WELL LEVEL MONITORING INVESTIGATION

Series 1, Series 2 and Supplemental
Well Series Final Review

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Hilding K.L. Spradlin

Abstract

During an 18 month period, three separate well level monitoring programs were conducted on the GKI Research Site. The Series 1 Wells, located around blasted, operational and spent retorts, confirmed that rubblization does improve horizontal communication and may possibly be effecting vertical communication. The Series 2 Wells, in contrast, have suggested that there is perched water above the mahogany oil shale bed, flowing in cracks and fissures, but not communicating freely either horizontally or vertically in areas not affected by retorting. The Supplemental Wells strengthened the findings of the Series 2 Wells by noting that there is very little horizontal communication of waters throughout the entire section as the heads of many of the wells are above surface elevations of another well a short distance away. All programs confirmed that the water table does vary seasonally, but even during wet periods this variance is not statistically significant.

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INTRODUCTION

The primary goal of the hydrologic and water resource investigations, currently underway at the Geokinetics Incorporated (GKI) Field Research Site (section 2, R22E, T14S) in Uintah County, Utah, is to determine if the development of a modified in-situ process by GKI will adversely impact water resources in the region.

With the research site virtually lacking surface waters such as creeks or lakes, process impacts to the water resources in the region are limited to underground water sources. Therefore, the primary goal can be specifically stated:

Determine if either groundwater from a shallow aquifer, produced water or leached water can contaminate any significantly cleaner underground water source.

This determination will require the following to be accomplished:

1. Characterize, identify and quantify the chemical constituents in groundwater, process water and leached water.
2. Determine the configuration of the geological formations that will be affected by the retorting process or which may be open to contamination by the retort effluent.
3. Determine the perturbation to groundwater movement caused by processing operations.
4. Determine the environmental transport, interactions and fate of solutes released to subsurface waters.
5. Quantify the discharge of produced water and determine the effects on surface and groundwater supplies and quality.

These various components of the primary goal will be reported upon separately and in combination as data and interpretations become available.

OBJECTIVES

It became apparent upon implementation of the GKI hydrology and water resource investigation that very little was known of the detailed hydrologic framework of the site. It was also realized that in order to effectively design and implement cost effective and efficient research programs to satisfy the goals set forth in the investigation, a basic knowledge of the local hydrologic framework would have to be obtained first. The well level monitoring program was designed with this in mind, and was implemented with the intention of obtaining this basic knowledge and, subsequently, obtaining a hydrologic stepping-stone for the rest of the investigation.

The specific objectives of the well level monitoring program were to:

1. Locate and identify the types of groundwater bodies above and below the mahogany oil shale bed;
2. Obtain physical and mathematical determinations of the movement of groundwaters through areas in which in-situ retorts have been developed and/or operated, as well as areas where such development is proposed.
3. Estimate groundwater volumes and direction of flow, and monitor for seasonal variations; and
4. Identify the more specific hydrologic and water resource research needs.

EXPERIMENTAL DESIGN

Thirty-three (33) wells comprising the first series of hydrologic monitoring wells were completed in January 1978. A second series of thirteen (13) wells was established later in June of that same year. This first and second series of wells will hereinafter be referred to as Series 1 and Series 2 Wells respectively.

Well level monitoring of the Series 1 Wells began on January 4, 1978 and was terminated on February 13, 1979. The monitoring program of the Series 2 Wells began on June 7, 1978 and is still in progress at this time.

In addition to the well level monitoring of the Series 1 and Series 2 Wells, on June 17, 1978 until December 26, 1978 a supplemental series of wells consisting of fourteen (14) previously drilled core holes scattered about the section became a third well level monitoring assignment.

The Series 1 Wells were distributed about various in-situ retorts, all of which had been previously blasted and a few had already been developed and operated. Of the thirty-three (33) wells proposed, twenty wells (20) were designated "shallow" wells and designed to monitor perched waters above the mahogany oil shale bed; thirteen (13) wells were designated "deep" and intended to provide monitoring access to the fracture waters below the rubblized zone.

All Series 1 Wells were assigned a unique two digit number. Those wells displaying an even first digit were the more numerous shallow wells which were distinguishable from the deep wells displaying an odd first digit. Specific locations and identifications of the wells, along with their associated retorts, are illustrated on Maps 1-3 Appendix A.

The shallow wells were drilled three inches in diameter and to depths ranging from 25 feet to 60 feet. These depths corresponded to approximately the midpoint of the retorting zones. These wells were surface cased to prevent untimely deterioration of the hole at the surface, and collars and caps were placed on each. Deep wells were drilled to depths well below the retorting zone with depths varying from 90 feet to 140 feet. Each of the wells was cased with the lower twenty or so feet of the casing being perforated. These wells were then packed a few feet above the perforation to minimize mixing of waters from above and below the mahogany. Collars and caps were installed on each casing at the surface. All well depths, collar elevations and specific locations are listed in Table 1 Appendix B.

The Series 2 Wells were proposed and drilled with the purpose of obtaining comparative data between shallow wells in areas not disturbed by blasting and wells monitoring previously blasted areas. This series of wells is located west of the pipeline in the north-central portion of the section. The design and general location is illustrated in Map 4 Appendix A. The wells were laid out in the shape of a cross with each well having a designated 200 series, three-digit number. The center well is numbered W-200, and the four legs of three wells each were numbered W211-W213, W221-W223, W231-W233 and W241-W243. These wells were drilled down to the mahogany marker bed, and were surface cased and capped for the same reason as given for the Series 1 Wells. All well depths, collar elevations and specific locations are listed in Table 2 of Appendix B.

The fourteen (14) core holes of the Supplemental Series Wells are located at various points about the section. All these wells extend down below the mahogany oil shale bed. The general locations of the Supplemental Series Wells are illustrated on Map 5 Appendix A. All the core holes are surface cased and capped. The monitoring of these supplemental wells was implemented to attain general knowledge of the behavior of the hydrology about the section utilizing these various deep wells. All core hole depths, collar elevations and specific locations are listed in Table 3 Appendix B.

MONITORING AND ANALYSIS

Conductivity probes were used to ascertain the well levels. Throughout the monitoring program, various types of conductivity probes were utilized as it was found that oil communicating with the shallow wells in the Series 1 Wells tended to cause the conductivity probes to malfunction.

The monitoring of most of the Series 1 Wells began in January 1978, and three of the deep wells (W51, W52, W53) were added to the monitoring program in February of the same year.

During the monitoring period, due to the retorting operations in progress, many of the Series 1 Wells were destroyed or rendered useless. By June 1978, only half the wells remained, and by the end of the monitoring period, only thirteen wells were still being monitored. Also, over the thirteen months of monitoring, the sampling schedule decreased from three times a week to once a month as activity about the area of the retorts decreased. All data obtained from the Series 1 sampling is recorded in Table 4, Appendix B.

The monitoring schedule for the Series 2 Wells has remained constant throughout the entire monitoring period. Fifty six individual samplings, taken once a week, have been recorded for each well of the Series 2 Wells. The depths were measured to the nearest one-tenth of a foot as was the case for all wells monitored. Data obtained from the Series 2 samplings is recorded in Table 5 Appendix B.

The monitoring schedule for the Supplemental wells began as a bi-monthly sampling and decreased to once a month as accessibility to the wells lessened due to winter. This inaccessibility finally lead to the termination of the monitoring program in December 1978. Data obtained from the Supplemental wells series is recorded in Table 6, Appendix B.

The first step in the analysis of the collected data was to obtain first order statistical descriptions of the individual wells. The results are recorded in Table 7, Appendix B, and the methodology is discussed in Appendix C 1.

The data was then separated into quarterly or seasonal components. Comparative analysis, utilizing the statistical "F" Test, was conducted to determine if there were:

1. Significant differences between the mean of all wells in a series of wells for a season to the mean obtained for the same wells for another season; and
2. Significant differences between seasonal means obtained for one series of wells to seasonal means of another series of wells.

The seasonal breaks were the first day of January, April, July and October. The means were obtained for each series of wells by averaging all readings of all wells in the series obtained in four consecutive monitoring periods, two prior and two after the first day of the seasonal break. The statistical "F" Test will be described further in Appendix C 2.

DISCUSSION OF RESULTS

Visual observations of data from all well series verified that there were seasonal variations in water levels. It was noticed that some of the wells, but not all, would have rising heads during peak spring runoff, but would slowly decline as the drier seasons neared. Surprisingly though, the number of wells affected by the spring runoff were in the minority, thereby not significantly altering a particular well series mean of their respective water table elevations. This was verified by the "F" Statistical Test of means within the same well series. Results of the statistical "F" Test are recorded in Table 8 Appendix B.

Inspection of the standard deviations from the seasonal means for the Series 1 Shallow Wells indicated that the blasting of retorts had improved horizontal communication considerably. The standard deviations for the shallow wells of Series 1 averaged around ± 3.7 feet whereas those obtained from the Series 2 Wells was ± 13.8 feet.

The deep wells from the Series 1 Wells showed very little patterning. Mean well levels varied from 6750 feet to 6775 feet. None of the wells were found to exceed the mean head of the shallow wells, but some were found to approximately equal the mean head of the shallow wells. The following possibilities exist with the findings of the deep wells:

1. The casings and packings worked properly and therefore the deep wells depict highly varied heads among themselves naturally;
2. The casings and/or packings in many of the deep wells were damaged due to retorting operations in the vicinity of the wells causing communication to be developed between shallow and deep wells; or
3. Due to the blasting of retorts, vertical communication through the mahogany has developed.

The second and third possibilities can be further elaborated upon by recognizing that if water does communicate vertically through the mahogany, the heads of the various deep wells may not be indicating true heads. They could instead be a measure of the water allocated to them. It would be expected that if there is communication through the mahogany to several wells that they would reach the mean head of the shallow wells over time. Visual inspection of the data has strengthened this possibility as it has been noticed that most of the deep wells have shown a continual increase in water elevation throughout the monitoring period.

Visual inspection of data has also indicated that some sort of vertical communication does exist as some of the deep wells show a perturbation to their mean head during spring runoff. Deep wells and shallow wells displaying seasonal runoff perturbations were compared to each other. It was suspected that if the deep well perturbations coincided exactly with those of the shallow wells, that there was a strong possibility that the casings and/or packing had malfunctioned. Secondly, if there is a lag in time then it is most likely suggestive of blast related communication through the mahogany oil shale bed. Unfortunately, due to relatively varying times that the shallow wells displayed a seasonal perturbation to its normal mean, it was impossible to determine if a lag time existed or not.

The Supplemental Series convincingly illustrated that the mean heads of individual wells in undisturbed areas are highly variable about the section. Since these wells were not packed or cased to eliminate vertical communication through the mahogany, comparisons could not be conducted between the Supplemental Series and the Series 1 Deep Wells.

The Series 2 Wells were checked, utilizing a Standard "t" Statistical Test of the means to evaluate possible flow patterns. Unfortunately, due to large standard deviations obtained, the results of the "t" Test were inconclusive. The standard "t" Statistical Test is discussed greater in greater detail in Appendix C3.

CONCLUSIONS AND RECOMMENDATIONS

The well level investigation did answer many of the preliminary questions that needed answering, and has also provided GKI with a relatively solid base to build their future hydrology and water resource investigations upon. On the other hand, the investigation was a good example to GKI of inefficient and poorly planned investigative procedures. They were expensive, time consuming and relatively non-productive.

This program was inefficient right from the beginning for the following reasons:

1. Specific goals to be obtained from each of the monitoring programs were not stated;
2. The design of the monitoring programs failed to minimize or control variables;
3. The design of the investigation was conducted without the specific goals in mind; and
4. Very little thought was given to alternative methods that may have been more efficient, cost effective and less time consuming during the design of the investigation.

Much that has been learned from this investigation is confirmation of that which has been previously discovered through various unrelated procedure. The Series 1 Shallow Wells confirmed that rubblization or retort blasting does improve horizontal communication. The extent of communication has yet to be determined.

The Series 2 Wells, in contrast, have suggested that there is perched water above the mahogany oil shale bed, flowing in cracks and fissures, but not communicating freely either horizontally or vertically. Neither the Series 1 Shallow Wells or the Series 2 Wells could give an estimate as to how much groundwater could be found perched above the mahogany or if there is a flow to the water at all. The investigation did not include any pump down tests or recharge investigations.

The Series 1 Shallow Wells and the Series 2 Wells, through well level monitoring, did show that there is significant contributions to some wells from spring runoff. As to why some show marked perturbations and others of the wells indicate absolutely no variability to seasonal influences has yet to be determined.

From a statistical standpoint, it was concluded that although a few of the wells displayed significant variability to seasonal perturbations, the water table above the mahogany does not significantly change from one season to another. This investigation was not long enough to confirm the above statistical conclusion during long periods of continued draught.

The Supplemental Well Series has suggested that there is very little horizontal communication of waters throughout the entire section as the heads of many of the wells are above surface elevations of another well a relatively short distance away. This is reinforced by the amount of water found in the various wells and the lack of water outcropping on the surface at any one moment.

Finally, the deep wells of the Series 1 Wells suggested the only new knowledge of the local hydrologic structure by indicating that there is vertical communication through the mahogany underneath the retorts in the vicinity of Series 1. Unfortunately, it has not yet been determined if this is due to blast related fracturing of the mahogany or if the communication was caused by malfunctioning casings and/or packings.

The following recommendations have been formulated from the findings of this investigation.

1. All well level monitoring programs currently in progress should be terminated immediately;
2. A well designed groundwater investigation based on current knowledge of the immediate geology of the research section should be designed and implemented; and

3. Design and implement a cost-effective and efficient hydrologic investigation to determine water volumes and flow rates, and to evaluate horizontal and vertical communications.

The well level monitoring program, as it stands now, has exhausted its ability to provide us with new and beneficial knowledge. It would be advisable to discontinue the monitoring of the well levels until after a geologic investigation with respect to the hydrologic structure of the section has been conducted. The geologic investigation should be designed to give GKI specific answers to the structure, the extent of communication and volumetric data for those areas above the mahogany oil shale bed and also below the mahogany. If after the geologic investigation has been conducted, it is felt that a well level monitoring program can answer some specific questions, then thought should be given to modifying the monitoring program to fit those specific goals.

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APPENDIX A. MAPS.

1. Series 1 - Specific locations of hydrologic monitoring wells about Retorts #13, 14 and #15.
2. Series 1 - Specific locations of hydrologic monitoring wells about Retorts #11, 12 and #16.
3. Series 1 - Water monitoring well locations.
4. Series 2 - Hydrological Studies Wells.
5. Location of Supplement Series Wells on Section 2.

• WELL EXTENDING INTO RETORT LEVEL

⊙ WELL EXTENDING BELOW RETORT LEVEL

SERIES I: MAP 1.
SPECIFIC LOCATIONS OF
HYDROLOGIC MONITORING
WELLS

MAP 2 SERIES I
SPECIFIC LOCATIONS OF
HYDROLOGIC MONITORING
WELLS

- WELL EXTENDING INTO RETORT LEVEL
- ⊙ WELL EXTENDING BELOW RETORT LEVEL

-13-

MAP 3
SERIES I
WATER MONITORING
WELL LOCATIONS

SCALE: 1" = 100'

LEGEND:

RETORT BLASTED
AND BURNED

RETORT BLASTED

WATER
MONITORING
WELLS

ENVIRONMENTAL
LAB

WEATHER
STATION

MAP 4
SERIES 2 HYDROLOGICAL STUDIES WELLS

SECTION 2, T14S, R22E, UTAH COUNTY, UTAH

GEOKINETICS INC.

LEGEND

• HYDROLOGICAL STUDY
WELL

0 500' 1000' 2000'

MAP 5
LOCATION OF SUPPLEMENT
SERIES WELLS ON SECTION 2

GEOKINETICS INC.
KG

0 500' 1000'
SCALE

APPENDIX B. TABLES.

1. Series 1 Wells - Collar elevation, depths and locations.
2. Series 2 Wells - Collar elevation, depths and locations.
3. Supplemental Wells - Collar elevations, depths and locations.
4. Series 1 - Data.
5. Series 2 - Data.
6. Supplemental Well Data.
7. First order statistics for Series 1, Series 2 and Supplemental Well Series.
8. Results of Statistical "F" Test.

TABLE 1

SERIES #1 WELLS

Well	Depth	Collar Elevation	Northing	East ing
25B	36.0	6711.2	4891.31N	4547.35E
25A	35.5	6710.0	4913.05N	4563.61E
25	35.0	6709.4	4934.06N	4578.59E
12	90.0	6707.2	4955.61N	4593.67E
26	34.0	6708.1	4976.34N	4608.41E
26A	32.0	6707.1	4997.28N	4624.67E
26B	32.5	6707.3	5017.34N	4638.99E
18	95.0	6711.7	5029.80N	4558.99E
17	93.0	6714.1	4964.90N	4511.58E
28B	38.0	unknown*	5063.88N	4572.26E
27B	40.0	unknown*	4932.04N	4489.02E
15	100.0	6718.9	4946.91N	4419.39E
27A	52.5	6719.0	4988.71N	4447.52E
23	54.0	6718.5	5020.26N	4469.29E
13	100.0	6717.2	5033.71N	4473.18E
24	53.0	6717.9	5046.8 N	4484.92E
28A	52.5	6715.9	5022.07N	4665.83E
16	93.5	6713.7	5009.82N	4708.22E
61	36.3	6716.4	4841.13N	4460.83E
62	45.0	6722.4	4911.80N	4363.09E
11	81.5	6700.4	4884.43N	4695.16E
51	99.0	6719.0	4681.44N	4423.82E
52	105.0	6722.1	4725.81N	4352.26E
14	300.0	6720.9	5129.80N	4363.54E
53	106.0	6723.0	4735.50N	4330.48E
21	24.0	6700.8	4879.67N	4691.88E
22	24.0	6701.5	4889.86N	4698.40E
31	100.0	6718.8	4755.68N	4413.64E
32	139.3	6726.5	4829.36N	4315.67E
41	50.2	6720.3	4743.31N	4403.43E
42	50.3	6718.8	4770.62N	4423.54E
43	57.4	6725.6	4813.60N	4306.69E
44	57.0	6725.3	4840.97N	4327.10E

* Collar elevations were never obtained

TABLE 2

SERIES 2 WELLS

Well	Depth	Collar Elevation	Northing	Easting
200	51.6	6732.4	3923.47	2284.50
211	43.4	6730.4	3850.04	2352.38
212	46.2	6731.4	3776.61	2420.27
213	46.2	6734.2	3703.18	2488.15
221	53.0	6737.2	3855.42	2211.23
222	52.6	6743.2	3787.36	2137.96
223	65.4	6750.5	3719.31	2064.69
231	56.2	6733.9	4023.47	2284.50
232	55.4	6733.1	4069.34	2147.67
233	54.6	6733.6	4142.06	2079.49
241	47.3	6729.1	3991.82	2357.49
242	41.1	6723.6	4060.17	2430.49
243	38.1	6718.6	4128.53	2503.48

TABLE 3

SUPPLEMENTAL SERIES WELLS

Well	Depth	Collar Elevation	Northing	Easting
c.h.1	120.0	6778.3	4510.80N	1133.39E
c.h.2	151.0	6822.0	3082.51N	310.87E
c.h.3	112.0	6828.6	815.94N	521.53E
c.h.4	59.7	6701.2	4230.37N	2922.75E
c.h.5	75.0	6741.9	3272.22N	2312.56E
c.h.6	81.1	6790.5	1816.36N	1484.25E
c.h.7	59.8	6798.8	388.82N	2475.80E
c.h.8	96.0	6740.2	4994.44N	1690.00E
c.h.9	90.0	6719.2	4584.09N	2310.84E
c.h.10	68.0	6720.0	4128.25N	2396.39E
c.h.11	100.0	6744.3	4181.98N	1799.41E
c.h.12	88.0	6746.8	3788.23N	2068.96E
c.h.13	77.0	6738.3	3655.47N	2428.34E
ERDA	137.0	6729.6	5268.86N	3658.11E

TABLE 4

SERIES #1 WELLS

*-dry well

Well	1-4-78	1-15-78	1-20-78	1-23-78	1-25-78	1-27-78	2-1-78	2-8-78
25B	6677.9	6677.9	6678.0	6678.1	6678.0	6678.0	6678.0	6678.0
25A	6674.2	6674.2	6674.4	6674.4	6674.3	6674.3	6674.4	6674.3
25	6674.4	6674.4	6674.6	6674.6	6674.6	6674.6	6674.6	6674.6
12	6650.6	6655.1	6659.5	6661.1	6660.7	6660.8	6662.4	6660.6
26	6686.1	6685.8	6684.3	6685.8	6685.7	6685.7	6686.3	6686.5
26A	6677.3*	6677.3*	6677.4*	6677.4*	6677.5*	6677.5*	6677.5*	6677.5*
25B	6674.3	6673.9	6674.0	6674.0	6674.0	6674.0	6674.0	6674.1
18	6613.9*	6618.7	6619.7	6620.4	6618.4	6618.7	6618.7	6620.1
17	6658.2	6665.6	6665.6	6665.8	6665.8	6665.9	6670.0	6667.3
28B	-	-	-	-	-	-	-	-
27B	-	-	-	-	-	-	-	-
15	6617.4	6619.9	6621.7	6622.9	6623.3	6623.5	6623.9	6625.2
27A	6664.2*	6664.2*	6664.2*	6664.2*	6664.3*	6664.3*	6664.3*	6664.3*
23	6667.8*	6667.8*	6667.8*	6667.9*	6668.1*	6668.1*	6668.1*	6668.1*
13	6618.2	6618.8	6619.2	6619.6	6619.7	6619.8	6620.0	6620.2
24	6665.8	6665.5	6665.4	6665.6	6665.5	6665.5	6665.4*	6665.4*
28A	6664.3*	6664.3*	6664.3*	6664.3*	6664.4*	6664.4*	6664.4*	6664.3*
16	6617.7*	6617.7*	6617.7*	6617.7*	6617.8*	6617.8*	6617.8*	6618.5
61	6679.3	-	-	-	-	6679.3	6679.3	6679.3
62	6674.9*	6674.9*	-	-	-	6674.9*	6674.9*	6674.9*
11	6626.1	6638.5	-	6647.0	-	-	6649.9	-
51	-	-	-	-	-	-	6635.8	-
52	-	-	-	-	-	-	6625.0	-
14	-	-	-	-	-	-	-	-
53	-	-	-	-	-	-	6639.9	-
21	6675.4	6681.0	-	-	-	-	6680.9	-
22	6675.1	6678.5	-	-	-	-	6678.5	-
31	-	-	-	-	-	6619.2	6619.8	-
32	6685.4*	6601.5	-	-	-	6601.9	6602.7	-
41	6674.0	6673.9	-	-	-	-	6674.0	-
42	6674.0	6673.9	-	-	-	-	6674.0	-
43	6670.6	6673.0	-	-	-	-	6673.1	-
44	6670.9	6671.7	-	-	-	-	6671.8	-

TABLE 4

SERIES #1 WELLS (cont)

*-dry well

Well	2-15-78	2-22-78	3-1-78	3-10-78	3-13-78	3-15-78	3-17-78	3-20-78
25B	6678.0	6578.0	6678.0	6677.9	6677.9	6678.0	6677.9	6677.9
25A	6674.3	6574.3	6674.5	6674.3	6674.5	6674.5	6674.5	6674.5
25	6674.6	6574.8	6674.9	6675.1	6675.1	6675.1	6675.1	6675.1
12	6660.0	6560.0	6661.2	6652.4	6650.2	6648.7	6647.5	6646.8
26	6686.3	6585.9	6686.0	6686.6	6686.2	6686.3	6686.3	6686.2
26A	6677.5*	6577.5*	6677.5*	6677.5*	6677.5*	6677.5*	6677.5*	6677.5*
26B	6674.1	6573.7	6675.2	6675.2	6675.3	6675.2	6675.3	6675.1
18	6621.5	6522.3	6623.5	6624.9	6625.2	6625.6	6625.8	6626.0
17	6664.1	6662.9	6662.9	6661.1	6661.5	6661.4	6661.6	6661.9
28B	-	-	-	-	-	-	-	-
27B	-	-	-	-	-	-	-	-
15	6627.1	6529.9	6631.0	6631.6	6631.9	6631.6	6631.8	6632.3
27A	6664.3*	6664.3*	6664.3*	6664.3*	6664.3*	6664.3*	6664.3*	6664.3*
23	6668.1*	6668.2*	6668.3*	6668.4*	6668.4*	6668.4*	6668.4*	6668.4*
13	6620.6	6621.1	6621.6	6621.9	6622.1	6622.1	6622.2	6622.2
24	6665.4*	6665.5*	6665.5*	6665.5*	6665.5*	6665.4*	6665.4*	6665.4*
28A	6664.3*	6664.3*	6664.3*	6664.3*	6664.3*	6664.3*	6664.3*	6664.3*
16	6618.5	6618.6	6618.6	6618.6	6618.6	6618.7	6618.8	6618.6
61	6679.3	6679.3	6679.3*	6679.3*	6679.3*	6679.3	6679.3	6679.3
62	6674.9*	6674.8*	6674.8*	6674.8*	6674.8*	6674.8*	6674.8*	6674.8*
11	-	-	6655.7	-	-	-	-	-
51	-	-	6656.9	-	-	-	-	-
52	-	-	6643.0	-	-	-	-	-
14	-	-	-	-	-	-	-	-
53	-	-	6650.5	-	-	-	-	-
21	-	-	6680.9	-	-	-	-	-
22	-	-	6678.5	-	-	-	-	-
31	-	-	6622.9	-	-	-	-	-
32	-	-	6602.6	-	-	-	-	-
41	-	-	6673.9	-	-	-	-	-
42	-	-	6674.0	-	-	-	-	-
43	-	-	6673.4	-	-	-	-	-
44	-	-	6672.3	-	-	-	-	-

TABLE 4

Well	SERIES #1 WELLS (cont)						*-dry well	
	3-22-78	3-24-78	3-28-78	3-31-78	4-6-78	4-13-78	4-20-78	4-27-78
25B	6677.9	6677.9	6677.8	6677.9	6677.9	6678.0	6677.9	6677.9
25A	6674.7	6674.7	6674.7	6674.7	6675.0	6676.6	6676.6	6677.2
25	6675.1	6675.0	6675.2	6675.2	6675.4	6675.9	6676.6	6676.9
12	6646.4	6646.0	6645.1	6644.6	6638.8	6638.4	6638.2	6637.8
26	6686.2	6686.2	6686.1	6686.0	6685.9	6685.9	6686.1	6686.1
26A	6677.5*	6677.5*	6677.5*	6677.5*	6677.5*	6677.5*	6677.5*	6677.5*
26B	6675.2	6675.1	6675.1	6675.1	6675.2	6676.7	6676.6	6676.5
18	6626.2	6626.4	6626.8	6627.2	6627.7	6627.7	6624.0	6670.2
17	6662.2	6662.3	6662.5	6662.2	6662.8	6662.4	6664.4	6663.4
28B	-	-	-	-	-	-	-	-
27E	-	-	-	-	-	-	-	-
15	6632.3	6632.3	6632.6	6632.6	6628.0	6628.5	6638.5	6643.0
27A	6664.3*	6664.3*	6664.3*	6664.3*	6664.3*	6664.3*	6664.3*	6664.3*
23	6668.4*	6668.4*	6668.4*	6668.4*	6668.4*	6668.4*	6668.4*	6668.4*
13	6622.2	6622.3	6622.3	6622.5	6623.1	6623.4	6623.7	6623.7
24	6665.4*	6665.8*	6665.7*	6665.7*	6665.8*	6665.7*	6665.7*	6665.7*
28A	6664.3*	6664.3*	6664.3*	6664.3*	6664.3*	6664.3*	6664.3*	6664.3*
16	6618.6	6618.6	6618.6	6618.6	6617.9	6617.9	6617.9	6617.9
61	6679.3	6679.3	-	6679.4	6679.4	-	6679.4	-
62	6674.9	6674.9	-	6676.9	6677.2	-	6676.6	-
11	-	-	-	6654.8	6656.1	-	6654.6	-
51	-	-	-	-	6635.7	-	6665.6	-
52	-	-	-	-	6652.6	-	6653.2	-
14	-	-	-	-	6573.8	-	-	-
53	-	-	-	-	6650.5	-	6651.0	-
21	-	-	-	-	6680.8	-	6680.8	-
22	-	-	-	-	6678.3	-	6678.1	-
31	-	-	-	6673.2	6674.1	-	6664.9	-
32	-	-	-	6602.8	6594.3	-	6600.8	-
31	-	-	-	6674.5	6674.9	-	6675.2	-
42	-	-	-	6674.4	6674.2	-	6675.0	-
43	-	-	-	6674.8	6673.2	-	6672.1	-
44	-	-	-	6674.8	6673.1	-	6673.2	-

TABLE 4

SERIES #1 WELLS

(cont)

*-dry well

Well	5-4-78	5-11-78	5-18-78	5-25-78	5-31-78	6-7-78	6-14-78	6-21-78
25B	6681.6	6678.3	-	-	-	-	-	-
25A	6676.7	6676.4	-	-	-	-	-	-
25	6677.3	6676.6	6675.6	-	-	-	-	-
12	6661.8	6662.7	6663.3	6661.2	6660.9	6660.6	-	6657.7
26	6686.1	6685.9	6684.5	6686.2	6679.2	6678.2	6677.8	6677.3
26A	6677.5*	6677.5*	6677.5*	6677.5*	6677.5*	6677.5*	6677.5*	6677.5*
26B	6677.0	6676.9	6676.3	6676.1	6675.9	6675.6	6675.6	6675.5
18	6665.2	6664.2	6665.3	6664.1	6662.0	6660.3	-	6656.3
17	6678.1	6675.9	-	-	-	-	-	-
28B	-	-	-	-	-	-	-	-
27B	-	-	-	-	-	-	-	-
15	6633.7	6624.5	6624.3	6624.9	6625.4	6625.5	-	6624.6
27A	6664.3*	6664.3*	6664.3*	6664.3*	6664.3*	6665.8	6666.3	6665.5
23	6668.4*	6668.4*	6668.4*	6668.4*	6668.4*	6668.4*	6676.4*	6675.2*
13	6624.2	6624.7	6624.7	6654.7	6654.7	6652.8	-	6652.2
24	6665.7*	6665.7*	6665.7*	6665.7*	6665.7*	6665.7*	6665.8*	6665.7*
28A	6664.3*	6664.3*	6664.3*	6664.3*	6664.3*	6664.4	-	6664.4
16	6617.9	6617.9	6617.9	6617.9	6618.6	6618.5	-	-
61	6679.3	6679.3	6679.3*	6679.3*	6679.3*	6679.3*	-	6683.5
62	6676.6	6676.6	6676.9	6676.6	6676.6	6676.5	6676.4	6676.5
11	6655.4	6658.2	6657.6	6665.6	6667.2	6670.3	-	6669.1
51	6665.6	6666.1	6666.0	6665.8	6665.7	6672.4	-	6671.6
52	6653.7	6654.8	6654.9	6654.9	6654.9	6656.1	-	6655.0
14	-	-	-	-	-	-	-	-
53	6651.0	6652.0	6652.0	6652.1	6652.1	6650.3	-	6650.0
21	6682.1	6682.0	6681.9	6678.4	6677.6	6678.3	6678.1	6678.2
22	6678.5	6678.5	6678.0	6678.7	6678.0	6678.3	6678.5	6678.3
31	6664.9	6674.0	6673.8	6662.3	6659.9	6658.1	-	-
32	6600.0	6600.7	6600.6	6601.6	6601.9	6601.7	-	6602.4
41	6675.2	6675.4	6675.8	6675.4	6673.7	6673.4	6673.0	-
42	6675.0	6675.2	6675.1	6675.1	6674.7	6673.8	-	-
43	6672.1	6674.7	6674.7	6673.0	6672.9	6672.9	6672.9	6672.7
44	6675.0	6675.2	6675.2	6672.4	6673.3	6672.3	6672.4	6672.5

TABLE 4

SERIES #1 WELLS

(cont)

*-dry well

Well	6-28-78	7-5-78	7-12-78	7-20-78	8-2-78	8-24-78	8-30-78	9-6-78
25B	-	-	-	-	-	-	-	-
25A	-	-	-	-	-	-	-	-
25	-	-	-	-	-	-	-	-
12	6658.3	6657.1	6657.6	6658.3	6665.3	6668.0	6664.6	6664.8
26	-	6677.5	6677.4	6677.1	-	-	-	-
26A	6677.5*	6677.5*	6677.4*	6677.4*	-	-	-	-
26B	6675.5	6675.6	6675.4	6675.3	-	-	-	-
18	6656.2	6654.7	6652.9	6650.7	-	-	-	-
17	-	-	-	-	-	-	-	-
28B	-	-	-	-	-	-	-	-
27B	-	-	-	-	-	-	-	-
15	6631.3	6626.5	6626.7	6627.2	6627.5	-	-	-
27A	-	-	-	-	-	-	-	-
23	6675.2*	6676.3*	6676.4*	6676.4*	6676.5*	6676.5*	6676.5*	6676.5*
13	-	6651.3	6651.8	6650.9	6646.2	6646.0	6645.6	6655.8
24	6665.7*	6665.8*	6665.7*	665.7*	6665.7*	6665.7*	6665.7*	6665.7*
28A	6664.5	-	6664.6	6664.7	6663.9*	6664.0*	6664.0*	6664.0*
16	-	6618.7	6618.8	6618.9	6619.0	6619.0	6619.7	6619.4
61	6684.6	6686.4	6685.9	6686.0	6685.7	6683.6	6683.4	6683.2
62	6676.8	6676.7	6681.7	6676.9	6677.0	6676.9	6677.0	6676.8
11	6661.8	6664.7	6661.4	6660.1	6668.0	6667.3	6661.1	6667.2
51	6671.9	6671.6	6671.8	6671.7	6671.1	6669.6	6669.4	6669.1
52	6655.1	6655.2	6654.8	6655.1	6656.4	6655.8	6655.4	6656.0
14	6590.5	-	-	-	-	-	-	-
53	6650.2	6650.2	6650.2	6649.6	6649.3	6649.4	6649.1	6649.4
21	6676.5	6678.6	6678.6	6678.6	6678.7	6678.9	6678.6	6678.5
22	6678.4	6678.5	6678.4	6678.5	6678.3	6678.1	6677.5	6678.0
31	-	6653.5	6650.8	6647.6	6645.1	6645.5	6644.2	6645.0
32	6602.5	6602.7	6602.7	6603.0	6602.5	6603.8	6604.3	6603.5
41	-	-	-	-	-	-	-	-
42	-	-	-	-	-	-	-	-
43	6673.0	6675.6	6672.8	6673.3	6672.3	6674.0	6673.8	6673.3
44	6672.5	6673.1	6672.2	6672.6	6671.9	6672.3	6672.1	6672.4

TABLE 4

SERIES #1 WELLS

(cont)

*-dry well

Well	9-13-78	9-20-78	9-27-78	10-4-78	10-11-78	10-18-78	10-25-78
25B	-	-	-	-	-	-	-
25A	-	-	-	-	-	-	-
25	-	-	-	-	-	-	-
12	6665.0	-	6660.4	6664.6	6664.7	6664.2	6663.8
26	-	-	-	-	-	-	-
26A	-	-	-	-	-	-	-
26B	-	-	-	-	-	-	-
18	-	-	-	-	-	-	-
17	-	-	-	-	-	-	-
28B	-	-	-	-	-	-	-
27B	-	-	-	-	-	-	-
15	-	-	-	-	-	-	-
27A	-	-	-	-	-	-	-
23	6676.5*	6676.5*	6676.5*	6676.5*	-	-	-
13	6656.2	6656.4	6654.88	6661.1	6660.9	6659.8	6659.8
24	6665.7*	6665.7*	6665.7*	6665.7*	6665.7*	665.7*	6665.7*
28A	-	-	-	-	-	-	-
16	6620.3	6620.4	6621.3	6616.9	6617.2	6614.9	6614.3
61	6683.4	6683.5	6682.6	6683.0	6682.8	6682.3	6682.1
62	6677.0	6677.2	6676.7	6676.4	6677.5	6677.1	6676.9
11	6667.4	6667.2	6665.8	6656.6	6656.5	6656.5	6656.3
51	6669.2	6669.4	6667.9	6667.9	6667.4	6666.3	6665.9
52	6652.3	6657.1	6655.0	6654.7	6654.8	6654.2	6654.1
14	-	-	-	-	-	-	-
53	6650.0	6650.1	6649.3	6649.7	6649.8	6649.2	6649.0
21	6678.6	6678.8	6677.7	6674.0	6674.0	6673.9	6673.7
22	6678.1	6678.1	6678.0	6678.5	6677.9	6677.8	6677.6
31	6645.2	6645.7	6644.2	6644.2	6644.0	6643.3	6643.1
32	6603.5	6603.7	6596.4	6602.3	6600.4	6599.5	6599.4
41	-	-	-	-	-	-	-
42	-	-	-	-	-	-	-
43	6673.8	6673.8	6673.0	6673.6	6672.0	6671.7	6671.4
44	6672.4	6672.6	6672.6	6672.6	6673.2	6672.6	6672.5

TABLE 4

SERIES #1 WELLS (cont)

*-dry well

Well	11-1-78	11-29-78	12-12-78	12-27-78	1-23-78	2-13-78
25B	-	-	-	-	-	-
25A	-	-	-	-	-	-
12	-	-	-	-	-	-
26C	6664.1	6665.3	-	6665.4	6665.4	6665.4
26A	-	-	-	-	-	-
26B	-	-	-	-	-	-
18	-	-	-	-	-	-
17	-	-	-	-	-	-
28B	-	-	-	-	-	-
27B	-	-	-	-	-	-
15	-	-	-	-	-	-
27A	-	-	-	-	-	-
23	-	-	-	6674.1	-	-
13	6655.3	6655.6	-	6654.9	-	-
24	6665.7*	6667.3	6671.9	6672.4	-	-
28A	-	-	-	6678.6	-	-
16	6620.4	6620.9	6620.9	6620.9	6621.4	6621.2
61	6682.0	6681.6	6681.6	6681.0	6680.7	6680.1
62	6676.8	6676.9	6676.8	6676.6	6676.6	6676.4
11	6655.3	6654.0	-	6653.1	6655.9	6654.4
51	6667.1	6664.9	6664.1	6678.0	6678.4	6678.4
52	6652.1	6650.7	6650.8	6650.3	6648.6	6647.3
14	-	6591.4	-	-	6590.9	6591.0
53	6649.6	6649.6	6648.8	6647.5	6646.5	6646.0
21	6678.9	6679.0	-	6678.8	6679.1	6678.8
22	6678.6	6678.6	-	6678.4	6678.7	6679.0
31	6655.4	6656.2	6660.5	6659.3	6657.1	-
32	6602.9	6604.1	6603.9	6603.9	6603.6	6603.6
41	-	-	6674.2	6671.3	-	-
42	-	-	6673.8	6673.8	-	-
43	6673.2	6675.2	6675.2	6674.9	6675.6	-
44	6672.6	6672.7	6672.9	6672.7	6672.7	6671.7

TABLE 5

SERIES #2 WELLS

Well	6-7-78	6-14-78	6-21-78	6-28-78	7-5-78	7-12-78	7-20-78	7-26-78
200	6686.1	6686.7	6687.4	6686.7	6688.4	6697.9	6688.1	6688.2
211	6726.5	6729.0	6729.1	6729.1	6728.7	6723.1	6729.7	6729.7
212	6722.6	6685.5	6685.5	6685.5	6685.6	6685.7	6685.8	6685.5
213	6714.5	6696.6	6696.2	6696.5	6696.6	6696.6	6696.8	6697.7
221	6687.5	6733.2	6732.7	6732.8	6732.4	6732.2	6732.7	6732.4
222	6702.1	6734.2	6734.3	6733.5	6734.5	6734.4	6734.0	6733.9
223	6704.4	6724.4	6723.3	6622.9	6722.1	6721.9	6721.1	6720.5
231	6697.3	6687.2	6688.1	6688.8	6688.9	6688.9	6688.9	6688.8
232	6692.2	6690.7	6692.0	6692.3	6692.7	6693.4	6698.8	6693.9
233	6701.4	6686.5	6685.7	6685.7	6685.8	6685.8	6685.9	6685.5
241	6729.1	6692.9	6693.2	6693.4	6693.7	6694.0	6694.1	6694.2
242	6682.0	6682.6	6682.7	6682.6	6682.6	6682.9	6682.7	6682.6
243	6672.4	6686.6	6686.8	6667.5	6686.8	6687.5	6687.4	6687.5

Well	8-2-78	8-10-78	8-16-78	8-23-78	8-30-78	9-6-78	9-13-78	9-20-78
200	6685.0	6685.5	6685.0	6687.0	6686.9	6687.6	6688.3	6687.8
211	6729.7	6729.4	6729.2	6729.2	6729.3	6729.2	6729.1	6729.4
212	6685.9	6685.7	6685.9	6686.1	6686.1	6686.1	6686.3	6686.4
213	6696.9	6696.8	6696.6	6696.9	6696.8	6696.8	6696.7	6696.9
221	6732.6	6732.8	6732.6	6732.4	6732.2	6732.4	6732.5	6729.3
222	6734.0	6733.8	6733.8	6733.7	6733.6	6733.2	6733.6	6733.3
223	6720.1	6718.8	6718.3	6717.7	6717.6	6717.7	6718.7	6717.8
231	6689.0	6688.6	6688.9	6689.1	6689.1	6689.1	6689.2	6689.1
232	6694.0	6694.1	6694.1	6694.4	6694.3	6694.1	6695.1	6694.3
233	6685.8	6685.9	6685.8	6686.0	6685.9	6686.0	6686.2	6686.2
241	6694.4	6694.7	6694.8	6695.1	6695.2	6695.3	6695.6	6695.3
242	6682.7	6683.1	6682.8	6683.0	6683.1	6683.1	6683.4	6683.3
243	6684.6	6687.7	6687.9	6688.1	6687.9	6688.3	6688.7	6688.4

TABLE 5

SERIES #2 WELLS (cont)							
Well	9-27-78	10-4-78	10-11-78	10-17-78	10-25-78	11-2-78	11-8-78
200	6688.1	6687.6	6687.4	6687.1	6686.9	6687.7	6688.0
211	6728.3	6728.2	6728.2	6728.2	6728.1	6723.0	6723.1
212	6686.3	6686.4	6686.1	6685.9	6685.7	6686.4	6686.4
213	6695.8	6696.0	6695.4	6695.2	6695.0	6696.6	6696.6
221	6731.5	6731.6	6731.4	6731.3	6731.4	6730.9	6730.8
222	6733.5	6733.3	6733.3	6733.2	6733.4	6733.7	6733.7
223	6723.2	6722.8	6722.6	6722.3	6721.8	6715.1	6714.8
231	6689.0	6688.9	6688.6	6688.5	6688.4	6688.4	6689.4
232	6694.6	6694.3	6694.2	6693.7	6693.4	6694.9	6694.7
233	6685.8	6685.5	6684.7	6684.4	6683.5	6686.2	6686.2
241	6695.7	6695.3	6695.2	6694.6	6694.3	6696.3	6696.3
242	6683.2	6682.6	6682.5	6682.0	6682.0	6683.2	6683.2
243	6689.1	6688.9	6688.8	6688.4	6688.3	6690.0	6690.2

Well	11-16-78	11-22-78	11-29-78	12-6-78	12-13-78	12-20-78	12-27-78
200	6688.3	6688.8	6689.2	6689.6	6689.7	6689.9	6690.8
211	6722.8	6723.0	6722.3	6722.3	6722.6	6723.8	6725.7
212	6686.5	6686.5	6686.5	6686.5	6686.5	6686.5	6686.7
213	6696.7	6696.6	6696.5	6696.6	6696.4	6696.7	6696.5
221	6730.9	6730.6	6730.6	6730.6	6730.5	6730.4	6730.5
222	6733.7	6733.6	6733.5	6733.5	6733.5	6733.7	6733.5
223	6714.2	6713.9	6713.7	6713.4	6712.9	6712.4	6711.7
231	6689.4	6689.3	6689.4	6689.3	6689.3	6689.5	6689.2
232	6694.8	6694.8	6694.7	6694.8	6694.6	6695.0	6695.1
233	6686.0	6686.2	6686.0	6685.2	6685.8	6685.7	6685.9
241	6696.4	6696.5	6696.5	6696.5	6696.4	6696.3	6696.3
242	6683.3	6683.3	6683.3	6683.4	6683.2	6683.1	6683.1
243	6690.2	6690.5	6690.5	6690.7	6690.7	6690.7	6690.7

TABLE 5

SERIES #2 WELLS (cont)

Well	1-3-79	1-10-79	1-17-79	1-24-79	1-30-79	2-7-79	2-14-79	2-21-79
200	6690.7	6690.9	6691.1	6691.4	6691.4	6691.7	6691.4	6691.7
211	6726.7	6727.1	6726.7	6726.4	6726.7	6726.7	6726.7	6724.7
212	6686.4	6686.4	6686.4	6686.4	6686.4	6686.4	6686.4	6686.7
213	6696.5	6696.5	6696.5	6696.5	6696.5	6696.5	6696.2	6693.5
221	6730.5	6730.2	6730.5	6730.5	6730.5	6729.5	6730.5	6730.2
222	6733.7	6733.7	6733.7	6733.7	6733.7	6733.7	6733.7	6733.7
223	6711.2	6710.5	6710.0	6709.5	6709.5	6709.0	6709.5	6705.0
231	6689.2	6689.4	6689.4	6689.4	6689.4	6689.4	6689.4	6689.4
232	6694.8	6694.8	6694.8	6694.8	6694.8	6694.6	6694.6	6694.6
233	6685.9	6685.9	6685.9	6686.1	6685.9	6685.9	6685.6	6685.9
241	6696.1	6696.1	6696.1	6696.1	6696.1	6696.1	6696.1	6696.1
242	6683.1	6683.1	6683.1	6683.1	6683.1	6683.1	6683.6	6683.1
243	6690.0	6690.9	6690.6	6690.9	6690.9	6690.9	6688.6	6687.9

Well	2-28-79	3-7-79	3-14-79	3-21-79	3-28-79	4-4-79	4-11-79	4-18-79
200	6691.9	6692.0	6692.0	6692.1	6692.1	6692.2	6692.3	6692.3
211	6724.6	6724.8	6725.2	6725.7	6728.0	6728.6	6728.8	6728.8
212	6686.7	6686.8	6686.8	6686.6	6686.9	6686.9	6687.1	6687.1
213	6693.6	6693.7	6693.8	6693.9	6694.0	6694.1	6694.3	6694.3
221	6730.4	6730.5	6730.2	6730.3	6730.3	6730.3	6730.3	6730.3
222	6733.7	6733.8	6733.7	6733.6	6733.7	6733.8	6733.8	6733.8
223	6705.0	6705.1	6704.7	6704.8	6735.7	6740.1	6739.2	6739.2
231	6689.6	6689.6	6689.5	6689.5	6689.6	6689.6	6689.7	6689.7
232	6694.5	6694.6	6694.7	6694.8	6694.7	6694.7	6694.7	6694.7
233	6685.6	6685.6	6685.4	6685.7	6685.8	6685.7	6685.8	6685.8
241	6696.3	6696.3	6696.4	6696.7	6696.7	6696.8	6696.8	6696.8
242	6683.3	6683.3	6689.4	6719.5	6721.2	6718.8	6717.0	6717.0
243	6688.0	6688.1	6713.7	6715.5	6715.7	6714.0	6715.4	6715.4

TABLE 5

SERIES #2 WELLS (cont)

Well	4-25-79	5-2-79	5-9-79	5-16-79	5-23-79	5-30-79	6-6-79	6-13-79
200	6692.1	6692.1	6692.4	6692.5	6692.6	6692.6	6692.6	6692.7
211	6728.6	6728.3	6728.4	6728.1	6727.6	6727.4	6725.7	6725.8
212	6687.7	6687.5	6687.1	6687.5	6687.8	6687.8	6687.9	6687.9
213	6695.1	6695.1	6695.1	6695.4	6695.4	6695.4	6695.6	6695.6
221	6730.2	6730.0	6729.9	6730.0	6729.9	6729.9	6730.0	6730.0
222	6733.7	6733.5	6733.4	6733.4	6733.3	6733.3	6733.2	6733.1
223	6733.0	6730.7	6728.2	6727.8	6727.3	6727.3	6726.3	6725.8
231	6689.5	6689.5	6689.5	6689.3	6689.4	6689.4	6689.6	6689.5
232	6694.6	6694.5	6694.5	6694.7	6694.9	6694.9	6694.8	6694.8
233	6685.6	6685.6	6685.7	6685.7	6685.7	6685.7	6686.2	6686.1
241	6696.9	6696.9	6696.6	6696.6	6696.8	6696.8	6696.9	6696.9
242	6714.5	6713.3	6712.4	6711.8	6711.3	6711.2	6709.8	6709.0
243	6705.7	6703.9	6702.3	6702.1	6701.0	6700.8	6699.9	6699.4

Well	6-20-79	6-27-79
200	6692.7	6692.7
211	6725.9	6725.9
212	6687.9	6687.9
213	6695.7	6695.7
221	6729.9	6729.9
222	6733.0	6733.0
223	6725.3	6725.0
231	6689.5	6689.5
232	6694.7	6694.7
233	6686.3	6686.3
241	6696.9	6696.9
242	6708.5	6708.3
243	6699.0	6698.8

TABLE 6

SUPPLEMENT SERIES WELLS

	6-17-78	7-12-78	8-9-78	8-23-78	9-6-78	9-20-78	10-4-78	10-17-78
ch#1	6754.0	6753.6	6752.6	6752.6	6753.1	6753.3	6752.3	6751.5
ch#2	6776.8	6779.2	6780.2	6780.8	6781.2	6781.7	6779.8	6778.9
ch#3	6808.3	6808.2	6808.2	6807.9	6807.6	6807.8	6807.0	6806.3
ch#4	6638.8	6639.2	6639.9	6641.5	6641.5	6641.2	6641.2	6639.9
ch#5	6721.8	6722.3	6721.3	6720.9	6720.9	6720.8	6720.7	6719.2
ch#6	6738.3	6738.2	6738.3	6738.8	6739.1	6739.5	6739.7	6739.1
ch#7	6767.7	6768.3	6768.4	6767.3	6768.6	6768.4	6770.2	6768.7
ch#8	6709.9	6709.5	6709.6	6709.9	6708.9	6708.8	6708.4	6707.6
ch#9	6713.4	6712.6	6712.0	6711.8	6688.5	6689.3	6699.8	6699.1
ch#10	6683.9	6682.2	6680.1	6677.3	6675.9	6675.8	6675.4	6674.5
ch#11	6723.6	6736.6	6736.7	6725.5	6725.3	6725.3	6724.9	6724.9
ch#12	6722.1	6722.6	6709.2	6698.9	6695.6	6695.6	6695.6	6693.9
ch#13	6713.0	6703.0	-	6698.7	6680.5	6680.7	6682.1	6680.6
ERDA	6672.8	6672.9	6673.3	6673.6	6673.7	6673.7	6673.4	6673.2

	11-2-78	11-28-78	12-26-78
ch#1	6751.8	6752.0	6751.7
ch#2	-	6782.9	6783.0
ch#3	-	-	-
ch#4	6644.7	6645.4	6643.7
ch#5	-	-	-
ch#6	-	-	-
ch#7	-	-	-
ch#8	6711.2	6710.7	6711.0
ch#9	6710.4	6710.0	6707.7
ch#10	6679.6	6680.1	6680.0
ch#11	6734.0	6733.7	6733.5
ch#12	6694.0	6694.3	6690.5
ch#13	6696.6	6696.0	6696.3
ERDA	6673.2	6673.3	6673.6

TABLE 7

FIRST ORDER STATISTICS

Series 1	Well	Mean	Standard Deviation	Variance	Sample Size
	25B	6678.1	0.7	0.5	26
	25A	6674.9	0.9	0.8	26
	25	6675.2	0.8	0.7	27
	12	6657.3	8.5	71.5	50
	26	6684.3	3.4	11.5	35
	26B	6675.2	0.9	0.8	36
	18	6636.4	18.3	336.5	34
	17	6664.5	4.4	19.2	26
	15	6628.2	5.1	26.3	36
	13	6635.9	16.6	274.7	48
	24	6667.2	2.9	8.2	9
	16	6618.8	1.5	2.1	43
	61	6661.5	2.3	5.4	38
	62	6676.8	1.0	1.0	34
	11	6658.2	8.9	79.5	35
	51	6655.5	7.9	62.0	32
	52	6652.6	5.8	34.1	32
	14	6587.5	7.7	58.9	5
	53	6649.5	2.2	4.9	32
	21	6678.5	2.2	5.0	34
	22	6678.2	0.7	0.5	34
	31	6651.5	14.4	207.2	31
	32	6601.9	2.1	4.5	35
	41	6674.2	1.1	1.3	16
	42	6674.4	0.5	0.3	15
	43	6673.4	1.2	1.4	35
	44	6672.8	1.0	1.0	36

TABLE 7

FIRST ORDER STATISTICS (cont)

Series 2	Well	Mean	Standard Deviation	Variance	Sample Size
	200	6689.9	2.6	6.9	55
	211	6726.9	2.3	5.1	55
	212	6686.5	0.7	0.4	55
	213	6695.9	1.0	1.0	55
	221	6731.0	1.0	1.0	55
	222	6733.6	0.4	0.1	55
	223	6717.5	15.8	249.1	55
	231	6689.2	0.3	0.1	55
	232	6694.4	1.0	1.0	55
	233	6685.8	0.4	0.1	55
	241	6695.8	1.1	1.2	55
	242	6691.4	13.9	192.5	55
	243	6693.6	9.6	92.1	55

Supplement Series	Well	Mean	Standard Deviation	Variance	Sample Size
	CH#1	6752.6	0.8	0.6	11
	CH#2	6780.7	1.5	2.3	10
	CH#3	6807.7	0.7	0.5	8
	CH#4	6641.6	2.2	4.8	11
	CH#5	6721.0	0.9	0.8	8
	CH#6	6738.9	0.6	0.4	8
	CH#7	6768.5	0.8	0.6	8
	CH#8	6709.6	1.1	1.2	11
	CH#9	6705.0	9.3	86.5	11
	CH#10	6678.6	3.0	9.0	11
	CH#11	6729.5	5.3	28.1	11
	CH#12	6701.1	11.5	132.3	11
	CH#13	6692.8	11.3	127.7	11
	ERDA	6673.3	0.3	0.1	11

TABLE 8

Results of Statistical "F" Test

Series 1 Shallow Wells

<u>Sampling Quarters</u>	<u>Sample Size</u>	<u>St. Deviation</u>	<u>Variance</u>	<u>Mean</u>
April 78	34	3.7	13.7	6677.2
July 78	35	5.4	29.5	6675.9
October 78	24	3.6	13.2	6676.7
January 79	29	3.1	9.6	6676.2

"F" Test = .64 df=3 df=118
Means are not significantly different. Rejection area = .01

Series 2 Wells

<u>Sampling Quarters</u>	<u>Sample Size</u>	<u>St.Deviation</u>	<u>Variance</u>	<u>Mean</u>
July 78	52	19.8	391.2	6700.9
October 78	52	18.8	351.6	6701.6
January 79	52	17.4	301.7	6701.2
April 79	52	18.7	348.6	6707.4

"F" Test = 1.43 df=3 df₂=204.
Means are not significantly different. Rejection area = .01

APPENDIX C. DESCRIPTION.

1. First Order Statistics.
2. Statistical "F" Test.
3. Statistical "t" Test.

APPENDIX C1

First Order Statistics

The first order statistics of all data presented in this paper included the sample mean, its standard deviation and variance from the sample mean and the size of the sample.

The following symbols are used in describing the above statistical parameters.

$\bar{X}$ = sample mean
 s = standard deviation
 s^2 = variance
 N = sample size
 f = observation frequency
 x = individual observation

The arithmetic mean ($\bar{X}$) is defined as the sum of all observations divided by the number of observations. Mathematically described:

$$\bar{X} = \frac{\sum_{i=1}^N X_i}{N} = \frac{\sum f_i X_i}{N} = \frac{\sum f_i X_i}{f_i}$$

The variance is defined as the sum of squares of the deviations of the observations from the mean divided by one less than the total number of observations.

$$s^2 = \frac{\sum_{i=1}^N (X_i - \bar{X})^2}{N-1} = \frac{\sum X_i^2 - (\sum X_i)^2 / N}{N-1}$$

The standard deviation is defined as the positive square root of the variance. Thus the standard deviation is given by:

$$s = \sqrt{\frac{\sum_{i=1}^N (X_i - \bar{X})^2}{N-1}}$$

APPENDIX C 2

Statistical "F" Test

The Statistical "F" Test is a test of a hypothesis concerning more than two populations means through the analysis of variance.

The null hypothesis for the "F" Test is $\mu^1 = \mu^2 = \mu^3 = \dots = \mu^K$. It is more convenient than the Standard "t" Test for two reasons.

1. It is less tedious and time consuming,
2. There is less probability of falsely rejecting at least one of the hypothesis utilizing the "F" Test. A major disadvantage of running multiple "t" Test to compare means is that the probability of falsely rejecting at least one of the hypothesis increases as the number of "t" Tests increases.

Symbols used:

S^2 $\equiv$ Variance - described in Appendix C 1.

W $\equiv$ The subscript "W" refers to the within-population variability.

B $\equiv$ The subscript "B" designates a measure of the variability among the sample means for the five populations.

When independent random samples are drawn from normal populations with equal variances, the quantity S_B/S_W possesses a probability distribution in repeated sampling that is known as an "F" Distribution.

The analysis of variance for testing the equality of k populations means is described below.

Null Hypothesis : $\mu^1 = \mu^2 = \dots = \mu^K$

Alternative Hypothesis: At least one of the population means is different from the others.

Test Statistic:

$$F = \frac{S^2_B}{S^2_W}$$

Where :
$$S^2_W = \frac{(N_1 - 1)S_1^2 + (N_2 - 1)S_2^2 + \dots + (N_K - 1)S_K^2}{N_1 + N_2 + \dots + N_K - K}$$

And:
$$S^2_B = \frac{\sum N_1 \bar{X}_1^2 - (\sum N_1 \bar{X}_1)^2 / N}{K - 1}$$

Rejection Region: Reject if "F" is greater than the tabulated value for α d.f.1 = (k-1) and d.f.2 = (N₁+N₂+...+N_K-K)

APPENDIX C3

Statistical "t" Test

The "t" Test is a test to compare two sample means of the same population. It replaces the normal distribution "Z" Test when sample sizes are small ($N_1 + N_2 < 30$).

As for large samples, the most logical decision maker to test the hypothesis $(\mu_1 - \mu_2) = 0$ is based on the difference in the sample means, $(\bar{X}_1 - \bar{X}_2)$, based on independent random samples of N_1 and N_2 observations, respectively, from the two populations. If the sample difference is too far away from $(\mu_1 - \mu_2) = 0$, we reject the null hypothesis. The rejection area is roughly more than two standard deviations of the probability distribution for $\bar{X}_1 - \bar{X}_2$.

Null hypothesis: $(\mu_1 - \mu_2) = 0$

Alternative hypothesis: $(\mu_1 - \mu_2) \neq 0$

Test Statistic: $t = \frac{\bar{X}_1 - \bar{X}_2}{S \sqrt{1/N_1 + 1/N_2}}$

$$S \sqrt{1/N_1 + 1/N_2}$$

for $\alpha = .05$, $df = N_1 + N_2 - 2$

APPENDIX D. FIGURES.

1. Series 1 Shallow Wells - April 78.
2. Series 1 Shallow Wells - July 78.
3. Series 1 Shallow Wells - October 78.
4. Series 1 Shallow Wells - January 79.
5. Series 1 Deep Wells - April 78.
6. Series 1 Deep Wells - July 78.
7. Series 1 Deep Wells - October 78.
8. Series 1 Deep Wells - January 79.
9. Series 2 Wells - July 78.
10. Series 2 Wells - October 78.
11. Series 2 Wells - January 79.
12. Series 2 Wells - April 79.

FIGURE 1
SERIES I SHALLOW WELLS
APRIL '78 WATER LEVELS

SCALE: 1" = 100'

WATER
 MONITORING
 WELLS

ENVIRONMENTAL
 LAB

WEATHER
 STATION

-17-

FIGURE 2
SERIES I SHALLOW WELLS
JULY '78 WATER LEVELS

SCALE: 1" = 100'

WATER
MONITORING
WELLS

ENVIRONMENTAL
LAB

WEATHER
STATION

6664.5

• DRY

• W-28B
NO DATA

• DRY

• 6675.5

• 6665.5

• DRY
• 6677.4

• W-62
6677.9

NO DATA

• NO DATA
• NO DATA

NO DATA

6678.4

W-21
6678.0

6672.6

• W-61
6685.1

6673.5

• NO DATA
• NO DATA

OFFICES
WAREHOUSE
SHOP

RECREATION
HALL

HOUSING

25.5

FIGURE 4
SERIES I SHALLOW WELLS
JANUARY '79 WATER
LEVELS

FIGURE 6
SERIES I DEEP WELLS
JULY '78 WATER LEVELS

SCALE: 1" = 100'

FIGURE 8
SERIES I DEEP WELLS
JANUARY '79 WATER LEVELS

SCALE: 1" = 100'

WATER
MONITORING
WELLS

ENVIRONMENTAL
LAB

FIGURE 9
SERIES II WELLS
JULY '78 WATER LEVELS

GEOKINETICS INC.

KG

SCALE: 1" = 100'

FIGURE 10
SERIES II WELLS
OCTOBER '78 WATER LEVELS

GEOKINETICS INC.

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(N)

FIGURE II
SERIES II WELLS
JANUARY '79 WATER LEVELS

GEOKINETICS INC.

KG

SCALE: 1" = 100'

FIGURE 12
SERIES II WELLS
APRIL '79 WATER LEVELS

GEOKINETICS INC.

KG

SCALE: 1" = 100'