Area Characterization

Appendices

Appendix A: Ground Water Quality Parameters List

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East King County
Ground Water Management Plan

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Area Characterization

Appendix A

Ground Water Quality Parameters List

East King County
Ground Water Management Plan

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A.2: Sampling parameters

BIOLOGICAL/PHYSICAL/INORGANIC PARAMETERS

PARAMETER	UNIT	DETECTION LIMIT	PREFERRED METHOD
BIOLOGICAL			
Total Coliforms	Cellular Units/100ml	1	MF
Fecal Coliforms	Cellular Units/100ml	1	MF
PHYSICAL			
Total Dissolved Solids	mg/L	1	EPA 160.1
Total Hardness, $CaCO_3$	mg/L	1	EPA 130.2
Alkalinity			
Bicarbonate	mg/L	1	EPA 310.1
Carbonate	mg/L	1	EPA 310.1
INORGANIC			
Calcium	mg/L	0.10	EPA 200.7
Iron	mg/L	0.01	EPA 200.7
Manganese	mg/L	0.002	EPA 200.7
Magnesium	mg/L	0.10	EPA 200.7
Potassium	mg/L	1.0	EPA 200.7
Sodium	mg/L	0.5	EPA 200.7
Chloride	mg/L	1.0	EPA 325.2
Nitrate-N	mg/L	0.01	EPA 353.2
Silica	mg/L	0.1	EPA 200.7
Sulfate	mg/L	1.0	EPA 375.4
Zinc	mg/L	0.002	EPA 200.7
Silver	mg/L	0.01	EPA 200.7
Selenium	mg/L	0.001	EPA 270.2
Mercury	mg/L	0.0002	EPA 245.1
Fluoride	mg/L	0.02	EPA 340.2
Barium	mg/L	0.003	EPA 200.7
Copper	mg/L	0.002	EPA 200.7
Cadmium	mg/L	0.002	EPA 200.7
Lead	mg/L	0.001	EPA 239.2
Chromium	mg/L	0.006	EPA 200.7
Arsenic	mg/L	0.001	EPA 206.2

VOLATILE ORGANIC COMPOUNDS with MCLs
EPA METHOD 524.2

COMPOUND	DETECTION LIMIT µg/L	MCL µg/L
Vinyl Chloride	0.5	2
1,1-Dichloroethylene	0.5	7
1,1,1-Trichloroethane	0.5	200
Carbon Tetrachloride	0.5	5
Benzene	0.5	5
1,2-Dichloroethane	0.5	5
Trichloroethylene	0.5	5
p-Dichlorobenzene	0.5	75
Chlorobenzene	0.5	100
1,2-Dichlorobenzene	0.5	600
C-1,2-Dichloroethylene	0.5	70
T-1,2-Dichloroethylene	0.5	100
1,2-Dichloropropane	0.5	5
Ethylbenzene	0.5	700
Styrene	0.5	100
Tetrachloroethylene	0.5	5
Toluene	0.5	1000
Total Xylenes	0.5	10000
m + p-Xylenes	0.5	---
o-Xylenes	0.5	---
Ethylene Dibromide	0.5	0.05
1,2-Dibromo-3-Chloropropane	0.5	0.2
Methylene Chloride	0.5	5
1,2,4-Trichlorobenzene	0.5	70
1,1,2-Trichloroethane	0.5	5
Total Trihalomethanes	0.5	100
Chloroform (THM)	0.5	---
Bromodichloromethane (THM)	0.5	---
Chlorodibromomethane (THM)	0.5	---
Bromoform (THM)	0.5	---

MCL = Maximum Contaminant Level

VOLATILE ORGANIC COMPOUNDS without MCLs
EPA METHOD 524.2

COMPOUND	DETECTION LIMIT µg/L
Chloromethane	0.5
Bromomethane	0.5
Chloroethane	0.5
1,1-Dichloroethane	0.5
2,2-Dichloropropane	0.5
1,1-Dichloropropene	0.5
C-1,3-Dichloropropene	0.5
T-1,3-Dichloropropene	0.5
1,3-Dichloropropane	0.5
1,1,1,2-Tetrachloroethane	0.5
Bromobenzene	0.5
1,2,3-Trichloropropane	0.5
1,1,2,2-Tetrachloroethane	0.5
o-Chlorotoluene	0.5
p-Chlorotoluene	0.5
Dibromomethane	0.5
m-Dichlorobenzene	0.5
o-Dichlorobenzene	0.5
Dichlorodifluoromethane	0.5
Trichlorofluoromethane	0.5
Bromochloromethane	0.5
Isopropylbenzene	0.5
N-Propylbenzene	0.5
1,3,5-Trimethylbenzene	0.5
Tert-Butylbenzene	0.5
1,2,4-Trimethylbenzene	0.5
Sec-Butylbenzene	0.5
P-Isopropyltoluene	0.5
N-Butylbenzene	0.5
Napthalene	0.5
Hexachlorobutadiene	0.5
1,2,3-Trichlorobenzene	0.5

SEMI-VOLATILES BY GC/MS
EPA METHOD 625

COMPOUNDS	DETECTION LIMITS µg/L
N-Nitrosodimethylamine	5
Aniline	2
Phenol	2
bis(2-Chloroethyl)ether	2
2-Chlorophenol	2
1,3-Dichlorobenzene	2
1,4-Dichlorobenzene	2
Benzyl Alcohol	2
2-Methylphenol	2
bis(2-Chloroisopropyl)ether	2
4-Methylphenol	2
N-Nitroso-di-n-dipropylamine	2
Hexachloroethane	2
Nitrobenzene	2
Isophorone	2
2-Nitrophenol	5
2,4-Dimethylphenol	2
Benzoic Acid	5
bis(2-Chloroethoxy)methane	2
2,4-Dichlorophenol	2
1,2,4-Trichlorobenzene	2
Naphthalene	2
4-Chloroaniline	2
Hexachlorobutadiene	2
4-Chloro-3-Methylphenol	2
2-Methylnaphthalene	2
Hexachlorocyclopentadiene	5
2,4,6-Trichlorophenol	2
2,4,5-Trichlorophenol	2
2-Chloronaphthalene	2
2-Nitroaniline	5
Dimethylphthalate	2
Acenaphthylene	2
2,4-Dinitrotoluene	5

SEMI-VOLATILES (continued)

3-Nitroaniline	5
Acenaphthene	2
2,4-Dinitrophenol	10
4-Nitrophenol	5
Dibenzofuran	2
2,4-Dinitrotoluene	5
Diethylphthalate	2
4-Chlorophenyl-phenyl ether	2
Fluorene	2
4-Nitoaniline	5
4,6-Dinitro-2-methylphenol	5
N-Nitrosodiphenylamine	2
Azobenzene	2
4-Bromophenyl-phenyl ether	2
Hexachlorobenzene	2
Pentachlorophenol	5
Phenanthrene	2
Anthracene	2
Di-n-butylphthalate	2
Fluoranthene	2
Benzidine	50
Pyrene	2
Butylbenzylphthalate	2
3,3-Dichlorobenzidine	3
Benzo(a)anthracene	2
Chrysene	2
bis(2-Tehylhexyl)phthalate	2
Di-n-octylphthalate	2
Benzo(b)fluoranthene	2
Benzo(k)fluoranthene	2
Benzo(a)pyrene	2
Indeno(1,2,3-cd)pyrene	4
Dibenzo(a,by)anthracene	4
Benzo(g,h,i)perylene	4

The above detection limits are based on "clean" samples. Dilution may be required for exceptionally dirty samples.

PESTICIDES/PCBs
EPA METHOD 508

CHLORINATED PESTICIDES	DETECTION LIMITS µg/L	MCL µg/L
Alachlor	0.05	
Aldrin	0.04	
Atrazine	0.6	
HCH-alpha	0.03	
HCH-beta	0.06	
HCH-delta (a)	0.09	
HCH-gamma (Lindane)	0.04	4
Butachlor	0.1	
Chlorobenzilate	Qualitative	
Chlordane	0.5	2
Chlordane-alpha		
Chlordane-gamma		
Chloroneb		
Chlorothalonil		
4,4-DDD	0.05	
4,4-DDE	0.04	
4,4-DDT	0.10	
Dieldrin	0.04	
Endosulfan II	0.05	
Endosulfan I	0.04	
Endosulfan Sulfate	0.08	
Endrin Aldehyde	0.1	
Endrin	0.05	0.2
Etridiazole		
Heptachlor Epoxide	0.03	0.2
Heptachlor	0.03	0.4
Hexachlorobenzene	0.004	
Hexachlorocyclo-pentadiene	0.004	
Methoxychlor	0.2	40
Metolachlor	0.1	
Metribuzin	0.01	
C-Permethrin		
T-Permethrin		
Propachlor	0.2	

PESTICIDES/PCBS (continued)

Simazine	1	
Toxaphene	5.0	5
Trifluralin		

POLYCHLORINATED BIPHENYLS

PCB-1016	0.5	0.5
PCB-1221	2.0	0.5
PCB-1232	0.5	0.5
PCB-1242	0.5	0.5
PCB-1248	0.5	0.5
PCB-1254	0.5	0.5
PCB-1260	0.5	0.5

HERBICIDES
EPA METHOD 515.1

COMPOUNDS	DETECTION LIMITS µg/L	MCL µg/L
2,4-D	0.1	70
2,4-DB		
2,4,5-T	0.1	
2,4,5-TP (Silvex)	0.1	50
3,5-Dichlorobenzoic Acid		
4-Nitrophenol		
Acifluorfen		
Bentazon		
Chloramben		
Dalapon	1	200
DCPA (Dacthal)	500	
5-Hydroxydicamba		
Dicamba	1	
Dichlorprop		
Dinoseb		7
Pentachlorophenol (PCP)		
Picloram		500
Tricamba	1	

Area Characterization

Appendix B

Quality Assurance Project Plan/Data Collection and Analysis Plan

December 1994

Available upon request from
King County Department of Natural Resources
Ground Water Management Program

East King County
Ground Water Management Plan

December 1998

Area Characterization

Appendix C

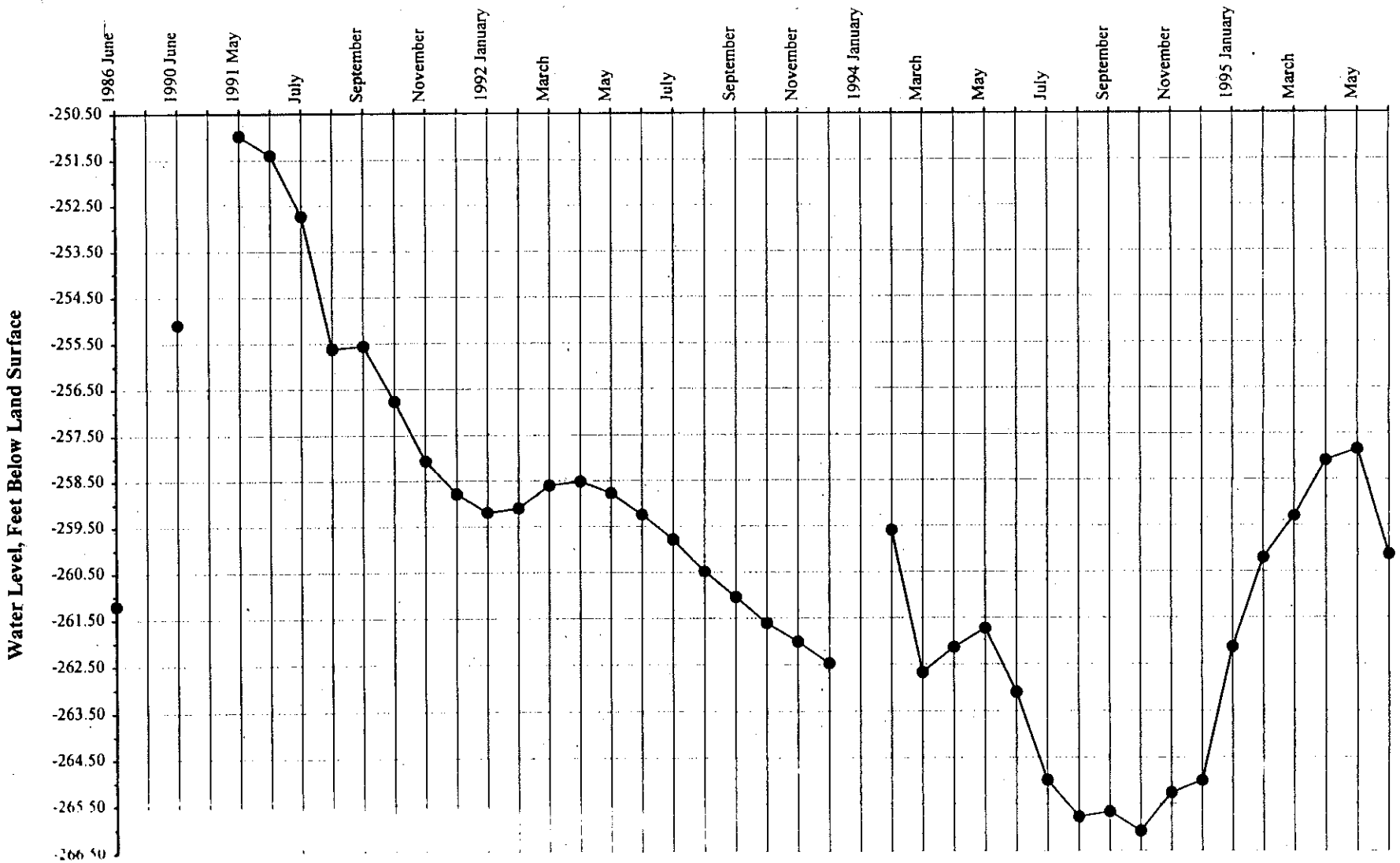
Water Level Monitoring Graphs

East King County
Ground Water Management Plan

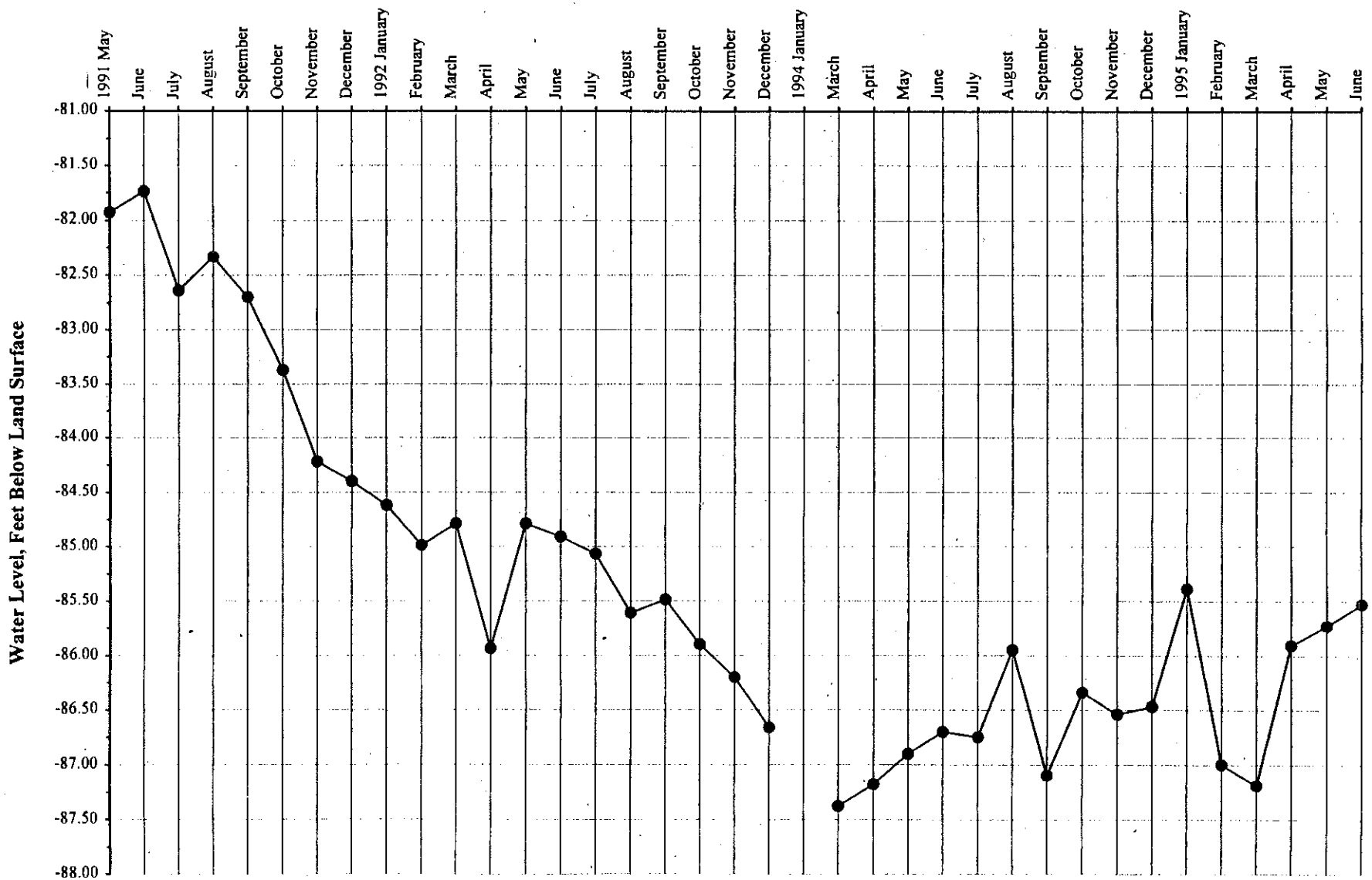
December 1998

Robert Vezzoni, 24N/8E-20M1

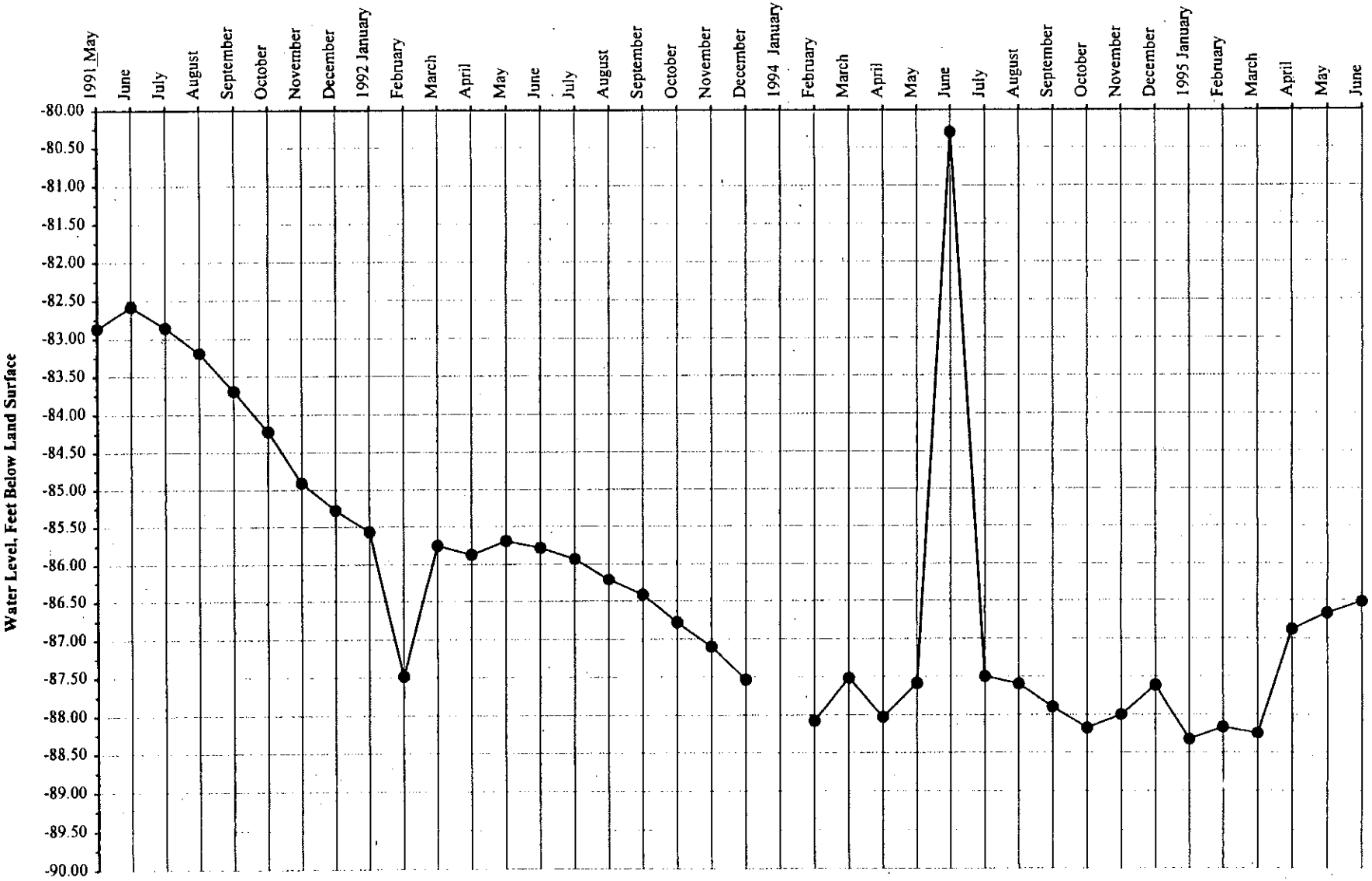
(281 ft., 6 in. casing in Vashon recessional, 5 ft. 12 slot screen at 276 ft., surface ele. 560 ft.)

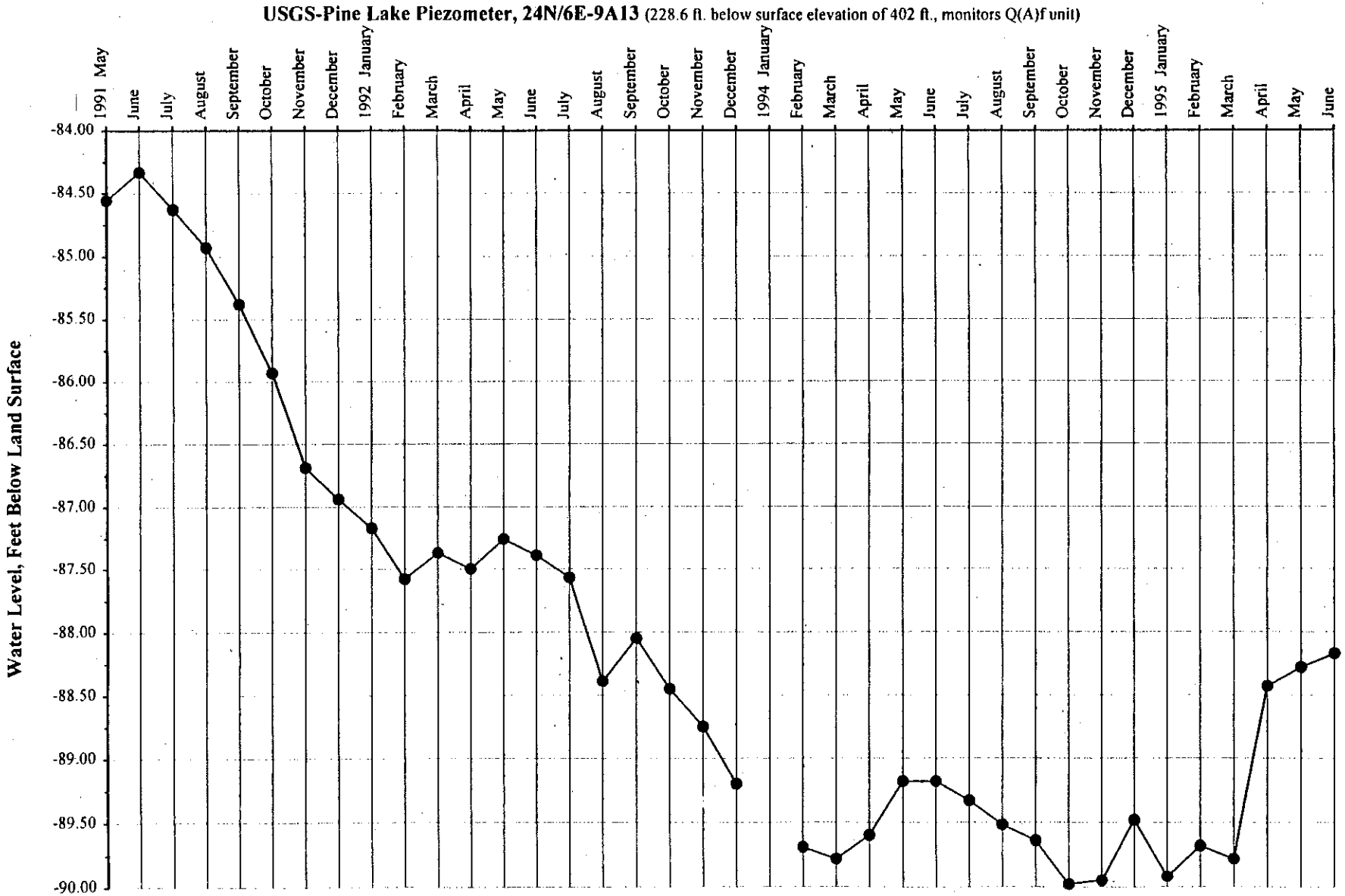


USGS-Pine Lake, 24N/6E-9A15 (piezo depth 170 ft, in the median portion of the Qva unit, surface elevation 402 ft)

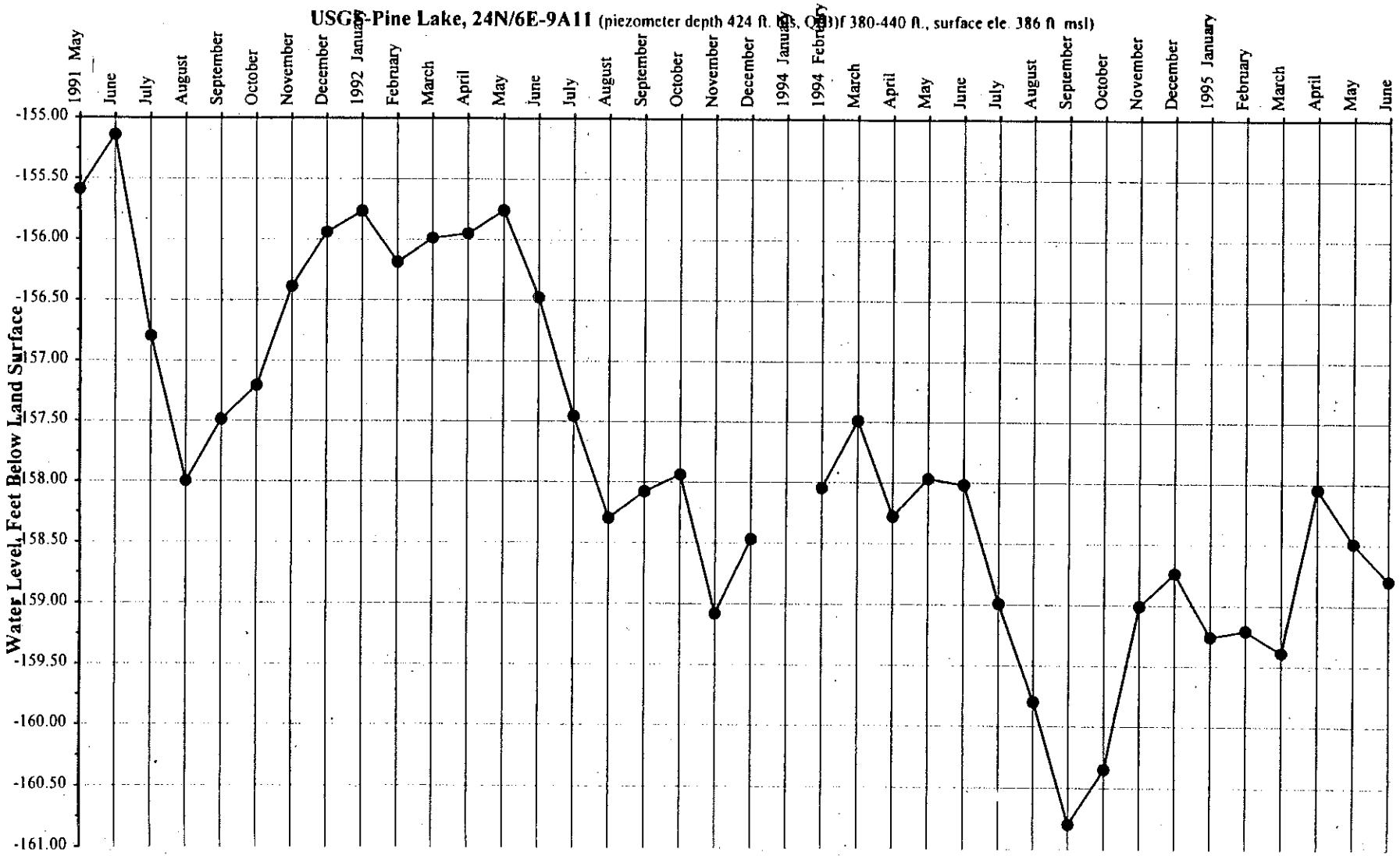


USGS-Pine Lake, 24N/6E-9A14 (piezo depth 203 ft, in the basal portion of Qva, surface elevation 402 ft msl)



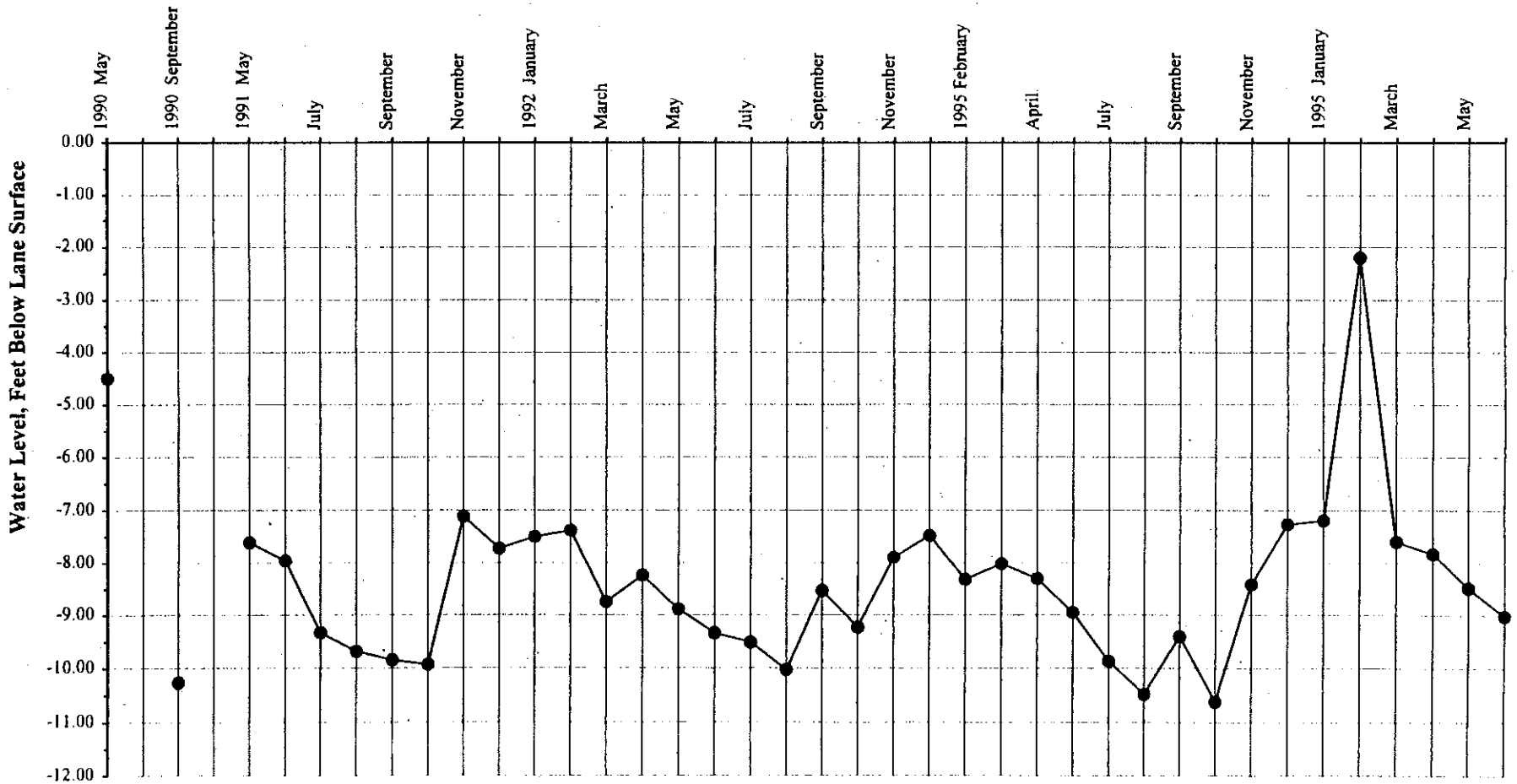

USGS-Pine Lake Piezometer, 24N/6E-9A13 (228.6 ft. below surface elevation of 402 ft., monitors Q(A)f unit)
Water Level, Feet Below Land Surface
-84.00
-84.50
-85.00
-85.50
-86.00
-86.50
-87.00
-87.50
-88.00
-88.50
-89.00
-89.50
-90.00
1991 May
June
July
August
September
October
November
December
1992 January
February
March
April
May
June
July
August
September
October
November
December
1994 January
February
March
April
May
June
July
August
September
October
November
December
1995 January
February
March
April
May
June

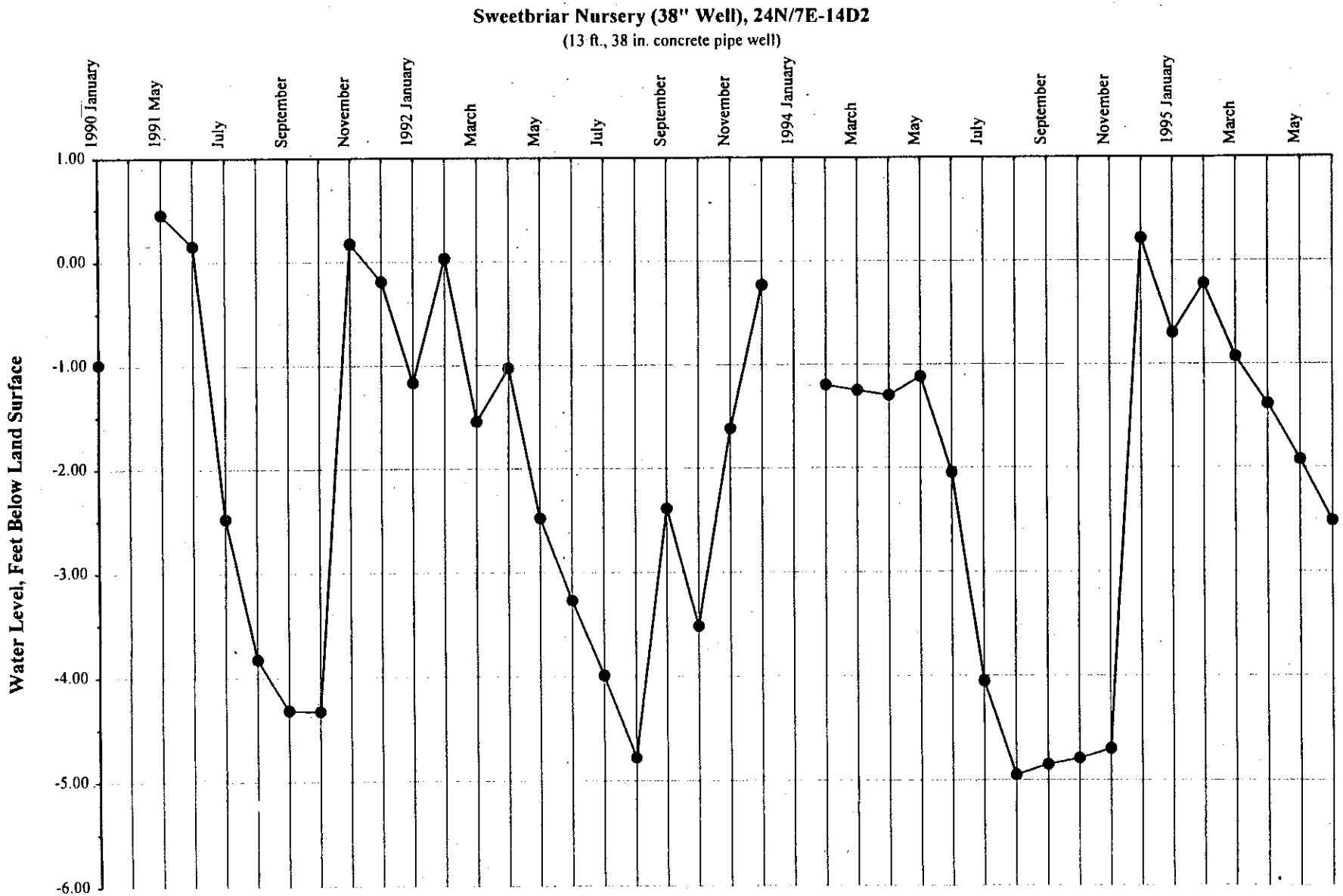
USGS-Pine Lake, 24N/6E-9A12 (piezometer 120.1 ft. below surface elevation of 402 ft msl, Qva formation)
Water Level, Feet Below Land Surface
1991 May
July
September
November
1992 January
March
May
July
September
November
1994 January
March
May
July
September
November
1995 January
March
May
-69.00
-69.50
-70.00
-70.50
-71.00
-71.50
-72.00
-72.50
-73.00
-73.50
-74.00
-74.50
-75.00
-75.50
-76.00
-76.50
-77.00
-77.50
-78.00


USGS-Pine Lake, 24N/6E-9A11 (piezometer depth 424 ft. bls, QB)f 380-440 ft., surface ele. 386 ft msl)
Water Level, Feet Below Land Surface
-155.00
-155.50
-156.00
-156.50
-157.00
-157.50
-158.00
-158.50
-159.00
-159.50
-160.00
-160.50
-161.00
1991 May
June
July
August
September
October
November
December
1992 January
February
March
April
May
June
July
August
September
October
November
December
1994 January
1994 February
March
April
May
June
July
August
September
October
November
December
1995 January
February
March
April
May
June

Roger Thorson, 25N/7E-21C1

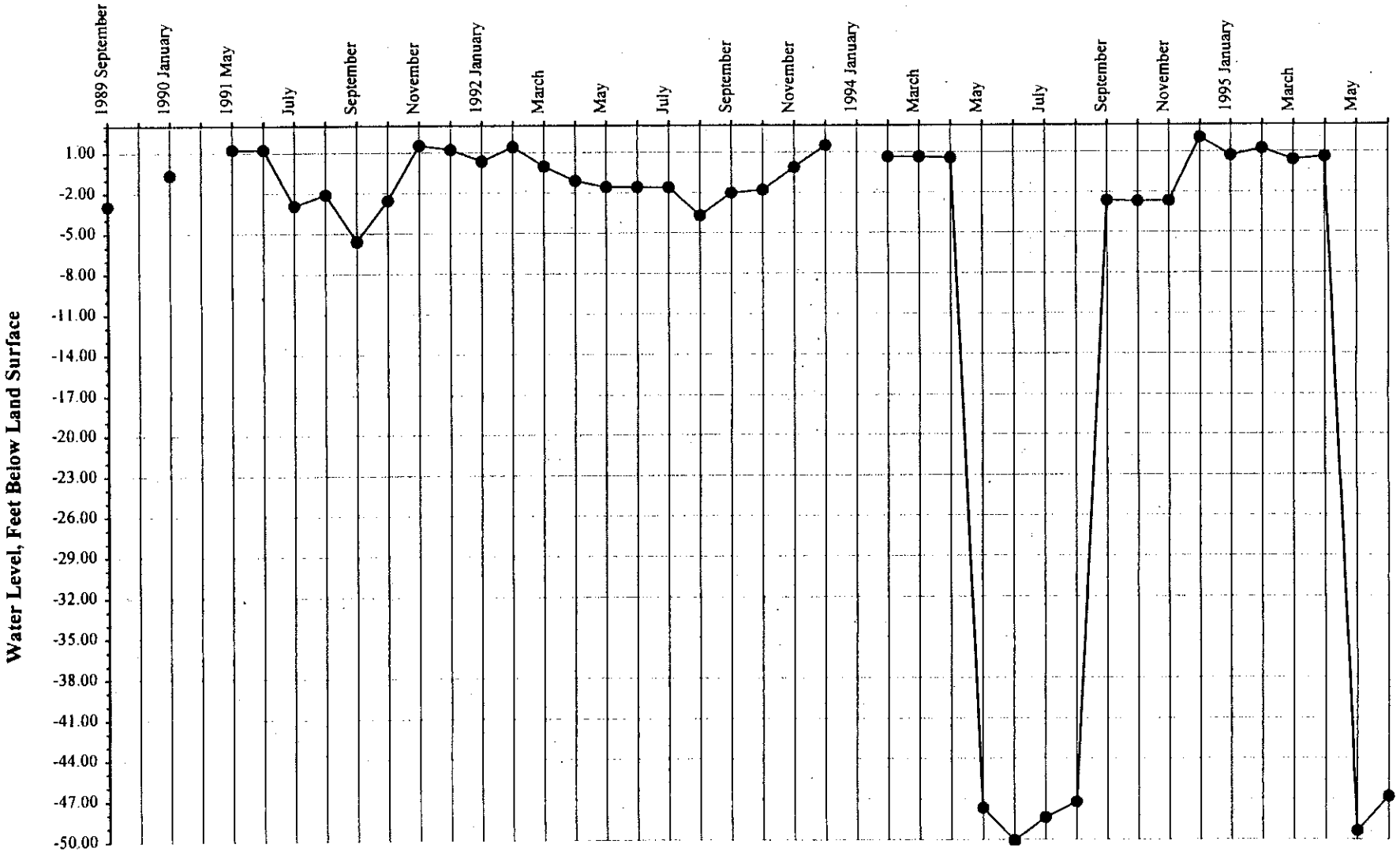
(35ft., 6 inch casing, no screen, Qal formation, surface elevation 70 ft. msl, 30 gallons per minute with zero drawdown after one hour)




Sweetbriar Nursery (38" Well), 24N/7E-14D2
(13 ft., 38 in. concrete pipe well)
Water Level, Feet Below Land Surface
1.00
0.00
-1.00
-2.00
-3.00
-4.00
-5.00
-6.00
1990 January
1991 May
July
September
November
1992 January
March
May
July
September
November
1994 January
March
May
July
September
November
1995 January
March
May

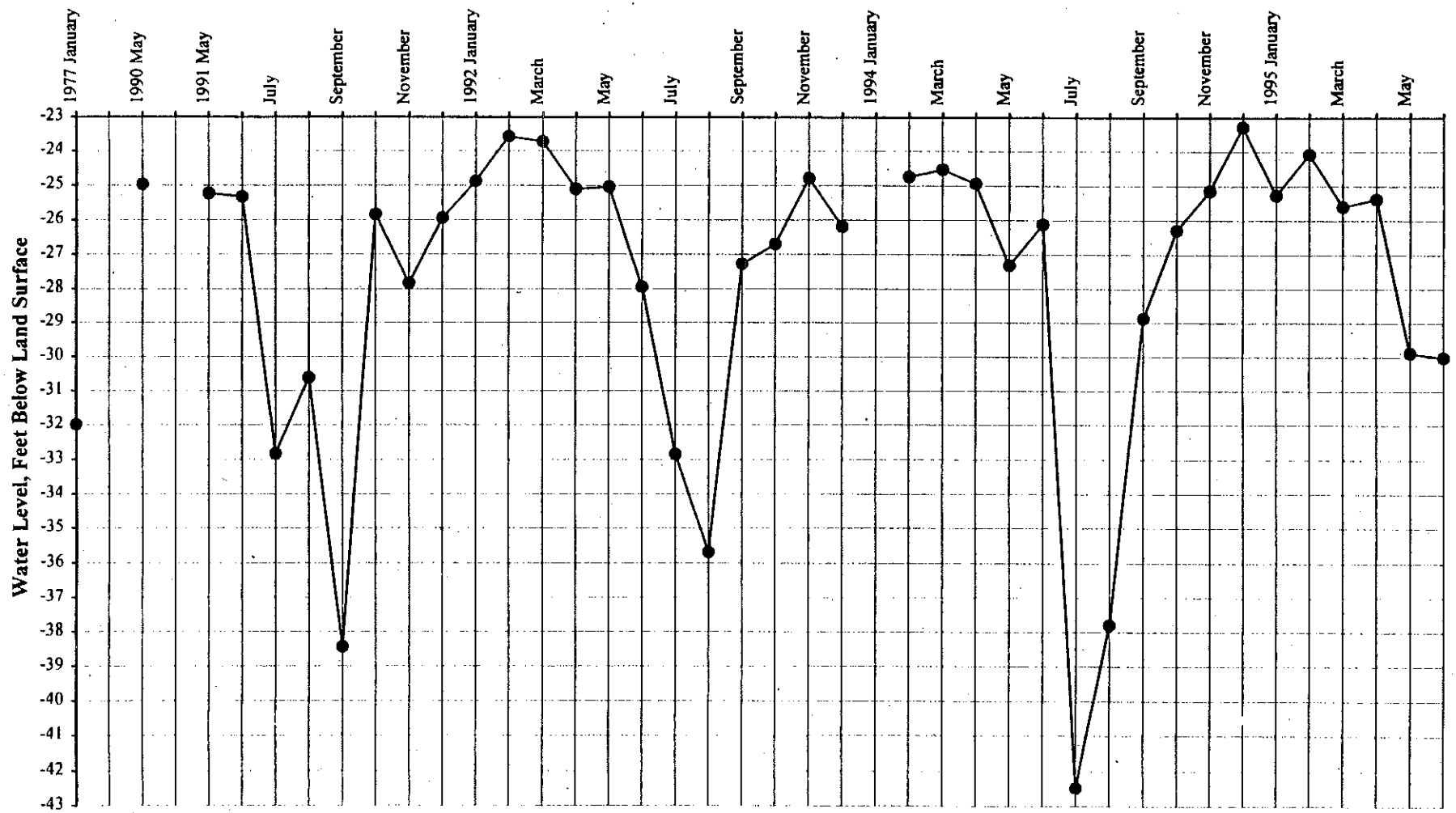
Sweetbriar Nursery (6" Well), 24N/7E-14D1

(well depth 150 ft., Alluvial Sediments, 5 in. diam. 12 slot screen from 135-150 ft bls)



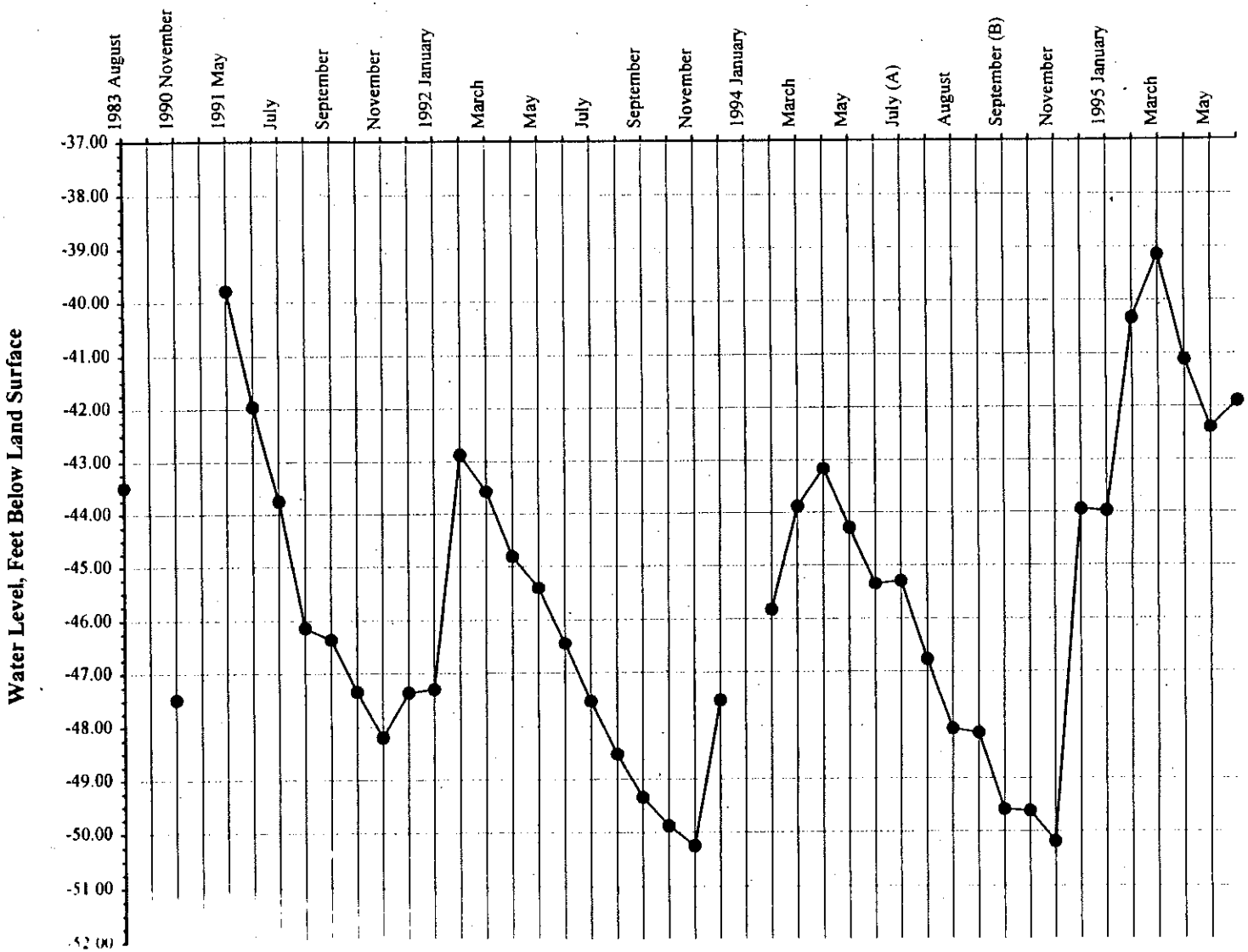
George Sutherland, 25N/6E-20E1

(20 slot screen from 112 to 117 ft bls, and 12 slot from 117 to 122 ft. bls, surface ele. 70 ft msl, Q(B)c formation, 45 gallons per minute with 24 ft drawdown after ? hours)

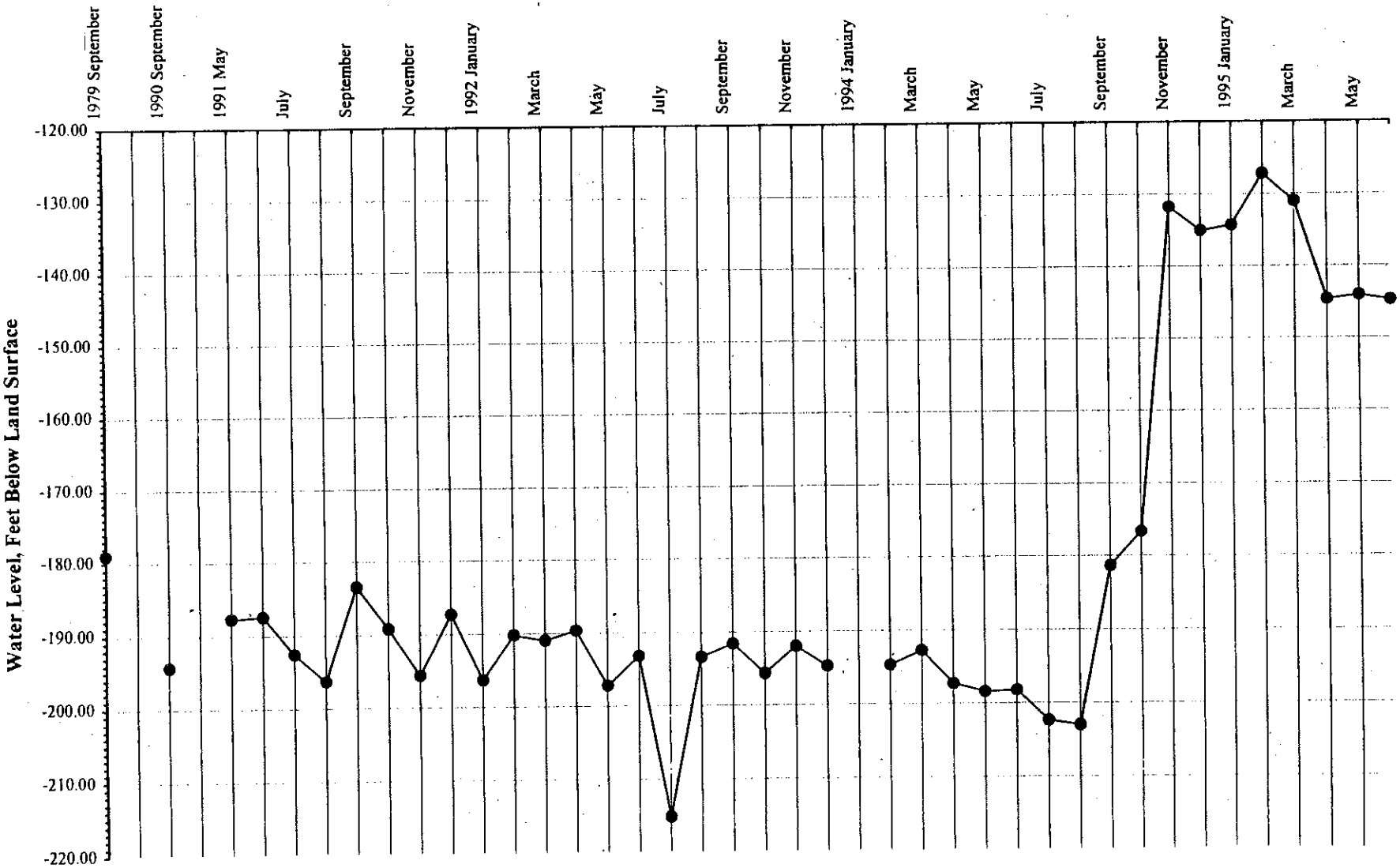


Mr. Stanley Cozad-26N/07E-30P01

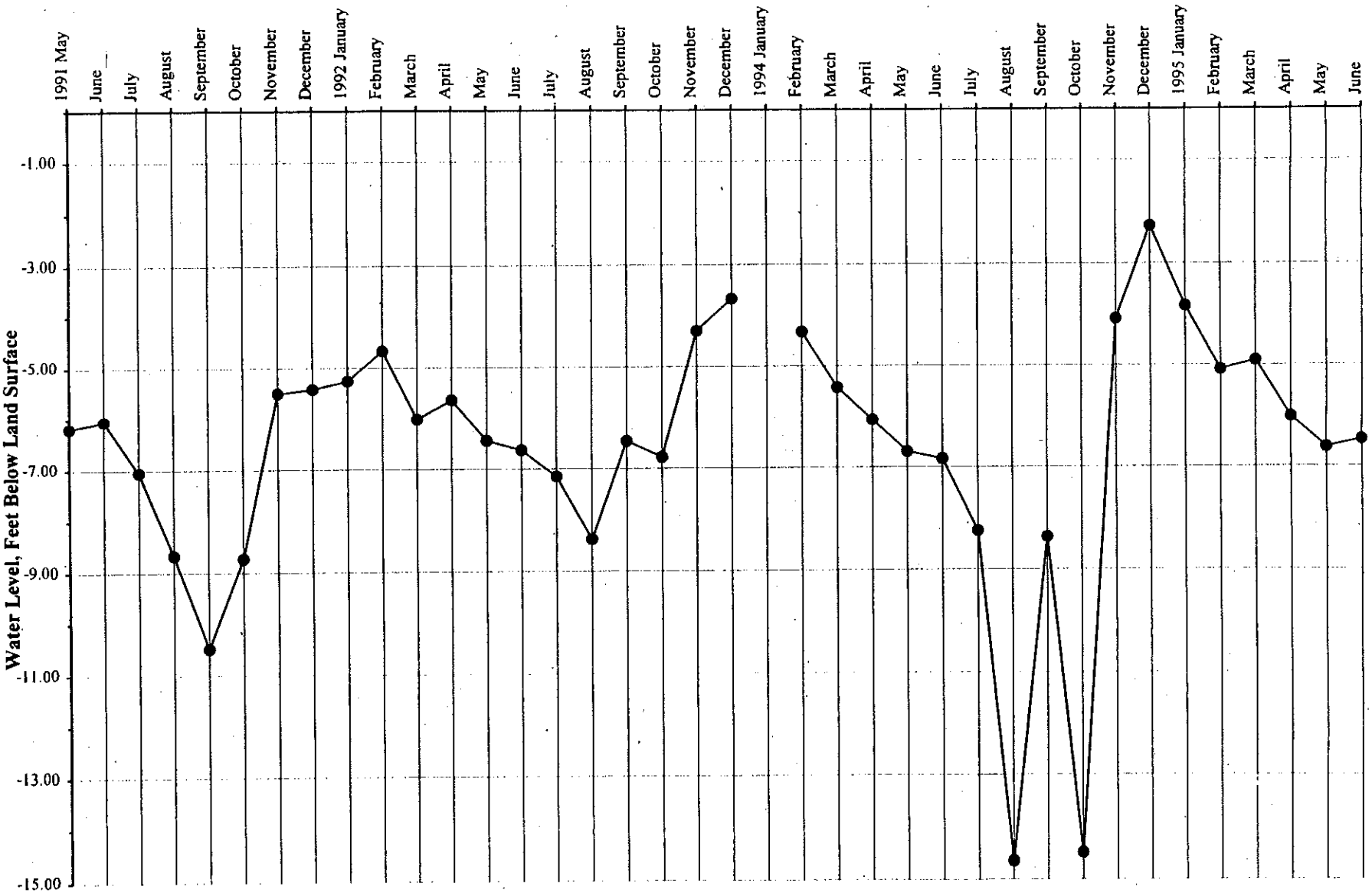
(Qvt formation, 60' depth, surface elevation ~410', bailer test indicated 15 gal/min w/ 2' drawdown after 2hrs)



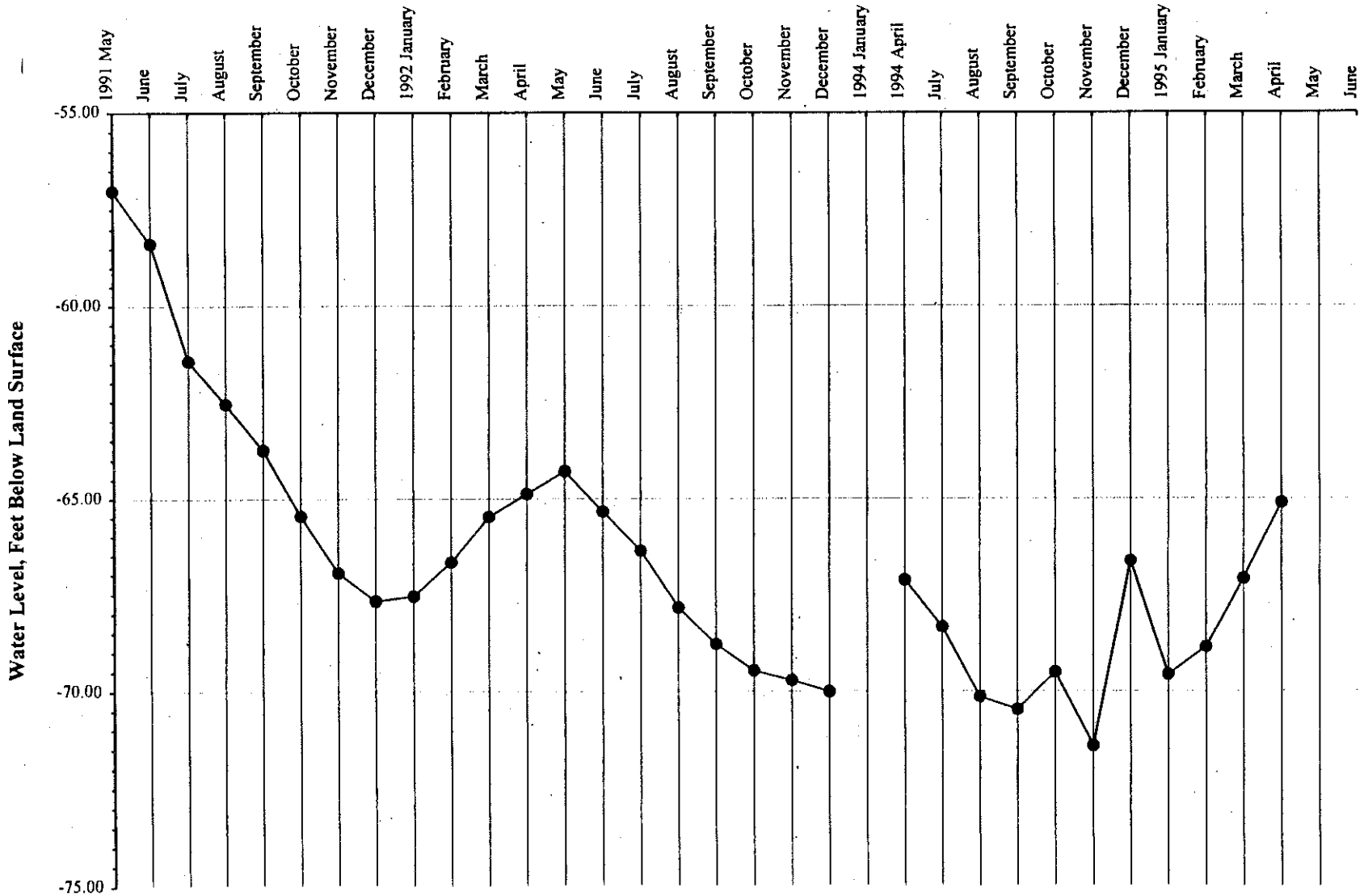
Ben Spiess, 24N/07E-13E01 (398 ft, 8 in. dia., 10 gallons per minute, surface elevation 295 ft msl, fractured basalt at 296 ft below land of casing)



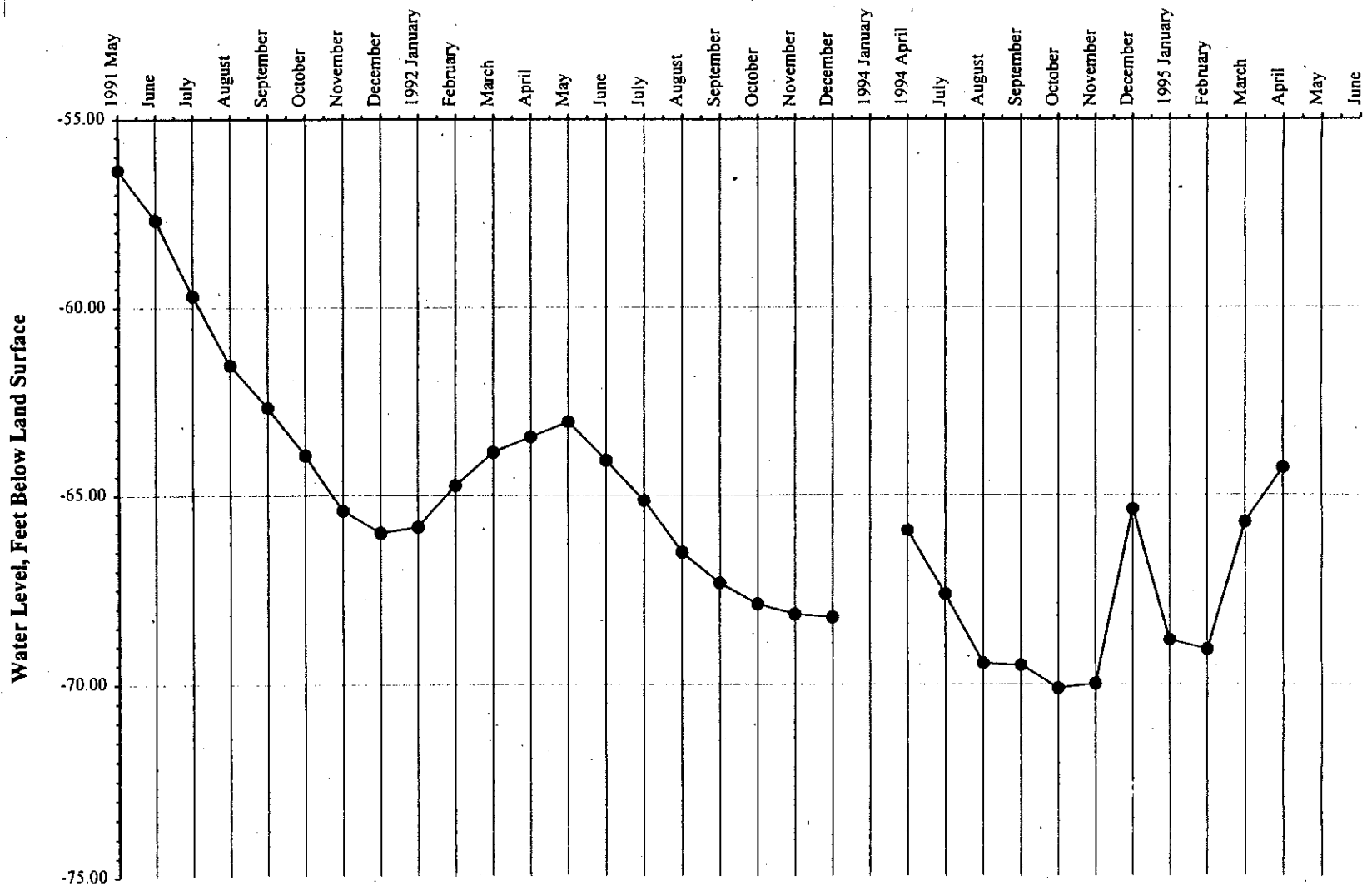
Art Schacklett, 26N/7E-9F2 (30 ft well, black shale, surface elevation ~295 ft, bailer test 3 gal/min with 25 ft drawdown after 1 hour)



Sammamish Plateau Water & Sewer District, 24N/6E-11L1P02 (Qva formation, well depth 95', 2" diameter PVC piezometer, screened from 85'-95', surface elevation ~420' msl)

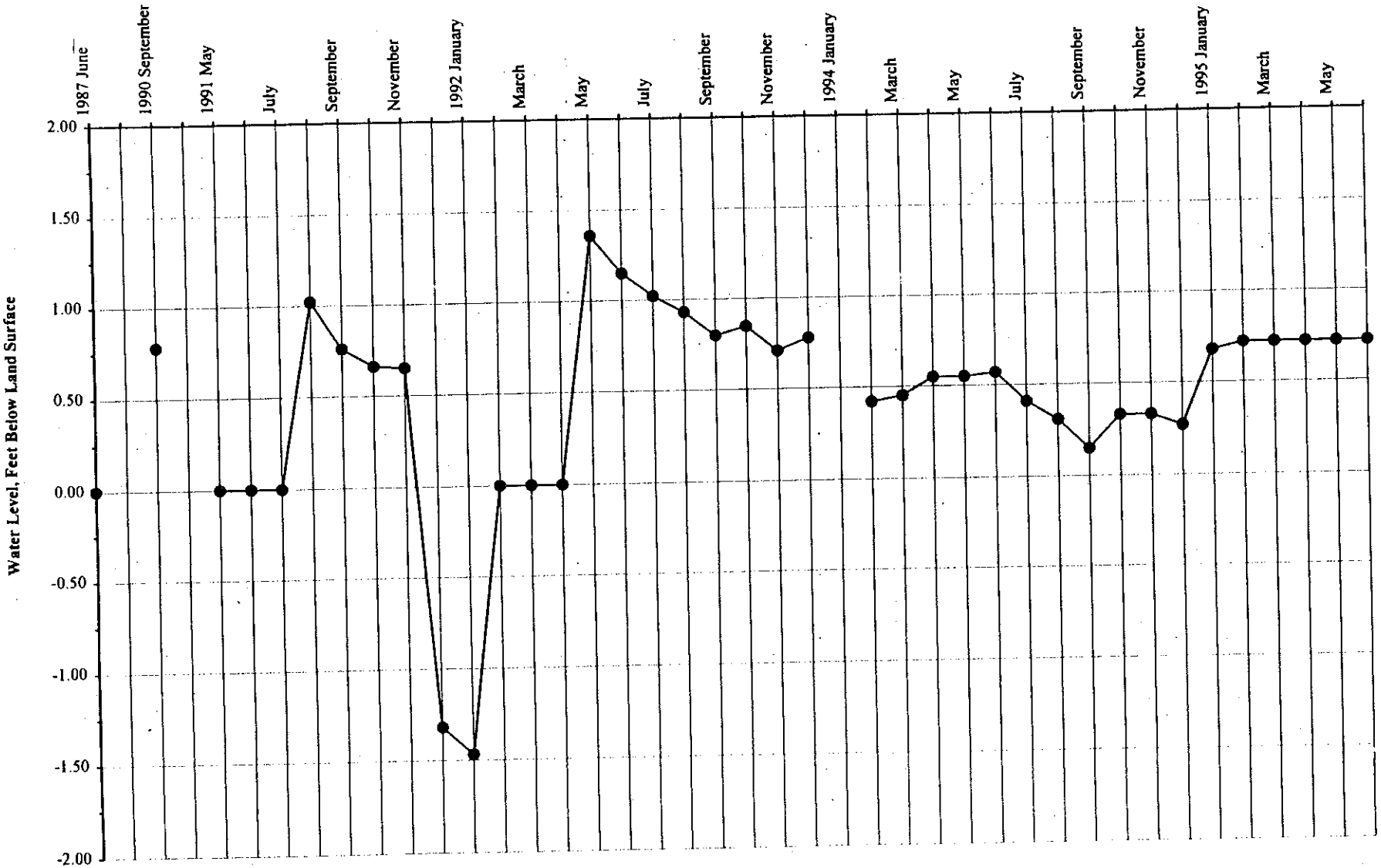


Sammamish Plateau Water & Sewer District, 24N/6E-11L1P01 (Qva formation, well depth 135', 2" diameter PVC piezometer, screened from 125'-135', surface elevation ~420' msl)

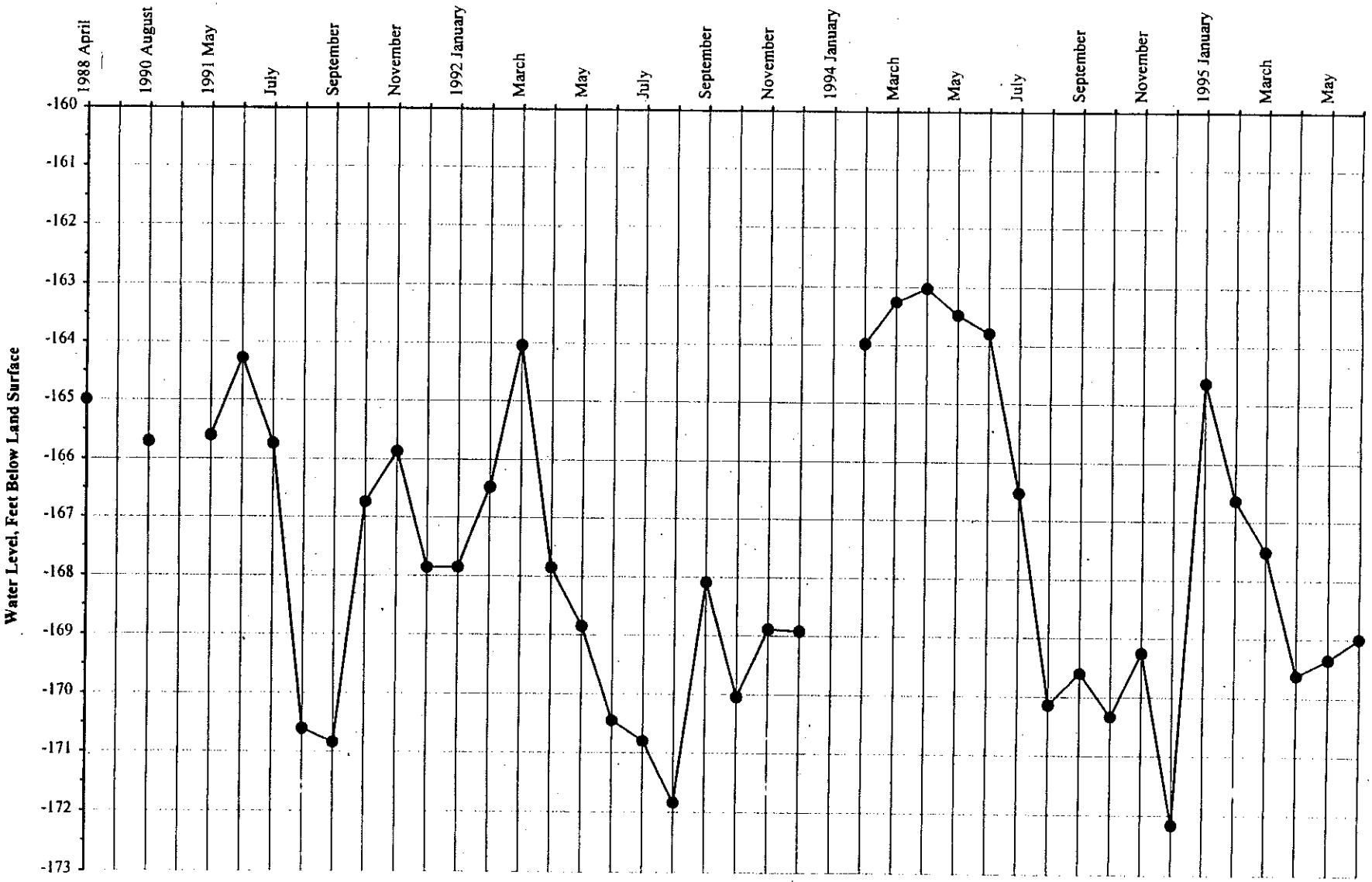


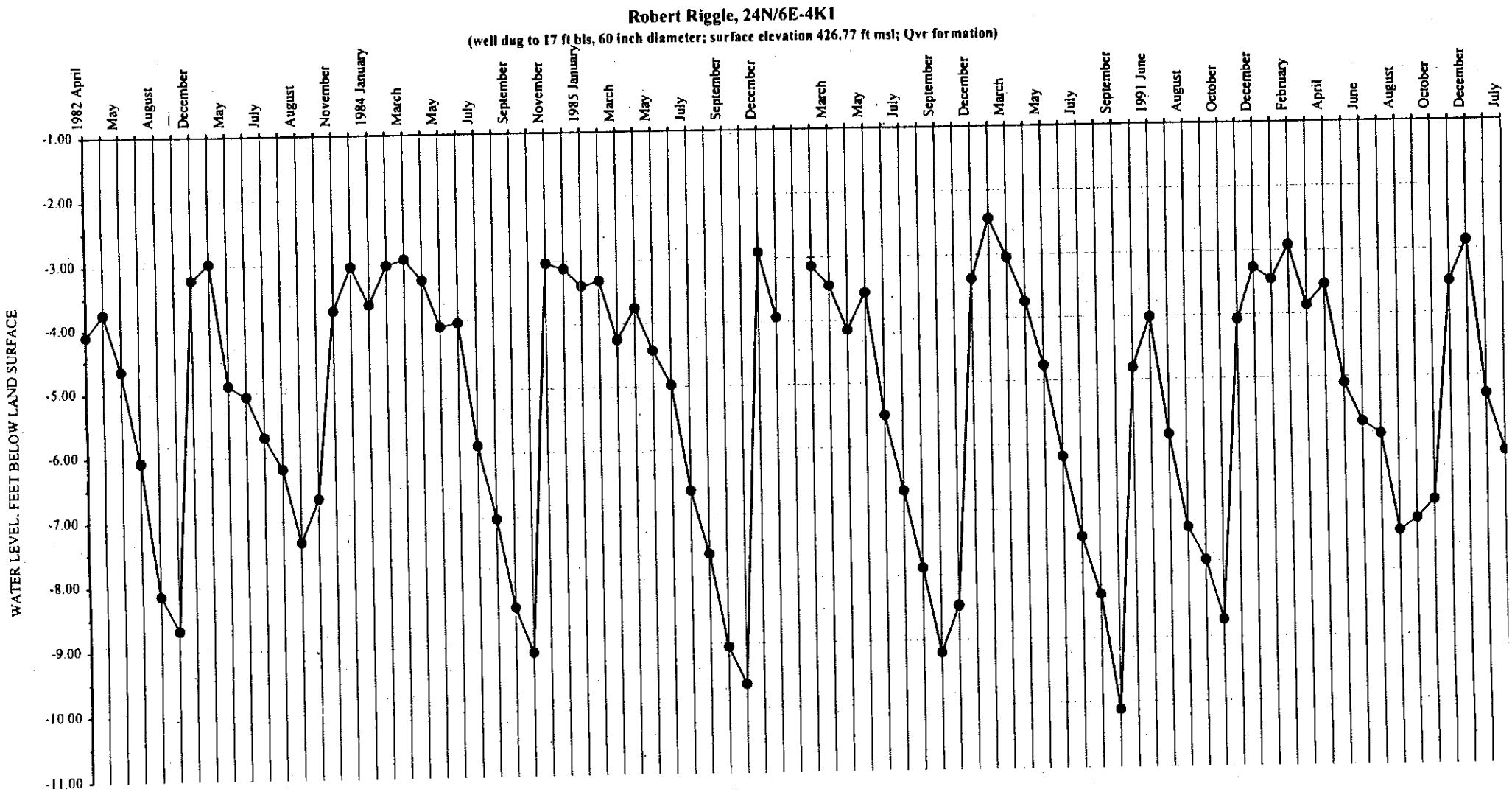
Sammamish Plateau Water & Sewer, 24N/7E-8F2

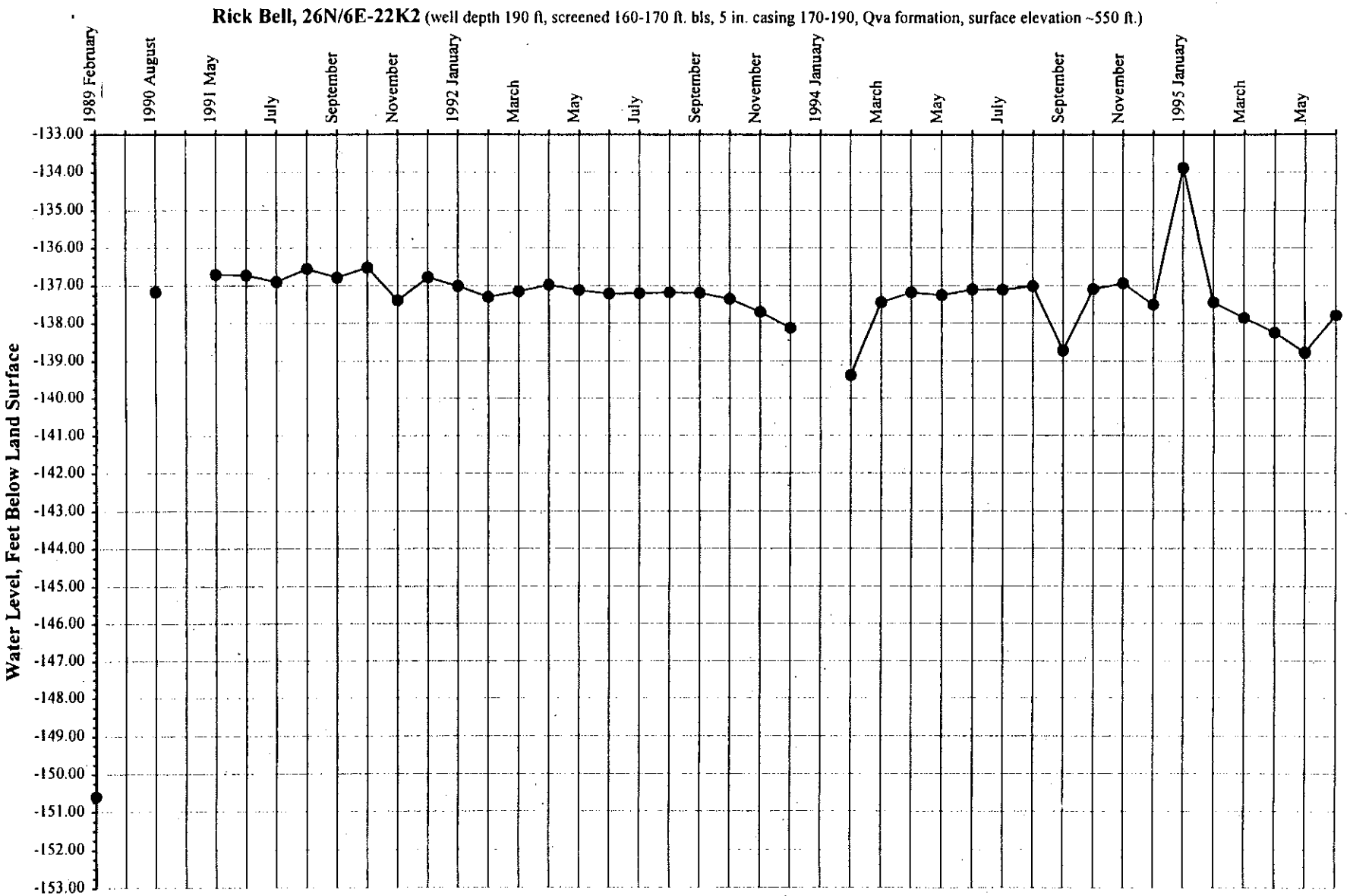
(888 ft depth, confined multiple aquifers, Q(B)c formation, surface elevation 90 ft msl)



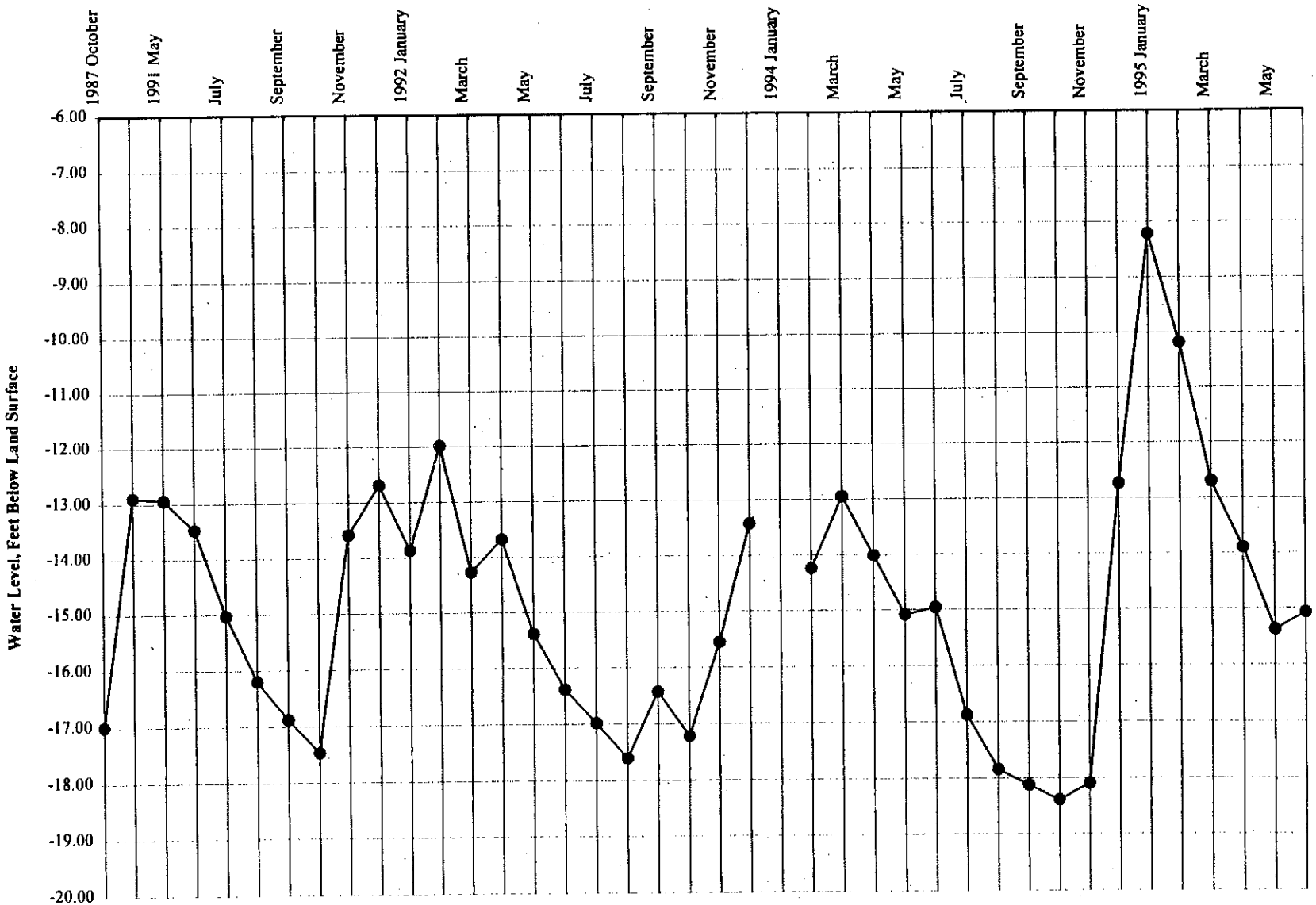
Robert Ranard 26N/6E-2M1 (well depth 229 ft bls, casing to 229 ft, Q(A)c formation, surface elevation ~490 ft)



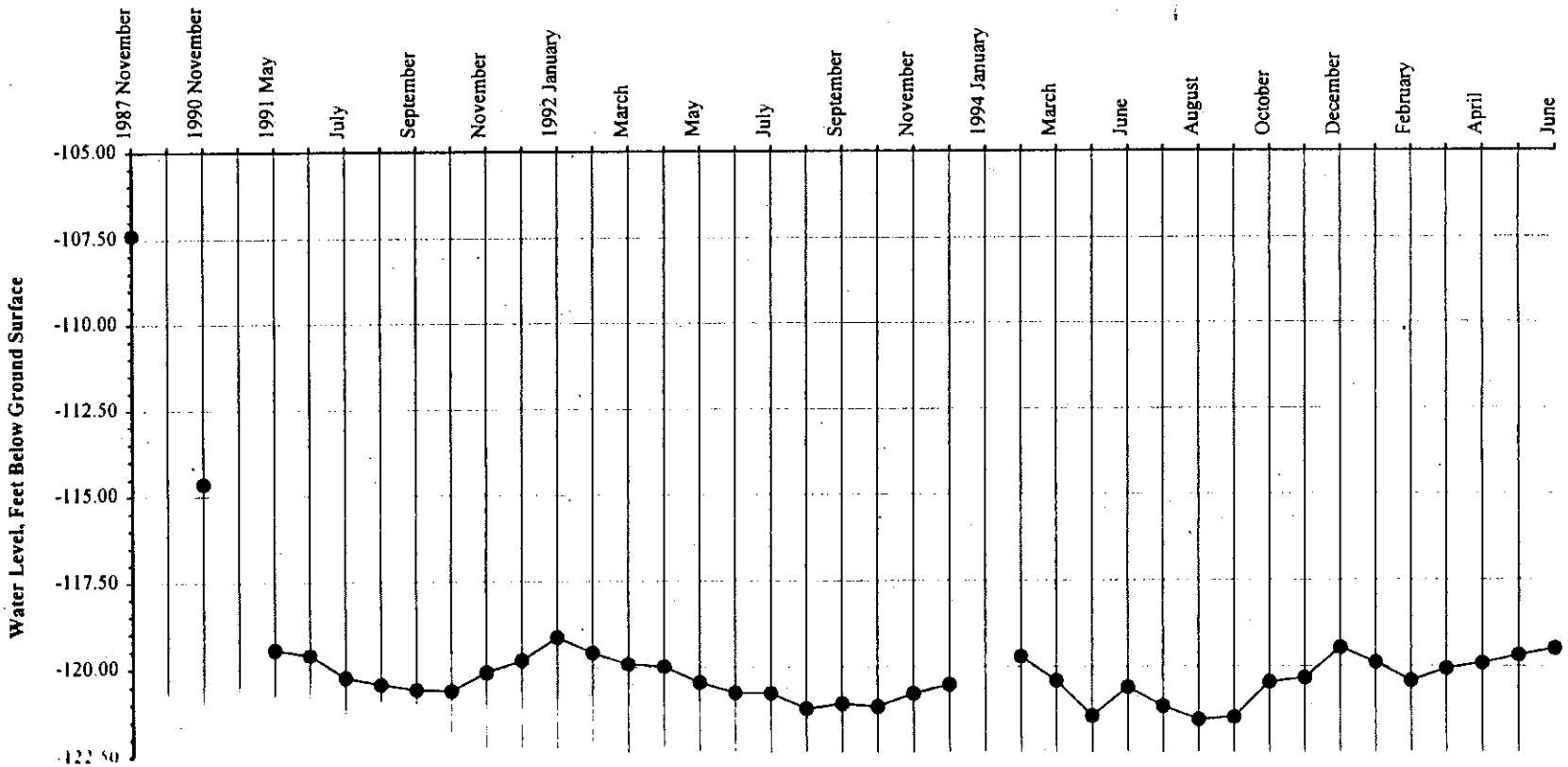

Robert Riggle, 24N/6E-4K1
(well dug to 17 ft bls, 60 inch diameter; surface elevation 426.77 ft msl; Qvr formation)
WATER LEVEL, FEET BELOW LAND SURFACE
-1.00
-2.00
-3.00
-4.00
-5.00
-6.00
-7.00
-8.00
-9.00
-10.00
-11.00
1982 April
May
August
December
May
July
August
November
1984 January
March
May
July
September
November
1985 January
March
May
July
September
December
March
May
July
September
December
March
May
July
September
1991 June
August
October
December
February
April
June
August
October
December
July


Rick Bell, 26N/6E-22K2 (well depth 190 ft, screened 160-170 ft. bls, 5 in. casing 170-190, Qva formation, surface elevation ~550 ft.)
Water Level, Feet Below Land Surface
-133.00
-134.00
-135.00
-136.00
-137.00
-138.00
-139.00
-140.00
-141.00
-142.00
-143.00
-144.00
-145.00
-146.00
-147.00
-148.00
-149.00
-150.00
-151.00
-152.00
-153.00
1989 February
1990 August
1991 May
July
September
November
1992 January
March
May
July
September
November
1994 January
March
May
July
September
November
1995 January
March
May

Eva Pierce, 23N/8E-15J6, (Qal formation, well depth 40', bottom of casing 40', bailer test indicate 25 gal/min with 4' drawdown after 1 hrs)

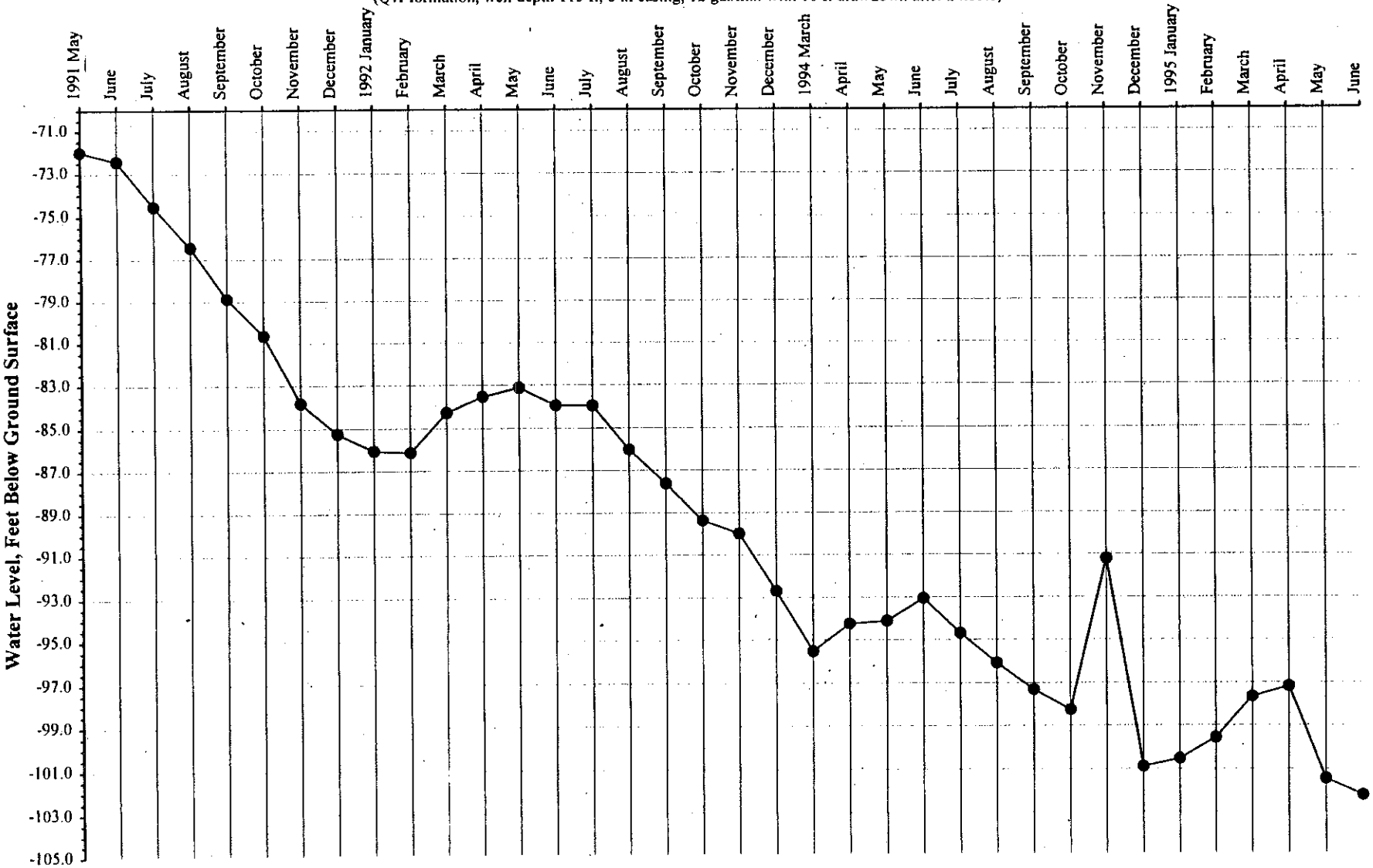


City of Seattle-26N/06E-25C02 (Q(B)c formation, 852' well depth, 12" casing to 500', 8" casing 800', 20' torch slotted 6" pipe, 5' of blank pipe)

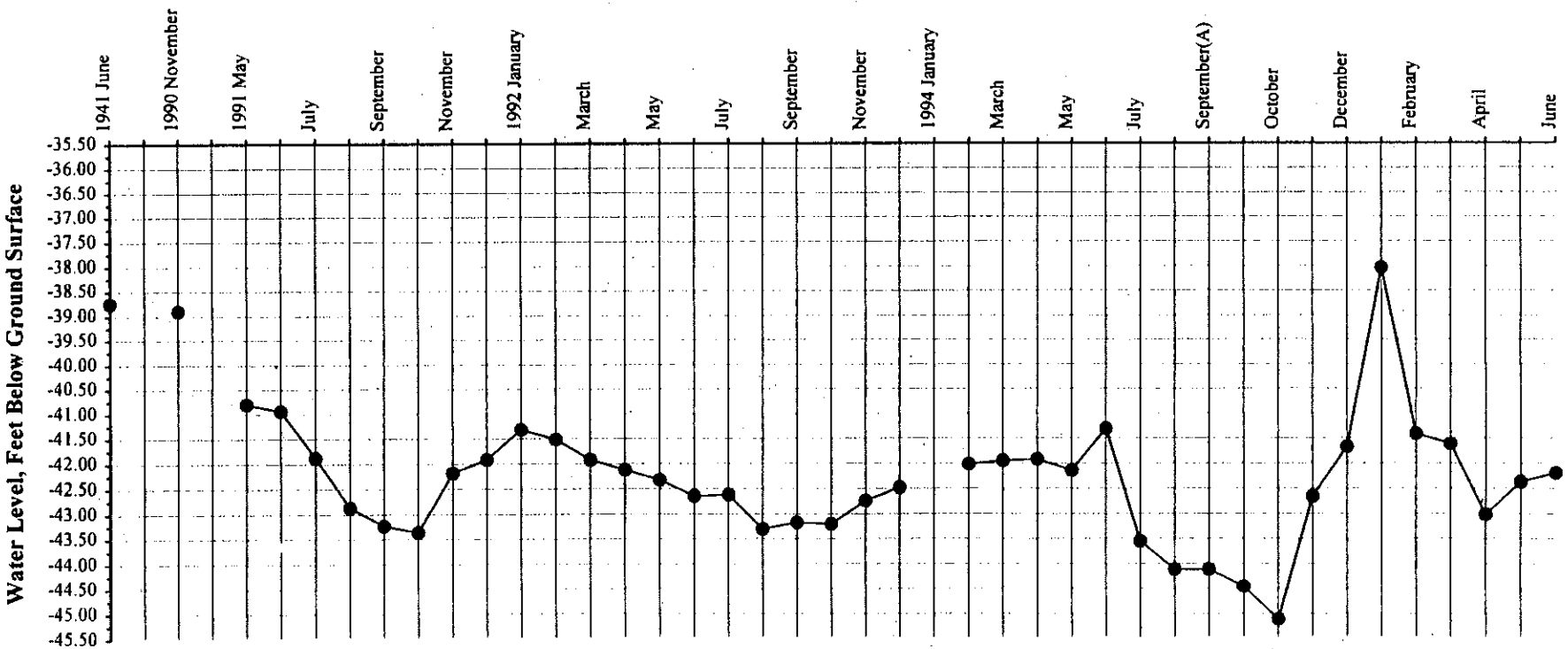


Mr. Dennis Thoennes-25N/7E15R02

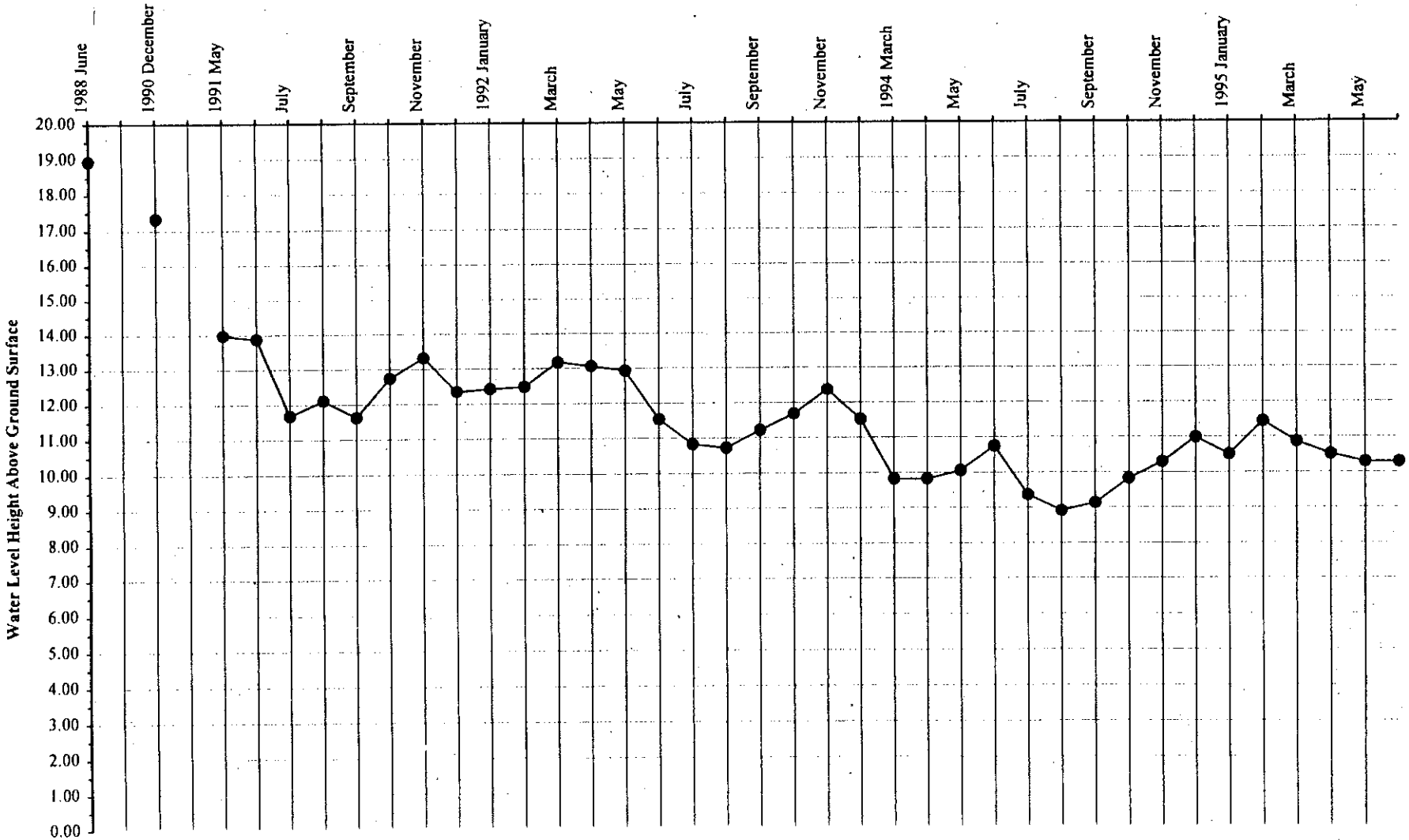
(Qvr formation, well depth 115 ft, 6 in casing, 12 gal/min with 10 ft drawdown after 2 hours)



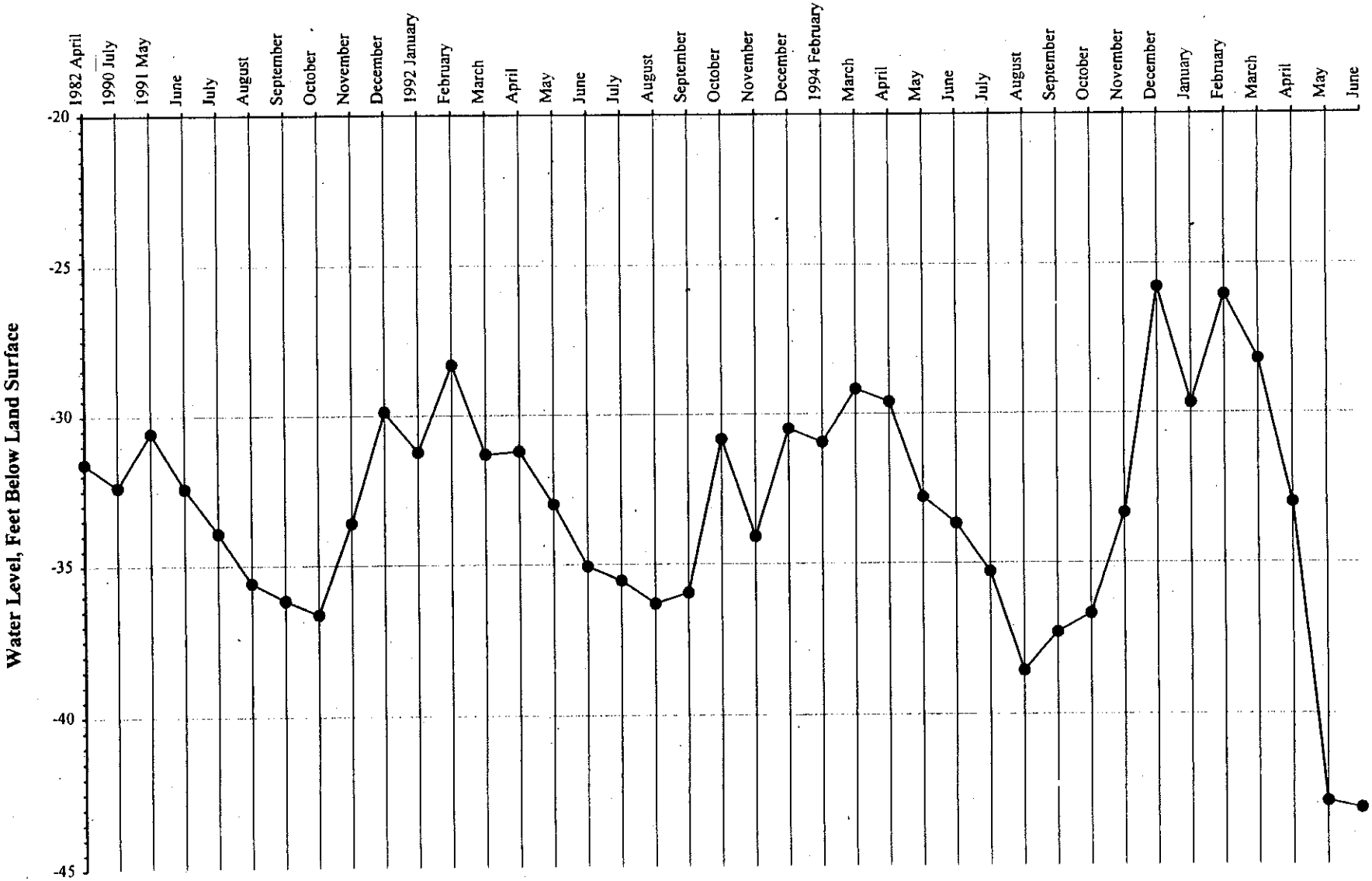
Mr. Dean Gibbs-26N/06E-13N01 (Q(A)c formation, 236' well depth, 6" casing, pump @~135')

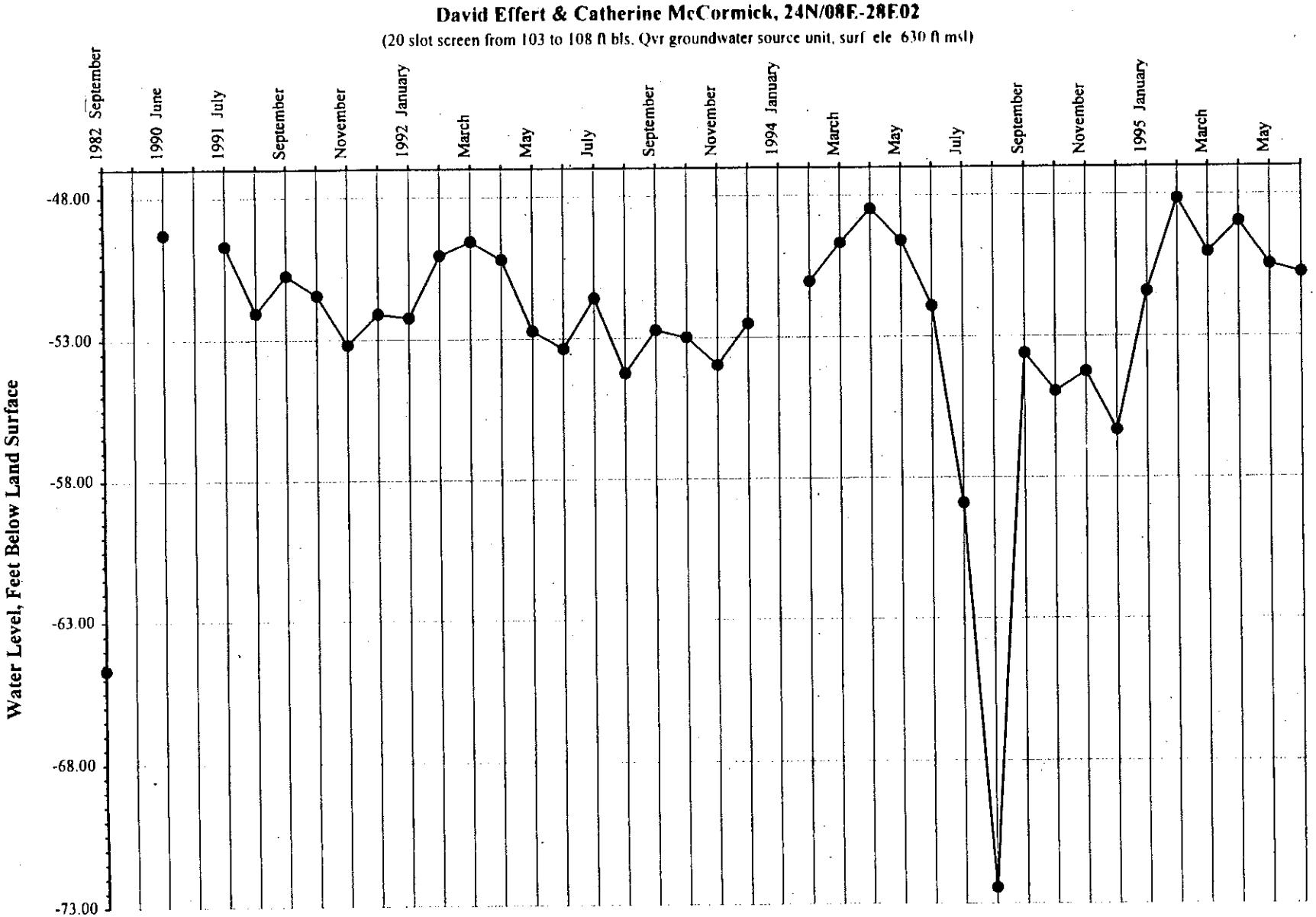


Dale Waid-25N/07E-7E01(659' deep, 8" diameter, star perforator 1/4" by 1" from 565 to 595', Q(A)c formation, surface elevation ~55', 500 gallons per minute with 69 ft drawdown after 24 hours)



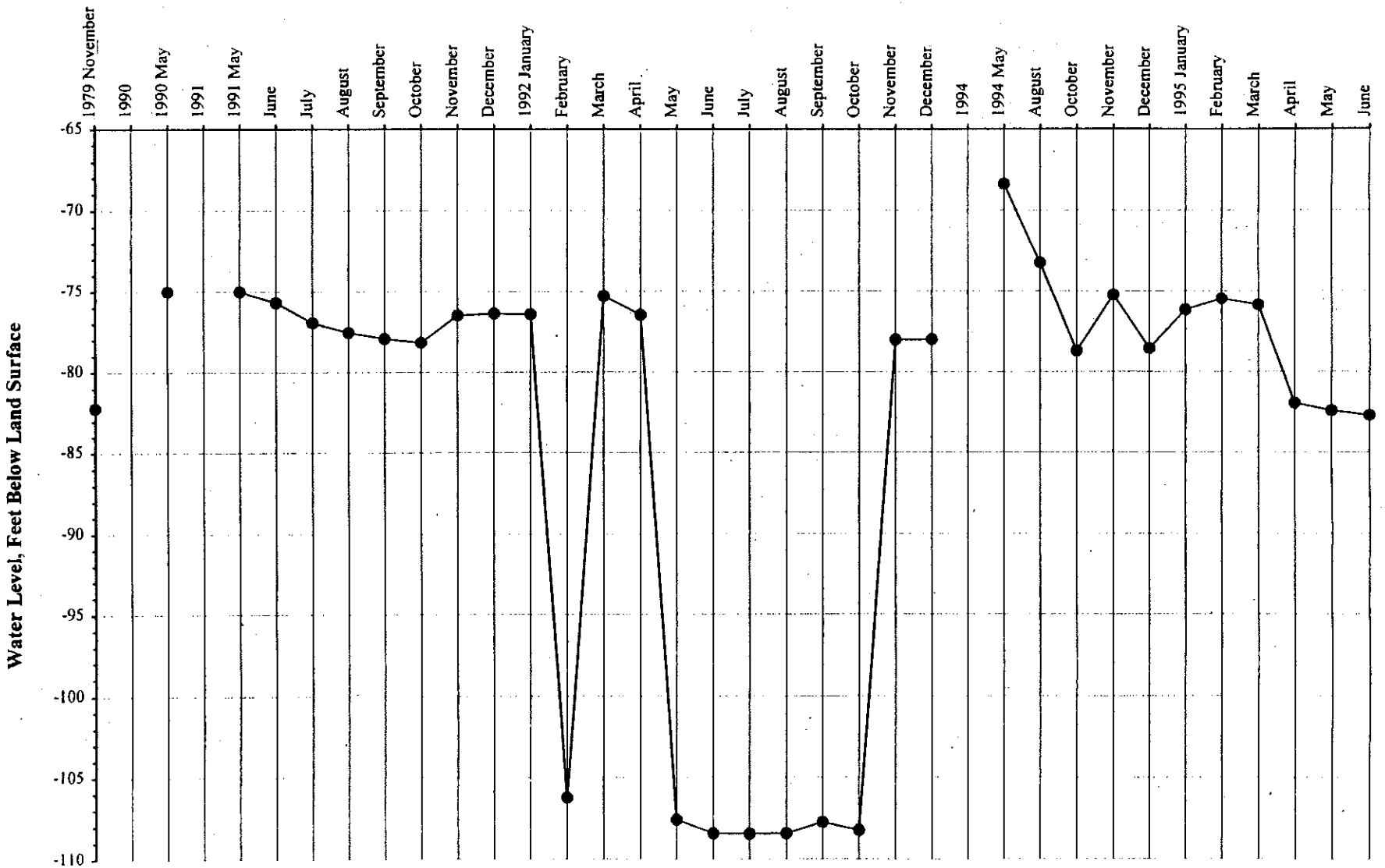
Mr. Wm L. Gneechi 24N/07E-15D01 (Qal formation, well depth 49.5', surface elevation ~105', bailer test indicated 20 gal/min with 5' drawdown after 1hrs.)



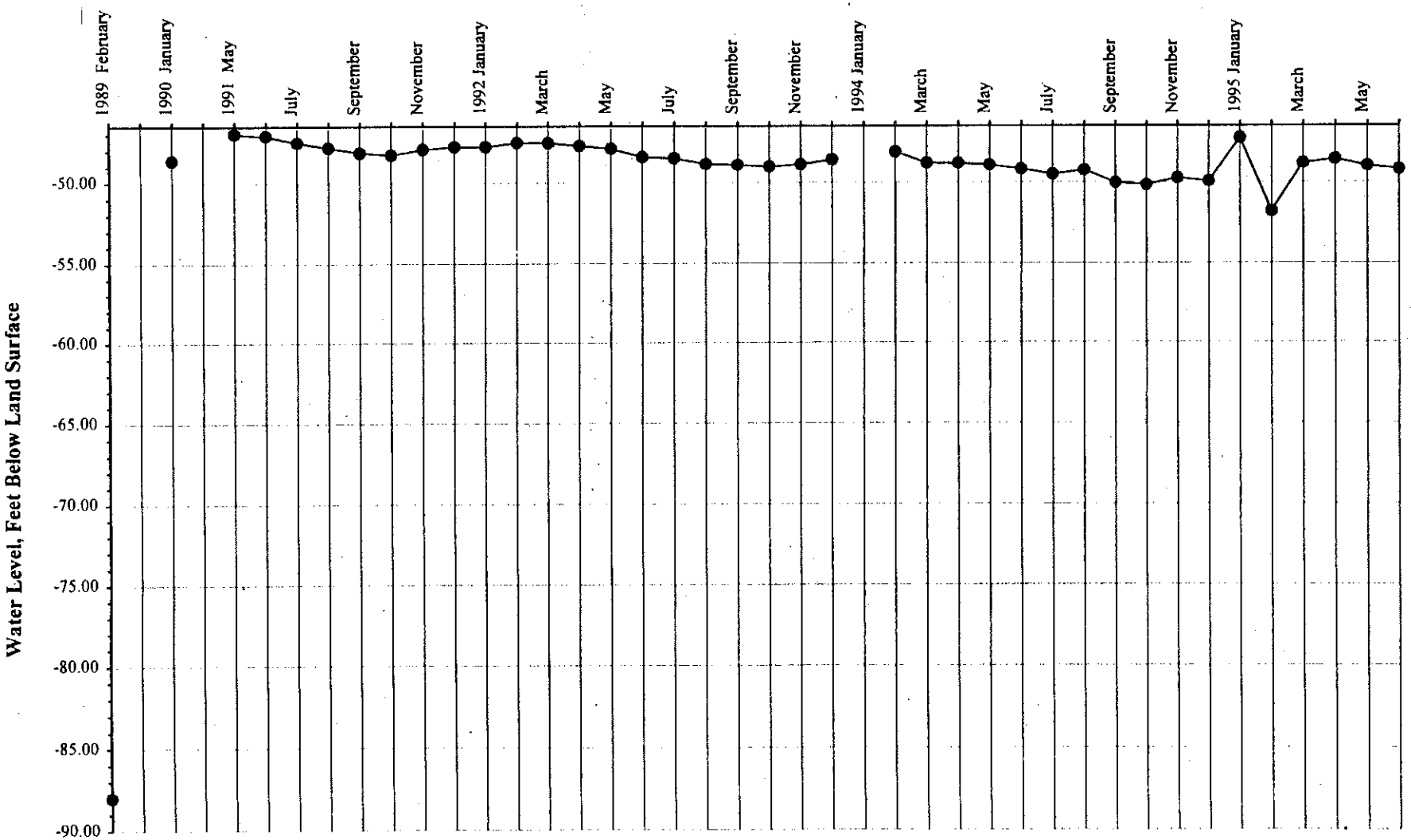

David Effert & Catherine McCormick, 24N/08E-28E02
(20 slot screen from 103 to 108 ft bls. Qvr groundwater source unit, surf ele 630 ft msl)
Water Level, Feet Below Land Surface
-48.00
-53.00
-58.00
-63.00
-68.00
-73.00
1982 September
1990 June
1991 July
September
November
1992 January
March
May
July
September
November
1994 January
March
May
July
September
November
1995 January
March
May

Highline School Dist #401, 23N/8E-13N1

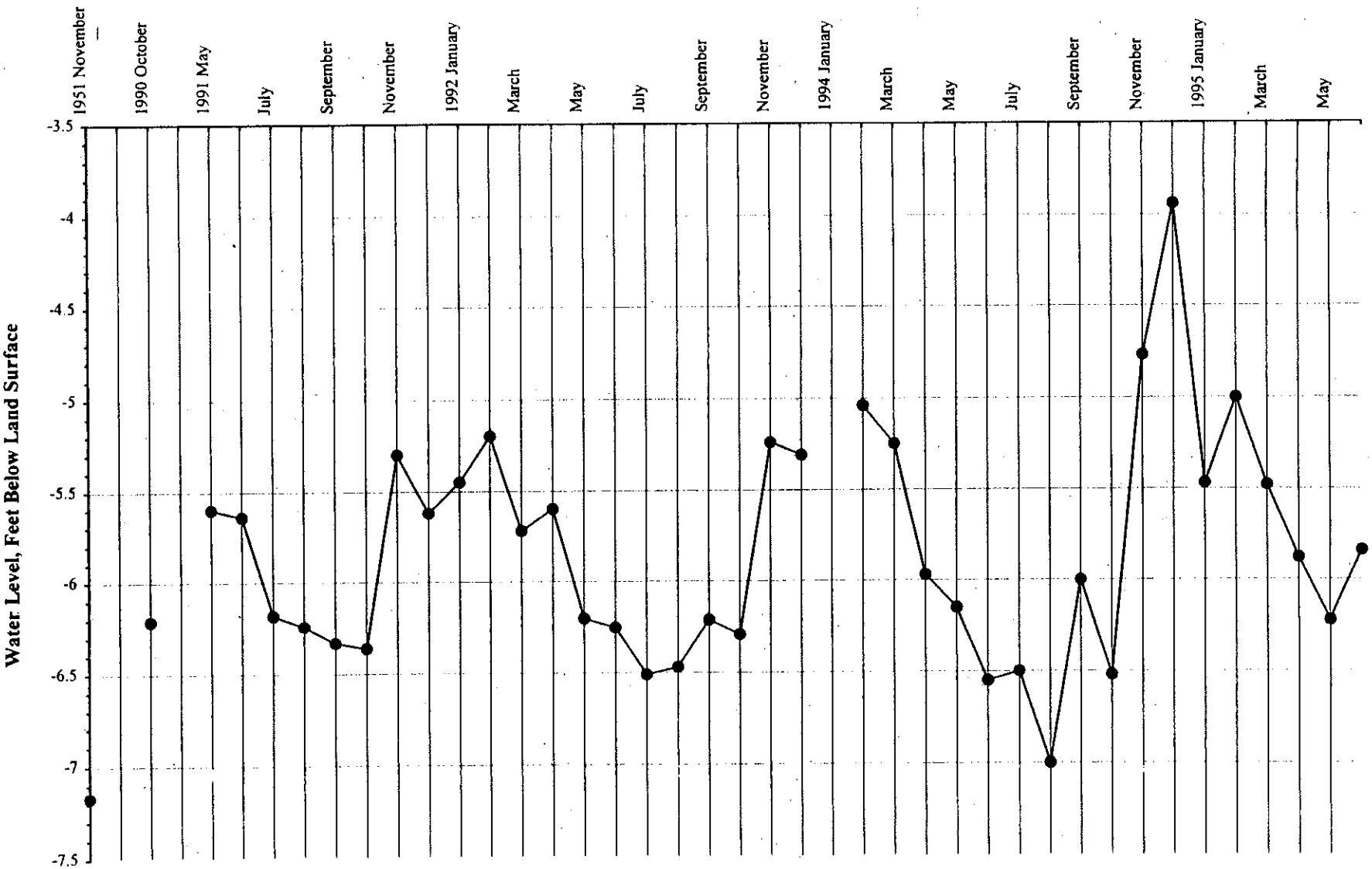
(5ft well screen bottom at 194 ft bls; land elevation 595 ft msl; Qal formation; ~150 gallons per minute with 21 feet drawdown)

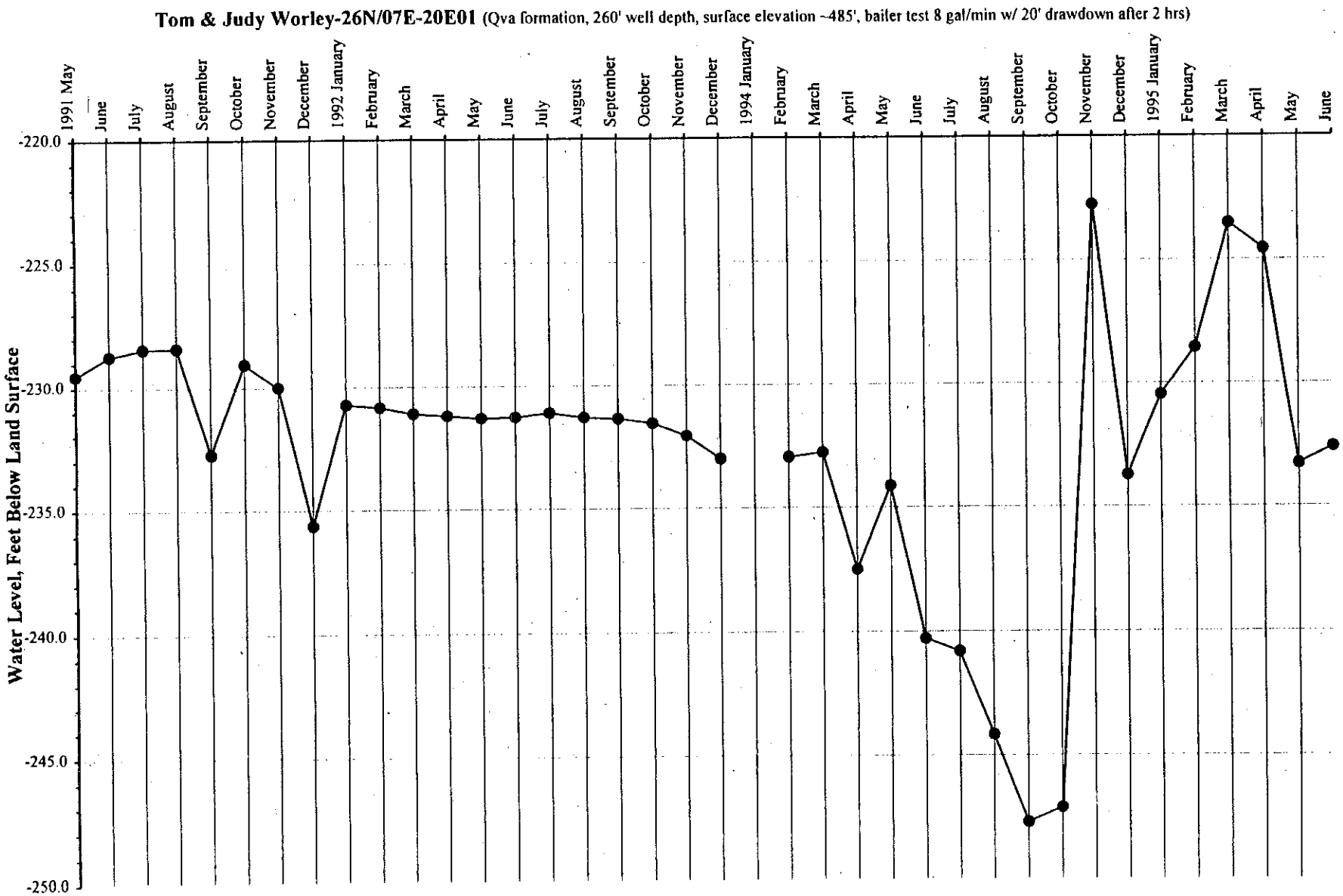


H. Michael Green, 25N/7E-34M1 (Q(A)c well drilled 296ft bls, casing ends 284ft bls, surface elevation 140 ft. msl, 2.5 gallons per minute with 104 ft drawdown after 2 hours)

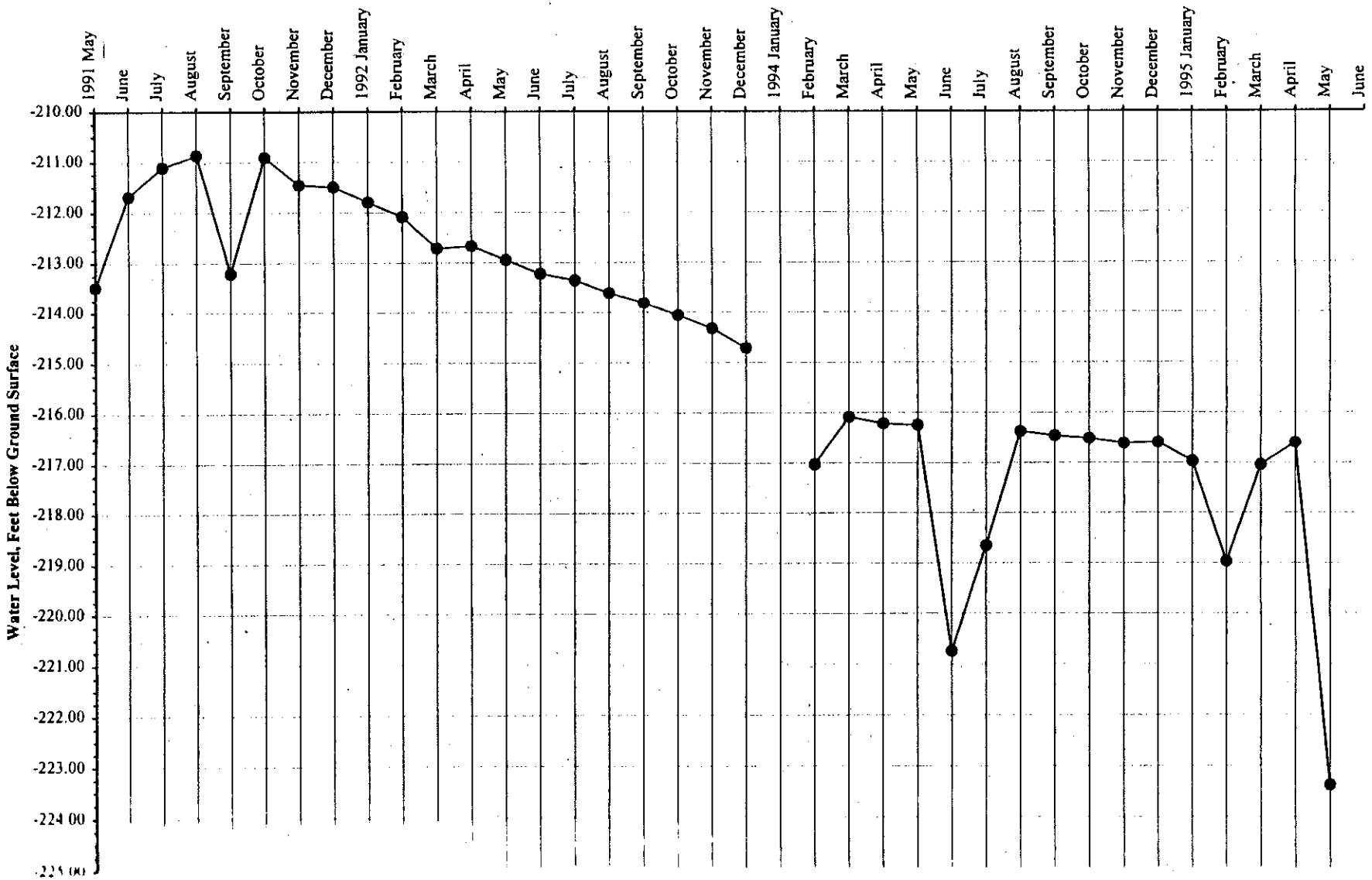


Mr. John Johanson-24N/07E-08G01 (Qal formation, 8.5' depth, surface elevation ~85', 30" concrete casing, hand dug)



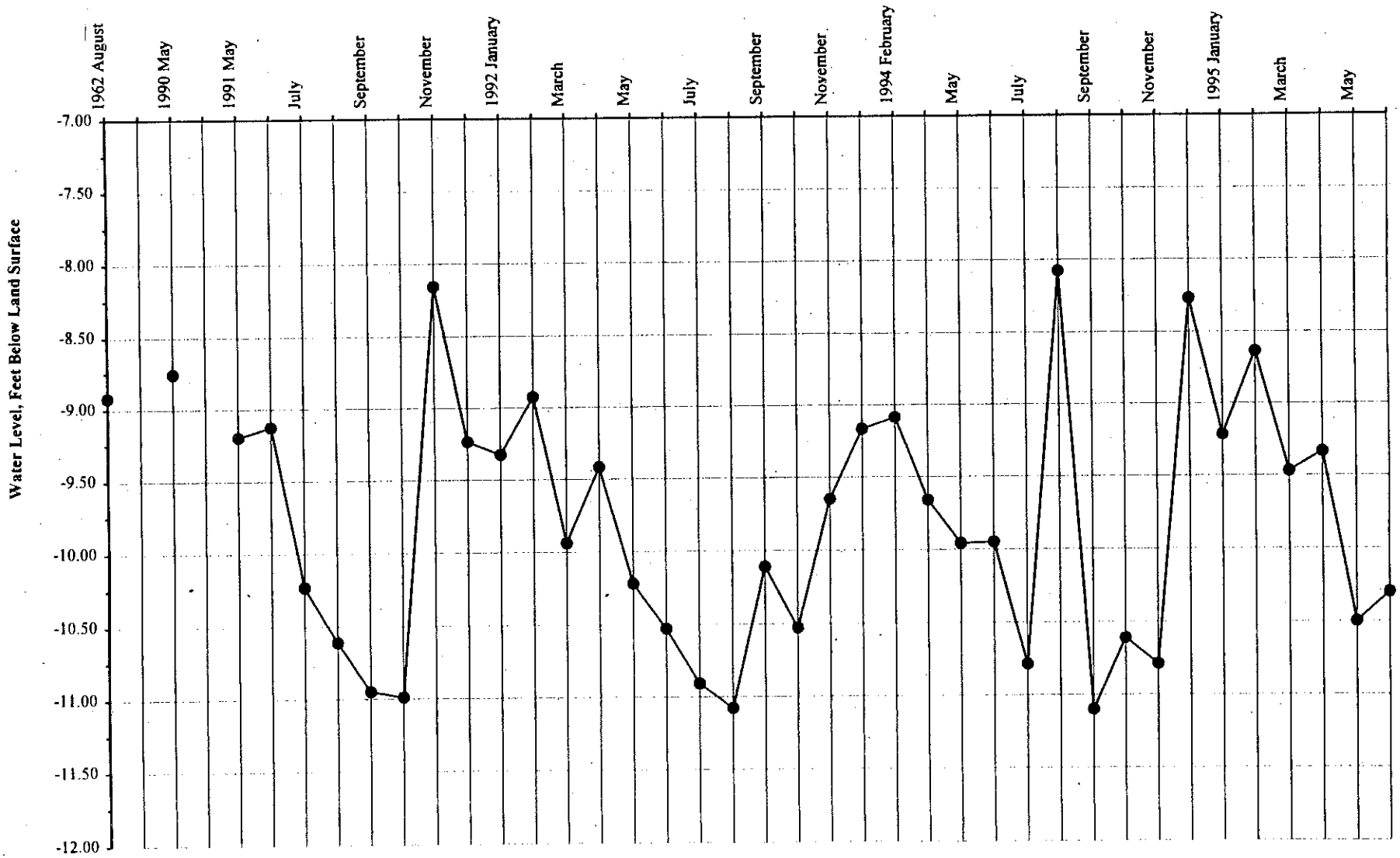

Tom & Judy Worley-26N/07E-20E01 (Qva formation, 260' well depth, surface elevation ~485', bailer test 8 gal/min w/ 20' drawdown after 2 hrs)
Water Level, Feet Below Land Surface
-220.0
-225.0
-230.0
-235.0
-240.0
-245.0
-250.0
1991 May
June
July
August
September
October
November
December
1992 January
February
March
April
May
June
July
August
September
October
November
December
1994 January
February
March
April
May
June
July
August
September
October
November
December
1995 January
February
March
April
May
June

Kenneth Peterson-25N/7E-17A01 (Qva formation, 247 ft deep, 6 in casing, bailer test 10 gal/min with 3 ft drawdown after 1 hrs)

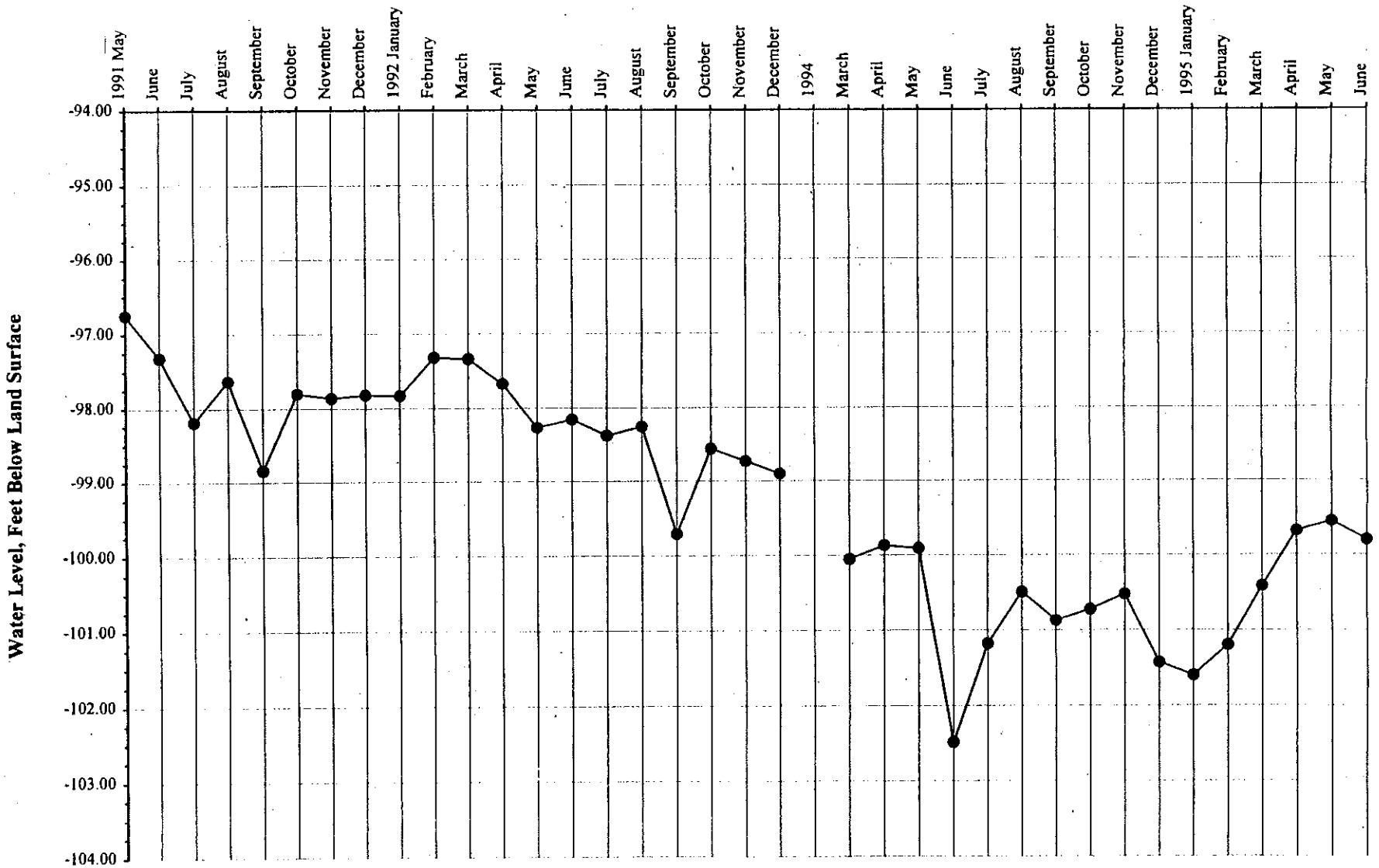


King County Parks Department, 23N/8E-9J1

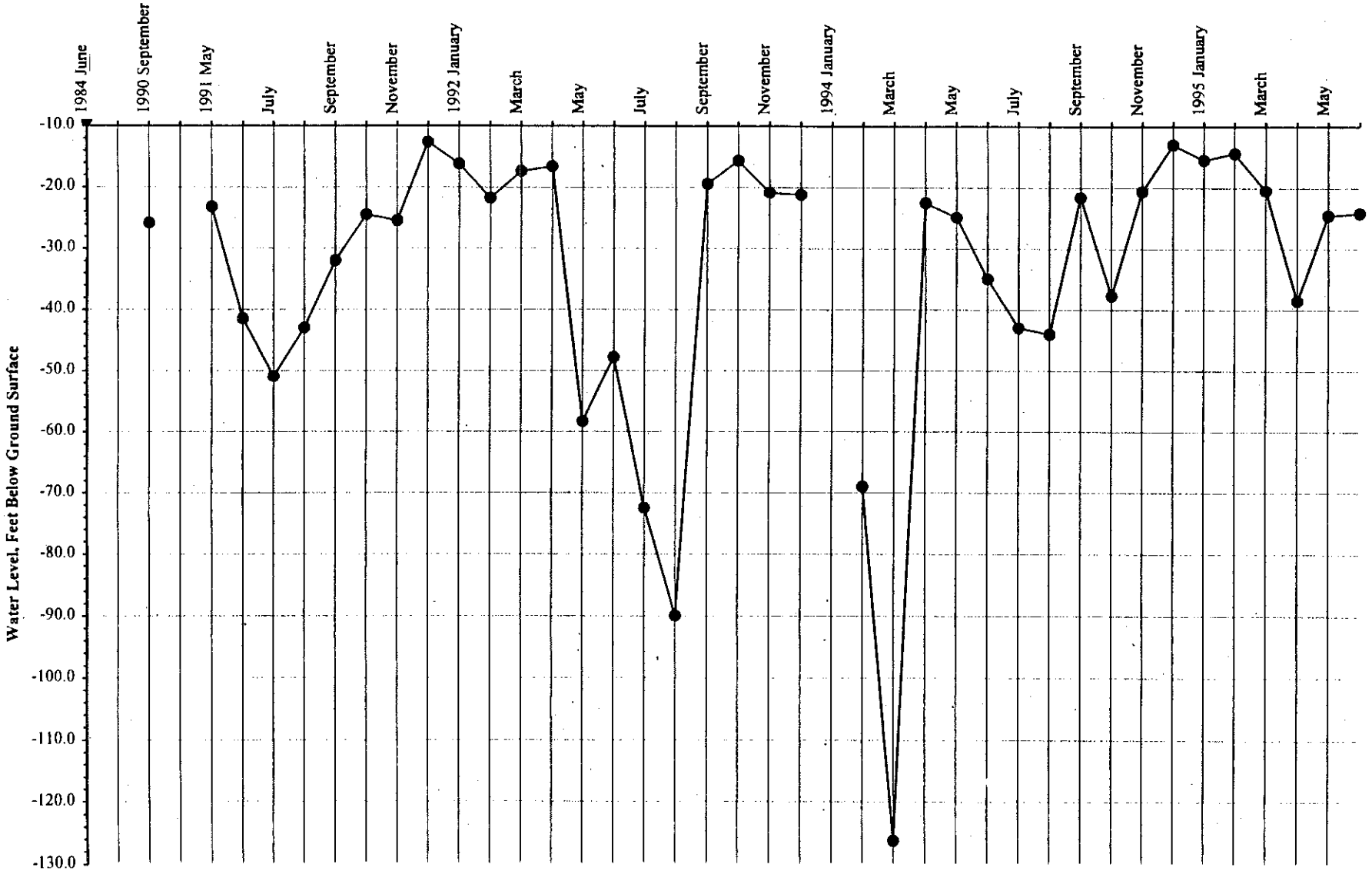
(16 foot, 36 inch diameter hand dug well, sounded in 1962 at 13.1 feet, Qal formation)



Lyle Pigort, 24N/6E-9N2 (6in casing, well depth 199ft bls, screen from 189-199 ft, Qvt formation, surface elevation ~420 ft)

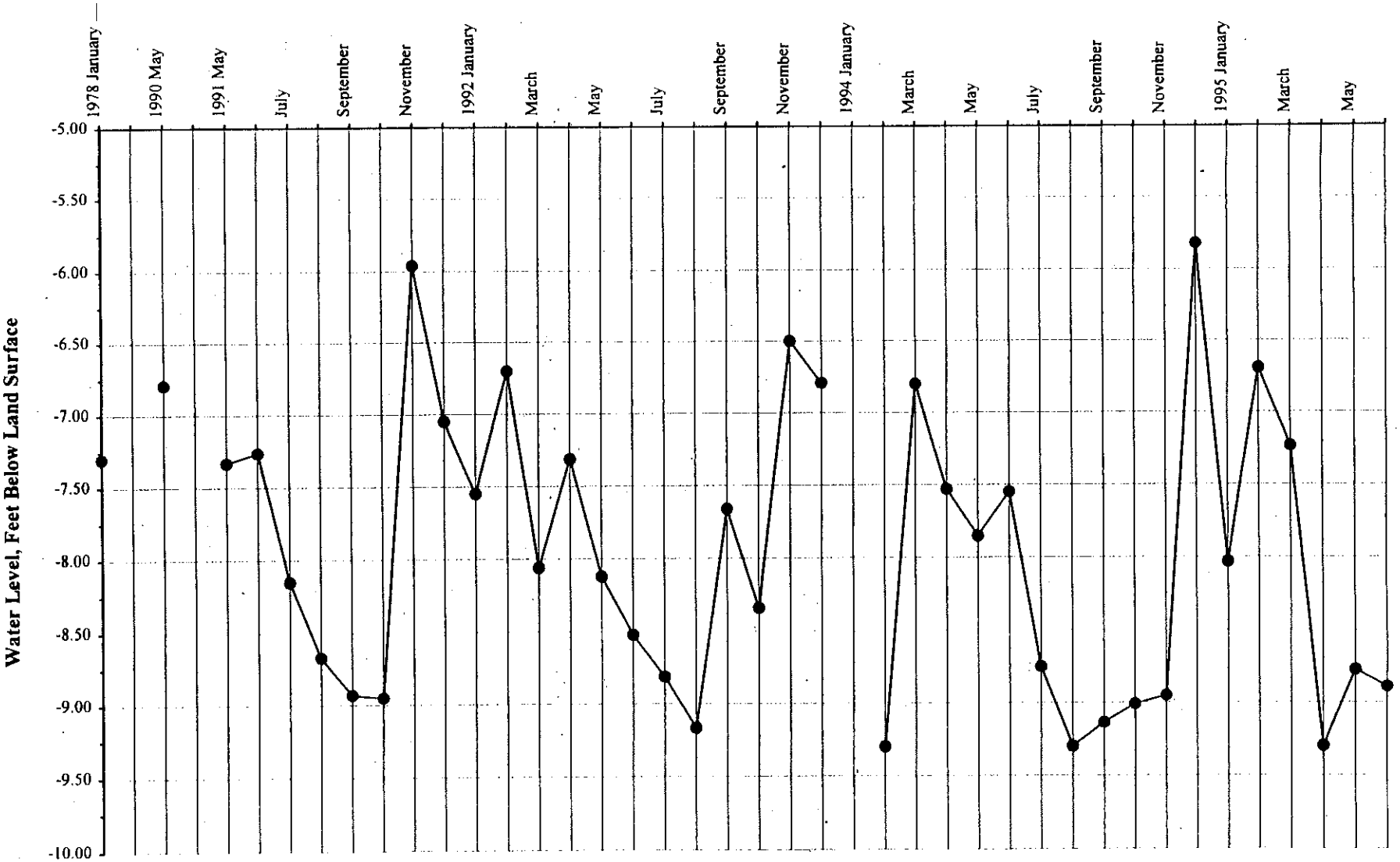


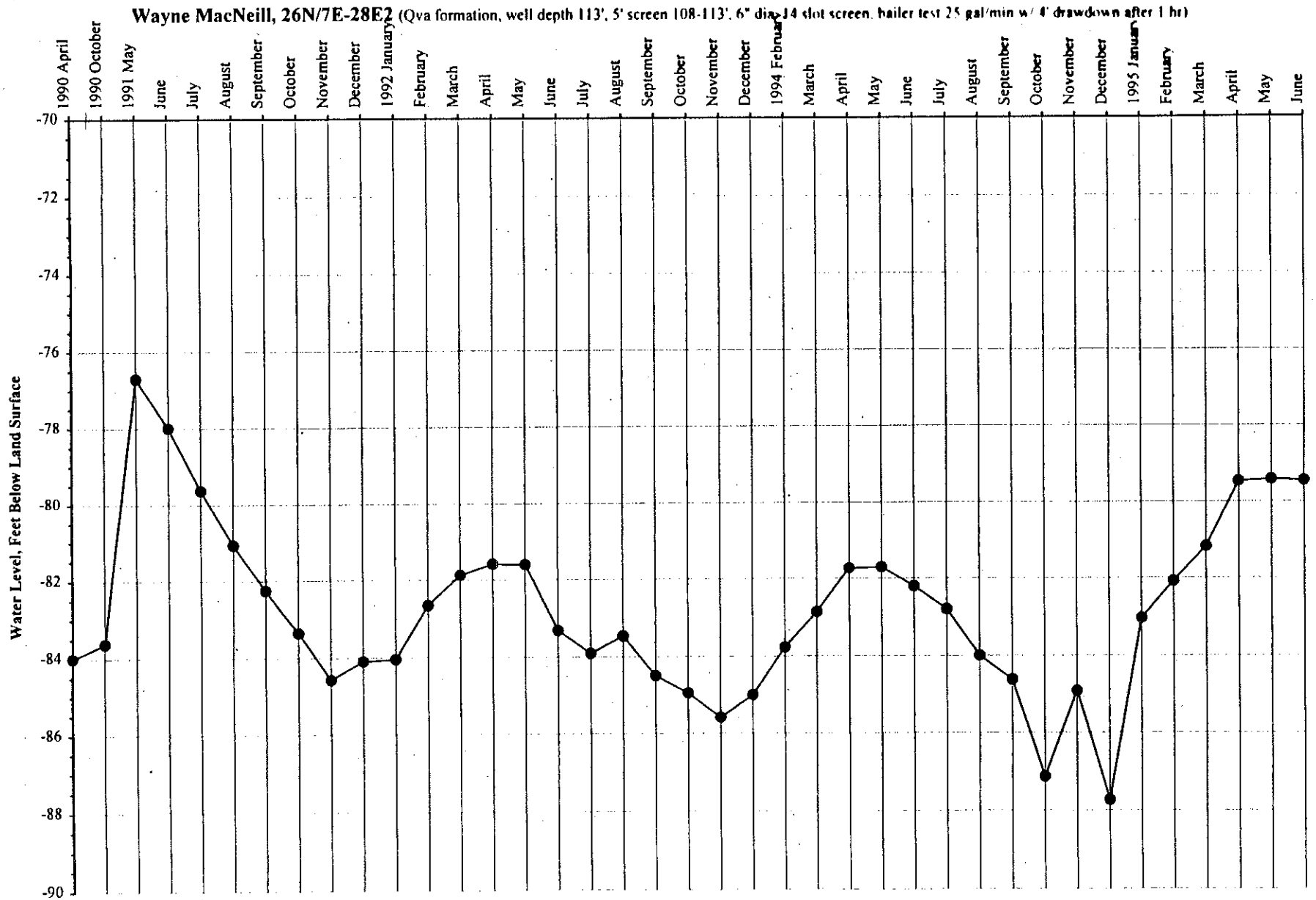
Mr. Rick La France-26N/07E-14P01 (Bedrock well, Shale from 15' to 130', bailer test resulted in 1gal/min with 90' drawdown after 1hr)

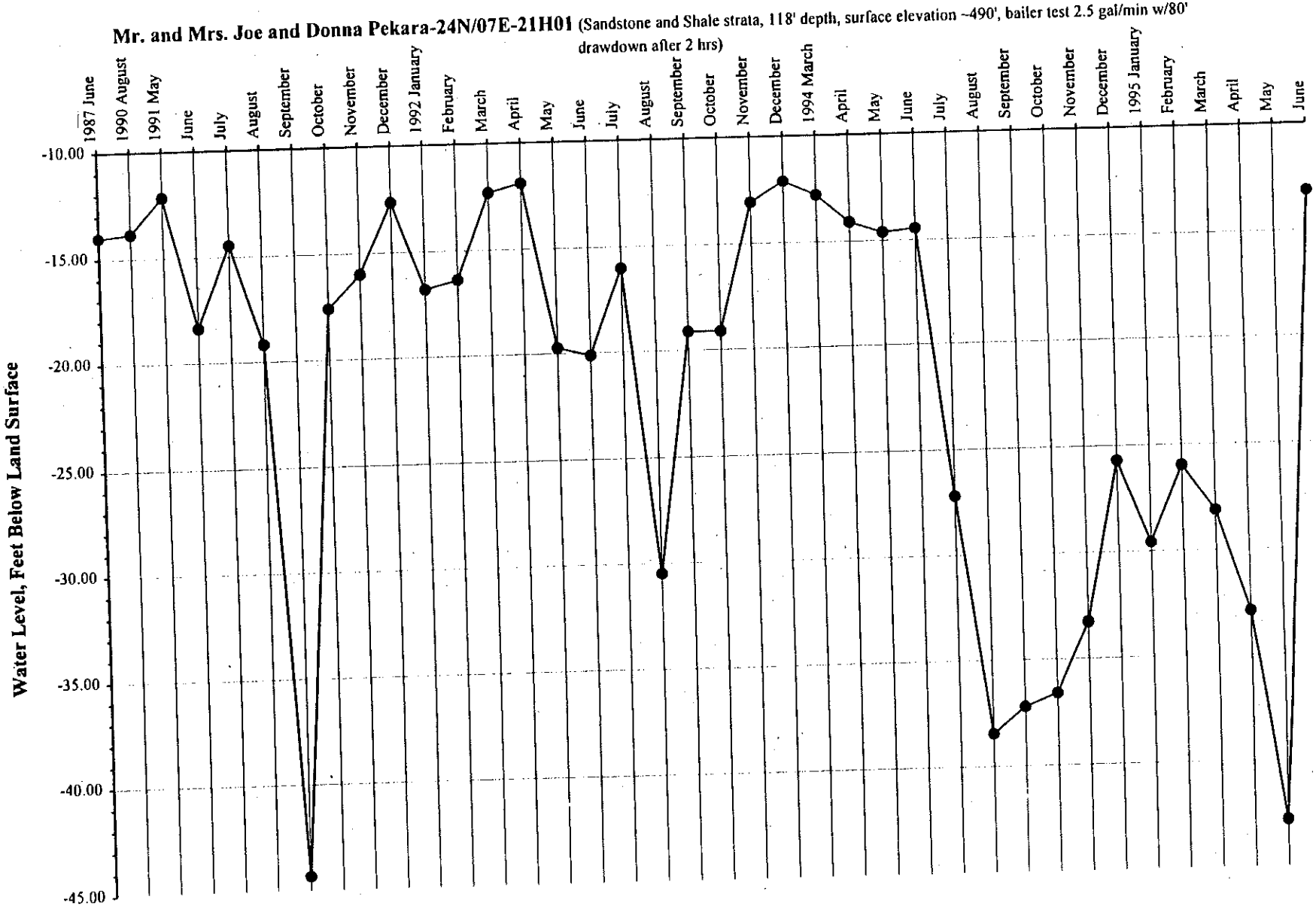


George Macris, 23N/8E-3L3

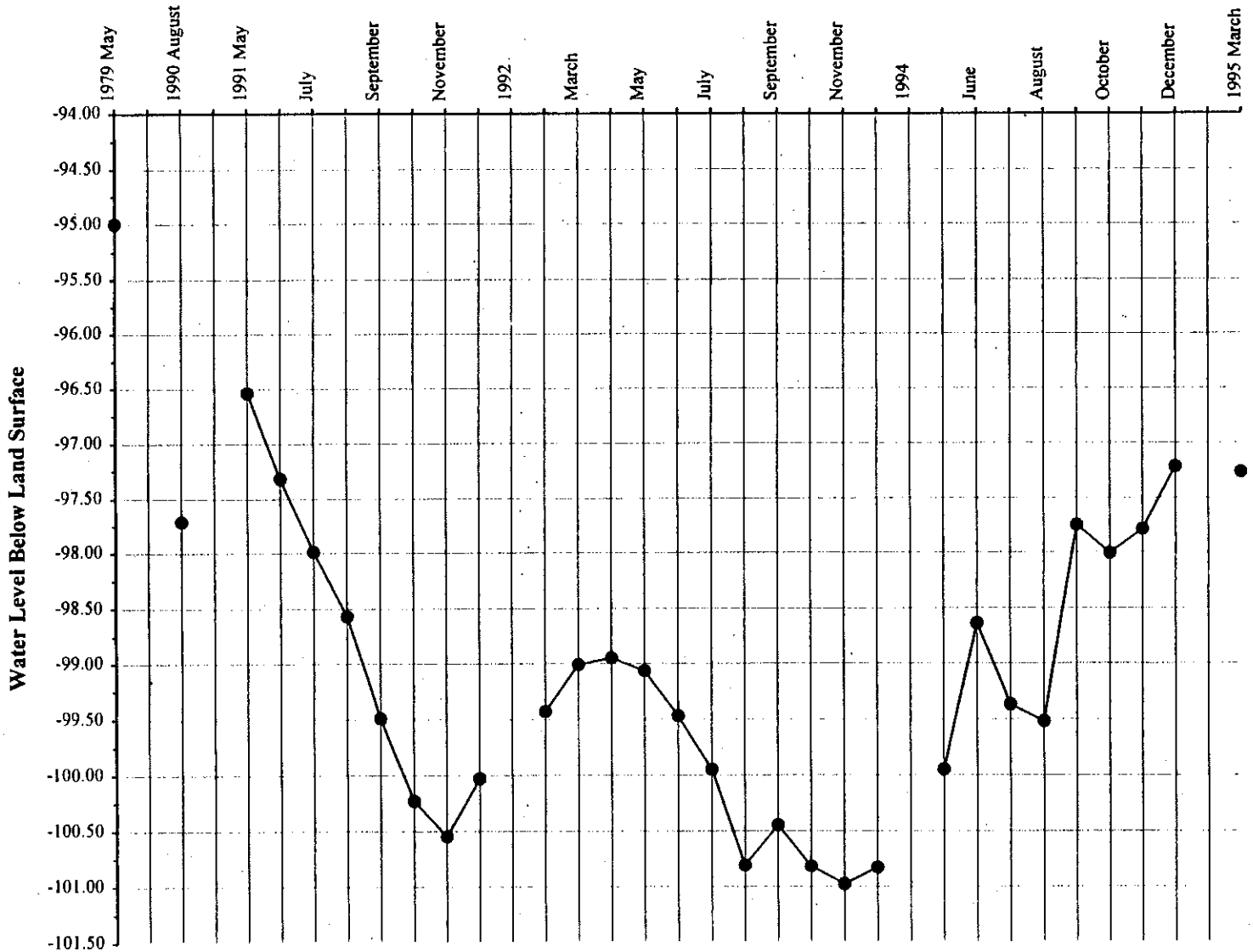
(well depth 230 ft bls; surface elevation 435 ft msl; Qal formation, 40 gallons per minute with 25 ft drawdown after 2.5 hours)




Wayne MacNeill, 26N/7E-28E2 (Qva formation, well depth 113', 5' screen 108-113', 6" dia, 14 slot screen, bailer test 25 gal/min w/ 4' drawdown after 1 hr)
Water Level, Feet Below Land Surface
-70
-72
-74
-76
-78
-80
-82
-84
-86
-88
-90
1990 April
1990 October
1991 May
June
July
August
September
October
November
December
1992 January
February
March
April
May
June
July
August
September
October
November
December
1994 February
March
April
May
June
July
August
September
October
November
December
1995 January
February
March
April
May
June


Mr. and Mrs. Joe and Donna Pekara-24N/07E-21H01 (Sandstone and Shale strata, 118' depth, surface elevation ~490', bailer test 2.5 gal/min w/80' drawdown after 2 hrs)
Water Level, Feet Below Land Surface
-10.00
-15.00
-20.00
-25.00
-30.00
-35.00
-40.00
-45.00
1987 June
1990 August
1991 May
June
July
August
September
October
November
December
1992 January
February
March
April
May
June
July
August
September
October
November
December
1994 March
April
May
June
July
August
September
October
November
December
1995 January
February
March
April
May
June

Mike Nodke-25N/06E-24K01 (120 ft depth, 6 inch casing, no screen, Qvt formation, surface elevation ~420 ft msl, 7 gallons per minute with 22 ft drawdown after one hour)



Area Characterization

Appendix D

Exploratory Well Log (Loutsis Park)

East King County
Ground Water Management Plan

December 1998

RECORD OF WELL LOG GWMP-1

Sheet 1 of 5

PROJECT: King County/Snoqualmie/WA
PROJECT NO: 953-1100.003
LOCATION: Carnation, WA

DRILLING DATE: July/August, 1995
DRILL RIG: Speedstar 72
ADDITIVES: Water

DATUM: MSL
COORDINATES N:
E:

COLLAR ELEV: NA
GROUND SURFACE: NA
INCLINATION: -90°

DEPTH (FEET)	ROCK TYPE / DESCRIPTION	GRAPHIC LOG	SAMPLE NUMBER	SAMPLE TYPE	TEMPERATURE (°C)	CONDUCTANCE (µS/m)	Ph	WATER LEVELS	WELL COMPLETION
0	Compact, green-brown, rounded COBBLES and coarse SAND, trace silt		1-8	GRAB					16-inch Borehole →
20									
40	Compact, water bearing, dark gray, rounded COBBLES,. coarse SAND and GRAVEL with some SILT				13	132	7.4	45.5	12-inch Casing →
60	Loose, dark gray, rounded COBBLES and GRAVEL with some SAND		8-16		15	150	6.9		
80					14	120	6.9		
100	Loose, dark gray, rounded COBBLES and GRAVEL with some SILT		16-24		13	120	7.1	21.2	10-inch Casing →
120					13.5	110	7.0		
140	Loose, dark gray, round to subround GRAVEL and SAND		24-32		12.6	115	7.0	22.4	
160	Loose, gray, COBBLES and GRAVEL				14.7	130	6.9		
180	Tight		32-40					35.5	
200	Heaving Log continues				11.2	135	7.2	20.8	

SCALE: 1" = 25'
DRILLING CONTRACTOR: Holt
DRILLER: R. Miller

LOGGED: M. Klisch/M. Amann/S. Groom
CHECKED: B. Anderson
DATE: 8/23/95

RECORD OF WELL LOG GWMP-1

PROJECT: King County/Snoqualmie/WA
PROJECT NO: 953-1100.003
LOCATION: Carnation, WA

DRILLING DATE: July/August, 1995
DRILL RIG: Speedstar 72
ADDITIVES: Water

DATUM: MSL
COORDINATES N:
E:

COLLAR ELEV: NA
GROUND SURFACE: NA
INCLINATION: -90°

DEPTH (FEET)	ROCK TYPE / DESCRIPTION	GRAPHIC LOG	SAMPLE NUMBER	SAMPLE TYPE	TEMPERATURE (°C)	CONDUCTANCE (µS/m)	Ph	WATER LEVELS	WELL COMPLETION
200	Loose, gray, COBBLES and GRAVEL			GRAB	13	135	7.2		
220			40-48		11.3	120	7.3	30.2	
240					11.7	113	7.2		12-inch Casing →
260			48-56		11.8	130	7.2		
	275								
280	Loose, silty fine SAND, trace to some GRAVEL and COBBLES				11.8	130	7.2		
	295								10-inch Casing →
300	Stiff, gray, sandy SILT and CLAY		56-64		12.5	130	7.5	104	
320									
340			64-72						
360									
380			72-80						
400	Log continues								

SCALE: 1" = 25'
DRILLING CONTRACTOR: Holt
DRILLER: R. Miller

LOGGED: S. Groom
CHECKED: B. Anderson
DATE: 8/23/95

RECORD OF WELL LOG GWMP-1

PROJECT: King County/Snoqualmie/WA
PROJECT NO: 953-1100.003
LOCATION: Carnation, WA

DRILLING DATE: July/August, 1995
DRILL RIG: Speedstar 72
ADDITIVES: Water

DATUM: MSL
COORDINATES N:
E:

COLLAR ELEV: NA
GROUND SURFACE: NA
INCLINATION: -90°

DEPTH (FEET)	ROCK TYPE / DESCRIPTION	GRAPHIC LOG	SAMPLE NUMBER	SAMPLE TYPE	TEMPERATURE (°C)	CONDUCTANCE (µS/m)	Ph	WATER LEVELS	WELL COMPLETION
400	Stiff, gray, SILTY CLAY							Dry	
420			80-88	GRAB					
440			88-96						12-inch Casing →
460									
480			96-104						
500									12-inch Drive Shoe (in place) →
520			104-112						
540									
560			112-120						10-inch Casing →
580									
600	Log continues								

SCALE: 1" = 25'
DRILLING CONTRACTOR: Holt
DRILLER: R. Miller

LOGGED:
CHECKED: B. Anderson
DATE: 8/23/95

RECORD OF WELL LOG GWMP-1

PROJECT: King County/Snoqualmie/WA
PROJECT NO: 953-1100.003
LOCATION: Carnation, WA

DRILLING DATE: July/August, 1995
DRILL RIG: Speedstar 72
ADDITIVES: Water

DATUM: MSL
COORDINATES N:
E:

COLLAR ELEV: NA
GROUND SURFACE: NA
INCLINATION: -90°

DEPTH (FEET)	ROCK TYPE / DESCRIPTION	GRAPHIC LOG	SAMPLE NUMBER	SAMPLE TYPE	TEMPERATURE (°C)	CONDUCTANCE (µS/m)	pH	WATER LEVELS	WELL COMPLETION
600	Stiff, gray, SILTY CLAY		120-128	GRAB				Dry	10-inch Casing →
620									
640			128-136						
660									
680			136-144						
700									
720			144-152						
740									
760			152-160						
780									
800	Log continues								

SCALE: 1" = 25'
DRILLING CONTRACTOR: Holt
DRILLER: R. Miller

LOGGED:
CHECKED: B. Anderson
DATE: 8/23/95

RECORD OF WELL LOG GWMP-1

PROJECT: King County/Snoqualmie/WA
PROJECT NO: 953-1100.003
LOCATION: Carnation, WA

DRILLING DATE: July/August, 1995
DRILL RIG: Speedstar 72
ADDITIVES: Water

DATUM: MSL
COORDINATES N:
E:

COLLAR ELEV: NA
GROUND SURFACE: NA
INCLINATION: -90°

DEPTH (FEET)	ROCK TYPE / DESCRIPTION	GRAPHIC LOG	SAMPLE NUMBER	SAMPLE TYPE	TEMPERATURE (°C)	CONDUCTANCE (µS/m)	Ph	WATER LEVELS	WELL COMPLETION
800	Stiff, gray, SILTY CLAY		160-168	GRAB				Dry	
820									10-inch Casing
840			168-176						
860									
880			176-184						
900									
920			184-192						
940									
960			192-200						
980									
1000	End of Log								10-inch Drive Shoe (in place)

SCALE: 1" = 25'
DRILLING CONTRACTOR: Holt
DRILLER: R. Miller

LOGGED:
CHECKED: B. Anderson
DATE: 8/23/95

RECORD OF WELL LOG GWMP-1

PROJECT: King County/Snoqualmie/WA
PROJECT NO: 953-1100.003
LOCATION: Carnation, WA

DRILLING DATE: July/August, 1995
DRILL RIG: Speedstar 72
ADDITIVES: Water

DATUM: MSL
COORDINATES N:
E:

COLLAR ELEV: NA
GROUND SURFACE: NA
INCLINATION: -90°

DEPTH (FEET)	ROCK TYPE / DESCRIPTION	GRAPHIC LOG	SAMPLE NUMBER	SAMPLE TYPE	TEMPERATURE (°C)	CONDUCTANCE (µS/m)	Ph	WATER LEVELS	WELL COMPLETION
800	Stiff, gray, SILTY CLAY		160-168	GRAB				Dry	10-inch Casing →
820									
840			168-176						
860									
880			176-184						
900									
920			184-192						
940									
960			192-200						
980									
1000	End of Log								10-inch Drive Shoe (in place) →

SCALE: 1" = 25'
DRILLING CONTRACTOR: Holt
DRILLER: R. Miller

LOGGED:
CHECKED: B. Anderson
DATE: 8/23/95

Area Characterization

Appendix E

Geophysical Methodology

East King County
Ground Water Management Plan

December 1998

B1 TDEM SURVEY

The TDEM technique was selected because it provides several advantages over drilling and other geophysical techniques. TDEM measures electrical resistivity of the subsurface materials in addition to modeling depth and thickness of subsurface layers. The relative concentration of silt and clay in subsurface material is important for hydrologic investigations and empirical data has established a good correlation between resistivity values and the silt and clay concentration in sedimentary material. Clay and silt have low resistivity, while sand and gravel have relatively high resistivity. TDEM also provides better vertical and lateral resolution compared to traditional DC resistivity techniques. The technique utilizes a relatively small survey area which is advantageous for property access and avoiding cultural interference from fences, power lines, and other infrastructure. The TDEM technique is fast (2 to 5 large loop soundings per day) and less expensive than other geophysical techniques and exploratory drilling.

The initial phase of the TDEM survey consisted of seventeen 100-meter loops conducted throughout the survey area. These loops were located in areas with minimal cultural interference that provided good coverage of the survey area. A second phase of the TDEM survey consisted of six 300-meter loops. The larger loops were conducted in areas where there was suitable site access.

B1.1 TDEM Methodology

The TDEM method is a tool to determine subsurface conditions based on the contrasting electrical properties of the materials. The method measures the electrical conductivity of subsurface materials in ohm-meters. The TDEM system consists of a square transmitter loop (copper wire 20 to 500 meters on a side) laid on the ground surface and connected to a regulated current source. The receiver is a smaller multiple-turn coil in the center of the transmitter loop or a large loop coincident with the transmitter loop.

A current is run through the transmitter loop and cycled on and off in pulses of alternating polarity. The cycling of the transmitter current induces eddy currents that decay into the subsurface with time. As these eddy currents decay, they are increasingly influenced by the electrical properties of deeper layers in the subsurface. The eddy currents create a secondary magnetic field that is measured by the receiver and a decay curve is recorded. The decay curve is used to calculate a layered resistivity-depth model of the subsurface based on a best-fit to the observed data.

The depth of exploration varies, depending on the conductivity of the subsurface, the transmitter loop size, available power from the transmitter, and ambient noise levels. As a general rule, the depth of exploration is between one and three times the transmitter loop diameter.

B1.1.1 Limitations

The TDEM method assumes flat-lying and laterally homogeneous layers within the area under the transmitter loop. Dipping interfaces and lateral inhomogeneity within the footprint of the loop will be averaged together when calculating resistivities and depths. The ability to resolve a given layer is dependent on it having sufficient thickness and electrical contrast with the surrounding materials to create an inflection in the decay curve. As a general rule, the vertical resolution is limited to about one-fourth the transmitter loop size. Some uncertainty may result in the interpretation of TDEM data due to the wide range of resistivities that can be associated with a given rock type and the overlap of resistivity values for different rock types. This uncertainty can normally be reduced by a knowledge of the local geology.

B1.2 TDEM Instrumentation

The TDEM survey was conducted using Zonge Engineering and Research Organization instrumentation consisting of a GDP-16 receiver, NT-20 or GGT-10 transmitter, and TEM-3 receiver coil. Both 100-meter and 300-meter transmitter loops were utilized and consisted of 10-16 gauge stranded copper wire. The NT-20 transmitter and TEM-3 receiver coil were used in conjunction with the 100-meter loops and the GGT-10 transmitter and a coincident receiver loop were used in conjunction with the 300-meter loops. The system was powered by two 12-volt deep-cycle batteries.

B1.3 TDEM Data Collection

A total of 23 TDEM soundings were conducted throughout the core survey area (Figure 1). The TDEM survey consisted of seventeen soundings using a square 100-meter transmitter loop and 6 soundings were conducted using a square 300-meter transmitter loop.

The loop wire was premarked at 50-meter intervals and a brunton compass was used to square the loops. An 8-10 ampere current was applied to the transmitter loop and the each sounding was stacked (summed) 1024-2048 times to remove the effects of random noise. In addition, each sounding was recorded three times to assure repeatability of the results. An on-screen display of standard errors was monitored during acquisition to assess the quality of the data being collected. At the completion of each sounding the decay curve was displayed to insure that an adequate level of data quality was being obtained. The data were stored digitally in the memory of the instrument and later downloaded to a computer for processing. The location of the soundings were referenced to the local features and plotted on the 7.5 minute USGS base map.

B1.4 TDEM Data Processing

The TDEM data were downloaded to a personal computer and imported into the computer software package TEMIX-Z Version 3.16 by Interpex Limited. TDEM data are interpreted using a modeling approach. A model is generated, either by an iterative computer methodology (smooth model) or manually (discrete model). A smooth model is a numerically intensive approach where the resistivity of up to 19 layers, with fixed thickness, are varied to generate a TDEM response that best fits the data. The shape of this smooth model was used to guide the manual input of a discrete resistivity-depth model consisting of fewer (generally five or less) layers. This discrete model was submitted to a TEMIX-Z inversion process which adjusts the resistivity and thickness of the discrete layers until a "best fit" to the observed data is achieved. An equivalence analysis was run on the final discrete model to determine a set of equivalent resistivity-depth models that also fit the observed data within a 15% tolerance of the best-fit model. The scatter observed in the equivalence models represents the ability of the observed data to resolve a given layer or resistivity. A plot of the observed data, final resistivity-depth models, and equivalence analysis for each sounding can be found in Appendix C.