YUCCA MOUNTAIN PROJECT

Studies

Hydraulic and Tracer Testing at the C-Holes Complex 1995-1997

Presented to:
Nuclear Waste Technical Review Board

Presented by:
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and
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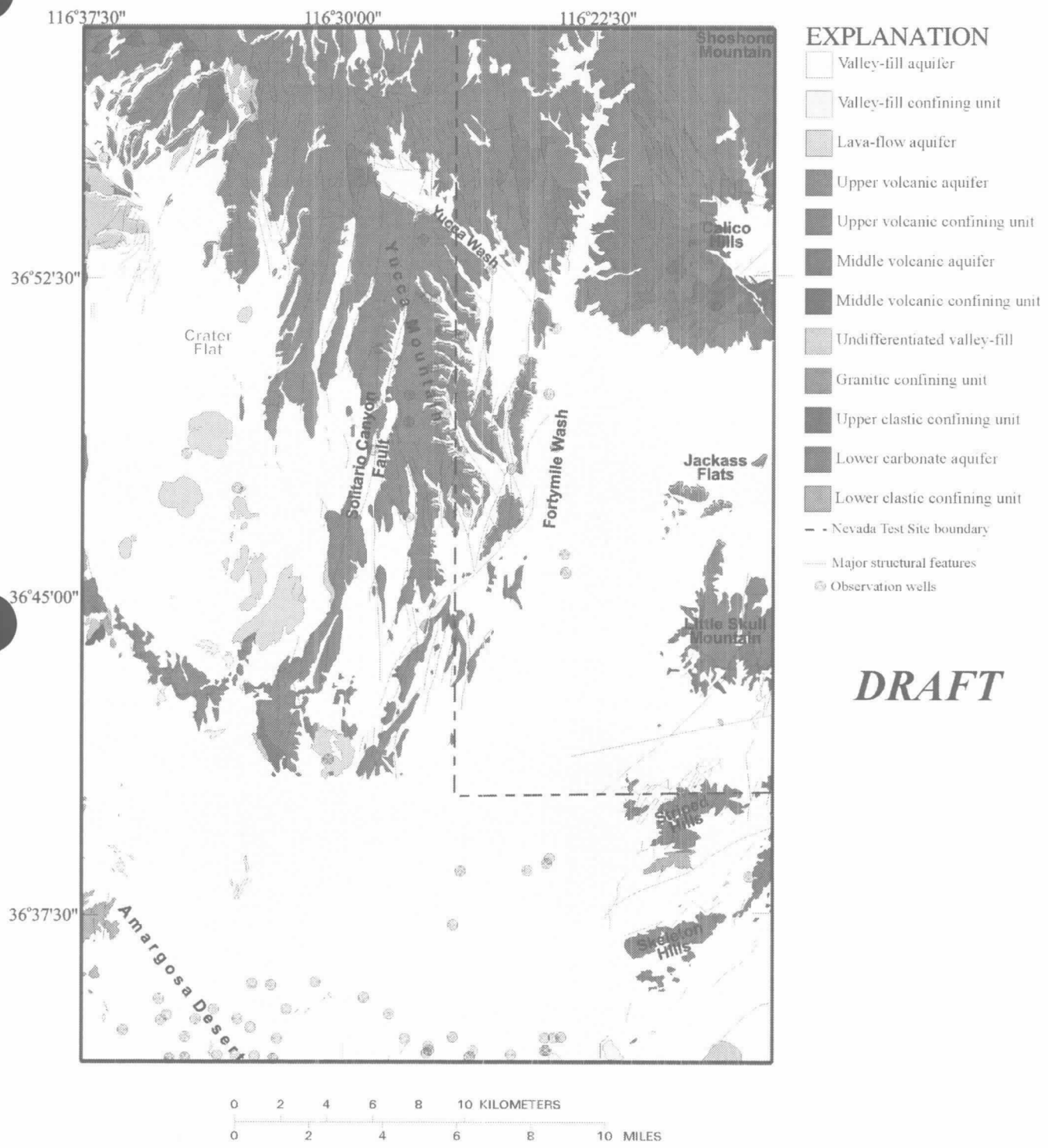
Los Alamos National Laboratory

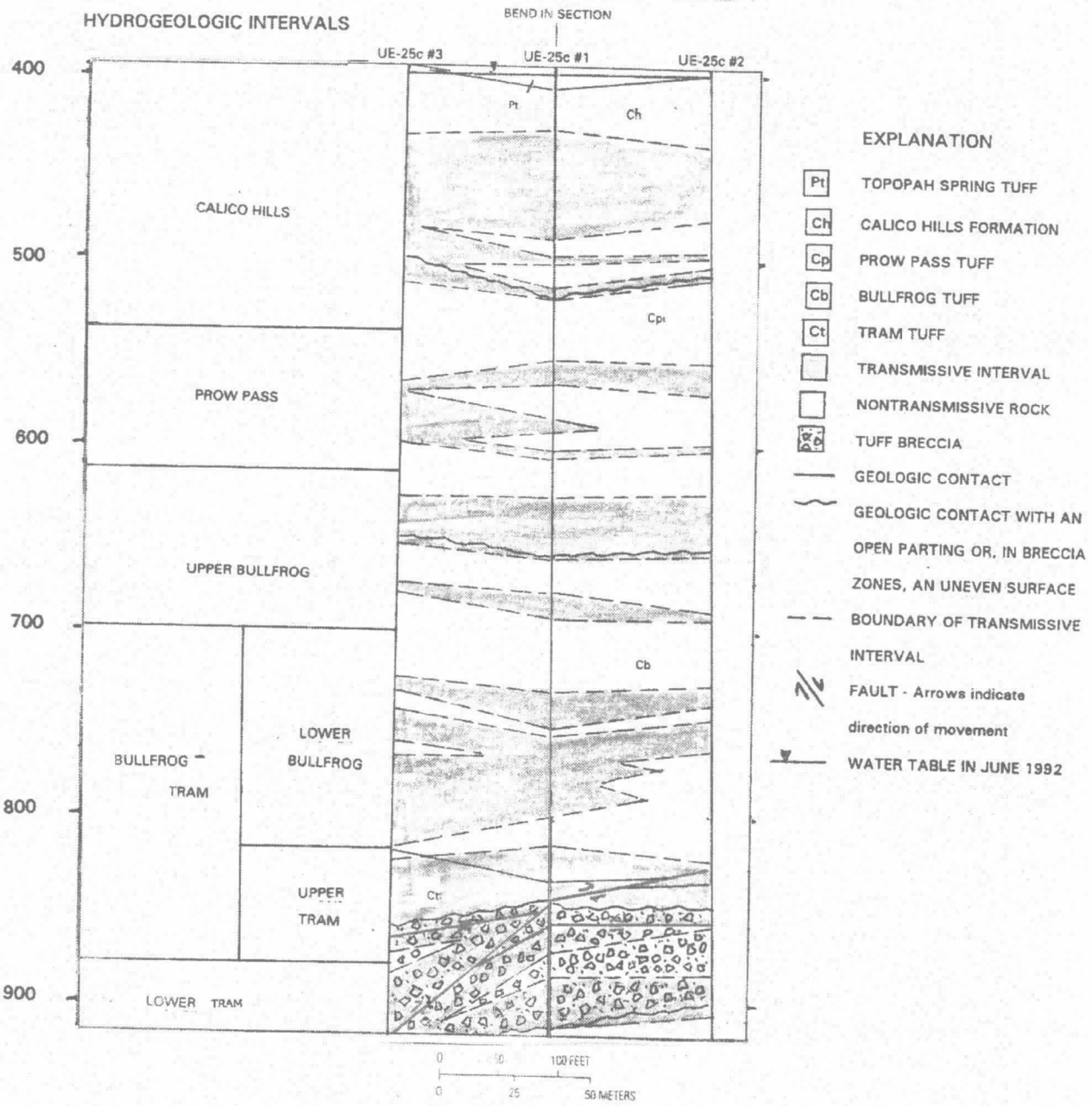
January 20-21, 1998

U.S. Department of Energy
Office of Civilian Radioactive
Waste Management

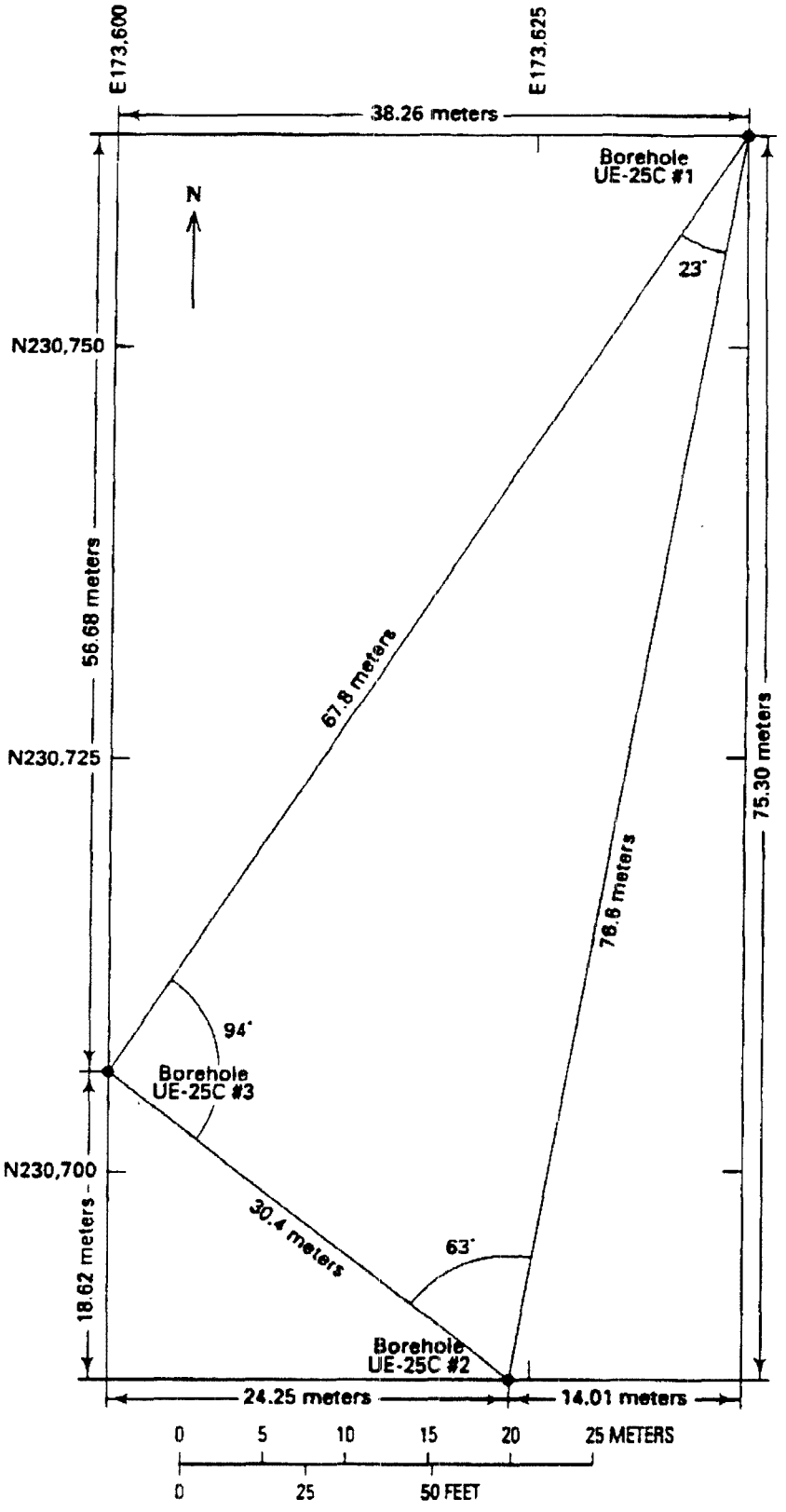


HYDRTRAC.PPT.125.NWTRB/1-20/21-98 2

Generalized hydrogeologic units with major structural features (limestone aquifer, lower volcanic aquifer, and lower volcanic confining unit do not appear at the land surface).



Hydrogeologic intervals in the C-holes during hydraulic and tracer tests, 1995 to 1997 (Modified from Geldon, 1996)



Surface locations of boreholes UE-25c #1, UE-25c #2, and UE-25c #3. [Map is referenced to Nevada State Central Zone Coordinates.]

Hydraulic and Conservative Tracer Tests

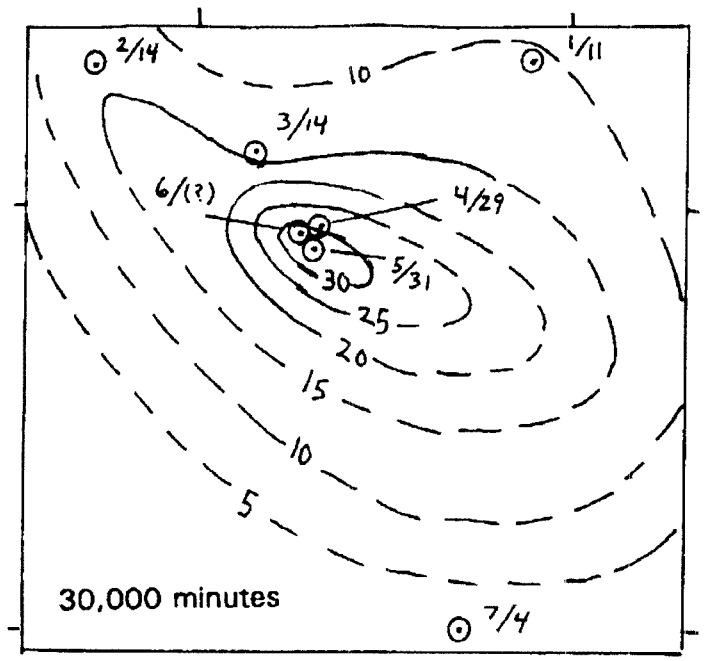
- Open-hole Hydraulic Test in 5/95
- Observation Wells Packed off in 6/95 Hydraulic Test (Plus Flow Survey)
- Long-term Hydraulic Test from 5/8/96 to 11/12/97. Distant Observation Wells Monitored.
- 2/96 Iodide Tracer Test in Lower Bullfrog-Upper Tram
- 1/9/97 Pyridone Tracer Test in Lower Bullfrog (c1-c3)
- 1/10/97 2, 6 DFBA Tracer Test (c2-c3)

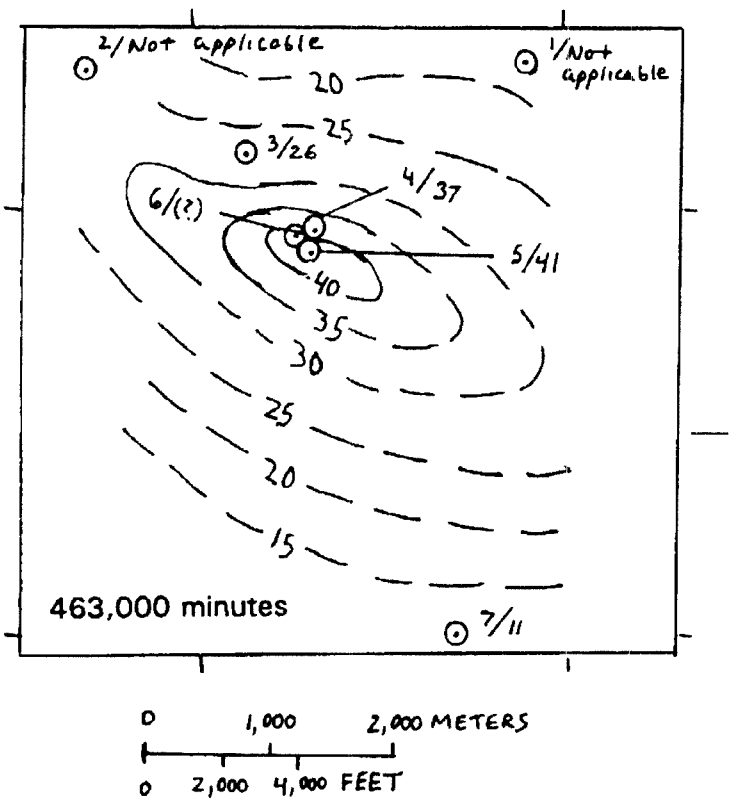
Hydraulic Test in UE-25 C#3, 1995 to 1997

	TEST 1	TEST 2	TEST 3	TEST 4
START PUMPING	5/22/95	6/12/95	2/08/96	5/08/96
STOP PUMPING	6/01/95	6/16/95	2/13/96	3/26/97
LENGTH (DAYS)	10.0	4.0	4.9	322.3
INTERVAL PUMPED	CALICO HILLS TO TRAM	CALICO HILLS TO TRAM	BULLFROG-TRAM	LOWER BULLFROG
DISCHARGE (L/S)	17.9	22.5	8.49	9.53
PUMPING WELL DRAWDOWN (M)	7.76	10.9	2.86	5.98
OBSERVATION WELLS	C#1,C#2, WT#14, WT#3,H-4, ONC-1	C#1,C#2	C#1,C#2	C#1,C#2, WT#14, WT#3,H-4, ONC-1
DISTANCE TO OBSERVATION WELLS (M)	29-3,526	29-86	29-86	29-3,526
GEOLOGIC UNITS IN OBSERVATION WELLS	TOPOPAH SPRING TO LITHIC RIDGE	CALICO HILLS TO LOWER BULLFROG	CALICO HILLS TO BULLFROG-TRAM	TOPOPAH SPRING TO LITHIC RIDGE
OBSERVATION WELL DRAWDOWN (CM)	0-43	43-352	14-25	15-51

Hydraulic Properties

BOREHOLE/INTERVAL	R (M)	T (M^2/D)	K (M/D)	S
C-HOLES				
CALICO HILLS	29-78	6-9	0.1-0.2	0.0002
PROW PASS	29-81	40-60	2-3	0.0003-0.0004
UPPER BULLFROG	29-83	40-100	0.8-4	0.00002-0.0009
LOWER BULLFROG	29-86	1,300-1,600	20-50	0.0002-0.002
UPPER TRAM	30-87	800-900	20-40	0.0001-0.001
COMPOSITE	29-83	1,800-2,600	7-18	0.001-0.003
ONC-1 (PROW PASS)	843	1,000	5	0.001
H-4 (PROW PASS TO LITHIC RIDGE)	2,245	700	2	0.002
WT#14 (TOPOPAH SPRING AND CALICO HILLS)	2,249	1,300	≈10	0.002
WT#3 (BULLFROG)	3,526	2,600	≤60	0.002
TUFFACEOUS ROCKS	≤3,526	2,100-2,600	UNKNOWN	0.0005-0.003





EXPLANATION

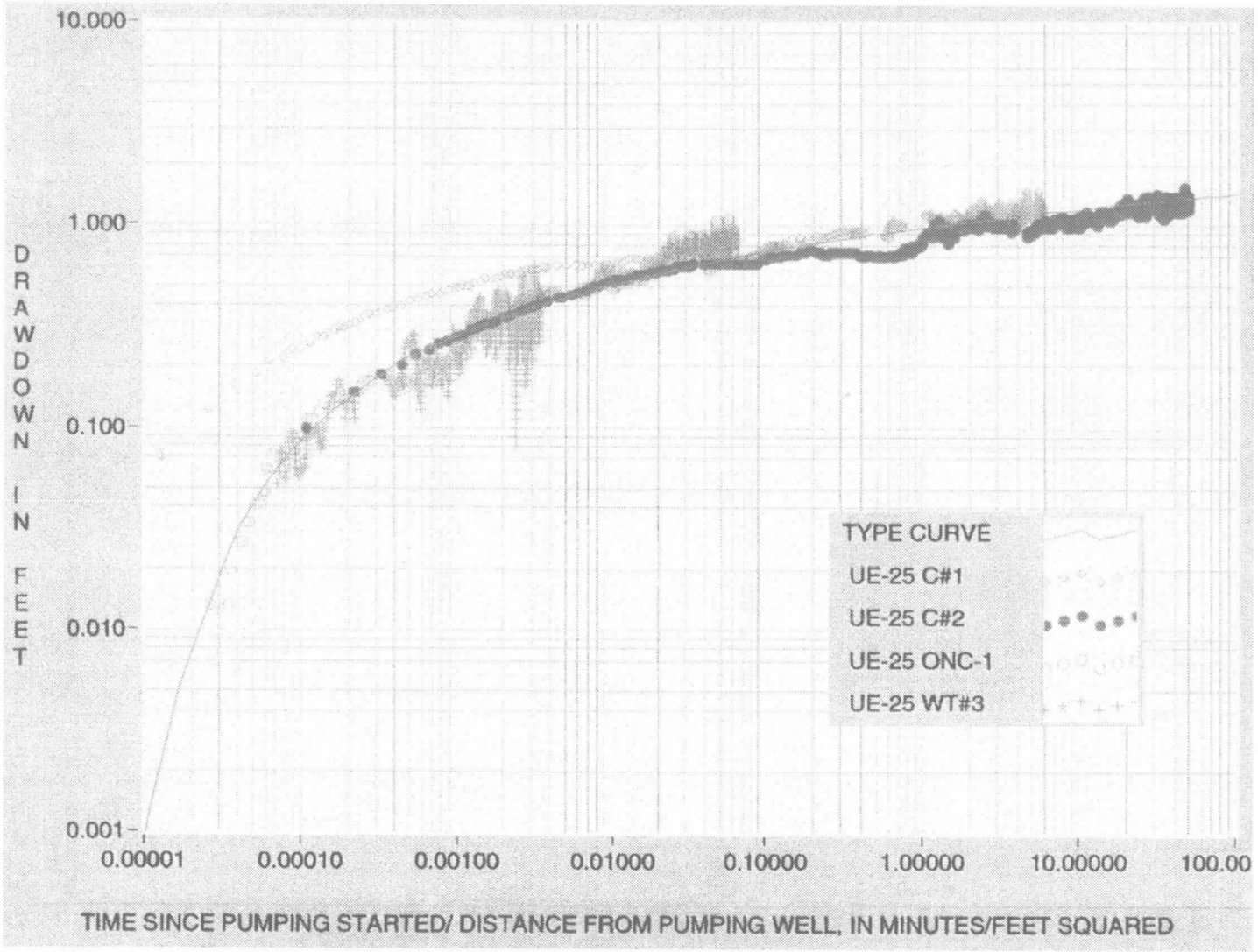
1/0.36 OBSERVATION WELL - Well number to left of slash; drawdown, in centimeters, to right of slash; not applicable if drawdown affected by a recharge boundary

— 0.4 - - - LINE OF EQUAL DRAWDOWN - Interval, 5 centimeters;

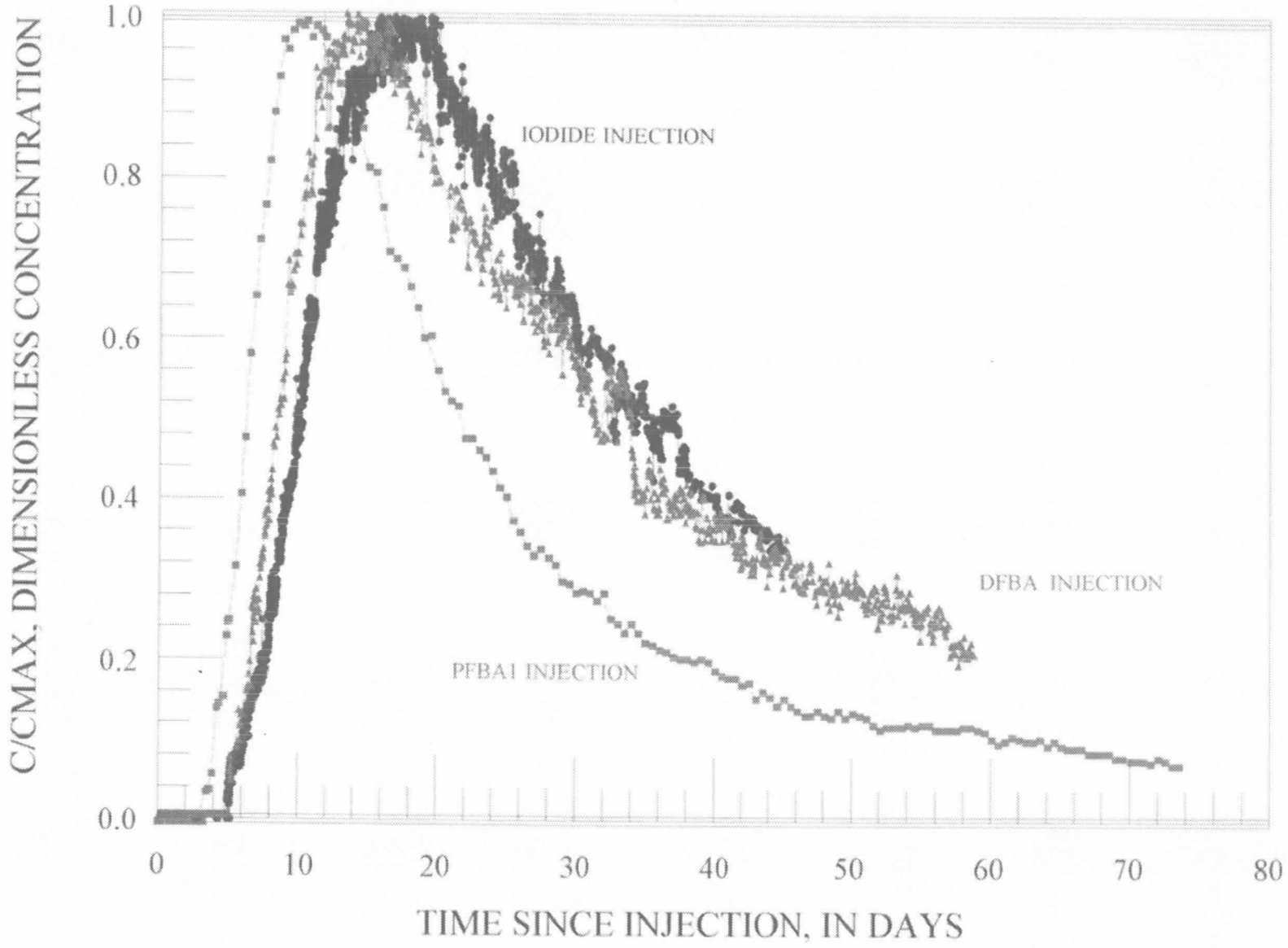
OBSERVATION WELL NUMBERS

1. UE-25 WT#14
2. USW H-4
3. UE-25 ONC-1
4. UE-25 c#1
5. UE-25 c#2
6. UE-25 c#3
7. UE-25 WT#3

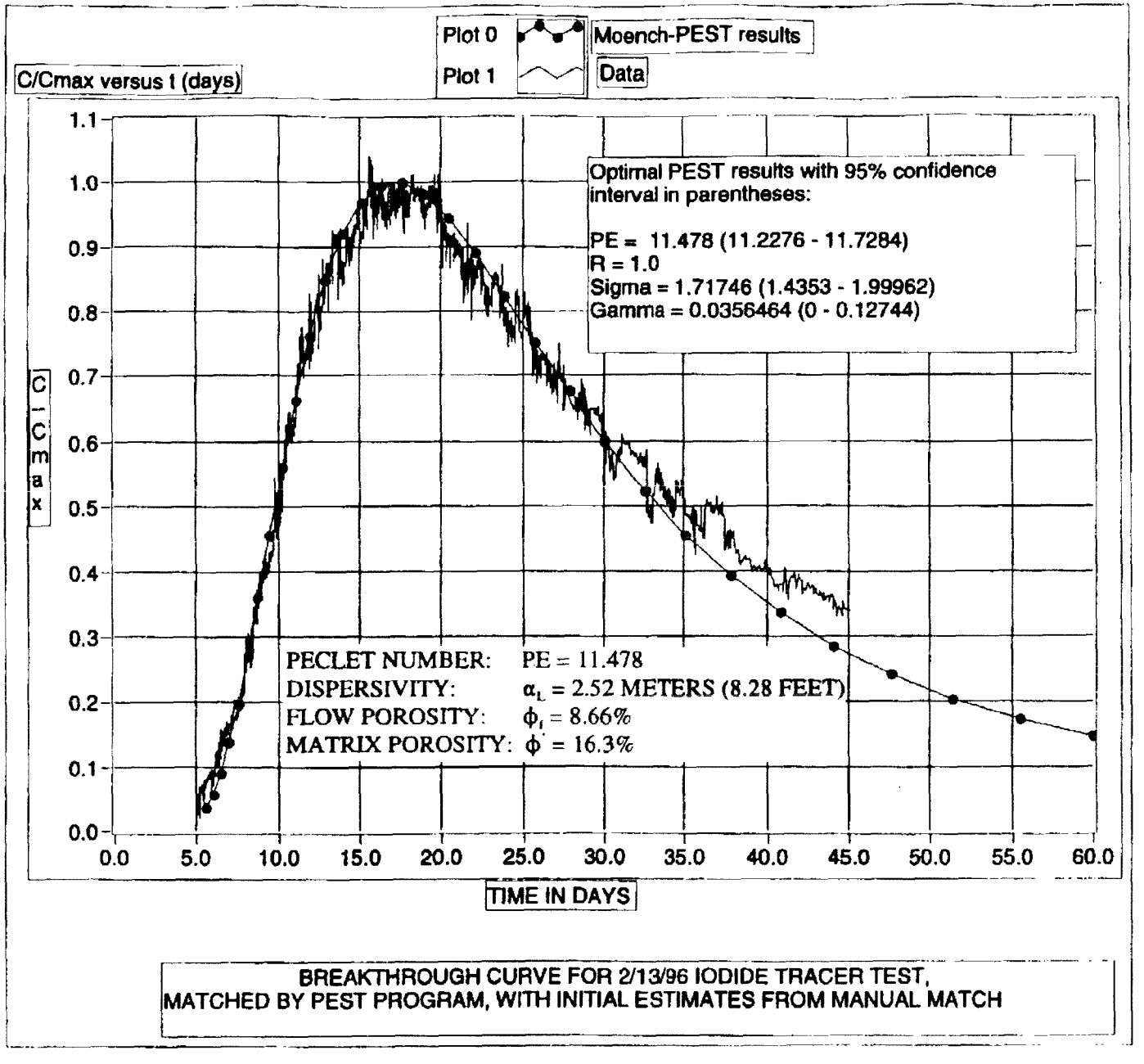
Distribution of drawndown in observation wells 30,000 minutes (20.3 days) and 463,000 minutes (321.5 days) after pumping started in UE-25 c#3 on May 8, 1996



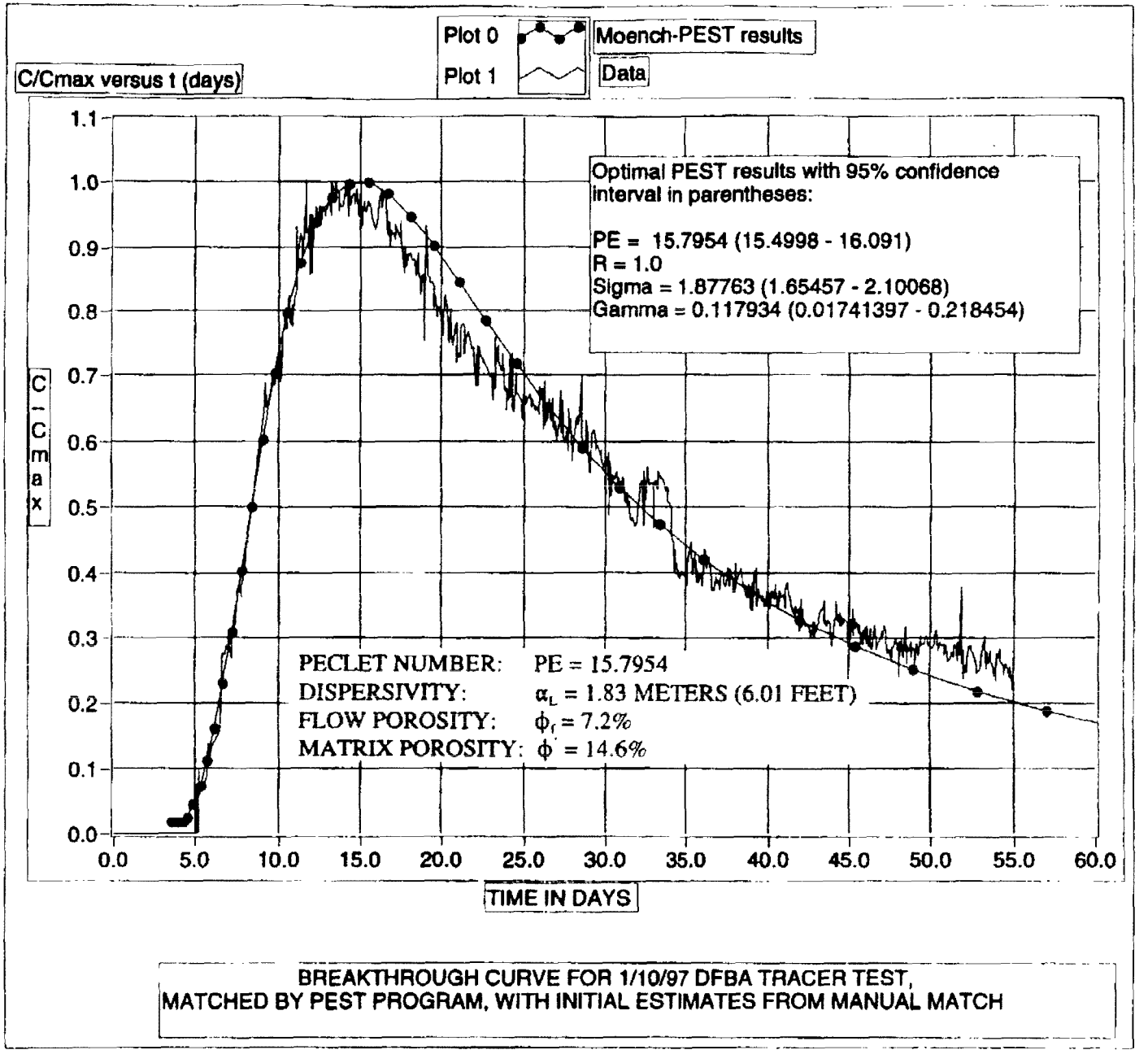
Analysis of drawdown in observation wells as a function of time divided by the square of the distance from the pumping well, hydraulic test in UE-25 c#3, May 8, 1996 to March 26, 1997



IODIDE, PFBA1, AND DFBA INJECTIONS IN UE-25 C#2

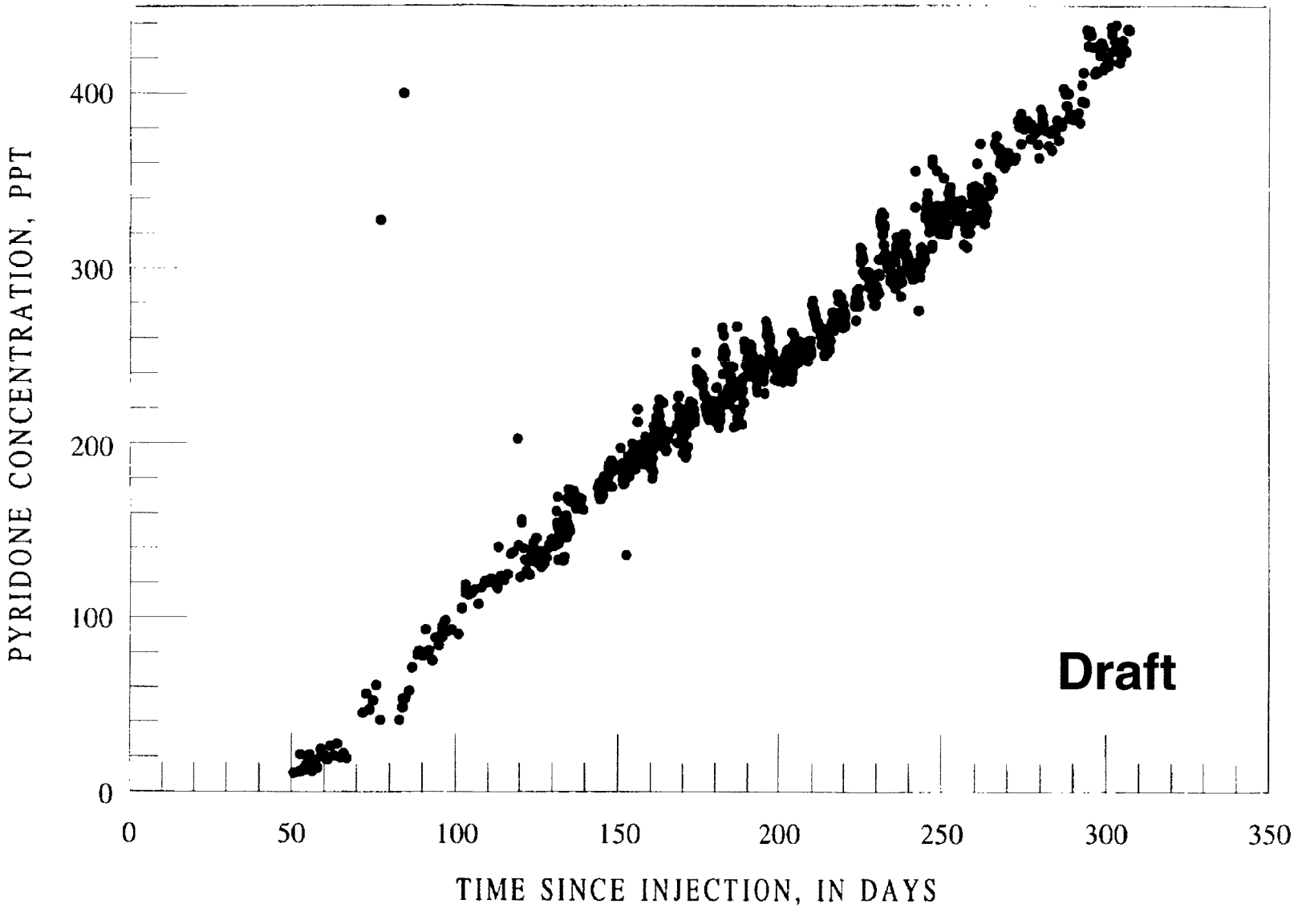


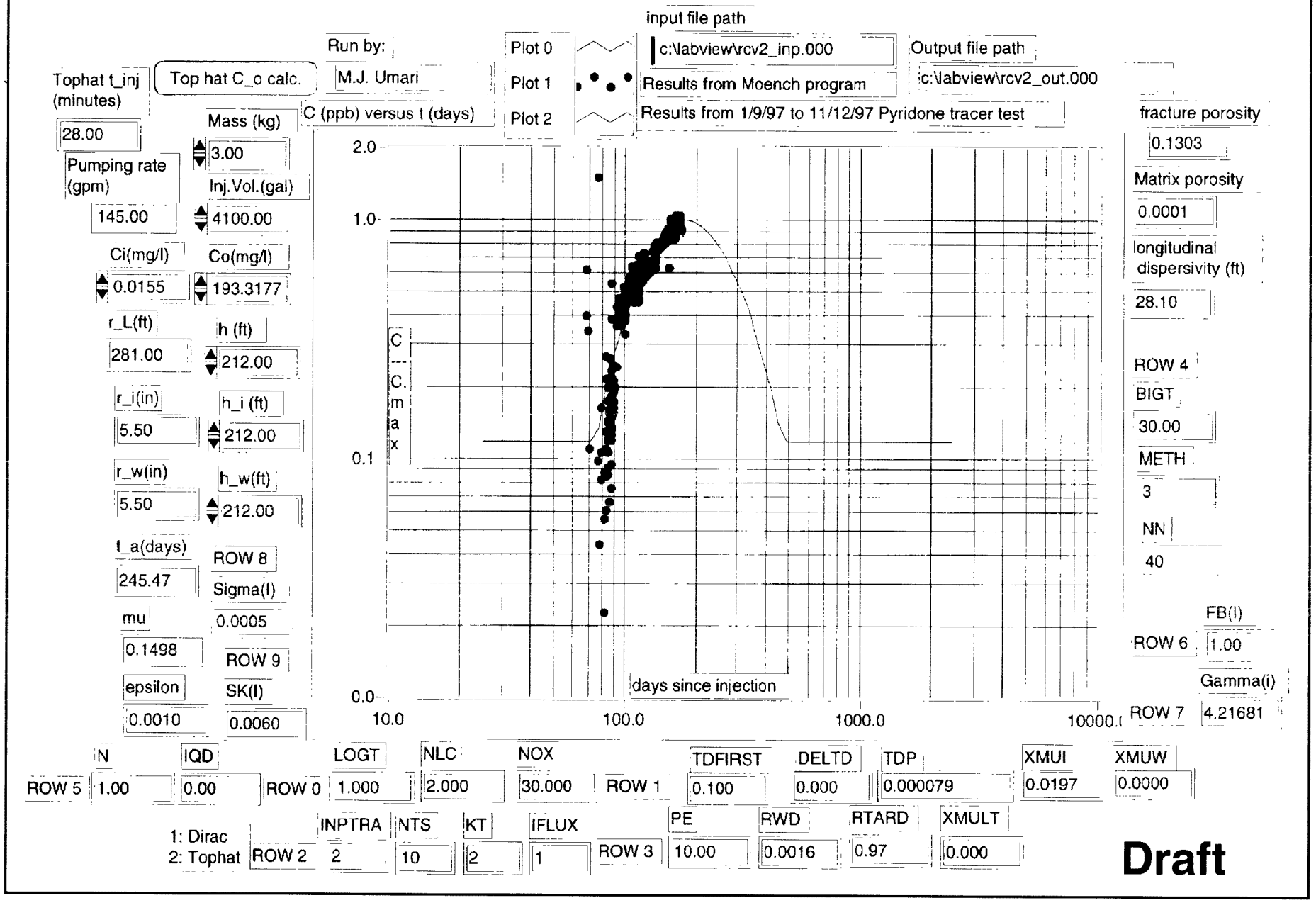
BREAKTHROUGH CURVE FOR 2/13/96 IODIDE TRACER TEST,
MATCHED BY PEST PROGRAM, WITH INITIAL ESTIMATES FROM MANUAL MATCH



BREAKTHROUGH CURVE FOR 1/10/97 DFBA TRACER TEST,
MATCHED BY PEST PROGRAM, WITH INITIAL ESTIMATES FROM MANUAL MATCH

C-Wells Tracer Studies




input file path
Run by:
M.J. Umari
Plot 0
Plot 1
Plot 2
c:\labview\rcv2_inp.000
Output file path
c:\labview\rcv2_out.000
Results from Moench program
Results from 1/9/97 to 11/12/97 Pyridone tracer test
Tophat t_inj (minutes)
28.00
Top hat C_o calc.
C (ppb) versus t (days)
Mass (kg)
3.00
Pumping rate (gpm)
145.00
Inj.Vol.(gal)
4100.00
Ci(mg/l)
0.0155
Co(mg/l)
193.3177
r_L(ft)
281.00
h (ft)
212.00
r_i(in)
5.50
h_i (ft)
212.00
r_w(in)
5.50
h_w(ft)
212.00
t_a(days)
245.47
ROW 8
Sigma(I)
0.0005
mu
0.1498
ROW 9
SK(I)
0.0060
epsilon
0.0010
2.0
1.0
0.1
0.0
C / C.max
10.0
100.0
1000.0
10000.0
days since injection
fracture porosity
0.1303
Matrix porosity
0.0001
longitudinal dispersivity (ft)
28.10
ROW 4
BIGT
30.00
METH
3
NN
40
FB(I)
ROW 6
1.00
Gamma(i)
ROW 7
4.21681
N
IQD
ROW 5
1.00
0.00
LOGT
NLC
NOX
ROW 0
1.000
2.000
30.000
TDFIRST
DELTD
TDP
ROW 1
0.100
0.000
0.000079
XMUI
XMUW
0.0197
0.0000
1: Dirac
2: Tophat
INPTRA
NTS
KT
IFLUX
ROW 2
2
10
2
1
PE
RWD
RTARD
XMULT
ROW 3
10.00
0.0016
0.97
0.000
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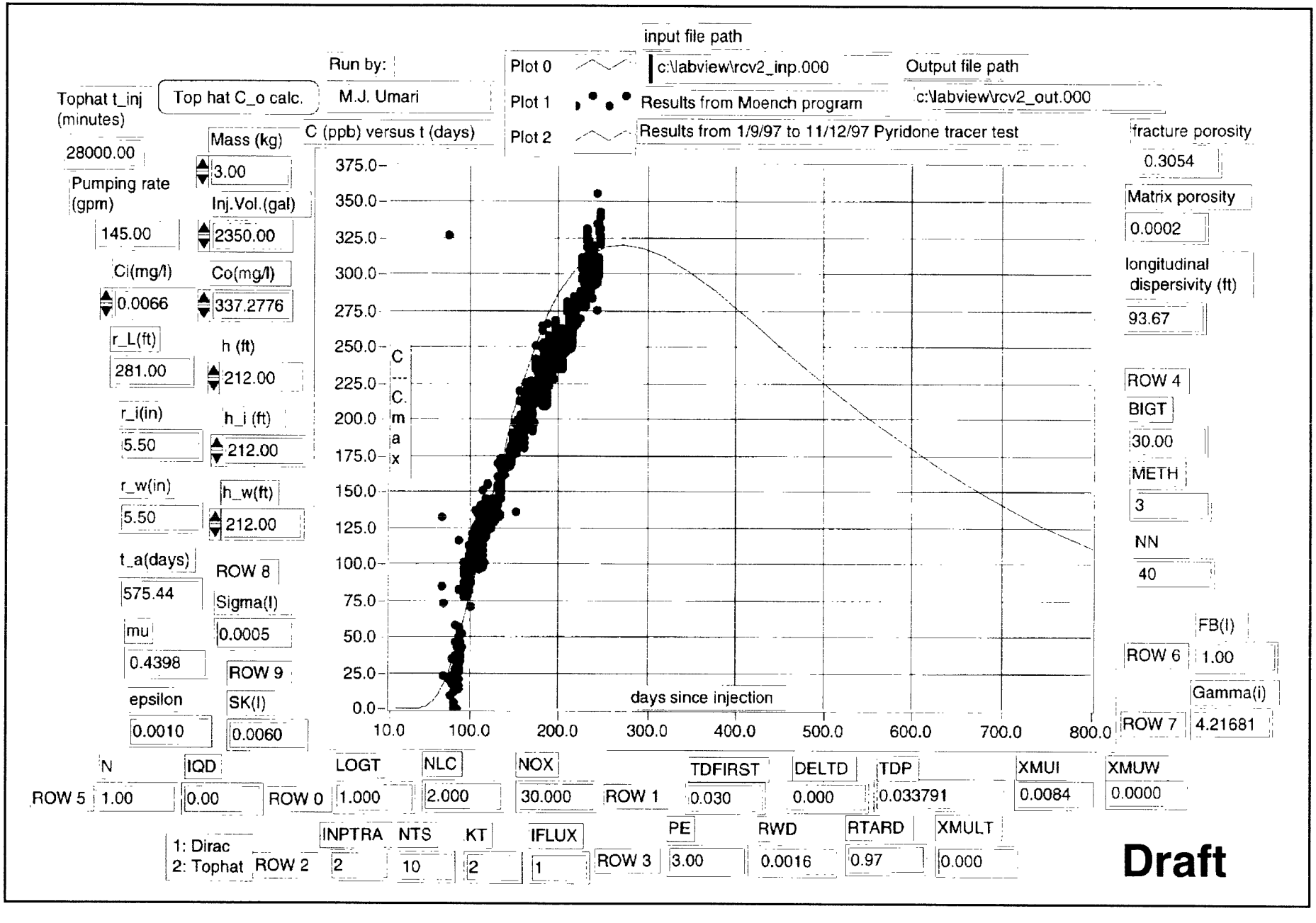
input file path
Run by:
Plot 0
c:\labview\rcv2_inp.000
Output file path
Tophat t_inj (minutes)
Top hat C_o calc.
M.J. Umari
Plot 1
Results from Moench program
c:\labview\rcv2_out.000
C (ppb) versus t (days)
Plot 2
Results from 1/9/97 to 11/12/97 Pyridone tracer test
fracture porosity
0.3054
Mass (kg)
28000.00
3.00
Pumping rate (gpm)
Inj.Vol.(gal)
145.00
2350.00
Matrix porosity
0.0002
Ci(mg/l)
Co(mg/l)
longitudinal dispersivity (ft)
0.0066
337.2776
r_L(ft)
h (ft)
93.67
281.00
212.00
ROW 4
r_i(in)
h_i (ft)
BIGT
5.50
212.00
30.00
r_w(in)
h_w(ft)
METH
5.50
212.00
3
t_a(days)
ROW 8
NN
575.44
Sigma(l)
40
mu
0.0005
FB(l)
0.4398
ROW 6
1.00
ROW 9
Gamma(i)
epsilon
SK(l)
ROW 7
4.21681
0.0010
0.0060
C
C.max
days since injection
375.0
350.0
325.0
300.0
275.0
250.0
225.0
200.0
175.0
150.0
125.0
100.0
75.0
50.0
25.0
0.0
10.0
100.0
200.0
300.0
400.0
500.0
600.0
700.0
800.0
N
IQD
LOGT
NLC
NOX
TDFIRST
DELTD
TDP
XMUI
XMUW
ROW 5
1.00
0.00
ROW 0
1.000
2.000
30.000
ROW 1
0.030
0.000
0.033791
0.0084
0.0000
1: Dirac
2: Tophat
INPTRA
NTS
KT
IFLUX
PE
RWD
RTARD
XMULT
ROW 2
2
10
2
1
ROW 3
3.00
0.0016
0.97
0.000
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	UE-25 c#2 IODIDE	UE-25 c#2 PFBA1	UE-25 c#2 DFBA	UE-25 c#1 PYRIDONE
Mass injected (kg)	5.0 (Iodide)	10.08 kg	11.35 kg	3.02 kg
Mass recovered [kg/ (%)]	2.347 (47%)	7.0 (69%)	7.598 (67%)	0.036 no peak (10/20/97) (1.2%)
Breakthrough (days)	5.07	2.51	5.07	56.3
Peak Conc. (ug/L)	99.5	350	251	0.392 maximum (10/20/97)
Peclet Number	11	11	12-15	10/3
Dispersivity (m)	2.6	2.6	2.4-1.9	8.56/28.5
Flow porosity (%)	8.6	6.0	9.9-7.2	13/30
Matrix porosity (%)	19	6.38	8.8-13.2	.01/.02

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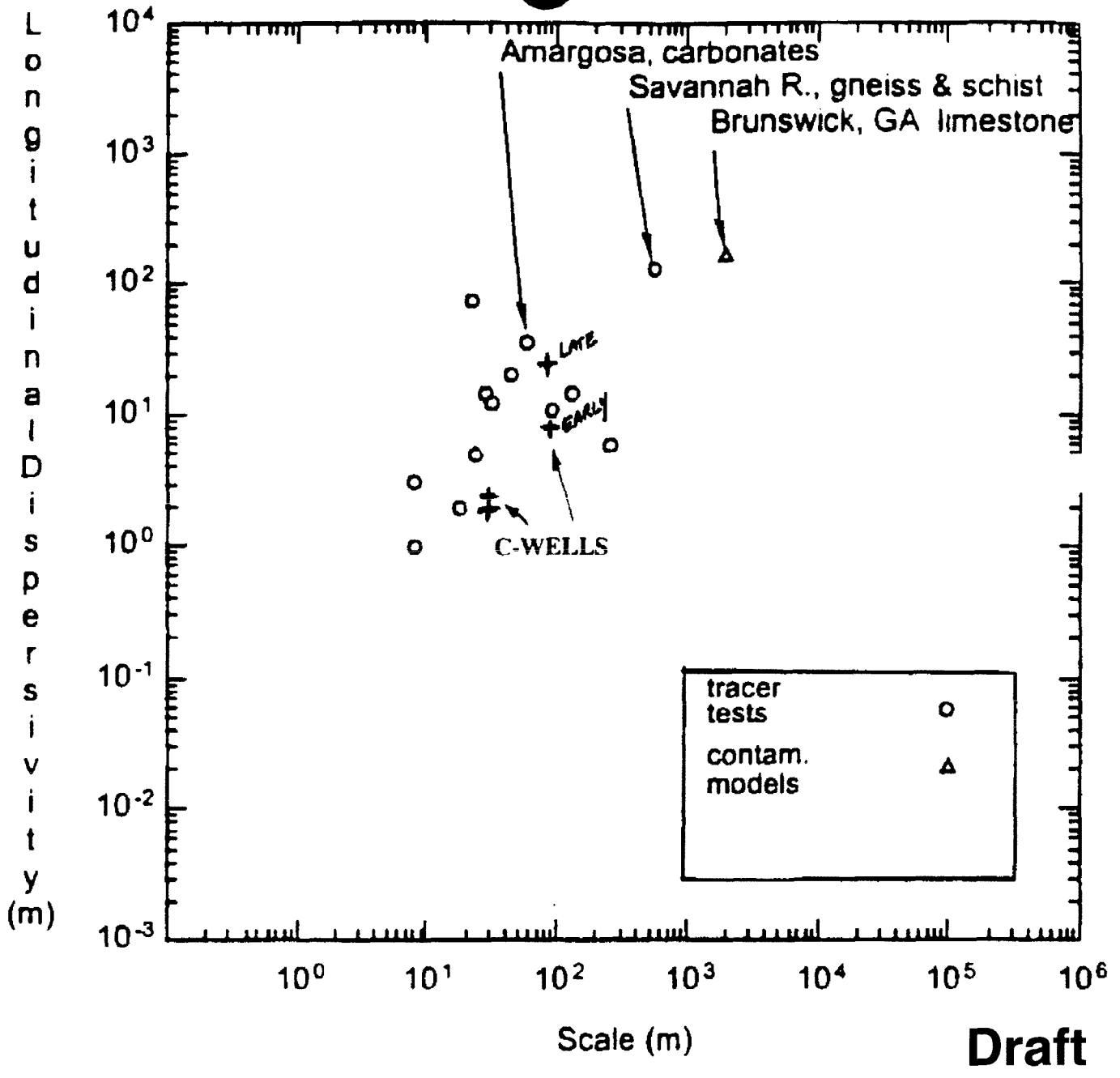
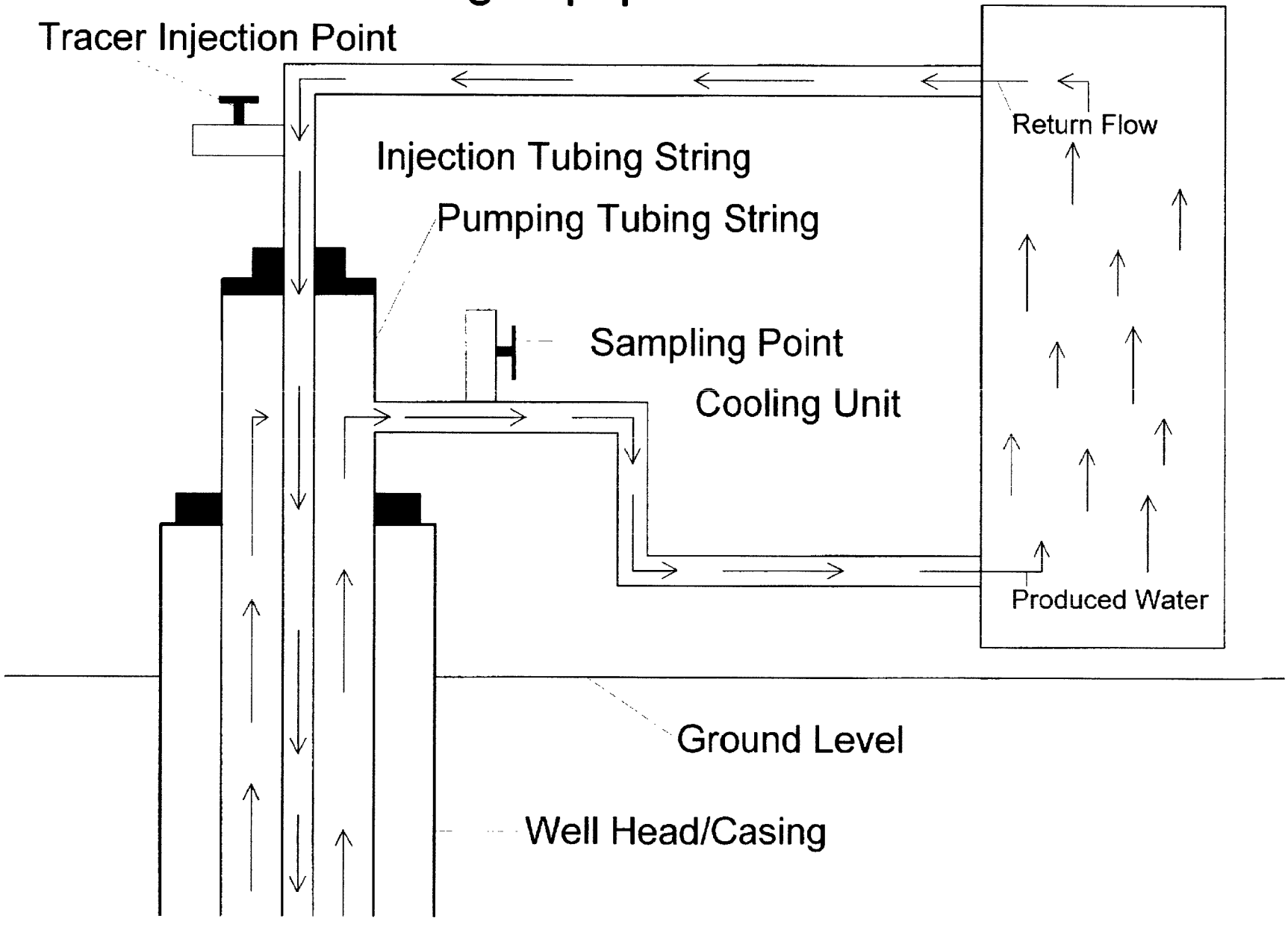

Longitudinal Dispersivity (m)
10^4
10^3
10^2
10^1
10^0
10^{-1}
10^{-2}
10^{-3}
Amargosa, carbonates
Savannah R., gneiss & schist
Brunswick, GA limestone
LATE
EARLY
C-WELLS
tracer tests
contam. models
10^0
10^1
10^2
10^3
10^4
10^5
10^6
Scale (m)

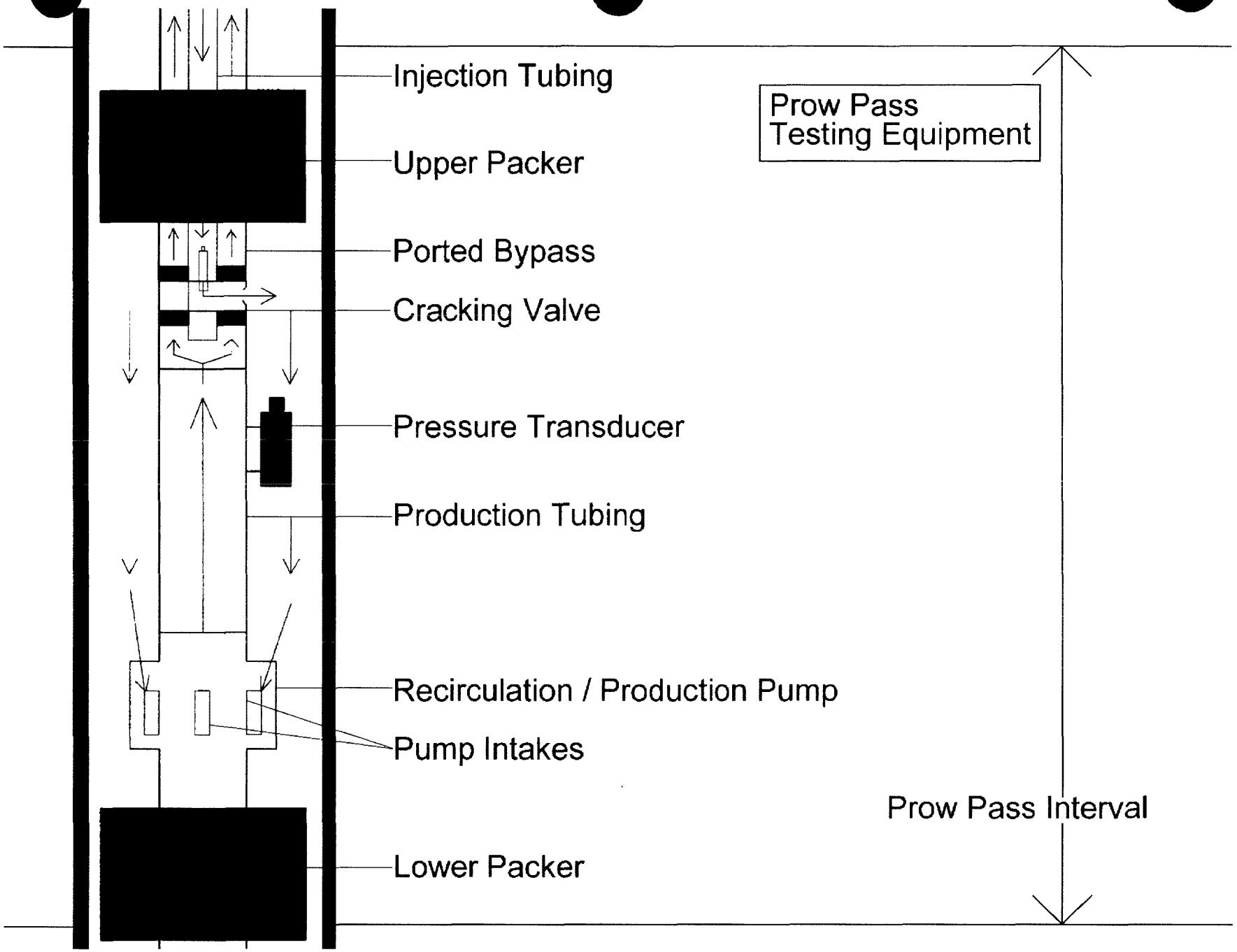
Draft

Future Testing Plans at the C-holes

- Prow Pass Hydraulic and Conservative Tracer Testing
  - Prow Pass is Low-Flow Zone: With Bullfrog Gives Range in Hydraulic and Transport Parameters
  - One of First Horizons to be Reached by Radionuclides from Breached Repository
  - Special Equipment Designed for Test
  - Reinstrumentation Complete by 2/98; Start Testing in 3/98
- Hydraulic and Tracer Testing in Paintbrush Canyon Fault at C-holes
  - Deferred to FY99 Because of Budget
  - Will provide hydraulic and transport parameters for a fault in the SZ: critical for explicitly representing faults in SZ flow and transport models
- Conduct hydraulic and conservative tracer testing at other locations near Yucca Mountain

Prow Pass Testing Equipment




Injection Tubing
Upper Packer
Ported Bypass
Cracking Valve
Pressure Transducer
Production Tubing
Recirculation / Production Pump
Pump Intakes
Lower Packer
Prow Pass
Testing Equipment
Prow Pass Interval

Summary

- Variations in major constituent concentrations in saturated zone waters in volcanic units unlikely to have major impact on transport parameters.
- Variations in climate are unlikely to have significant impact on the chemistry of saturated zone waters along flowlines from recharge areas through Yucca Mountain to Amargosa Valley.
- Water from well J-13 can be used in laboratory experiments to represent saturated zone waters in volcanic units. The experiments should be carried out over a range of pH conditions.
- The redox potential of saturated zone waters may be sufficiently low to stabilize the less mobile forms of several important radionuclides.