIGI-QUARTZ PRESSURE TRANSDUCER

-RANGE 0-15 psi

-ACCURACY ± 0.08 psi

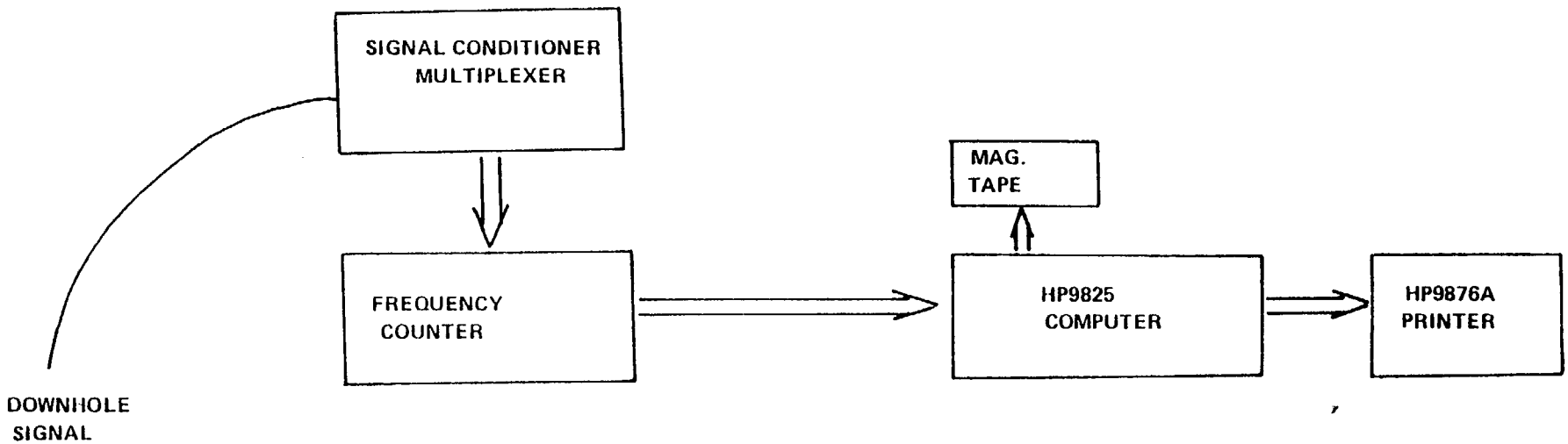
-RESOLUTION ± 0.008 psi

DOWNHOLE PROBE CONFIGURATION



NOT TO SCALE

DATA RECORDING EQUIPMENT



DATA HANDLING AND REPORTING

-PRESSURE, TEMPERATURE, AND DEPTH-TO-WATER LEVEL DATA SENT TO BASALT RECORDS MANAGEMENT CENTER AND DATA BASE MANAGEMENT (IBM) ON WEEKLY BASIS

-MONTHLY DATA PACKAGES FOR DC-19, -20, AND -22

-ISSUED

APRIL (SD-BWI-DP-045)

MAY (SD-BWI-DP-046)

JUNE (SD-BWI-DP-048)

JULY (SD-BWI-DP-050)

AUGUST (SD-BWI-DP-052)

SEPTEMBER (SD-BWI-DP-054)

OCTOBER (SD-BWI-DP-056)

-DRAFT

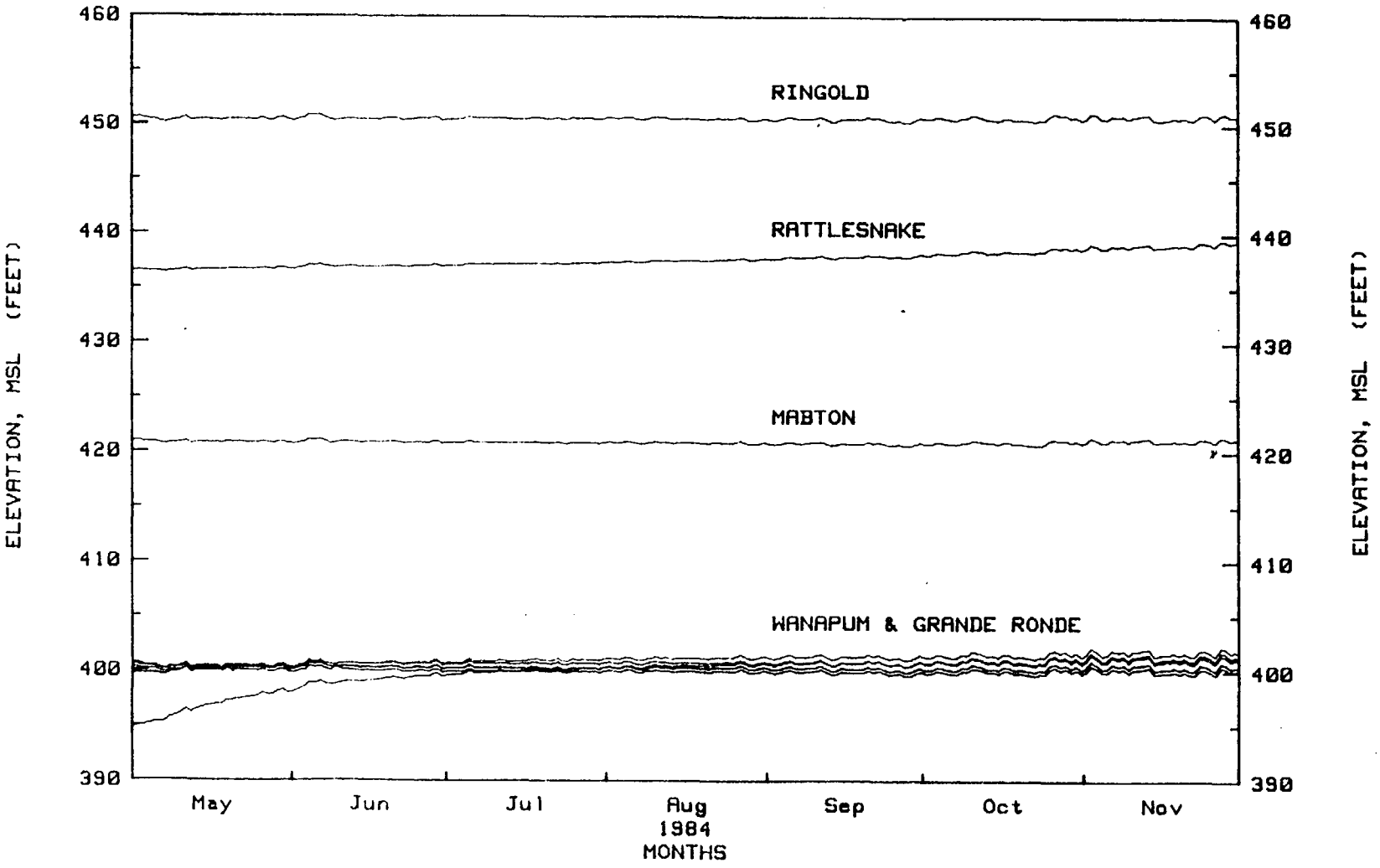
PRE-APRIL (SD-BWI-DP-055)

-DRILLING AND TESTING QUARTERLY REPORTS

-ALL DATA IS REPORTED AND APPROPRIATELY FLAGGED

BOREHOLE NUMBER: DC-19 HYDROGEOLOGIC UNIT: SADDLE MTN/WANAPUM/GRANDE RONDE

LOCATION: HANFORD SITE DATUM ELEVATION: MEAN SEA LEVEL

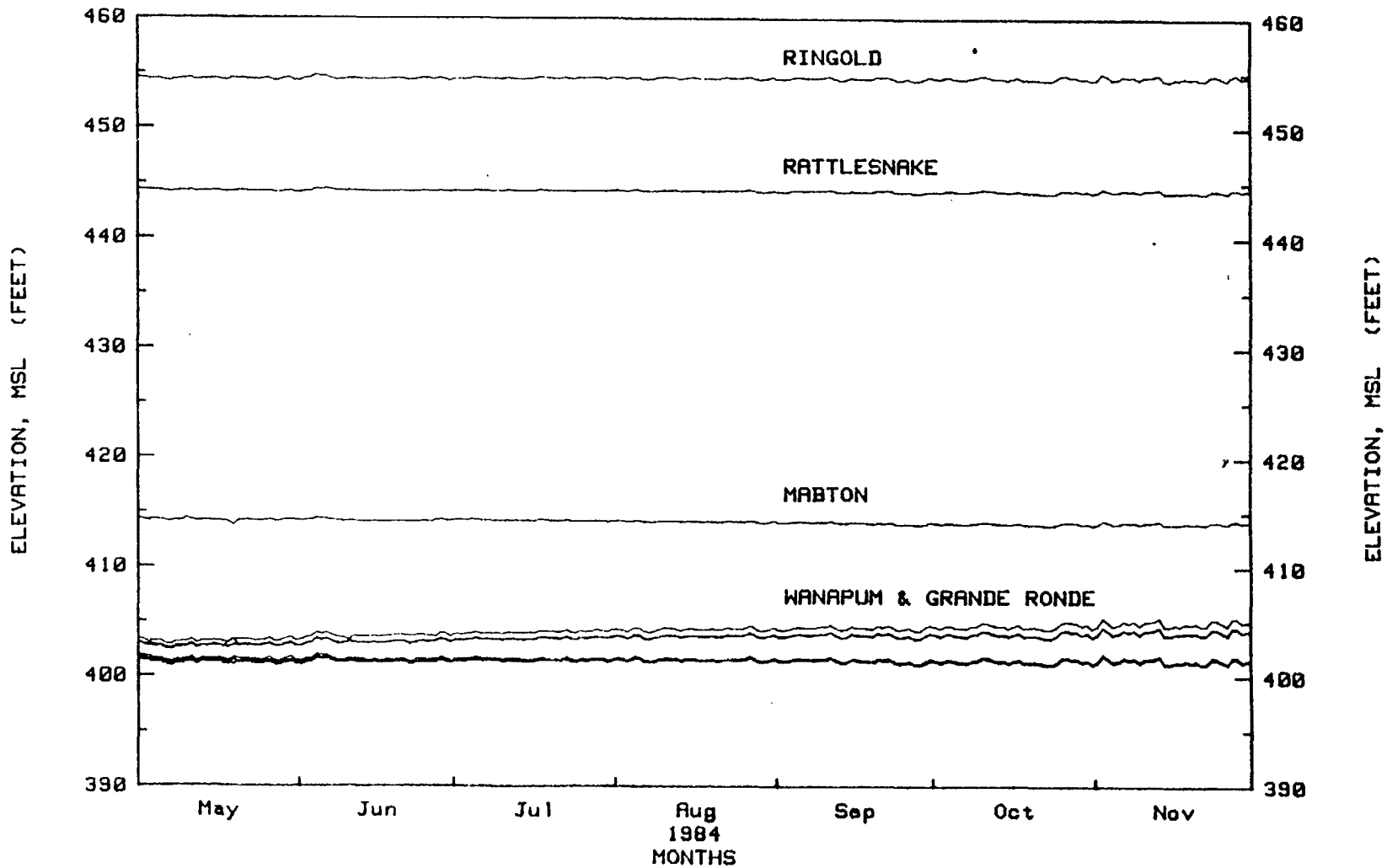


HYDROGRAPH FOR BOREHOLE NUMBER DC-19

Program WHYDAT Rev 4.4 FILE: 19ASDR

BOREHOLE NUMBER: DC-20 HYDROGEOLOGIC UNIT: SADDLE MTN/WANAPUM/GRANDE RONDE

LOCATION: HANFORD SITE DATUM ELEVATION: MEAN SEA LEVEL

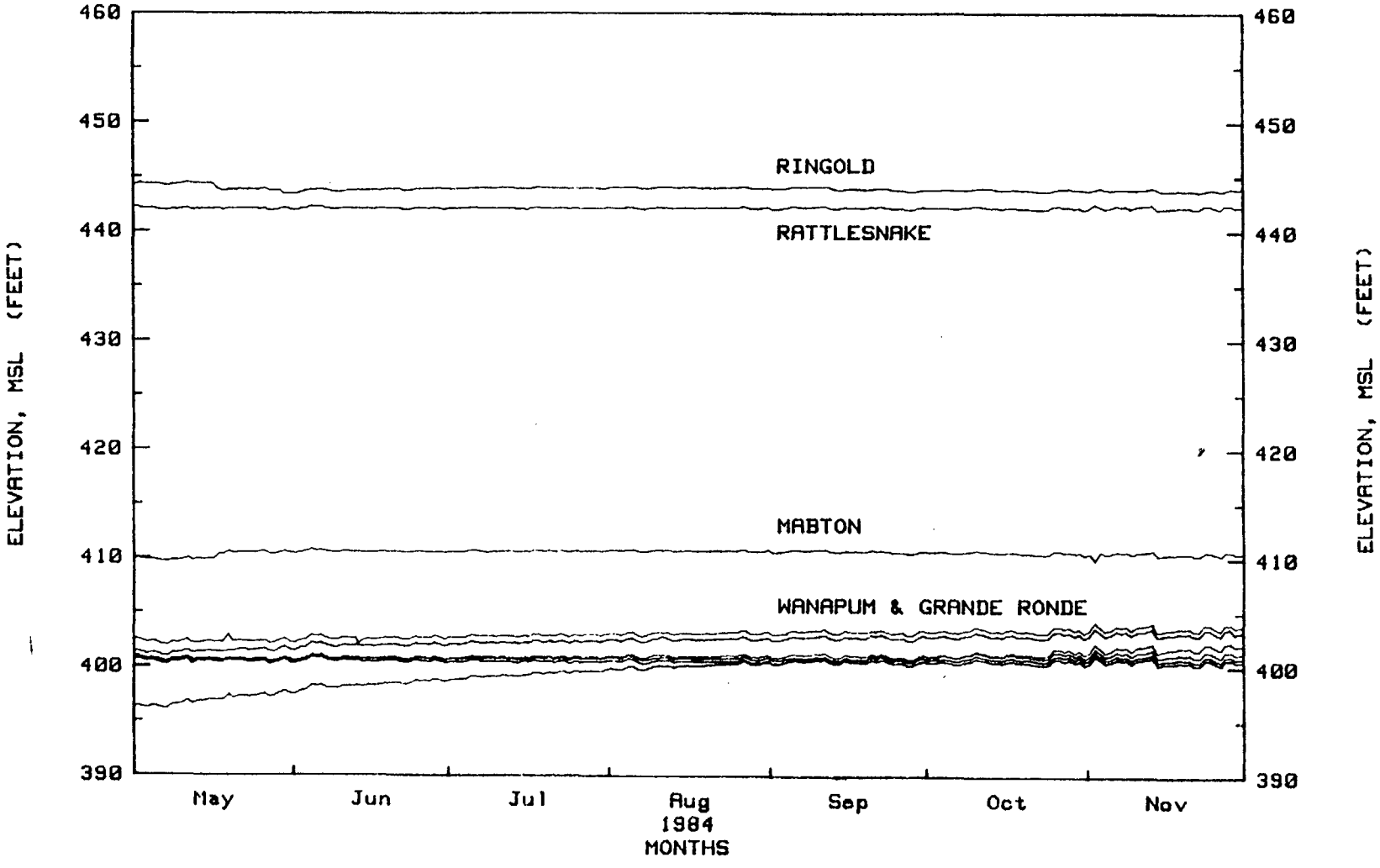


HYDROGRAPH FOR BOREHOLE NUMBER DC-20

Program WHYDAT Rev 4.4 FILE: 20ASBR

BOREHOLE NUMBER: DC-22 HYDROGEOLOGIC UNIT: SADDLE MTN/WANAPUM/GRANDE RONDE

LOCATION: HANFORD SITE DATUM ELEVATION: MEAN SEA LEVEL

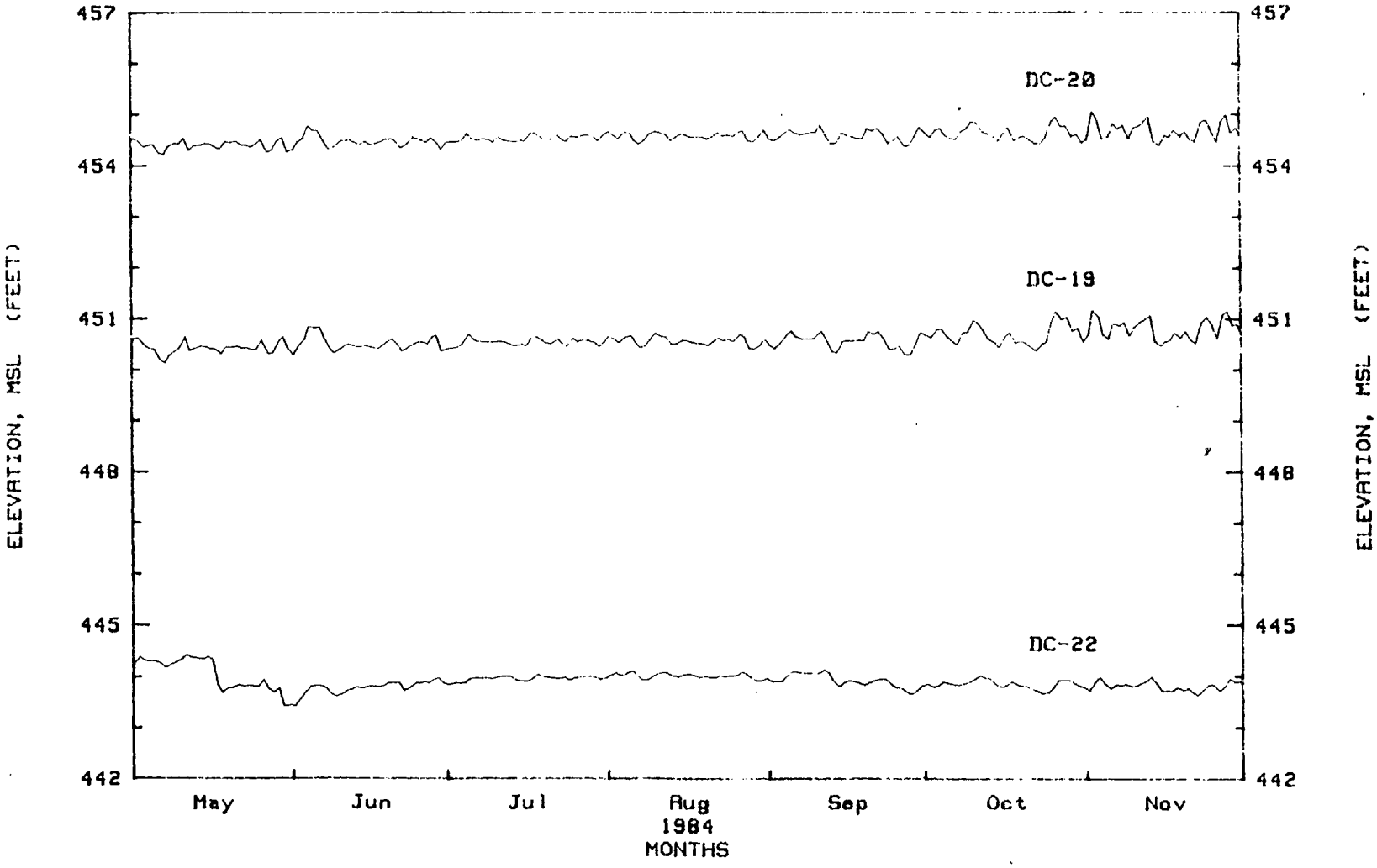


HYDROGRAPH FOR BOREHOLE NUMBER DC-22

Program WHYDAT Rev 4.4 FILE: 22ASBR

BOREHOLE NUMBER: DC-19,20,22 HYDROGEOLOGIC UNIT: BASAL RINGOLD

LOCATION: HANFORD SITE DATUM ELEVATION: MEAN SEA LEVEL

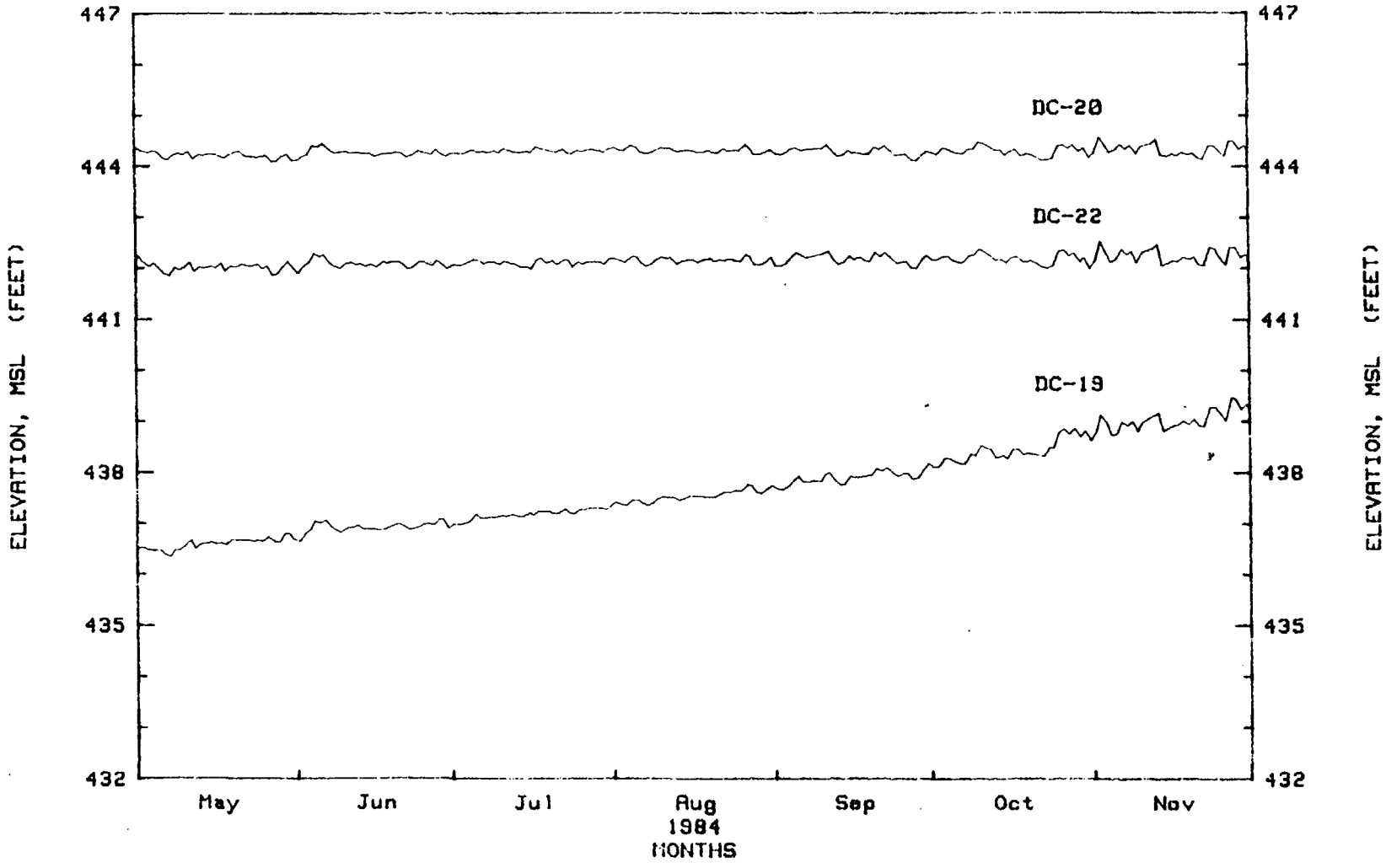


HYDROGRAPH FOR BOREHOLE NUMBER DC-19,20,22

Program WHYDAT Rev 4.4 FILE: 19ASBR

BOREHOLE NUMBER: DC-19,20,22 HYDROGEOLOGIC UNIT: RATTLESNAKE RIDGE INTERBED

LOCATION: HANFORD SITE DATUM ELEVATION: MEAN SEA LEVEL

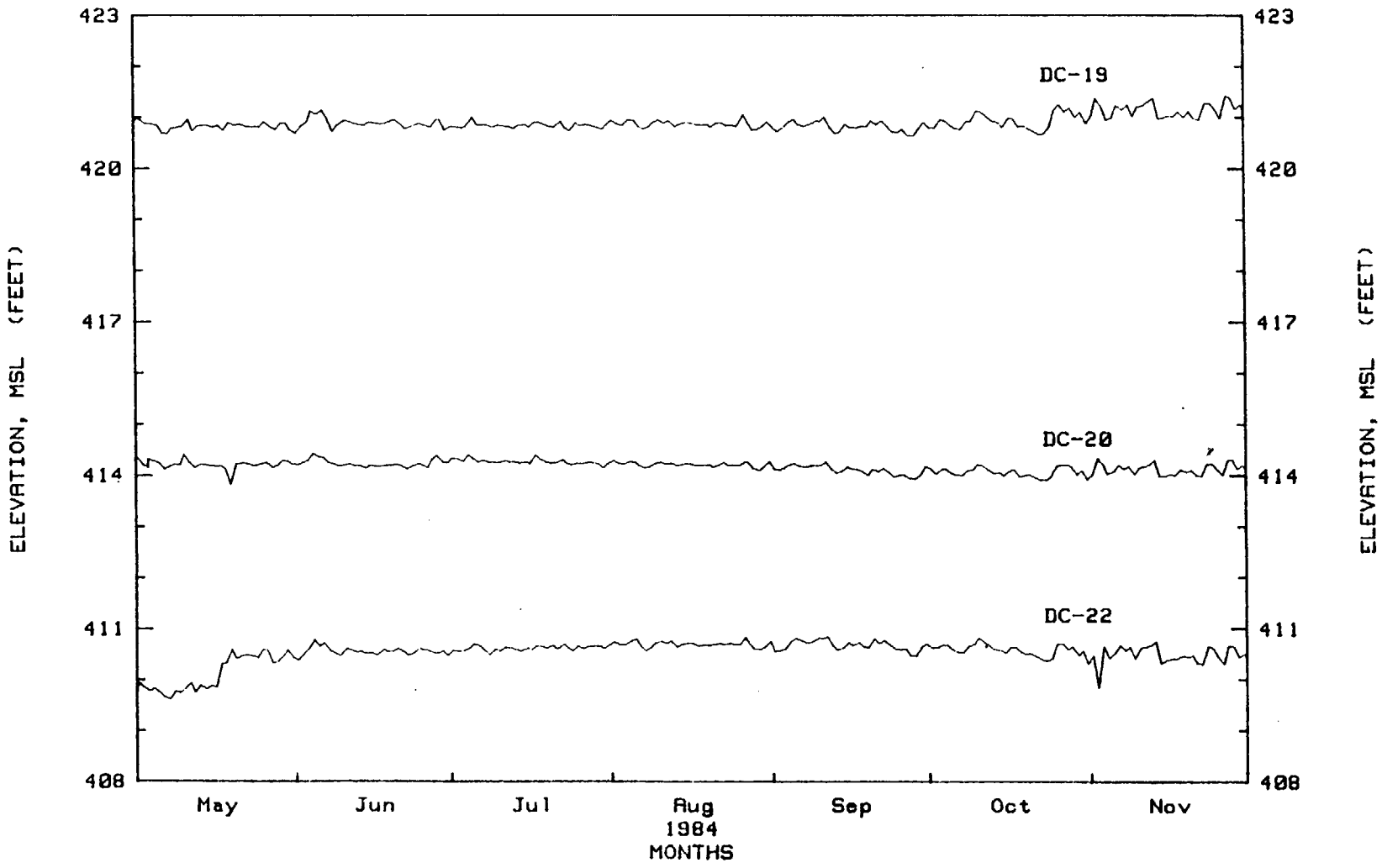


HYDROGRAPH FOR BOREHOLE NUMBER DC-19,20,22

Program WHYDAT Rev 4.4 FILE: 19ASRR

BOREHOLE NUMBER: DC-19,20,22 HYDROGEOLOGIC UNIT: MABTON INTERBED

LOCATION: HANFORD SITE DATUM ELEVATION: MEAN SEA LEVEL

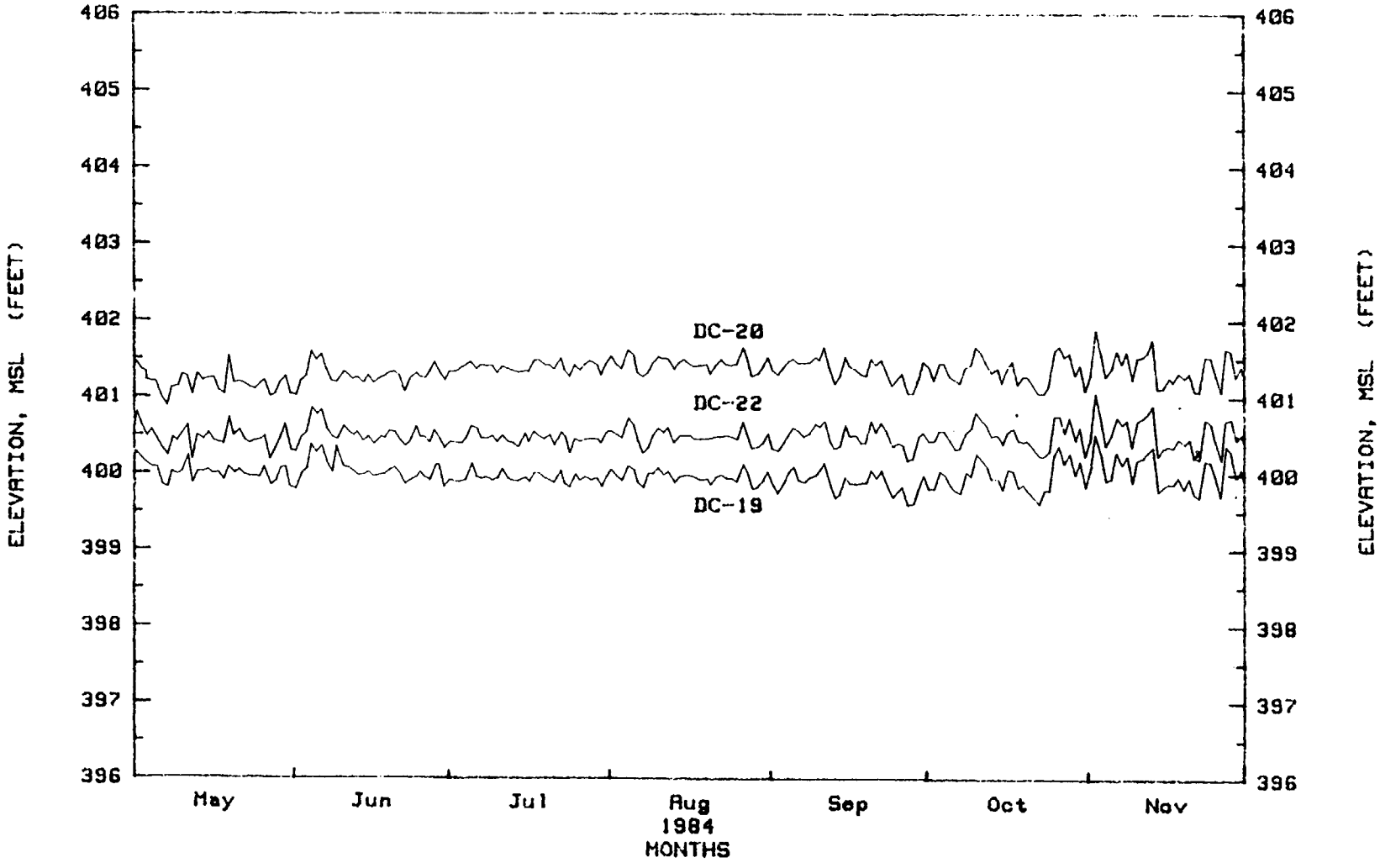


HYDROGRAPH FOR BOREHOLE NUMBER DC-19,20,22

Program WHYDAT Rev 4.4 FILE: 19DSMB

BOREHOLE NUMBER: DC-19,20,22 HYDROGEOLOGIC UNIT: PRIEST RAPIDS INTERFLOW ZONE

LOCATION: HANFORD SITE DATUM ELEVATION: MEAN SEA LEVEL

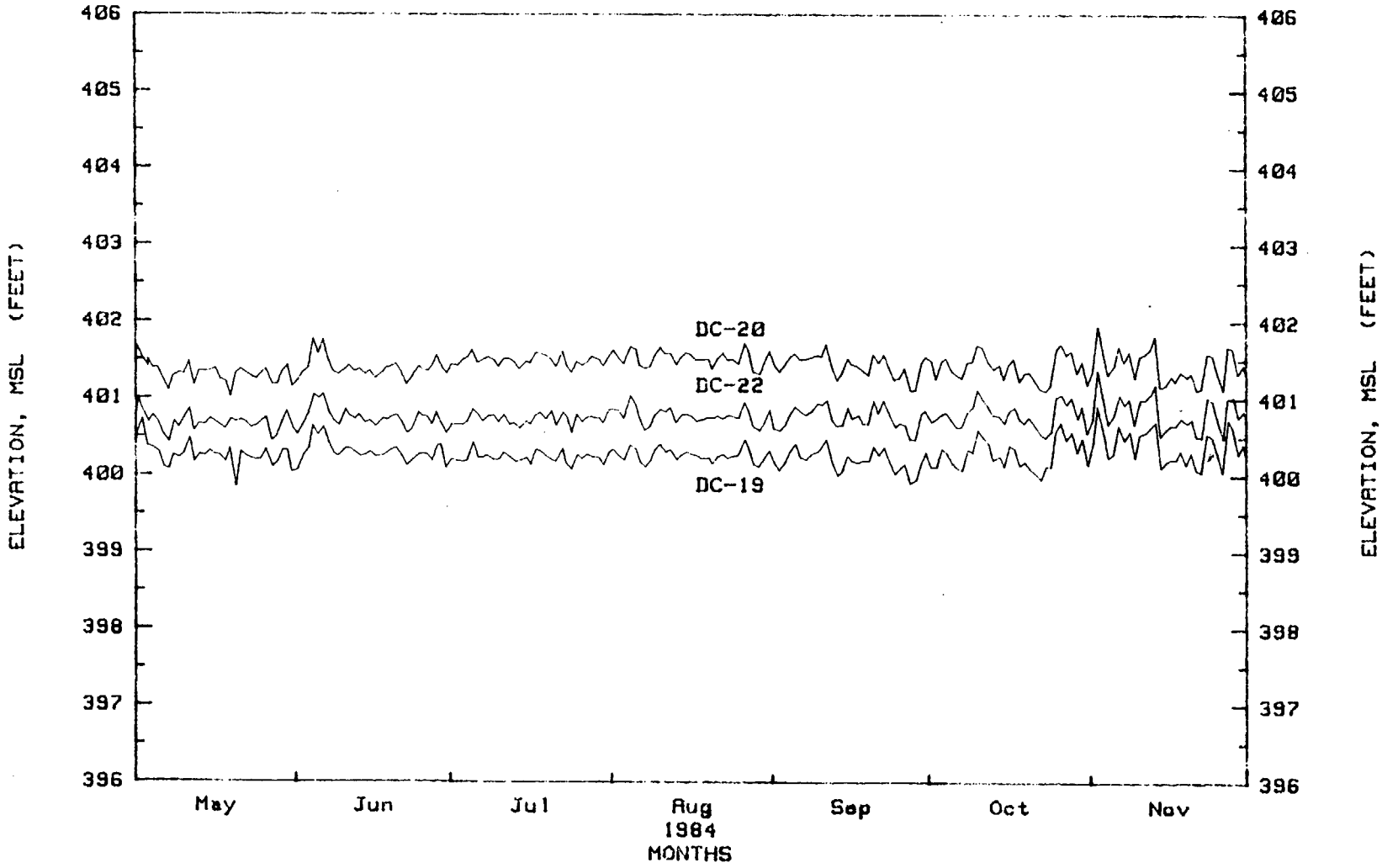


HYDROGRAPH FOR BOREHOLE NUMBER DC-19,20,22

Program WHYDAT Rev 4.4 FILE: 19CNPR

BOREHOLE NUMBER: DC-19,20,22 HYDROGEOLOGIC UNIT: SENTINEL GAP

LOCATION: HANFORD SITE DATUM ELEVATION: MEAN SEA LEVEL

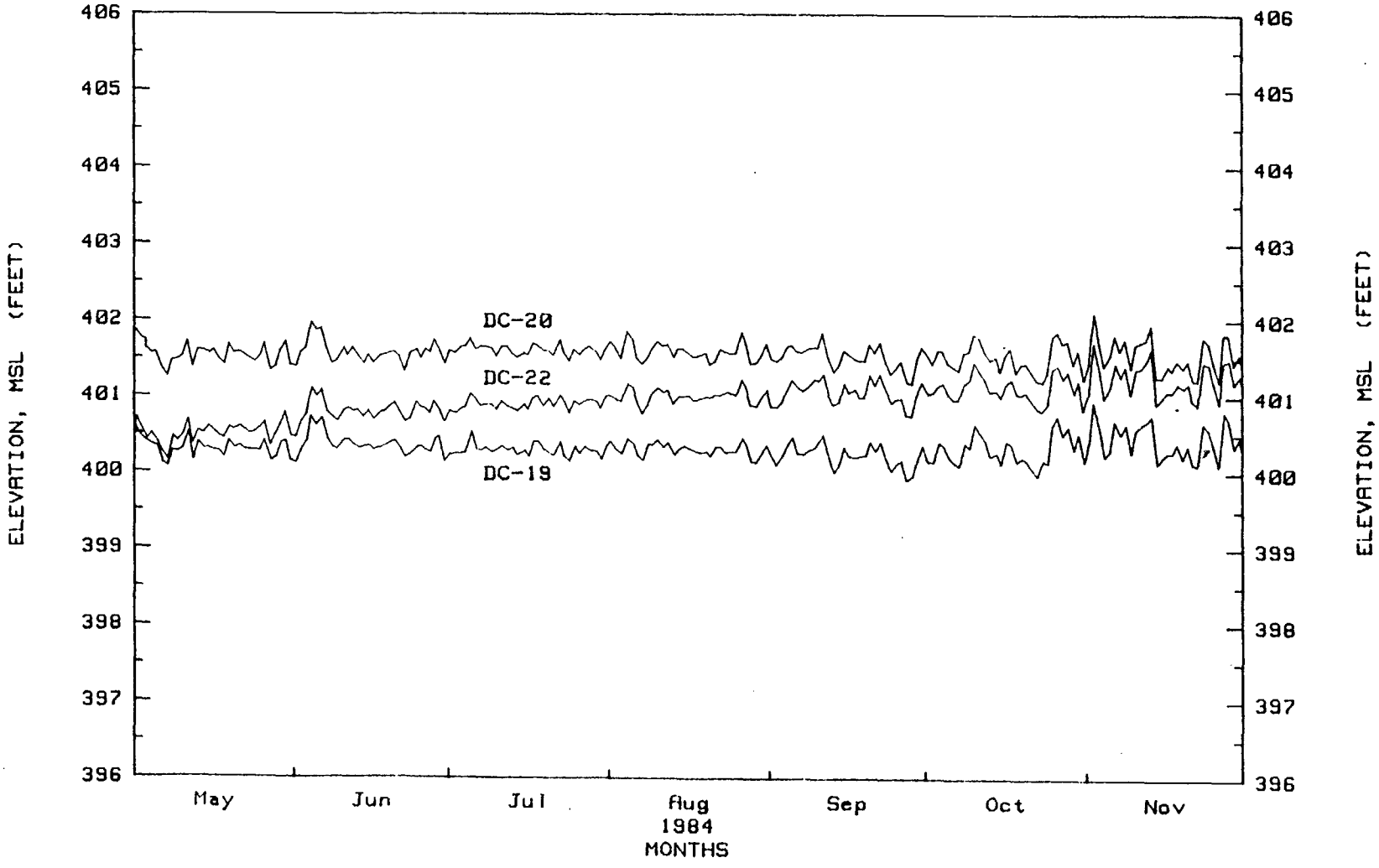


HYDROGRAPH FOR BOREHOLE NUMBER DC-19,20,22

Program WHYDAT Rev 4.4 FILE: 19CWSG

BOREHOLE NUMBER: DC-19,20,22 HYDROGEOLOGIC UNIT: GINKGO

LOCATION: HANFORD SITE DATUM ELEVATION: MEAN SEA LEVEL

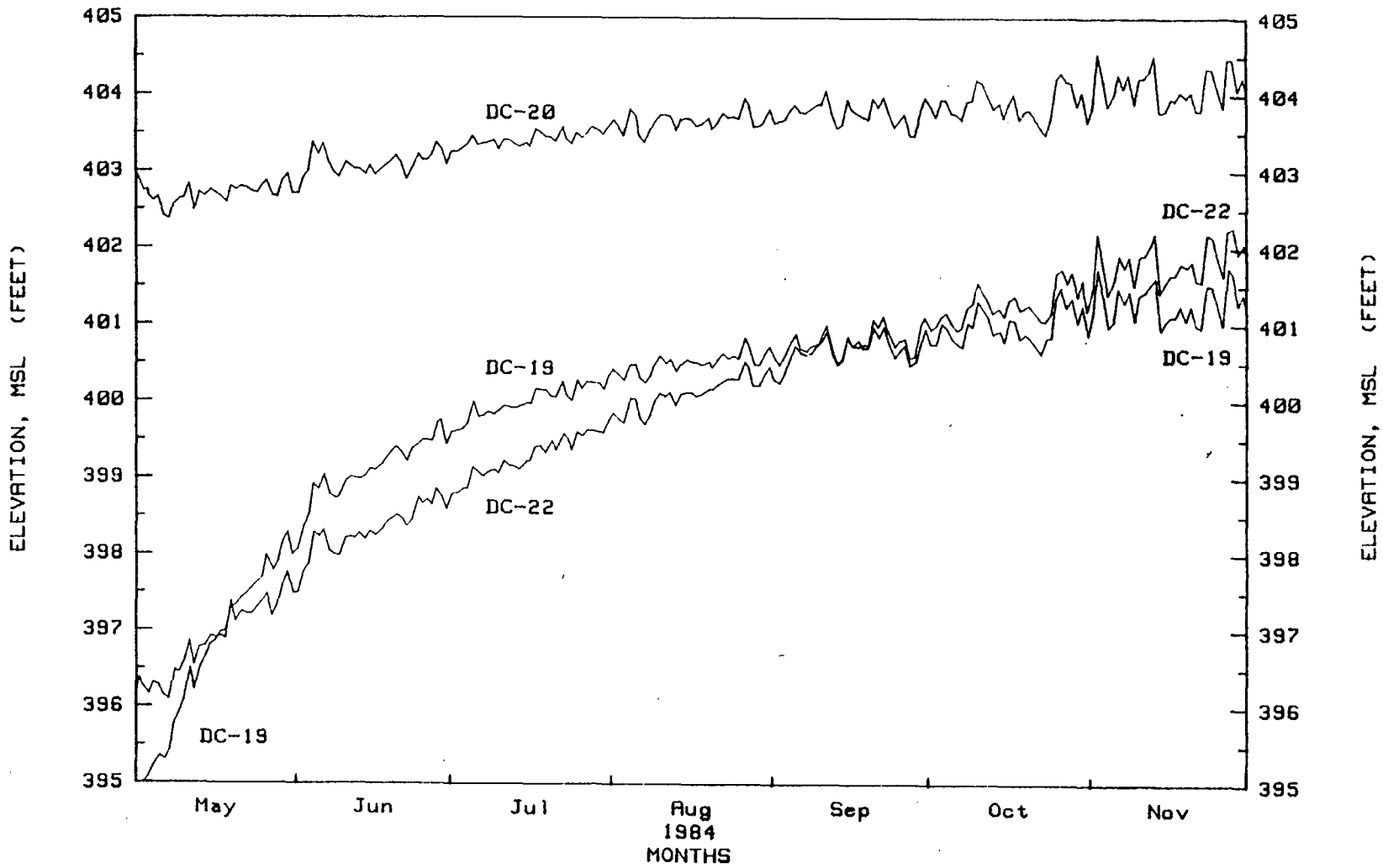


HYDROGRAPH FOR BOREHOLE NUMBER DC-19,20,22

Program WHYDAT Rev 4.4 FILE: 19CWGK

BOREHOLE NUMBER: DC-19,20,22 HYDROGEOLOGIC UNIT: ROCKY COULEE FLOW TOP

LOCATION: HANFORD SITE DATUM ELEVATION: MEAN SEA LEVEL

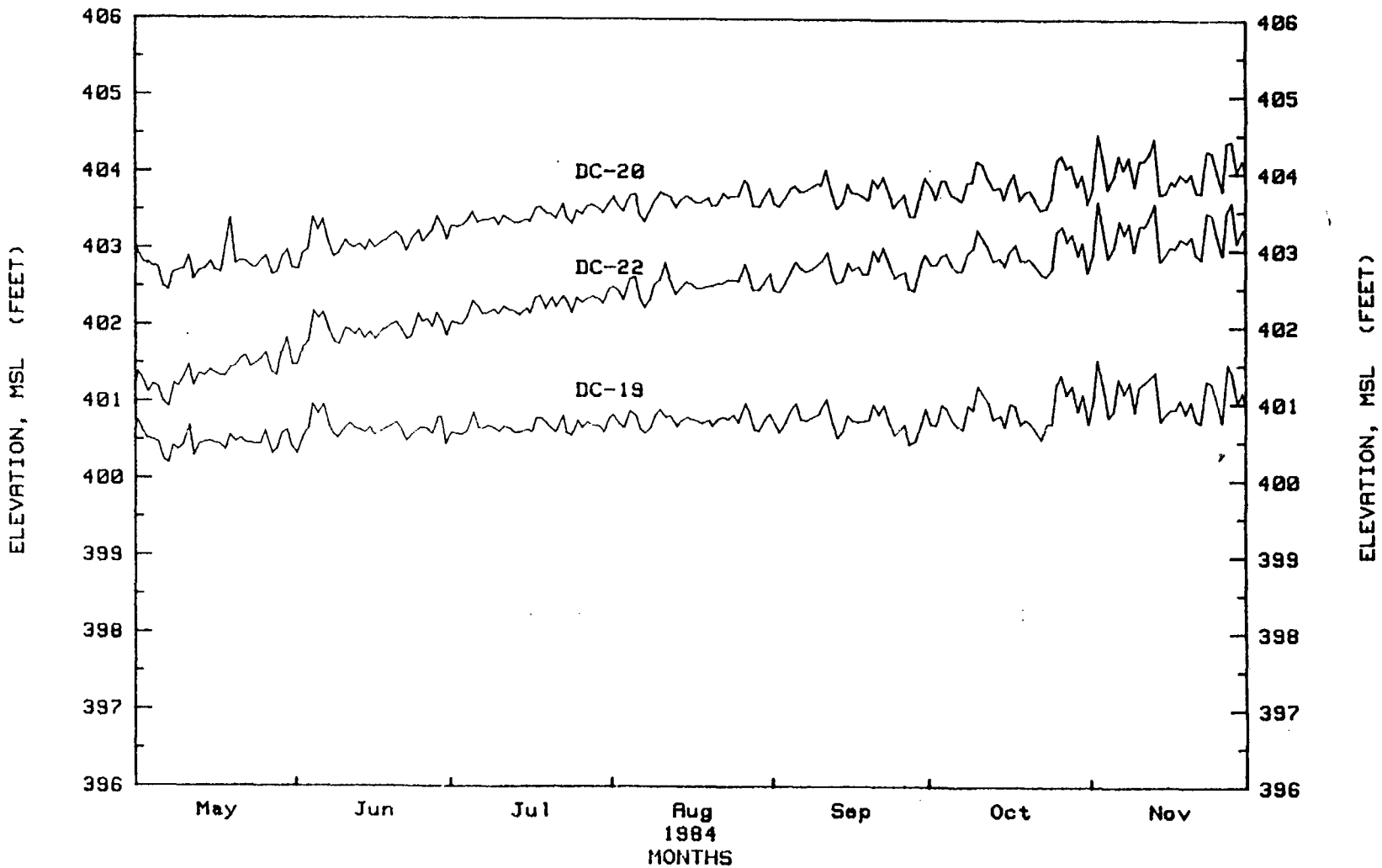


HYDROGRAPH FOR BOREHOLE NUMBER DC-19,20,22

Program WHYDAT Rev 4.4 FILE: 19CGRC

BOREHOLE NUMBER: DC-19,20,22 HYDROGEOLOGIC UNIT: COHASSETT FLOW TOP

LOCATION: HANFORD SITE DATUM ELEVATION: MEAN SEA LEVEL

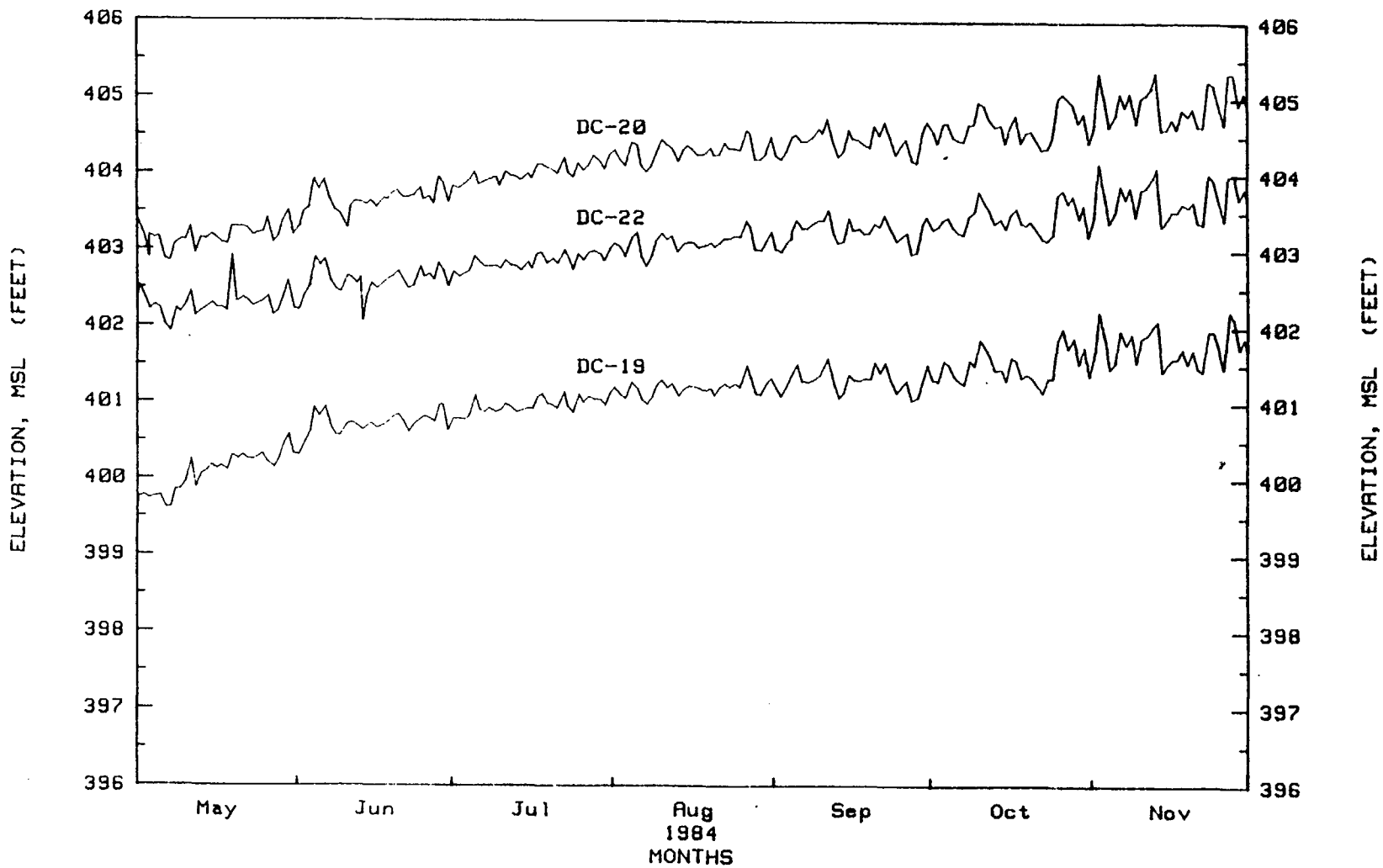


HYDROGRAPH FOR BOREHOLE NUMBER DC-19,20,22

Program WHYDAT Rev 4.4 FILE: 19CGCO

BOREHOLE NUMBER: DC-19,20,22 HYDROGEOLOGIC UNIT: UMTANUM FLOW TOP

LOCATION: HANFORD SITE DATUM ELEVATION: MEAN SEA LEVEL

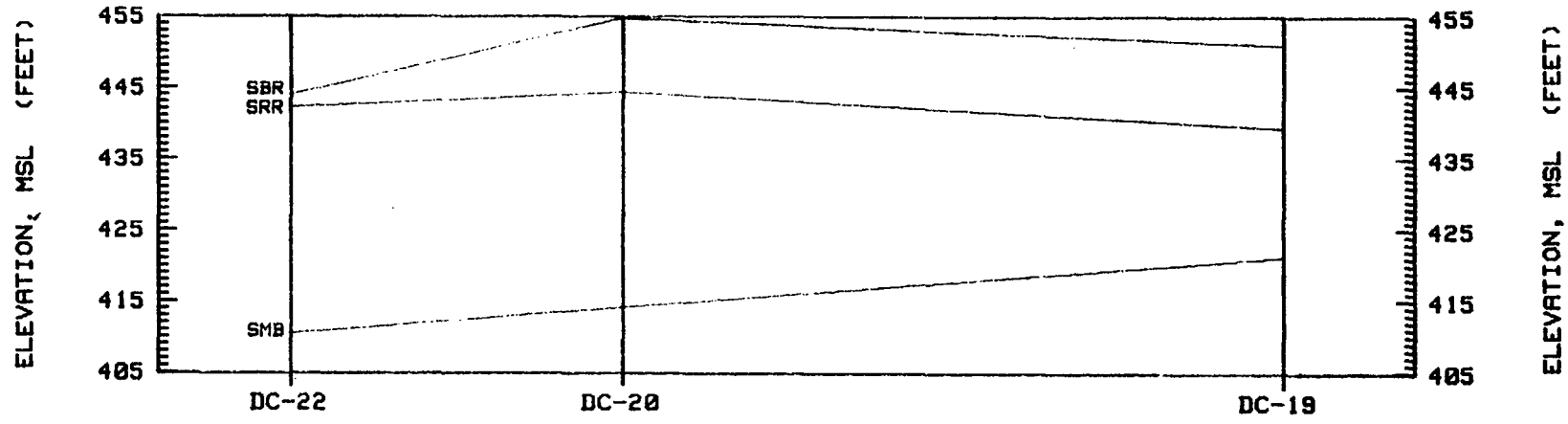


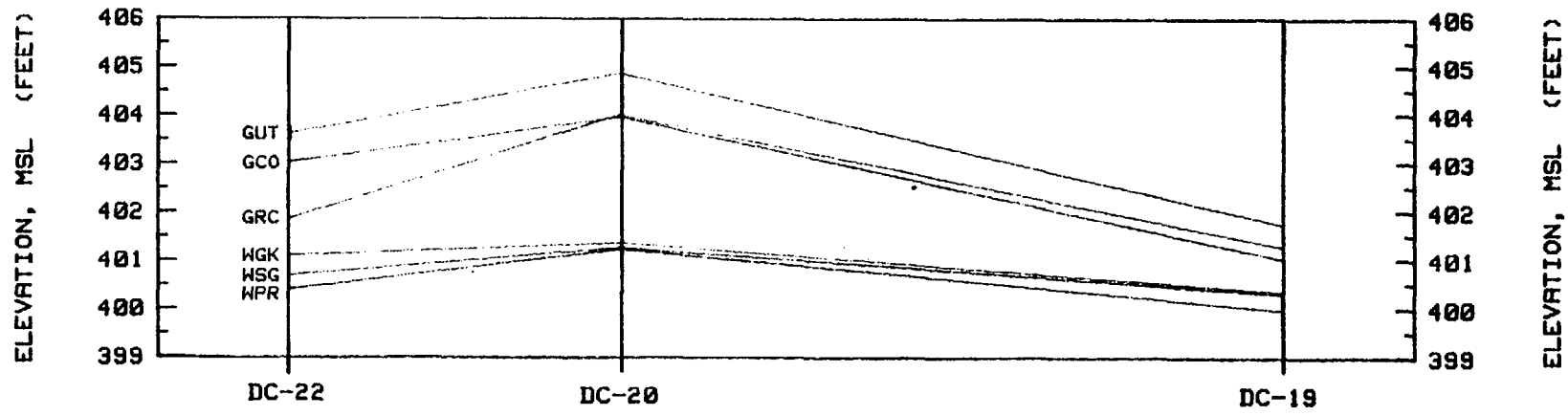
HYDROGRAPH FOR BOREHOLE NUMBER DC-19,20,22

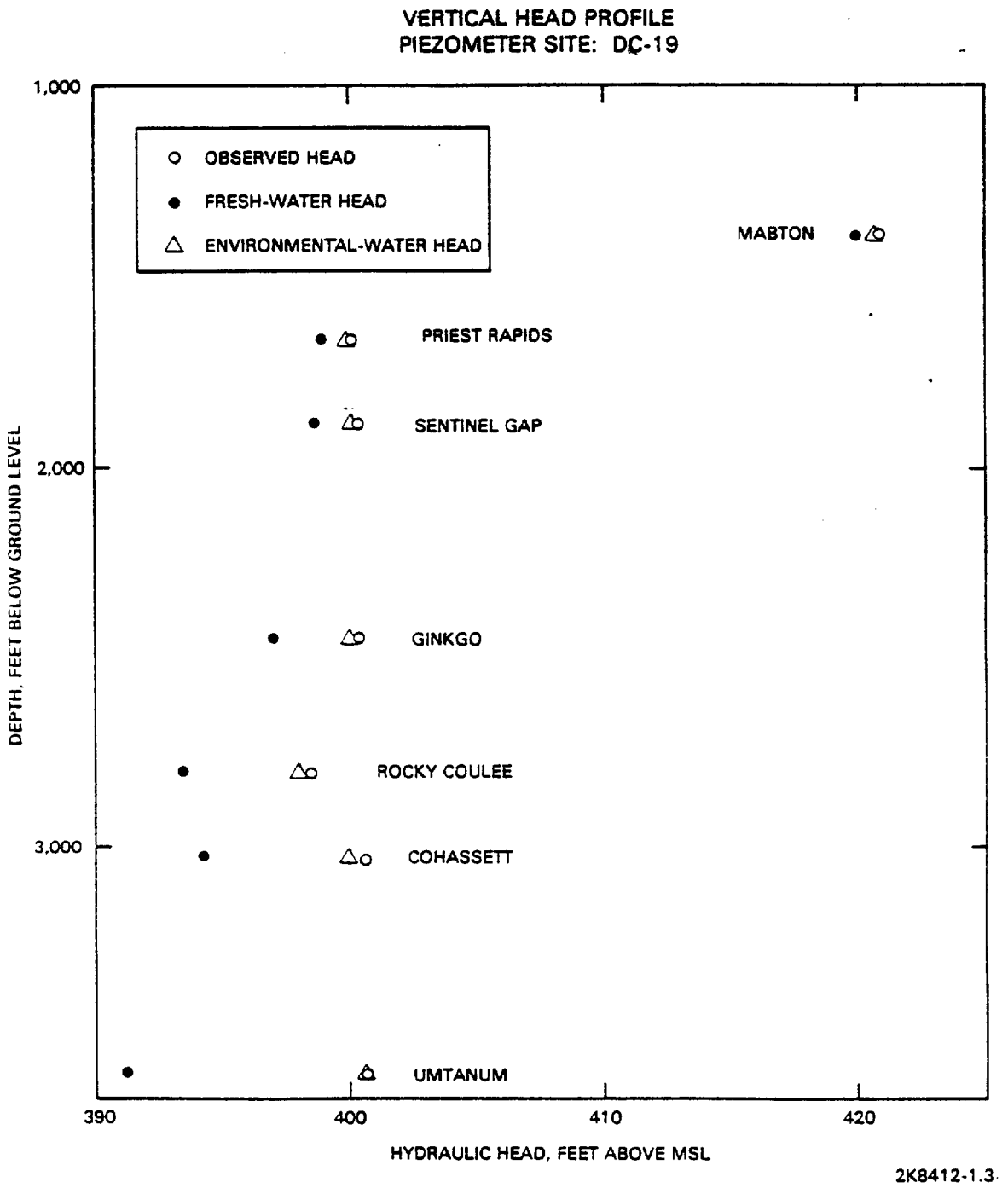
Program WHYDAT Rev 4.4 FILE: 19CGUT

COMPARISON OF HYDRAULIC HEADS AMONG DC-19,-20, AND -22

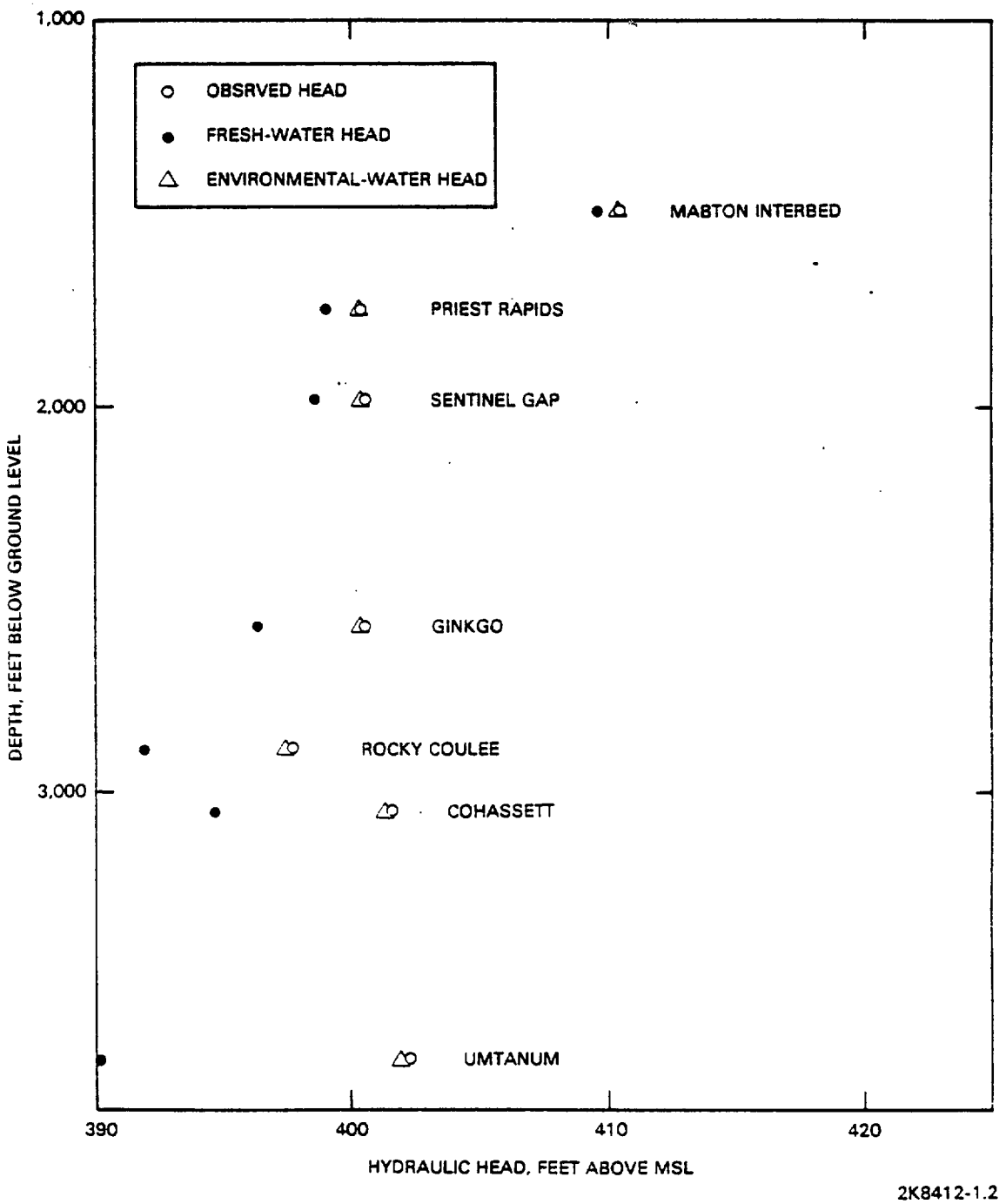
FOR NOVEMBER 29, 1984






VERTICAL HEAD PROFILE
PIEZOMETER SITE: DC-19
1,000
2,000
3,000
OBSERVED HEAD
FRESH-WATER HEAD
ENVIRONMENTAL-WATER HEAD
MABTON
PRIEST RAPIDS
SENTINEL GAP
GINKGO
ROCKY COULEE
COHASSETT
UMTANUM
DEPTH, FEET BELOW GROUND LEVEL
390
400
410
420
HYDRAULIC HEAD, FEET ABOVE MSL
2K8412-1.3

VERTICAL HEAD PROFILE
PEIZOMETER SITE: DC-22



2K8412-1.2

BAROMETRIC EFFECTS

-WATER LEVEL DECLINES WITH INCREASE IN ATMOSPHERIC PRESSURE AND VISA-VERSA

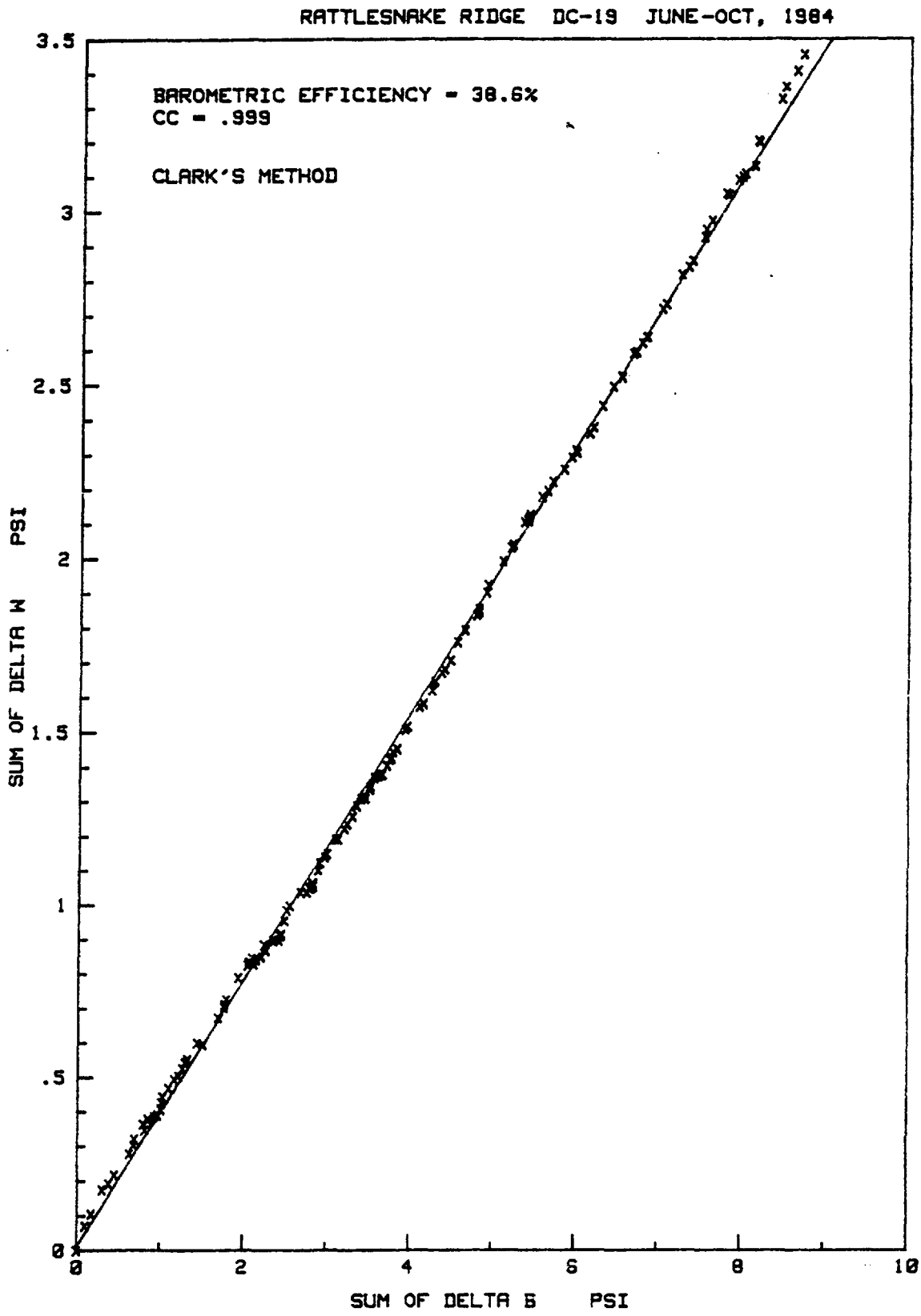
-BAROMETRIC EFFICENCY

-CLARK'S METHOD

-Summation of Incremental Changes in Water Level, W, Versus

Summation of Corresponding Incremental Changes in Atmospheric Pressure, B.

-Compensates for Effects of Water- Level Trends



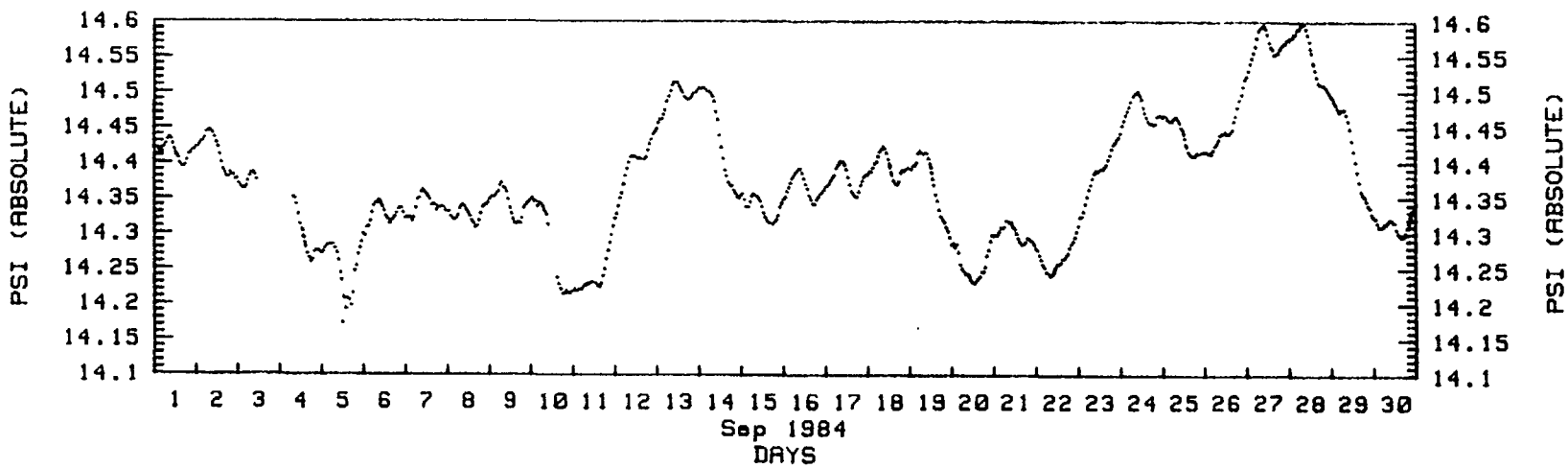
Program: PLOT Rev 2.01
File: AP6-10

BAROMETRIC EFFICIENCIES
(PERCENTAGE)

MONITORED INTERVAL	DC-19	DC-20	DC-22
BASAL RINGOLD	58.7	54.4	15.5
RATTLESNAKE	38.6	34.2	44.8
MABTON	48.5	33.3	40.2
PRIEST RAPIDS	69.5	71.7	70.9
SENTINEL GAP	71.9	79.7	74.3
GINKGO	76.1	79.3	74.5
ROCKY COULEE	81.6	81.1	84.2
COHASSETT	79.3	78.6	78.2
UMTANUM	80.8	86.8	81.3

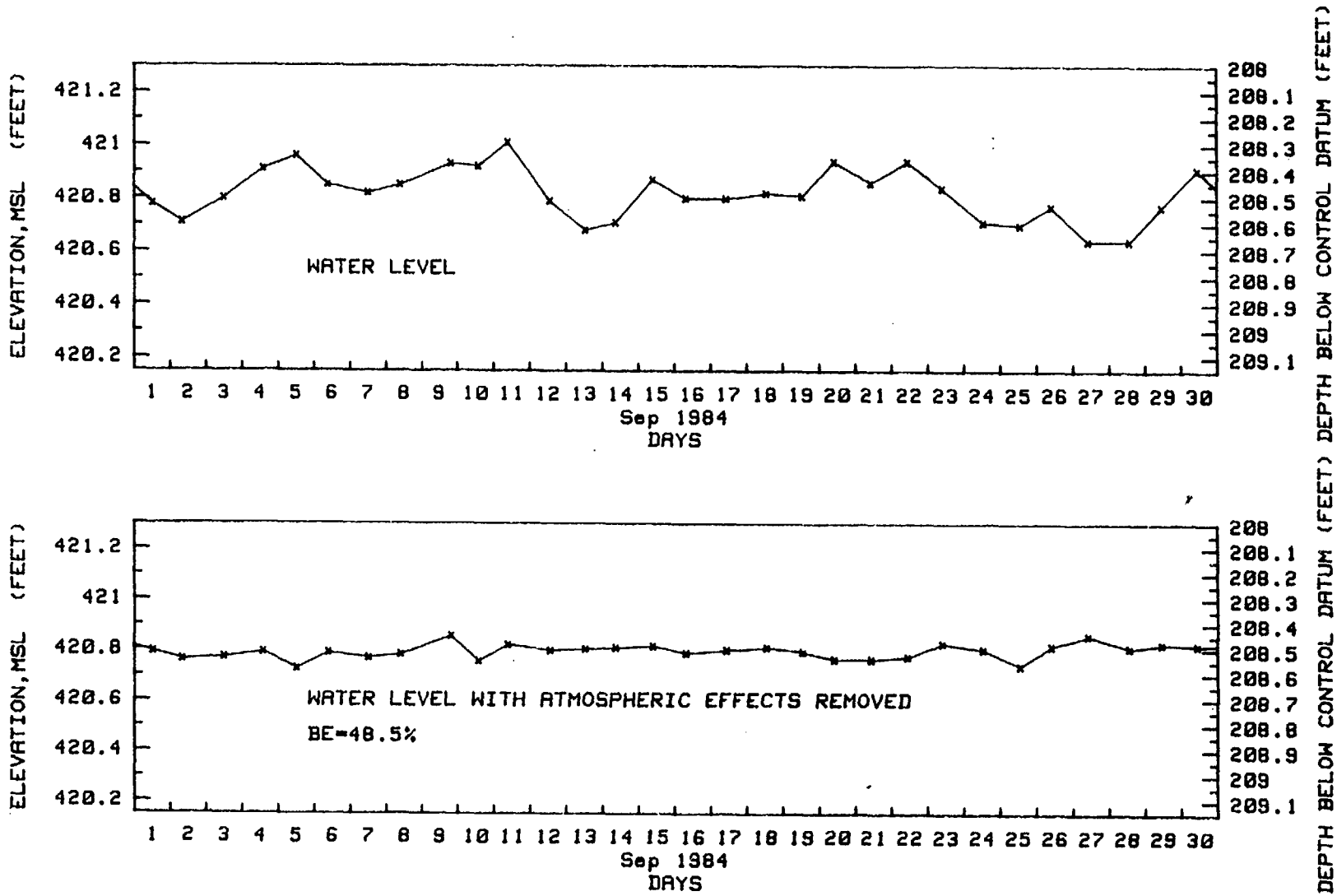
BOREHOLE NUMBER: DC-19C HYDROGEOLOGIC UNIT: ATMOSPHERIC PRESSURE

CONTROL DATUM ELEVATION (ft): 629.10 PROBE SEAT DEPTH (ft): 0



BOREHOLE NUMBER: DC-19D HYDROGEOLOGIC UNIT: MABTON INTERBED

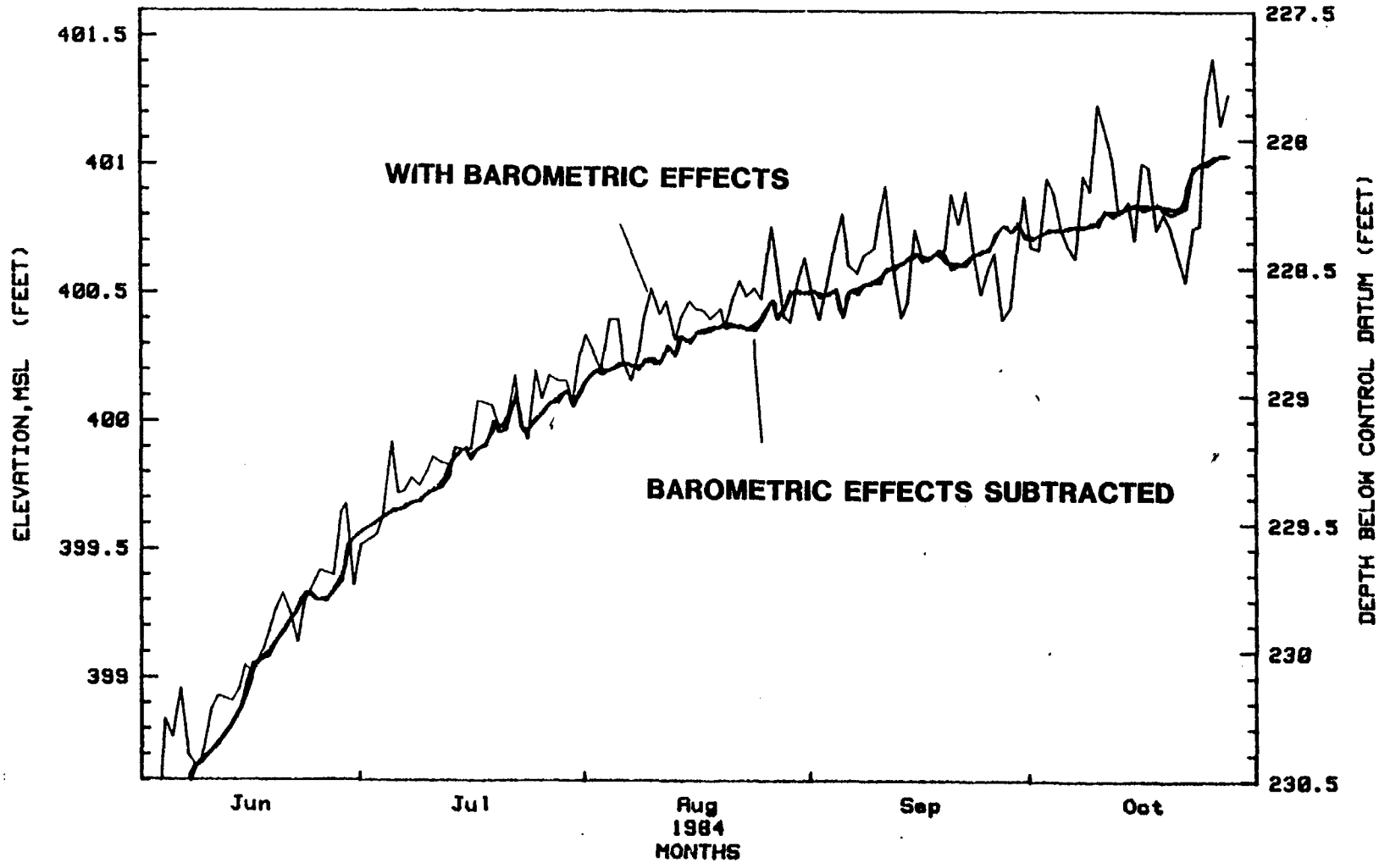
CONTROL DATUM ELEVATION (ft): 629.30 PROBE SEAT DEPTH (ft): 1402



BOREHOLE NUMBER: DC-19C HYDROGEOLOGIC UNIT: ROCKY COULEE FLOW TOP

LOCATION: N28808.11 W70243.98 CONTROL DATUM: BRASS CAP

CONTROL DATUM ELEVATION (ft): 629.10 BOREHOLE DEPTH (ft): 3983



HYDROGRAPH FOR BOREHOLE NUMBER DC-19C

Program WHYDAT Rev 4.4 FILE: 19CGRC

EARTH TIDE EFFECTS

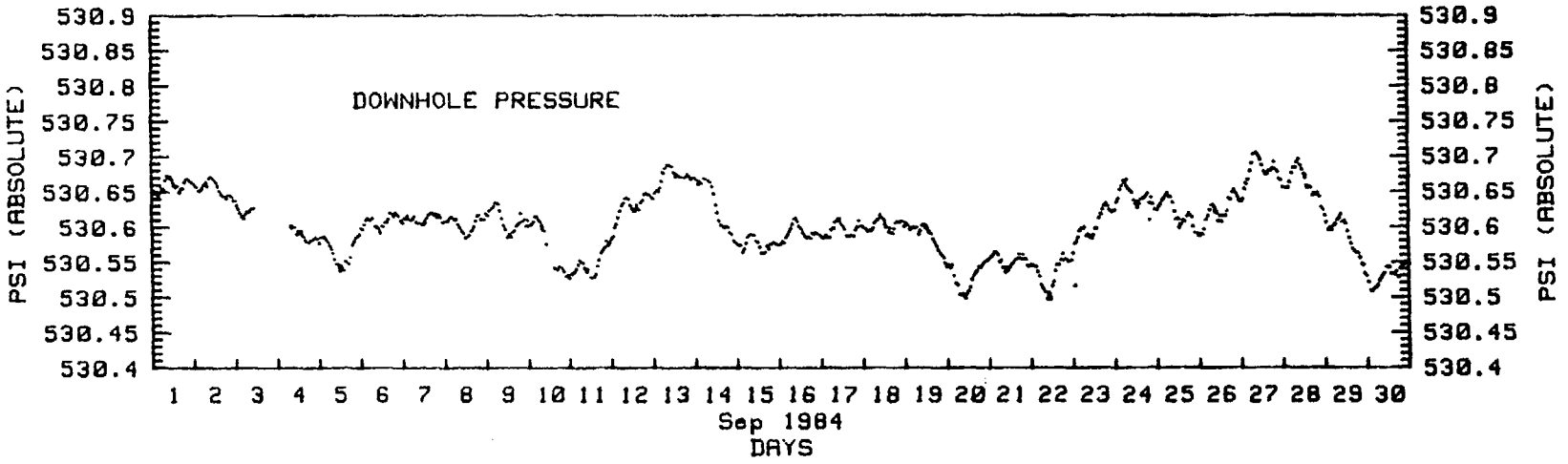
-REGULAR SEMIDIURNAL FLUCTUATIONS OF SMALL MAGNITUDE($\pm$0.05 ft)

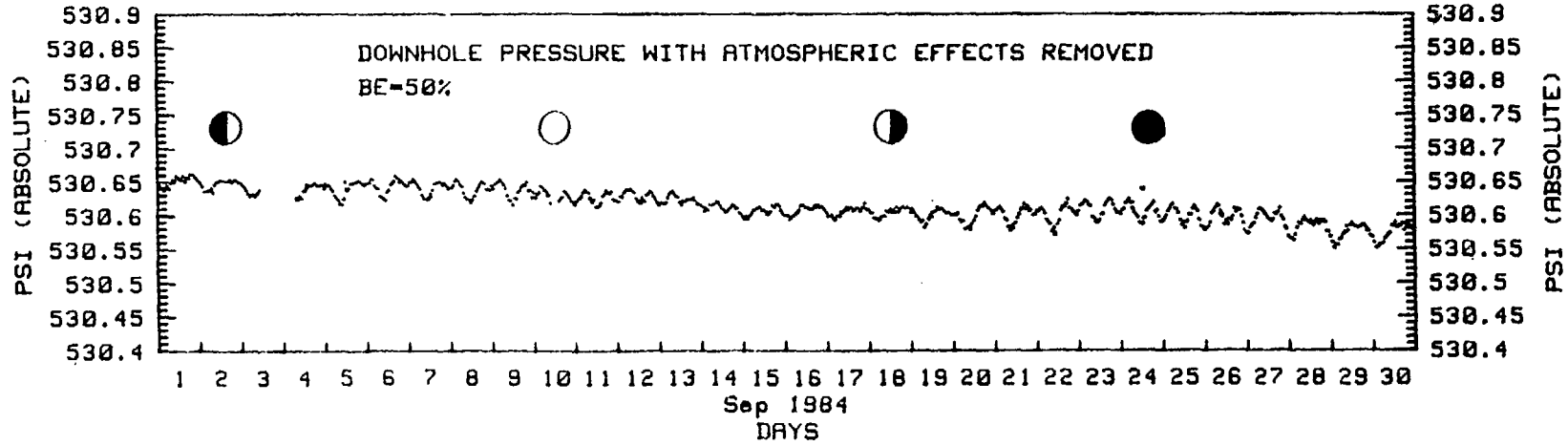
- -semidiurnal component
- -diurnal component
- -twice monthly component

-attraction exerted on the earth's crust by the moon and sun

BOREHOLE NUMBER: DC-19D HYDROGEOLOGIC UNIT: MABTON INTERBED

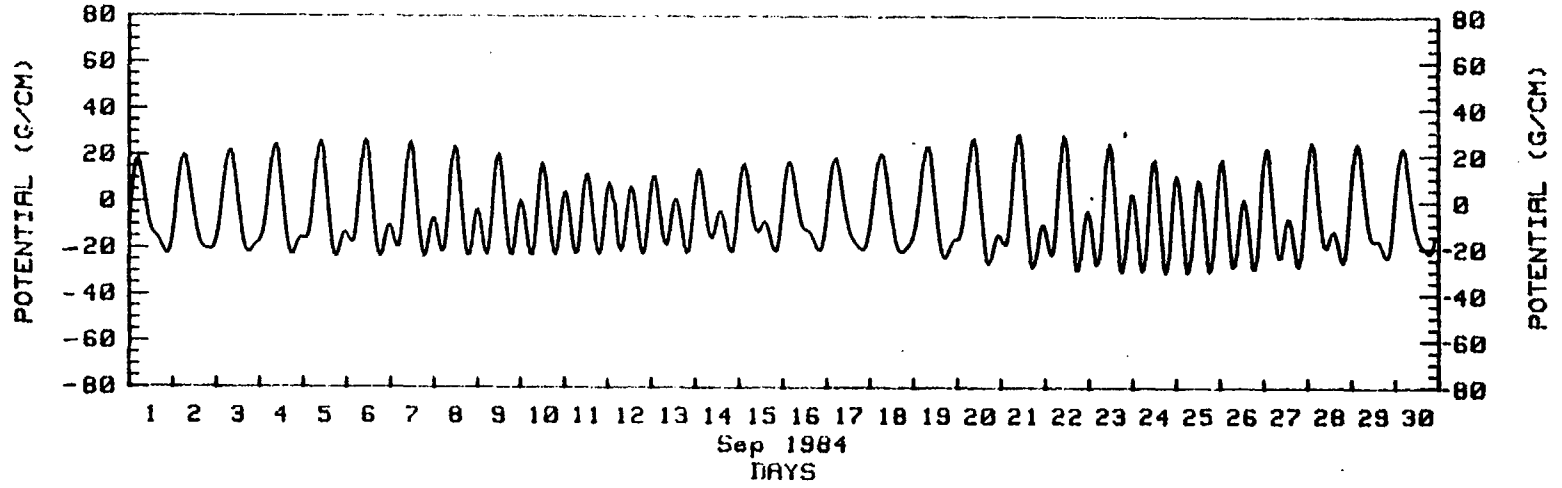
CONTROL DATUM ELEVATION (ft): 629.23 PROBE SEAT DEPTH (ft): 1402





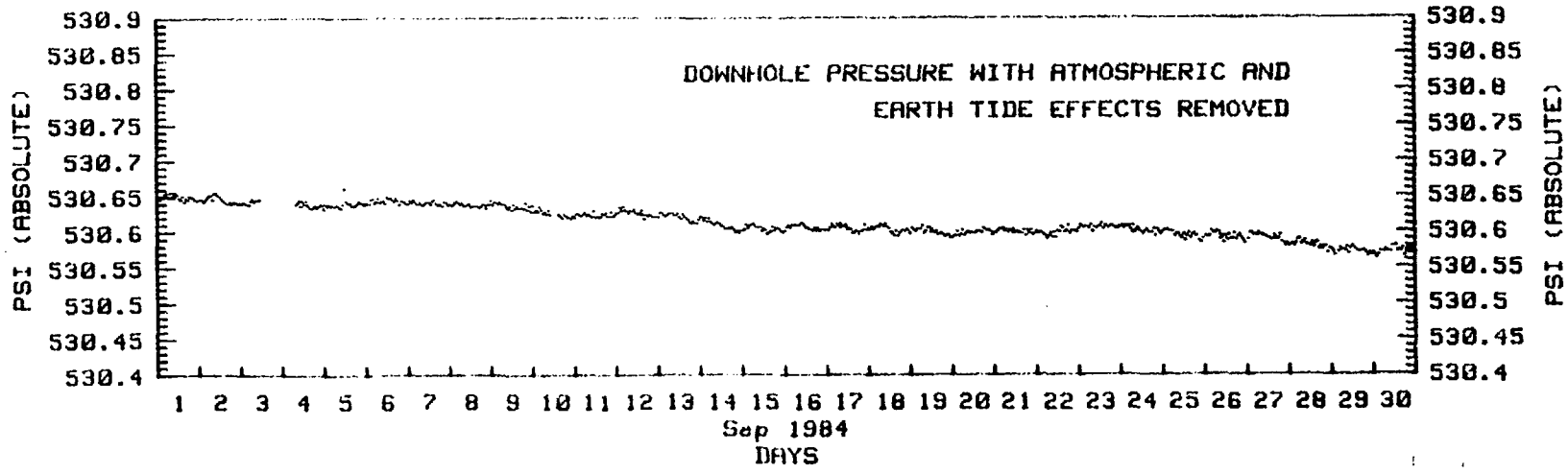
BOREHOLE NUMBER: EARTH TIDE DATA HYDROGEOLOGIC UNIT: EARTH-MOON-SUN

CONTROL DATUM ELEVATION (ft): 629.23 PROBE SEAT DEPTH (ft): NA



BOREHOLE NUMBER: DC-19D HYDROGEOLOGIC UNIT: MABTON INTERBED

CONTROL DATUM ELEVATION (ft): 629.23 PROBE SEAT DEPTH (ft): 1402



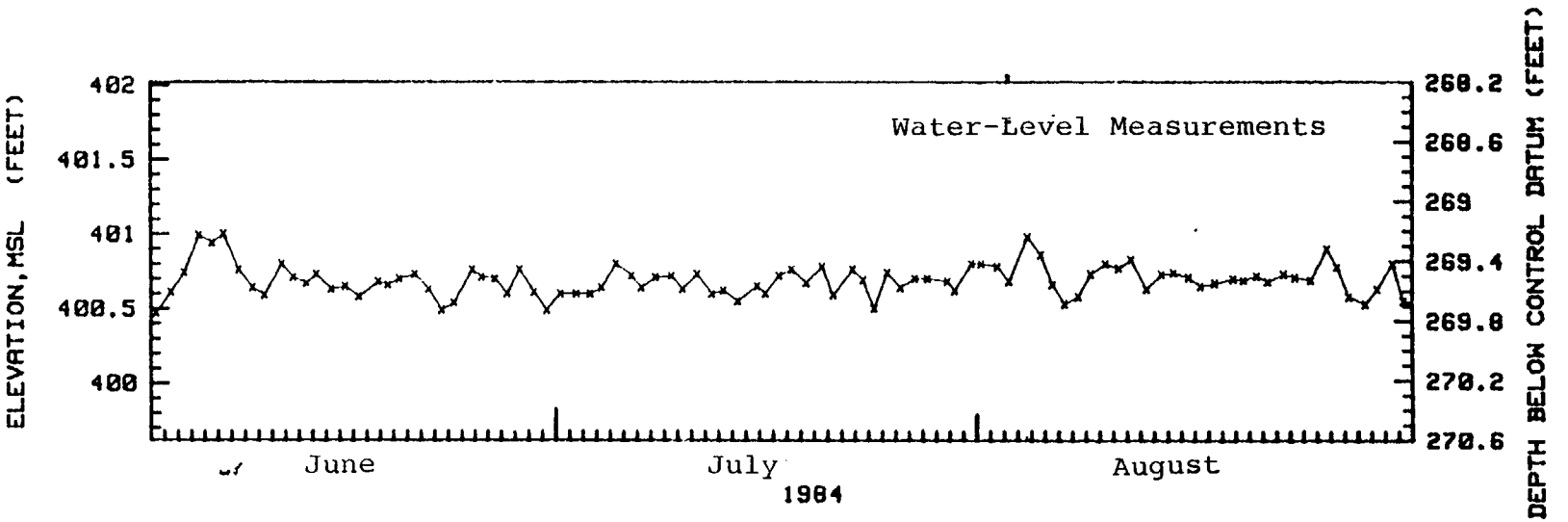
PRESSURE PROBE CONCERNS

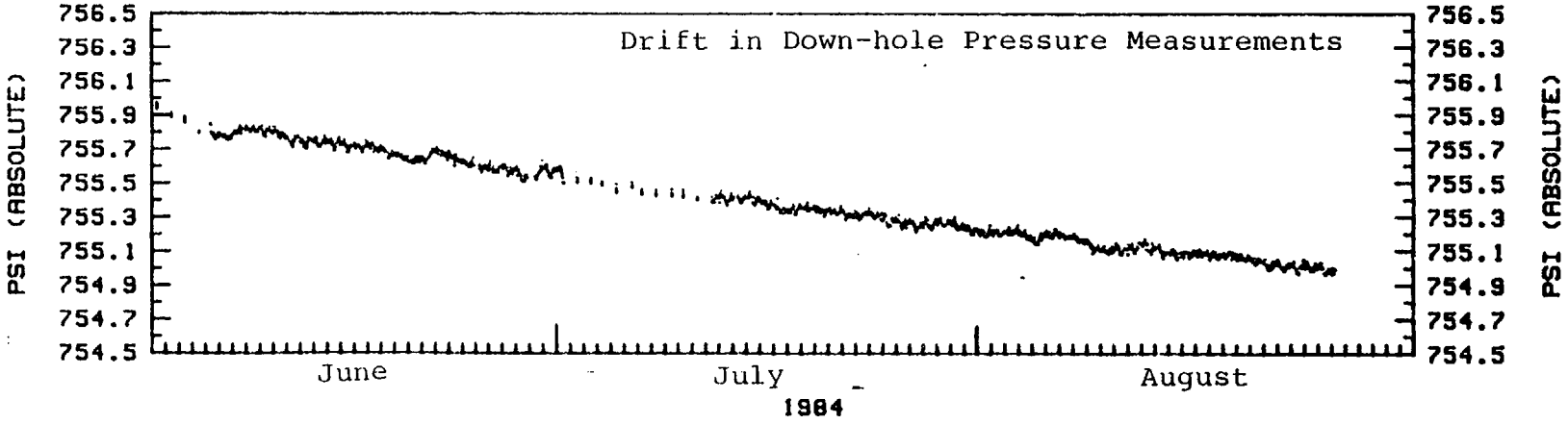
1. DRIFT IN PRESSURE READINGS WHICH DOES NOT CORRESPOND TO WATER LEVEL READINGS

2. NOISE IN PRESSURE MEASUREMENTS FROM DEEPEST PIEZOMETERS, ESPECIALLY WHEN USING MULTIPLEXER

BOREHOLE NUMBER: DC-22C HYDROGEOLOGIC UNIT: SENTINEL GAP

CONTROL DATUM ELEVATION (ft): 670.22 PROBE SEAT DEPTH (ft): 1989

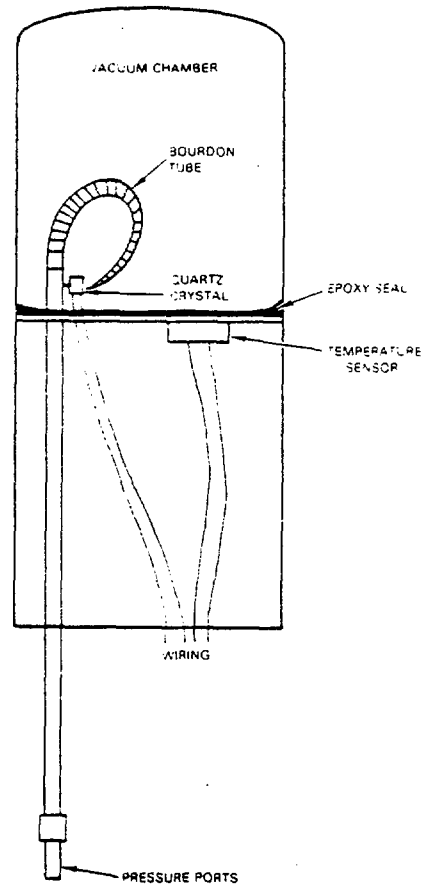




POSSIBLE CAUSES OF TRANSDUCER DRIFT

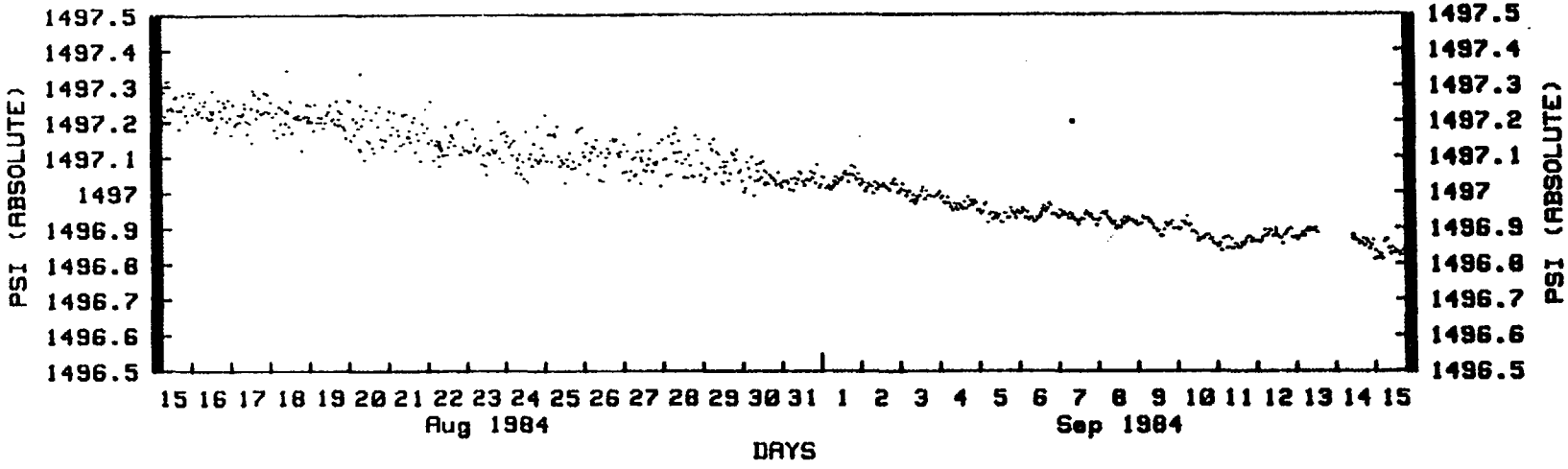
1. MECHANICAL STRESS RELIEF IN BOURDON TUBE.
2. LEAKAGE OF AIR INTO VACUUM CHAMBER.
3. PRESSURE CHANGE IN VACUUM CHAMBER CAUSED BY OUT-GASSING OF EPOXY.
4. NORMAL AGING OF QUARTZ CRYSTAL.
5. CONTAMINATION OF QUARTZ CRYSTAL BY OUT-GASSING OF EPOXY

PAROSCIENTIFIC DIGI-QUARTZ TRANSDUCER



BOREHOLE NUMBER: DC-22C HYDROGEOLOGIC UNIT: UMTANUM

CONTROL DATUM ELEVATION (ft): 670.22 PROBE SEAT DEPTH (ft): 3708



DRIFT IS NOT LINEAR THROUGHQUT MONITORING PERIOD

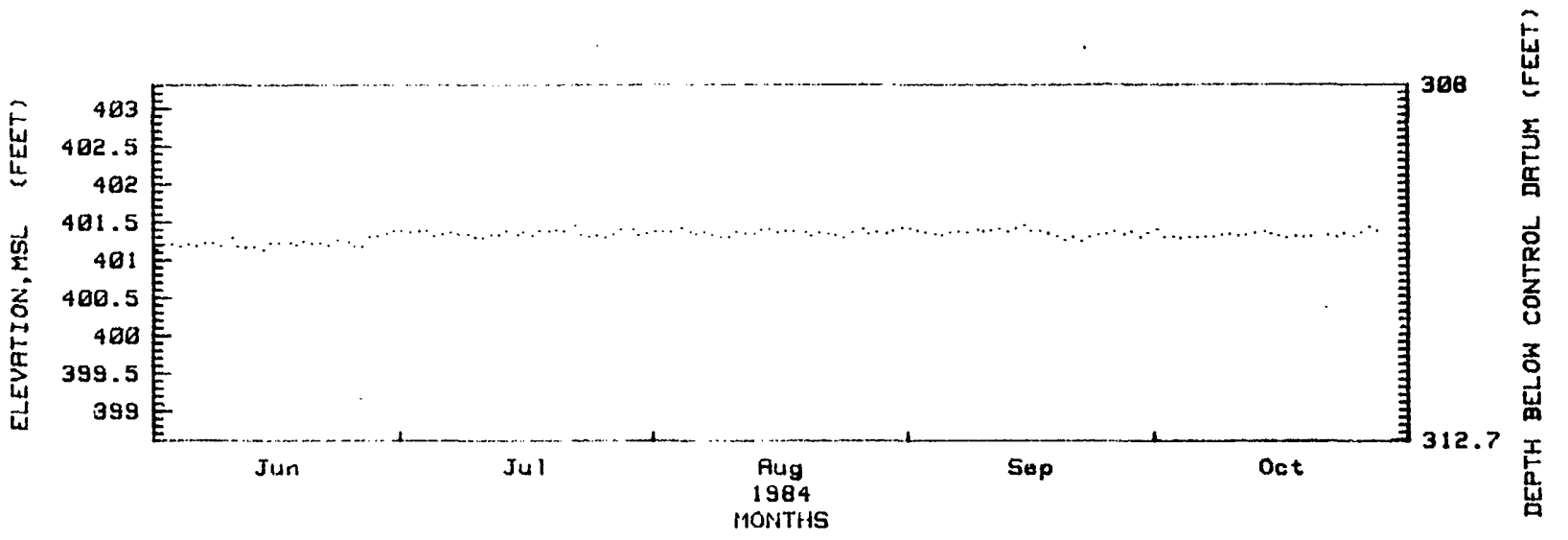
DRIFT CORRECTION

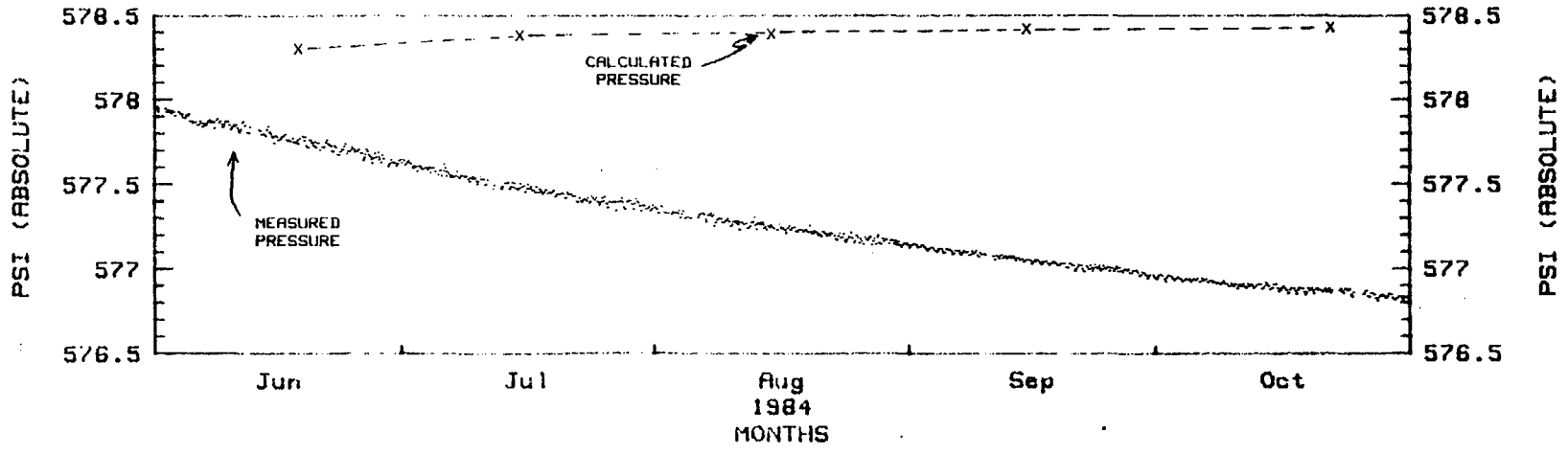
-RE-CALIBRATE AND SHIFT PRESSURE DATA IN RESPONSE TO CALIBRATED CHANGE

-CALCULATIONS OF DOWNHOLE PRESSURE FROM WATER-LEVEL DATA (HEADCO)

BOREHOLE NUMBER: DC-20C HYDROGEOLOGIC UNIT: PRIEST RAPIDS INTERFLOW ZONE

CONTROL DATUM ELEVATION (ft): 711.31 PROBE SEAT DEPTH (ft): 1617





CALIBRATION PROCEDURE

-RE-CALIBRATE EXISTING PROBES IN LAB BETWEEN 100 AND 1500 PSI

-PLACE CALIBRATED PROBE IN FIELD CHECK FACILITY (DC-8)

-PLACE PROBE IN PIEZOMETER WHERE PRESSURE READINGS ARE TAKEN AT 4 INTERMEDIATE DEPTHS AND SEATING NIPPLE

-DEEPEST PIEZOMETER IN EACH FACILITY WILL BE TEMPERATURE LOGGED

-FIELD CHECK FACILITY WILL BE TEMPERATURE LOGGED AT LEAST WEEKLY WHILE IN USE

HANFORD SITE BASELINE MONITORING

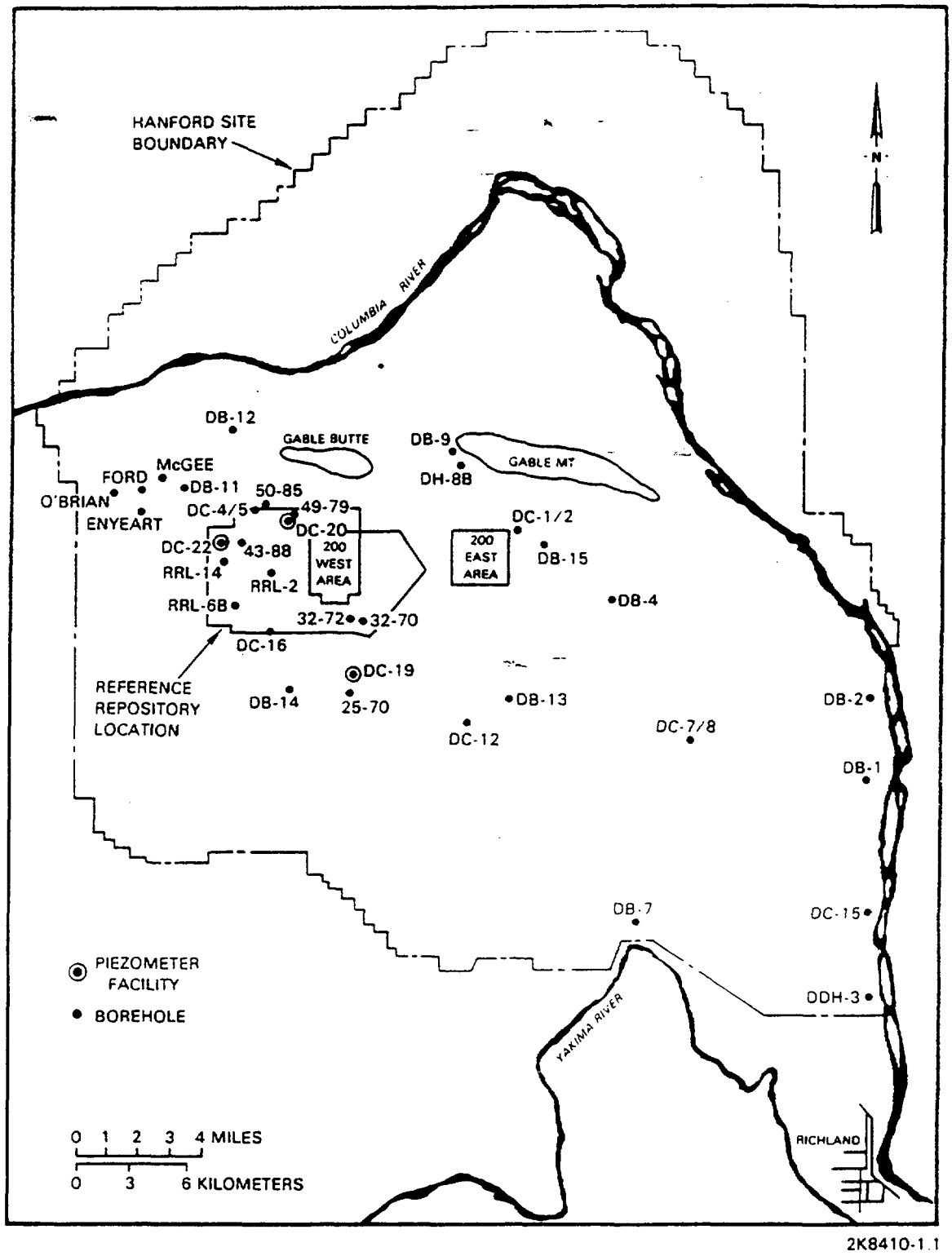


FIGURE 1. Location Map of the Hanford Site Monitoring Network Boreholes and the DC-19, DC-20 and DC-22 Piezometer Facilities.

MONITORING HORIZONS

UNCONFINED

25-70
32-70
32-72
43-88
49-79
50-85

MABTON INTERBED

DC-16B
DB-9
DB-8B
DB-13
DB-7
DB-4

PRIEST RAPIDS INTERFLOW

O'BRIAN
FORD
ENYEART
DB-12
DB-14
DC-16C
DB-1
DB-11

WANAPUM

DB-2
DB-15
DC-1
McGEE

GINKGO FLOW TOP

DDH-3

ROCKY COULEE FLOW TOP

RRL-6B
RRL-14
RRL-2
DC-4/5
McGEE

GRANDE RONDE

DC-7/8
DC-12
DC-15
DC-1
DC-2

DOCUMENTATION

SWANSON, L.C. AND LEVENTHAL,B.A.,1984, GROUNDWATER MONITORING DATA AND BOREHOLE DESCRIPTIONS FOR THE HANFORD SITE MONITORING NETWORK WELLS, SD-BWI-DP-042

INCLUDES:

-DATA SOURCES

-WELL CONSTRUCTION DETAILS

-WELL AS-BUILTS

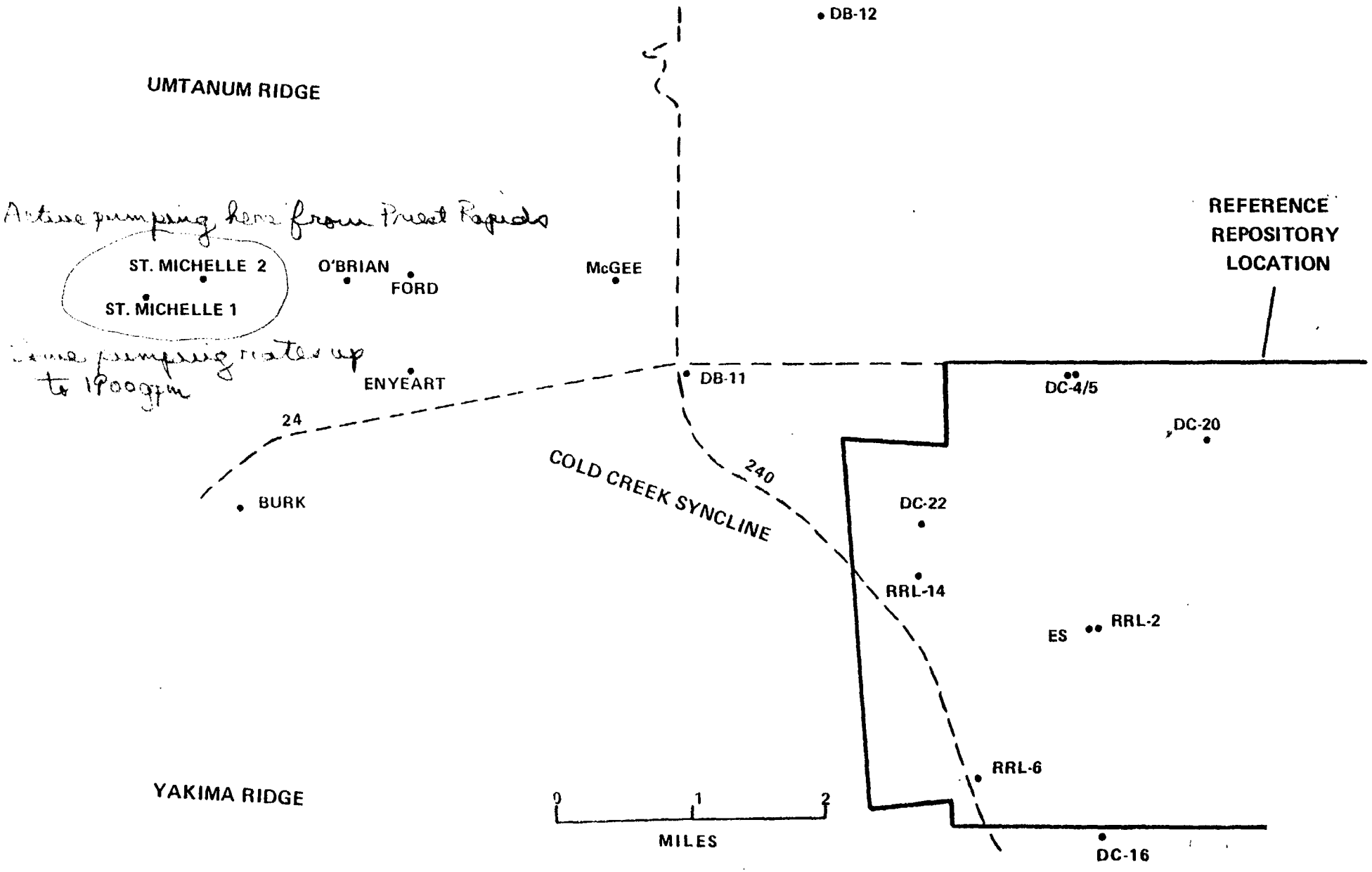
-MONITORING PERIOD, FREQUENCY,DEPTH INTERVAL,AND STRATIGRAPHIC HORIZON

-HYDROGRAPHS

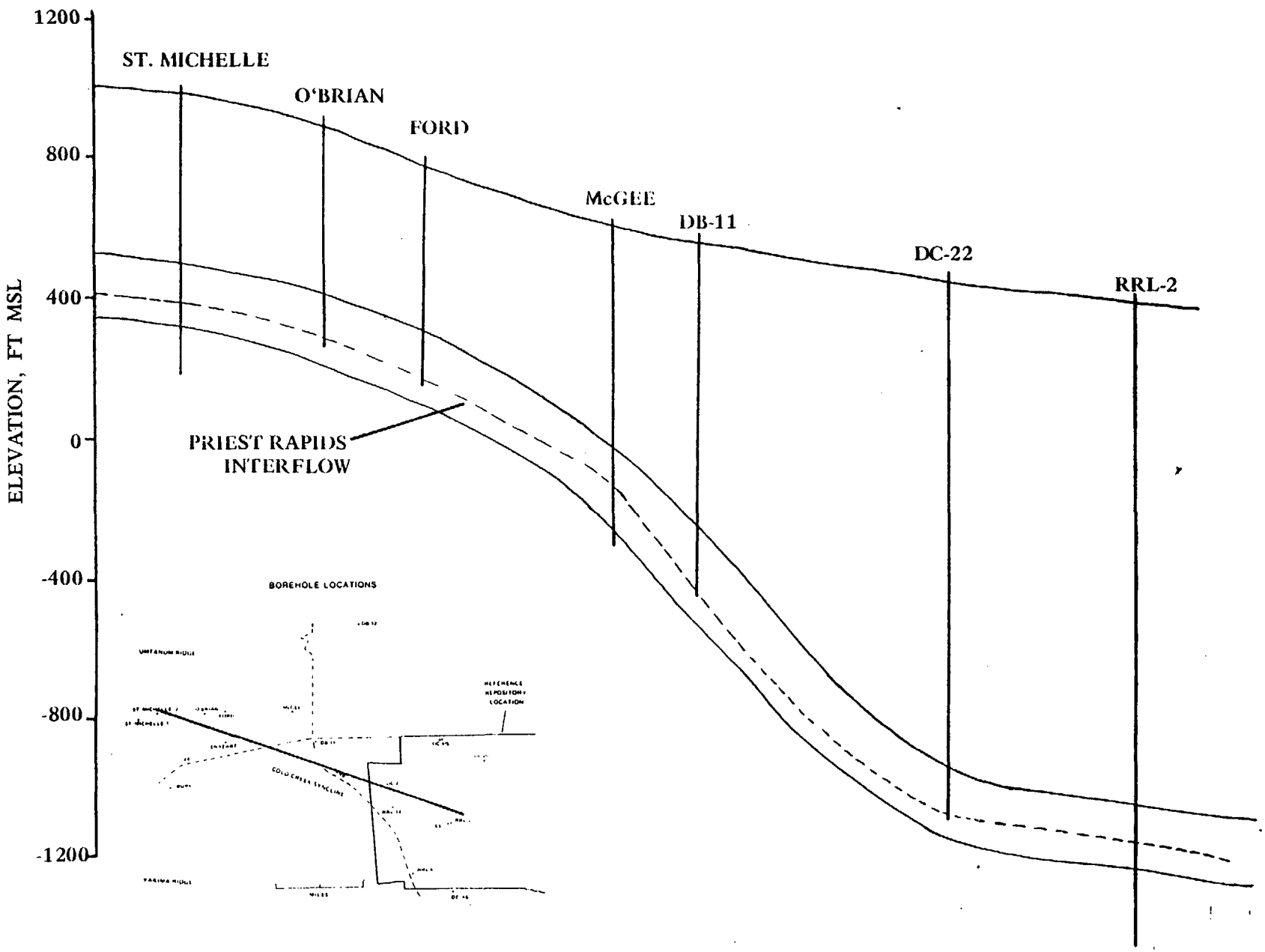
-DATA TABLES

BROWN,W.R., DRAFT, INTEGRITY TESTING PLANS FOR BOREHOLES IN THE HANFORD SITE MONITORING NETWORK, SD-BWI-TP-039.

BOREHOLE LOCATIONS



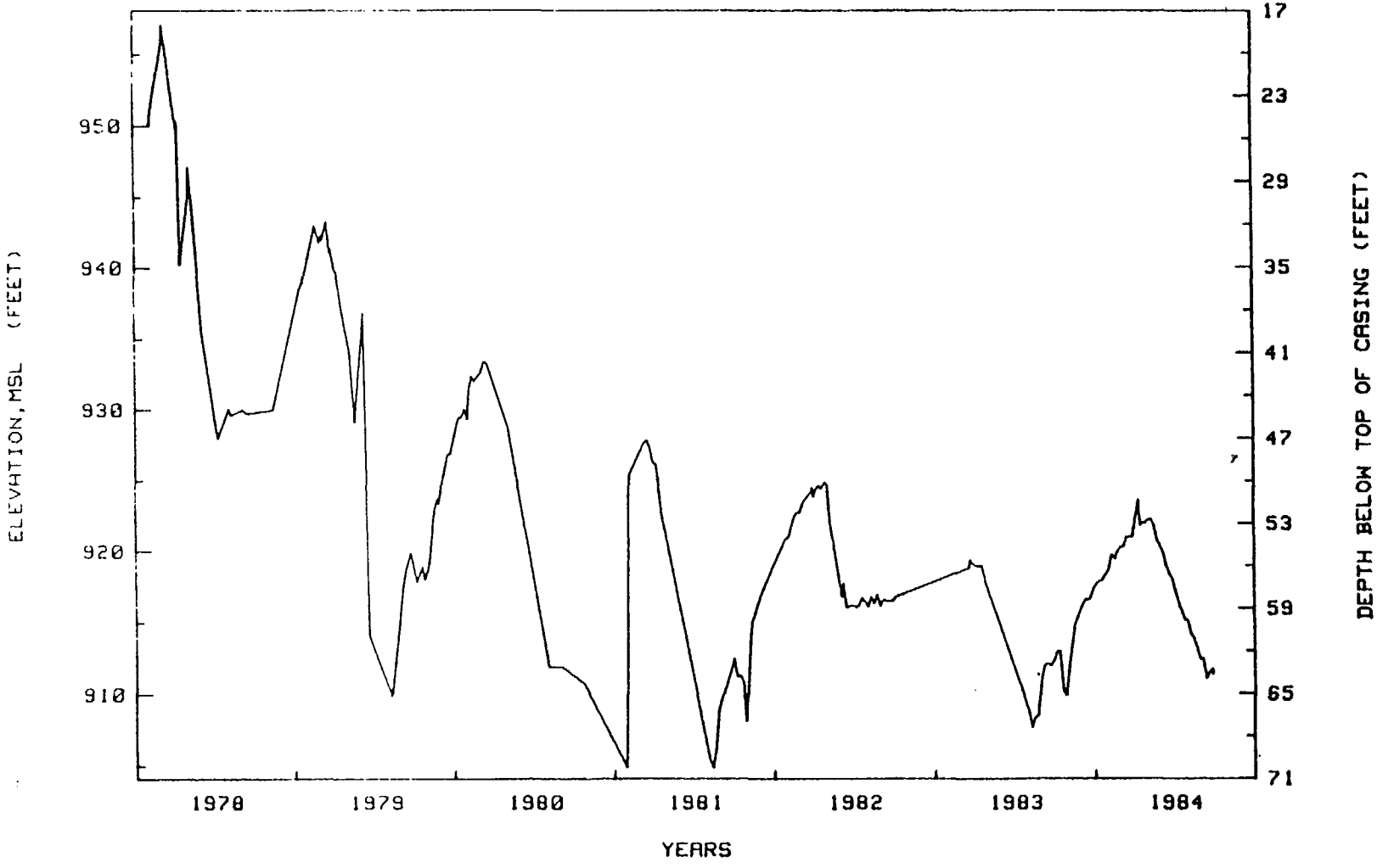
PRIEST RAPIDS INTERFLOW IN UPPER COLD CREEK VALLEY



BOREHOLE NUMBER: OBRIAN HYDROGEOLOGIC UNIT: PRIEST RAPIDS FLOW TOP

LOCATION: N 454,404 E 2,183,767 MEASURING POINT: TOP OF CASING

MEASURING POINT ELEVATION (ft): 975.09 BOREHOLE DEPTH (ft): 707.00



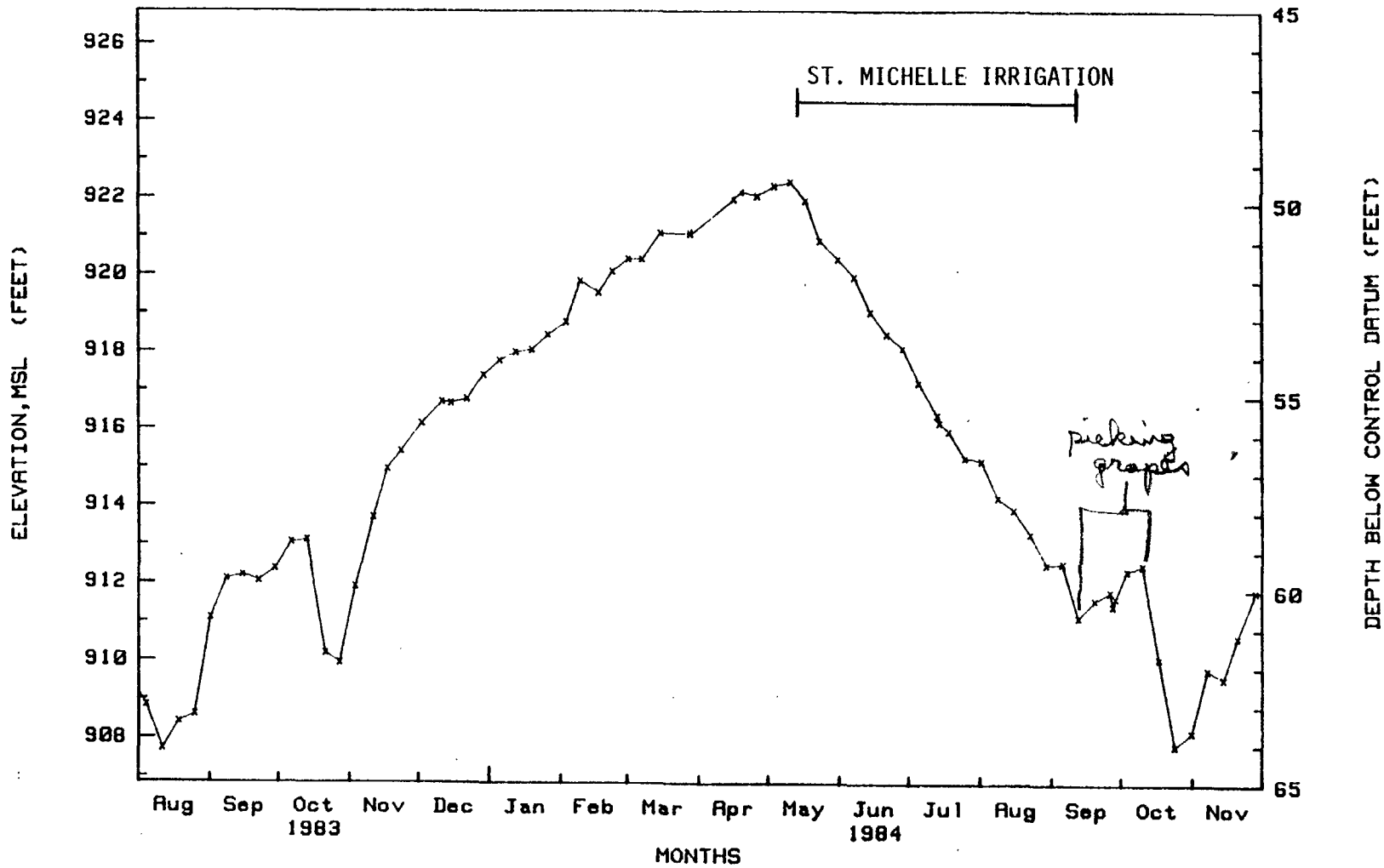
HYDROGRAPH FOR BOREHOLE NUMBER OBRIAN

Program HHYDAT Rev 4.4 FILE: OBRIAN

BOREHOLE NUMBER: OBRIAN HYDROGEOLOGIC UNIT: PRIEST RAPIDS FLOW TOP

LOCATION: N 454,404 E 2,183,767 CONTROL DATUM: BRASS CAP

CONTROL DATUM ELEVATION (ft): 971.85 BOREHOLE DEPTH (ft): 707



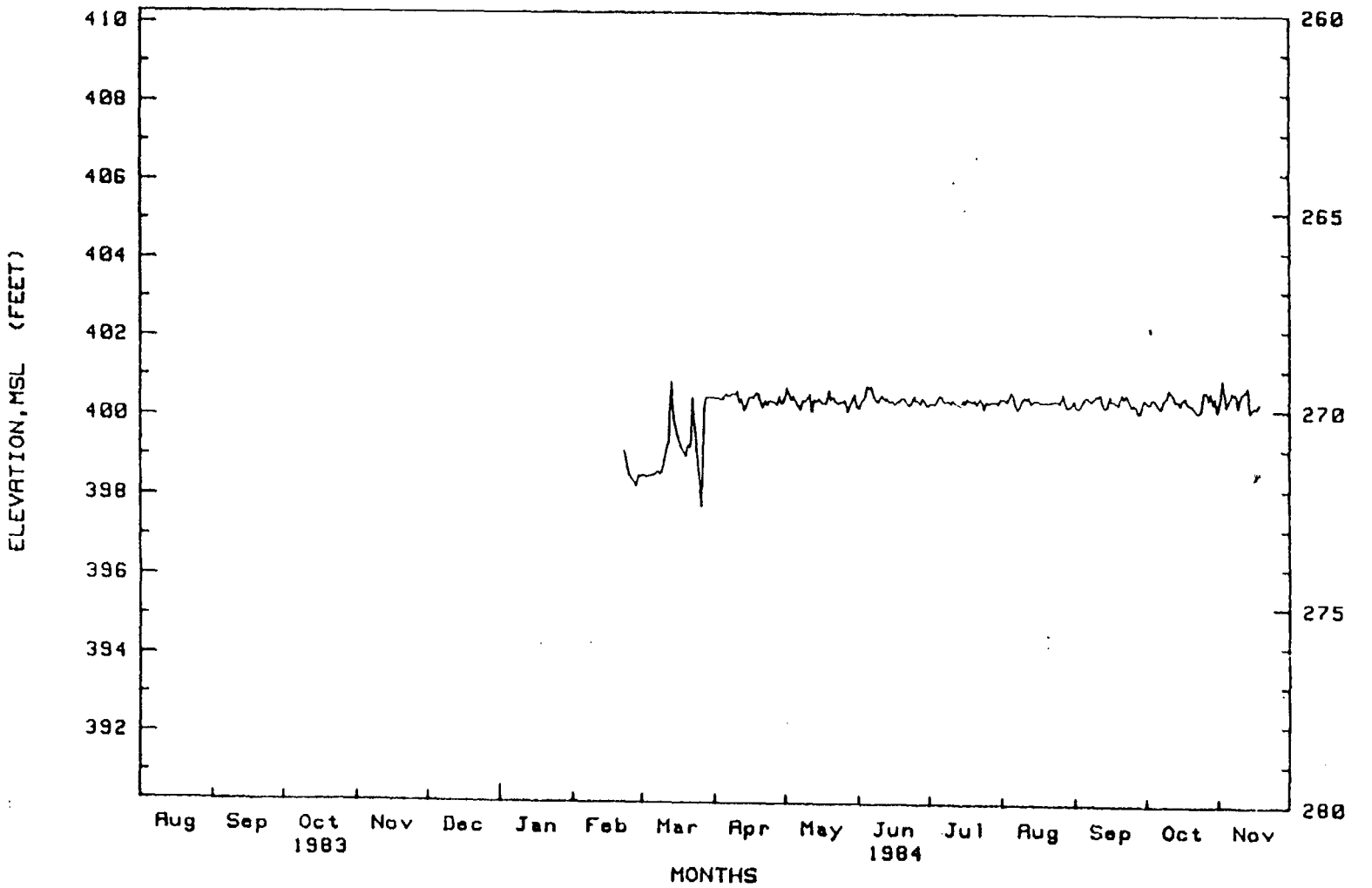
HYDROGRAPH FOR BOREHOLE NUMBER OBRIAN

Program WHYDAT Rev 4.4 FILE: OBRIAN

BOREHOLE NUMBER: DC-22C HYDROGEOLOGIC UNIT: PRIEST RAPIDS INTERFLOW ZONE

LOCATION: N 448,600 E 2,204,188 CONTROL DATUM: BRASS CAP

CONTROL DATUM ELEVATION (ft): 670.28 BOREHOLE DEPTH (ft): 3960



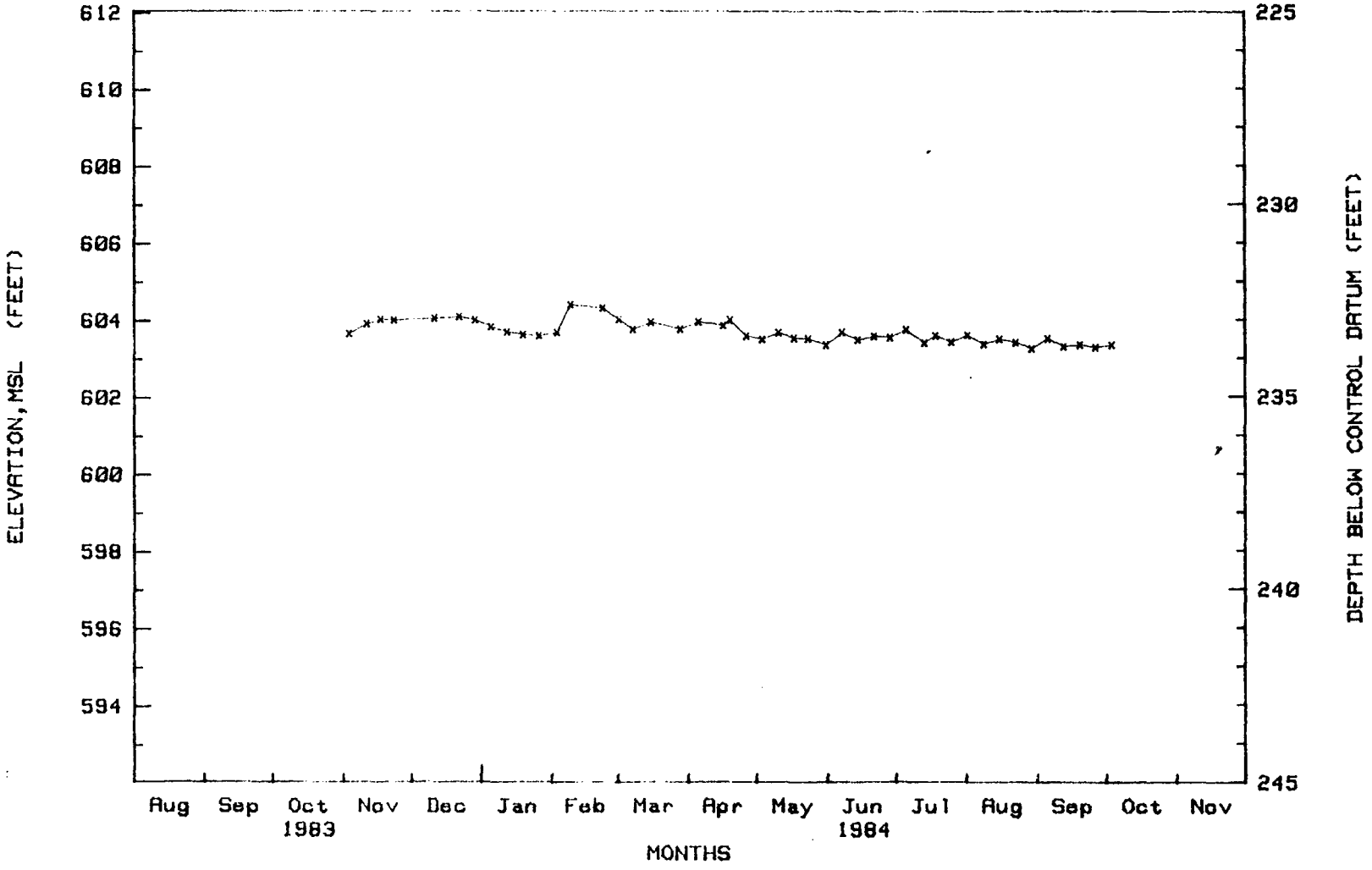
HYDROGRAPH FOR BOREHOLE NUMBER DC-22C

Program WHYDAT Rev 4.4 FILE: 22CHPR

BOREHOLE NUMBER: MCGEE INTERVAL HYDROGEOLOGIC UNIT: COMPOSITE GRANDE RONDE

LOCATION: N 457,773 E 2,191,775 CONTROL DATUM: BRASS CAP

CONTROL DATUM ELEVATION (ft): 837.05 BOREHOLE DEPTH (ft): 3123



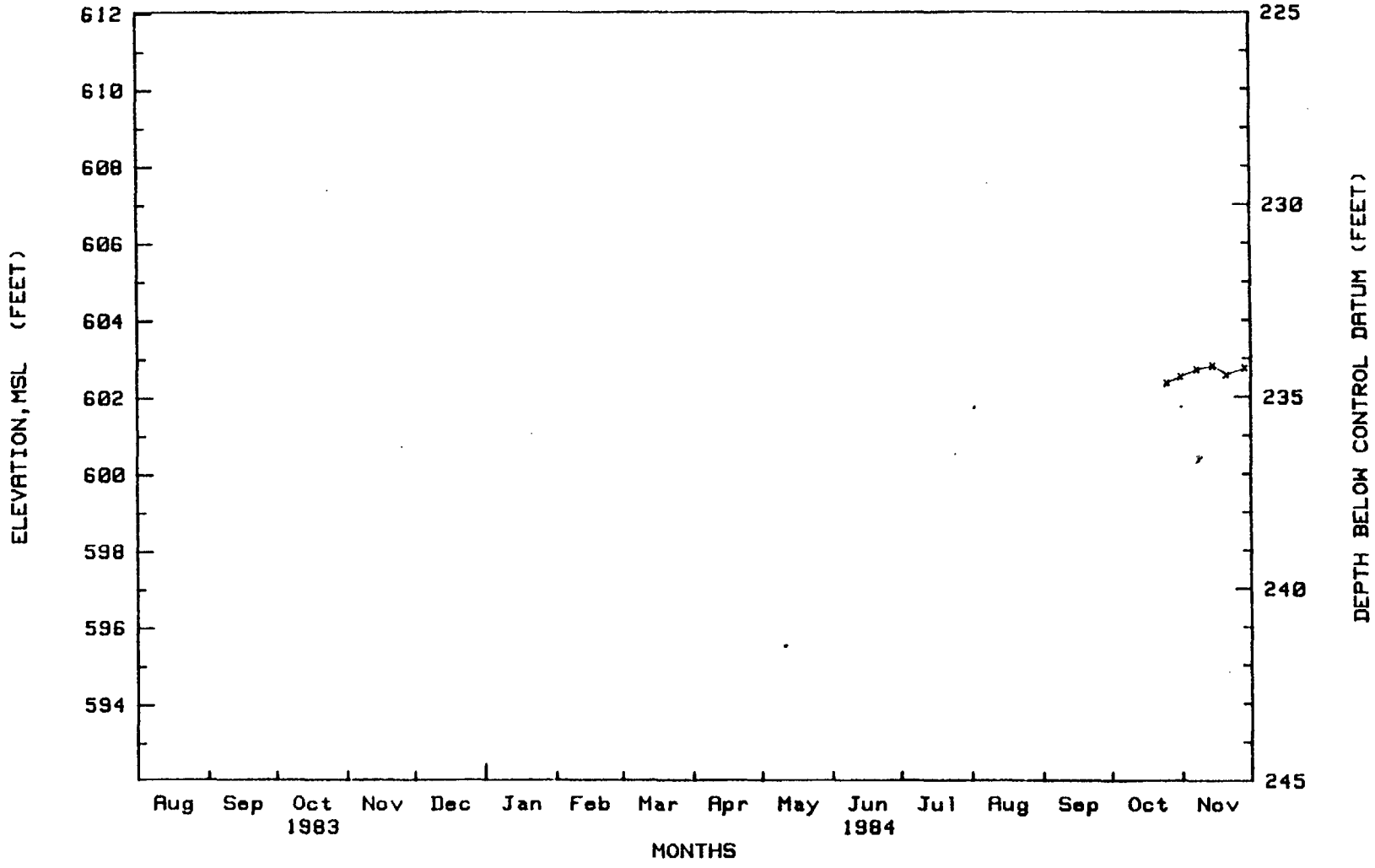
HYDROGRAPH FOR BOREHOLE NUMBER MCGEE INTERVAL

Program WHYDAT Rev 4.4 FILE: MCGCGR

BOREHOLE NUMBER: MCGEE INTERVAL HYDROGEOLOGIC UNIT: ROCKY COULEE FLOW TOP

LOCATION: N 457,773 E 2,191,775 CONTROL DATUM: BRASS CAP

CONTROL DATUM ELEVATION (ft): 837.05 BOREHOLE DEPTH (ft): 3123



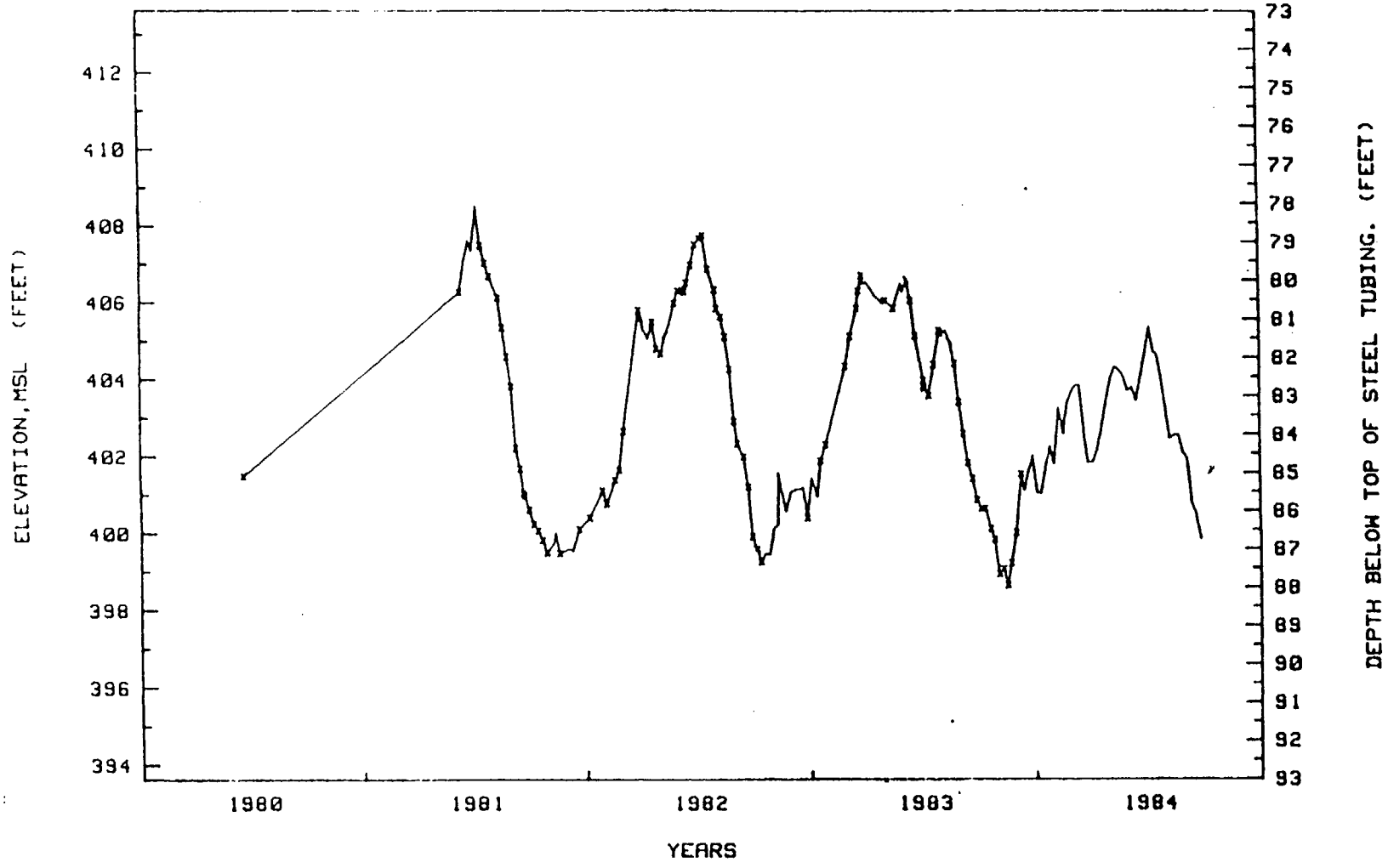
HYDROGRAPH FOR BOREHOLE NUMBER MCGEE INTERVAL

Program WHYDAT Rev 4.4 FILE: MCGRC

BOREHOLE NUMBER: DB-12 HYDROGEOLOGIC UNIT: PRIEST RAPIDS FLOW TOP

LOCATION: N 468,066 E 2,200,145 MEASURING POINT: TOP OF STEEL TUBING.

MEASURING POINT ELEVATION (ft). 486.62 BOREHOLE DEPTH (ft): 707.00



HYDROGRAPH FOR BOREHOLE NUMBER DB-12

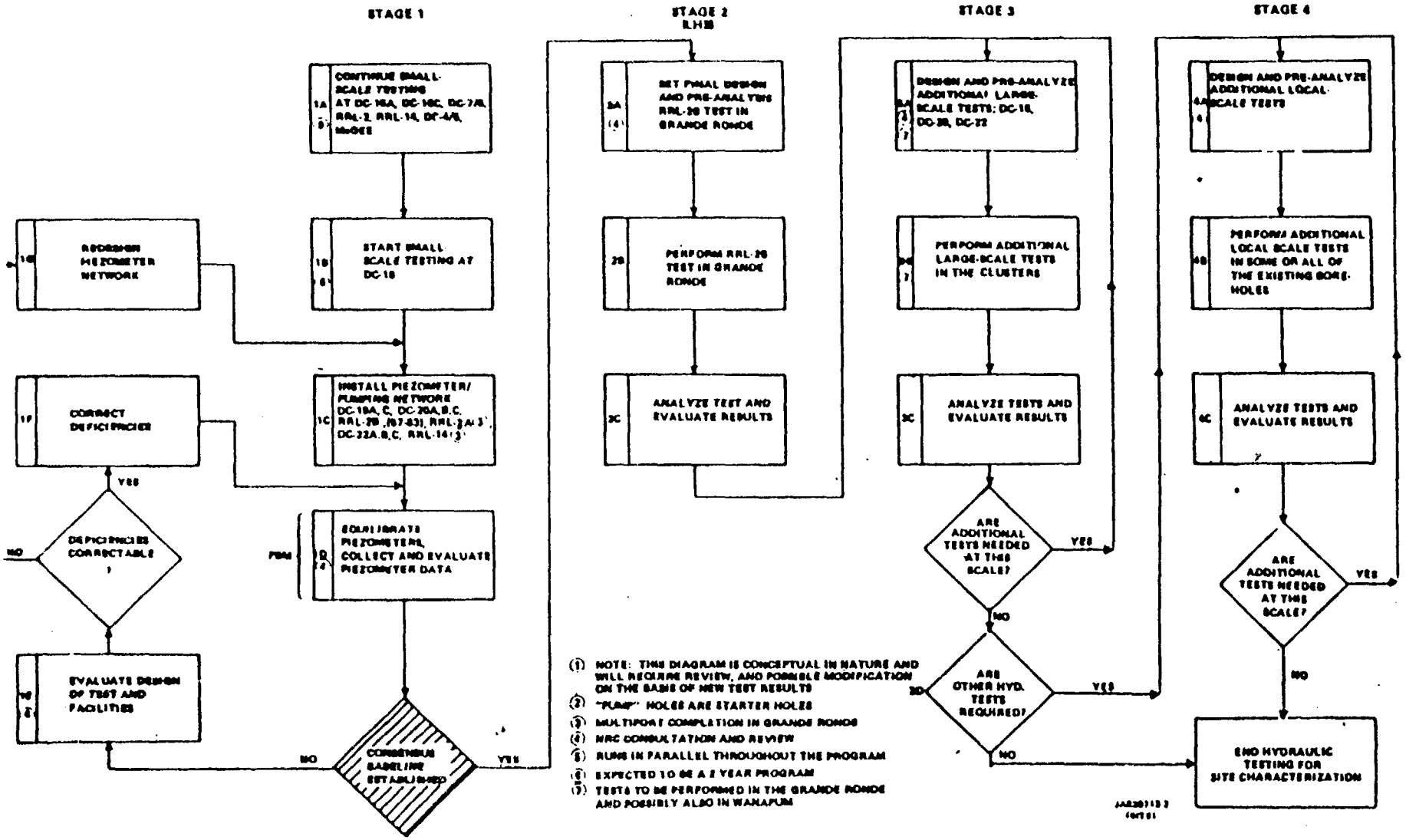
Program HHYDAT Rev 4.4 FILE: DB-12B

SUMMARY

- MOST ZONES APPEAR TO BE NEAR EQUILIBRIUM
- LOW VERTICAL AND HORIZONTAL GRADIENTS IN THE WANAPUM AND GRANDE RONDE BASALTS
- DEVELOPING THE TOOLS TO DEAL WITH BAROMETRIC AND EARTH TIDE EFFECTS ON WATER-LEVEL AND DOWNHOLE PRESSURE DATA
- DEVELOP UNDERSTANDING OF TOTAL DATA COLLECTION SYSTEM
- VERY LITTLE SEASONAL WATER-LEVEL FLUCTUATIONS IN THE RRL

Figure 2.

LOGIC DIAGRAM FOR BWIP BOREHOLE: HYDROLOGIC TEST STRATEGY (1)



(1) NOTE: THIS DIAGRAM IS CONCEPTUAL IN NATURE AND WILL REQUIRE REVIEW, AND POSSIBLE MODIFICATION ON THE BASIS OF NEW TEST RESULTS
(2) "PUMP" HOLES ARE STARTER HOLES
(3) MULTIPORT COMPLETION IN GRANDE RONDE
(4) NRC CONSULTATION AND REVIEW
(5) RUNS IN PARALLEL THROUGHOUT THE PROGRAM
(6) EXPECTED TO BE A 2 YEAR PROGRAM
(7) TESTS TO BE PERFORMED IN THE GRANDE RONDE AND POSSIBLY ALSO IN WANAPUM

PURPOSES OF
PBM VS. SPHERES OF ASSESSMENT

PURPOSE	SPHERE
o PRE-TEST/PRE-ES TEST BASELINING	o RRL AND ADJACENT AREA
o GENERAL SITE CHARACTERIZATION	o HANFORD SITE
o REGIONAL GROUNDWATER FLOW MODEL CALIBRATIONS	o REGIONAL (EXTENDED PASCO BASIN AND BEYOND)

BASELINE EVALUATION TOOLS

- PARAMETRIC SENSITIVITY
- CHARACTERIZATION OF ERROR
- APPLIED STATISTICS
- INDEPENDENT DATA SOURCES
- STRESS DATA
- RATES OF CHANGE

ELEMENTS OF SUBJECTIVE EVALUATION

- INTERPRETATION
- CONCEPTUALIZATION
- PREDICTABILITY
- CONSEQUENCE
- CONFIDENCE

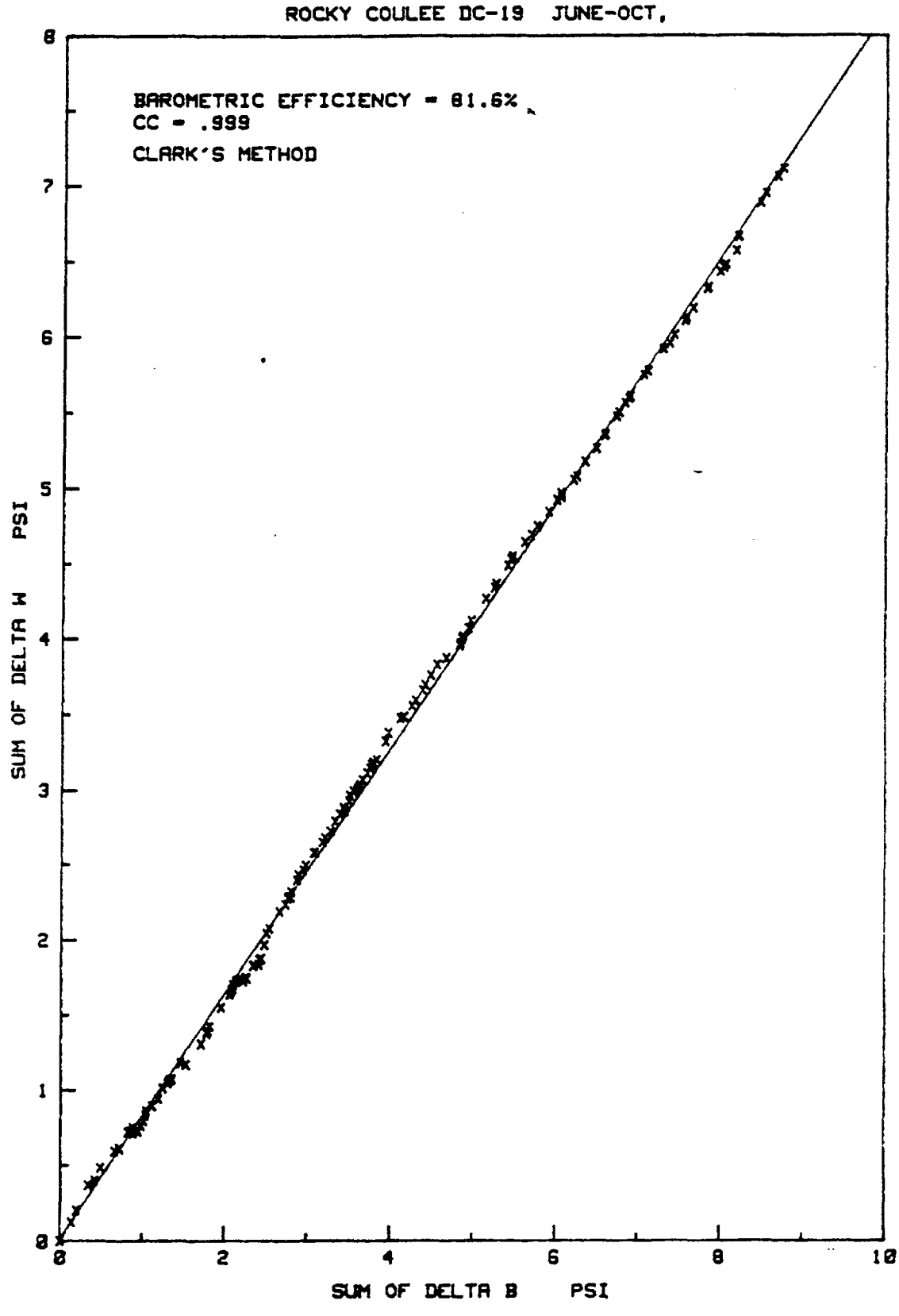
INTERPRETATION

- CORRELATIONS WITH STRESS
- CASCADE OF FILTERS
- CONSISTENCY

CORRELATIONS WITH RIVER STAGE

$$Z\ (DB7) = 344.39 - 0.00176\ t + 0.14232Z\ (YAKIMA)$$

$$Z\ (DB\text{-}12B) = 383.73 + 0.00408\ t + 0.74605\ Z\ (COLUMBIA) - 0.65707\ (YAKIMA)$$

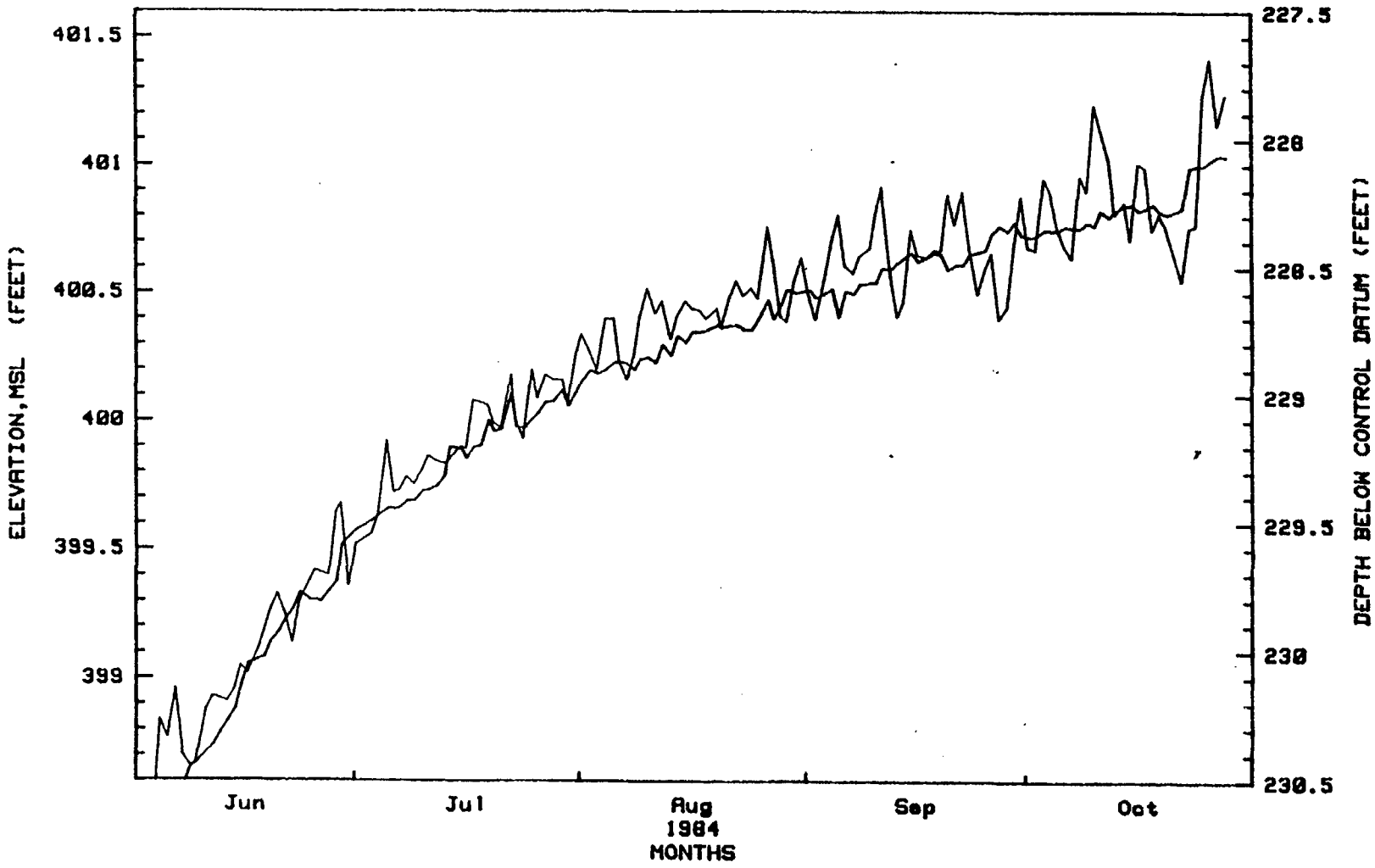


Program: PLOT Rev 2.01
File: RPS-10

BOREHOLE NUMBER: DC-19C HYDROGEOLOGIC UNIT: ROCKY COULEE FLOW TOP

LOCATION: N28808.11 W70243.98 CONTROL DATUM: BRASS CAP

CONTROL DATUM ELEVATION (ft): 629.10 BOREHOLE DEPTH (ft): 3983



HYDROGRAPH FOR BOREHOLE NUMBER DC-19C

Program WHYDAT Rev 4.4 FILE: 19CGRC

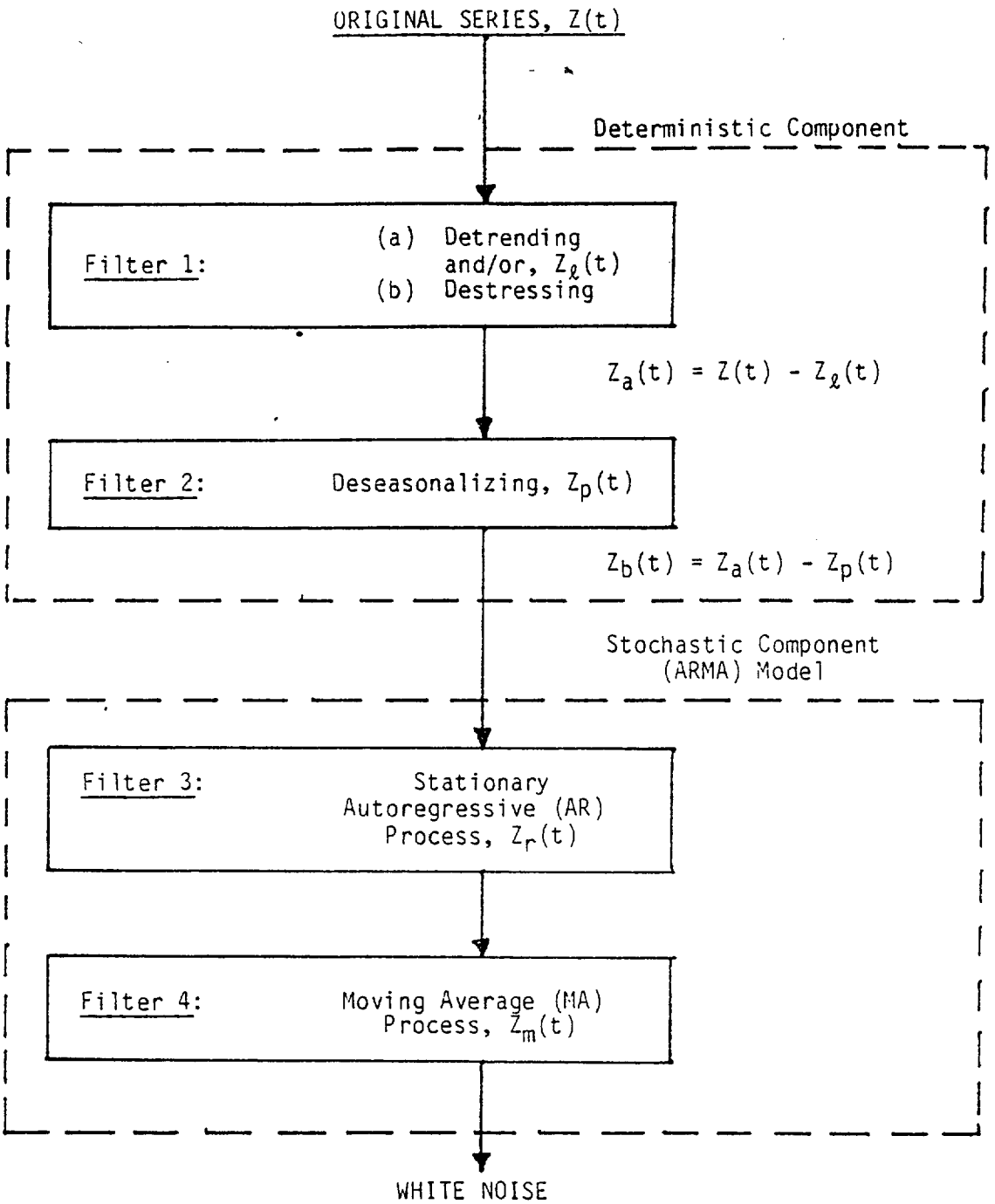


Figure 2.3: A Typical Cascade of Filters

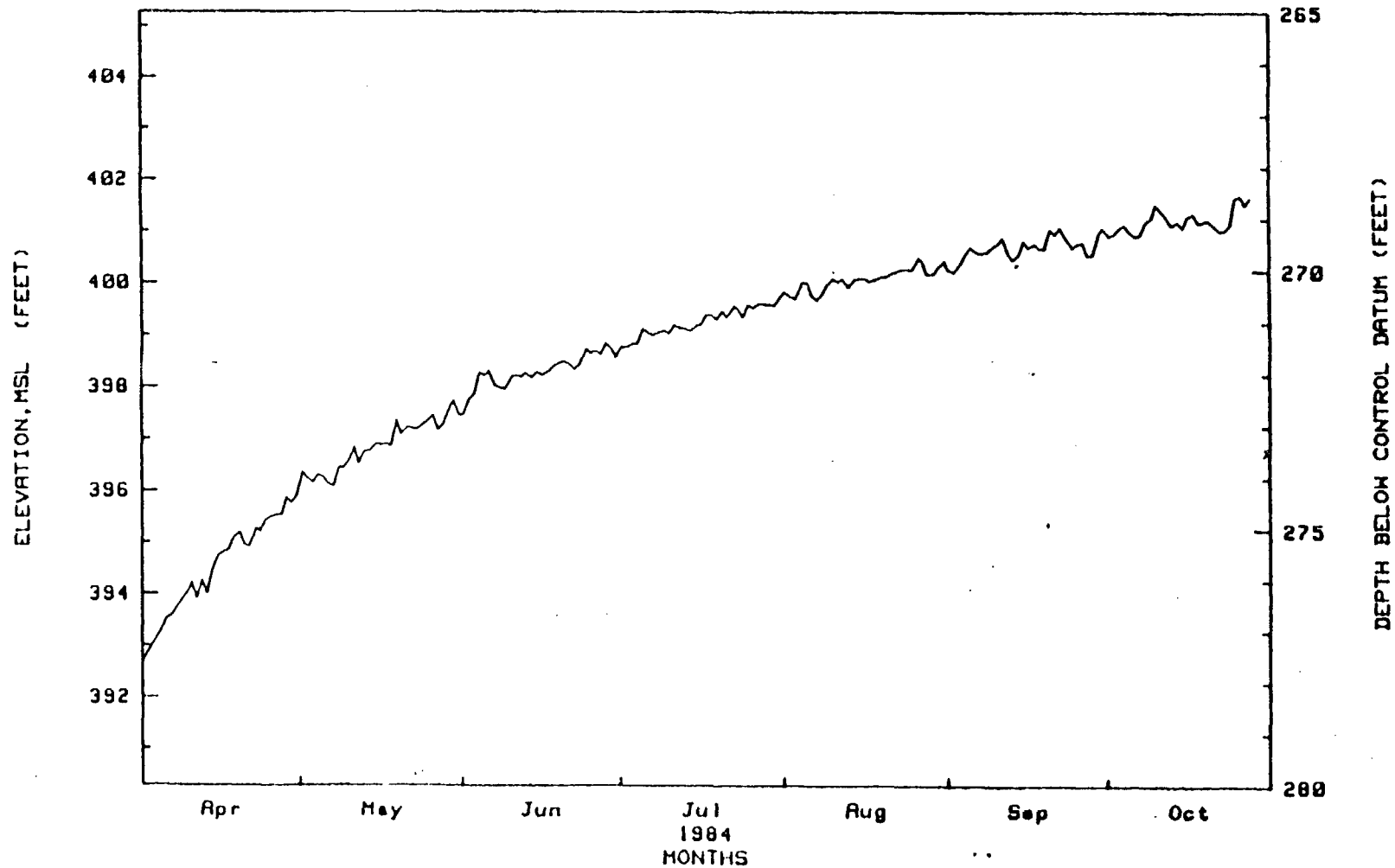
CONCEPTUALIZATION

- CONSISTENCY WITH CONCEPTUAL MODELS
- CAUSE / EFFECT RELATIONSHIPS
- HYDRAULIC ISOLATION IMPLICATIONS
- PHYSICAL MEANINGFULNESS

BOREHOLE NUMBER: DC-22C HYDROGEOLOGIC UNIT: ROCKY COULEE FLOW TOP

LOCATION: N 448,600 E 2,204,188 CONTROL DATUM: BRASS CAP

CONTROL DATUM ELEVATION (ft): 670.28 BOREHOLE DEPTH (ft): 3960



HYDROGRAPH FOR BOREHOLE NUMBER DC-22C

Program HWYDAT Rev 1.4 FILE: 22CGRC

Table 5.

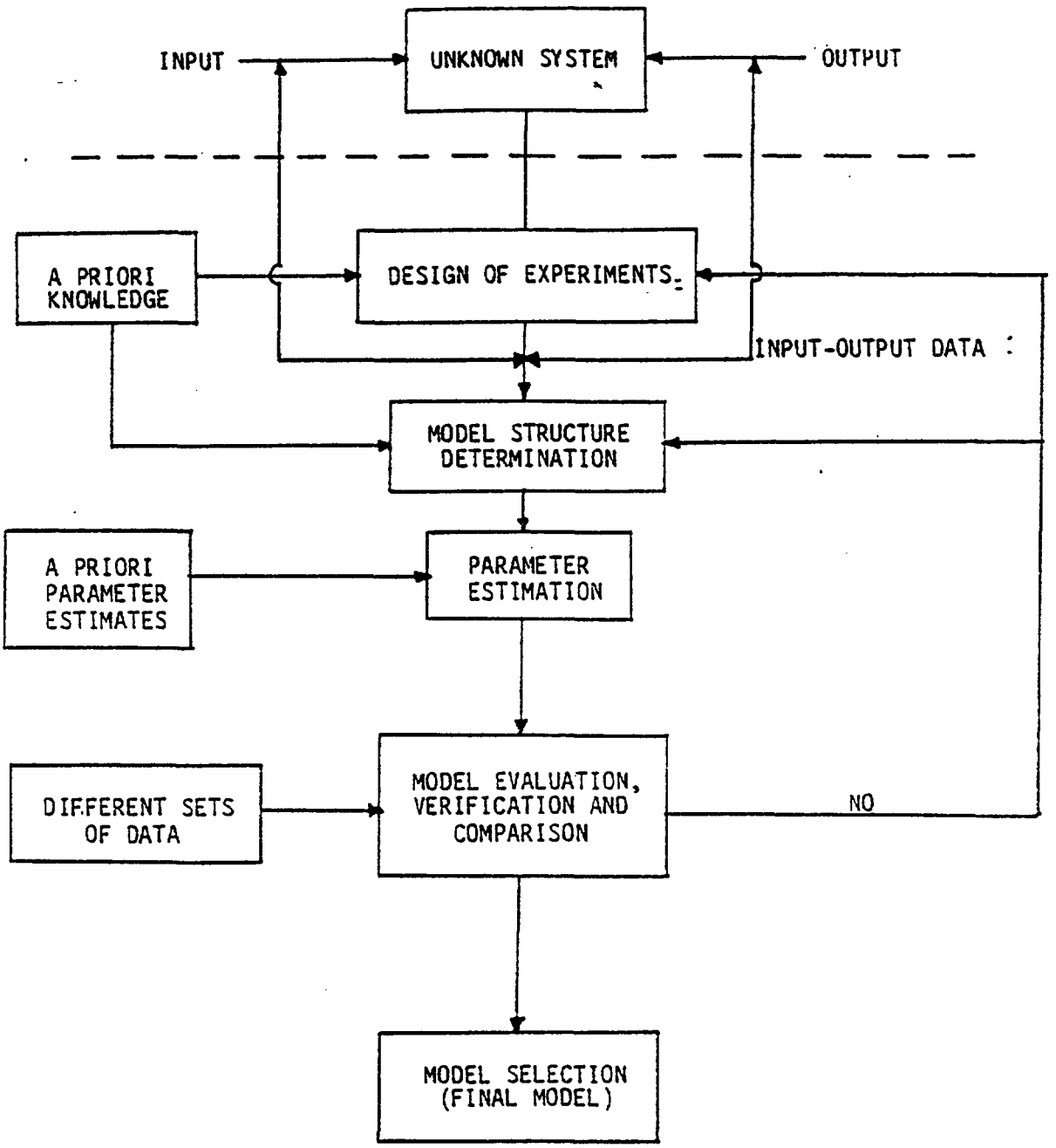
POSSIBLE BASES FOR HYDRAULIC ISOLATION POTENTIAL INFERRED FROM WATER-LEVEL DYNAMICS

	DYNAMIC CHARACTERISTICS	INFERENCE
↑ PROBABILITY OF INCREASED ISOLATION POTENTIAL	Stable (no trends)	Steady state. Isolated.
	Trending, no other variations	Dynamic equilibrium.
	Seasonal variations.	Interaction with active, near-surface groundwater flow regime.
↓	Responsive to precipitation and/or evaporation patterns.	Part of active, near-surface groundwater flow regime.

Note: The above relationships apply generally to natural dynamic systems. Other dynamic patterns may be applicable to anthropogenic effects, such as groundwater withdrawals from select horizons. The isolation potential implicit from such regimes must be evaluated subjectively.

PREDICTABILITY

- DATA PARTIONING
- APPLICATION
- REPRESENTATIVENESS AND REASONABLENESS
- SIMPLICITY



Steps in System Modeling and Identification

DATE	DAYS	OBSERVED DEPTH TO WATER (FT)	27-DAY PRED. (FT)	2-WEEK PRED. (FT)	1-WEEK PRED. (FT)
4-04-84	0	276.99	276.91	277.03	277.12
4-05-84	1	276.77	276.81	276.92	276.97
4-06-84	2	276.69	276.72	276.80	276.82
4-07-84	3	276.54	276.62	276.69	276.68
4-08-84	4	276.40	276.52	276.58	276.53
4-09-84	5	276.24	276.43	276.47	276.38
4-10-84	6	276.06	276.33	276.35	276.23
4-11-84	7	276.37	276.23	276.24	276.08
4-12-84	8	276.01	276.14	276.13	275.94
4-13-84	9	276.28	276.04	276.02	275.79
4-14-84	10	275.83	275.94	275.91	275.64
4-15-84	11	275.53	275.85	275.79	275.49
4-16-84	12	275.46	275.75	275.68	275.34
4-17-84	13	275.43	275.65	275.57	275.20
4-18-84	14	275.17	275.56	275.46	275.05
4-19-84	15	275.09	275.46	275.34	274.90
4-20-84	16	275.34	275.36	275.23	274.75
4-21-84	17	275.37	275.27	275.12	274.61
4-22-84	18	275.00	275.17	275.01	274.46
4-23-84	19	275.07	275.07	274.89	274.31
4-24-84	20	274.95	274.98	274.78	274.16
4-25-84	21	274.78	274.88	274.67	274.01
4-26-84	22	274.75	274.78	274.56	273.87
4-27-84	23	274.74	274.69	274.45	273.72
4-28-84	24	274.40	274.59	274.33	273.57
4-29-84	25	274.51	274.49	274.22	273.42
4-30-84	26	274.37	274.40	274.11	273.27
7-12-84	100	271.14	266.91	266.03	262.12
7-14-84	101	271.18	266.81	265.92	261.97
7-15-84	102	271.07	266.71	265.81	261.82
7-16-84	103	271.06	266.62	265.70	261.67
7-17-84	104	270.88	266.52	265.59	261.52
7-18-84	105	270.87	266.42	265.48	261.37
7-19-84	106	270.96	266.33	265.37	261.22

MODEL	SLOPE	INTERCEPT	R^2	APRIL X^2	JULY X^2
27-DAY	-0.1	276.91	0.96	0.0031	0.51
14-DAY	-0.11	277.03	0.91	0.0037	0.75
7-DAY	-0.15	277.12	0.99	0.03	2.34

Table 5. Example of model identification and goodness-of-fit testing applied to water-level data at DC-22.

CONSEQUENCE

- SENSITIVITY
- LIMITS OF ACCURACY

IMPACT OF BASELINE UNCERTAINTY

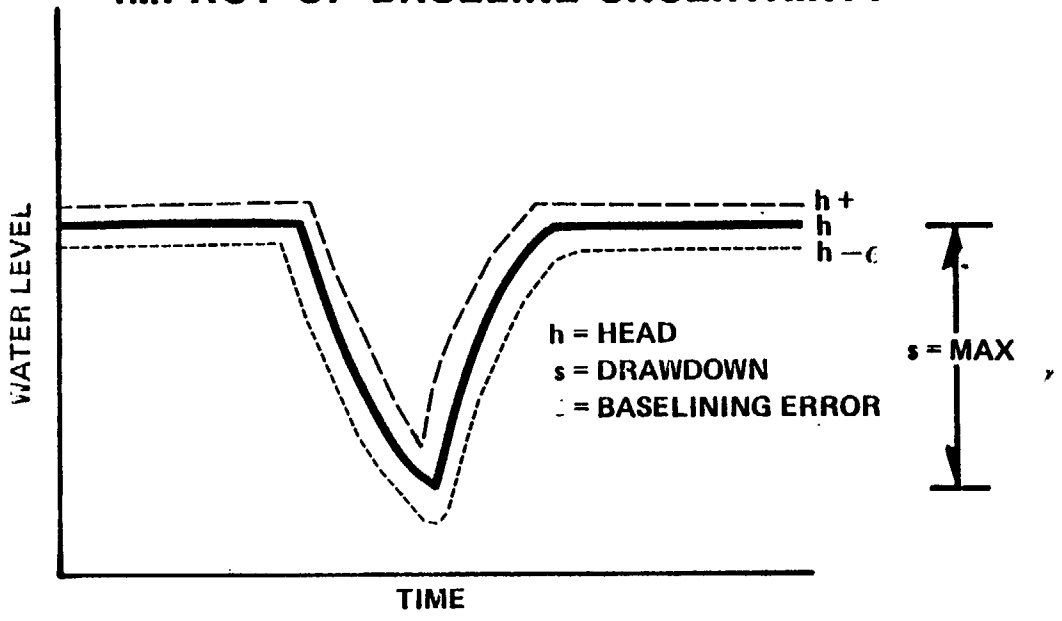
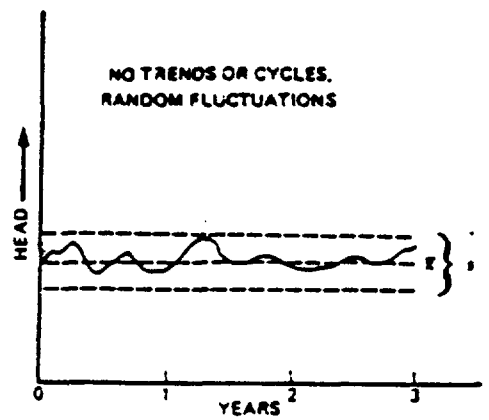
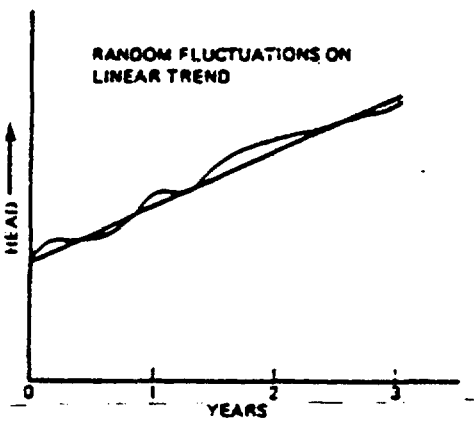
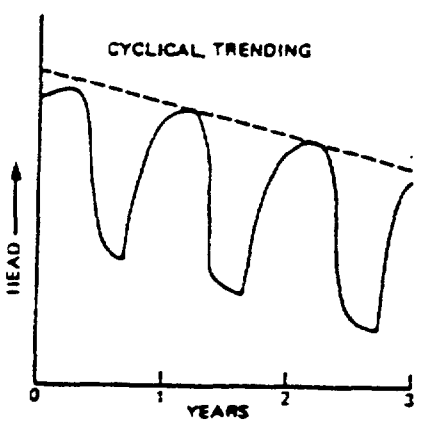


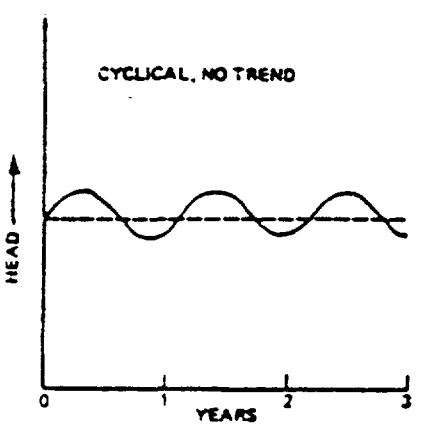
Figure 15.

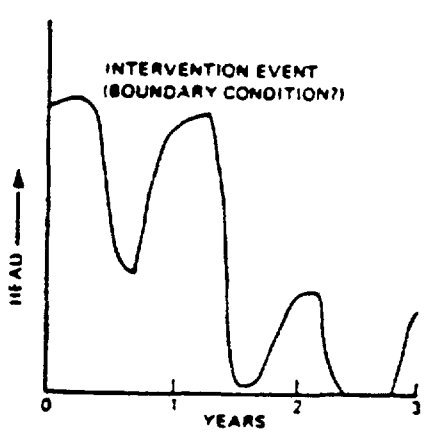
SCENARIOS FOR TIME-SERIES HEAD OBSERVATIONS











INSTRUMENT	UNCERTAINTY	SOURCE
Pressure Transducer (0-3,000 psi)		
accuracy	± 0.02 %	Mfg.
voltage	(nil)	est.
repeatability	± 0.005 %	Mfg.
reolution	± 0.001 %	Mfg.
bias	± 0.01 %/mo	Mfg.
response	0.25 sec	Mfg.
Temperature Probe		
accuracy	± 1° F	Mfg.
repeatability	± 1° F	Mfg.
resolution	1° F	Mfg.
response time	? (TBD)	--
bias	? (TBD)	-
voltage	(nil)	est.
Steel Measurement Tape (300- & 500-ft)		
stretch	± 0.01 ft	est.
thermal	± 0.01 ft	est.
Borehole Depth		
vertical	± 2 ft	logs
horizontal	± 20 ft	logs

Table 5. Summary of instrumentation uncertainties being considered in conjunction with SWIP piezometric baselining activities.

psi = lb/in²
Mfg. = manufacturers claim
TBD = to be determined
nil = negligible

EXAMPLE OF SENSITIVITY FUNCTION

THEIS EQUATION

$$T = \frac{Q}{4\pi s} W(u)$$

$$\text{WHERE } u = \frac{r^2 S}{4Tt}$$

$$\text{AND } W(u) = \int_u^{\infty} \frac{e^{-x}}{x} dx$$

THE SENSITIVITY FUNCTION IS:

$$\frac{dT}{ds} = \frac{4\pi T}{Q} \left[e^{-u} - W(u) \right]^{-1}$$

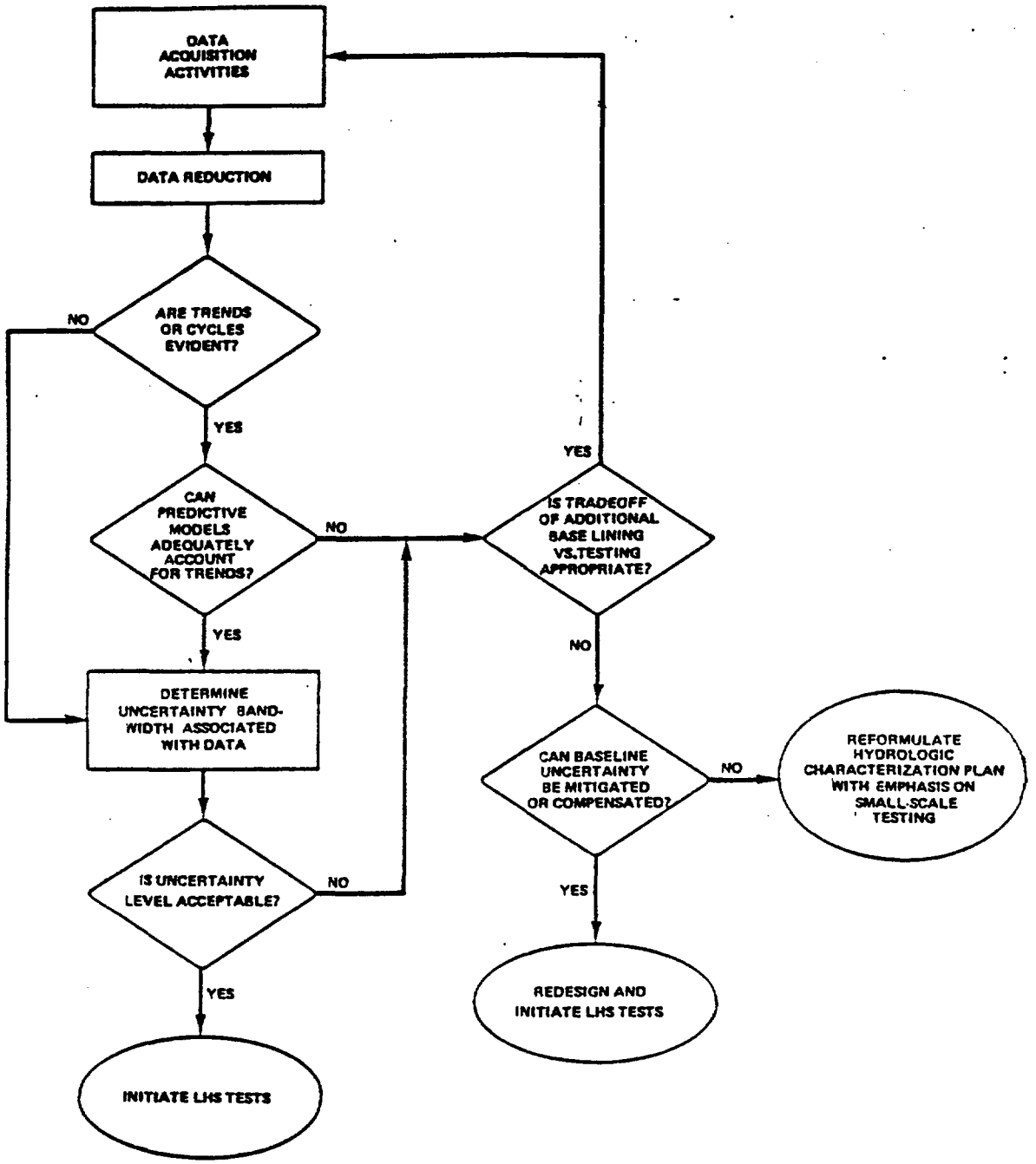
AND IN DIMENSIONLESS TERMS:

$$\frac{dT}{ds} \frac{Q}{4\pi T^2} = \left[e^{-u} - w(u) \right]^{-1}$$

$$\text{THUS } T_e = \left(\frac{dT}{ds} \right) s_e$$

CONFIDENCE

- **REASONABLE ASSURANCE**



LOGIC SEQUENCE FOR PIEZOMETRIC BASELINE EVALUATION AND LHS START-UP

STRATEGY AND PRELIMINARY PLANS FOR MULTIPLE-WELL, LARGE-SCALE HYDRAULIC STRESS TESTING OF SELECTED HYDROGEOLOGIC UNITS AT THE RRL-2 LOCATION

DOE-BWIP MEETING WITH NRC
DECEMBER 12 - 13, 1984
SILVER SPRINGS, MARYLAND

P.M. ROGERS

TOPICS

- STRATEGY FOR TESTING AT RRL-2
- TEST OBJECTIVES
- FACILITIES
- PRE-TEST ANALYSIS/DESIGN
- TEST EXECUTION
- TEST ANALYSIS
- SCHEDULE

STRATEGY FOR LHS TESTING

- FOUR STAGES IN THE SITE SPECIFIC INVESTIGATION
- STAGE TWO TESTING AT RRL-2

STAGES OF INVESTIGATION

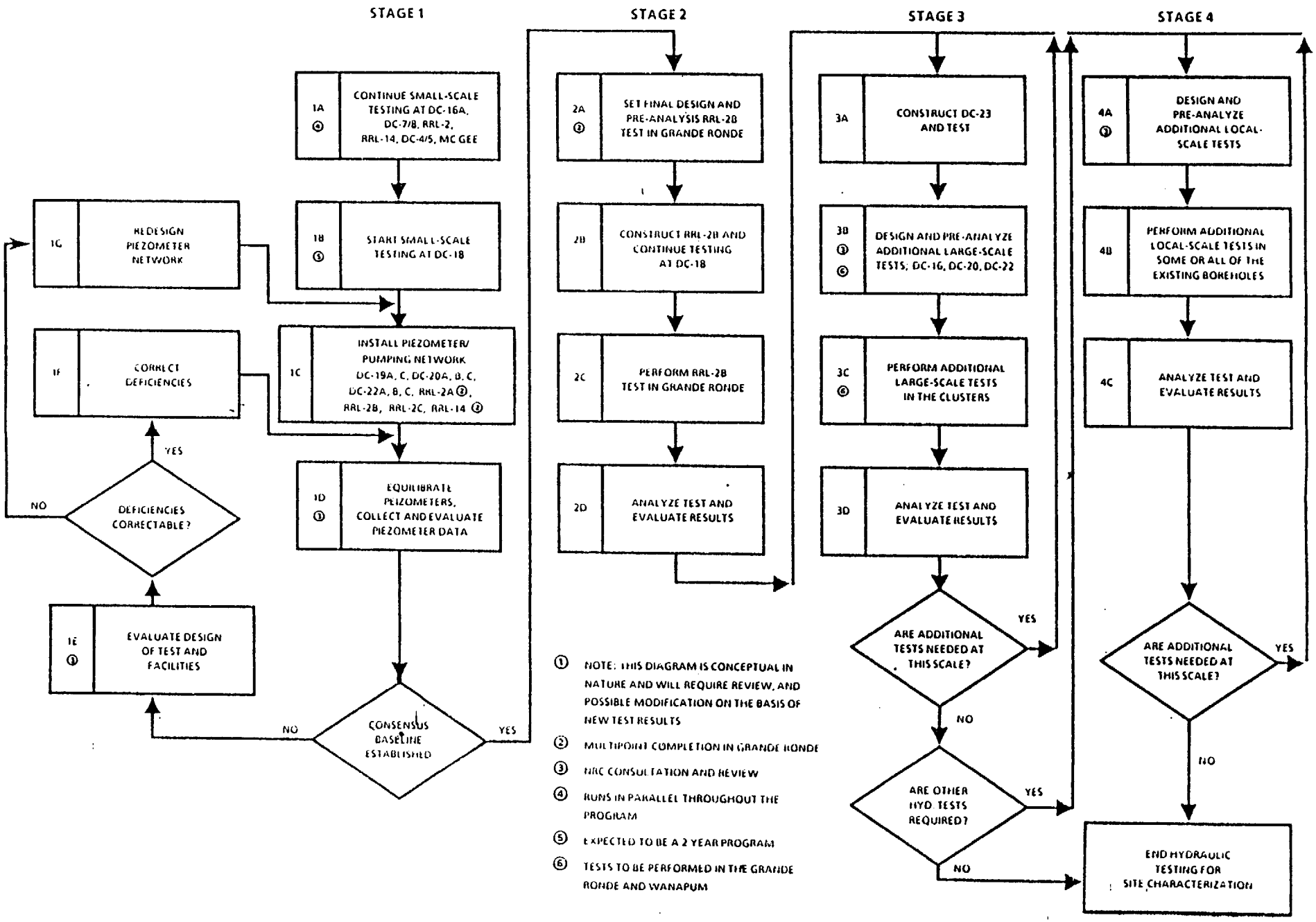
- GROUNDWATER-LEVEL BASELINE MONITORING PROGRAM (STAGE 1)
- MULTIPLE-WELL, LARGE-SCALE HYDRAULIC STRESS TESTING AT RRL-2 (STAGE 2)
- MULTIPLE-WELL, LARGE-SCALE HYDRAULIC STRESS TESTING AT DC-16, DC-20, AND DC-22 (NO TEST ORDER IMPLIED, STAGE 3)
- ADDITIONAL TESTS, BOTH LARGE AND SMALL SCALE AS REQUIRED (STAGE 4)

STAGE TWO TESTING AT RRL-2

- WILL PROVIDE EARLY PARAMETER VALUES FOR PERFORMANCE ASSESSMENT
- WILL PROVIDE DATA AND POSSIBLE SUPPORT FOR EXPLORATORY SHAFT CONSTRUCTION
- WILL FACILITATE DESIGN OF STAGE 3 TESTS

LOGIC DIAGRAM FOR BWIP HYDROLOGIC TEST STRATEGY ①

(AFTER NUCLEAR REGULATORY COMMISSION, 1983)



TEST OBJECTIVES

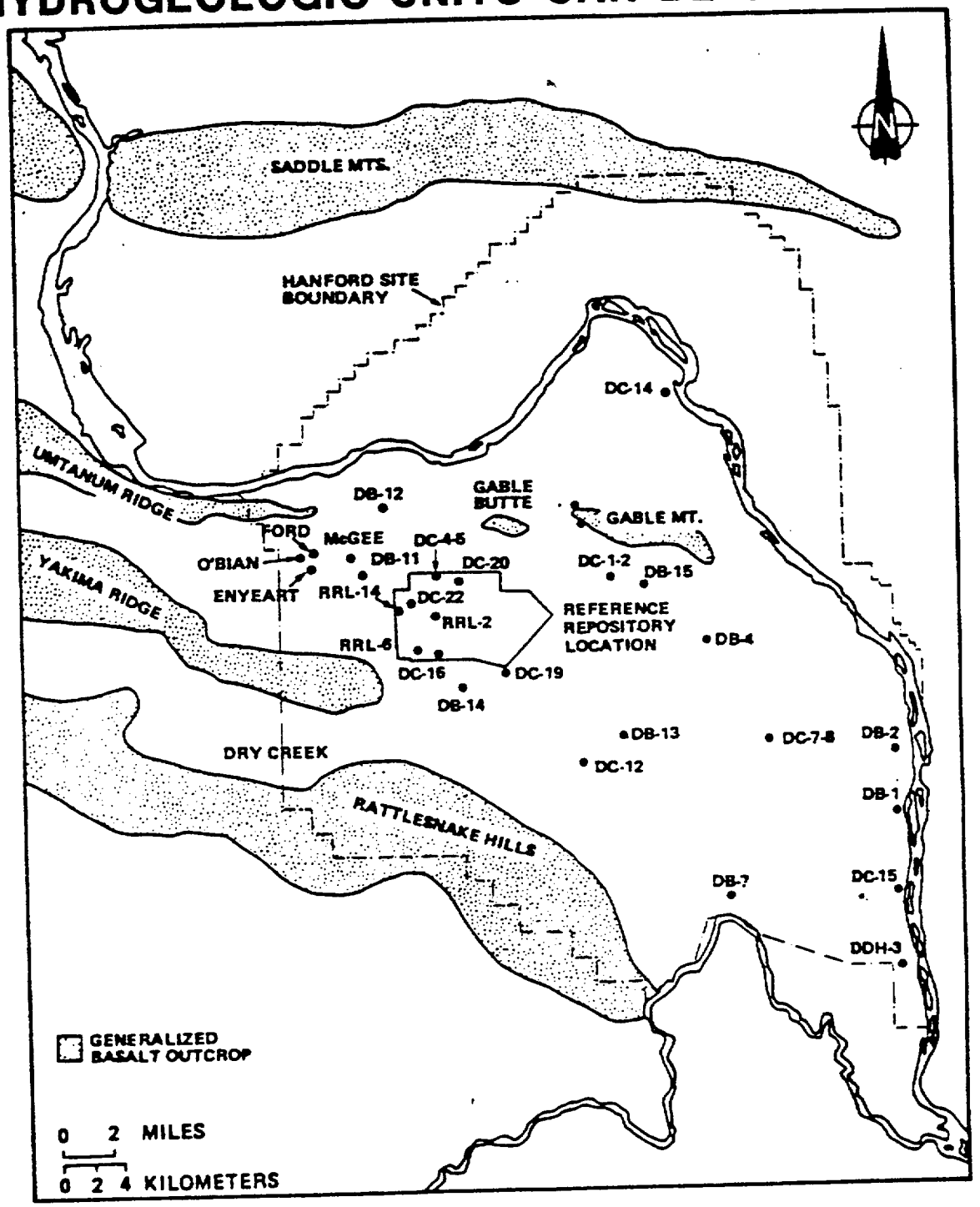
- MAXIMIZE THE AREAL EXTENT OF TEST INFLUENCE IN SELECTED HYDROGEOLOGIC UNITS OF THE GRANDE RONDE BASALT
- QUANTIFY FLOW TOP HYDRAULIC PARAMETERS (CONDUCTIVITY, STORATIVITY, EFFECTIVE POROSITY, AND DISPERSIVITY)
- QUANTIFY LEAKANCE (ANALYTICALLY)
- QUANTIFY POINT VALUES OF Kv ANALYTICALLY USING OBSERVATIONS OF PRESSURE CHANGE IN FLOW INTERIORS AND FLOW TOPS (RRL-2C)
- QUANTIFY VERTICAL HYDRAULIC CONDUCTIVITY (Kv) OF FLOW INTERIORS (USING NUMERICAL MODEL INVERSE TECHNIQUES)
- OBTAIN REPRESENTATIVE HYDROCHEMICAL SAMPLES
- FACILITATE DESIGN OF SUBSEQUENT LHS TESTS

BOREHOLES, WELLS,

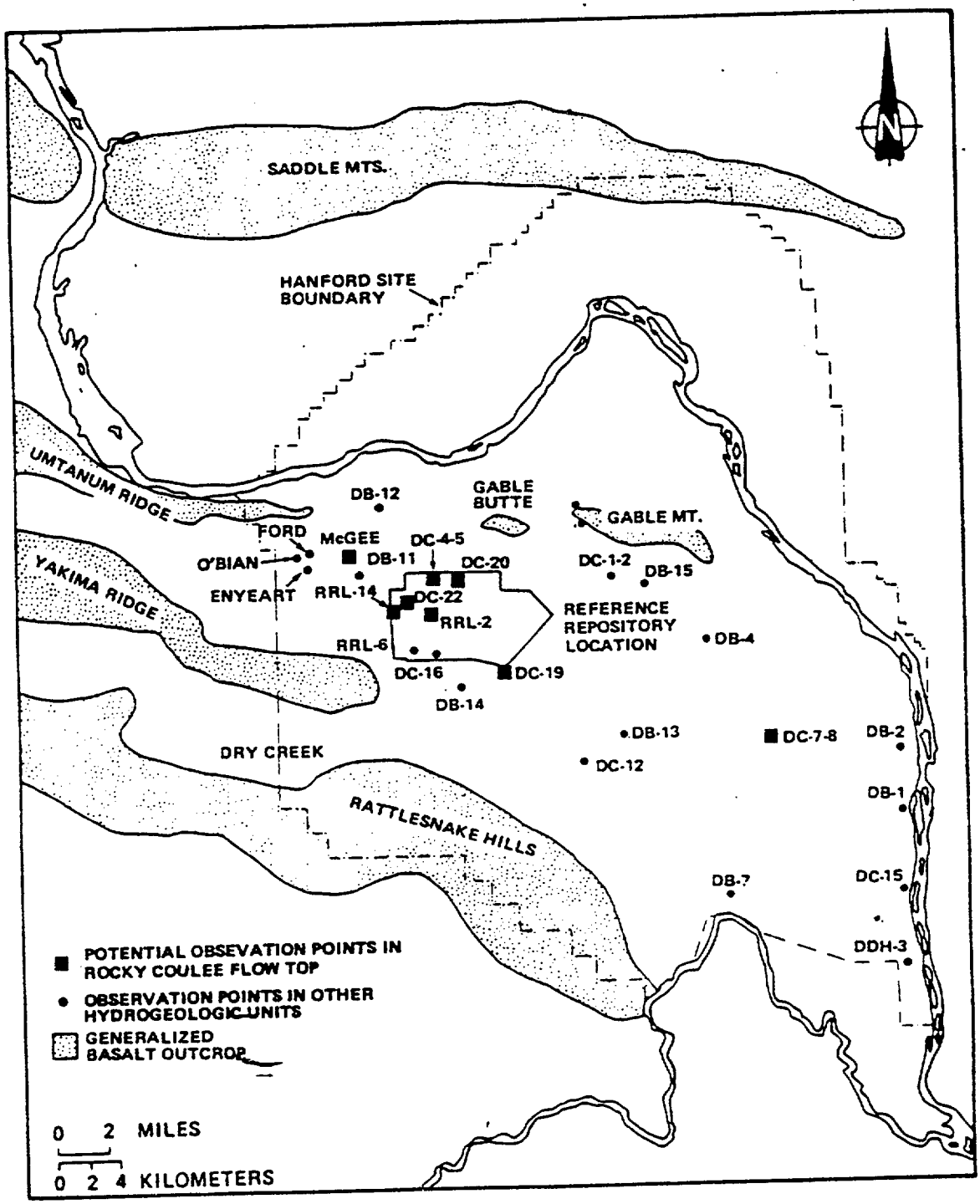
AND PIEZOMETERS USED FOR WATERLEVEL OBSERVATION

	PRINCIPLE OBSERVATION POINTS FOR L HTESTS AT RRL-2										OBSERVATION POINTS TO BE MONITROED AS PART OF THE GROUND WATER MONITORING PROGRAM																					
	RRL-2C	RRL-2A	RRL-6	RRL-14	DC-16	DC-20	DC-22	DC-4/5	DC-19	M^c GEE	DB-14	DB-11	DB-12	ENYEART	FORD	O'BRIAN	DB-9	DB-8B	DC-2	DC-1	DC-12	DB-13	DB-15	DB-4	DC-14	DC-7/8	DB-7	DB-2	DB-1	DC-15	DDH-3
DISTANCE FROM RRL-2B (miles)	250 FT	800 FT	1.4	1.4	1.6	1.6	1.5	1.8	3.4	4.4	2.9	3.6	4.9	5.5	5.8	6.2	6.7	6.8	7.0	7.0	8.0	8.1	8.1	10.1	12.5	14.1	15.6	18.9	19.8	21.5	26.5
UNCONFINED																															
SADDLE MOUNTAINS BASALT					X	X	X		X								X	X				X		X			X				
WANAPUM BASALT					X	X	X		X		X		X	X	X	X				X			X					X	X		X
ROCKY COULEE FLOW TOP	X	X		X		X	X	X	X	X																X					
COHASSETT FLOW TOP	X	X	X	X	X	X	X	X	X	X																X					
GRANDE RONDE No. 5 FLOW TOP	X	X	X	X	X			X		X															X	X					
UMTANUM FLOW TOP		X	X	X	X	X	X	X	X	X											X				X	X					X
GRANDE RONDE COMPOSITE																			X												

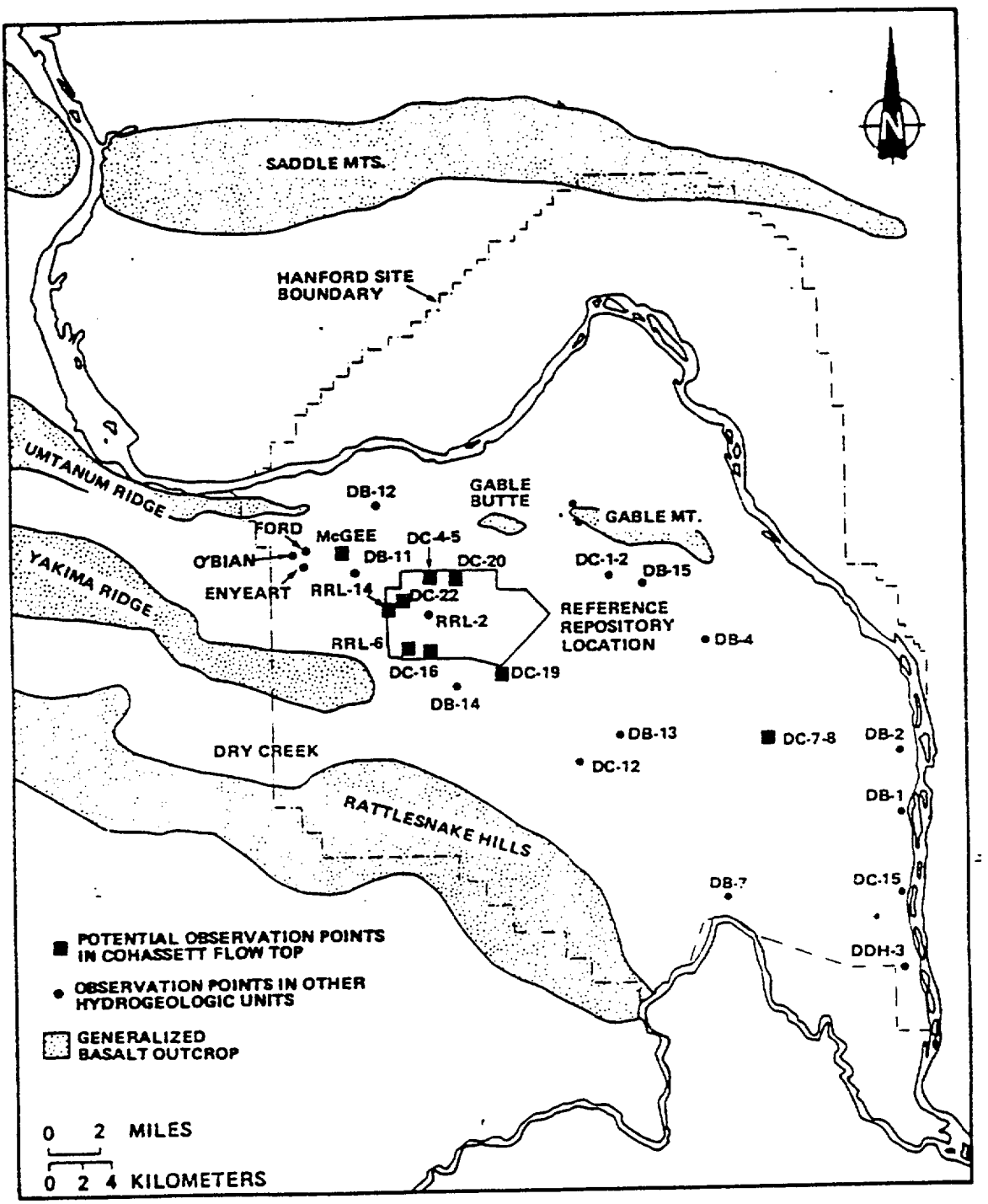
LOCATION OF BOREHOLES, WELLS, AND PIEZOMETERS ON THE HANFORD SITE WHERE WATER LEVEL DATA FROM SELECTED HYDROGEOLOGIC UNITS CAN BE OBTAINED



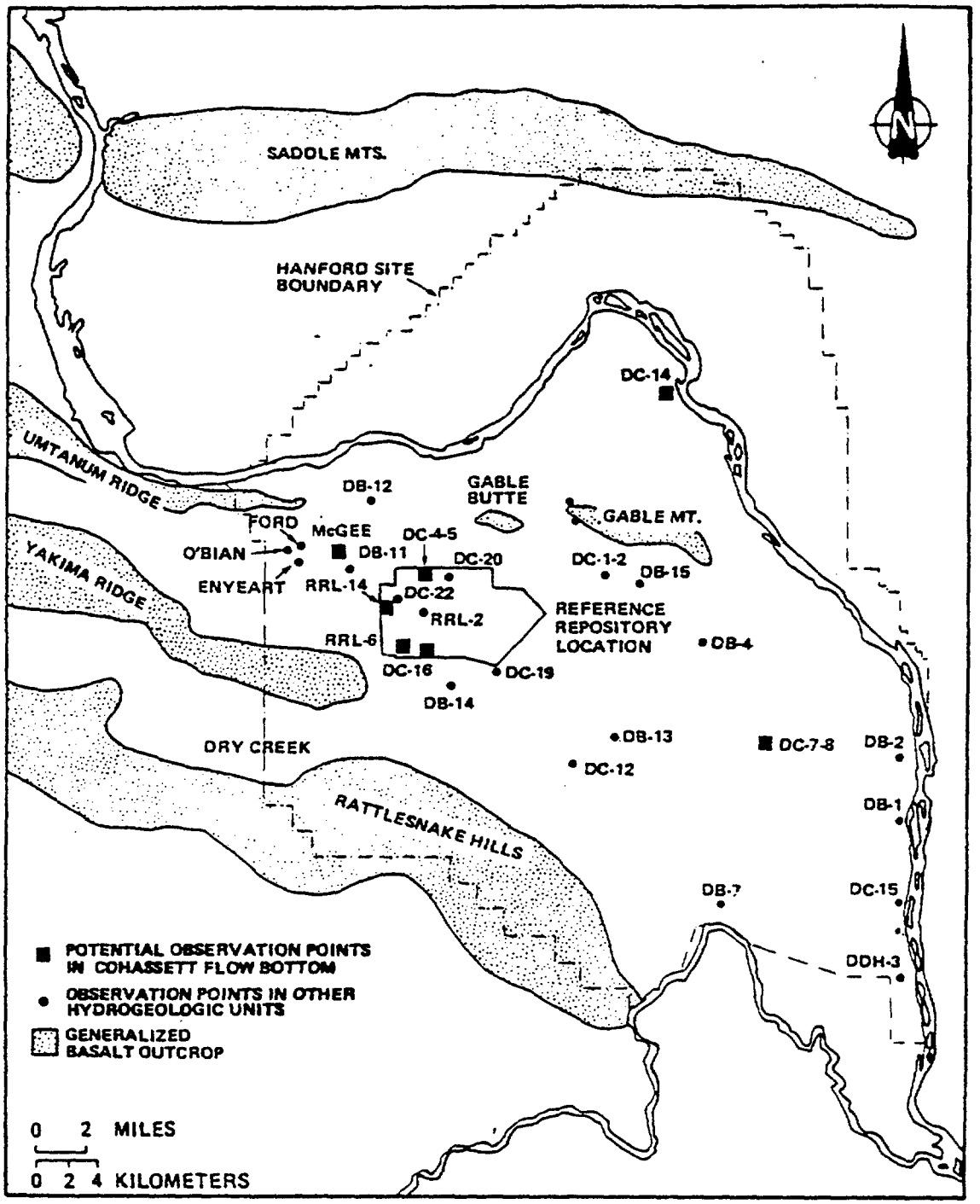
POTENTIAL OBSERVATION POINTS IN ROCKY COULEE FLOW TOP



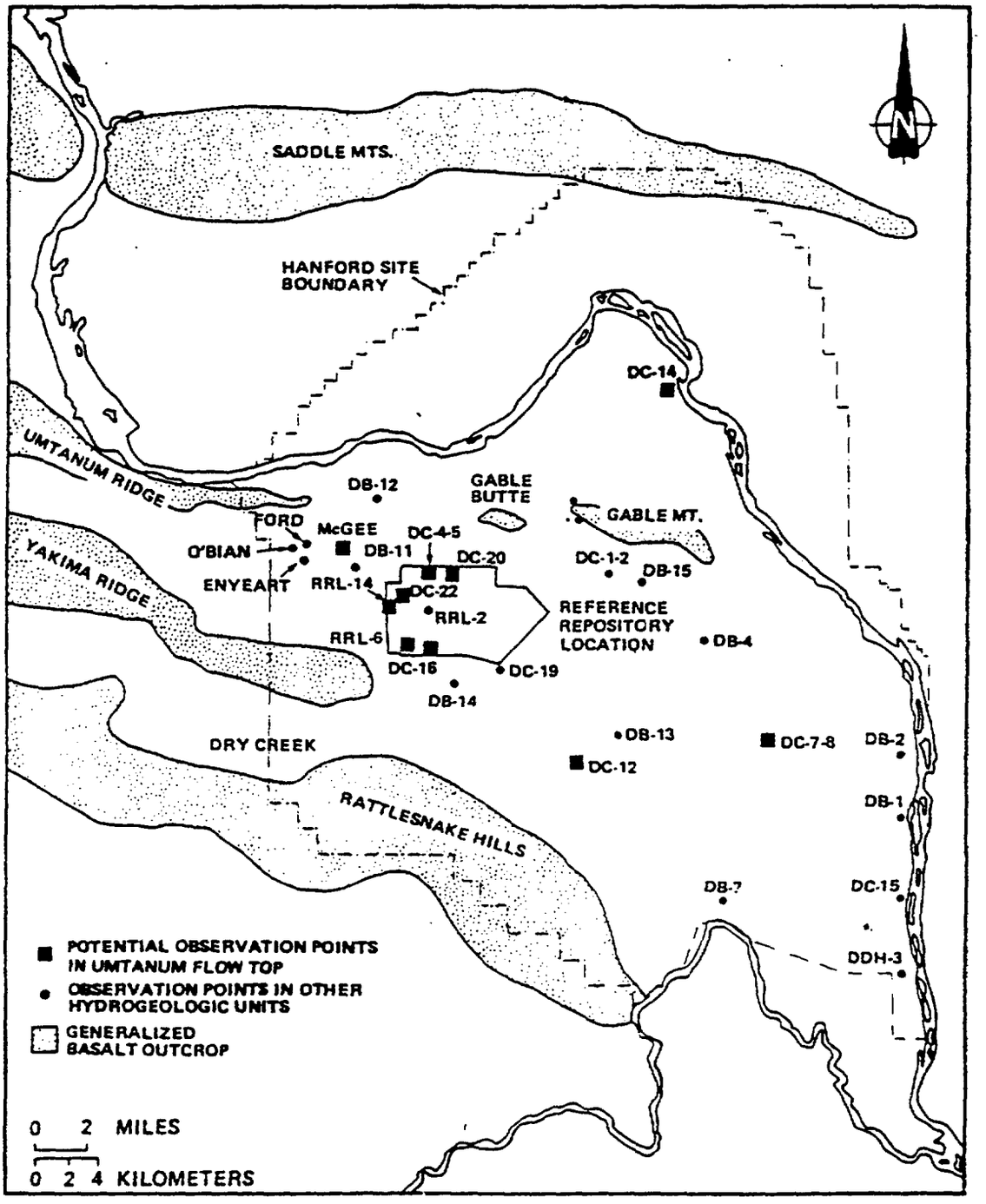
POTENTIAL OBSERVATION POINTS IN COHASSETT FLOW TOP



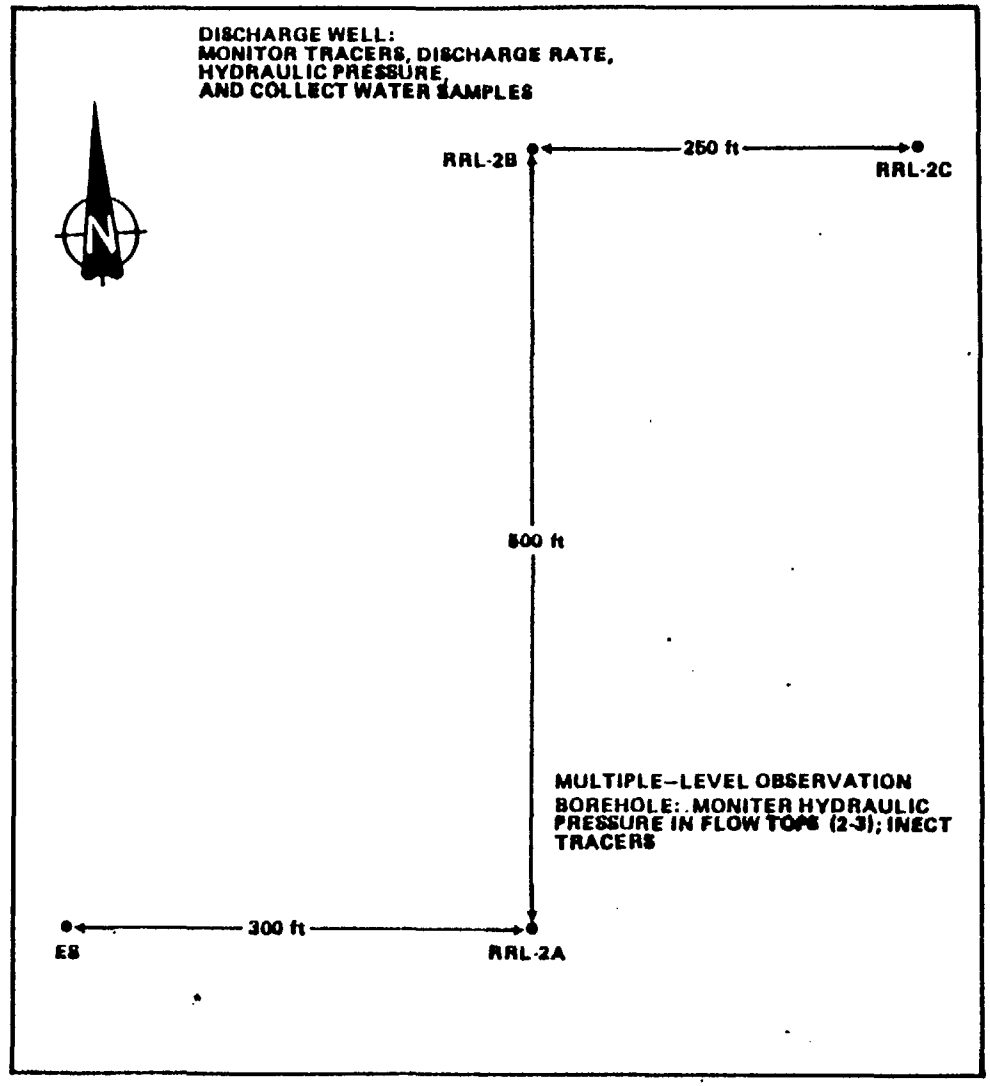
POTENTIAL OBSERVATION POINTS IN COHASSETT FLOW BOTTOM



POTENTIAL OBSERVATION POINTS
UMTANUM FLOW TOP

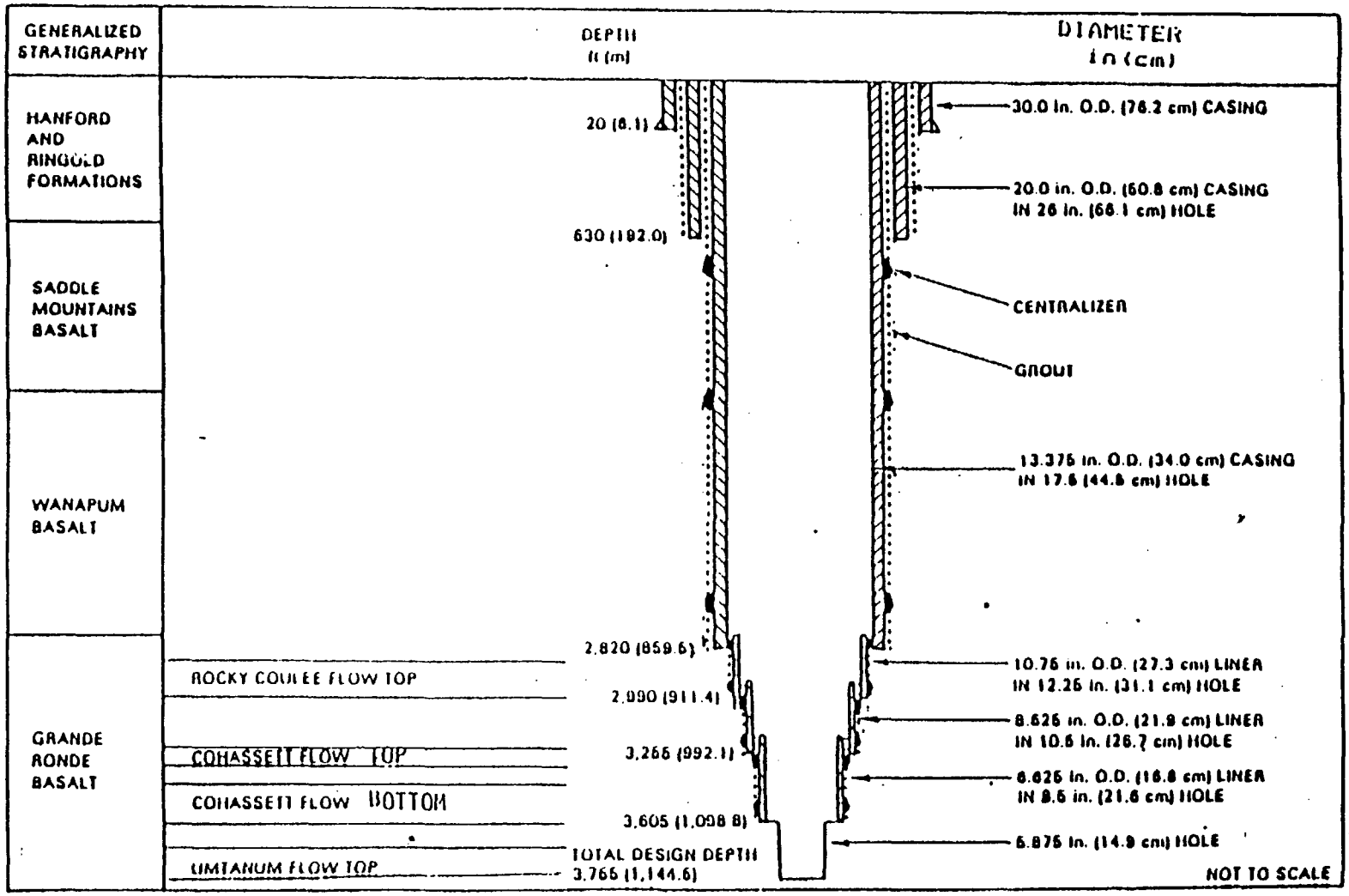


PLAN VIEW ILLUSTRATION THE RELATIONSHIP OF BOREHOLES AT THE RRL-2 SITE



GENERALIZED RRL-2 CONFIGURATION

PROPOSED CONCEPTUAL DESIGN OF WELL RRL-2B



2K8408-10.2

BOREHOLE RRL-2A

COMPLETION AND HISTORY DETAILS

- COMPLETED AS A NOMINAL 3-INCH HOLE FROM 2,713 TO 3,973 FEET
- DURING CONSTRUCTION THE ROCKY COULEE FLOW TOP WAS CEMENTED TO CONTROL DRILLING FLUID LOSS
- TESTS HAVE BEEN PERFORMED TO DETERMINE THE TRANSMISSIVITY OF SELECTED HYDROGEOLOGIC UNITS
- SEVERAL HYDROGEOLOGIC UNITS HAVE BEEN HYDRAULICALLY FRACTURED FOR THE DETERMINATION OF IN SITU STRESSES OF THE ROCK

BOREHOLE RRL-2A (CONTINUED)

LIMITATIONS AND CONCERNS

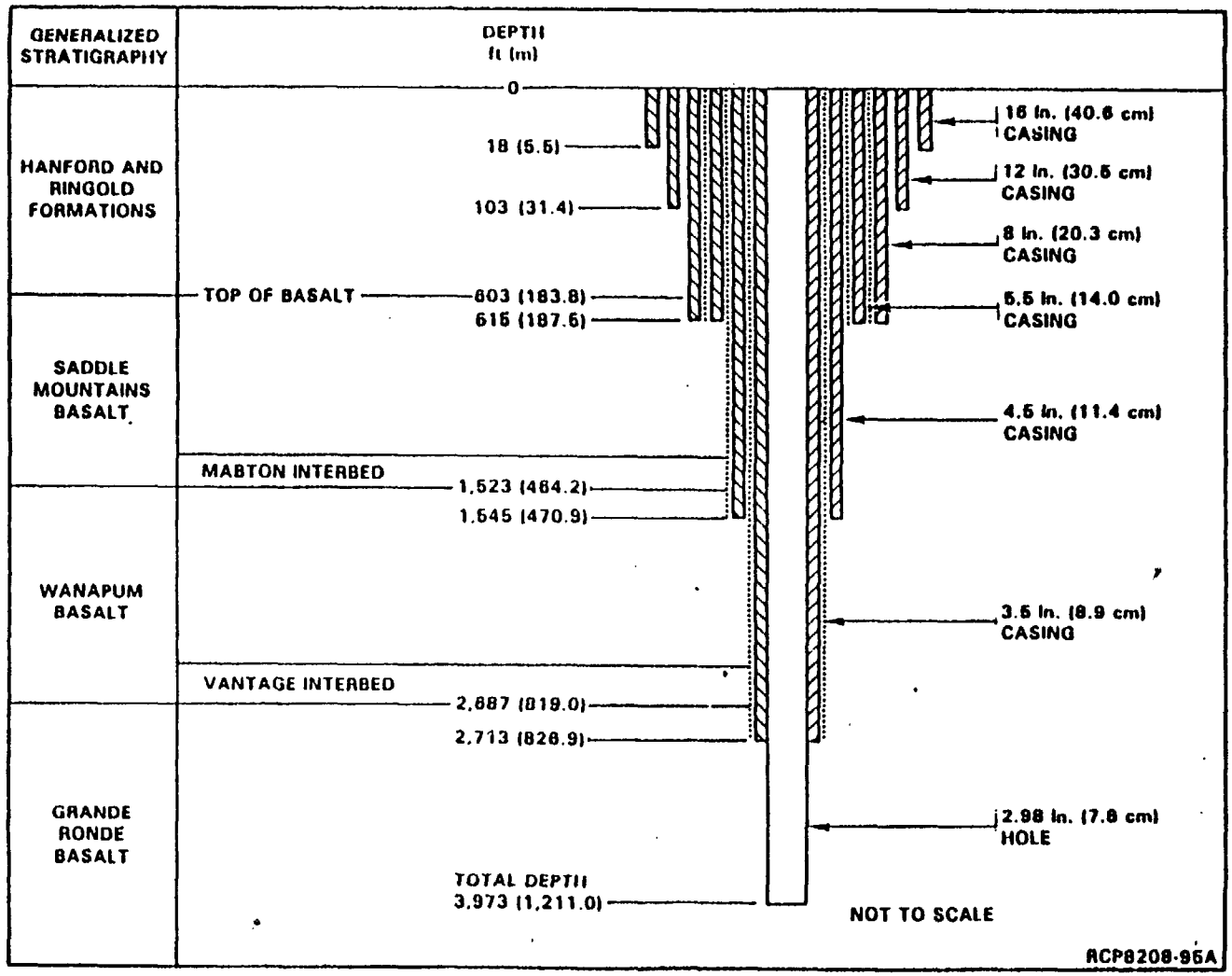
- CEMENTATION OF THE ROCKY COULEE PRECLUDES USING RRL-2A AS A TRACER INJECTION WELL FOR THE ROCKY COULEE TRACER TEST
- DATA COLLECTED FROM RRL-2A WILL ALWAYS HAVE A GREATER DEGREE OF UNCERTAINTY ASSOCIATED WITH IT DUE TO THE HYDROFRACTURING OF SELECTED FLOW INTERIORS
  - PACKERS MAY NOT SEAT COMPLETELY
  - GEOLOGIC MATERIAL IN BOREHOLE VICINITY MAY BE ALTERED
- BOREHOLE SIZE PRECLUDES USING MORE CONVENTIONAL MONITORING EQUIPMENT
- IMPRACTICAL TO MONITOR FLOW INTERIORS DUE TO PACKER COMPLIANCE

BOREHOLE RRL-2A

MITIGATING MEASURES

- CONSTRUCT AN OBSERVATION WELL SPECIFICALLY DESIGNED TO MEET THE TEST OBJECTIVES FOR THE LHS TEST AT RRL-2
  - MULTIPLE LEVEL OBSERVATIONS OF FLOW TOPS (3) AND FLOW INTERIORS (3)
  - FLOW INTERIOR OBSERVATIONS NOT SUBJECT TO PACKER COMPLIANCE
  - WELL LOCATED OUTSIDE OF POTENTIAL EFFECTS OF HYDROFRACTURING AT BOREHOLE RRL-2A
- LOCATE PUMPING WELL RRL-2B OUTSIDE OF POTENTIAL EFFECTS OF HYDROFRACTURING AT BOREHOLE RRL-2A
- QUANTIFY THE EFFECTS OF HYDROFRACTURING IN BOREHOLE RRL-2A BY RETESTING AND COMPARISON OF RESULTS TO PRIOR TESTS

NOTE: HYDROFRACTURING WAS PERFORMED FOR THE PURPOSE OF IN SITU STRESS DETERMINATION, NOT TO INCREASE WELL PRODUCTION

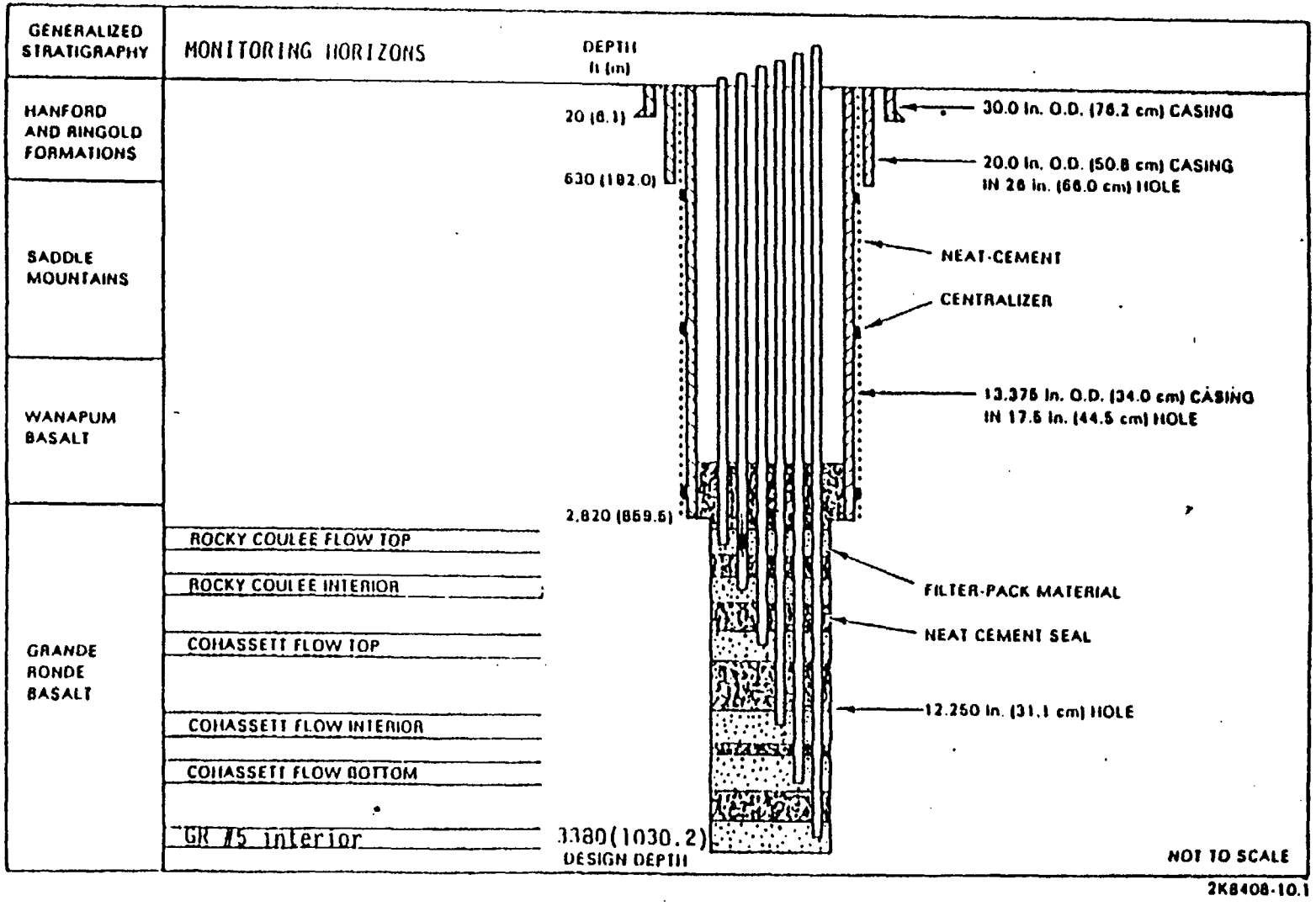


NOTE: During construction the Rocky Coulee flow top was cemented to control drilling fluid loss.

FIGURE 8 AS-BUILT OF BOREHOLE RRL-2A

DRAFT

PROPOSED CONCEPTUAL DESIGN OF WELL RRL-2C



LHS BOREHOLE COMPLETIONS AND INSTRUMENTATION

- RRL-2B WILL HAVE DOWNHOLE PRESSURE TRANSDUCER
- RRL-2C WILL HAVE SIX PIEZOMETER TUBES; THREE IN FLOW TOPS AND THREE IN FLOW INTERIORS
- RRL-2A WILL HAVE A TAM STRADDLE PACKER SYSTEM CAPABLE OF MONITORING 3 OR 4 SELECTED FLOW TOPS*
- A MULTIPLE LEVEL MONITORING SYSTEM MAY BE INSTALLED IN ANOTHER BOREHOLE
- MC GEE WELL, RRL-6, AND RRL-14 WILL HAVE A TAM STRADDLE PACKER SYSTEM CAPABLE OF MONITORING 3 OR 4 SELECTED FLOW TOPS*

* ONE - THREE ZONES MAY BE MONITORED SIMULTANEOUSLY WITH THE TAM STRADDLE PACKER SYSTEM

PRE-TEST PARAMETRIC ANALYSIS

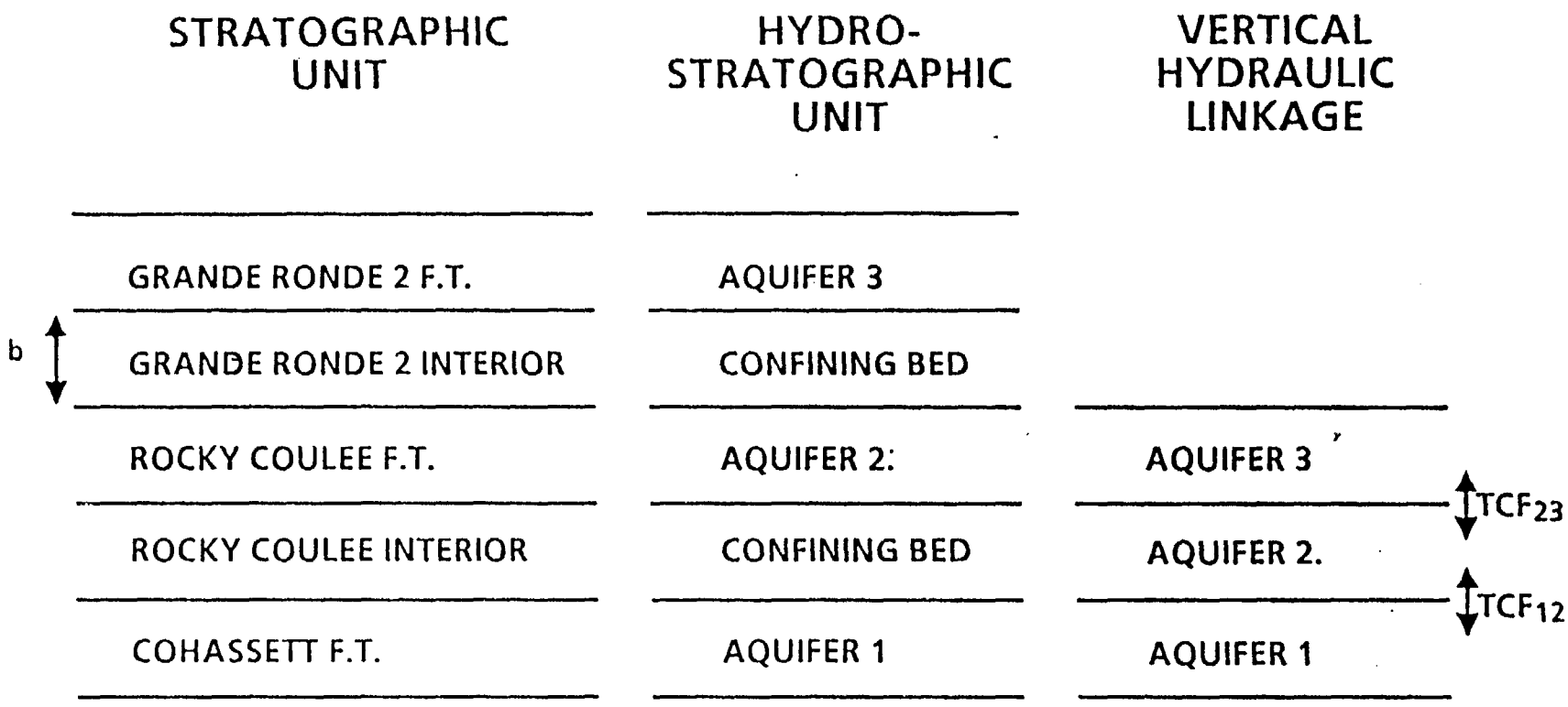
- ESTIMATE HYDROLOGIC BEHAVIOR ON LARGE SCALES
- DECISION MAKING TOOL FOR
  - TEST TYPE, E.G. CONSTANT RATE DISCHARGE, PRESSURE PULSE, OR INJECTION
  - TARGETED WATER LEVEL DRAWDOWN AND ASSOCIATED DISCHARGE RATE
  - TEST DURATION

APPROACH TO PARAMETRIC ANALYSIS

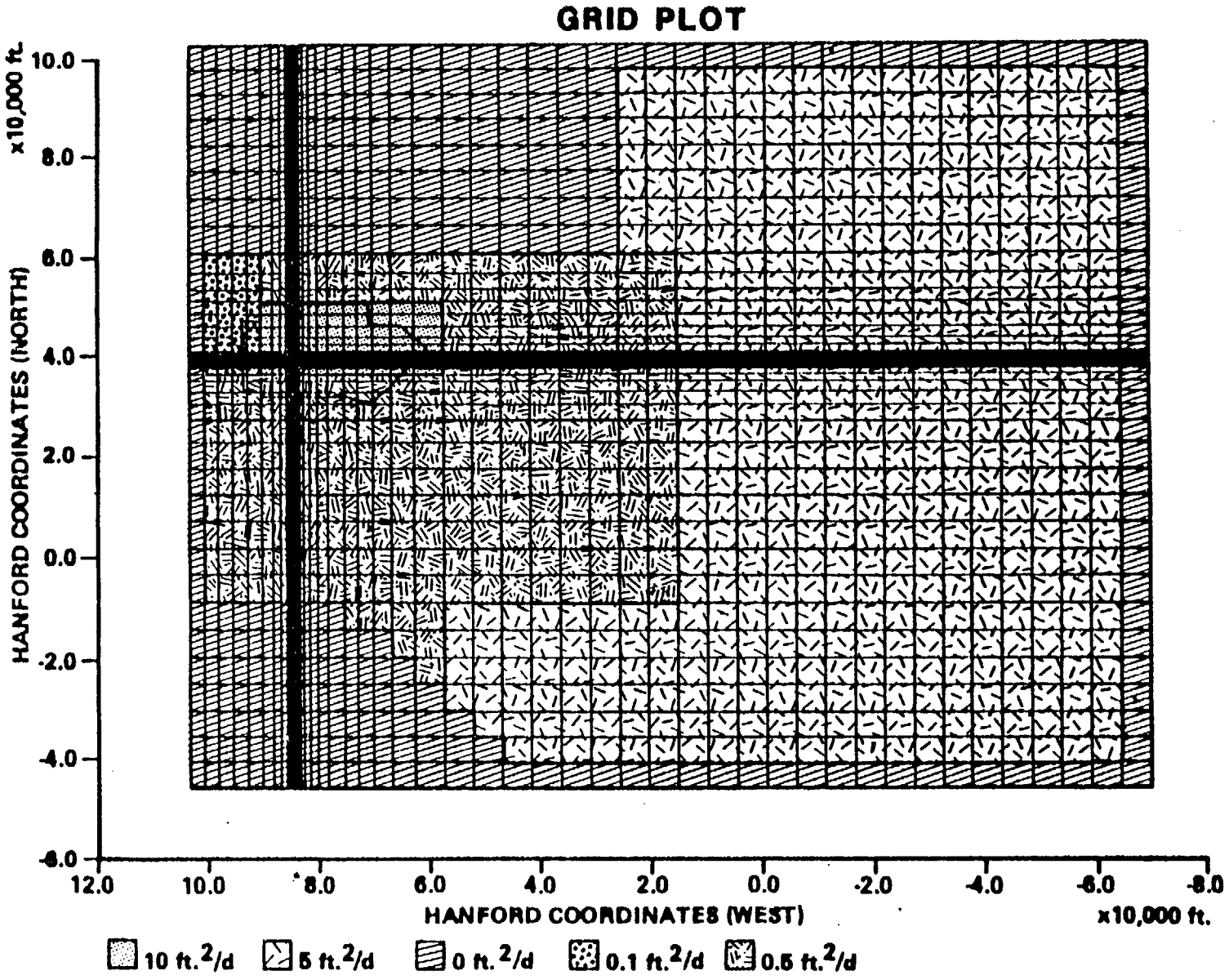
- SELECT A CONCEPTUAL MODEL OF THE HYDROGEOLOGIC SYSTEM
- DETERMINE LIKELY RANGE OF CONTROLLING PARAMETERS, I.E. TRANSMISSIVITY, STORAGE COEFFICIENT, VERTICAL HYDRAULIC CONDUCTIVITY)
- SELECT A MEANS TO TEST THE VARIOUS COMBINATIONS OF PARAMETERS

CONCEPTUAL MODEL OF THE HYDROGEOLOGIC SYSTEM

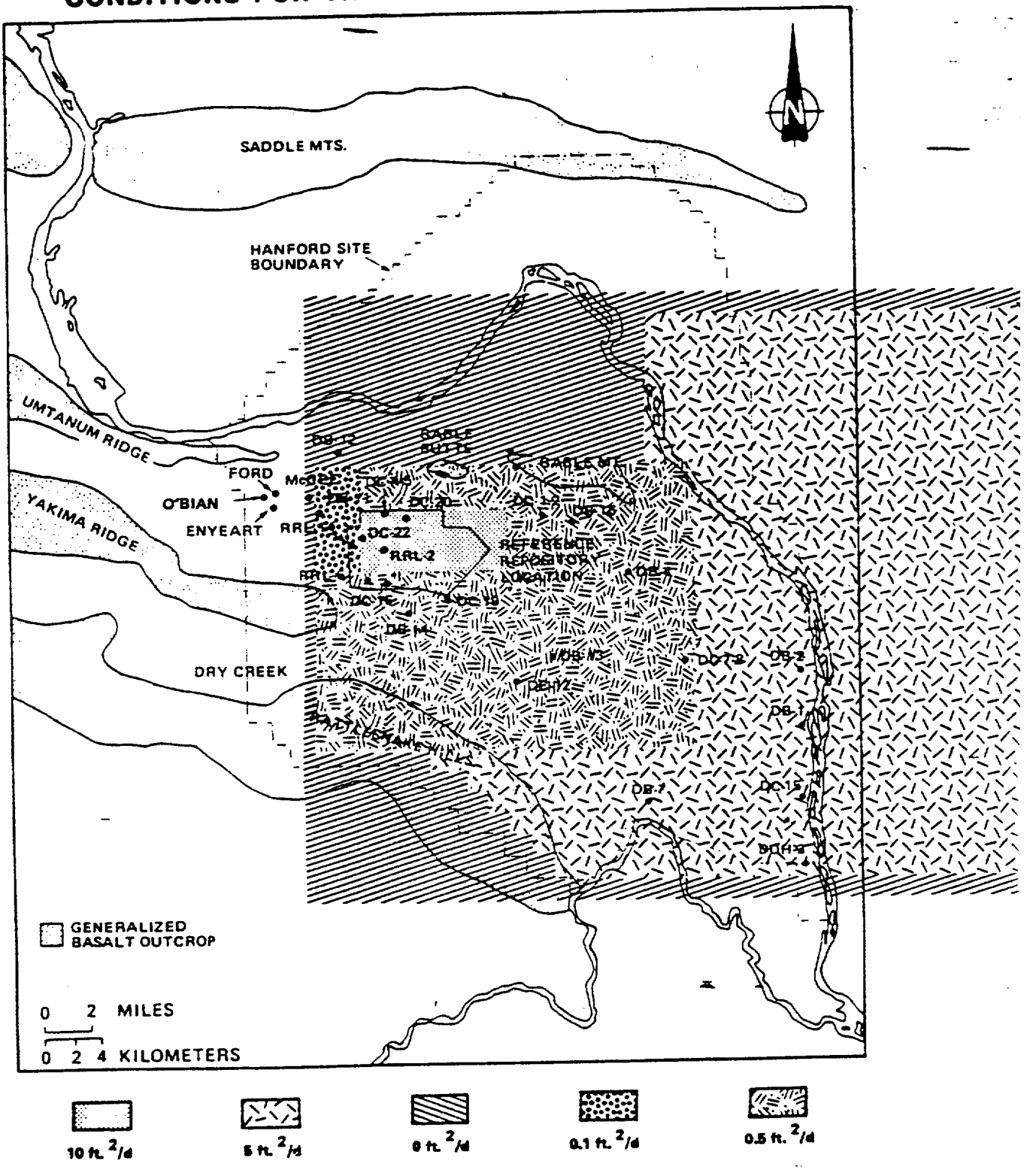
- IN SECTION THE SYSTEM IS MODELED AS THREE LAYERS FOR EACH HYDROGEOLOGIC HORIZON TO BE STRESSED:
  - TOP LAYER BEING A CONFINING BED WITH NO STORAGE OVERLAYING
  - THE MIDDLE LAYER OF RELATIVELY HIGHER TRANSMISSIVITY WHICH OVERLAYS
  - THE BOTTOM CONFINING LAYER WITH NO STORAGE
- IN PLAN THE SYSTEM IS ASSUMED ISOTROPIC, HOMOGENEOUS EXCEPT FOR THE EXTREME EDGES WHICH ARE CONSIDERED TO BE EITHER:
  - IMPERMEABLE BOUNDARIES OR
  - CONSTANT POTENTIAL BOUNDARIES, ALTERNATIVELY,
- IN PLAN THE SYSTEM IS ASSUMED ISOTROPIC, HETEROGENIOUS AND
  - BOUNDARIES ARE ASSUMED IMPERMEABLE


STRATOGRAPHIC UNIT
HYDRO-STRATOGRAPHIC UNIT
VERTICAL HYDRAULIC LINKAGE
GRANDE RONDE 2 F.T.
AQUIFER 3
b
GRANDE RONDE 2 INTERIOR
CONFINING BED
ROCKY COULEE F.T.
AQUIFER 2:
AQUIFER 3
TCF23
ROCKY COULEE INTERIOR
CONFINING BED
AQUIFER 2.
TCF12
COHASSETT F.T.
AQUIFER 1
AQUIFER 1

TRANSMISSIVITY DIS i RIBUTION AND BOUNDARY CONDITIONS FOR THE ROCKY COULEE FLOW TOP



ASSUMED TRANSMISSIVITY DISTRIBUTION AND BOUNDARY CONDITIONS FOR THE ROCKY COULEE FLOW TOP



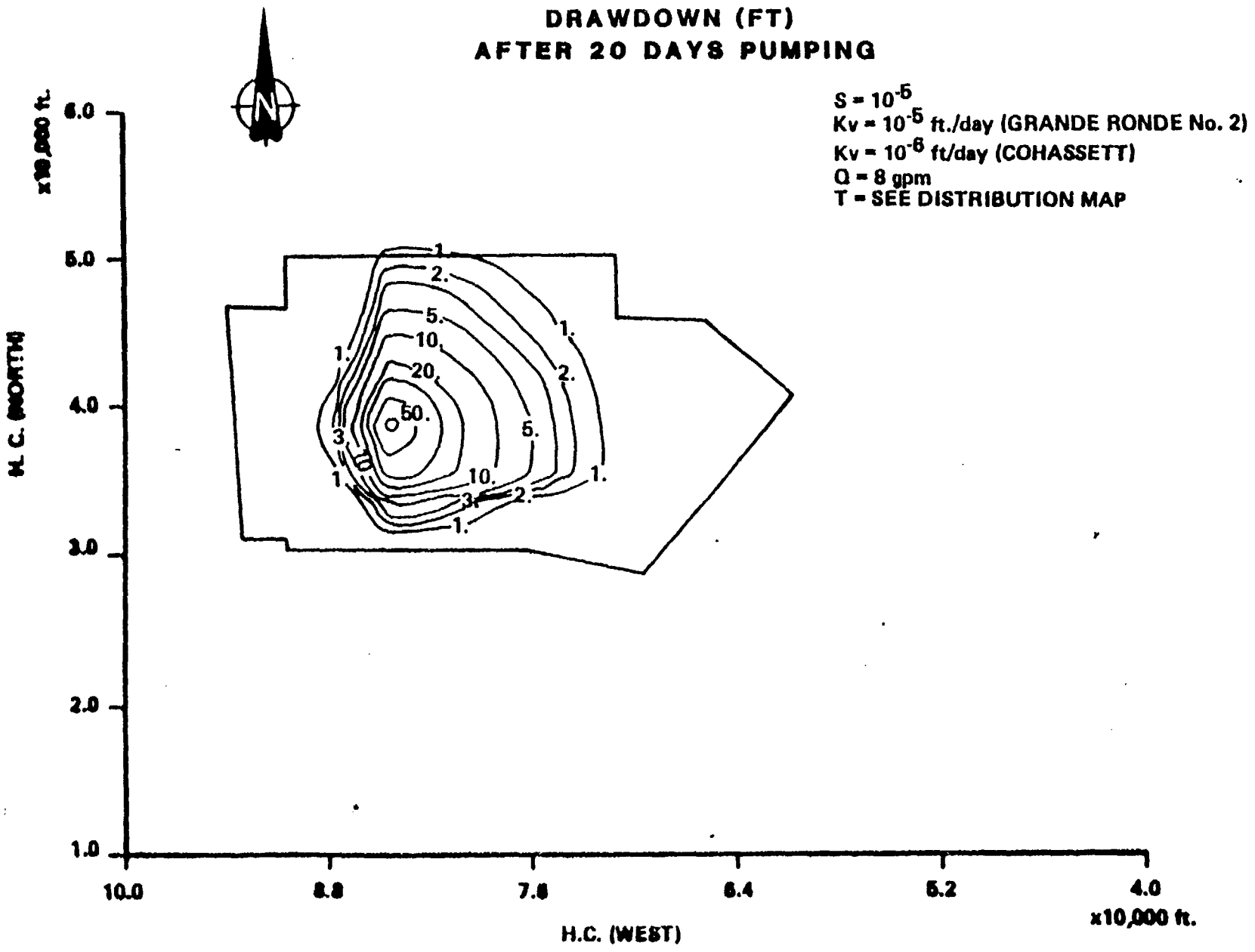
TRANSMISSIVITY ESTIMATED FROM SMALL SCALE TESTS (IN FT^2/DAY)

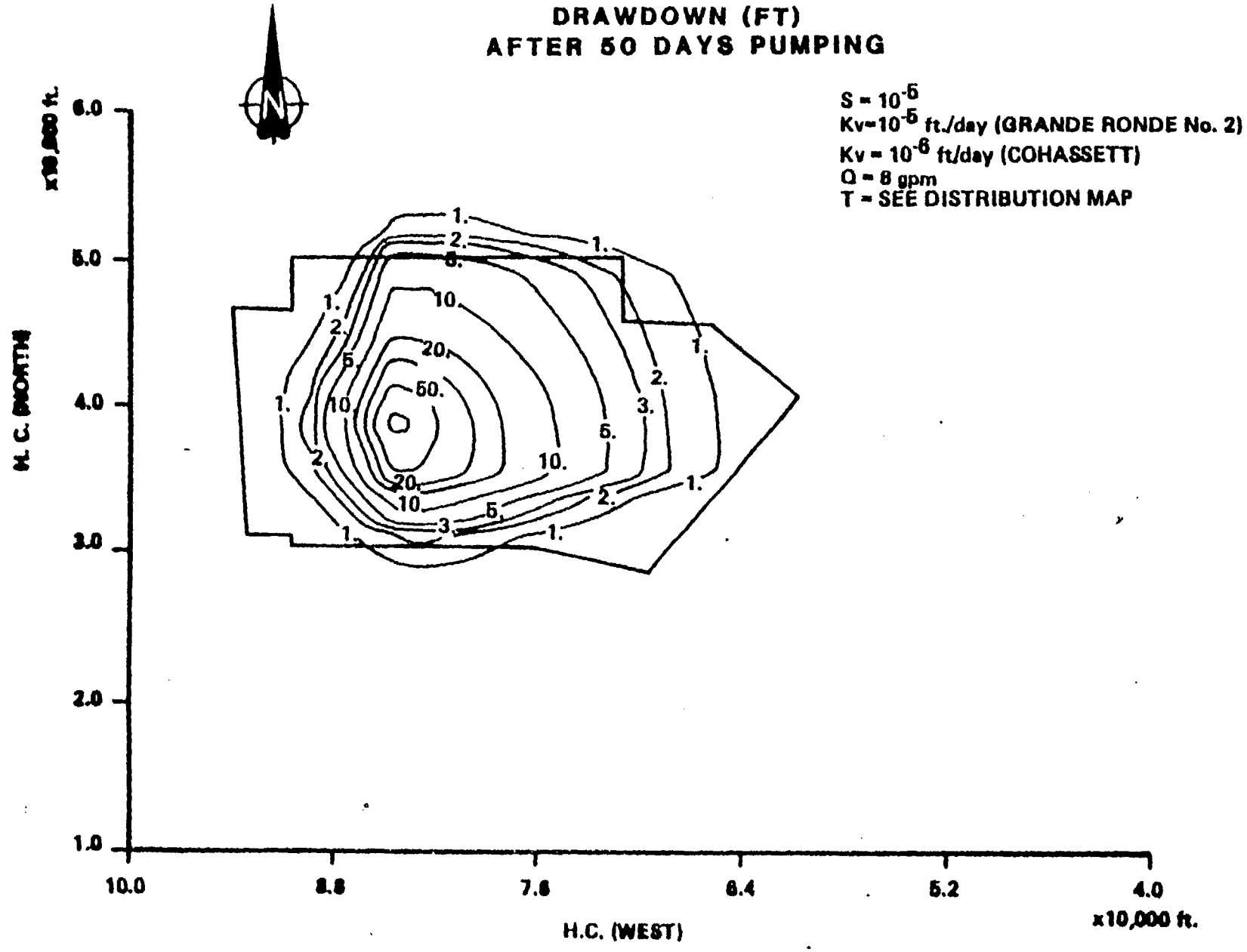
BOREHOLE NUMBER/ NAME	ROCKY COULEE FLOW TOP		
	HIGH	LOW	BEST
MCGEE	1,000	10	230
RRL-2A	100	10.0	10.0
DC-19C	1	0.1	0.5
DC-22C	10	0.001	0.1
	n = 4 Ave = 280 Sigma = 484	n = 4 Ave = 5.0 Sigma = 5.7	n = 4 Ave = 60.15 Sigma = 113.3

VALUES OF PARAMETERS USED IN PARAMETRIC ANALYSIS

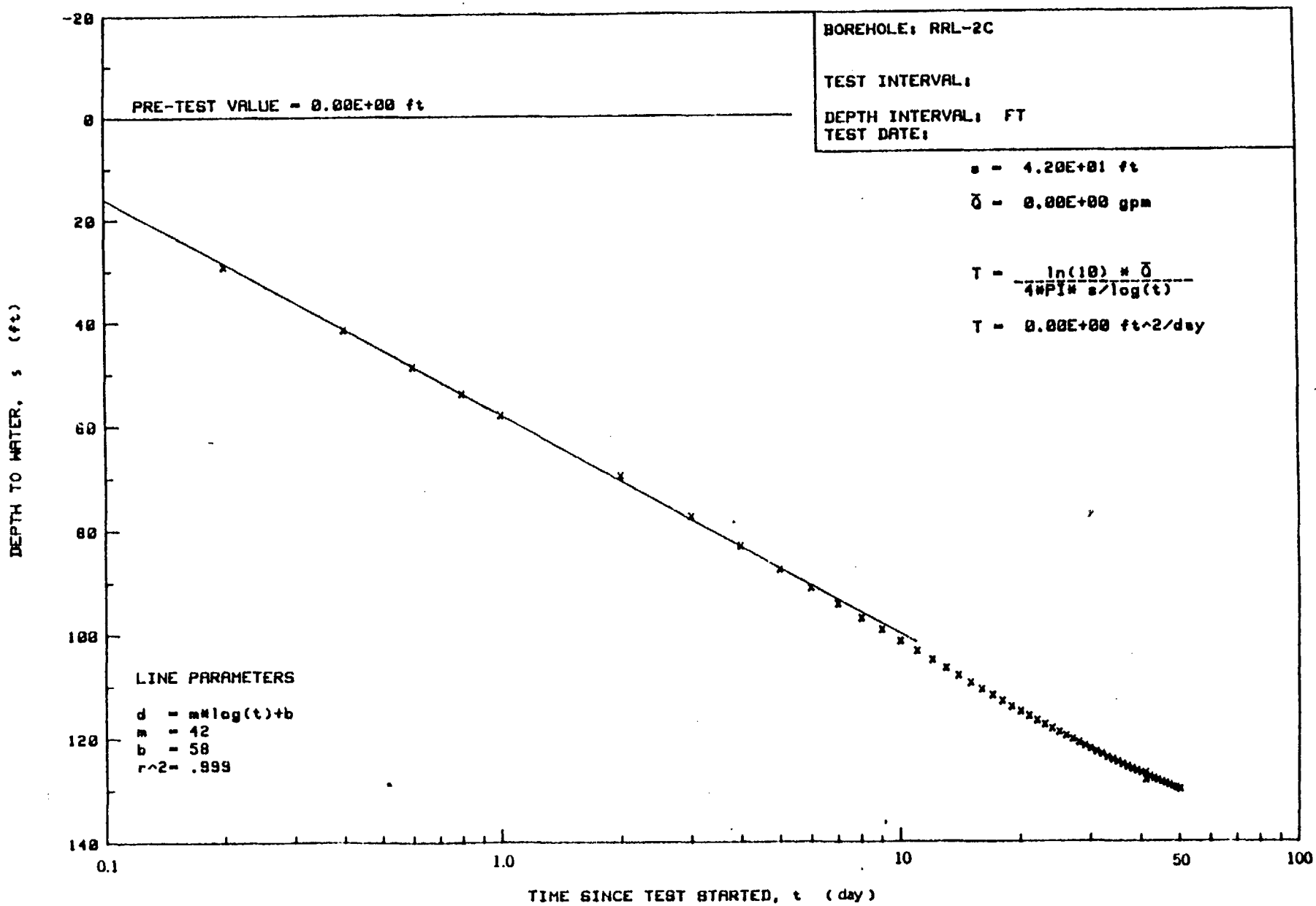
HYDROGEOLOGIC UNIT	TRANSMISSIVITY FT^2/DAY	VERTICAL HYDRAULIC CONDUCTIVITY FT/DAY	STORAGE COEFFICIENT
GRANDE RONDE NO. 2 FLOW TOP	10	N/A	10^{-5}
GRANDE RONDE NO. 2 FLOW INTERIOR	N/A	3×10^{-6}	N/A
ROCKY COULEE FLOW TOP	0.1 - 10*	N/A	10^{-5}
COHASSETT FLOW INTERIOR	N/A	3×10^{-5}	N/A
COHASSETT FLOW BOTTOM	10	N/A	10^{-5}

* ASSUMED ISOTOPIC AND HETEROGENEOUS


DRAWDOWN (FT)
AFTER 20 DAYS PUMPING
S = 10-5
Kv = 10-5 ft./day (GRANDE RONDE No. 2)
Kv = 10-6 ft/day (COHASSETT)
Q = 8 gpm
T = SEE DISTRIBUTION MAP
N
H.C. (NORTH) x10,000 ft.
6.0
5.0
4.0
3.0
2.0
1.0
10.0
8.8
7.8
6.4
5.2
4.0
x10,000 ft.
H.C. (WEST)
1
2.
5.
10.
20.
50.
1.
2.
5.
10.
20.
3.
1.
10.
3.
2.
1.


DRAWDOWN (FT)
AFTER 50 DAYS PUMPING
S = 10-5
Kv=10-5 ft./day (GRANDE RONDE No. 2)
Kv = 10-6 ft/day (COHASSETT)
Q = 8 gpm
T = SEE DISTRIBUTION MAP
N
6.0
5.0
4.0
3.0
2.0
1.0
10.0
8.8
7.6
6.4
5.2
4.0
x10,000 ft.
H.C. (WEST)
1.
2.
5.
10
20.
50.
3.

DRAWDOWN vs TIME FOR RRL-2C



ANALYTIC SOLUTION OF SIMULATED DATA

1)

$$T = \frac{2.3\ Q}{4\ \pi\ \Delta\ s}$$

$$S = \frac{2.25\ T\ t/r^2}{\log^{-1}\ (s/\Delta S)}$$

WHERE:

T = TRANSMISSIVITY, FT^2/DAY

Q = FLOW RATE, FT^3/DAY

S = DRAWDOWN OVER ONE LOG CYCLE OF TIME, FT

S = STORAGE COEFFICIENT, DIMENSIONLESS

t, s = TIME AND DRAWDOWN, RESPECTIVELY AT ANY POINT ON STRAIGHT LINE, PLOT, DAYS AND FEET

r = DISTANCE FROM PUMPING WELL TO OBSERVATION POINT, FT

1) COOPER AND JACOB (1946)

ANALYTIC SOLUTION OF SIMULATED DATA FOR OBSERVATIONS NEAR RRL-2C

$$Q = 8 \text{ qpm} = 1540 \text{ FT}^3\text{/day}$$

$$\Delta s = 43.5 \text{ FT (FROM PLOT)}$$

$$T = \frac{2.3\ (1540)}{4\ \pi\ (43.5)}$$

$$T = 6.5 \text{ FT}^2\text{/day compared to } 10 \text{ FT}^2\text{/day assigned to model nodes enar RRL-2C}$$

$$t = 10 \text{ days}$$
$$s = 101 \text{ feet}$$
$$r = 190 \text{ feet}$$

$$S = \frac{2.25\ (6.5)\ 10/(190)^2}{\text{Log}^{-1}\ (101/43.5)}$$

$$= 1.9 \times 10^{-5} \text{ say } 2 \times 10^{-5}$$

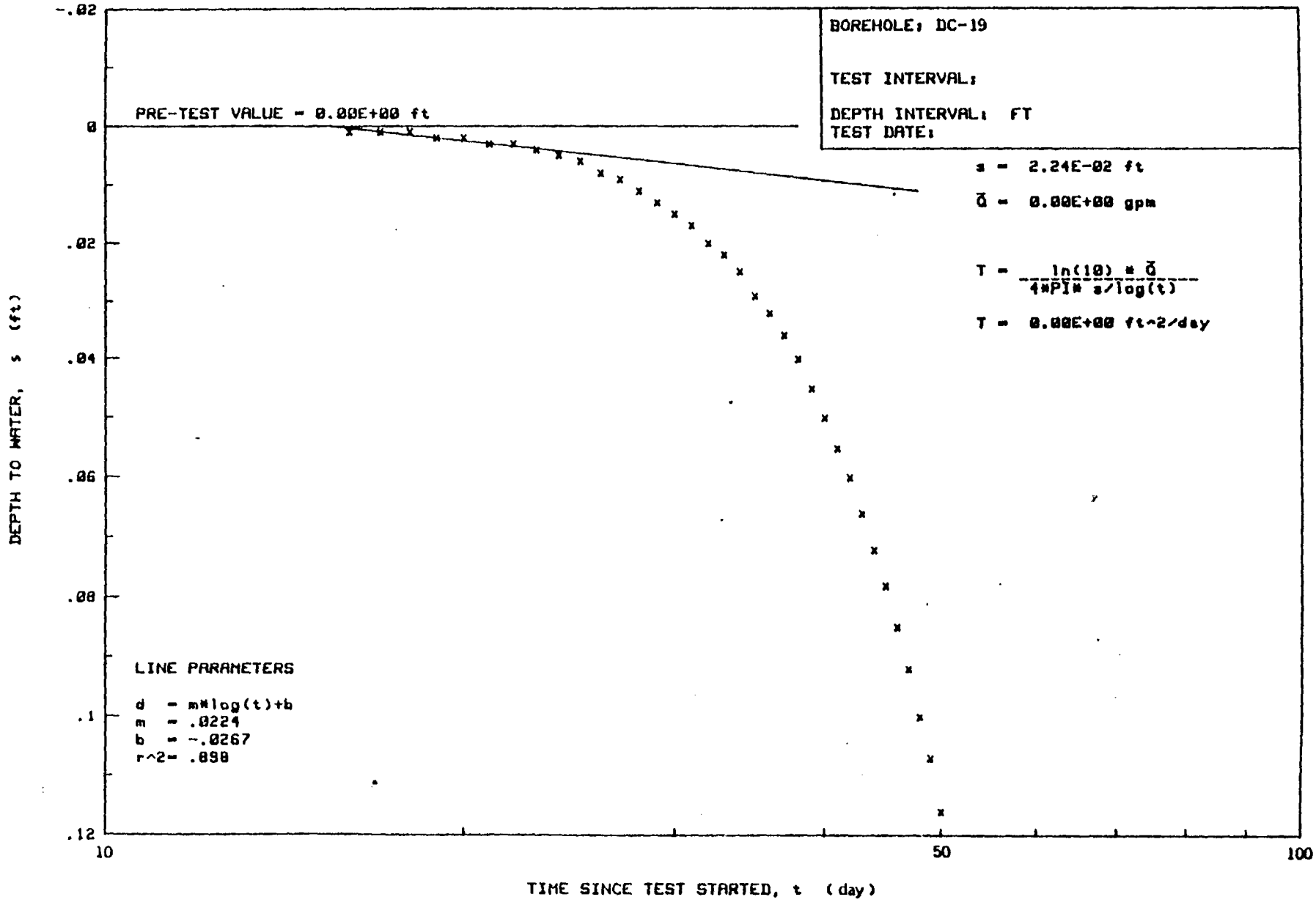
VALID FOR
$u \leq 0.01$

OR $t \geq \frac{r^2\ S}{4\ T\ 0.01}$

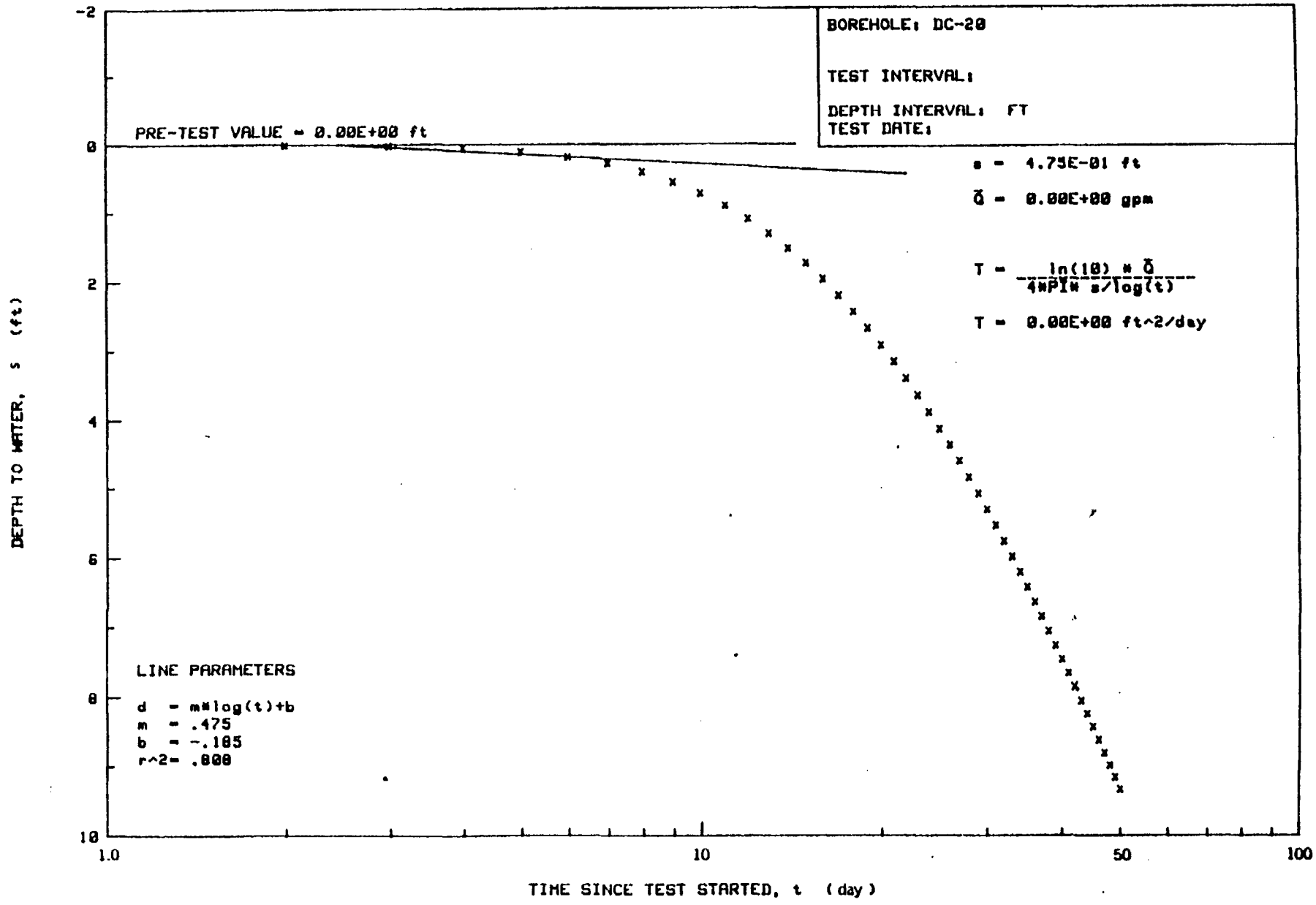
$$t \geq \frac{(190)^2\ (2 \times 10^{-5})}{(4)\ 6.5\ (0.01)}$$

$t \geq 2.8$ days

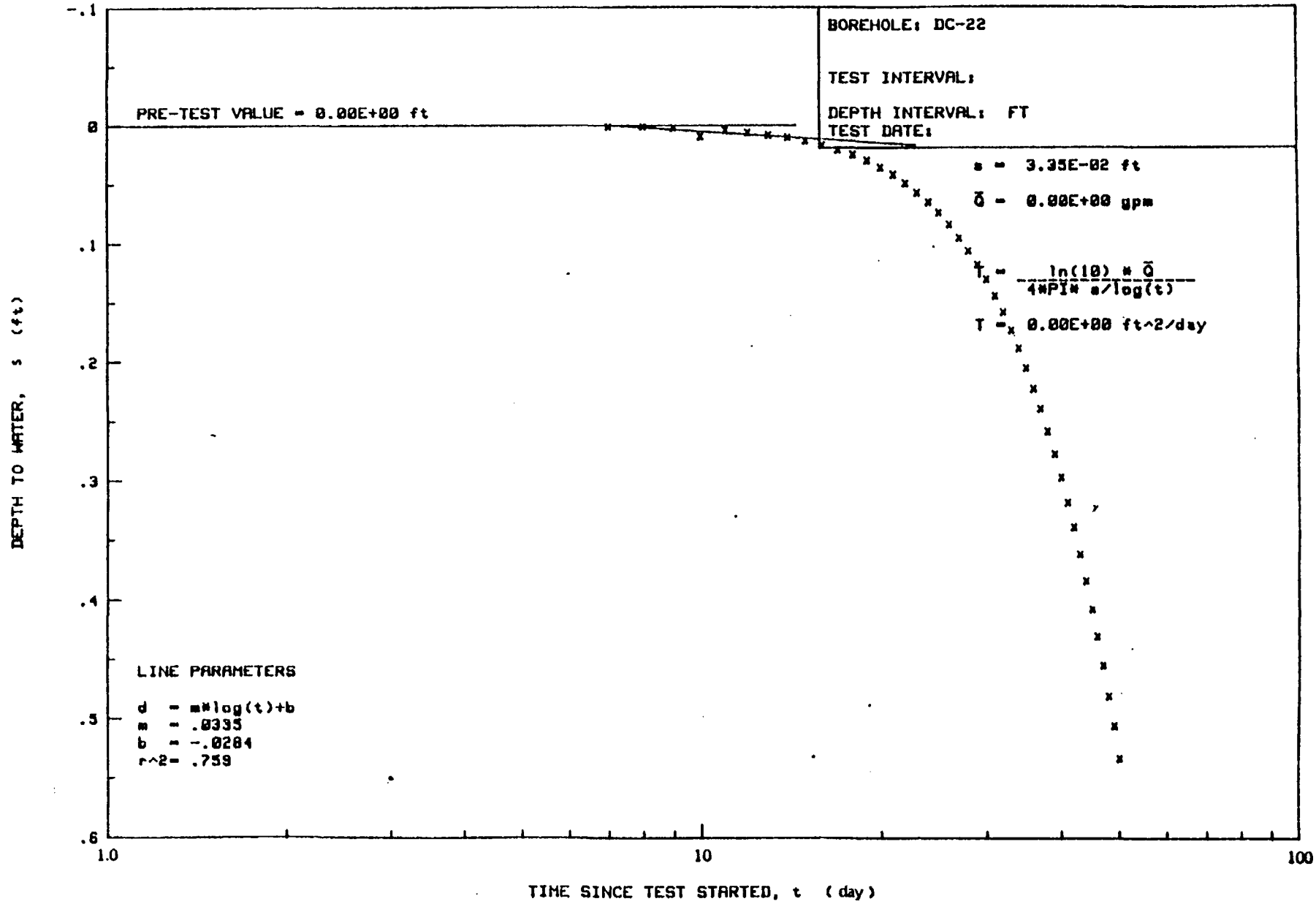
DRAWDOWN vs TIME FOR DC-19

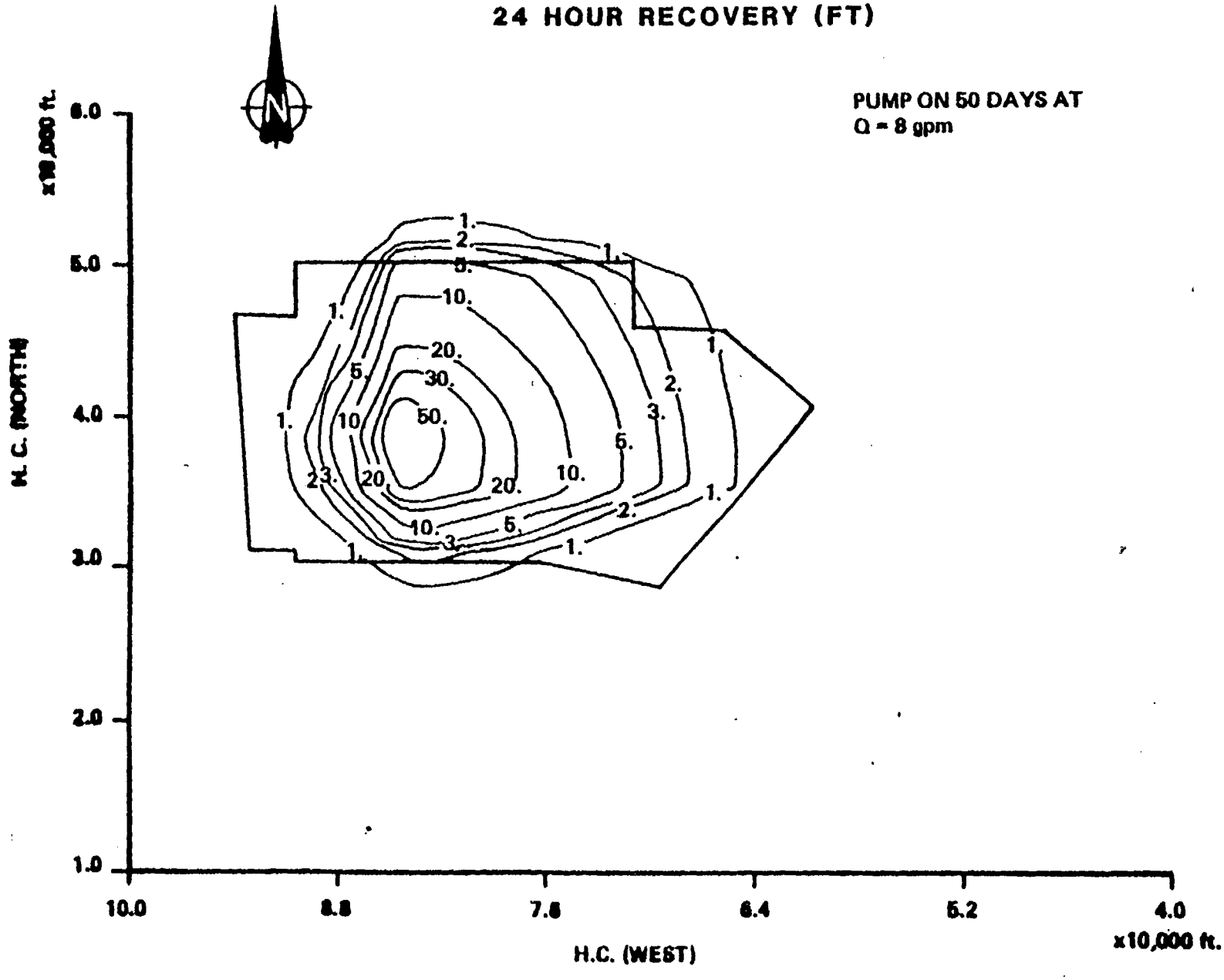


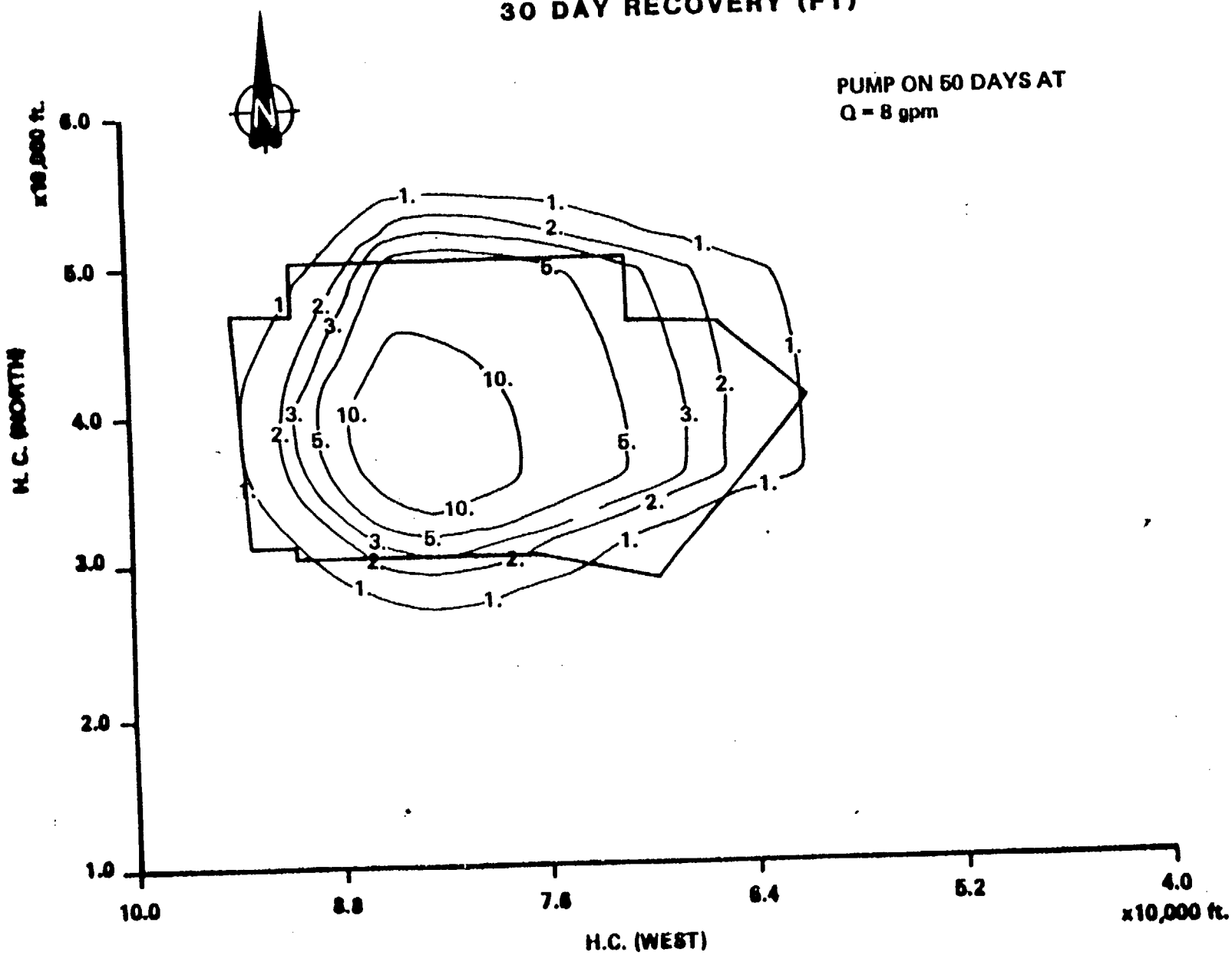
DRAWDOWN vs TIME FOR DC-20

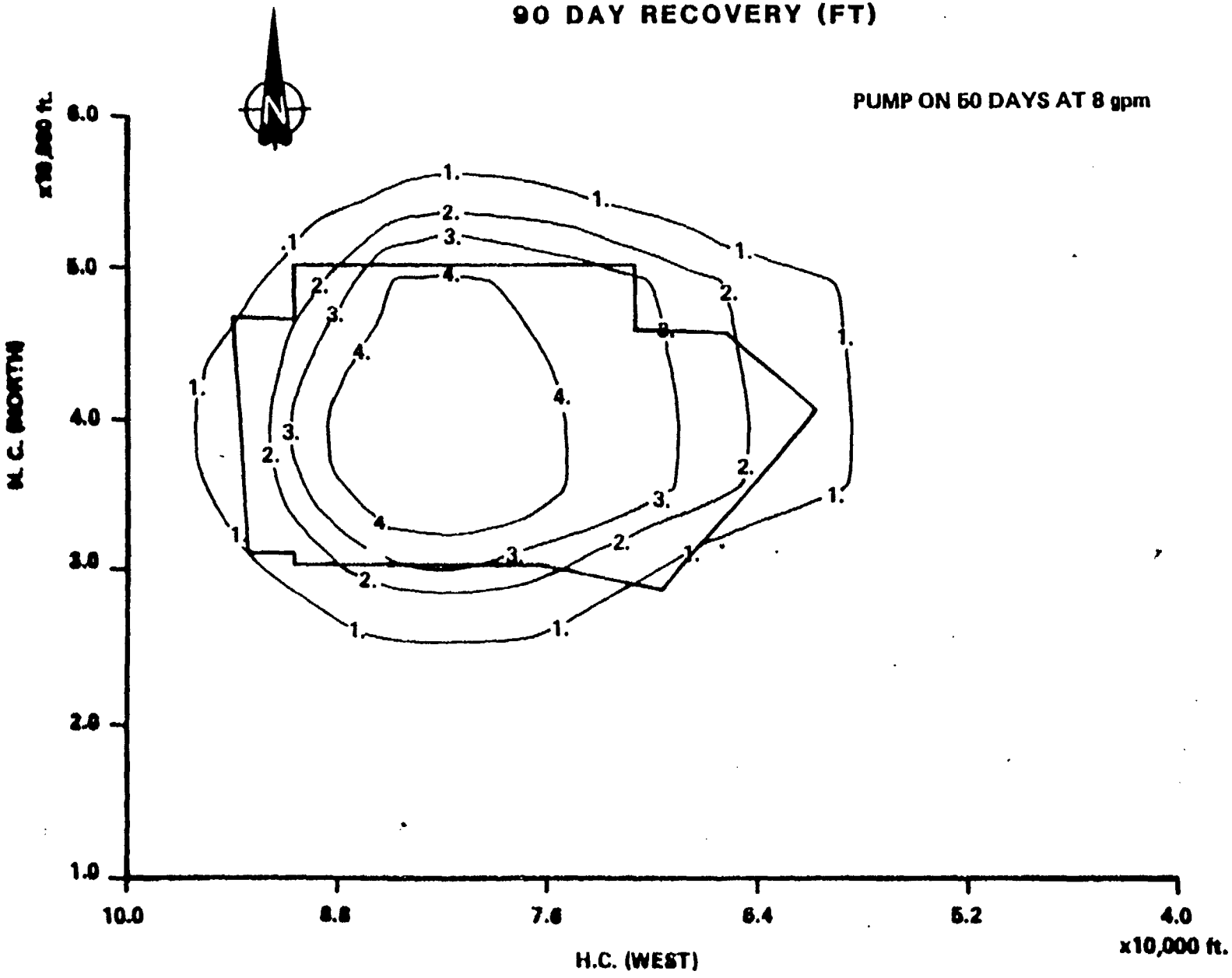


DRAWDOWN vs TIME FOR DC-22

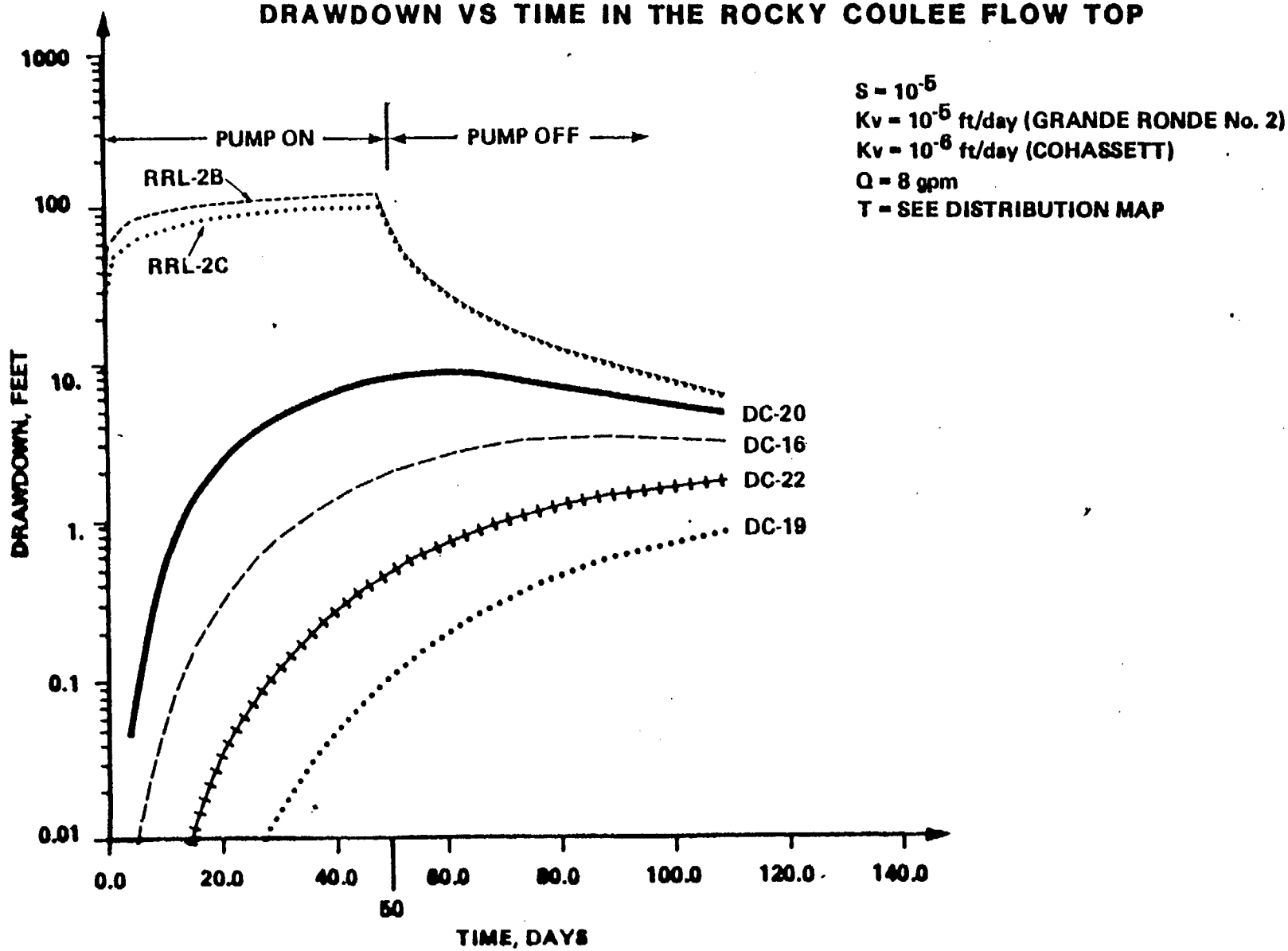


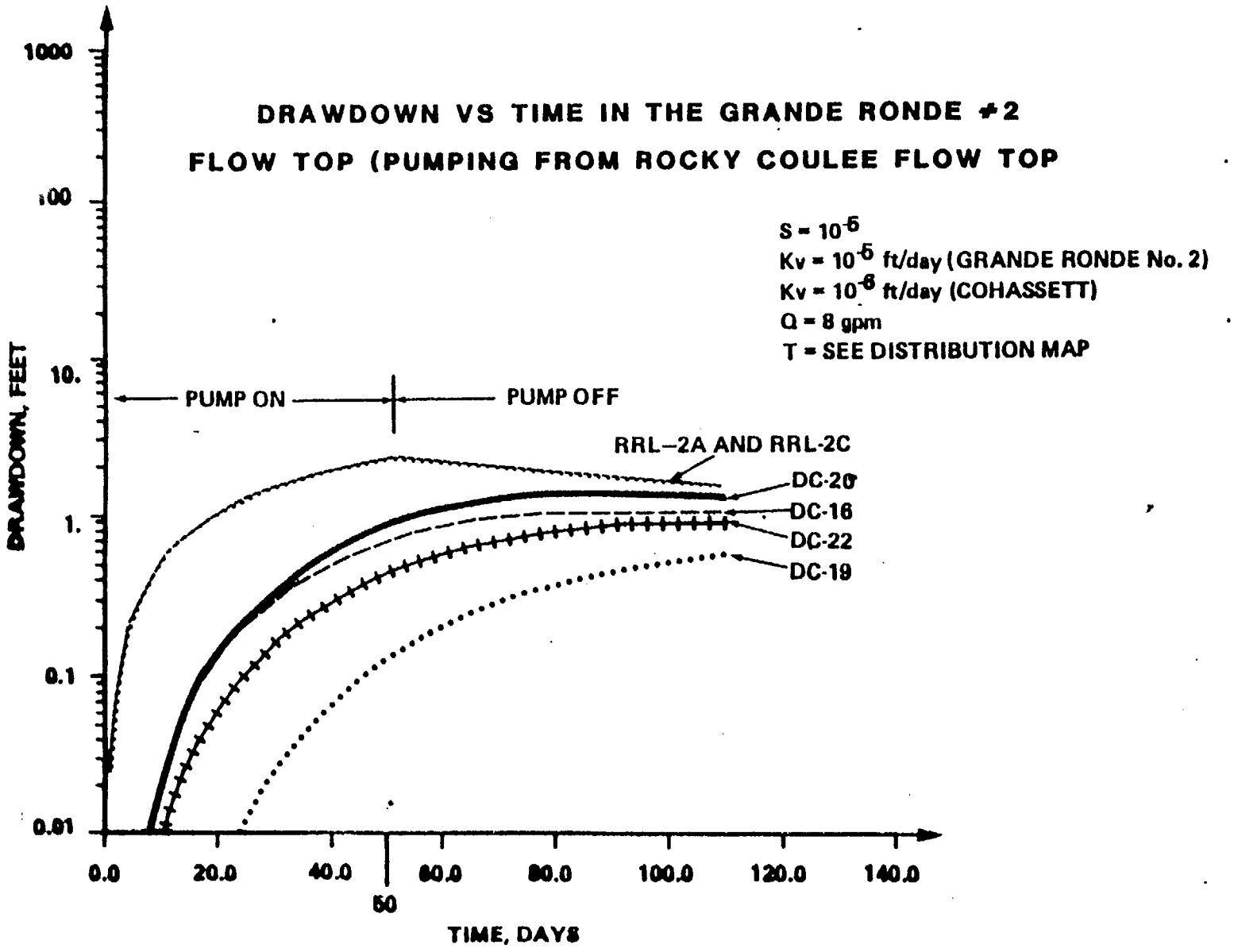

24 HOUR RECOVERY (FT)
PUMP ON 50 DAYS AT
Q = 8 gpm
N
H.C. (NORTH)
x10,000 ft.
6.0
5.0
4.0
3.0
2.0
1.0
10.0
8.8
7.6
6.4
5.2
4.0
H.C. (WEST)
x10,000 ft.

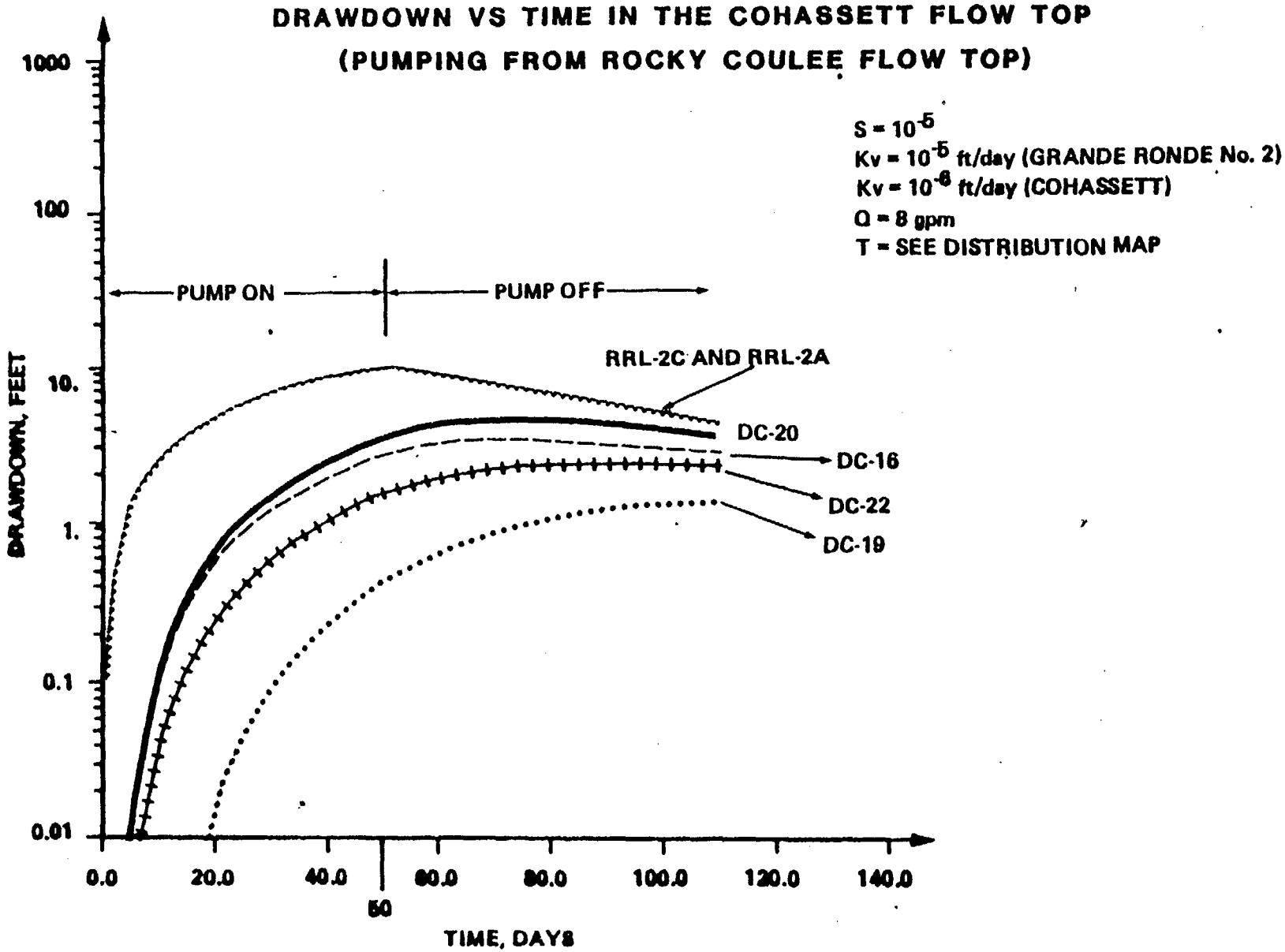

30 DAY RECOVERY (FT)
PUMP ON 50 DAYS AT
Q = 8 gpm
N
6.0
5.0
4.0
3.0
2.0
1.0
10.0
8.8
7.6
6.4
5.2
4.0
x10,000 ft.
H.C. (WEST)


90 DAY RECOVERY (FT)
PUMP ON 50 DAYS AT 8 gpm
N
6.0
5.0
4.0
3.0
2.0
1.0
10.0
8.8
7.6
6.4
5.2
4.0
x10,000 ft.
H.C. (WEST)

DRAWDOWN VS TIME IN THE ROCKY COULEE FLOW TOP




DRAWDOWN VS TIME IN THE GRANDE RONDE #2
FLOW TOP (PUMPING FROM ROCKY COULEE FLOW TOP
S = 10-5
Kv = 10-5 ft/day (GRANDE RONDE No. 2)
Kv = 10-6 ft/day (COHASSETT)
Q = 8 gpm
T = SEE DISTRIBUTION MAP
PUMP ON
PUMP OFF
RRL–2A AND RRL-2C
DC-20
DC-16
DC-22
DC-19
DRAWDOWN, FEET
1000
100
10.
1.
0.1
0.01
0.0
20.0
40.0
50
60.0
80.0
100.0
120.0
140.0
TIME, DAYS


DRAWDOWN VS TIME IN THE COHASSETT FLOW TOP
(PUMPING FROM ROCKY COULEE FLOW TOP)
S = 10-5
Kv = 10-5 ft/day (GRANDE RONDE No. 2)
Kv = 10-6 ft/day (COHASSETT)
Q = 8 gpm
T = SEE DISTRIBUTION MAP
PUMP ON
PUMP OFF
RRL-2C AND RRL-2A
DC-20
DC-16
DC-22
DC-19
DRAWDOWN, FEET
1000
100
10.
1.
0.1
0.01
0.0
20.0
40.0
60.0
80.0
100.0
120.0
140.0
50
TIME, DAYS

TEST SEQUENCE

- TEST SELECTED HYDROGEOLOGIC UNITS IN THE GRAND RONDE IN THE FOLLOWING ORDER
  - ROCKY COULEE FLOW TOP
  - COHASSETT FLOW TOP
  - COHASSETT FLOW BOTTOM
  - UMTANUM FLOW TOP

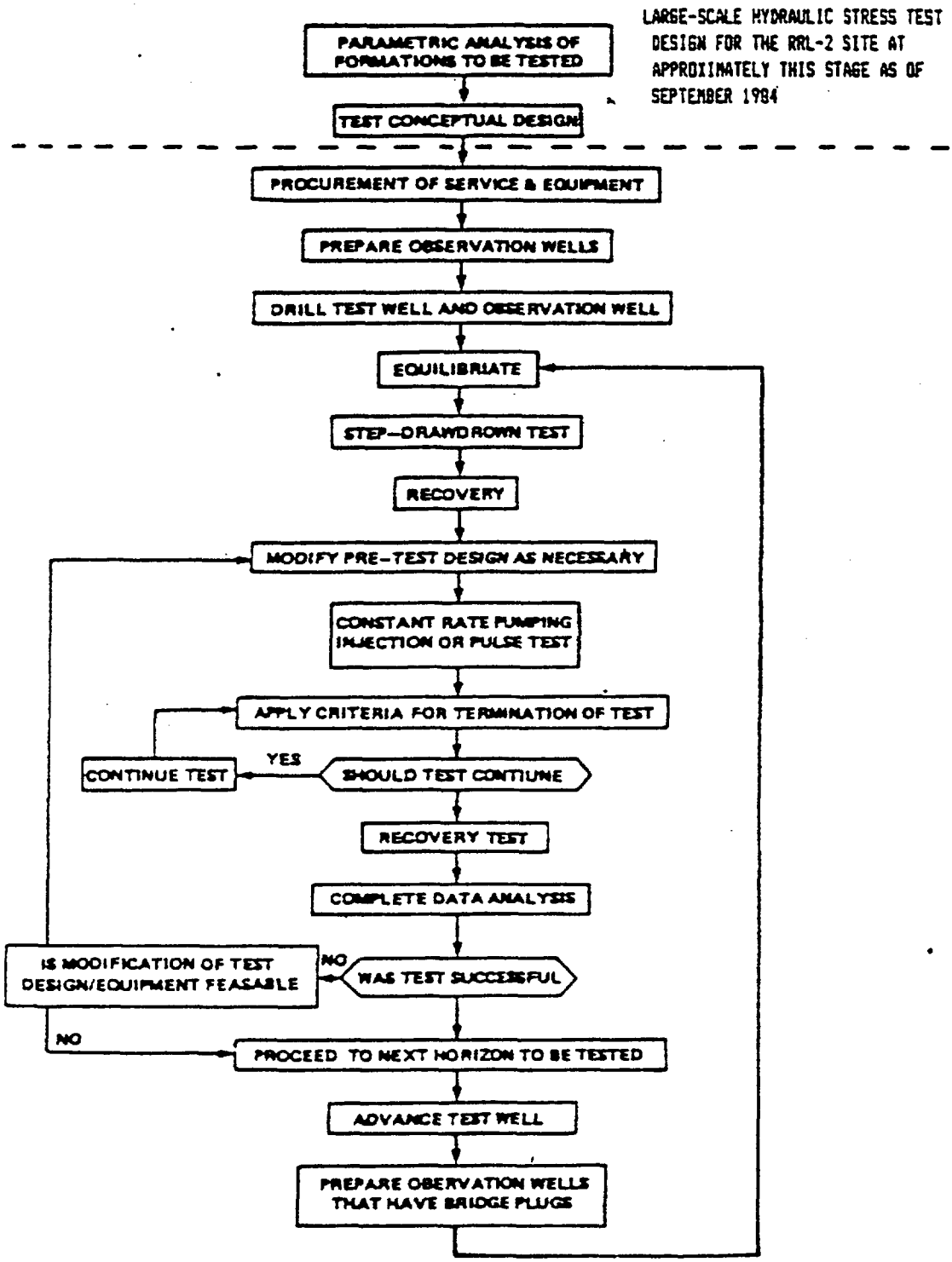


FIGURE 9 LOGIC DIAGRAM FOR DESIGN AND IMPLEMENTATION OF LARGE-SCALE HYDRAULIC STRESS TESTING AT THE RRL-2 SITE

TEST ANALYSIS

- QUANTIFY FLOW TOP HYDRAULIC PARAMETERS
  - ANALYTICAL TECHNIQUES FOR T, S, K'/b', AND BOUNDARIES
    THEIS (1935)
    COOPER AND JACOB (1946)
    HANTUSH (1956)
    HANTUSH (1960)
    FERRIS (1962)
  - ANALYTICAL TECHNIQUES FOR EFFECTIVE POROSITY AND LONGITUDINAL DISPERSIVITY
    APPROPRIATE ANALYSES TO BE DETERMINED
  - NUMERICAL TECHNIQUES FOR T, S,
    INVERSE MODELING USING PARAMETER VARIATION TECHNIQUE

- QUANTIFY FLOW INTERIOR HYDRAULIC PARAMETERS
  - ANALYTICAL TECHNIQUE FOR Kv
    NEUMAN AND WITHERSPOON (1972)
  - NUMERICAL TECHNIQUES FOR Kv
    INVERSE MODELING USING PARAMETER VARIATION TECHNIQUE

- REMOVE BAROMETRIC AND EARTH TIDE EFFECTS FROM WATER-LEVEL DATA
  - CLARK (1967)
  - NARASIMHAN (1984), VAN DER KAMP (1983)

SCHEDULE FOR LHS TESTING AT RRL-2