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FEB 14 1994

Myrna Rueff
 Geologist
 Missouri Department of Natural Resources
 Department of Geology and Land Survey
 P.O. Box 250
 Rolla, MO 65401

Attention: Myrna Rueff

Subject: Additional Data for SLAPS Suitability Study

Dear Ms. Rueff:

Enclosed are copies of the handouts from the meeting held in Kansas City on February 8, 1994. Copies of preliminary calculations on the rate of movement of contaminants by diffusion, and rate of movement of contaminants through the 3M unit, using "Fuzzy set theory, are also included for your review. Following are responses to questions and comments from MDNR.

Responses to MDNR Questions

1. Diffusion numbers come from Freeze and Cherry.
2. Use of effective porosity.
 - A. An effective porosity of 15% was used for the contaminant transport model. This value came from Table 6.9 of Boutwell, S. H., et al (1985). Modeling Remedial Actions at Uncontrolled Hazardous Sites, Office of Research and Development, U.S. Environmental Protection Agency, EPA/540/2-85/001. A sensitivity analysis for the porosity was conducted as part of the model calibration.
 - B. Vertical contaminant transport calculations are being revised to reflect the use of an effective porosity that is consistent with the contaminant transport model. They will be forwarded when completed.



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- C. Effective porosity can be calculated from data from pump tests performed on unconfined aquifers. M10-25 is the only well pair that was tested that was unconfined. Unfortunately, an evaluation of the pump test data revealed that the test did not run long enough to overcome the elastic storage effect in the observation well. Since the water level did not stabilize in the observation well an accurate computation of effective porosity can not be derived from the test data.

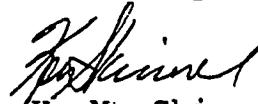
- 3. Dave Kyllonen, who analyzed the pump test data, is presently unavailable. We want to discuss the conversion of pump test transmissivity values to hydraulic conductivity with Dave and will forward the requested numbers as soon as possible.

Notes on handouts

The groundwater contour maps show the effects of the pump tests.

The axes on the hydrograph for M10-25 were inadvertently mislabeled. The y-axis should be drawdown and the x-axis should be time.

Sincerely,



K. M. Skinner
FUSRAP/Geotech Supervisor

KMS/kg/IOM:KMS_0080

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3. Dave Kyllonen, who analyzed the pump test data, is presently on vacation. As a result, conversion of pump test transmissivity values to hydraulic conductivity could not be performed. The requested numbers will be forwarded as soon as possible.

Notes on handouts

The groundwater contour maps show the effects of the pump tests.

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Attached for your information are two exhibits pertaining to the SSSS.

Exhibit I shows the effects of molecular diffusion on contaminant transport. The data presented on the exhibit does not include reactions with the aquifer skeleton. The radionuclides of concern at SLAPS have effective diffusion coefficients in the range of 1×10^{-10} to 1×10^{-11} m²/sec. Ra⁺² has an effective diffusion coefficient on the order of 1×10^{-10} whereas Th⁺⁴ and U⁺⁶ have an effective diffusion coefficient on the order of 1×10^{-11} . The plot of concentration versus time indicates the concentration at the bottom of the subunit 3M clay layer. The average thickness was taken as the combined thickness of subunits 3T and 3M at boring B-1. The conceptualization of the system involves transport by advection and hydrodynamic dispersion in unit 2 and by diffusion in units 3T and 3M.

Exhibit II presents an analysis of flow and transport through unit 3M using Fuzzy set theory. The numbers on the spreadsheet preceded by a ▶ are "fuzzy" numbers represented by the belief graphs shown to right of the numbers. This represents a powerful intermediate step between "crisp" calculations, such as that presented in the old version of the SSSS, and the monte carlo simulation technique, which requires a significant amount of data to define the statistical distribution of the parameters.

EXHIBIT I

Molecular Diffusion

Molecular Diffusion			
Average Thickness	6.1 meters		
Diffusion Coefficient	1.00E-10	to	1.00E-11 sqm/sec
Time (years)	Time (Seconds)	C/C ₀ D*=1.00E-10	C/C ₀ D*=1.00E-11
10	315360000	0	0
100	3153600000	1.57652E-14	0
500	15768000000	0.000592557	0
1000	31536000000	0.015144266	1.57652E-14
5000	1.5768E+11	0.27737219	0.000592557
10000	3.1536E+11	0.44243433	0.015144266
100000	3.1536E+12	0.80808979	0.44243433
100000000	3.1536E+14	0	0.980622003
Relative Concentration			

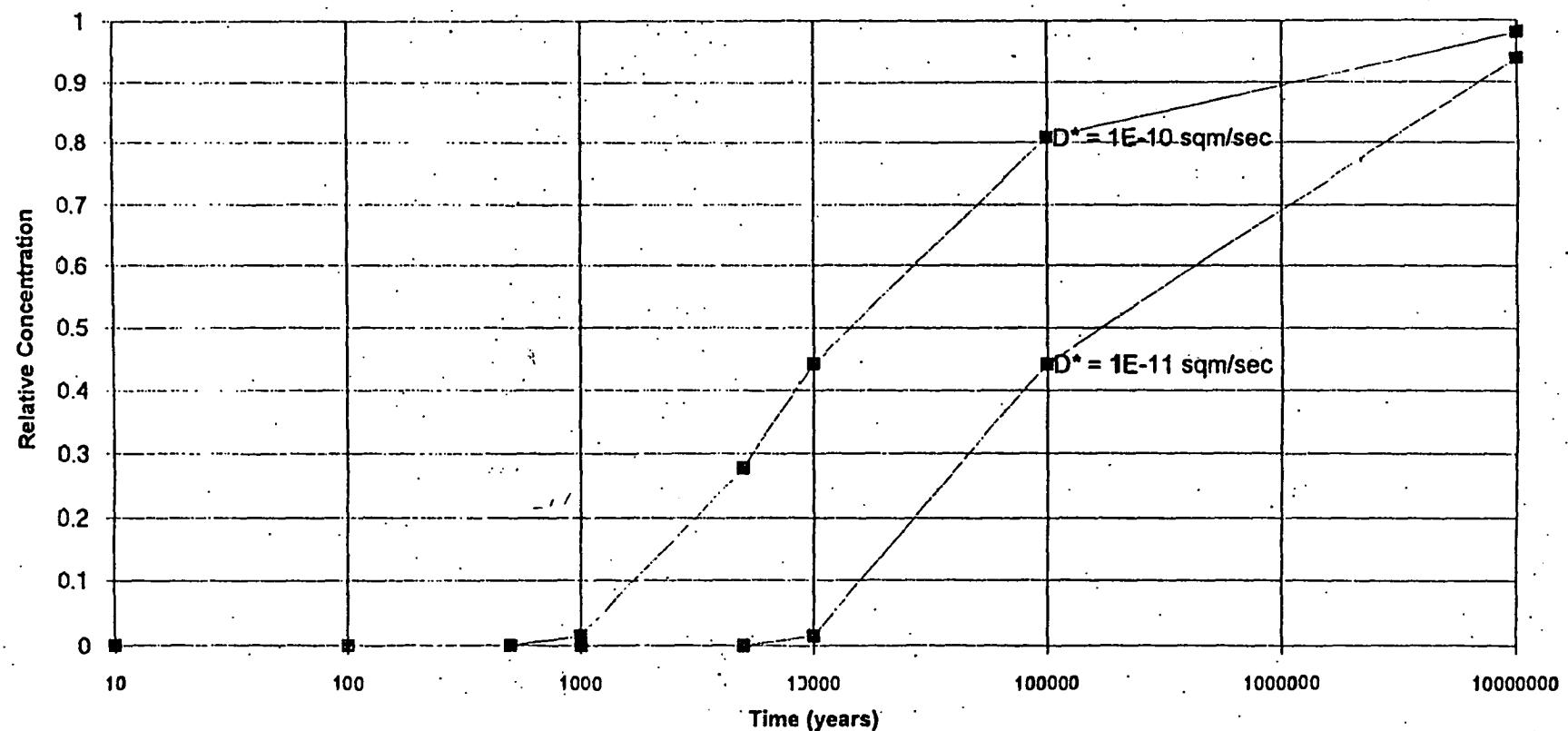
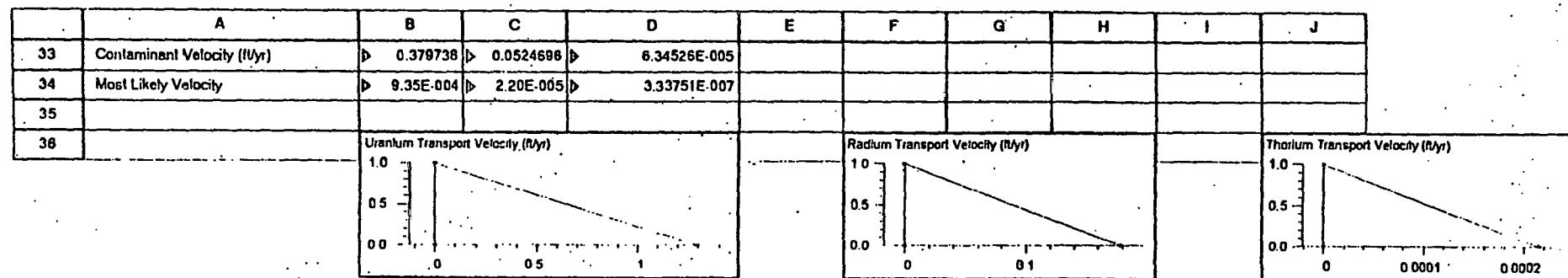
Concentration vs. Time for Diffusion

Exhibit II

Transport through Subunit 3M



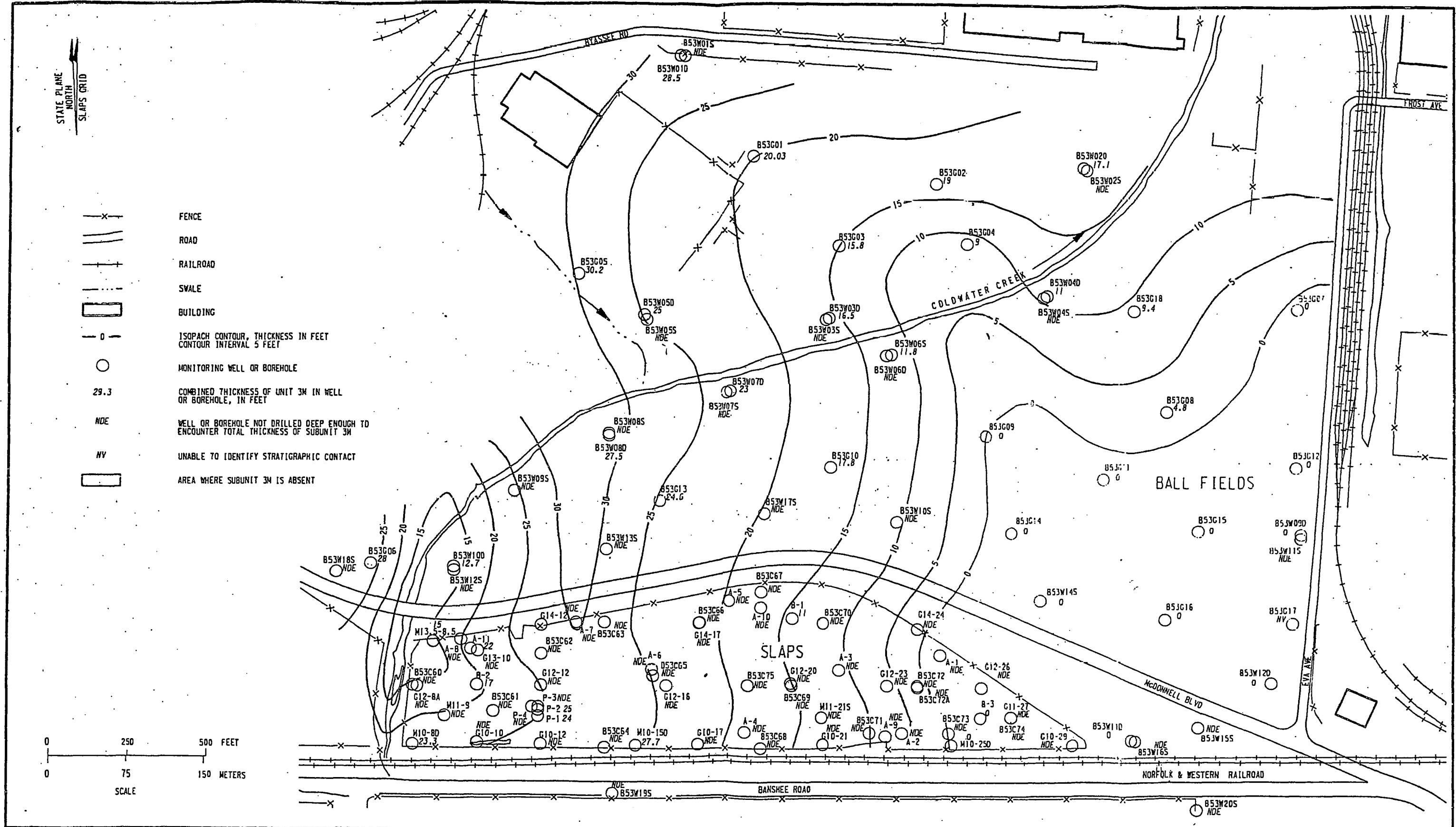


Figure 3-10
Isopach Map of Subunit 3M

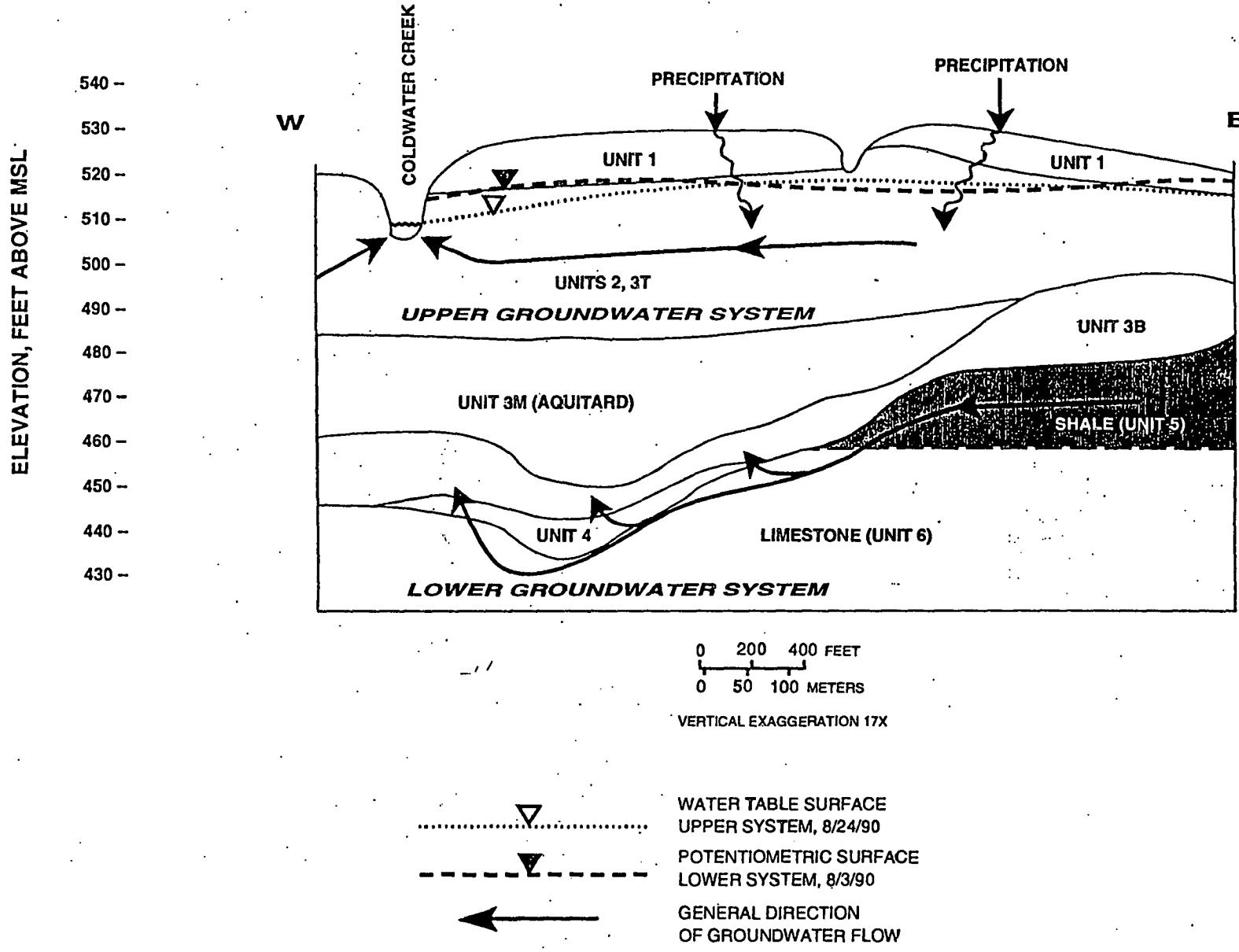


Figure 4-6
Conceptual Model of Groundwater Flow at SLAPS

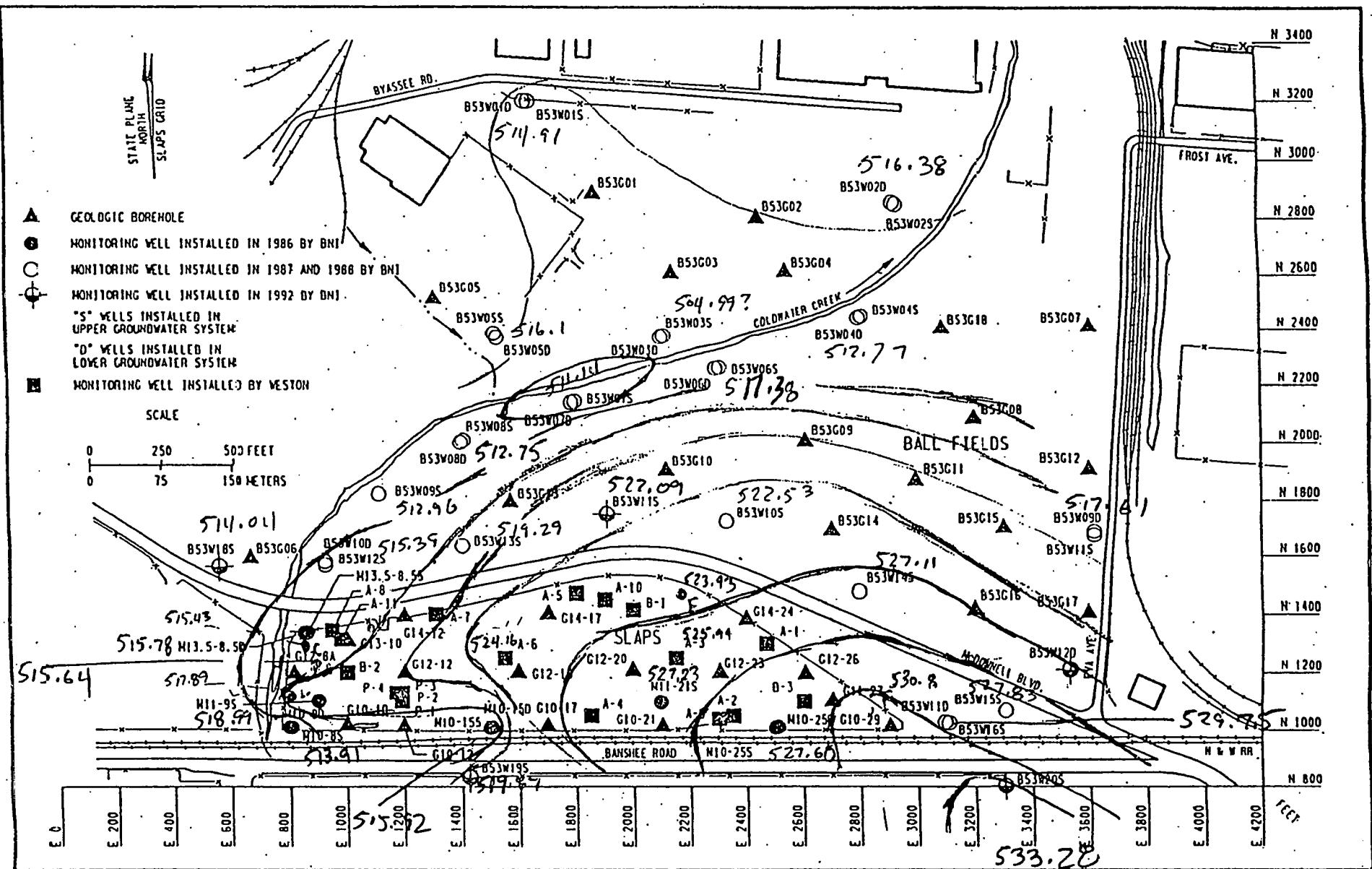
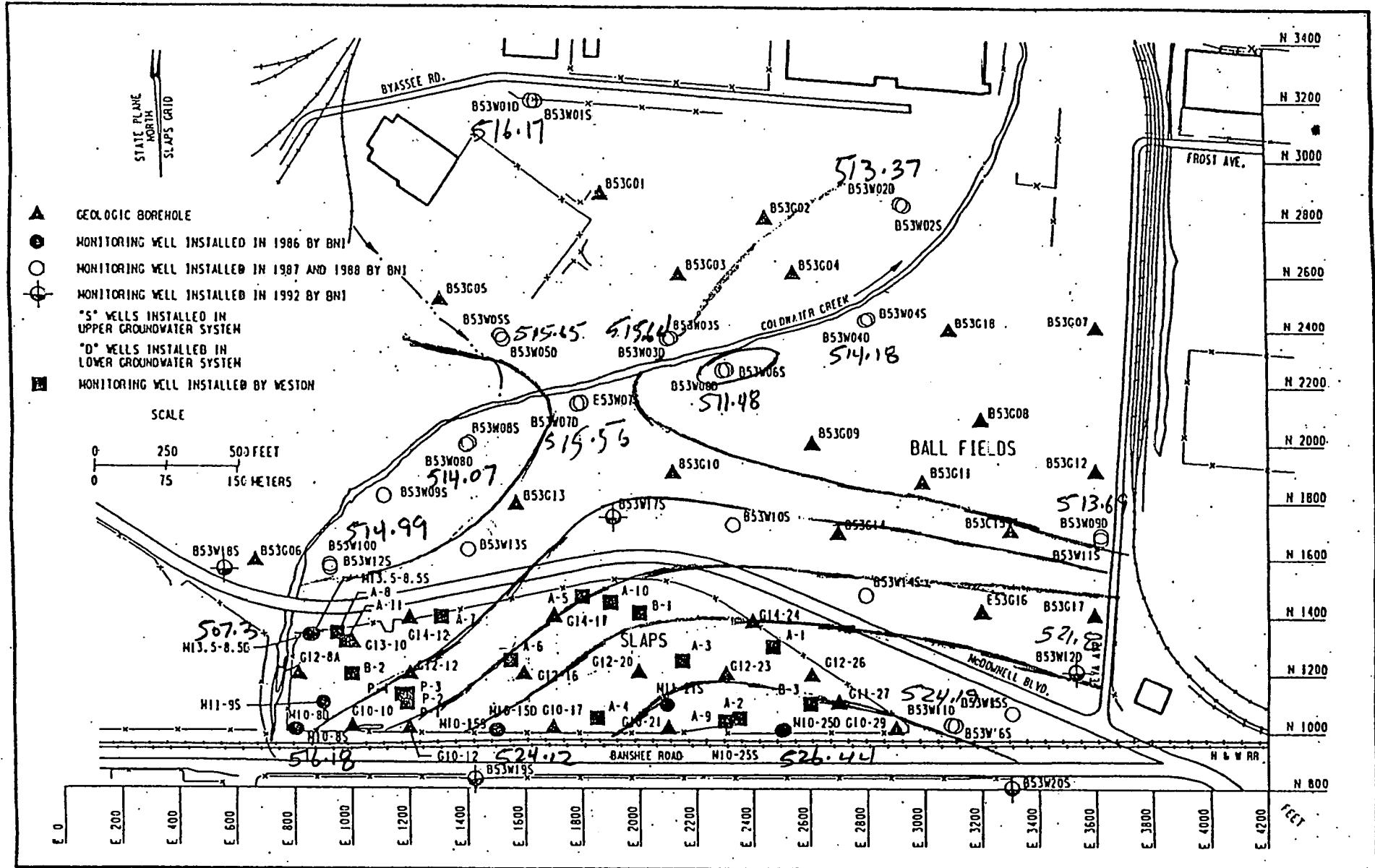


Figure 3-1
Borehole and Monitoring Well Locations



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Figure 3-1
Borehole and Monitoring Well Locations

E-23

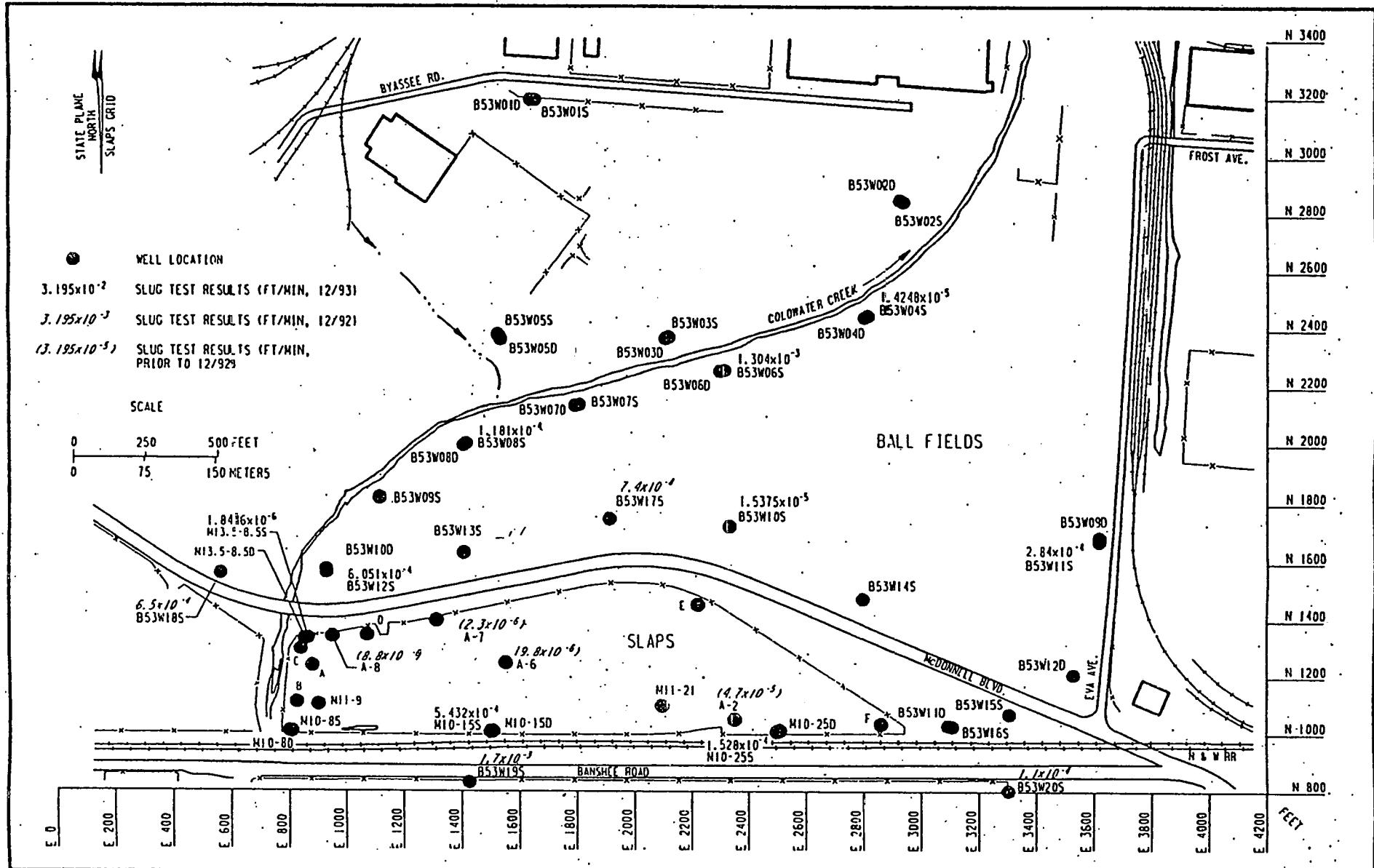
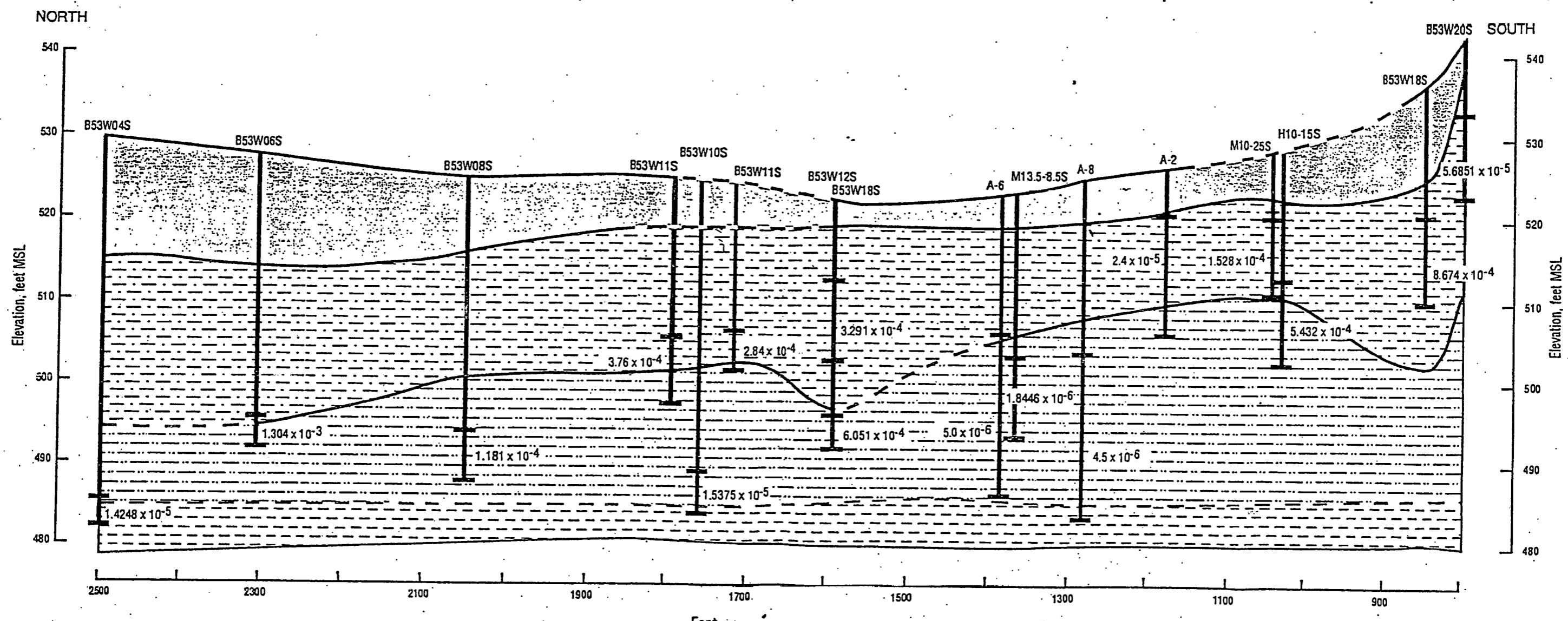


Figure E-1
Shallow Well Slug Results
Falling Head Test

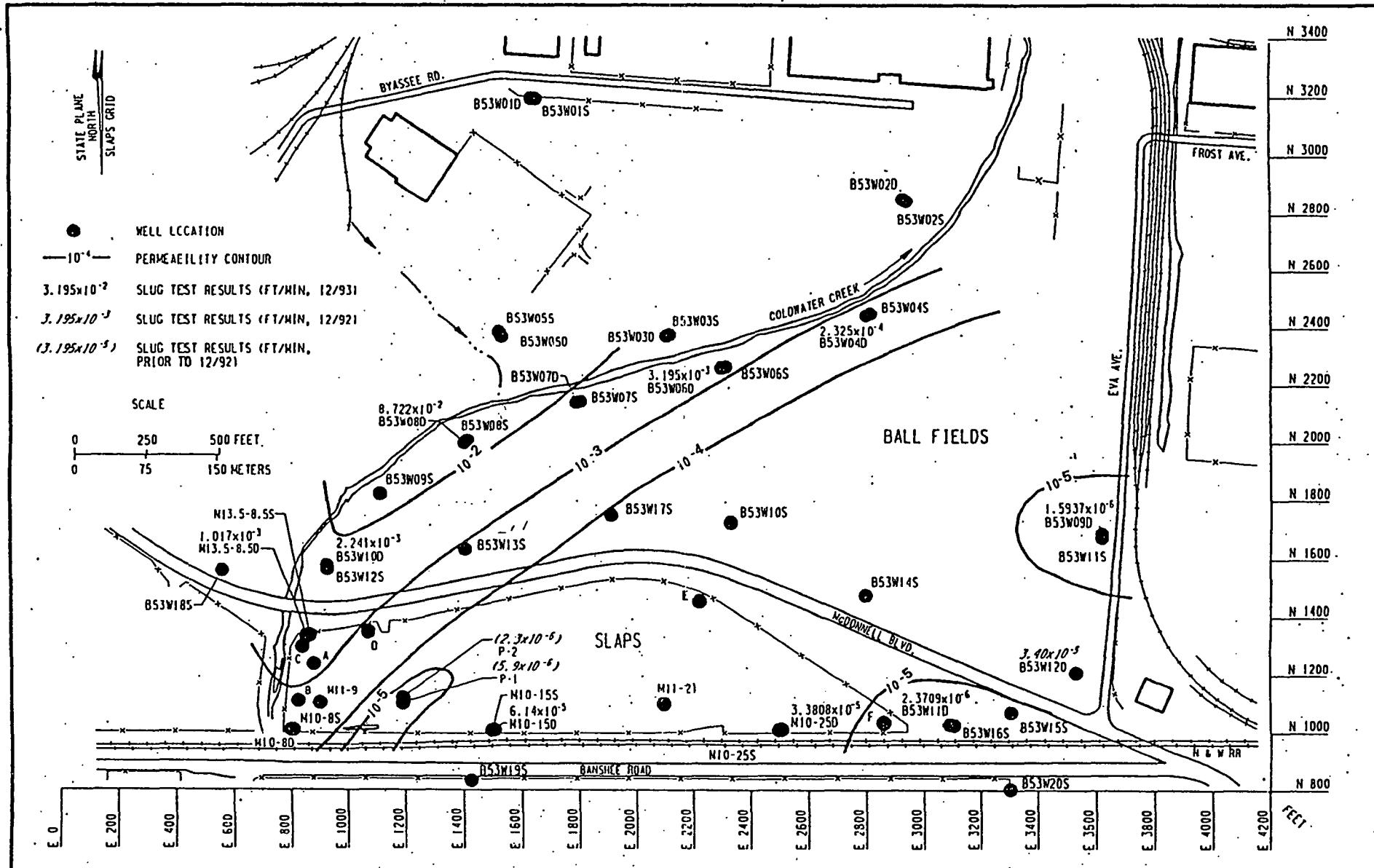


Notes: For definition of subunits see BNI (1994) SLAPS site suitability study.
Wells projected on to a hypothetical north-south cross section contacts estimated where dashed.

5×10^{-6} Screen interval with permeability in feet/min.

Fill 3T
 2 3M Borehole/Monitoring Well

Figure E-2
Schematic Cross Section Through SLAPS Site Showing Field Permeabilities

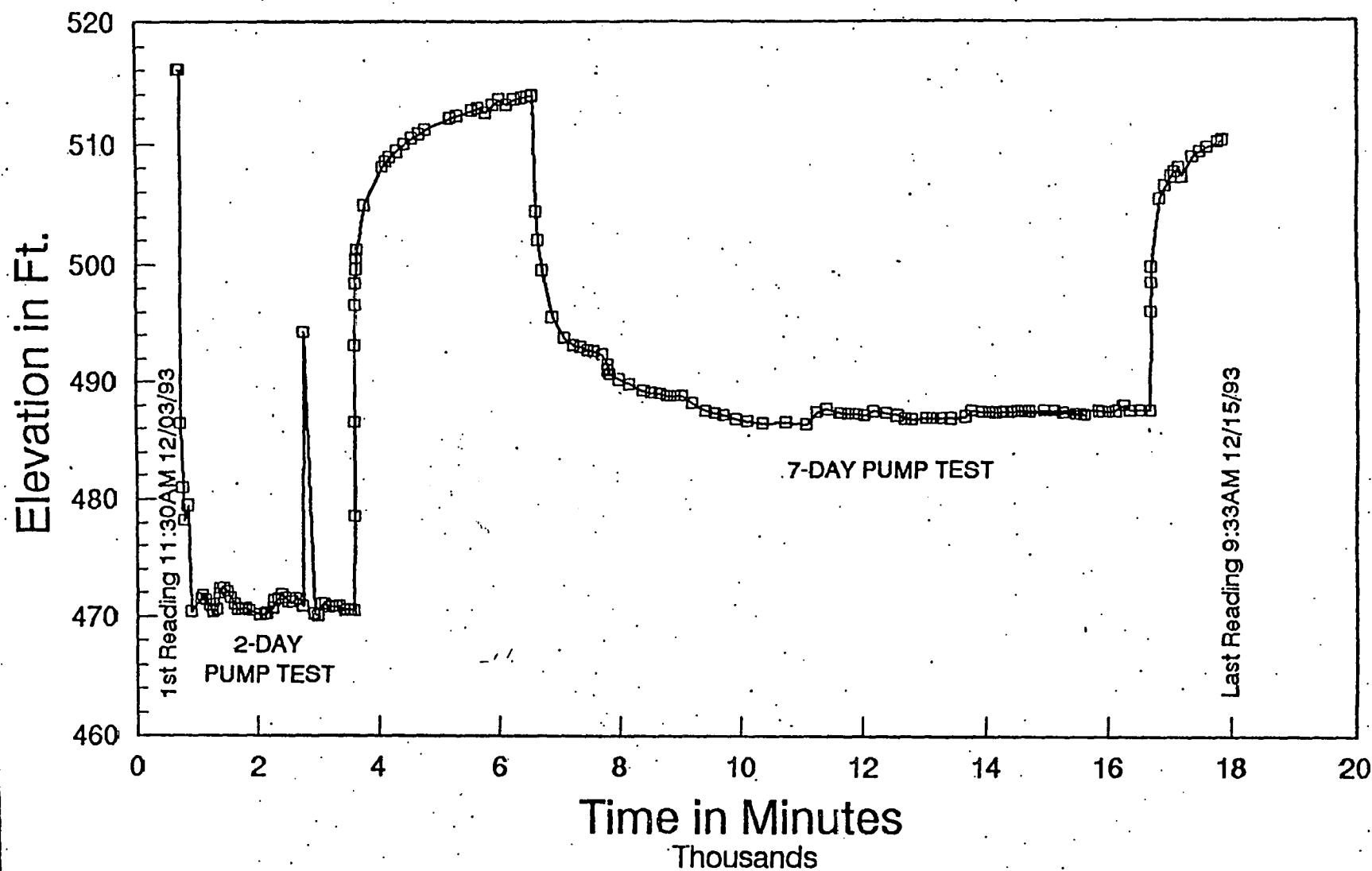


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Figure E-3
Deep Well Slug Results
Falling Head Test

SLAPS/BALL FIELD HYDROGRAPH

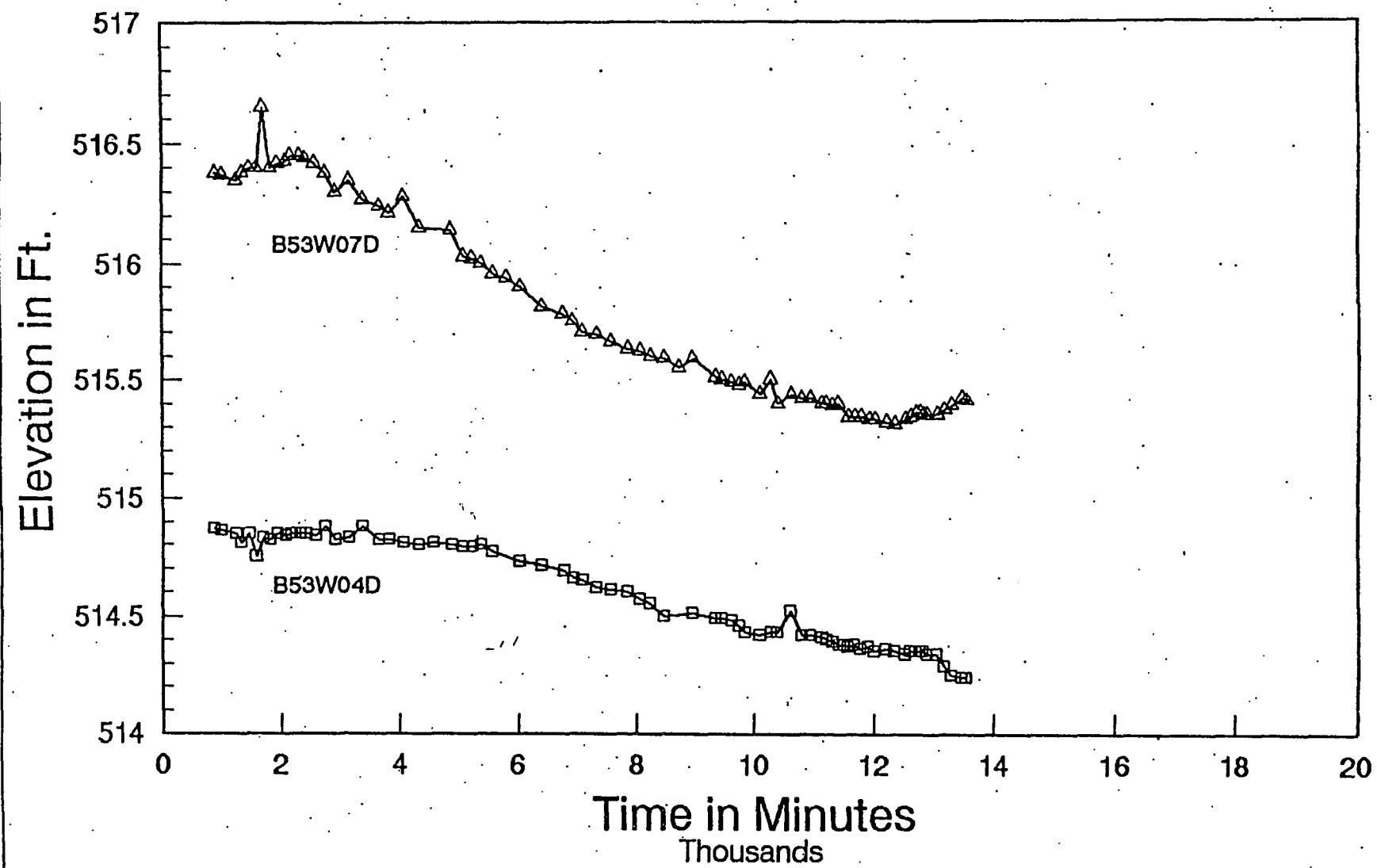
B53W06D WATER LEVELS



WATER LEVELS TAKEN MANUALLY USING A DOWNHOLE ELECTRIC WATER LEVEL PROBE

SLAPS/BALL FIELD HYDROGRAPH

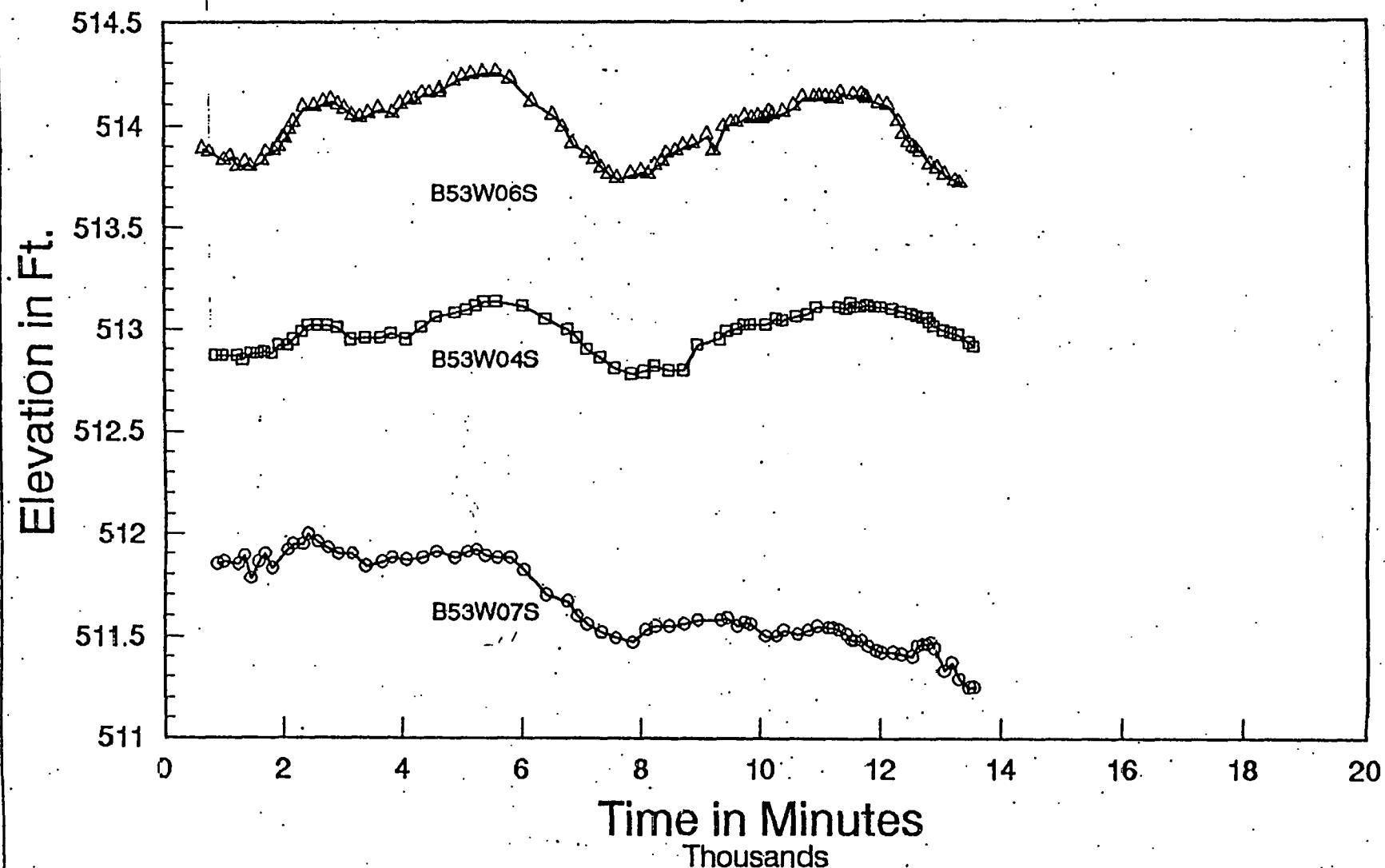
B53W04D and B53W07D WATER LEVELS



WATER LEVELS TAKEN MANUALLY USING A DOWNHOLE ELECTRIC WATER LEVEL PROBE

SLAPS/BALL FIELD HYDROGRAPH

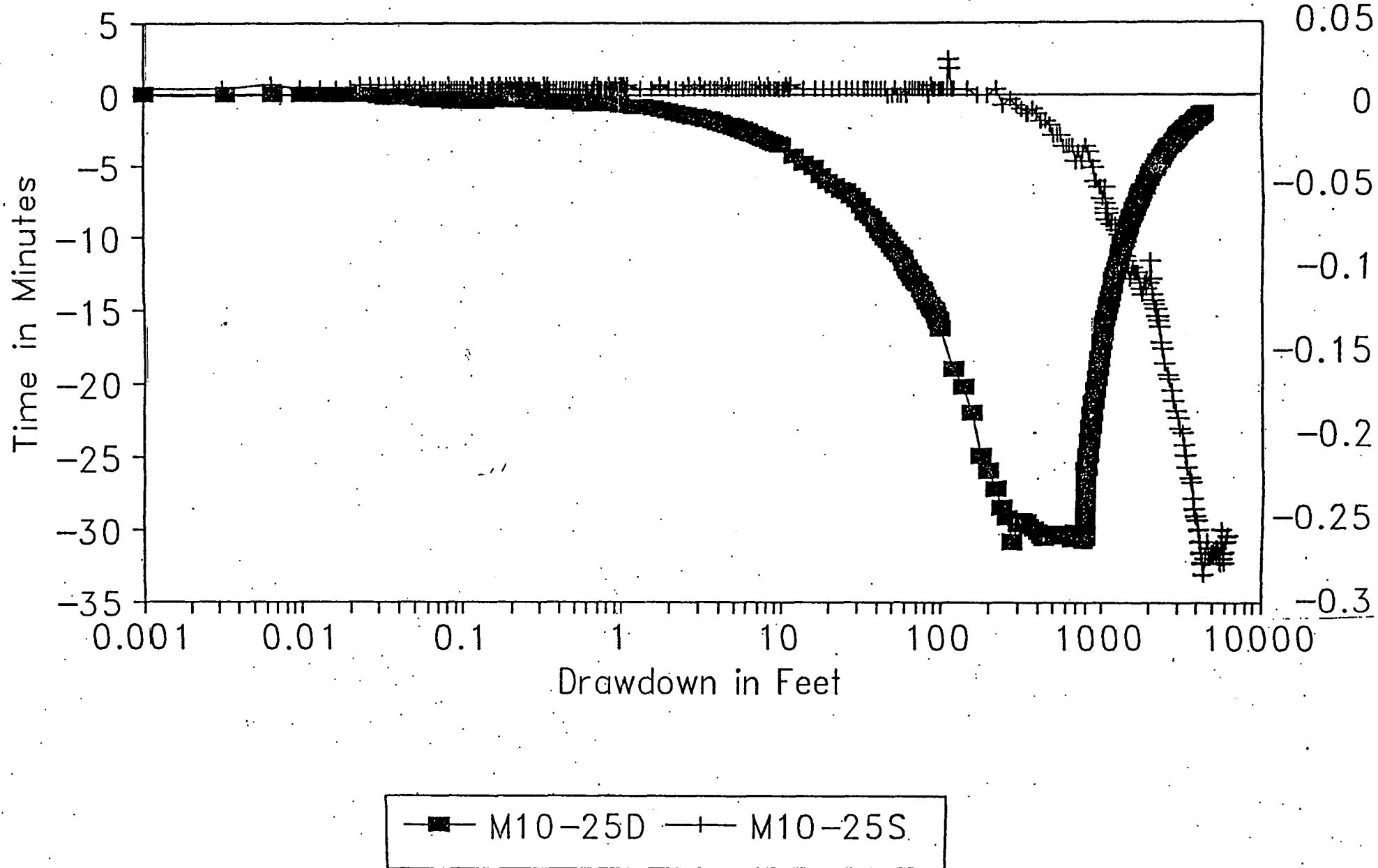
B53W04S, B53W06S and B53W07S WATER LEVELS



WATER LEVELS TAKEN MANUALLY USING A DOWNHOLE ELECTRIC WATER LEVEL PROBE

SLAPS Hydrograph

M10-25D and M10-25S



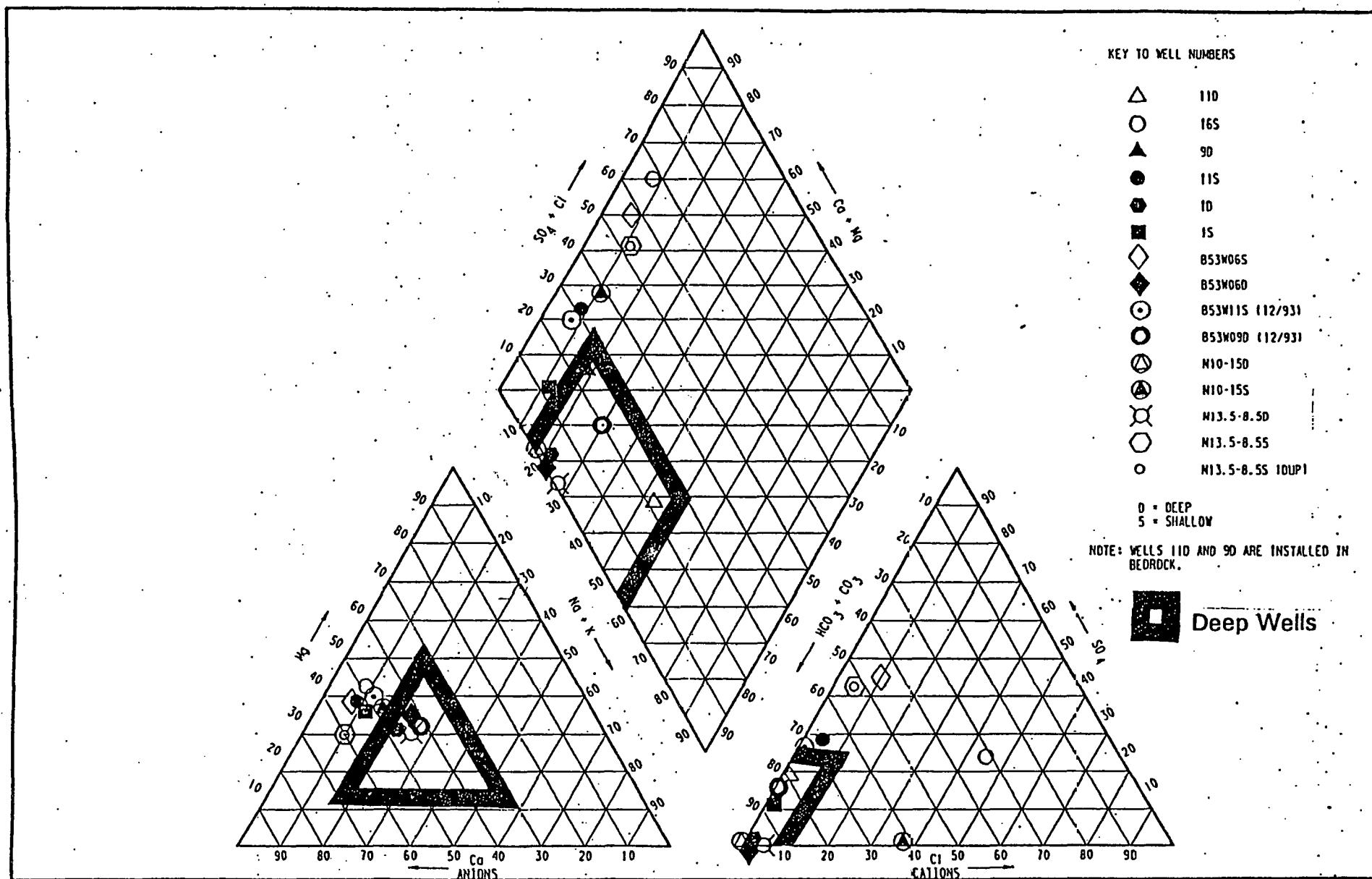
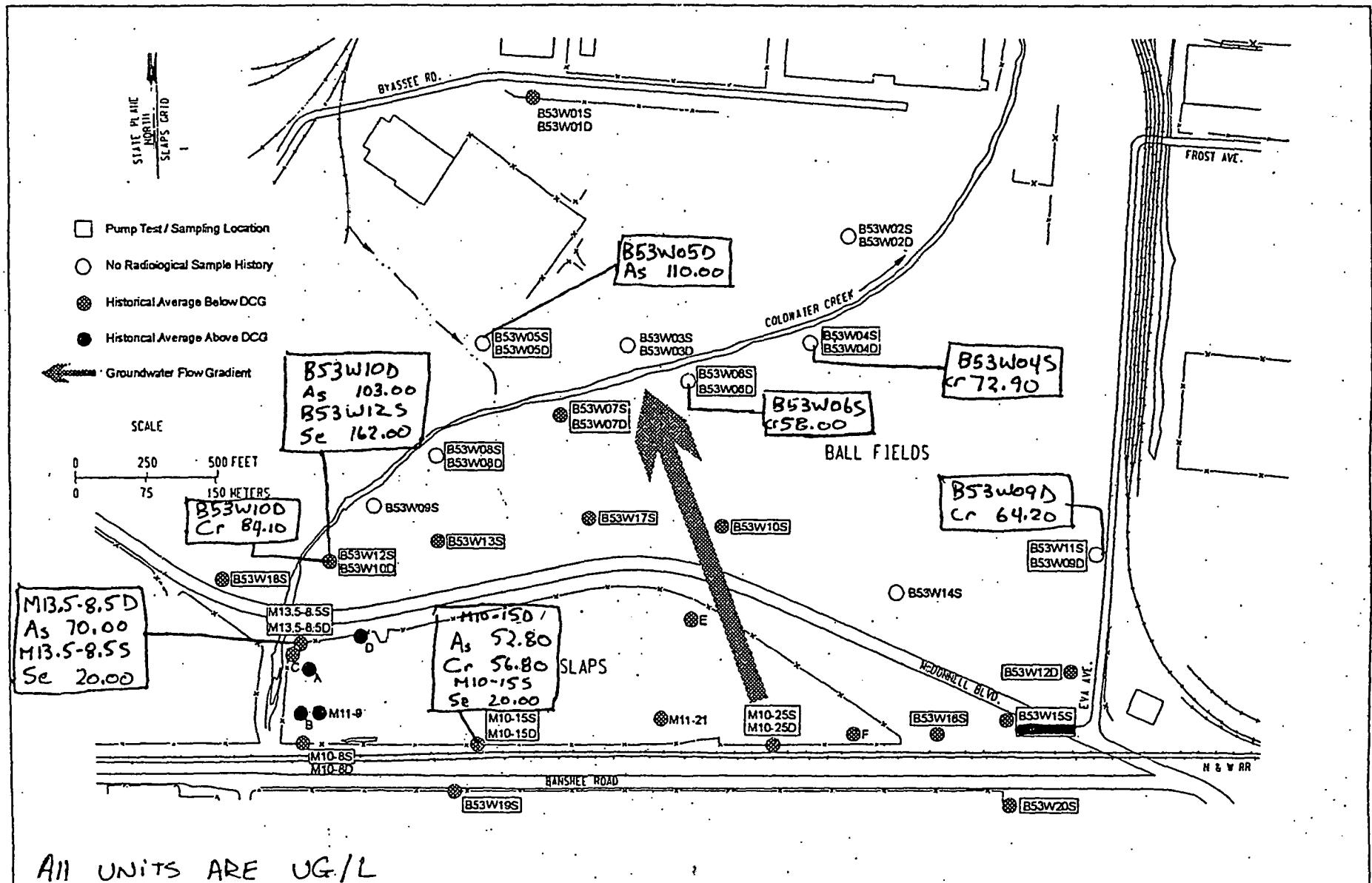
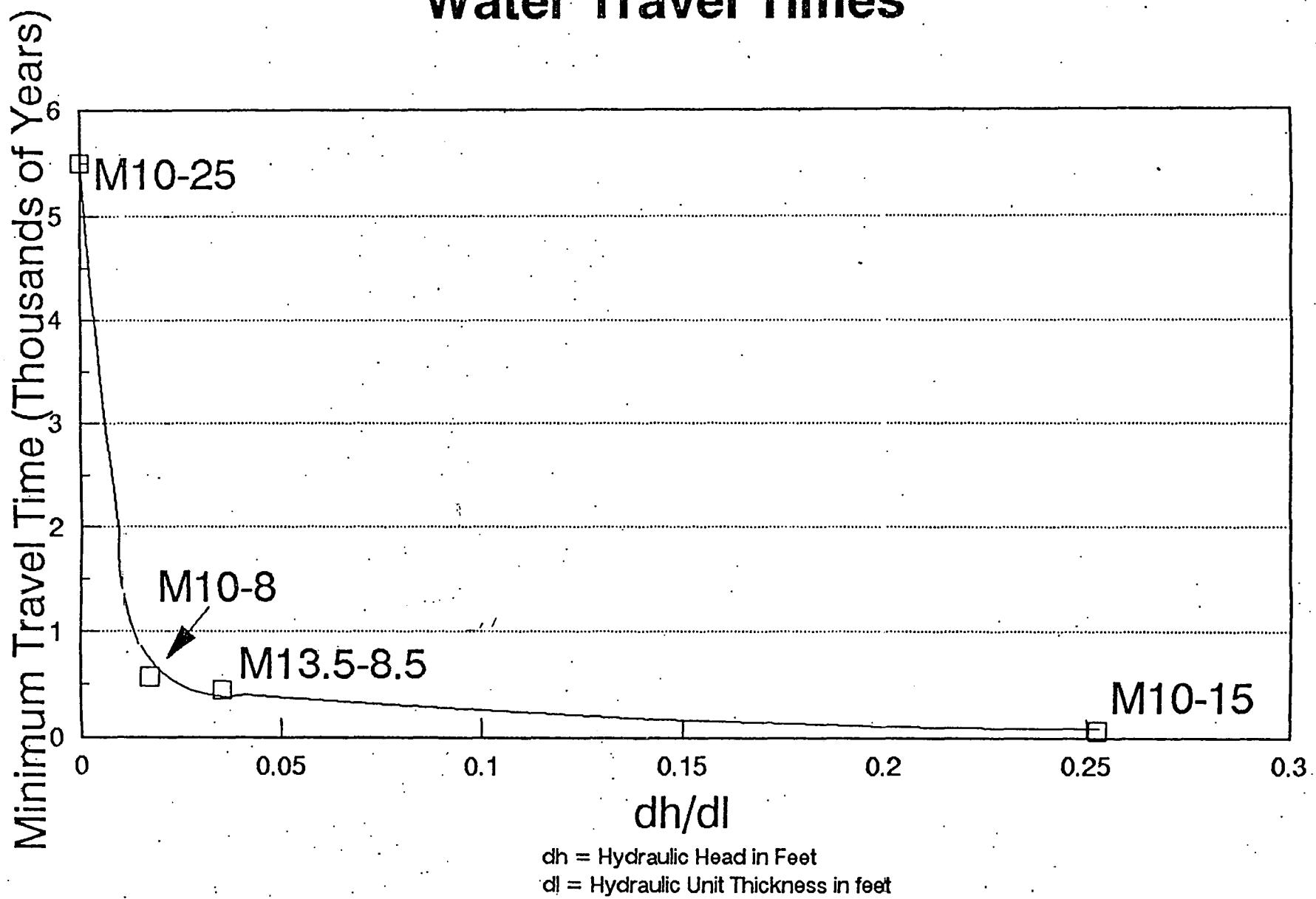


Figure E-4
Trilinear Water Chemistry Diagram for Well Pairs in the Ball Fields Area

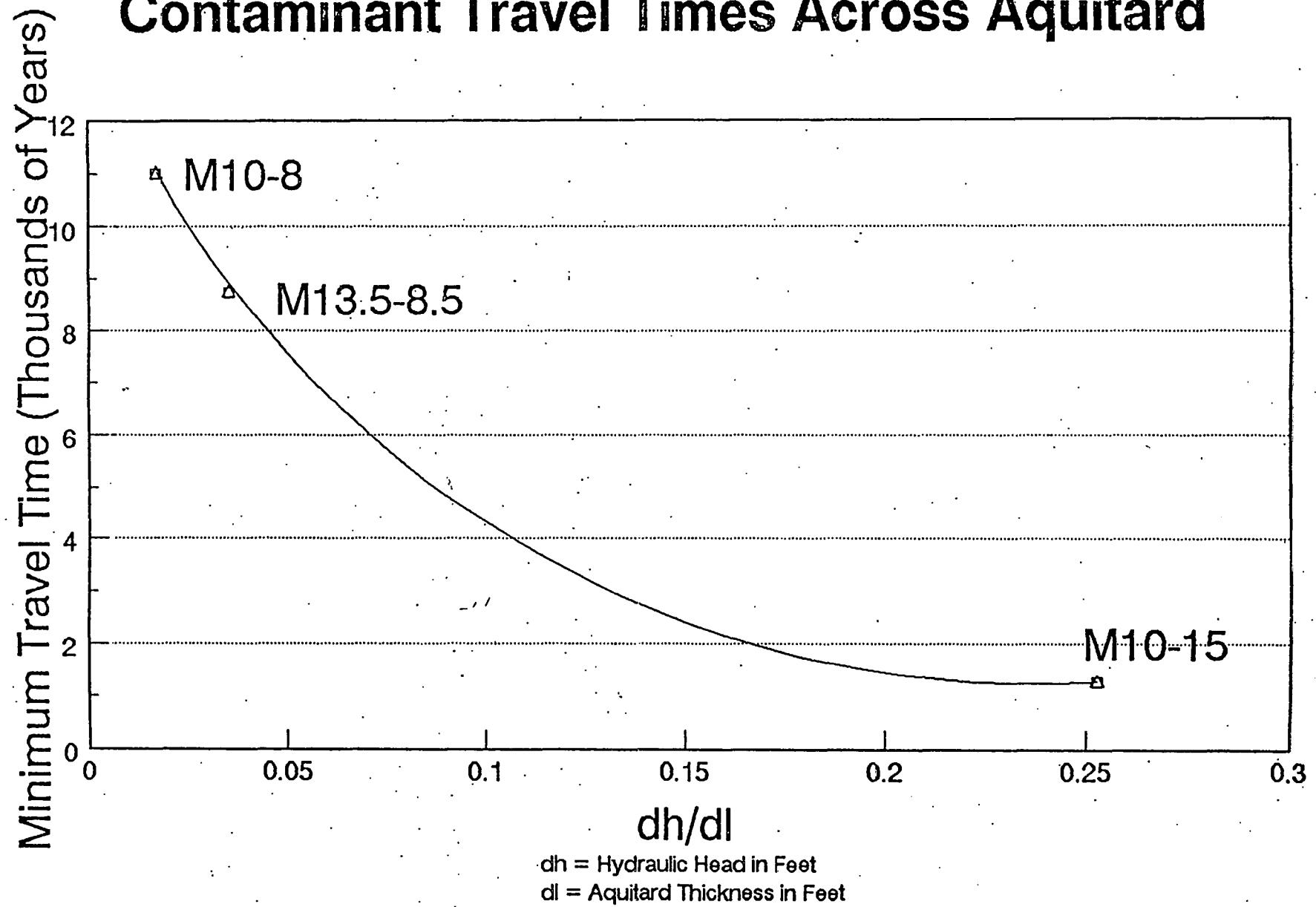


SLAPS PUMP TEST / SAMPLING LOCATIONS

Water Travel Times



Contaminant Travel Times Across Aquitard



SUMMARY CONCLUSIONS

- 1) Where the 3M unit is present, it effectively isolates the lower water bearing unit from the upper water bearing unit.**
- 2) Where 3M is absent, the upper and lower water bearing units are in direct communication.**
- 3) Recharge of the lower unit is occurring in the Southeast corner of the site.**
- 4) Difference in water quality parameters substantiate the conclusion stated above.**
- 5) The horizontal transport model is valid with regard to the additional data.**
- 6) Vertical travel for the most mobile contaminant , at the well location with the highest vertical downward gradient, is in excess of 1200 years.**

Table 4
 Maximum, minimum, 25, 50, and 75 percentile values for
 constituents in water from Mississippi and Missouri River Alluvium

Constituent	Maximum	Data in milligrams per liter			Minimum
		75	50	25	
Iron (Fe)	48	9.4	5.2	2.9	.06
Manganese (Mn)	4.3	.95	.75	.39	.15
Calcium (Ca)	172	133	106	81	46
Magnesium (Mg)	48	34	26	19	10
Sodium (Na)	224	16	11	7.6	1.1
Potassium (K)	6.2	5.0	3.9	1.4	.8

Table Excerpted from:
 Water Resources of the St. Louis Area, Missouri, 1974.

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Formerly Utilized Sites Remedial Action Program (FUSRAP)

ADMINISTRATIVE RECORD

for the St. Louis Site, Missouri



U.S. Department of Energy